ASSIST – Assessment and Evaluation Tools for Telemedicine

Telemedicine assessment framework

Theories and methods applied to telemedicine assessment

Final draft – 13 September 2012

Document information

Project title

ASSIST -Assessment and Evaluation Tools for Telemedicine

ESA contract no

23001/09/NL/AF

ESA technical officer

Francesco Feliciani

Organisation responsible for the deliverable

empirica – Gesellschaft für Kommunikations und Technologieforschung mbH, Bonn, Germany

Authors

Reinhard Hammerschmidt, empirica

Tom Jones, empirica

Delivery date: 13 September 2012

Dissemination level

x	P	Public
	C	Confidential, only for members of the consortium and ESA

Version history

Version	Date	Changes made	By	Sent to
V1.0	13.09.2012	Version for publication	RH	website

Statement of originality

This deliverable contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both.

Table of Contents

1 Introduction

Ammenwerth and de Keizer [1] note that evaluation of health information systems and services has to deal with a multitude of heterogeneous variables, like actors (the people), the artefacts (the technology), the environment in which it is implemented as well as with their interactions - plus, most importantly, the outputs and outcomes. One could also say that telemedicine has medical, technical, psycho-social, organisational, business and societal aspects. Assessing telemedicine means to incorporate all these aspects. The research of Ammenwerth [1] on the evaluation methods of 1,035 studies in health information systems shows that there is a huge bandwidth of evaluation methods, but many, if not most, are not suitable to deal with a comprehensive, holistic evaluation of a telemedicine service as they have numerous methodological shortcomings. To avoid and address these shortcomings a full evaluation of the outcomes and impacts of a telemedicine service needs to fulfil the following requirements:

The purpose of assessment

An assessment should always be the answer to a specific question and designed to fit this purpose. In real live the development of telemedicine services goes through various iterations including numerous decisions determining the direction and finally success of a telemedicine service. Several evaluation approaches such as health technology assessment (HTA) focus on the health systems perspective trying to answer the question *if* a technology should be used by a health service or reimbursed by insurances. There is another perspective stepping in earlier, which is taken by the ASSIST assessment framework, focusing on the development and improvement and asking *how* a service can be made sustainable. Within the context of improvement there are numerous other questions to answer so whether colour vitality is good enough for example. For a comprehensive, impartial assessment, however, medical or technical aspects will need to be judged by the impact they cause on a stakeholder in the context of the real implementation environment. The outputs of the technical system alone may or may not have an impact.

Benefits and Costs

The assessment framework must be able to identify and account for a change of “utility” or benefits for the stakeholders in a positive as well as a negative direction. Several methods only account for positive, beneficial changes which neglect that newly introduced systems and processes come at a cost. Neglecting costs is especially problematic if the stakeholder receiving the benefit is not the same who has to bear the costs. We call this benefit shift. These benefit shifts are an important reason for system failure. In essence it is the sum of costs and benefits, i.e. the net-benefit, that an assessment method needs to determine.

In addition, several assessment frameworks, especially financial ones, do not account for intangible benefits, because they are difficult to measure. In our opinion this is not a good reason for excluding them. As some studies prove there are a number of methods that help to estimate intangible benefits like the willingness to pay approach [2]. Further to this tangible costs and benefits are not as easy to measure as their quantitative, monetary metric might suggest. Often costs labelled with the same name can include highly varying concepts. A good example is staff costs. Does the calculation account for part time employees, does it include or exclude organisational overheads and social security contributions. Measured over a period of time and what to do with changes in the meantime?

The difficulties of measurement bring us to the need for testing rigour.

Objectivity and validity

In social sciences there are four commonly applied quality tests a method should pass [3]:

- Construct validity: establishing correct operational measures for the concepts being studied
- Internal validity: establishing a causal relationship, whereby certain conditions are shown to lead to other conditions, as distinguished from spurious relationships
- External validity: establishing the domain to which a study's findings can be generalized
- Reliability: demonstrating that the operations of a study – such as the data collection procedure – can be repeated, with the same results.

These basic principles are important and should be applied. However there will remain a degree of uncertainty and failure, if a method is built upon several input variables and these input variables are taken from a number of sources using various methods. Therefore an assessment framework needs to provide provision to test the rigour of its results and account for the uncertainty necessarily included, e.g. by carrying out sensitivity analysis.

Evaluations have a known tendency to understate costs and overstate benefits. This tendency increases where the basis of estimation relies more on judgement than facts and where the person delivering the estimate has an incentive to overstate performance. The UK Green Book[4] calls this optimism bias and proposes to adjust it by decreasing benefits and increasing costs. An assessment framework should provide means to counter optimism bias.

Sustainability: ex-ante assessment, business modelling, affordability, risk assessment

Sustainability is a major concern for telemedicine projects and their funders. Christopher Gordon describes sustainability as referring to "the ability to continue any given activity into the future within the likely existing resources of an organisation, as part of its ongoing budgetary and management processes"[5]. In the context of assessment, **a service model for telemedicine is sustainable when it provides organisations with this above described ability to continue activities**. Therefore sustainability cannot be regarded as something static. It requires an ongoing process that adapts the service to changing environmental conditions like new technological trends, behaviour of competitors in the market and changes to regulations or customer requirements.

In the overall policy context of the eHealth market, sustainability of a telemedicine service would also imply the ability of providing the service over the long run and without the active support of research funds or subsidies restricted in their duration.

From this definition we draw four requirements to telemedicine assessment:

- The method must be able to assess the history of a service and to project its future.
- A projection requires a service model on which assumptions can be based. This also implies a corporate strategy and the development of a business plan.
- An appraisal must assess the affordability of an undertaking, which means that the needed amount of cash, and cash flow is available and net returns also take into account the cost of financing (e.g. the interest rate of a bank loan).
- The method should provide means to assess risks, e.g. those of market development assumptions, competitor behaviour etc.

Multiple stakeholders

Most of the published evaluation studies focus on assessing the impact of telemedicine on a single stakeholder. Assessment can differ widely dependent on the point of view from which it is performed. Telemedicine related analyses make no exception. A study showed that patients benefited extensively from an eHealth application, but that the healthcare provider was the main entity to finance the eHealth investment [6]. While this is not consistent with a normal market setting where the main beneficiaries tend to pay, it is nevertheless a common constellation in healthcare. Here the situation is often one in which private benefits (to the investor) do not provide a sufficient incentive for investment, but social benefits (to all stakeholders) do. So this is to be reflected in the assessment method by ensuring that all stakeholders' perspectives are being analysed. The assessing party will learn which stakeholder gain and

which lose. It then has a basis to tackle veto players in adapting the implementation strategy e.g. by changing the business model.

Health system, market and operational environment

The assessment method needs to account for the environment of a telemedicine service at different levels. A telemedicine service cannot be assessed in isolation of the organisation it is implemented in. This **operational environment**, i.e. its organisational structures and cultures, has a crucial influence on the adoption and benefits of a telemedicine solution. “It is obvious that successful governance models are based on the culture and organisational structure of the hospital” [7]. Apparently, “strong leadership support for realising potential efficiency gains” and a “structure supporting free flow of information” are preconditions for successful implementation [8].

The respective national or regional **health system** sets important framework conditions. Especially the effect of payment mechanisms on the distribution of financial and non-financial benefits needs to be taken into account. Generally, the payment system affects affordability and can lead to insufficient financial incentives for investment. “Under certain payment mechanisms, some reported benefits can’t be realised by providers, or they may even suffer a financial loss in adopting EHRs” [9].

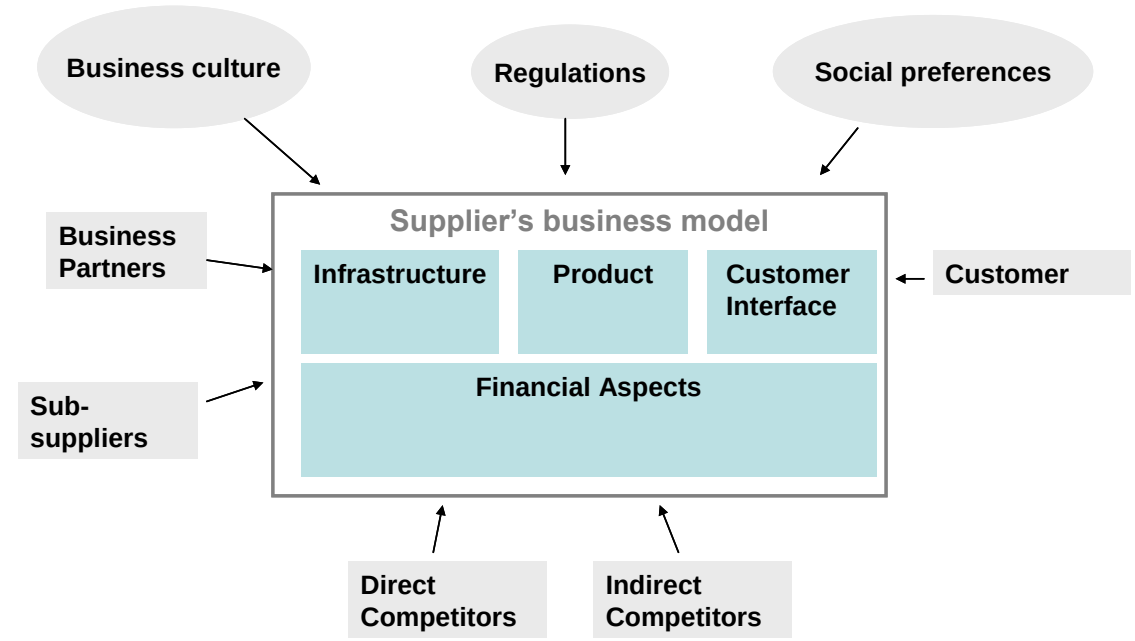
The market environment - particularly the structure of the economic sector/industry – sets the conditions for successfully acting in the market. In economics, the concept of a market means any structure that allows buyers and sellers to exchange goods, services and information. The market environment is a strongly limiting factor to business strategies and inter alia determines the profitability of a venture [10, 11]. The market environment consists of

- business partners and value system pre-suppliers,
- the individual and social preferences, buying power etc. of customers,
- direct and indirect competitors,
- laws and regulations for the respective sector,
- financial markets and the banking system
- and the power of policy institutions to regulate the market, particularly competition.

This set of conditions is different from industry to industry and from nation to nation. This is especially true in the healthcare sector where a lot of regulations exist. In many countries or regions health service provision is a government duty. Such markets have only one customers (a monopsony) leading to very specific conditions.

For the assessment framework this means that it needs to depict the value system/ the value chain which maybe different from service to service.

Figure 1 - The market environment



© empirica 2008

Some methods explicitly exclude the environment from their measurements, in order to be able to come up with widely generalisable, externally valid results. But this severely limits the usefulness of their outcomes in any specific business situation. In our opinion the environment is such an important condition to be reflected when assessing the sustainability of any telemedicine service that it must not be excluded. This however means that the result cannot be strictly generalised beyond the respective environment considered.

Time dimension

Most products or services undergo a specific life cycle from the first idea to routine use, and finally they are supplanted by another more appropriate or new service [12]. Important stages in the early phase of development are pilots which are often funded by research agencies or industry. This market validation phase is ideally followed by a scale up to a routine service. This life cycle has two implications: Firstly it means that values such as the number of users are not fixed but vary over time. Secondly for the assessment to be meaningful, it needs a forward looking, formative evaluation to allow for course correcting actions to be taken. This refers to the general aim of addressing improvement as has been elaborated above.

Comparability of measures and options

Decision making requires the discussion of options that might not be comparable at first sight like comparing a task done by a nurse to that transferred to an IT system. The assessment method we are looking for needs to make those options comparable.

Multi-factor analysis

An assessment of telemedicine needs a holistic approach to be able to cover its multi faceted character. Technical and functional performance as well as integration into healthcare information systems are, however, not values by its own. They are indirectly valued by the users and also preferably measured in this way.

Conciseness of model

Conciseness is another important requirement of the assessment method especially because the ASSIST assessment framework shall not target mainly at trained health economists but project leader who should be brought in a position to self assesses their service. Thus the framework needs to be reasonable complex to cover all the requirements listed here in a sufficient way, but it also needs to reduce the number of input data and output measure so that:

- Data provision is possible for stakeholders themselves in a pragmatic way. The figures asked for need to be available in the organisation or easily gathered. Otherwise data will be reported incompletely or wrongly.
- Also the output measures need to be balanced between easy to grasp and complex enough to deal with that multi-faceted topic.

The method has to weigh between the two risks to a model: over-simplification and over-complexity.

Applicability to telemedicine & space technology

Telemedicine is a term applied to a range of activities and services. The common theme is a medical activity supported over a distance, yet this can be a very heterogeneous field. Thus the assessment framework needs to account for the widest possible set of telemedicine applications in the widest possible types of healthcare settings, including primary, secondary and tertiary care, and civilian, commercial, custodial, military and disaster recovery activities. A possible approach to reduce the complexity is the guiding principle of the classification of telemedicine applications into domains of similar nature.

The method review conducted shows that assessment methods that have previously been successfully applied to space based telemedicine have advantages over more general approaches for investment in the public sector, because they have developed some context-specific measures.

1.1 This document

Chapter two of this report is devoted to the detailed presentation of the ASSIST assessment framework. Based on the existing experience the chapter addresses the theoretical foundations of the framework, the proposed evaluation model structure with its four basic components qualitative analysis, data input, quantitative analysis and performance measures.

This document is the output of a project funded by the European Space Agency. It documents the state of work at the end of the project. Further work is envisaged and input to this is welcomed.

2 Evaluation framework

The aim to support the transition from projects to routine, sustainable services requires the ASSIST assessment framework to account for both, telemedicine services in general, and those making use of space assets in particular. The framework was designed to be generic as far as possible to be applicable to a variety of services potentially also from other domains such as Energy. The tool and its current instantiation however were designed to accurately fit *healthcare organisation to healthcare organisation* telemedicine services as well as *patient/informal carer to healthcare organisation* telemedicine. Developed on these specific domain examples, the methodology and model should be suitable for adaptation to other telemedicine domains. Still after finalising the ASSIST project there is some room for improvement of both assessment framework and tool. The assessment framework reflects the status of debate in the scientific community. The study team will contribute to this debate in areas which seem to need further thought especially what regards the inclusion of intangible benefits.

The following sections elaborate on the details of the ASSIST assessment framework, utilising the existing experience based on a literature review and detailed analysis of 16 assessment frameworks [13], building on insights from cooperation with validation sites, and drawing from the study team's experience in evaluating past and current projects.

2.1 Building on methods used in existing methodologies

A review of 16 different telemedicine evaluation initiatives concluded that none of the existing frameworks is readily suitable for the purposes of the ASSIST project [1, 13-23]. All lack some elements, sub-methods or techniques that make them usable for the purpose at hand. Nevertheless, the state-of-the-art provided a good starting point for developing a framework that meets the needs of the evaluation of impacts in telemedicine. The generic eHealth IMPACT/EHR IMPACT evaluation methodology was identified as the best starting point for developing the telemedicine evaluation model and its associated tools [24]. This methodology does not cover all requirements of a rigorous, fit for purpose methodology addressing all subtleties of the requirements formulated above, but it has proved to deliver impartial results due to its application in several eHealth cases and was therefore thought to provide a good foundation.

2.2 Theoretical foundations of proposed methodology

In order to "provide clear, relevant and impartial information to be used for evidence-based decision making concerning the possible migration of the services developed by telemedicine projects into real operational undertakings"[25], the methodology has two features. One is an objective, impartial assessment of the impact and potential of project-generated services. The other is a meaningful comparison of future potential between different options. These two features give evidence-based support to *if* and, more importantly, *how* to proceed with post-pilot implementation and how to modify the planned service to render it (more) successful.

The theoretical foundation of the ASSIST methodology is *value theory*, and in particular, the concept of value added. Value added in economics is the additional value resulting from transformations of factors of production into a ready product. At its simplest, it is the difference between the value of a product

and the aggregate value of its individual components provided by other participants in the value system. Over the last decade, value added has been a widely used approach supporting investment decision making.

In the context of a holistic ASSIST assessment, the effects and outcomes of a telemedicine service can be defined as value-added to society, either in part or as a whole, by implementing and using telemedicine services. This standpoint, called the social planner's perspective, encompasses the impacts to all affected actors and is consistent with the recommendations of the Hanover Consensus [26]. The value-added equals the total value of a health service provided with the support of telemedicine less the total value of a health service provided without this kind of support.

value added from telemedicine = value of health service with telemedicine – value of health service without telemedicine

This societal perspective includes all stakeholders and aggregates their respective gains and losses, or benefits and costs. Positive effects, or benefits, create value, negative effects, or costs, occur when value is reduced. The total value added is the sum of positive and negative 'value added', which is also referred to as net benefit.

This societal perspective can be disaggregated into the benefits and costs of each stakeholder group. Furthermore, what may be a benefit to one group may be a cost to another group, and in the aggregate some of them may cancel out. The analysis must expose these shifts in value in order to provide a reasonable account of the impact of telemedicine to individual stakeholders as well as society as a whole. Beyond this, an integrated health services system may have *emergent* characteristics, which lead to benefits in the aggregate. For example, shared access to comprehensive patient data facilitated by an integrated healthcare information system cannot be reaped by individual stakeholders alone.

Cost benefit analysis (CBA) is the approach for turning these theoretical foundations into a pragmatic evaluation tool [24]. Among others the UK Treasury's Green Book [4], Germany's WiBe [27] and the White House Office of Management and Budget [28] specify the CBA methodology as an appropriate tool for analysing the impact of investments and activities in domains of public interest, including healthcare. CBA enables the impact on all stakeholders to be included in a socio-economic evaluation, over the selected timescales, and the identification of the narrower financial components within the costs and benefits, also for individual stakeholder groups. These subsets can include the data used for Cost Analysis (CA), Cost Effectiveness Analysis (CEA) and Cost Utility Analysis (CUA). CBA is in general the more comprehensive concept with the challenge, however, of monetarising the benefits.

Due to it being imbedded into a concrete health system environment, any telemedicine project evaluation has to rely on a bespoke analysis with two start points. One is developing an understanding of the healthcare needs, diagnostic, clinical, healthcare and organisational setting in which a telemedicine service operates. When the evaluation is performed by project and programme managers, this part can be assumed as given. The other is identifying relevant impacts over time, based on an initial hypothesis about the expected and aimed for impacts. Within this second part, the qualitative analysis builds up to a quantitative valuation of each indicator by assigning monetary values to it.

The result of such an assessment, the net impact presented in monetary units, complies with the two highly desirable conditions of absolute assessment outcome and comparability between options. The latter is given by a direct comparison of net impact values. In this way, CBA leads to a clear information base for final decision making, which can be retraced and, if deemed necessary, modified by the decision maker with own estimates.

2.3 The evaluation model

The evaluation model defines the structure of the tool for estimating the costs and benefits of a telemedicine project over time. The time horizon starts from the point in time when first investments

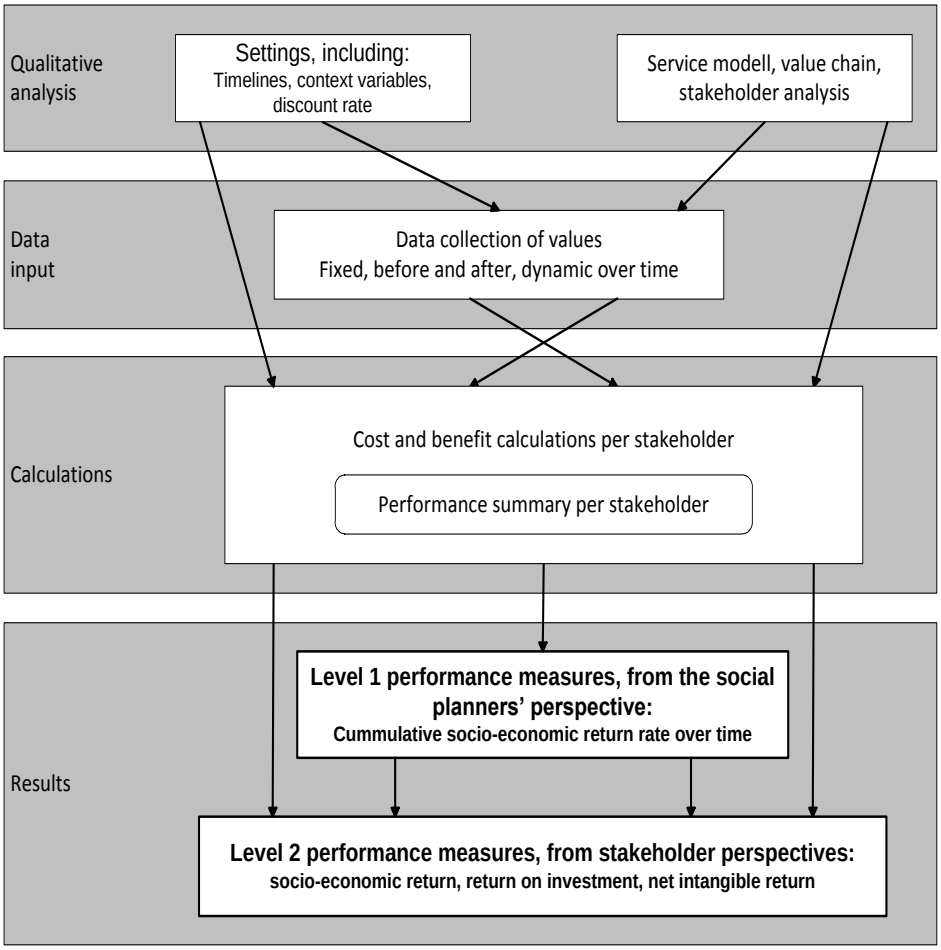
have been made to the project and the way care has been conducted began to change. It extends into the future, in order to help project managers with decisions on further investment.

2.3.1 Structure

The evaluation model follows four subsequent steps as shown in Figure 1:

- Qualitative analysis, defining the scope and context of the evaluation
- Quantitative data input
- Calculations of estimated costs, benefits, and net benefits over time, including summary analyses for each stakeholder group
- Results summary and analyses presentation

Figure 2: Structure of the ASSIST evaluation model



Source: © empirica 2012

The first step in the ASSIST methodology is defining the scope and context of the evaluation. This includes setting basic boundaries of timing, health system setting, discount factors, and the enabling or obstructing influence of the regulatory environment. The stakeholders and their relation to each other in the form of a value chain and service model are an important perquisite and defining feature of the qualitative assessment. It sets the number and type of stakeholders to be accounted for.

The second step involves the collection and input of data, which later feed all calculations in the model. Data input includes the patient population, staffing, unit costs, monetary values, and assumption schedules used for estimates where actual data is not available. For the two domains of telemedicine a

pre-defined set of indicators is available that can be utilised depending on the context and stakeholder analyses inputs. Chapter **Fehler! Verweisquelle konnte nicht gefunden werden.** in this document deals with more details on the topic of measurement indicators and procedures.

The third part of the model draws from all previous information available. The value of costs and benefits is calculated using combinations of data separately for each stakeholder group. The calculations include adjustments for contingencies, and discounting. Data are assigned to one of three types of impacts: financial, resource or intangible impacts.

The final step of the assessment is the calculation of performance measures, which are intended for decision support and as basis for corrective action. The data allows getting overviews of the overall socio-economic performance and sub-analyses of the performance in aggregate and for each stakeholder, as described in section 2.7. The aim is to help decision makers identify affordability aspects, financial and other risks, and point of highest impact.

The following sections provide more detailed information about each of the four levels of the ASSIST assessment framework. The descriptions are guiding the reader through the logic of the model from the user's perspective, where the four stages of the methodology are addressed chronologically.

2.4 Qualitative analysis

The qualitative analysis of the service in question and its environment is critical. Many benefits, as well as negative impacts, are triggered or reduced by external factors and internal characteristics.

2.4.1 Context of the telemedicine service and scope of analysis

An essential perspective for any telemedicine project is an understanding of the healthcare and organisational settings and therewith the service as well as business model. It defines the users and other stakeholders of the service and the technical functionality to be developed. These altogether also define the evaluation scope.

Healthcare systems usually have specific, national regional and local features. The extent to which a service is, or can be integrated into the healthcare system has an impact on the probability of successful long-term service provision. Understanding the organisational background helps to identify the investment motives and development path of the project, as well as to identify relevant users and other stakeholders. Embedding a telemedicine system in the healthcare setting is creating an ICT supported service. The ICT systems technical and functional performance like video frame rates or colour fidelity may be pivotal for the usability and sustainability of the solution. Without an integrated service model, however, it is not sufficiently described to be assessed.

For analytical soundness, the ASSIST assessment framework leaves out tertiary impacts. Secondary impacts are only indirectly generated based on primary impacts and necessarily each level of impacts would add uncertainty to an order of magnitude. In addition, it would be difficult to define a clear relation between cause and effect. An example may be freed staff time, a secondary effect that became available due to more effective care, the primary cause. The question now is what to do with the freed staff time? Itcan be used to lay off staff, take over other tasks or reduce cues or allow compensating staff shortage. What will be done with the time we would call a tertiary order impact and leave out on the quantitative side. It will, however, be a necessary part of the qualitative evaluation to address these. Even more indirect effects like the level of employment in a sector of the economy are thinkable but even more doubtful to relate to the cause.

The qualitative analysis has to identify process changes, including different and new workflows, clinical practices, and working patterns. *These lay the basis for revealing positive and negative effects from*

using the telemedicine systems. At the next level of assessment, all of these factors, like users' reactions, both objective signs of behavioural change and subjective opinions, play a significant role in assessing and assigning quantitative benefits and costs.

The ASSIST tool, developed on the basis of this framework, serves the purpose of guiding the evaluator through defining the scope and context and then identifying the relevant impacts to all stakeholders. As said elsewhere, "information system modelling is organisation modelling" [29] and thus, defining the settings of the telemedicine service is critical to the evaluation. Partly the tool supports users to adjust and fine-tune the tool settings in terms of relevant actors and the occurrence, or not, of predefined impacts.

2.4.2 Stakeholder analysis

The *stakeholder analysis* involves a precise analysis of the actual people and organisations affected by the telemedicine service. This is critical for ensuring a holistic approach to evaluation. An important part is the identification of potential *veto-players* who can, through their political or organisational power, stop an initiative, as well as driving players, who have an intrinsic interest in conversion of pilot applications into routine services. Stakeholders not necessarily need to be active agents in the service. They may also be affected by changes caused through the telemedicine service like a shift from hospital care to primary care resulting in fewer admissions to the hospital.

The ASSIST assessment framework provides a structure for the stakeholder analysis. The team has identified five high-level stakeholder groups with several subgroups. A stakeholder group has a common role and related to this a common set of indicators to measure impacts on this group. The ASSIST tool provides the possibility to individualise the set of stakeholder groups and subgroups as fit for the specific case. This includes the expansion of the tool to different small stakeholder groups within the predefined categories. For example, the healthcare staff involved in a telemedicine service can include different types of doctors, nurses, therapists, and other professionals. The assessment framework defines the need to pay attention to healthcare staff as separate stakeholder groups, but the evaluator will have to identify how many these groups are, and what types of professionals they involve. The stakeholder groups and subgroups pre-defined in the assessment are described below.

2.4.2.1 Individuals

Individuals include two subgroups – patients and informal carers.

Patients

Patients can be chronically or acutely ill, or both. They may need interventions, may be subject to interventions, or have just completed interventions and need monitoring. They may be active participants of a service or cases in a therapy. Patients may also be healthy people at relatively high risk of becoming ill. A healthy elderly person with a family history of heart diseases, who decides to join a home monitoring programme on prevention grounds, falls under the stakeholder group 'patients'. So does a soldier injured in a military action. Patients are usually expected to benefit from telemedicine services. Benefits include the patient's valuation of the service expressed as better health status, fewer and more effective intervention and better quality of life. On the other hand, some business models require patients to become more active in their own care or pay for the service, which could be perceived as a negative impact.

Sometimes it is meaningful to subdivide the group of patients in more specific groups. For example, if telemedicine is for patients with diabetes, you may need to identify the numbers of type 1 and type 2 patients. You may want to classify them by types of complication, such as ophthalmic, renal, neurological and circulatory, or by insulin dependent or non-insulin dependent. Physicians should define a classification that is relevant for effects expected from the telemedicine service for the patients as well as their efforts with these different groups of patients.

Informal carers

Informal carers are usually family members, neighbours, colleagues, or friends who provide care to patients for free. They can be affected by changes in the care delivery processes, as some of their task may become obsolete or may have to be altered or replaced by other roles.

2.4.2.2 Health Provider Organisations (HPOs) and staff

Health provider organisations include all kinds of professional care service providers, from classical primary care practices, secondary care hospitals, through social care services at home or in a nursing home. HPOs are in the core of most service and business models for telemedicine services.

HPOs employ healthcare professionals, and pay for some of the other resources needed for healthcare too, such as drugs, clinics, outpatient facilities and other hospital facilities such as theatres and pharmacies. They also receive income from patients, governments, health insurers and other third parties. Telemedicine services may change some of these cash flows.

Some HPOs pay for telemedicine equipment, installing it, maintaining it and training people to use it. Hospitals may lose income when patients avoid admissions or stay for fewer days. They may increase their income from more outpatient appointments. These cash flows usually change over time.

HPOs are business entities or in another way independent entities. ASSIST differentiates between for-profit and not-for-profit entities. Not-for-profit entities have a lower discount rate.

Tele service centres

Tele service centres provide healthcare services. Most telemedicine services include an entity that takes this role. They can be part of a bigger entity like a hospital. For the purposes of telemedicine service assessment and the importance of tele service provision in the service models, the centre should be separate for analytical purposes and handled as a business unit even if this is currently not the case.

In most centres, qualified nurses and physicians provide advice to patients. In this way the tele service centre can also be differentiated from telemedicine supplier, which only provides technical and organisational support but no medical services.

Primary care organisations

Primary care organisations include single practices of general practitioners (GPs), group practices, or larger primary care centres.

Specialist care organisations

These include the provision of secondary services outside of hospitals. In some countries, cardiologists, dermatologists, and other specialists run their own surgery, or join forces in a group practice for a particular speciality. Military medical units can be included in this group, both in non-combative and conflict and war roles.

Hospitals

Hospitals are the conventional secondary and tertiary care organisations, but can also include civilian and military rehabilitation centres. For the purposes of assessing telemedicine services, we must differentiate between inpatient, outpatient, and emergency services. Each type of service can be affected differently by the introduction of routine telemedicine services. The obvious impact theme relates to the volume of work, but other effects like changes in roles and responsibilities must also be taken into account.

Medical transportation services

These include ambulance car services but also medical evacuation and transportation by plane. They can be provided either by a hospital, the air force, or by an independent organisation. There are different types of ambulance services, such as emergency that transfer patients from scene, emergencies that transfer patients between hospitals and first on scene specialists. There are also routine patient transfer services.

Nursing homes

Nursing homes provide living facilities for elderly and fragile people, with on-demand as well as regular nursing services. They can provide nursing care, social care, or both. Nursing homes can be users of telemedicine consultations with GPs or specialists, and can be affected by a change in demand due to telemedicine enabling people to stay at their own home.

Community Nursing Services (CNS)

Community nursing is characterised by patients living at home, who receive regular visits from nurses.

Ccare professionals

In many evaluation methodologies, care staff are only regarded as employees in the social care systems. However, they can be powerful drivers or veto-players as individuals. Ultimately, they are direct users and providers of telemedicine services and thus the sustainability of an initiative depends on their acceptance and endorsement of the new model of care. The group includes all doctors, nurses, therapists, military medical personnel, social care workers, and support staff. They are employed by an HPO. Their personal attitude towards a telemedicine service depends on the impact it has on their daily activities. Specifically, the perception of whether telemedicine makes their life easier or more difficult has a big impact on job satisfaction, motivation, and finally also their quality of life.

2.4.2.3 Payers

Payers are organisations that manage the financial flows of the health and social care system. Depending on the country, these can be private or public insurance companies, not-for profit funds, local, or national authorities. The distinct feature of payers is that they collect contributions from the population in some form, pool the risk of care need, and reimburse HPOs for care services. The contributions can also be indirect, via the general tax system. Reimbursement to HPOs can also be via budgets.

Healthcare payers

Healthcare payers deal with primary, secondary, tertiary, and military healthcare, and cover the healthcare value chain from prevention, through diagnosis, treatment, and rehabilitation. In some countries, integrated care programmes that go into the realm of home care can be also covered by healthcare payers.

Social care payers

Social care payers usually focus on care for elderly, disabled, and otherwise socially disadvantaged people, who are not necessarily sick. Home monitoring services often address both, health and social care needs, which sometimes leads to uncertainties as of who should be paying.

Social security offices

Social security offices are responsible for the administration of unemployment benefits, including benefits in case of prolonged sick leave. The latter can be relevant for telemedicine, since faster

treatments and more independent living options for chronic patients could impact on the financial burden of the offices.

2.4.2.4 Non-ICT organisations

This stakeholder group is affected by telemedicine, but is usually not directly involved in telemedicine projects.

Pharmaceutical industry

Pharmaceutical companies could observe changes in demand for their products, which can be an effect of implementing telemedicine services. These changes can go either way. The impact is expected to be on the business side of companies, and specifically on the product mix. It should be noted that in order to observe a measurable impact, the scale of telemedicine services and associated changes in drug regimes must be significant.

All employers

This group consist of companies who employ people that are also patients in the service. Regardless of the specific business sector, employers have an interest in a healthy workforce. In some cases, telemedicine can support this by prevention or earlier return to the workplace.

2.4.2.5 ICT industry

The ICT industry has a direct stake in telemedicine services, since ICT vendors are suppliers of the technology needed for gathering and exchange of data. Their interest in telemedicine is on development and selling of products. Other suppliers, internal to larger organisations such as military authorities, also have an interest in telemedicine, as they are often involved in the technology set up and maintenance. The following sub-groups can present both, external vendors and internal departments within organisations, depending on the specific project.

Telecom suppliers

Telecommunication suppliers are responsible for the transfer of data from one place to another. They are not concerned with the content of the data. Telecom suppliers include also SatCom service providers.

Telemedicine suppliers

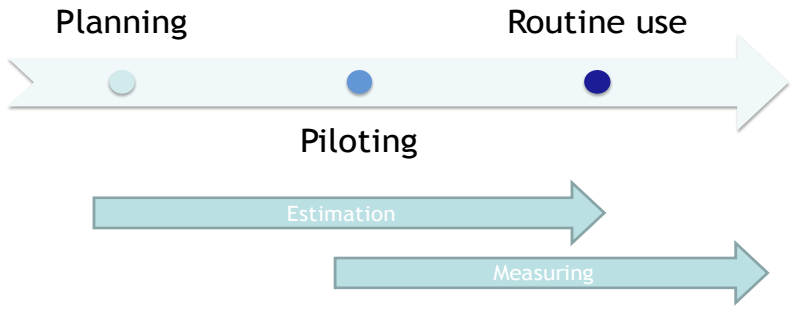
Software suppliers provide the components needed in order to manage the data before and after its transfer. Hardware suppliers distribute devices, from PCs and monitors, to personal health tools like ECG, blood pressure, or glucose measurement sensors. More and more telemedicine supplier's provide an integrated technical service including maintenance, installation and hosting.

2.5 Data input and data collection

This is a brief overview of the types of data required. An indicator usually consists of several data items over the period of assessment. The final indicators can be found in chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**.

ASSIST can be used to assess and evaluate telemedicine services during the planning phase, while setting it up, piloting or trialling it and when it is in routine use. For each phase, estimates of data will be needed. The amount of estimation reduces as implementation and scale up progresses. However some effects especially clinical impacts are difficult to measure and effort for accurate measurement is high.

Therefore it is acceptable to partly rely on estimates also while in routine use. In chapter 2.6.2 we explain how the ASSIST assessment framework deals with these unavoidable uncertainties.



The preferable source of data are healthcare provider and telemedicine service organisations. They can provide data from their routine services. Where such data does not exist, estimation by evaluators will be necessary. Information on monetary values of all relevant costs and benefits is seldom readily available from HPOs, because their statistical and financial records usually do not record these routinely. The evaluators will need to survey this data for each individual assessment.

Monetary values

Monetary values of costs and benefits will usually be estimated at constant prices over the whole investment life-cycle of design and development, engagement, testing, implementation, operation and change. All values will be based on prices for the year of evaluation and for the country in which the service is provided. Only in countries where inflation is a major concern and would considerably bias these data, inflation-adjusted data can be used. Empirical evidence has shown that in recent years, inflation was not a major concern in most countries, and slight adjustments will have virtually no effect on outcomes. VAT should be deducted from prices where possible.

Resources

Estimates of all stakeholders' involvement will rely on estimations of the *time* allocated to these activities. Professionals' time redeployed from other activities and additional costs, such as new project teams are examples. Redeployed time for health provider organisations is monetarized based on the salary of employees per working time.

Intangible impacts

Estimating the monetary value of intangibles impacts applies several techniques. Revealed preference is used to estimate time savings of citizens. An average salary is used as a proxy here.

For the valuation of the service a stated preference approach was used. Due to the character of ASSIST as a self assessment tool, willingness to pay could not be used as it needs a trained scientist to set up a negotiation interview. Instead of that we assigned monetary values to a valuation questionnaire. Xxxexplain WTP tool

2.5.1 Data collection

Data collection can be a chapter in its own and the issues related to data collection will only be roughly touched here. In principal all data can be used in an analysis ranging from best guess to data from clinical trials. The better the validity of the data the more valid will be the final results of an ASSIST analysis.

Some appropriate metrics can be found in organisations' archives and information systems. These include some clinical data and statistics, telemedicine service utilisation statistics, workload statistics, changes in capital and operational expenditure, and prices.

Some costs and most benefits have to rely on estimates and assumptions. Ideally, assessments should perform detailed observational studies to establish precise changes in clinical practices, time allocations to tasks or quality of care. However, given temporal and budgetary constraints, semi-structured interviews can provide both, qualitative conclusions and some of the information needed to make estimates and assumptions needed for quantifying the impact [3, 30].

Interviews are recommended as the primary information gathering technique, only complemented by distributing detailed questionnaires. The latter can be too rigid, leaving little room for elaboration to gain knowledge on the background, context, motivations, drivers, and the eventual impact of individual initiatives [3]. Fully structured questionnaires offer limited scope to capture spontaneous reactions or subtle affinities, or reluctance by stakeholders, and are resource-intensive. Qualitative methods using semi-structured group interviews offer scope to seek consistent information and to reflect specific healthcare settings, such as changes to clinical and working practices. They are also fruitful and open enough to elucidate stakeholders' perspectives, to cover a wide range of opinions and the strength of opinions held [31]. Thus the process of evaluation is often as insightful as the eventual results and project and programme managers should utilise on this opportunity.

When making a decision on the use of interviews and surveys, evaluators should take into account the risks of over-simplification and over-complexity. The multi-faceted character of telemedicine makes this domain in general very complex, which means that each area has many options. This makes standardised surveys very elaborate and difficult to construct. A huge number of options need to be narrowed down to the option applicable to the specific case. As the assessments will involve innovative projects, there will always be the problem that the project team has found a new way of doing things, which is not reflected in a rigid questionnaire. To put it the other way around: We can only construct a questionnaire for issues we known about. Trying to deal with all aspects makes a data gathering instrument rigid and over-complicated. Over-simplifying would not cover enough details about the particular telemedicine service.

Even data from supposedly very rigorous methods like clinical trials can deliver misleading results when for example the subjects haven't been selected with special care e.g. an unbalanced distribution of degrees of severity of the illness. In addition pilots are often conducted in centres of excellence that anyhow deliver a high standard of care and motivated and skilled patients tend to participate in clinical trials.

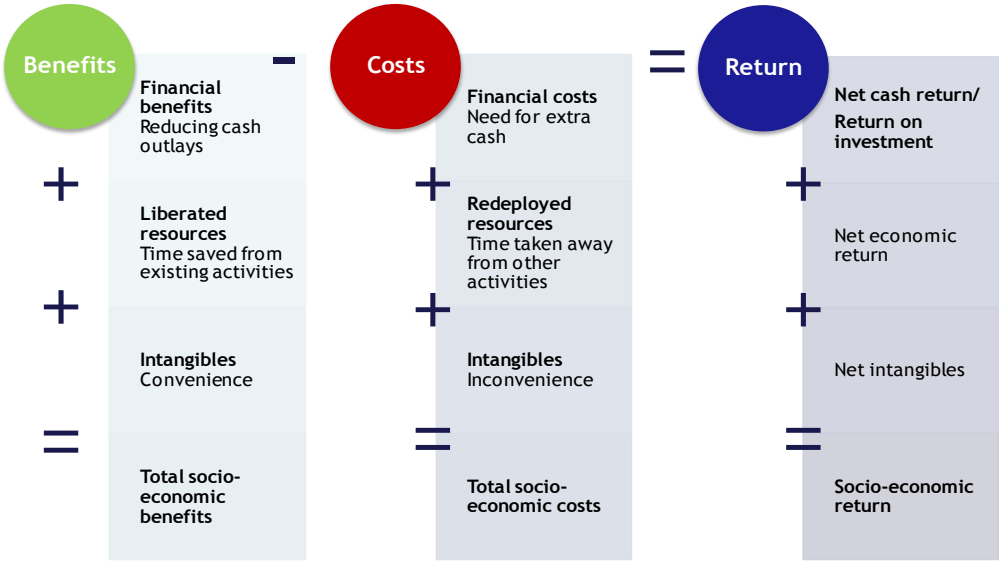
What seems to be more important than actual validity of the data is making transparent the level of validity and the connected variance of results. Validity of data should be improved iteratively depending on their influence on the end results. In chapter 2.6.2 we further explore the reliance of ASSIST on distributions.

2.6 Quantitative analysis – calculations

The quantitative analysis in the assessment methodology reflects and builds on the qualitative work done before. The generic model allows for a variety of impact indicators to be included. These factors affect both benefit and cost estimates. This multi-factor approach ensures that the assessment provides a comprehensive measure of the performance and potential of telemedicine services.

2.6.1 Mathematics

The mathematics behind the ASSIST assessment framework allows the conversion of data and qualitative insights into a quantitative, monetary set of results that can guide decision-making.



At the most basic level, the analysis is founded on individual indicators *j* for benefits, b_j^k and costs, c_j^k. These can be of three categories: financial, redeployed and liberated resources, and intangible impacts. The mark $k = \{f, r, i\}$ indicates the respective category of the benefit or cost indicator.

$k = f$ denotes purely ***financial***, or cash impacts. These are benefits and costs that are part of cash flows. An example is fees for services of any kind.

$k = r$ denotes indicators for benefits and costs representing redeployable factors of production, such as time and other ***resources*** that do not directly affect accounting reports and individuals' purses. An example is saved time of professionals working in a hospital, which they can redeploy to other tasks. Redeployable resources can be converted into, or drawn from, cash streams, but this requires managerial decisions and often organisational change.

$k = i$ presents benefits and costs of ***intangible***, social nature, which are purely non-financial impacts. An example is increased work-satisfaction of employees.

The sets of permanent values, $p = (p^1, p^2, p^3, ...)$, and of time series values $s_t = (s_t^1, s_t^2, s_t^3, ...)$, provide the basis for calculating the monetary value of each benefit indicator b_i^k and each cost indicator c_j^k. The monetary values are functions of the variables p and s for the relevant year of calculation (*t*), and the contingency factor *σ*:

$$b_j^k(t) = f_j(s_t, p, \sigma) \quad (1)$$

$$c_j^k(t) = g_j(s_t, p, \sigma) \quad (2)$$

Evaluations can use a consistent methodology, but the models need constructing for each case to reflect their specific settings. Specific functions are created for each individual indicator. The evaluator defines the time period in which a specific impact indicator is applicable to the project at hand. The extent to which the indicator applies to a particular evaluation depends on the setting. This is at the level of cost and benefit calculations of the model. There are several techniques for estimating a particular benefit or cost indicator [32, 33]. Examples of such techniques include:

- Time changes of citizens relying on estimates of the value of time.
- Changes in travel costs relying on estimates of travel costs.
- Changes of time or numbers of medical procedures can be estimated from unit cost calculations.
- Quality gains can be better-informed patients, timeliness of care, effectiveness of care, patient safety and streamlined care. Some of these can be estimated using unit cost calculations, such as avoided hospital admissions.

- Intangible benefits, such as the value to patients and organisations, rely on stakeholder behaviour (revealed preference) or stated preference.

For the cost side, an illustration is the costs to citizens for providing consent, a cost that can occur in many instances related to storage and transmission of personal data. Citizens who wish their data to be shared across healthcare providers have to give their explicit informed consent at registration. This is a purely non-financial effort of category *k=soc* facing every registered patient once. A proxy for the value of this effort is the time it takes to collect information and provide the consent. The time is either precisely measured, or estimated by healthcare staff providing the detailed information and answering any questions. For this illustration, an average time estimate is 5 minutes per patient. This applies to all new registrations in the relevant year, since we focus on the registration consent, provided only once. Let us assume that 200,000 patients register with the system for a given year. In reality, this number is from the internal statistics of each site team. The final variable is the monetary value of time. Given that the target population is the average citizen, an appropriate proxy for the monetary value of time is average income. A reasonable value is €20 per hour. Each evaluation researches incomes to reflect the actual levels. In order to complete the cost function in its clearest form, we have to assign a contingency factor. Taking an adjustment of 10% means a factor σ of 1.1. This gives the following cost function for the effort by citizens to provide up-front, one-off, informed consent for registration, for year t, in which 200,000 new patients are registered:

$$c^{i}_{patientconsent}(t) =$$

(time for consent in hours) x (number of patients in year t) x (average hourly income) x (contingency factor) =

(5/60) x 200,000 x 20 x 1.1 =

€366,667 (3)

The number 366,667 in this case is just a monetary representation of the estimated value of the required effort, not a financial outlay for patients and therewith belongs to the category of intangible costs, or category $k = i$. As already stressed, the value is a proxy, and as such only an estimate.

Other functions can be much simpler and precise. A simple example is given by straight reductions in costs per patient, where the introduction of a telemedicine system improves the financial position of a healthcare provider and/or a third party payer. This benefit factor, to be reported by internal studies within the organisation, is a tangible, financial impact and thus of category $k = f$. The corresponding benefit function for a particular year is the annual extra cash saved multiplied by the respective contingency factor.

The value of Annual Benefit (AB) in year t of each category k is defined as the sum of the individual benefit b^k indicators, as shown by equation 4. The value of Annual Costs (AC) of each category k is derived correspondingly, depicted by equation 5. For *n* benefit indicators and *m* cost indicators, the annual benefit and cost for category k are:

$$AB^k = \sum_{i=1}^{n} b_i^k(t) \quad (4)$$

$$AC^k = \sum_{j=1}^{m} c_j^k(t) \quad (5)$$

The Present Value (PV) of the Annual Benefit for category k in year *t* of the initiative is the sum of the individual benefit indicators for category k discounted by the discount rate *r*. Equation 6 shows the mathematical representation:

$$\text{PV of AB}^k = (1+r)^{-(t-\alpha)} \sum_{i=1}^{n} b_i^k(t) = (1+r)^{(\alpha-t)} \sum_{i=1}^{n} b_i^k(t) \quad (6)$$

Because the base year for discounting is the year of evaluation, say 2010, an additional variable (α) denotes the time to this year. α becomes negative when estimating future performance. The cost discounting works in the same way. Equation 7 shows the present value of the annual Net Benefit (NB) of category k in year *t*, which is the discounted difference between the annual benefit and annual cost:

$$\text{PV of annual NB}^k = (1+r)^{(\alpha-t)}\left(\sum_{i=1}^{n} b_i^k\ (t) - \sum_{j=1}^{m} c_j^k(t)\right) \tag{7}$$

The PV of the cumulative net benefit, or the Net Present Value (NPV) of category k of the service, is the sum of discounted annual net benefits of each year, up to year *T*, the end of the horizon. The mathematical function is shown by equation 8:

$$\text{NPV}^k = \sum_{t=0}^{T}\left[(1+r)^{(\alpha-t)}\left(\sum_{i=1}^{n} b_i^k(t) - \sum_{j=1}^{m} c_j^k(t)\right)\right] \tag{8}$$

Written out, the NPV of the three categories *financial*, *redeployable* and *intangible* are illustrated by equations 9 to 11:

$$\text{Cash NPV} = \sum_{t=0}^{T}\left[(1+r)^{(\alpha-t)}\left(\sum_{i=1}^{n} b_i^f(t) - \sum_{j=1}^{m} c_j^f(t)\right)\right] \tag{9}$$

$$\text{Redeployable NPV} = \sum_{t=0}^{T}\left[(1+r)^{(\alpha-t)}\left(\sum_{i=1}^{n} b_i^r(t) - \sum_{j=1}^{m} c_j^r(t)\right)\right] \tag{10}$$

$$\text{Social NPV} = \sum_{t=0}^{T}\left[(1+r)^{(\alpha-t)}\left(\sum_{i=1}^{n} b_i^i(t) - \sum_{j=1}^{m} c_j^i(t)\right)\right] \tag{11}$$

The economic net benefit is defined as the sum of financial and redeployable economic resources. Using the discounted values, this effectively means adding equations 9 and 10:

$$\text{Economic NPV} = \text{Cash NPV} + \text{Redeployable NPV}$$

$$= \sum_{t=0}^{T}\left[(1+r)^{(\alpha-t)}\left(\sum_{i=1}^{n} b_i^f(t) + \sum_{i=1}^{n} b_i^r(t) - \sum_{j=1}^{m} c_j^f(t) - \sum_{j=1}^{m} c_j^r(t)\right)\right] \tag{12}$$

The socio-economic impact consists of all three categories, adding the social dimension to the economic one. In a discounted form, this means adding equations 11 and 12:

$$\text{Socio-Economic NPV} = \text{Economic NPV} + \text{Social NPV}$$

$$= \left[(1+r)^{(\alpha-t)}\left(\sum_{i=1}^{n} b_i^f(t) + \sum_{i=1}^{n} b_i^r(t) + \sum_{i=1}^{n} b_i^i(t) - \sum_{j=1}^{m} c_j^f(t) - \sum_{j=1}^{m} c_j^r(t) - \sum_{j=1}^{m} c_j^i(t)\right)\right] \tag{13}$$

Equations 14 and 15 deal with calculations of return rates. First, the Economic Return on Investment (ROI) is defined in equation 14. It involves both economic indicator categories, $k = cash$ and $k = redp$. The economic ROI is comparable to a traditional return from an investment, say in a conventional business project, yet does not require the step of converting redeployable resources into cash. It is calculated as follows:

$$\text{Proxy economic ROI} = \frac{\sum_{t=0}^{T}\left[(1+r)^{(\alpha-t)}\left(\sum_{i=1}^{n} b_i^f(t) + \sum_{i=1}^{n} b_i^r(t) - \sum_{j=1}^{m} c_j^f(t) - \sum_{j=1}^{m} c_j^r(t)\right)\right]}{\sum_{t=0}^{T}\left[(1+r)^{(\alpha-t)}\left(\sum_{j=1}^{m} c_j^f(t) + \sum_{j=1}^{m} c_j^r(t)\right)\right]} \quad (14)$$

In the final step, equation 15 calculates the Socio-Economic Return (SER) of the investment, which is the ratio of discounted cumulative net benefits and cumulative costs:

$$\text{SER} = \frac{\left[(1+r)^{(\alpha-t)}\left(\sum_{i=1}^{n} b_i^f(t) + \sum_{i=1}^{n} b_i^r(t) + \sum_{i=1}^{n} b_i^i(t) - \sum_{j=1}^{m} c_j^f(t) - \sum_{j=1}^{m} c_j^r(t) - \sum_{j=1}^{m} c_j^i(t)\right)\right]}{\sum_{t=0}^{T}\left[(1+r)^{(\alpha-t)}\left(\sum_{j=1}^{m} c_j^f(t) + \sum_{j=1}^{m} c_j^r(t) + \sum_{j=1}^{m} c_j^i(t)\right)\right]} \quad (15)$$

The SER is the primary and most comprehensive performance parameter used for assessment of eHealth investments in ASSIST. It provides a comprehensive measure of value for money, accounting for all social and economic impacts in relation to the costs associated with those impacts.[1] Sub-analysis, such as the rate of return (ROI) in purely economic terms or cash flow impacts for business entities follow the same logic as presented above, albeit with a narrower range of cost and benefit indicators, mainly derived from accounting definitions and linked to the entities' investment. For such analyses, equations 4 and 5 include only economic factors of production or only financial factors, respectively.

This presentation provides the basic concepts behind the mathematics of the ASSIST assessment framework.

Discounting

Discounting is a common economic concept reflecting an individual's preference to have money or resources now to employ them and gain value from them as opposed to later. Whether some intangible benefits should be discounted is a matter of debate, as the utility of health is perceived different from those of money or products. Until further clarity is reached we follow the advice by Drummond to do so, which means that all indicator are discounted in the same way [18].

The ASSIST assessment framework discounts positive and negative impacts to net present values. The base year is the first year of analysis. The default discount rate can be set at 3.5%, reflecting an average factor of current official rates found across Europe [34]. The ASSIST tool allows evaluator to adjust this rate. The default discount rate is a social time preference rate. For investment decisions one would expect a higher rate similar to corporate bonds. ASSIST differentiates between for-profit and not-for-profit stakeholders. Not-for-profit stakeholders are calculated with the social time preference rate.

2.6.2 Uncertainties in evaluation

There are several ways of dealing with uncertainties in evaluation. ASSIST offers two instruments dealing with uncertainties: contingencies and a sensitivity analysis using Monte Carlo.

Uncertainties come into evaluation because impacts were forgotten, are unclear or difficult to address. VAT is an example that is difficult to address. Another aspect is uncertainty in estimations or measurements. Optimism bias is an example that occurs in projects when future costs and benefits need to be estimated. It is a "demonstrated, systematic tendency for project appraiser to be overly optimistic" [4].

[1] For more detail on the advantages of SER and the diferences to ROI, see section 3.7 below.

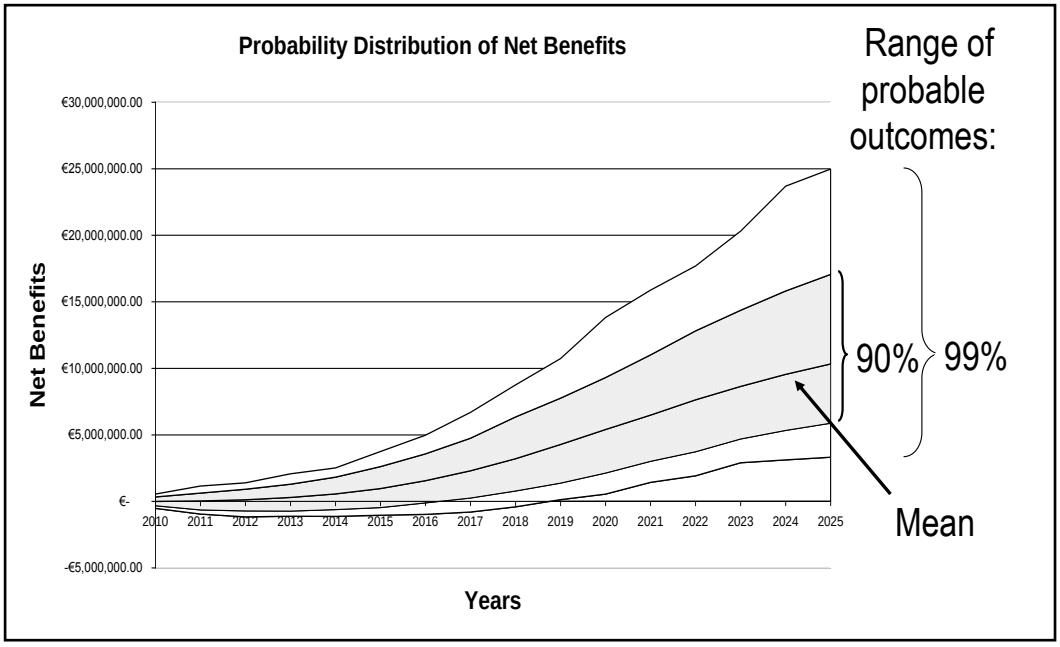
Contingencies

The evaluation techniques presented above provide baseline estimations of costs and benefits. Contingency adjustments reflect the reliance on estimation. They increase costs and reduce benefits. Contingencies can be as high as 70% for some baseline monetary values. The model has a default value for each group of impact factors, which can be adjusted if necessary.

Probability, variance and Monte Carlo

Interpreting the outcomes of the evaluations should rely on their order of magnitude, not their absolute values. For this reason, the model makes use of Bayesian probabilities, which interpret the concept of probability as "a measure of a state of knowledge", in contrast to interpreting it as a frequency or a physical property of a system[35, 36]. In combination with repeated random sampling following Monte-Carlo simulation methods, the result is assessment outcomes in the form of ranges. The predictive power of a range is larger than the power of a specific point within that range. The presentation is illustrated in figure 2.

Figure 3: Example of a range-based assessment outcome



Source: empirica 2009

The illustrative fan-chart would suggest that the costs of the project will certainly be exceeded by the benefits. The curve of the mean impact can serve as a guide, but certainty is given only by the range. Adjusting input values can allow project managers to identify actions within their power, which shift the range in the desired direction.

2.7 Performance measures

The proposed methodology provides a concise, but limited answer to a specific question like whether it is worth to continue investing. It can also be used as a powerful tool that supports decision makers in their long-term visions, as well as project and programme managers in the guidance of running projects. Performance measures are shown in the form of charts presenting various performance factors over time. The selection of performance indicators was guided by two primary questions from the perspective of decision makers:

- Is it worth going ahead with the project, and daring the step to routine service provision?
- What needs to be changed in order to succeed in going ahead?

Addressing these two questions ensures sustainability of future developments in running and emerging projects. The second question applies equally to the point of decision on what to do after a project and to various decision points during the lifetime of development and implementation projects. In the latter case, these questions can be the fundamental part of regular check points, potentially triggering changes in the direction of activities and their ultimate actual SER.

The measures that need monitoring are of two levels. The first level provides the big picture, taking the perspective of the social planner. The concept of the social planner has its roots in welfare economics and refers to a hypothetic decision-maker who attempts to achieve the best result in sum. Thus, **level 1 performance measures include aggregate parameters for society as a whole**, pointing to potentially unsustainable developments. Level 1 measures focus on the following three types of parameters:

- Socio-economic return (SER)
- Economic return on investment (economic ROI)
- Cash flow

The details are discussed on section 2.7.1 below.

The second level of performance measures provides more details on specific impacts and helps identify points of high positive impact as well as potential affordability gaps for individual stakeholders. **Level 2 performance measures address individual point of view of key stakeholder groups and sub-groups.** These measures allow decision makers to identify causes of potential challenges identified by the analysis of level 1 measures, and thus initiate corrective action. The indicators at this level are:

- SER for each stakeholder
- Economic ROI for each stakeholder
- Cash flow for each stakeholder

2.7.1 Level 1 performance measures

Level 1 performance measures are the highest level of results presentation, summarising the performance along the three indicators SER, ROI, and cash flow over time. -.

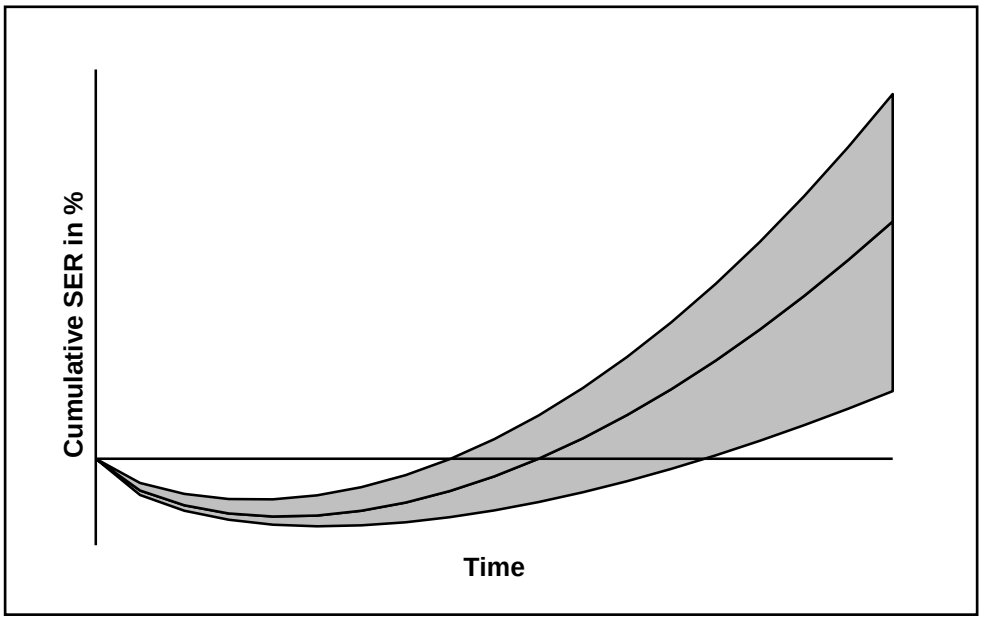
Socio-economic return

The SER is defined as the ratio of net benefit to costs over time. This measure comprises all positive and negative impacts, including financial and other economic resources, tangible changes in quality of life and work, as well as intangible, often emotional impacts. A positive ratio indicates a worthwhile endeavour from a socio-economic perspective. A ratio of zero equals an implicit break-even point at which the overall socio-economic impact is zero. The SER measure serves two main purposes. First, it is a comprehensive measure of all socio-economic factors, including non-economic indicators. This enables a comparison between the economic ROI performance and the socio-economic impact (SER) of an investment. Secondly, the SER measure, presented in percentages, allows different investment options to be compared on their relative return, rather than on the absolute values of impact. The advantage of using return rates instead of absolute values is illustrated by the following example. If one investment is expected to achieve cumulative net benefit of €200 million over a certain period, and another is returning €250 million over the same period, the absolute values would suggest choosing the second investment. However, this may be a sub-optimal choice. The first investment may bring €450 million worth of benefits at the cost of €250 million, while the second option needs €500 million in order to realise €750 million of benefit value. The SERs are 80% and 50% respectively. Despite the lower absolute value of net benefits, society is better off with the first option, as it gets better value for money. Another reason to present the socio-economic impact as a rate is to avoid confusion between the monetary value of social impacts and actual financial effects. The presentation of net socio-economic benefits in

monetary units, such as Euro, has led to misinterpretation of results and respective overoptimistic expectations regarding the financial return of eHealth investments, including telemedicine initiatives.

The first chart presents the cumulative SER over time, depicting the trends and making explicit how long it takes to achieve a positive return. As already noted, the SER is shown in a range, reflecting possible uncertainties in the input variables of the model.

Figure 4 - Illustration of aggregate cumulative SER of an investment



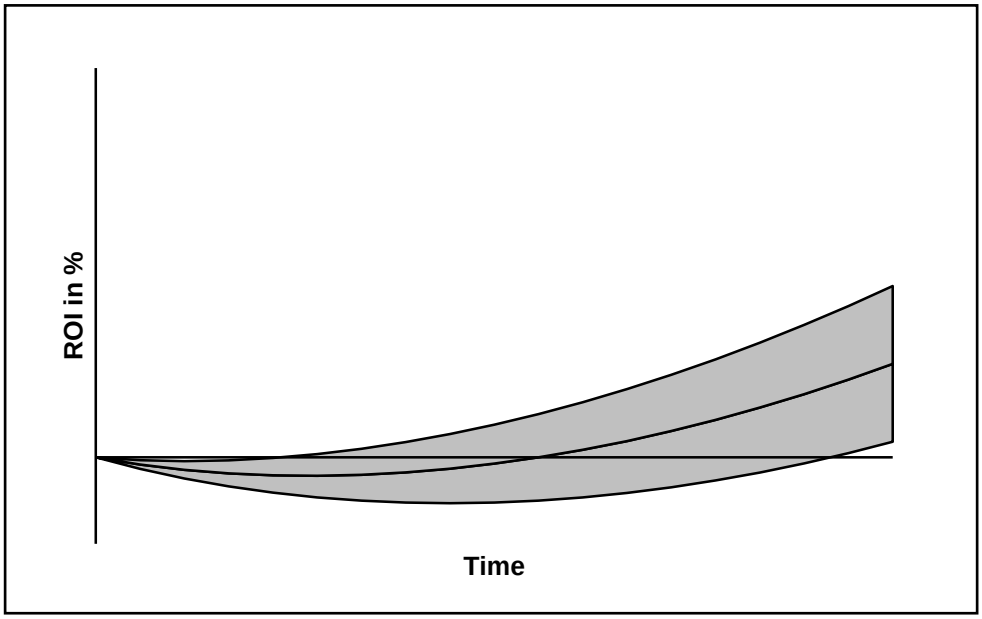
Source: empirica 2010

Positive SER is a necessary, however not sufficient, condition for long term sustainability of services.

Economic return on investment

The ROI measure includes only economic resources, traditionally defined as land, labour, and capital. In many instances, such as staff time and expenditure on technology, the value of resources is the opportunity cost. The resources could be employed for other purposes, if not used for telemedicine services. However, the realisation of the potential ROI into returns reflected in accounting reports is a challenging managerial task. For example, when eight doctors save one hour a day each, resource at the value of one full time equivalent (FTE) is liberated. The decision whether to dismiss one doctor, or assign other tasks to all doctors is separate from the value of benefit observed. The economic ROI would include a gain of one FTE regardless of how the liberated resource is used.

Chart 1: Illustration of aggregate economic ROI of an investment



Source: empirica 2010

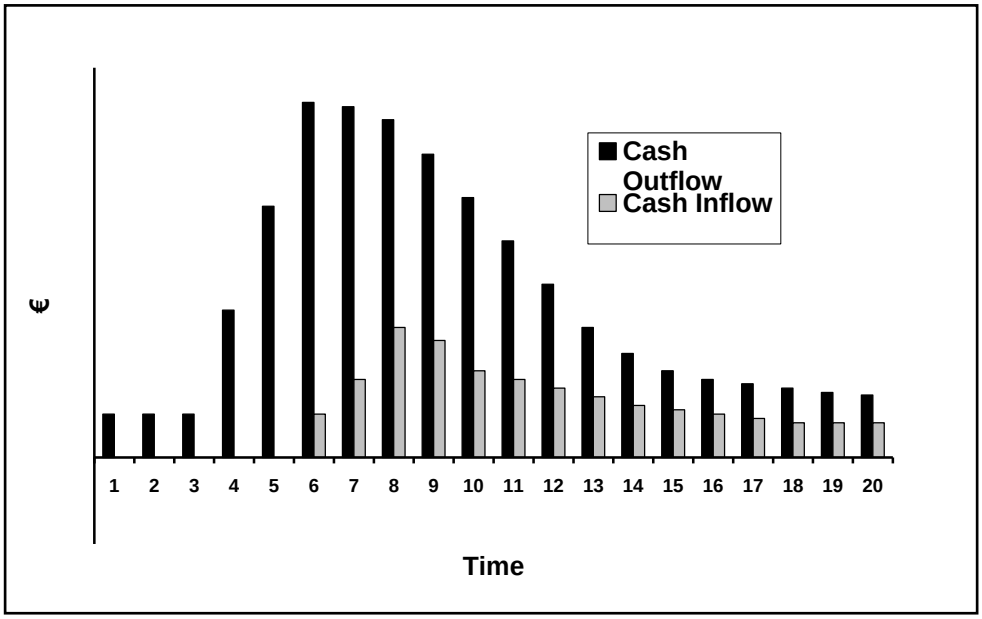
In contrast to the SER position, ROI is expected to take longer to be realised, as many benefits from telemedicine are intangible and non-economic. While the ROI is very important for organisations, especially those without a social mandate, individuals do not necessarily need an economic return in order to support an initiative. In many cases, individuals are prepared to invest economic values, such as money and time, in order to receive intangible benefits, such as comfort, health, and general wellbeing. While these latter benefits are accounted for in the ***socio*-economic parameter of SER**, they are not part of the **purely economic concept of ROI**.

The ROI measure is important mainly for general managers responsible for organisations. It defines the conditions for the business cases of private and public organisations.

Cash flow

Cash flow refers to the purely financial impacts of implementing telemedicine services. A positive net return reflects the generation of extra cash, which is sufficient to cover the required cash outlays. The more common position is one where the analysis identifies how much money needs financing and when. An illustrative aggregate performance is shown in Chart 5, depicting both cash inflow (benefits) and outflow (costs) for each period.

Chart 2: Illustration of aggregate cash flow impact



Source: empirica 2010

The cash flow analysis is the foundation for assessing affordability of investments. However, stakeholders are affected differently with respect to cash, and in many cases expenditures of one stakeholder is income to another. This may cancel out in the aggregate view of level 1 performance measures but be visible in level 2 performance.

Therefore the high level view is not sufficient for decision making, so managers will have to focus on the second level performance indicators in order to understand the details and the need for action.

2.7.2 Level 2 performance measures

At the second level, the measures become more detailed and allow more specific identification of adjustment requirements and adjustment options. The presentation of results includes six sets of charts and tables:

- Cumulative SER for each stakeholder
- Cumulative ROI for each stakeholder
- Annual cash flow for each stakeholder
- High impact benefits are the positive impacts

The first three sets are set in the same format as described above for the high-level performance indicators.

High impact benefits are the positive impacts that contribute the most to the overall performance. With view of transferring pilot projects into routine services, these benefits reveal the value proposition in the business model. High impact costs are those cost items that have a significant effect on the bottom line return measures.. A sensitivity analysis should identify the respective impact indicators of highest weight. The ASSIST tool provides the weight for each indicator. High impact on performance is associated with high risk. On the negative side, these costs must be controlled tightly, as overruns would endanger the whole project. On the gains side, when high impact benefits are not realised the net performance is at risk. Thus, the sensitivity analysis of the models facilitates the identification of risk factors and the mitigation of overall risk.

Glossary and abbreviations

AB: annual benefit

AC: annual costs

A&E: accident & emergencies

Assets: these are rights or other access to future economic benefits controlled by an entity as a result of past transactions or events. Software can be included with hardware as an asset

ASSIST: project by empirica, Telbios and IRER on assessment and evaluation tools for telemedicine funded by the ESA

Benefits: the monetary value of the gains in an accounting period from an investment of resources in productive services. Benefits can be tangible, and determined by price or transactions, or intangible, when shadow prices may be used to used to estimate monetary values. Benefits from eHealth can accrue to several stakeholders, including patients, carers, citizens, healthcare professionals, healthcare organisations and third party payers

Capital expenditure: expenditure on a project that has a benefit to an entity for more than one of its accounting periods. An example is a one-off expenditure to set up a large computer or communications facility that is expected to operate for five years before it needs to be replaced

Cash flow: the amount of money either paid out or received by an entity in an accounting period, or group of accounting periods, and either for capital items or annual operating activities. Cash flow is often classified as payments and receipts

CBA: cost-benefit analysis

CNS: community nursing services

Cost: the monetary value of the resources sacrificed in an accounting period to realise benefits and revenue from productive services. Costs can be tangible, and determined by price or transactions, or intangible, when shadow prices may be used to used to estimate monetary value. Costs of eHealth can incurred by several stakeholders, including patients, carers, citizens, healthcare professionals, healthcare organisations and third party payers

Depreciation: the measure of the cost or revalued amount of the economic benefits of tangible fixed assets consumed during an accounting period. Capital expenditure and the value of leases excluding interest payments, are usually depreciated each year of the useful life of the associated assets to reflect its use in each accounting period, and so their reduced value at the end of each accounting period. Depreciation is an item of costs

Desk research: as opposed to field research literature and internet research are used to gain information on a specific topic

ECG: abbreviation for electrocardiogram and electrocardiograph

Expenditure: the amount of money spent in an accounting period, and related to the activities in the accounting period, or a group of accounting periods, usually the financial year of the entity. Examples are the salaries paid to staff and / or annual licence fees paid to eHealth suppliers for the use of their software. This type of expenditure is also referred to as revenue expenditure, distinguishing it from capital expenditure like buying a new building

Revenue: the amount of money received in an accounting period, and related to the sales or activities in the accounting period, or a group of accounting periods, usually the financial year of the entity. It should not be confused with revenue expenditure. An example is the money received for services provided to patients

Impact factors: impact is a neutral description of an effect. It does not judge on the direction of impact which can be, positive as well as negative

Investment: expenditure on an activity, or project, to achieve a return over its proposed life-cycle, such as expenditure on an eHealth application and change management to achieve an improvement in healthcare quality, access or efficiency. It is often comprised of items of capital expenditure, and can also include additional or re-allocated revenue expenditure. An example is an eHealth project that includes the expenditure on hardware, software and changing the clinical and working practices needed to realise the benefits

Discounting: estimated values of costs and benefits of an activity or project are adjusted using an interest rate that reflects a typical return that can be achieved from a business, service activity or public service. It is the technique by which monetary values from different points in time are converted into comparable measures at the time of analysis. Usually, it is absolute monetary values in the future that are reduced in order to show their present value, reflecting the opportunity cost of time, mainly interest, utility from consumption now instead of later. Discounting is particularly important in evaluating long-term investments where the benefits arise much after the point of investment expenditure. It also enables costs of projects with different life cycles to be compared

eHealth investment profile: the capital and revenue expenditure curve over the life-cycle of a proposed eHealth investment to include planning and development, implementation and operation

eHealth IMPACT: study for the European Commission on the economic impact of eHealth

eHealth utilisation: measures of the use of eHealth by an appropriate unit of activity, such as the number of active users, the number of transactions, or the number of live records

EHR IMPACT: study for the European Commission on the economic impact of electronic health records and ePrescribing systems

ESA: European Space Agency

Ex-ante: 'beforehand', 'before the event'. Based on prior assumptions. A forecast

Ex-post: 'afterwards', 'after the event'. Based on knowledge of the past. Measure of past performance

Financial resources: the volume of money from the various sources of finance for an investment, or project. In the context of eHealth, they are used to pay for the resources needed for a project, such as an ICT team, hardware and software, over its timescale

Financing: an arrangement that provides funds to pay for a planned or actual activity, or project. Two settings for the financing eHealth study are financing healthcare and financing eHealth. Providing funds for healthcare is achieved by three generic models, public money, such as from taxation, health insurance, either social or voluntary, or direct payment. Each of these can have many different arrangements, as found in the EU Member States. They all operate by transferring funds from citizens to reimburse healthcare providers, often through third party payers. eHealth financing can be part of reimbursement, or include access to additional funds, and can be seen as an arrangement for pay for eHealth investments, or projects, over their whole life. It can have several phases, such as financing for one-off or non-recurring costs of development, implementation or change management, and financing for continuous investment, such as an increase in annual expenditure on operating the eHealth services. Financing arrangements can have precise arrangements for managing the risks of an investment or project

Funding: the pot, or pots, of money that can be accessed to finance a proposed investment, or project. It will be available from the source of financing, and on the terms agreed for its use

FTE: full time equivalents

GP: general practitioners

Grant: assistance in the form of transfers of cash or assets to an enterprise in return for past or future compliance with certain conditions relating to the operating activities of the enterprise. Revenue and costs should be matched with one another. In many cases, the grant-making body has the right to recover all or part of a grant paid if the enterprise has not complied with the conditions under which the grant was made. IAS 20 Accounting for Government Grants and Disclosure of Government Assistance sets out further explanation

HPO: health provider organisation

ICT – information and communication technology

Inpatient: in most countries an inpatient is defined as a hospital patient who occupies a bed for at least one night in the course of treatment, examination, or observation

Intangible benefits: cf non-financial factors

Market price: an economic concept where the price of a good or service is negotiated between the market participants, such as a buyer and seller

Monetary Value: estimating costs and benefits where prices are not available from commercial transactions. Techniques such as shadow pricing and willingness to pay can used to help in estimating monetary values

Leasing: access to the use of assets through a lease, which is a contract for a specific asset where the ownership of the asset remains with the entity providing the finance for the lease, and the user pays a rental fee for the rights to use the asset. A finance lease transfers most, or all the risks of using the asset to the user, an operating lease can share the risks. IAS 17 Accounting for leases sets out further explanation

Life-cycle costs: the total cost of owning or using facilities, assets or services, expressed as items of capital or revenue expenditure needed for an investment, or project, over its whole time period. For an eHealth project, it can extend from planning, development, implementation and operation, and include expenditure on obsolescence, refreshment, upgrading, and changes to capacity to reflect significant change in utilisation

Liabilities: these are an entities' obligations to transfer economic benefits as a result of past transactions or events

Monetary units: a unit of value and money of a country, esp. the major or standard unit e.g. Euro or Dollar

Monte-Carlo-Simulation: Monte Carlo simulation is a method for iteratively evaluating a deterministic model using sets of random numbers as inputs. This method is often used when the model is complex, nonlinear, or involves more than just a couple uncertain parameters

NB: net benefit is the difference between benefits and costs

NPV: net present value

Net impact: outcome of a CBA or cost-effectiveness study

Non-financial resources of economic value: changes in factors of production like e.g. a reduction in hours spent on a task

Non-financial factors: intangible, often emotional impacts such as quality of life or convenience

Outpatient: opposed to inpatient stays for a day treatment, examination or day case only

Permanent value: a value that is assumed to stay constant during the time scale of the assessment

Performance measures: within ASSIST they are outputs enabling a decision on the whether a telehealth project can be transferred into a fully operational undertaking

PV: present value

QALYs: quality adjusted life years

Real resources: it includes the people who are needed for an activity, or project, the equipment and facilities needed throughout the whole time period of a project

Reliability: demonstrating that the operations of a study – such as the data collection procedure – can be repeated, with the same results. Sensitivity analysis is an important instrument for ensuring reliability

Resource allocation: resource allocation is the distribution of resources – usually financial - among competing groups of people or programs

Risk: this is uncertainty as to the amount of benefits, including potential for gain and exposure to loss.

ROI: economic return on investment (ROI.) The ROI measure includes only economic resources, traditionally defined as land, labour, and capital. In many instances, such as staff time and expenditure on technology, the value of resources is the opportunity cost. The resources could be employed for other purposes. However, the realisation of the potential ROI into returns reflected in accounting reports is a challenging managerial task. For example, when eight doctors save one hour a day each, resource at the value of one full time equivalent is liberated. The decision whether to dismiss one doctor, or assign other tasks to all doctors is separate from the value of benefit observed. The economic ROI would include a gain of one FTE regardless of how the liberated resource is used. The ROI measure is important mainly for general managers responsible for organisations. It defines the conditions for the business cases of private and public organisations

SER: socio-economic return (SER). The SER is defined as the ratio of net benefit to costs over time. This measure comprises all positive and negative impacts, including financial and other economic resources, tangible changes in quality of life and work, as well as intangible, often emotional impacts. A positive ratio indicates a worthwhile endeavour from a socio-economic perspective. A ratio of zero equals an implicit break-even point at which the overall socio-economic impact is zero

Social planner: takes an idealised perspective aiming at maximising value for society as a whole

Sources of financing: various types of arrangements that can be available to pay for the costs of an investment, or project, over its whole life. Examples include an increase in spending on eHealth by the entity, an increase in the budget for an internal ICT team to pay for an eHealth development or change management costs; arrangements with banks and institutions to pay for the additional capital or revenue expenditure of a project, such as the European Investment Bank (EIB), leasing arrangements and eHealth suppliers that provide services for an annual fee that includes development and capital expenditure spread over the life of a contract where the payments are classified as revenue expenditure

Stakeholder: individuals and organisations that are actively involved or passively affected by a telemedicine service, e.g. patients, healthcare staff in different care organisations, third party payers, management organisations, health authorities, technology and telecommunications providers, servicing companies

Telemedicine: a term applied to a range of activities and services with a common theme of a medical activity supported over a distance. Here it is used also for telehealth and telemonitoring as well as for doctor to doctor telemedicine

Time series value: a value that is assumed to vary substantially over the time horizon of the assessment.

Unit costs: the calculated cost of a given unit of a product, often using a costing model

Validity: establishing correct operational measures for the concepts being studied

Validity, internal establishing a causal relationship, whereby certain conditions are shown to lead to other conditions, as distinguished from spurious relationships

Validity, external: establishing the domain to which a study's findings can be generalized

Value added: the amount of the net benefits, so benefits minus costs, usually of a proposed project or investment, over a specified time, and often measured by cost benefit analysis and discounted to a net present value. It can be used to identify an optimal option available to an entity. Examples are where the estimated benefits to patients and healthcare providers from an eHealth project exceed its estimated costs over the project's investment life-cycle

Veto-players: who can, through their political or organisational power, stop an initiative, as well as drive it, and who have an intrinsic interest in conversion of pilot applications into routine services

WTP: willingness to pay, an economic concept for estimating monetary values for which no market price exists

Bibliography

1. Ammenwerth, E. and N. de Keizer, *An inventory of evaluation studies of information technology in health care: trends in evaluation research 1982-2002.* Stud Health Technol Inform, 2004. **107**(Pt 2): p. 1289-94.
2. Olsen, J.A. and R. Smith *Who Have Been Asked to Value What? A Review of 54 'Willingness-to-Pay' Surveys in Health Care*. 1999.
3. Yin, R.K., *Case study research - design and methods*. Applied Social Research Methods Series2003: Thousand Oaks.
4. UK HM Treasury, *The Green Book - Appraisal and Evaluation in Central Government*, 2003, TSO: London.
5. Gordon, C. *LabforCulture Glossary*. [cited 2009 24-02]; Available from: http://www.labforculture.org/en/funding/contents/glossary#50.
6. Jones, T., *E-health - financial and economic case studies*, A.o.C.C.A. (ACCA) and E.C.I.S.D. (EC-ISD), Editors. 2003.
7. Davis, M., *Stage 6 Hospitals: The Journey and the Accomplishments*, 2007, HIMSS Analytics.
8. Garrido, T., et al., *Effect of electronic health records in ambulatory care: retrospective, serial, cross sectional study.* BMJ, 2005. **330**(7491): p. 581.
9. Xu, S., *Advancing return on investment analysis for electronic health record investment. Impacts of payment mechanisms and public returns.* J Healthc Inf Manag, 2007. **21**(4): p. 32-9.
10. Porter, M., *The five competitive forces that shape strategy.* Harvard Business Review, 2008(1): p. 78-93.
11. Porter, M.E. and E.O. Teisberg, *Redefining health care : creating value-based competition on results*2006, Boston, Mass.: Harvard Business School Press. xvii, 506 p.
12. The Lewin Group, *Assessment of Approaches to Evaluating Telemedicine*, 2000, Office of the Assistant Secretary for Planning and Evaluation, US Department of Health and Human Services.
13. ASSIST, *Summary of Telemedicine Evaluation Initiatives*, 2010, empirica: Bonn.
14. Barlow, J., et al., *A systematic review of the benefits of home telecare for frail elderly people and those with long-term conditions.* J Telemed Telecare, 2007. **13**(4): p. 172-9.
15. Benefits Realisation & Achievement International Network, *White paper: measuring benefits in a healthcare context*, 2009.
16. Cusack, C.M., et al., *Health Information Technology Evaluation Toolkit: 2009 Update*, 2009, Agency for Healthcare Research and Quality - U.S. Department of Health and Human Services.
17. Davalos, M.E., et al., *Economic evaluation of telemedicine: review of the literature and research guidelines for benefit-cost analysis.* Telemed J E Health, 2009. **15**(10): p. 933-48.
18. Drummond, M.F., *Methods for the economic evaluation of health care programmes*. 3rd ed. Oxford medical publications2005, Oxford ; New York: Oxford University Press. 368.
19. e-Health Impact. *Study on Economic Impact of e-Health*. [cited 2010 22-03]; Available from: http://www.ehealth-impact.org/.
20. EUnetHTA. *HTA Core Model Handbook*. 2008 [cited 2010 22-03]; Available from: https://fio.stakes.fi/htacore/handbook.html.
21. Kidholm, K., et al., *Framework for ASsessment of Telemedicine - FAST - A framework based on the MethoTelemed project*, 2009.
22. Scott, R.E., et al., *National Telehealth Outcome Indicators Project [NTOIP] - Project Information Document and a Synthesis of Telehealth Outcomes* 2003, Health Telematics Unit, University of Calgary.
23. United States General Accounting Office, *Measuring Performance and Demonstrating Results of Information Technology Investments*, 1998.
24. EHR IMPACT, *Methodology for evaluating the socio-economic impact of interoperable EHR and ePrescribing systems*, 2008: Bonn.
25. European Space Agency, *Statement of Work for the Results Assessment of ESA-sponsored Telemedicine Project*, 2009.
26. von der Schulenburg, J., et al., *Deutsche Empfehlungen zur gesundheits-ökonomischen Evaluation - dritte und aktualisierte Fassung des Hannoveraner Konsens.* Gesundh ökon Qual manag, 2007(12): p. 285-290.
27. Röthig, P., *ICT Investionen begründen - Wirtschaftlichkeitsberechnungen mit dem WiBe-Konzept*, 2009, WiBe: Weimar.
28. White House Office for Management and Budget, *Circular No. A-94 - Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*, 1992.

29. Bott, O., A. Terstappen, and D.P. Pretschner, *Modeling, Simulating, and Visualizing Information System Artifacts in Healthcare - A General Approach to Analysis and Design*, 2000.
30. Westbrook, J.I., et al., *Multimethod evaluation of information and communication technologies in health in the context of wicked problems and sociotechnical theory.* J Am Med Inform Assoc, 2007. **14**(6): p. 746-55.
31. Kuckartz, Z., et al., *Qualitative Evaluation. Der Einstieg in die Praxis*2008, Wiesbaden: VS Verlag für Sozialwissenschaften.
32. Gartner, *eHealth for a Healthier Europe! – opportunities for a better use of healthcare resources*, 2009.
33. Canada Health Infoway, *Diagnostic Imaging Benefits Evaluation*, 2008.
34. Sorenson, C., M. Drummond, and P. Kanavos, *Ensuring value for money in health care - The role of health technology assessment in the European Union*, in *Observatory Studies Series*, European Observatory on Health Systems and Policies, Editor 2008.
35. Jaynes, E., *Probability Theory: The Logic of Science*2003: Cambridge University Press.
36. de Finetti, B., *Theory of probability* Vol. 2. 1974, New York: J. Wiley & Sons, Inc.,.
37. ACCA, *Telecardiology in Italy: benefits from a telemedicine network connecting chronic patients, general practitioners and healthcare provider organisations*, 2006.
38. Scott, R.E., et al., *Telehealth outcomes: a synthesis of the literature and recommendations for outcome indicators.* J Telemed Telecare, 2007. **13 Suppl 2**: p. 1-38.
39. York Health Economics Consortium, *Evaluation of the Telecare Development Programme*, 2009.
40. van Stel, H.F. and E. Buskens, *Comparison of the SF-6D and the EQ-5D in patients with coronary heart disease.* Health Qual Life Outcomes, 2006. **4**: p. 20.
41. Colitta, A. and D. Cianflone, *igeaSAT - Final Report*, 2008.