# Cost analysis of assistive technology

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**Abstract**. The SCAI instrument was designed to help clinicians estimate the economic aspects of the provision of assistive technology (AT) solutions to individual users. Using the instrument involves three steps: 1) describing the objectives of the individual AT programme 2) establishing the sequence and the timing of all the interventions that form the programme and 3) compiling a cost calculation table for each AT solution. The last distinguishes between social costs (the sum of all material and human resources mobilised by the intervention) and the financial plan (the actual disbursement of money over time by all actors involved). The social cost is the main indicator of the economic significance of the AT solution: alternative solutions should be compared in terms of their social cost. The financial plan identifies the expenditure, i.e. the cash that should be dispensed by the funding actors during the programme lifecycle.

The SCAI is not primarily intended as a decision-making tool; it ought to be looked at as an informative tool that adds to clinical assessment so as to make clinicians and users aware of the economic consequences of their decisions.

The article also explores the possibility of using SCAI to compare different individual AT programs. Based on a survey of several individual AT programs carried out over a number of years, an attempt has been made to infer social cost indicators for various categories of AT equipment. The first clear finding is that – not surprisingly – most AT solutions, though very expensive in terms of initial purchase price, lead to considerable savings in social costs due to the reduced assistance burden. The second major finding is the marked variation in the social costs of different individual cases where similar AT solutions were implemented, suggesting difficulty in establishing repeatable social cost figures for a given device: such figures also depend on the individual context of the AT solution, and on its inter-relationship with the other AT solutions composing the whole program.

## 1. Introduction

### *Cost Vs outcome analysis*

Nowadays, there is increasing demand for evidence of the *cost-effectiveness* of assistive technology (AT) products, not only by policy makers and financing agencies, who need such information to properly allocate resources and control how efficiently they are used, but also by health care professionals who are expected – today more so than in the past – to be accountable for the economic implications of their decisions or prescriptions [1] [2] [3] [4] [5]. Indeed, rehabilitation professionals need to know whether their AT choices have proved *effective* within the rehabilitation programme, have been *useful* for the client, and have made *efficient* use of resources [6].

Studies on this issue began to appear in the literature only recently. An article published in 1998 [7] offered a conceptual framework for AT cost-effectiveness analysis, based mainly on the findings of the CERTAIN project "*Cost effective rehabilitation technology through appropriate indicators*", a study partially financed by the European Commission within the TIDE programme - *Technology Initiative for the Disabled and the Elderly* [6]. The article listed a variety of cost and outcome issues stemming from AT cost effectiveness analysis, and reported on experimental work aimed at developing reliable and sensitive tools of measurement. In 2003, another article [8] provided a valuable review of the state-of-the-art of cost-analysis in assistive technology research.

In the last decade, considerable research work on this topic has been carried out in Europe, the US and Canada, and new analysis and measurement instruments have been developed and validated [9]. Such instruments include QUEST [10], IPPA [11], COPM [12], PIADS [13], MPT [14] and SCAI [15] and, although many issues are still open, these instruments are being used increasingly throughout the world.

This article chiefly focuses on *cost*: it presents the latest evolution of a cost analysis instrument – SCAI (Siva Cost Analysis Instrument), whose first release was published in 2001 [15]. The instrument is primarily intended for use in clinical practice for *ex-ante* cost estimates of individual assistive technology programmes. The article describes how the instrument works, and reports a first attempt to extend its use to aggregate the cost analyses of a number of individual cases. The findings appear promising, depicting possible cost trends of some widespread assistive technologies, and are quite informative with regard to the *social cost* of such technologies.

However, *cost analysis* makes sense only in close conjunction with *outcome analysis*. Indeed, for the sake of budget allocation, purely *financial* analyses might make sense independently of the outcome analysis ("how much money should I allocate to purchase the devices needed ?"). Conversely, *economic* analysis ("how many resources should I mobilise, including money, equipment, services, people-time etc… to keep the devices working?") makes sense only in relation to the achieved or expected outcome. In fact, judgement on whether an investment should be considered "high", or "small", depends on how worthy the outcome is considered to be according to the various perspectives (clinical, ethical, social etc).

An appropriate description of *outcome* is very important [16]. People not familiar with disability conditions may have difficulty in grasping the importance of assistive technology, and in understanding why it is worth investing resources in AT provision. In fact, assistive technology does not save lives, nor does it reduce morbidity or remove impairments: in other words it has no tangible impact on the "traditional" variables most people are familiar with. The *ICF model of disablement* [17] helps clarify this issue, and puts the problem into layman terms by clearly explaining how technology – classified by ICF as a contextual factor – can contribute to *reduce disablement* [18]. However, it will take time for the general public to become familiar with the ICF concept that 'disablement' is a *situation a person may encounter* due to the gap between personal limitations and contextual factors, rather than an *intrinsic characteristic of the person involved*.

Today's public opinion tends to see the role of AT as being a means of increasing the *quality of life* of the disabled; indeed it allows such people, their families and their primary networks to achieve a more satisfactory and resourceful lifestyle. However, *quality of life* is an holistic concept that cannot be reduced to a uni-dimensional measure: it is an inner perception that can only be "probed" according to selected dimensions, or making certain assumptions [7].

### *Individual Vs population analysis*

At this point some considerations should be made. First, outcome indicators of AT individual programmes, easily used in *service delivery practices*, are currently available [19]. Such indicators are not themselves powerful enough to embody absolute judgement, but they are useful – when associated with other observations – to detect whether the intended objectives have been achieved or are likely to be achieved, and help pinpoint possible "bugs" *in the product* or *the service delivery process* that could hamper the achievement of such objectives [20].

Secondly, no instruments are yet available to provide comprehensive *outcome* indicators at the population level. Population studies, based for example on cost utility techniques, have so far been carried out only for prosthetic equipment [21], where the outcome can be measured easily in terms of improved functionality. Probably the instrument SCAI (Siva Cost Analysis Instrument), quoted in the previous paragraph and described in detail in the following paragraphs, could also be used for population studies by aggregating the data of individual cases, however little has been done about that.

Third, the priority given to analysing the data at the individual level probably responds to a priority perceived in clinical practice. Indeed clinicians, in their capacity as custodians of AT public expense, are under pressure to account for the choices they make. For instance, the *Guidelines for Rehabilitation Activities* [22] issued by the Italian Ministry of Health require evidence of the *appropriateness of the prescription,* a concept that embodies both clinical significance and cost-effectiveness. It was within this framework that the SCAI instrument was developed, which is why it focuses primarily on *individual cases.* Thus, if SCAI is used in conjunction with the above described *outcome* instruments it allows for *cost effectiveness analysis* at the individual level.

However, a number of questions arise when comparing *cost* (always measured in monetary values) and *effectiveness* (which often cannot be measured in monetary values) [7].

For an economist, the ideal situation is to make use of a method that will evaluate outcome like the method insurance companies use when compensating for damage; such evaluation necessarily involves certain restrictive assumptions typical of the so-called *cost-benefit* analysis (e.g. looking at a person from the sole viewpoint of a taxpayer, a worker, a person exposed to certain risks etc.). Thus, by looking at cost in terms of investment, and outcome in terms of return, the overall balance indicates whether the return on the investment is *positive* or *negative* [6].

However such a restricted perspective is not consistent with an holistic approach. Translating effectiveness into monetary units raises ethical issues with no deterministic answer at either the *societal level* (who is going to judge how much money a one-point-gain in effectiveness is worth?) or the *individual level* (the perception of change is different among individuals). It would be misleading to use cost-benefit analysis as a decision tool in AT selection. Conversely, it makes more sense to analyse costs and effectiveness separately, and use the findings as informative elements to complement clinical experience, common sense and professional ethics.

Armed with the above concept, we will, in the following chapters, describe the rationale and the use of the SCAI instrument at the individual level, and present the findings of its first application to a population study.

# 2. Principles of cost analysis

### *Economical Vs financial analysis*

Before proceeding, the difference between *cost* and *expenditure* needs to be clarified. *Cost* is an *economic* concept, which refers to the use of resources, while, conversely, *expenditure* is a *financial* concept that refers to the flow of money [6] [7] [8].

Economists treat resources independently of whether they correspond, or not, to the actual disbursement of money. In fact, money is just a virtual entity established by society: its relationship with resources depends on market mechanisms, political processes, the cultural context etc. The same resource (e.g. one hour manpower of a home helper) may cost different amounts of money in different Countries or even in different regions. It depends on whether market demand is greater than offer (in which case the provider may easily negotiate higher payment) or vice-versa (in which case it is easier for the client to negotiate lower payment), on whether the market is “perfect” (i.e. regulated by the balance between demand and offer) or whether there are large-scale intermediaries (e.g. an Insurance Company or a National Health Service able to govern the prices of equipment and intervention). A resource can even not involve money disbursement: for instance, the assistance a family provides free-of-charge to a disabled member is a used resource – although invisible in financial records – thus it must be considered in cost analysis.

It is clear that *economic analysis* – unlike *financial analysis* – is of major significance in a cost-effectiveness assessment of assistive technology. Knowing the overall mobilisation of resources needed to achieve a given outcome leads to an understanding of the magnitude of the intervention, and helps detect whether the resources have been used efficiently (i.e. maximising their effectiveness).

However, this does not mean that *financial analysis* is meaningless: it is useful to indicate the cash that should be on hand for the various actors involved (the user, family, school, insurance, public health service, municipality, sponsors etc..), and to predict when money will be needed during the assistive technology programme. Being able to acquire a given resource when needed often depends on the stakeholder’s ability to buy it: thus a reasonable financial plan helps to prepare for necessary expenditure.

### *Economic analysis*

A sound *cost analysis* of an individual AT programme should take into account not only the purchase price of the equipment, but also all the resources used throughout the whole process: equipment, services, manpower of professionals, helpers and family members, time forgone, transport, administrative time, etc.

As stated above, cost analysis is not primarily concerned with money. However, since the resources involved in the process may be of different nature (equipment, time, skills etc…) they must, for the sake of calculation, be quantified through a common measurement system. It goes without saying that the most practical method is to convert them into monetary units. This conversion is called *valuation*.

For instance, the man-hours of an unpaid family member may be *valuated* by assigning them a market value similar to that of a paid assistant ("*If I had to hire a paid assistant, I would give him/her this amount of money*"). This is quite a reasonable method, although it is not the only one. If this family member holds a profession one should, in theory, assign the market value of the professional time lost ("*if he did not spend those hours in assisting me, he could spend them in his profession and thus get that amount of money*"). However *valuations* based on this principle (*cost opportunity)* lead to very different results in the case of family members holding a profession with high-earning potential (a lawyer, a physician) rather than a less paid profession.

Establishing a *conversion table* between resources and monetary units involves several other assumptions. For instance, should taxes be considered or not? Should discounting (assigning lower values to resources that will be used later) be introduced or not? Whatever the assumptions, there can be no surprise if the resulting figures seem totally unrelated to the actual flow of money observed in the financial records.

Depending on the purpose of the *cost analysis*, some parameters may need no consideration at all: *valuation* is just a mathematical manipulation – a simplification of reality – based on a set of assumptions. For instance, in the event of the purpose of the analysis being just to compare the economical impact of various possible AT solutions to the same individual, or to compare the same AT solution across various individuals, the absolute figures are of little interest: what is interesting is the observation of which figures are higher or lower than others. The choice of the method to obtain these figures is of little relevance, what is important is to stick to the same method for all cases.

The SCAI instrument is a good example of a simplified approach which is easily used in clinical practice to compare solutions within an individual AT programme.

### *Categorisation of costs*

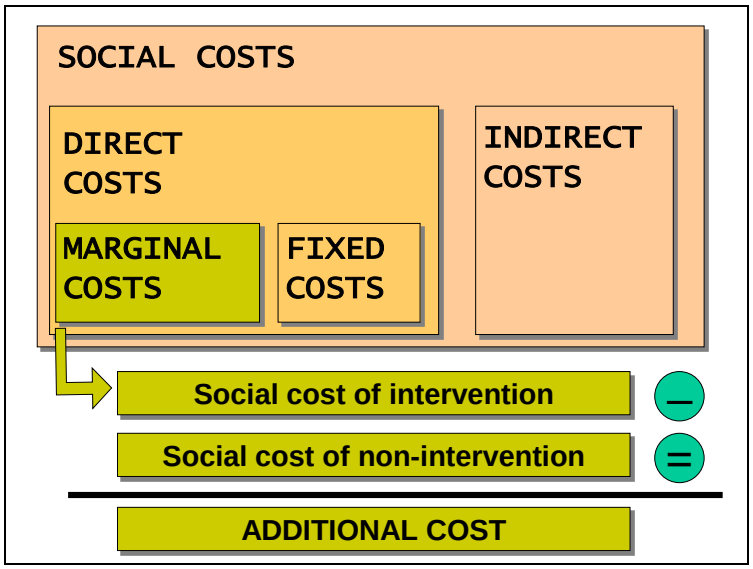
Within an individual AT programme, different costs are borne by the different actors: the user, family, municipality, Health Services etc. However, in order to have an overall economic indicator of the AT programme, the sum of all the resources mobilised by all the actors taking part in the process must be considered. This is the so-called *social cost*.

As visualised in ***Table 1,*** social cost can include *direct costs* - i.e. resources mobilised as a direct consequence of the assistive technology programme (e.g. purchasing and fitting the equipment, training the user, maintenance) – and *indirect costs* - e.g. *"client's work leave for undertaking a treatment"* or *"costs borne externally by the health sector, patients or their families"* [23].

Furthermore, cost analysis can be extended to include *fixed costs* (e.g. the cost of the assessment process leading to the decision about a certain AT programme) or restricted to just *marginal costs* (i.e. the additional resources mobilised to obtain one additional result i.e. the implementation of the AT programme decided on in the assessment). The decision concerning the extent of the cost analysis depends on the purpose of the study. An investigation into providing a population with assistive technology must consider all the costs of the processes of intake, assessment, prescription and administration. Conversely, if, for a disabled individual, alternative AT programmes have to be analysed and compared, the process of intake, assessment and prescription can be considered a *fixed (*or *unaffected) cost* (this cost being already in place independently of the programme to be chosen), while the cost items incurred after the prescription (such as those *affected* by the decision) are the *marginal costs* [7] [8].

Finally, the *marginal cost* of the intervention has little meaning in itself, unless compared with the *cost of non-intervention*. For instance, rebuilding a bathroom to improve the user's independence (*intervention*) may bring about considerable marginal costs, however the alternative decision, that of keeping the bathroom as it is (*non-intervention*), also brings about marginal costs (more assistance by a helper in the bathroom) as using the bathroom cannot be avoided. Hence, the useful economic indicator is the *additional cost* of *intervention Vs non-intervention*, rather than the marginal cost of the intervention in itself. In other words, what is important to know is the *additional cost of changing from an initial situation (without intervention) to a final situation (with intervention)*, just as *effectiveness analysis* measures the impact of *change* (initial situation Vs final situation) in the person's life.

**Table 1 - Categorisation of costs**




The concept of additional cost is particularly important in complex AT programmes that consist of sequences of several interventions. In these cases the additional cost of each intervention must be calculated considering the initial situation to be the one achieved through the previous interventions. For instance, if the first intervention consists of *fixing the architectural barriers* of a flat, the second of providing *a helper for two hours/day*, and the third of providing an *electric wheelchair*, the intervention *electric wheelchair* should be analysed by assuming the *having no barrier in the flat* and *having two hours/day of a helper* as the initial situation. Only this assumption will make it possible to obtain the additional cost of the whole AT programme, by simply adding up the additional costs of the single interventions.

## 3. The SCAI Instrument for Cost Analysis

### *Purpose of the instrument*

SCAI stands for *SIVA Cost Analysis Instrument*. It is intended as a tool to help the clinician and the client *estimate* the economical impact of an *individual AT programme*, and, especially, to *compare* the costs involved when different options are available to solve a specific problem.

It is primarily meant to facilitate communication among all the actors involved in the service delivery process – including the clients – and to instill an attitude of informed, responsible and efficient use of resources. People interested in using the instrument may include rehabilitation professionals, AT counsellors, funding agencies, and also persons with disabilities when directly submitting applications for independent living support.

### *Conceptual basis of the instrument*

The conceptual basis of SCAI draws upon the already quoted CERTAIN study. A further national project supported by the Italian Ministry of Health led to the development of the instrument as a tool for clinical practice in the context of the National Health Service [15].

SCAI focuses primarily on the *additional social costs of individual AT programmes*, i.e. the sum of all resources spent by all actors involved (hence the term *social*) as a *consequence of the decision* to adopt one specific programme rather than another (hence the term *additional*).

The costs of the *assessment* that led to this decision are excluded from this analysis, in that they appear – from the client's perspective – as fixed costs. For instance, if a client is prescribed a cheap pushchair rather than an expensive powered wheelchair, (s)he will incur different purchase and maintenance costs; however, the assessment that led to such a decision is the same in both cases, and falls outside the SCAI scope. Conversely, in certain circumstances, further assessment may be needed *after* the decision has been taken, for instance defining the configuration details of the chosen wheelchair. SCAI considers this kind of assessment as being embodied in the installation and fitting costs.

In most cases, Service Delivery Systems consider just the *purchase price* of the device, which – at first glance – would seem the most logical indicator to describe whether an AT solution is *cheap* or *expensive*. Unfortunately, this is not so, and, what's more, this view often leads to severe distortion of cost-outcome analysis.

***Table 4***, for instance, shows the purchase price, in terms of additional social cost over five years of use, of four assistive solutions that enable a wheelchair user to cope with a flight of stairs. The figures are in euros, actualised to 2006 values. It is interesting to observe that in this case the solution that appeared the cheapest at first glance (Mobile stairclimber) eventually proves to be one of the most expensive.

SCAI estimates the *additional social cost involved by the chosen solution over a certain period of time*. This basically includes four cost categories:

- *Investment*: cost of purchasing the equipment and having it installed, personalised and ready-to-use. This also includes the provision of adequate training for the client;
- *Maintenance*: running costs of technical maintenance; depending on the case, this may include repairs, insurance, power supply, etc.;
- *Services*: other services that may be needed in relation to the chosen AT solution (e.g. a bulky powered wheelchair might require specialised minibus transport instead of a cheaper ordinary bus);
- *Assistance*: the amount of human assistance needed in relation to the device (e.g. a pushchair works only if a personal assistant is there to push), independently of whether that manpower is paid for or offered for free by relatives or friends or volunteers.

Most of the above costs can be measured directly in monetary units. This may not be the case for unpaid ***assistance***: therefore SCAI looks first at the man-hours required and distinguishes – for the purpose of monetary valuation – among three types of assistance:

- ***Level A***: that which can be provided by anybody;
- ***Level B***: requiring no specific professional qualification but just good physical capabilities;
- ***Level C***: requiring specific professional qualification (e.g. a nurse, a computer technician, etc.)

In order to perform the SCAI calculations, some time parameters need to be defined. These are:

- the ***time span*** of the analysis, to be specified for the ***whole AT programme;***
- the ***clinical duration***, to be specified for ***each intervention*** within the AT programme;
- the ***technical duration***, to be specified for ***each AT solution*** considered for the intervention.

The ***time span*** is the time elapsing from the beginning of the ***AT programme*** to the end of the analysis. In retrospective analyses, where cases are examined in terms of what really happened over a known period, the decisions concerning the time span are quite free, have little influence on the results and depend mainly on the purpose of the research (e.g. comparison of cases over a given period). For prospective analyses, or semi-prospective analyses (where the AT programme is already in place but future effects can only be estimated), the unknown-future factor should be taken into account. The longer the time span, the

higher the probability of unexpected events. On the other hand, the effects of AT programmes can be better appreciated in the long-term perspective. The proper balance should be found case by case. For most intervention, a 5-years time span is a good balance.

***Clinical duration*** is the estimate of how long a specific ***intervention*** within the AT programme can be expected to be of value for the client before becoming useless.

***Technical duration*** is the estimate of how long a ***AT solution*** related to an intervention is going to last, in real use conditions, before needing replacement. A reasonable method to establish technical duration is to ask the manufacturer how long he would guarantee technical maintenance in a contract under such use conditions, and when would he consider it convenient to replace the item.

Technical and clinical duration often differ. When the *technical duration is shorter*, a new item of the same equipment should be purchased each time the technical duration is over, until the clinical duration has expired. When the *clinical duration is shorter*, the equipment becomes useless at the end of the clinical duration but may still have a residual value (it may be resold, or given back to the financing agency for use by others).

In the SCAI model, the upper limit of *clinical duration* is usually the *time span* of the analysis. SCAI is able to analyse only what happens within the time span, so in most cases it is reasonable to set the *time span* equal to the *clinical duration of the intervention* (in the case of simple AT programmes) or to the *longest clinical duration* among the various interventions (in the case of complex AT programmes).

When using SCAI to estimate the economic impact of *alternative AT programmes* for an individual, or of *alternative technical solutions to interventions*, the longer the *time span* and *clinical duration*, the higher the probability of wrong forecasts. An economic analysis based on today's assumptions may lose reliability when extended to the long term. This is because market failure, and changes in technology (e.g. impossibility to go on maintaining a device since it is no longer in the market and spare parts are no longer available) and prices etc. may force reconsideration of the assistive technology programme earlier than expected. However, no cost-outcome analysis can be performed without reasonable timing estimates, making a "wise guess" that considers, as a whole, all the above clinical and economical factors. There is no fixed recipe for such an estimate: however it should be consistent with the clinical judgements commonly made in medical practice, and, like those, based mainly on knowledge and experience.

### *How does the SCAI work*

At the first level, the instrument can be used as just a methodological guideline without filling in any forms, i.e. as a checklist that helps form an idea of the economic impact of a certain AT programme.

At the second level – which requires filling in the three SCAI forms as described below – the instrument leads to an estimate of the *costs* and *expenditure* for each AT solution. Although rough, this estimate is satisfactory for economic comparisons of *alternative solutions* for a given intervention.

At the third level SCAI can be used to estimate the cost of complex AT programmes that involve the provision of several devices at different times.

**Table 2 - SCAI 1st worksheet: defining the objectives of the AT programme**

| SCAI (Siva Cost Analysis Instrument) – 1st Step |
|---|
| *Synthesis of the clinical condition (only those aspects of interest for the AT programme)* |
| *Contextual issues (personal, family, living environment etc.)* |
| *Overall objectives of the AT Programme* |
| *Foreseen evolution in the case the AT programme not being carried out* |
| *Foreseen outcomes at the level of individual goals/expectations* |
| Foreseen outcomes at the level of family expectations |
| *Foreseen outcomes at the level of professional expectations* |
| *Foreseen outcomes at the level of community expectations* |

The instrument proceeds in three steps. The ***first step*** involves completing the first SCAI Form to describe the expected outcome (***Annex 1***). The form is subdivided into six parts (see ***Table 2***) according to the findings of the CERTAIN study [6], and the description is just free text following no specific checklist.

The ***second step*** (see the SCAI Worksheet 2, in ***Annex 2***) involves:

- subdividing the AT programme into the interventions (one or more) that form it;
- defining the time span of the analysis;
- indicating the assistance valuation parameters (hourly cost and expenditure, for level A, B and C);
- stating which Agencies will participate in the expenditure (if applicable).

***Table 3*** exemplifies how the form could be filled for a specific AT programme. The remaining sections of the form fill-in automatically based on the data of the various interventions defined in the 3rd step.

**Table 3 - SCAI 2nd worksheet: defining the time span and the valuation parameters**

| | | | |
|---|---|---|---|
| **Client** | **Matteo** | | |
| **Time span of the analysis** | *5 years* | *(Indicate whether in years or in months)* | |
| **Valuation of personal assistance costs** | | Hourly cost | Hourly expenditure |
| *Level A (can be provided by anybody)* | | 16 € | 0 € |
| *Level B (requiring strength and balance)* | | 18 € | 18 € |
| *Level C (requiring professional qualification)* | | 23 € | 23 € |
| **Agencies that share the expenditure (if applicable)** | | | |
| 1st Agency | *ASL* | | |
| 2nd Agency | *Municipality* | | |

The decision about the *time span* (how long the costs are going to be monitored) is very important. For long-term programmes (e.g. a disabled adult with stable impairment) the recommended time span could be in the range of *five or ten years*, for short term programmes (e.g. fast progressive pathologies) it may be reasonable to limit the observation to shorter times. If different AT programmes are to be compared it is essential that the time span be the same for all programmes, otherwise the resulting social costs will be of varying magnitudes.

Now the ***third step*** (see the SCAI Worksheet n.3, in ***Annex 3***): after the various interventions have been decided, the third SCAI form can be filled-in for each intervention. This involves:

- deciding the ***timing*** of the intervention (when is it expected to be implemented, within the time span: at the beginning – i.e. year or month 1 – or later – e.g. year or month 2);
- defining the expected ***clinical duration*** of the intervention;
- defining the various ***alternative AT solutions*** (one or more, if applicable);
- defining the expected ***technical duration*** of each AT alternative solution;
- stating which AT solutions are ***recyclable*** (can be re-used by others, if technically still in order at the end of the clinical duration) or ***reusable*** (can be used also beyond the time span, may the user still need them)
- providing the basic ***cost elements*** of each AT solution (investment, maintenance, services);
- providing the ***amount of assistance*** needed for each solution (number of actions per month; number of minutes per action), whether A or B or C level;
- in case any Agency participates in the ***expenditure***, indicating their ***share*** (%);
- defining what situation could be considered as ***non-intervention*** (i.e. what would happen if no intervention would be carried out);
- stating what AT solution has been eventually ***chosen***.

The *clinical duration* may cover the whole time span, or be shorter. Should the intervention be expected to be of clinical value beyond the time span, this should be indicated by answering "*yes*" to the question "*reusable?*".

The *technical duration* of each AT solution is independent of the time span, and may be longer or shorter than the clinical duration. In the event of it being shorter, the AT solution should be purchased enough times to cover the clinical duration; if it is longer, just the one purchase is needed. Note that it is important to state whether the device can be *re-cycled* for others if it is still in order at the end of the clinical duration.

For example, a stair climber will surely be recyclable while a leg prosthesis will not. From the economical viewpoint, the possibility to re-cycle gives a *residual value* to the device. For instance, a re-usable device with a technical duration of 10 years and a clinical duration of 7 years for a given user, has residual value as it can be assigned to another person for the remaining 3 years. For the sake of simplicity, residual value can be estimated through linear depreciation (3/10 of the purchase cost).

Once all the above data have been provided, ***Worksheet 3 automatically calculates the economic and financial indicators of each intervention***. In this calculation, the valuation of the *assistance* cost is based on hourly cost and expenditure indicated in the SCAI Worksheet 2, as explained above.

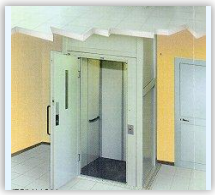
***Table 4*** shows an example of the results of applying the SCAI analysis to a specific case (comparison of four possible solutions to the intervention "*allowing to go upstairs and downstairs to the first floor*"). ***Table 5*** shows the detailed analysis giving the figures.

In ***older versions*** of the SCAI, a different form was used that allowed all calculations to be performed manually (see ***Annex 4***); for those who prefer using paper & pencil instead of automatic Excel calculation, the same case is shown according to the older forms in ***Table 6*** (comparative analysis of the four solutions) and ***Table 7*** (valuation of yearly assistance cost).

In this example, the following alternatives were explored:

- fixed stairclimber (FS)
- Vertical conveyor (VC)
- Mobile stairclimber (MS)
- Just human assistance (two helpers taking the person up- and downstairs) (2H)

**Table 4 - Analysis of alternative AT solutions for an intervention: summary**


| Solution | Fixed stairclimber | Vertical Conveyor | Mobile stairclimber | Just Human assistance |
|---|---|---|---|---|
| ***Initial investment*** | | | | |
| Purchase price | 9,880 € | 15,600 € | 3,867 € | |
| ***Economic analysis*** | | | | |
| Additional Social Cost over 5 years | 15,940 € | 7,075€ | 36,262 € | 64,800 € |
| ***Financial analysis*** | | | | |
| Expenditure by the user | 3,771 € | 7,179 € | 17,300 € | 32,400 € |
| Expenditure by Local Health Authority | - | | 3,867 € | - |
| Expenditure by the Municipality | 3,952 € | 4,680 € | 16,200 € | 32,400 € |
| Saving in yearly fiscal declarations | 3,557 € | 5,616 € | | |
| **Overall expenditure over 5 years** | **11,280 €** | **17,475 €** | **37,367 €** | **64,800 €** |

## Table 5 - Analysis of alternative AT solutions for an intervention: SCAI 3rd worksheet

| | | | | | |
|---|---|---|---|---|---|
| Client | **Matteo** | | | | |
| Problem | **Stairs** | | | | |
| | | | | | *actual years* |
| begins in year | *1* | Clinical duration | *5* | years | *5* |
| | **Solution 1** | **Solution 2** | **Solution 3** | **Solution 4** | **Solution 5** |
| | **Fixed stairclimber** | **Vertical conveyor** | **Mob.stairclimber** | | **non-intervention** |
| **Parameters** | | | | | |
| *Technical duration years* | *10* | *15* | *7* | | |
| *Recyclable ? (1>YES 0>NO)* | | | *1* | | |
| *Reusable ? (1>YES 0>NO)* | *1* | *1* | *1* | | |
| **Investment** | | | | | |
| *Overall cost* | € 9.880 | € 15.600 | € 3.867 | | |
| *% expenditure client* | 24% | 34% | | 100% | |
| *% expend.ASL* | | | 100% | | |
| *% expend.Other* | *76%* | *66%* | | | |
| **Maintenance** | | | | | |
| *Yearly cost* | € 280 | € 375 | € 220 | | |
| *% expenditure client* | 100% | 100% | 100% | 100% | |
| *% expend.ASL* | | | | | |
| *% expend.Other* | | | | | |
| **Services** | | | | | |
| *Yearly cost* | | | | | |
| *% expenditure client* | 100% | 100% | 100% | 100% | |
| *% expend.ASL* | | | | | |
| *% expend.Other* | | | | | |
| **Assistance level 1** | | | | | |
| *actions/month* | *60* | | | | |
| *minutes/action (+ waiting)* | *10* | | | | |
| *% expenditure client* | 100% | 100% | 100% | 100% | 100% |
| *% expend.ASL* | | | | | |
| *% expend.Other* | | | | | |
| **Assistance level 2** | | | | | |
| *actions/month* | | | *60* | | *120* |
| *minutes/action (+ waiting)* | | | *30* | | *30* |
| *% expenditure client* | 100% | 100% | 50% | 100% | 50% |
| *% expend.ASL* | | | | | |
| *% expend.Other* | | | *50%* | | *50%* |
| **Assistance Level 3** | | | | | |
| *actions/month* | | | | | |
| *minutes/action (+ waiting)* | | | | | |
| *% expenditure client* | 100% | 100% | 100% | 100% | 100% |
| *% expend.ASL* | | | | | |
| *% expend.Other* | | | | | |
| *Investment cost* | *€ 9.880* | *€ 15.600* | *€ 3.867* | | |
| *- Residual value* | *-€ 4.940* | *-€ 10.400* | *-€ 1.105* | | |
| *+ Maintenance cost* | *€ 1.400* | *€ 1.875* | *€ 1.100* | | |
| *+ Cost of services* | | | | | |
| *+ Valuation of Assistance* | *€ 9.600* | | *€ 32.400* | | *€ 64.800* |
| **= Social Cost** | **€ 15.940** | **€ 7.075** | **€ 36.262** | | **€ 64.800** |
| *Expenditure client* | *€ 3.771* | *€ 7.179* | *€ 17.300* | | *€ 32.400* |
| *expend.ASL* | | | *€ 3.867* | | |
| *expend.Other* | *€ 7.509* | *€ 10.296* | *€ 16.200* | | *€ 32.400* |
| **Additional Social Cost** | ***-€ 48.860*** | ***-€ 57.725*** | ***-€ 28.538*** | ***-€ 64.800*** | |

**Table 6 – Older SCAI forms: yearly comparative figures for the four alternatives (FS > fixed stairclimber; VC > Vertical conveyor; MS > mobile stairclimber; 2H > two helpers)**

| | | social costs of intervention | | | | Expenditure of client | | | | Expenditure ASL | | | | Expenditure others (municipality+tax deductions) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **FS** | **VC** | **MS** | **2H** | **FS** | **VC** | **MS** | **2H** | **FS** | **VC** | **MS** | **2H** | **FS** | **VC** | **MS** | **2H** |
| **Year 1** | *Investment* | 9.880 | 15.600 | 3.867 | | 9.880 | 15.600 | | | | | 3.867 | | | | | |
| | *Maintenance* | 280 | 375 | 220 | | 280 | 375 | 220 | | | | | | | | | |
| | *Services* | | | | | | | | | | | | | | | | |
| | *Assistance* | 1.920 | | 6.480 | 12.960 | | | 3.240 | 6.480 | | | | | | | | 3.240 |
| **Year 2** | *Investment* | | | | | -3.557 | -5.616 | | | | | | | 3.557 | 5.616 | | |
| | *Maintenance* | 280 | 375 | 220 | | 280 | 375 | 220 | | | | | | | | | |
| | *Services* | | | | | | | | | | | | | | | | |
| | *Assistance* | 1.920 | | 6.480 | 12.960 | | | 3.240 | 6.480 | | | | | | | | 3.240 |
| **Year 3** | *Investment* | | | | | -3.952 | -4.680 | | | | | | | 3.952 | 4.680 | | |
| | *Maintenance* | 280 | 375 | 220 | | 280 | 375 | 220 | | | | | | | | | |
| | *Services* | | | | | | | | | | | | | | | | |
| | *Assistance* | 1.920 | | 6.480 | 12.960 | | | 3.240 | 6.480 | | | | | | | | 3.240 |
| **Year 4** | *Investment* | | | | | | -5.939 | | | | | | | | | | |
| | *Maintenance* | 280 | 375 | 220 | | 280 | 375 | 220 | | | | | | | | | |
| | *Services* | | | | | | | | | | | | | | | | |
| | *Assistance* | 1.920 | | 6.480 | 12.960 | | | 3.240 | 6.480 | | | | | | | | 3.240 |
| **Year 5** | *Investment* | | | | | | | | | | | | | | | | |
| | *Maintenance* | 280 | 375 | 220 | | 280 | 375 | 220 | | | | | | | | | |
| | *Services* | | | | | | | | | | | | | | | | |
| | *Assistance* | 1.920 | | 6.480 | 12.960 | | | 3.240 | 6.480 | | | | | | | | 3.240 |
| | | | | | | | | | | | | | | | | | |
| -RESIDUAL VALUE | | 4.940 | 10.400 | 1.105 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| **TOTAL** | | **15.940** | **7.075** | **36.262** | **64.800** | **3.771** | **7.179** | **17.300** | **32.400** | | | **3.867** | | **7.509** | **10.296** | **16.200** | **32.400** |

**Table 7 - Older SCAI forms: comparative valuation of the assistance cost**

| ***Assistance*** | | *actions/month* | *minutes/action* | *min.travel/wait* | *yearly cost* | *yearly expenditure* |
|---|---|---|---|---|---|---|
| *level A* | *FS* | *60* | *10* | *0* | *1.920* | *0* |
| | *VS* | | | | | |
| | *MS* | | | | | |
| | *2H* | | | | | |
| *level B* | *FS* | | | | | |
| | *VS* | | | | | |
| | *MS* | *60* | *10* | *20* | *6.480* | *6.480* |
| | *2H* | *120* | *10* | *20* | *12.960* | *12.960* |
| *level C* | *FS* | | | | *0* | *0* |
| | *VS* | | | | | |
| | *MS* | | | | | |
| | *2H* | | | | | |

This example has been chosen as it clearly highlights a very common paradox seen in assistive technology. In this specific case, the most efficient solution (i.e. the one that makes the best use of resources) is the *Vertical Conveyor* (lowest social cost), despite it requiring the highest initial investment. The reason behind this is that it has the highest technical duration and allows complete independence i.e. no assistance cost.

One may argue that, for a given case, this solution is also the best as it provides a better quality of life by giving a feeling of independence (the person has more freedom in deciding when to go out, without having to wait for assistance). However, this consideration does not fall within the domain of cost analysis, but rather within that of *outcome* analysis. Nevertheless this solution could be considered the most efficient because it maximises outcome by minimising costs. However the contrary can occur. Indeed, it is often worth accepting a higher social cost for a more effective solution, or, in some cases, to *trade-off a less effective solution with lower social cost*. What is clearly inefficient is to trade-off higher social cost with less effective solutions.

A final comment concerns the concept of *additional social cost*. In this case, the initial situation – the person confined in the home – is theoretically a valid alternative (the person can live with it, though with poor quality of life), indeed, "non-intervention" brings no cost; thus the above figures correctly describe the additional social cost of moving the person from an initial situation (with poor quality of life) to a final situation (with better quality of life). Conversely, in the event of the initial situation *not being a valid alternative* for some reason (the person must go to work, or is at mortal risk if unable to leave the house), the last solution (*just assistants*) is, in fact, "non intervention": this means that the additional social cost of the vertical conveyor is not 7,075 euro but rather ***–57,725*** (7,075 – 64,800) (see ***Table 8***). The "minus" sign indicates that this assistive solution yields a *saving* rather than an investment.

**Table 8 - Example of resulting estimates in case the "non intervention" brings about unavoidable costs**

| | Fixed stairclimber | Vertical Conveyor | Mobile stairclimber |
|---|---|---|---|
| ***Initial investment*** | | | |
| Purchase price | 9,880 | 15,600 | 3,867 |
| ***Economic analysis*** | | | |
| Additional Social Cost over 5 years | - 48,860 | - 57,725 | - 28,538 |

### *Soundness of the instrument*

An efficient use of SCAI by health care professionals requires only a brief training course (one day is enough), mainly to instil a positive attitude towards calculations of this kind. Once the instrument is understood and the resources are quantified, filling in the forms is quite easy and fast in daily practice. For some data, assumptions may be required (technical and clinical duration, valuation of man-hours of assistance, etc.), but the different assumptions do not significantly affect the final output of the instrument, which is an economic comparison of alternative solutions. Certainly, *absolute figures* change in response to the different assumptions, but the *inter-relationships of the figures* show little variation. Such performance seems to indicate good reliability, validity and responsiveness, although systematic clinimetric studies have not yet been carried out, so it is still too early to draw firm conclusions.

A major limitation of SCAI – as readers with an economic background may have noticed from the beginning – is the absence of financial mathematics. This may cause two problems. First, costs incurred at different times do not have the same value as if they were incurred today: they should be *discounted*. Secondly, consistent mathematical processing is only possible when all the costs are *actualised*, i.e. referred to the same date. For simplicity's sake, SCAI takes no account of discount rates and actualisation coefficients to calculate the *present value* of the resources as an economist would do. Thus the resulting *absolute* figures can be biased, but this does not adversely affect the main SCAI output that – as already stated – lies in the *inter-relationships of the figures.*

## 4. Current and future developments

The SCAI instrument is currently being taught, and used for economic analysis, in the Postgraduate Course on Assistive Technology at the Catholic University of Milan, run in conjunction with the Don Gnocchi Foundation [44]. Furthermore, it is being increasingly used in clinical practice, mainly by therapists and physicians who have participated in the Course. SCAI helps instil an attitude of informed, responsible and efficient use of resources, confirming its notable educational value in bringing awareness to the fore.

SCAI is a first step towards the development of a more comprehensive instrument, embodying the CERTAIN financial-mathematical model [45] in an easy-to-use spreadsheet suitable for both clinical and administrative purposes. However, there still remain a number of non-trivial problems that call for international collaboration. For instance, investigations are needed to identify standard parameters for the valuation of assistance, as well as for the technical duration of different AT devices. Such parameters would bring consistency to the estimates and improve inter-rater reliability.

Whatever the developments, it is important to bear in mind that SCAI must not be looked on as a decision-making tool. Indeed, SCAI is intended as an informative tool to be used in conjunction with clinical

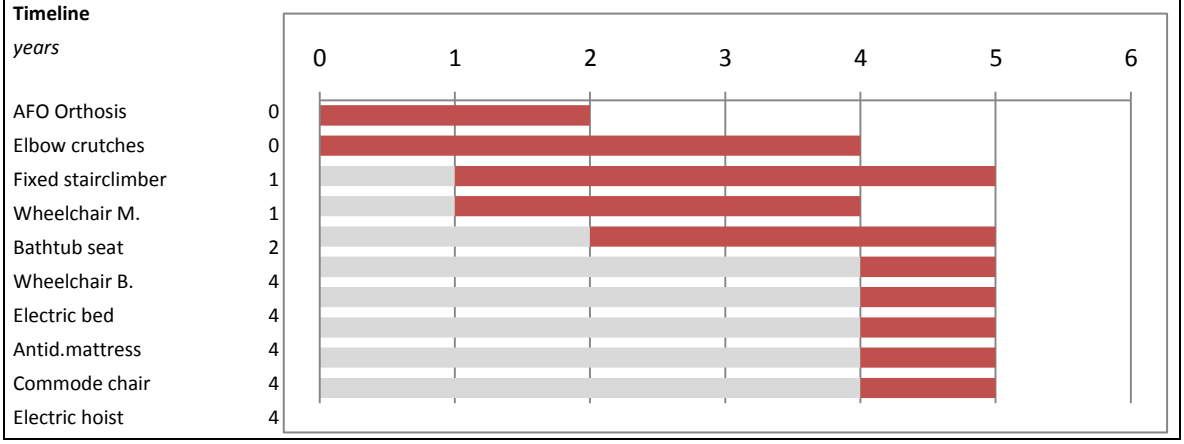
assessment and other social or ethical considerations, thus broadening the picture on which to make appropriate decisions for each individual case. The objectives of the AT programme must be clear, which is why the first step of SCAI is devoted to putting those objectives into words.

Let us return to the example of the AT solution for a disabled person living on the first floor, and who needs to go outdoors. It would not be appropriate to decide merely on the grounds of economic advantage whether such a solution should be provided. Overcoming a barrier is primarily a matter of social considerations, rehabilitation strategies, and human rights. Economic analysis enters the field only when there are alternative solutions that offer the same results; in this case it makes a lot of sense to find out which solution accomplishes the most efficient use of resources [25].

**Table 9 - Economic analysis of a complex individual AT programme**

| **Economical analysis** | | | | | |
|---|---|---|---|---|---|
| *problem* | *solution* | *beginning in year* | *purchase cost* | *add. social cost* | *residual value* |
| Walking | AFO Orthosis | 1 | € 62 | € 124 | |
| Walking support | Elbow crutches | 1 | € 60 | € 60 | |
| Stairs | Fixed stairclimber | 2 | € 9.880 | -€ 39.088 | -€ 5.928 |
| Indep.mobility | Wheelchair M. | 2 | € 912 | -€ 38.060 | -€ 365 |
| Bathing | Bathtub seat | 3 | € 110 | -€ 19.374 | -€ 44 |
| Assist.mobility | Wheelchair B. | 5 | € 905 | -€ 12.689 | -€ 724 |
| Stayin in bed | Electric bed | 5 | € 936 | € 210 | -€ 819 |
| Pressure sores | Antid.mattress | 5 | € 331 | € 99 | -€ 265 |
| Toileting | Commode chair | 5 | € 193 | € 6.512 | -€ 161 |
| Transferring | Electric hoist | 5 | € 625 | € 140 | -€ 547 |
| | | ***total*** | ***€ 14.014*** | ***-€ 102.065*** | ***-€ 8.852*** |
| | | | | | |
| **Financial analysis** | | | | | |
| *problem* | *solution* | *beginning in year* | *expend.client* | *expend. ASL* | *expend. Other* |
| Walking | AFO Orthosis | 1 | | € 124 | |
| Walking support | Elbow crutches | 1 | | € 60 | |
| Stairs | Fixed stairclimber | 2 | € 3.491 | € 3.557 | € 3.952 |
| Indep.mobility | Wheelchair M. | 2 | € 273 | € 912 | |
| Bathing | Bathtub seat | 3 | | € 110 | € 19.440 |
| Assist.mobility | Wheelchair B. | 5 | € 6.570 | € 905 | € 6.480 |
| Stayin in bed | Electric bed | 5 | € 93 | € 936 | |
| Pressure sores | Antid.mattress | 5 | € 33 | € 331 | |
| Toileting | Commode chair | 5 | € 6.480 | € 193 | |
| Transferring | Electric hoist | 5 | € 62 | € 625 | |
| | | ***total*** | ***€ 17.002*** | ***€ 7.753*** | ***€ 29.872*** |

**Timeline**



In 2007 Andrich and Caracciolo [26] analysed thirty-one individual assistive technology programmes carried out for persons with severe motor disabilities resulting from neurological pathologies. A *5-year* time span was chosed for three reasons:

- It is short enough for a predictable evolution of the individual clinical condition;
- It is long enough to observe a stable economic impact (e.g. contributions from public agencies were cashed);
- possible abandonment phenomena should have taken place (the literature confirms that most abandonment occurs within the 1st year or around the 5th year) [27].

The equipment used in the study ranged greatly within the ISO classification for assistive devices (standard ISO 9999). Most of it was provided by Local Health Authorities through the Italian National Prosthetic Assistance Scheme, or by the Municipalities (Home Adaptations Scheme for removal of architectural barriers), but when this was not possible the users purchased it out of their own pocket and got some limited financial help in the form of tax deductions or reduced VAT.

The findings include – for each intervention composing an individual assistive technology programme – the purchase cost of the equipment, the cost of the intervention, the weight of the equipment cost within the intervention cost, the cost of non-intervention, and the additional cost (intervention Vs non-intervention). The additional costs of the whole individual programme is found by adding up the additional costs of the various interventions according to the SCAI methodology (see example in ***Table 9***).

The first findings that merit discussion are those in the *additional cost of the whole programme,* at the end of column 5 of the first section of ***Table 9*** (€ - 102.065). This is an overall economic indicator of the individual AT programme. i.e. the difference between the social cost borne over 5 years as a consequence of AT intervention, and the social cost that would have occurred had there been no intervention (for the same 5-year period).

In the surveyed sample (***Table 10***), this *additional* cost ranges from –152,857 (the "minus" sign stands for a *cost saving*) to 172,261 euros, with 24,801 as average *saving*. The great variation in the cases makes it impossible to infer reliable correlations between a given clinical condition (age, pathology, case history) and the cost of the related AT programmes. This comes as no surprise as the literature already documents [14] [28] that the clinical condition is just one determinant in the choice of AT solutions, the others being the human and physical context where the person lives, the individual personality, the lifestyle and the activities involved.

**Table 10 - Global picture of the population sample surveyed in the study (all cost figures are in euros)**

| | *Purchase cost of equipment* | *Cost of intervention* | *% equipment* | *Cost of non intervention* | *Additional cost of intervention (interv. Vs non-interv.)* | *Additional cost of whole individual programme* |
|---|---|---|---|---|---|---|
| *Minimum value* | *45,000* | *173,243* | *100%* | *154,800* | *173,243* | *172,261* |
| *Maximum value* | *25* | *13* | *1%* | *0* | *-129,803* | *-152,857* |
| *Average* | *3,258* | *14,022* | *38%* | *22,474* | *-7,044* | *-24,801* |
| *Standard deviation* | *5,409* | *19,947* | *34%* | *26,685* | *29,259* | *65,732* |

A cursory browsing of this datum could lead to the conclusion that – in terms of social cost – most AT programmes generate considerable savings, while some just require investment[1]. However, a closer look at case history details shows that such conclusions would be incorrect. For instance, take the case of 'Nicoletta' [26]: her clinical condition was such that without an adequate AT programme her condition would have worsened considerably, and she may not even have survived. This means that the "non-intervention" alternative was beyond consideration, and no solid criterion could valuate it. Thus its cost was set at zero, causing the difference between the cost of intervention and the cost of non-intervention to be necessarily positive, making the AT programme appear as an investment, not as savings.

[1] To avoid misunderstandings: any consideration of whether the investment was "worth making or not" falls completely outside this discussion. It was taken for granted that the investment – however high – was necessary and appropriate to achieve the desired outcome in terms of life quality or rehabilitation goals.

In other cases, the "non-intervention" alternative was realistic: Anna, for instance, might have been able to carry on with just human assistance without some of the AT solution provided (being transferred / helped in the bathroom, being lifted / moved to prevent bed sores etc…), so it made sense to compare the costs of *doing independently by means of AT* versus *being dependent on assistance*. The overall conclusion here is:

- most individual AT programmes not only bring about positive changes in life quality, but also lead to considerable savings in terms of social cost;
- investments usually indicate severe situations requiring complex AT solutions with little room for alternatives;
- high savings usually indicate situations that, in principle, might be solved in a different manner, but have been solved very efficiently – in terms of social cost – thanks to assistive technology.

On looking at each AT solution, what appears at first glance is the disparity between the cost of equipment and the overall intervention cost (1% to 100% , average 38%). Indeed it can be seen that the purchase price of the equipment weighs little on the overall cost of the intervention, revealing that the initial purchasing cost seldom plays a major role in the overall intervention cost. This confirms the earlier statement that purchase price cannot be taken as *the* indicator of the cost of the AT solution, as is common in most service delivery systems. With regard to the *intervention cost* percentages: near 100% indicates devices with minor maintenance costs and which allow users complete independence, while low percentages indicate devices requiring major maintenance or involving a major need for human assistance. Such variability is evenly distributed across the various AT solutions independently of the purchase price, which can also vary greatly (min. 25 euros, max 45,000, average 3,258).

With regard to the *overall additional cost* of *each AT solution* (intervention VS non-intervention), similar, more detailed considerations apply to what was said above for the whole individual AT programme. In some cases the cost of non-intervention was set to zero simply because it could hardly be imagined (e.g. Nataly), or because the user could live with an already found solution (e.g. a older wheelchair). Thus each single case can be better understood by looking at the cost of intervention / cost of non-intervention figures separately, rather than just looking at their difference i.e. additional cost.

**Table 11 - Comparative analysis for equipment falling within ISO category 12.21.06 (manual wheelchairs)**

| *Assistive solution provided* | *Purchase cost of equipment* | *Cost of intervention* | *% of equipment* | *Cost of non intervention* | *Additional cost (intervention Vs non-int.)* |
|---|---|---|---|---|---|
| Self-propelled manual wheelchair (Meyra Eurochair1850) | 1,789 | 2,088 | 86% | 0 | 2,088 |
| Manual wheelchair (OffCarr Children) with seating system (JayFit backrest+cushion) | 3,924 | 9,901 | 40% | 0 | 9,901 |
| Manual wheelchair with tilting frame (AluRehab Netti III) | 3,595 | 9,473 | 38% | 0 | 9,473 |
| Manual wheelchair w.tilting frame (AluRehab Netti III) and seating system (Jay2 DeepContour) | 3,904 | 9,876 | 40% | 0 | 9,876 |
| Manual wheelchair (OffCarr Elegant) | 1,391 | 1,808 | 77% | 0 | 1,808 |
| Manual wheelchair (Progeo Exelle) | 2,158 | 7,606 | 28% | 0 | 7,606 |
| Lightweight manual wheelchair (Kuschaal ChampionCarbon) with seating system (Jay Back2) | 3,969 | 9,959 | 40% | 40,800 | -30,841 |
| Manual wheelchair (Quickie RXS) | 1,007 | 1,309 | 77% | 325 | 984 |
| Manual wheelchair (Meyra Eurochair) with seating system (Jay 2+Back2) | 2,453 | 7,988 | 31% | 20,400 | -12,412 |
| Manual wheelchair (Quickie RXS) with seating system (Jay 2+Back2) | 2,998 | 8,697 | 34% | 10,800 | -2,103 |
| Manual wheelchair (Quickie RXS) with seating system (Jay 2) | 2,998 | 42,297 | 7% | 0 | 42,297 |
| Manual wheelchair (Etac Cross) | 1,962 | 2,551 | 77% | 0 | 2,551 |
| | | | | | |
| *Minimum value* | *3,969* | *42,297* | *86%* | *40,800* | *42,297* |
| *Maximum value* | *1,007* | *1,309* | *7%* | *0* | *-30,841* |
| *Average* | *2,778* | *11,988* | *51%* | *8,702* | *6,425* |
| *Standard deviation* | *1,037* | *10,922* | *25%* | *12,655* | *16,829* |

There is no stable correspondence between purchase price and overall cost of the intervention, even within homogeneous clusters of comparable AT solutions. ***Table 11***, for instance, offers a comparative overview of the AT solution that appeared most frequently in the population surveyed (*manual wheelchairs with seating systems*). Although the standard deviation is more contained than in the global picture of ***Table 10*** – as could be expected – the purchasing cost of the equipment within a homogeneous set of items

varied greatly within the overall cost of intervention. The reason for this is that the individual contexts of the implemented devices differ one from the other. Then, in addition, most interventions are part of a set of interventions composing the whole AT programme, each of them being influenced by a previous intervention and, in turn, influencing subsequent interventions. For instance, the intervention "anti-decubitus mattress" may involve a different assistance set-up, depending on whether an adjustable bed was provided before or not. The economics of each intervention is calculated on the resource mobilised to move from situation A (before that intervention) to situation B (after that intervention).

# 5. Conclusions

This study confirms the feasibility of a technique for carrying out a *cost/outcome analysis* in individual assistive technology programmes. Such an instrument is proposed here, and we have tested it on a number of case studies; indeed, it is now being increasingly used in service delivery practice. The instrument generates data that can be useful both when *designing* individual AT programmes (comparison among valid alternatives for solving a problem) and when *comparing* different individual AT programmes. It takes on board not only equipment-related aspects, but also the assistance burden and the family commitment. Besides being of value in both clinical practice and service delivery administration, it is of educational value [24] [27] in that it provides a checklist (help-to-think) and a method for a comprehensive planning of assistive technology programmes.

Although the method seems mature for implementation in service delivery practice, some of the assumptions made for this study clearly need further investigation.

The first point is the maintenance cost of the devices: in this study, such costs were evaluated through the subjective estimates of manufacturers, end-users and health care professionals, rather than on the basis of a systematic monitoring of the products in real use during their lifecycle.

The second point is the human assistance burden required by an AT device: although the estimates made in this study can be considered precise enough in that they are based on daily observations, there are some determinants of the assistance set-up (had the user and his/her helper been trained adequately? Was the assistance correctly organised etc.) that greatly influence the social cost of assistance.

The third point is related to discounting. Introducing discounting brings about a decrease in the absolute values of both intervention and non-intervention costs. As explained in a footnote, this study intentionally did not include discounting for three reasons: 1) to keep the calculations simple; 2) because the point in time when various costs will be incurred is often unknown; 3) our focus was on cost inter-relationships (various AT solutions for the same problem, or various individual AT programmes) rather than on their absolute values. In the event of absolute values coming to the fore in researcher interest, discounting becomes important and a more refined cost model is called for.

The fourth point – probably the most difficult one – is related to the evaluation of "non-intervention" in cases where such an alternative is unrealistic or ethically unacceptable. For instance, for Nicoletta and Nataly, doesn't it make more sense to have the non-intervention cost valued "zero", rather than fall back on a standard default situation (for instance, long term hospitalisation in intensive care – which would easily raise the non-intervention cost to figures around one million euros in five years)? Obviously this decision has a major impact on the additional cost of the whole programme.

Whatever the developments, it is important to bear in mind that SCAI must *not* be looked on as a decision-making tool. This kind of instrument is intended as an informative tool for use in conjunction with clinical assessment and other social or ethical considerations. Such use will broaden the fundamental picture to ensure decisions that are appropriate to each individual case, and yield an overall idea of the economical implications of individual AT programmes.

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# APPENDIX 1

Fondazione Don Carlo Gnocchi Onlus

## *SCAI Worksheet 1 - Programme*

| **Client** | |
|---|---|

**Clinical background**

**Personal and social background**

**Objectives of the programme**

**Expected developments in case no intervention is carried out**

**Expected results in relation to individual expectations**

**Expected results in relation to family (or primary network) expectations**

**Expected results in relation to expectations of the caring professionals**

**Expected results in relation to expectations of the community**

# APPENDIX 2

## *SCAI Worksheet 2 - Synopsis of the programme*

**Client**

**Time span of the analysis** | | *years* | *(Indicate whether in years or in months)*

**Valuation of personal assistance costs**

| | Hourly cost | Hourly expendit. |
|---|---|---|
| *Level A (can be provided by anybody)* | | |
| *Level B (requiring strength and balance)* | | |
| *Level C (requiring professional qualification)* | | |

**Agencies that share the expenditure (if applicable)**

| | |
|---|---|
| 1st Agency | *Agency 1* |
| 2nd Agency | *Agency 2* |

**Economical analysis**

| *problem* | *solution* | *beginning in year* | *purchase cost* | *add. social cost* | *residual value* |
|---|---|---|---|---|---|
| 0 | | | | | |
| 0 | | | | | |
| 0 | | | | | |
| 0 | | | | | |
| 0 | | | | | |
| 0 | | | | | |
| 0 | | | | | |
| 0 | | | | | |
| 0 | | | | | |
| 0 | | | | | |
| | | ***total*** | | | |

**Financial analysis**

| *problem* | *solution* | *beginning in year* | *expend.client* | *expend. Agency 1* | *expend. Agency 2* |
|---|---|---|---|---|---|
| 0 | | | | | |
| 0 | | | | | |
| 0 | | | | | |
| 0 | | | | | |
| 0 | | | | | |
| 0 | | | | | |
| 0 | | | | | |
| 0 | | | | | |
| 0 | | | | | |
| 0 | | | | | |
| | | ***total*** | | | |

**Timeline**

# APPENDIX 3

## *SCAI Worksheet 3 - Cost Analysis of the single intervention*

Client

Problem

*actual years*

begins in year | Clinical duration | years

| | Solution 1 | Solution 2 | Solution 3 | Solution 4 | Solution 5 |
|---|---|---|---|---|---|
| | | | | | non-intervention |
| **Parameters** | | | | | |
| *Technical duration years* | | | | | |
| *Recyclable ? (1>YES 0>NO)* | | | | | |
| *Reusable ? (1>YES 0>NO)* | | | | | |
| **Investment** | | | | | |
| *Overall cost* | | | | | |
| *% expenditure client* | 100% | 100% | 100% | 100% | |
| *% expend.ASL* | | | | | |
| *% expend.Municip.* | | | | | |
| **Maintenance** | | | | | |
| *Yearly cost* | | | | | |
| *% expenditure client* | 100% | 100% | 100% | 100% | |
| *% expend.ASL* | | | | | |
| *% expend.Municip.* | | | | | |
| **Services** | | | | | |
| *Yearly cost* | | | | | |
| *% expenditure client* | 100% | 100% | 100% | 100% | |
| *% expend.ASL* | | | | | |
| *% expend.Municip.* | | | | | |
| **Assistance level 1** | | | | | |
| *actions/month* | | | | | |
| *minutes/action (+ waiting)* | | | | | |
| *% expenditure client* | 100% | 100% | 100% | 100% | 100% |
| *% expend.ASL* | | | | | |
| *% expend.Municip.* | | | | | |
| **Assistance level 2** | | | | | |
| *actions/month* | | | | | |
| *minutes/action (+ waiting)* | | | | | |
| *% expenditure client* | 100% | 100% | 100% | 100% | 100% |
| *% expend.ASL* | | | | | |
| *% expend.Municip.* | | | | | |
| **Assistance Level 3** | | | | | |
| *actions/month* | | | | | |
| *minutes/action (+ waiting)* | | | | | |
| *% expenditure client* | 100% | 100% | 100% | 100% | 100% |
| *% expend.ASL* | | | | | |
| *% expend.Municip.* | | | | | |
| *Investment cost* | | | | | |
| *- Residual value* | | | | | |
| *+ Maintenance cost* | | | | | |
| *+ Cost of services* | | | | | |
| *+ Valuation of Assistance* | | | | | |
| **= Social Cost** | | | | | |
| *Expenditure client* | | | | | |
| *expend.ASL* | | | | | |
| *expend.Municip.* | | | | | |
| **Additional Social Cost** | | | | | |

*Chosen solution (1,2..)*

| ***Initial purchase cost*** | ***Add.Social Cost*** | ***Residual value*** | ***Expenditure client*** | ***expend.ASL*** | ***expend.Municip.*** |
|---|---|---|---|---|---|

# APPENDIX 4

**SCAI**
**(Siva Cost Analysis Instrument)**
*Cost analysis of a specific solution for the intervention (alternative worksheet for manual calculation)*[2]

| | | | | | | |
|---|---|---|---|---|---|---|
| | client | | | | Clinical duration | |
| | Assistive solution | | | | Technical durat. | |
| | | Social cost of intervention | Social cost of Non-intervention | expenditure client | expenditure ……. | expenditure ……. |
| Year 1 | Investment | | | | | |
| | Maintenance | | | | | |
| | Services | | | | | |
| | Assistance | | | | | |
| Year 2 | Investment | | | | | |
| | Maintenance | | | | | |
| | Services | | | | | |
| | Assistance | | | | | |
| Year 3 | Investment | | | | | |
| | Maintenance | | | | | |
| | Services | | | | | |
| | Assistance | | | | | |
| Year 4 | Investment | | | | | |
| | Maintenance | | | | | |
| | Services | | | | | |
| | Assistance | | | | | |
| Year 5 | Investment | | | | | |
| | Maintenance | | | | | |
| | Services | | | | | |
| | Assistance | | | | | |

| | |
|---|---|
| - RESIDUAL VALUE | |

| | Intervention cost | Non-inter. cost | Expenditure by client | Expenditure by .. | Expenditure by .. |
|---|---|---|---|---|---|
| TOTALI | | | | | |

| | |
|---|---|
| ADDITIONAL SOCIAL COST | (social costo of intervention – social costo of non-intervention) |

| | Assistance | Actions/month | Minutes/action | Minutes travel/wait | Yearly cost | Yearly expendit. |
|---|---|---|---|---|---|---|
| With inter-vention | level A | | | | | |
| | level B | | | | | |
| | level C | | | | | |
| | | | | total | | |
| Without inter-vention | level A | | | | | |
| | level B | | | | | |
| | level C | | | | | |
| | | | | total | | |

[2] Here a 5-years time span has been used, which proved to be appropriate in most cases; however, longer of shorter time spans may be appropriate in some cases.