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Executive Summary

The challenges for semantic interoperability result from the need to combine the information collected and used in the perspective of seamless care provision across all elements of the healthcare value system, including clinical settings, the public health perspective of integrating individual clinical information for evidence-based decision-making at population level, and in the research perspective in integrating clinical and biomedical information across the continuum of biosciences. Further, information should go in other directions, such as from research to clinical settings and public health activities. Many data sets, whether minimum or expanded, data and metadata definitions, ranging from proprietary to standardised, controlled or otherwise organised vocabularies in the form of classifications and terminologies have been devised to meet a wide range of requirements, from ad hoc and subject-specific to more generalised and widely recognised. The variety of proposed solutions is increasing to meet the growing demand for solutions, but the rapid change and the sophistication of products (and the underlying research) makes them barely affordable even in better off countries.

The s*emantic*HEALTH vision is based on the perception that market solutions proposed so far are missing a consistent reference to robust interoperability principles. Many efforts have been made in recent years to address the issue, and most developments have focused on structural interoperability, with insufficient attention being devoted to semantic interoperability anchored in a shared formal, generalised representation of knowledge.

*Semantic*HEALTH is developing a *roadmap* and *recommendations* that pave the way to true semantic interoperability, taking advantage of state-of-the-art research outcomes. This deliverable, in particular, looks at the socio-economic aspects involved. These are analysed on the basis of the conceptual framework of the project. Semantic interoperability in the medical and health fields will surely take advantage of the processing power of machines, but it will continue to have to be understood and controlled by humans. The proposed perspectives therefore seek a compromise where complexity can be accommodated and the search for creative, yet simple, practical solutions that are manageable and safe for human interaction.

This deliverable provides a comparative cost benefit analysis model and initial recommendations on a socio-economic basis for improving semantic interoperability, which is a key ingredient for meeting present and future challenges of health systems, such as an ageing population or political pressure to reduce costs. Various levels of interoperability exist, of which two allow the exchange of semantically meaningful information (semantic interoperability). These two levels are distinguishable by their degree of semantic interoperability: partially with a varying degree below 100% and full with a degree of 100%. Although partial semantic interoperability does (by definition) not claim to allow each and every message to be seamlessly and semantically shared, most important messages can be shared with a degree of less than 100%. Imagine a newspaper that one can read and fully understand although one does not have the full active vocabulary, as only a limited set of words is being used in the newspaper.

Part of the project is to provide a framework and illustrative impact measures used to define the cost and benefit curves in detail. At present, numbers and magnitudes are illustrative figures and are not to be understood as statements about the actual value of different costs and benefits. The same applies to the functions taken to construct the cost and benefit curves. Their goal in this deliverable is to illustrate a specific type of curve shape, not the actual shape of the specific curves.

In general however, and looking at the given cost and benefit curves, it is obvious that already the availability of partial semantic interoperability with calculable costs can lead to significant benefits and that 100% semantic interoperability (SIOp) might (if achievable at all) lead to costs spiralling out of control. SIOp in health has to cope with a large number of highly dynamic systems, not only on an international level, but even more on national, regional and even intra-enterprise (e.g. departmental) levels. In this setting, reaching high levels of

interoperability is a resource-intensive task. A key outcome of this project is the definition of a position to give some insights on the optimal, or desired, level of SIOp that we should aim for.

After clarifying the objectives of this deliverable, we give a summary of the analytical and conceptual background of the project. This sets the basis for developing a simple, illustrative economic model of SIOp in chapter 3. The socio-economic issues already identified in the conceptual framework on this project (D1.1) are then analysed with reference to this model. The results of the analysis feed into concrete recommendations for further research and steps towards achieving interoperability, presented in chapter 5.

The main three recommendations stemming from the analysis of the socio-economic aspects of SIOp are the following:

- **Researchers need to investigate and analyse the exact shapes and behaviour of the cost and benefit curves of SIOp over time, i.e. construct a well-grounded CBA model.**
- **The then following technical and organisational developments should be guided by the results of the CBA, and in particular the estimation of an optimal degree of SIOp.**
- **To provide and ensure the sustainability of the given SIOp developments, continuous cooperation among stakeholders, and thus realisation of benefits over time together with the individual (private) incentives have to be understood and if necessary adjusted.**

The construct of a CBA model presented and discussed in this document is designed to support activities based on these recommendations.

1 Introduction and objectives

This deliverable focuses on the socio-economic issues of semantic interoperability (SIOp) with the goal to facilitate further work in workpackages 4 to 6 and provide recommendations to be included in the final roadmap (WP7). The presented material is based on the conceptual framework provided as deliverable D1.1, the overview of international experience provided in D1.2, the results of the Copenhagen workshop, various expert interviews, and the continuous research by the study team in the field of international and cross-disciplinary cooperation requiring semantic and other interoperability.

After clarifying the objectives of this deliverable, we give a summary of the analytical and conceptual background of the project. This sets the basis for developing a simple, illustrative economic model of SIOp in chapter 3. The socio-economic issues, many of which already identified in the conceptual framework on this project (D1.1), are then be analysed with reference to this model. Chapter 4 deals with those economic, social, legal, regulatory, etc. issues affecting the costs of and benefits from achieving SIOp. The results of the analysis feeds into concrete recommendations for further research and steps to be accounted for in the final SIOp roadmap, presented in chapter 5.

1.1 Approach and methods

This deliverable is the result of work on workpackage 3 of the SemanticHEALTH project. This was based on white and grey literature, output from other projects and further secondary materials, as well as on various expert interviews and the results of the first workshop in Copenhagen (Hotel Clarion) on 30 September 2006. All the partners attended as well as invited experts from Australia, Germany, Sweden, USA, UK. The goal of the workshop was to **identify the main issues and problems** (and not the solutions) challenging the semantic interoperability (SIOp) of the eHealth initiatives across the world, including socio-economic aspects.

The analysis makes use of results from related studies and projects such as I2-Health (eTEN Support Action: Interoperability Initiative for a European eHealth Area), eHealth ERA (FP6 ERA Member States Coordination Action: Towards the Establishment of a European eHealth Research Area), eHealth IMPACT (Study on Economic and Productivity Impact of eHealth), and continuous private research of the team members in the field of international and cross-disciplinary cooperation requiring semantic and other interoperability.

Based on this analytical background, a simple economic model was developed, which is used to illustrate the socio-economic challenges of SIOp. This model is also used for deliberating deployment and research recommendations on how to effectively remove barriers for semantic interoperability with special focus for eHealth research programme managers and eHealth policy makers at national and supra-national (European and global) level.

1.2 Objectives

The objectives of this deliverable are to provide the results of work in work-package 3. In particular, this includes:

- Identification, at the health systems level, of key health policy, legal and other socio-economic issues of relevance for the wider context of semantic interoperability
- Identification, at the organisational, of level socio-economic enablers and obstacles that help or hamper implementing meaningful interoperating systems
- Delineation of the research and implementation related issues and tasks in improving interoperability at the institutional, regional, national and trans-national level

- Synthesis and identification of initial / intermediate actions needed and milestones in the socio-economic domain for the short term (2-5 years) and the long term (4-10 years), to be incorporated into the European and global roadmap on SIOp.

These objectives are addressed by building a model for analysing the socio-economic impact of SIOp. This model provides a framework for identification and further analyses of the factors affecting the implementation of SIOp and its outcomes, as well as insights on specific steps requiring consideration for the final SIOp roadmap.

2 Analytical background

2.1 Conceptual framework of the project

Semantic interoperability (SIOp) is a key ingredient for meeting present and future challenges of health systems like an ageing population or political pressure to reduce costs. The challenges for semantic interoperability result both from the clinical settings perspective of seamless care provision across all elements of the healthcare value system (like disease management programmes, clinical pathways) and from the research perspective of integrating life sciences and medical information and knowledge.

The *Semantic*HEALTH *conceptual space* takes a human actor centric and process-oriented approach and is accordingly based on three key ***components***:

- health services *actors*
- healthcare delivery *processes* (health services value system) and support activities, including ICT
- interface with other *health-related domains* (public health and secondary uses such as research, training, education)

all these embedded in the ***context*** *of* their respective (national, regional) *health system* consisting of

- health *policy framework* (laws, regulations, associations, stakeholders, etc.)
- *infrastructure* (health system institutions, public health services, eHealth infrastructure).

It has always been communication, the exchange of data, information and knowledge, which has bound the healthcare delivery processes (from health promotion to long term care) and actors together. The kinds of data collected is very much goal dependent. While in principle the recording may be optimised for patient care, we see at the same time data being collected in the daily clinical environment to facilitate reimbursement, other may be used for management (planning, organisation, control), clinical outcome measurements, public health statistics or research purposes.

In order to realise the benefits from the increased availability of information and communication, and in particular the possibility of sharing information, the *interoperability* of systems and teams is crucial. Technical interoperability will ensure that spatial boundaries are eliminated. However, this will not be enough for realising the benefits from the enormous supply of information – syntactic and semantic interoperability are required to make the information usable for all collaborating in delivering healthcare.

Within this complex context we outline three dimensions of semantic interoperability that we need to take into account. We distinguish between an ***analytical dimension***, covering both, technological interoperability and socio-economic aspects of semantic interoperability, the ***application dimension*** focusing on specific application fields, and the ***research dimension*** which identifies key future research topics. These dimensions will be reflected upon using the broader conceptual space as a reference framework.

2.2 Defining interoperability

Based on the broad and holistic approach developed by the EU *i2-Health* project (Interoperability Initiative for a European eHealth Area), *Semantic*HEALTH applies the following IOp definition:

Health system interoperability is the ability, facilitated by ICT applications and

systems,

- *to exchange, understand and act on citizens/patient and other health-related information and knowledge*
- *among linguistically and culturally disparate clinicians, patients and other actors and organisations*
- *within and across health system jurisdictions in a collaborative manner.*

The *Semantic*HEALTH consortium aims essentially to address the ***transmission and use of meaning within the framework of seamless healthcare services***, between providers, patients, citizens and authorities. In essence the *Semantic*HEALTH goal is assuring *co-operability* and *collaboration* rather than only *inter-operability*.

As this Support Action is based on real existing implementations, or implementations planned for the near future, it distinguishes 4 levels, 2 of them allow for semantic interoperability:

Level 0:	no interoperability at all
Level 1:	technical and syntactical interoperability (no semantic interoperability)
Level 2:	two orthogonal levels of partial semantic interoperability Level 2a (quality): Unidirectional semantic interoperability Level 2b (quantity): Semantic interoperability of meaningful fragments
Level 3:	full semantic interoperability, sharable context, seamless co-operability

To explain and distinguish the 4 different levels, consider the following scenario: 56 year old Pádraig recently moved from Ireland to Spain to take up his new job in a multinational IT company. A few weeks after arriving, he falls ill, consults his local (Spanish) GP and his being transferred to the next hospital for further tests.

Level 0 (*no interoperability at all*) Pádraig has to undergo a full set of lengthy investigations to find out the cause of his severe pain. Unfortunately, results from the local GP as well as from his Irish GP are not available at the point of care within the hospital due to the missing technical equipment.

Level 1 *(technical and syntactical interoperability)* Pádraigs doctor in the hospital is able to receive electronic documents that were released from the Irish GP as well as his local GP upon request. Widely available applications supporting syntactical interoperability (such as web browsers and email clients) allow the download and provide immediate access. Unfortunately, none of the available doctors in the hospital is able to translate the Irish document, and only human intervention allows interpreting the information submitted by the local GP for adding into the hospitals information system.

Level 2 *(partial semantic interoperability)* The hospital doctor is able to securely access via the Internet parts of Pádraigs Electronic Health Record released by his Irish GP as well as the local GP that he visited just hours earlier. Although both documents contain mostly free text, fragments of high importance (such as demographics, allergies and medical history) are encoded using international coding schemes, which the hospital information system can automatically detect, interpret and meaningfully present to the attending physician.

Level 3 *(full semantic interoperability, co-operability)* In this ideal situation and after thorough authentication took place, the Spanish hospital information system is able to automatically access, interpret and present all necessary medical information about Pádraig to the physician at the point of care.

> Neither language nor technological differences prevent the system to seamlessly integrate the received information into the local record and provide a complete picture of Pádraigs health as if it would have been collected locally. Further, the anonymised data feeds directly into the tools of public health authorities and researchers.

It is desirable among all levels to achieve symmetrical SIOp, i.e. two or more systems semantically interoperate in a bidirectional way, rather than asymmetrical SIOp where one participant can use the others data but can not provide data usable by the other systems.

The partial nature could be expressed in terms of part-total ratio. For example, there may be SIOp within a number of institutions, but lack of SIOp across them.

In other words, **SIOp might not exist as an all-pervasive state, but rather be a *description of the relationship between specified systems or services***.

It must be kept in mind that *SIOp implementation also depends on social, cultural and human factors within each country, each system and each time period.* Full SIOp is not necessarily a consensual goal in every place at any fixed time. This was confirmed at the Copenhagen workshop. One of the four most important conclusions of the event was that: „Full semantic interoperability SHALL NOT BE a generic characteristic of eHealth initiatives: it shall be restricted to the smaller number of problems creating the most trouble" (partial SIOp).

There may be ***different approaches*** *to semantic interoperability***:**

1. Everyone adopts *a single, core model*. This – more than likely – becomes a long and tedious, probably even unsuccessful, process due to disagreement on key aspects of such a central model (see also standardisation process for standards in the health sector).
2. Everyone has its *own model* but follows *interchange standards* (communication, messaging) between the models. An essential prerequisite for this scenario includes bilateral and/or multilateral agreements between the participating parties.
3. Everyone agrees on *common data elements* with systematic unambiguous formats e.g. data descriptions (data types, terminologies, coding), meta data and information models.
4. Everyone uses a predefined *knowledge representation framework* (classes, attributes, definitions, identification principles) and *inference mechanisms* (inclusions, exceptions, constraints, reasoning etc)
5. Other

It quickly becomes clear that SIOp is part of a bigger challenge. The analyses in this deliverable, including the economic model of SIOp are based on the assumption that the other layers of IOp (see Table 1 below) have been sufficiently addressed in chapter 2.3 of deliverable D1.1 ("A multi-layer approach to interoperability").

TABLE 1: FOUR EHEALTH INTEROPERABILITY LAYERS AND RELATED ISSUES

Action layer and approach	Issues
Health policy layer: ***cooperation***	Vision & strategies Structures, processes & measures, incentives for actors Sustainable socio-economic and legal framework Privacy and confidentiality Certification of systems and devices
Health service provider (organisational) layer: ***collaboration***	Organisational structures and culture Intra & inter-jurisdictional service processes Change management, behavioural change Systems thinking, business process re-engineering
Semantic layer: ***interoperation***	Terminologies, classifications, ontologies Translation Sustainable development and implementation infrastructures, application support
Technical / functional layer: ***interoperation***	Technical standards Hardware and software connectivity User interfaces

Bottom line is that semantic interoperability should not have an On/Off switch. Rather, there can be varying degrees of semantic interoperability ranging from 0% (only technical/syntactic IOp, no SIOp) to 100% (full SIOp). This typically leads to different outcomes in terms of the usability of data and its effect on clinical and working practices, which is a critical characteristic of SIOp that needs to be reflected in the socio-economic analysis of this deliverable. The simple economic model presented in the next section is built on the grounds of this characteristic and allows illustrating the opportunities, challenges, and barriers to SIOp in the context of a common economic optimisation problem.

3 A simple economic model of semantic interoperability

As was made clear in the sections above, full SIOp does not subject to binary either/or conditions. We can have partial SIOp with (here simplistic) parameter values such as 'a little', 'some more' and 'a lot of'. Thus, the purpose of building such a simple, illustrative model of SIOp is to make a step towards answering a very concrete question: **"What is the optimal, or desired, level and degree of SIOp?"**

The answer very much depends on the point of view of the person answering. A researcher, desperately searching for vast quantity of data will probably plead for maximum SIOp, regardless of any side effects. Someone who has the job of data input, and whose task would become more demanding without any extra personal benefit will have an incentive to ask for as little change as possible, even if this means no SIOp at all.

For the model developed in this section, we use the perspective of society at large, not an individual stakeholder. In economic models, the society perspective is the sum of all individuals' perspectives, accounting for potential double-counts and other system effects. As has been discussed in the framework deliverable of this project (D1.1), many of the benefits expected from integration and interoperability will not be achieved at the individual level, they will only be realised when such a holistic, system-wide perspective is adopted. This approach is also consistent with serving the needs of the main target groups of the SemanticHEALTH project – eHealth research programme managers and eHealth policy makers at national and supra-national (European and global) level.

3.1 Setting the scene – SIOp as a service

In a way, SIOp can be seen as a service, which can be provided in different degrees. We assume that generally more interoperability is better than less. Providing a certain degree of this service brings a certain benefit (financial and other) and comes at a certain cost (also financial and other). In the literature, the cost side is often treated as a barrier or challenge, in pursuit of the ultimate goal – maximum provision of the service, i.e. full semantic interoperability. What has been made clear by this project, discussed in detail in other deliverables as well as at the Copenhagen workshop, is that this 'ultimate goal' (i.e. 100% SIOp) is not desirable at the present stage. So, the obvious question to ask is "How much SIOp should we initially aim for?" The answer, from an economic perspective and from a system's point of view, can be found by analysing more closely the costs and benefits associated with providing the 'service' of SIOp.

The first step is to estimate the shapes of the cost and benefit curves of providing SIOp. This is, how do the costs and the benefits change when we change levels (partial and full SIOp) and degrees of partial SIOp? The next step is to identify the optimal degree of partial semantic interoperability. It is a necessity that benefits exceeds the costs but not a sufficient characteristic at this point. Here, the comparison between marginal cost and benefits is the economically important measure. As long as the cost of providing one more 'unit' of a product or service is less than the benefits this brings, the quantity of service or product provision should be increased[1].

The following table will be later used to summarise the expected benefits and costs for the three different use cases analysed by this project, which correspond to work packages 4 to 6. It relates the various levels of SIOp (as described in chapter 2.2) to the three key purposes of medical information re-use, namely clinical care, public health and research (see chapter 3.5 for the completed table).

[1] For a more detailed discussion on optimal levels of provision and marginal costs and benefits, see Varian, H.R., "Intermediate Microeconomics: A Modern Approach", 6th ed., Norton, 2002

TABLE 1: SUMMARY OF COSTS AND BENEFITS FOR VARIOUS LEVELS AND PURPOSES

Information Reuse for	Purpose 1: **minimal data set purposes**	Purpose 2: **direct patient care purposes**	Purpose 3: **public health purposes**	Purpose 4: **research and knowledge sharing purposes**
Level 0 No SIOp ($\mathbf{D^0}$)				
Level 1 No SIOp but Technical IOp ($\mathbf{D^0}$)				
Level 2 Partial SIOp with varying degree of SIOp ($\mathbf{D^x}$)				
Level 3 Full SIOp ($\mathbf{D^{100}}$)				

3.2 Assumptions of the model

In order to keep the model concise and highlight the most important issues, let us consider the following abstract set up: We are looking at a population, or society, of 10 individuals, 3 of whom are physicians, 1 is a researcher in the medical field, and the remaining 6 are either healthy citizens or patients at any given point in time. The society is faced by one severe disease, which has the potential to become a pandemic, and a few minor diseases, some of which include symptoms similar to those of the severe disease. Let us also assume, that any given level of semantic interoperability is utilised to the full extent. For example, if a doctor can use and understand the researcher's information, he or she will always do so. Some may see this assumption as trivial, yet it is a critical factor for the realisation of benefits. We will return to this issue later on.

An important feature of the model is that it is static. We have already established that SIOp is a dynamic process, which is one of the biggest challenges for achieving sustainable levels of SIOp (see D1.1). However, this static model is serving the purpose of analysing the socio-economic aspects to be included in the final roadmap. The beauty lies in the model's simplicity, which allows for the various issues to be illustrated in a clear and concise way.

Important Reminder: Last but not least, the reader should be aware that none of the concrete numbers presented below are based on any rigorous research. They are illustrative figures and are not to be understood as statements about the actual value of different benefits. The same applies to the functions taken to construct the cost and benefit curves. Their goal is to illustrate a specific type of curve shape, not the actual shape of the specific curves.

3.3 The cost curve

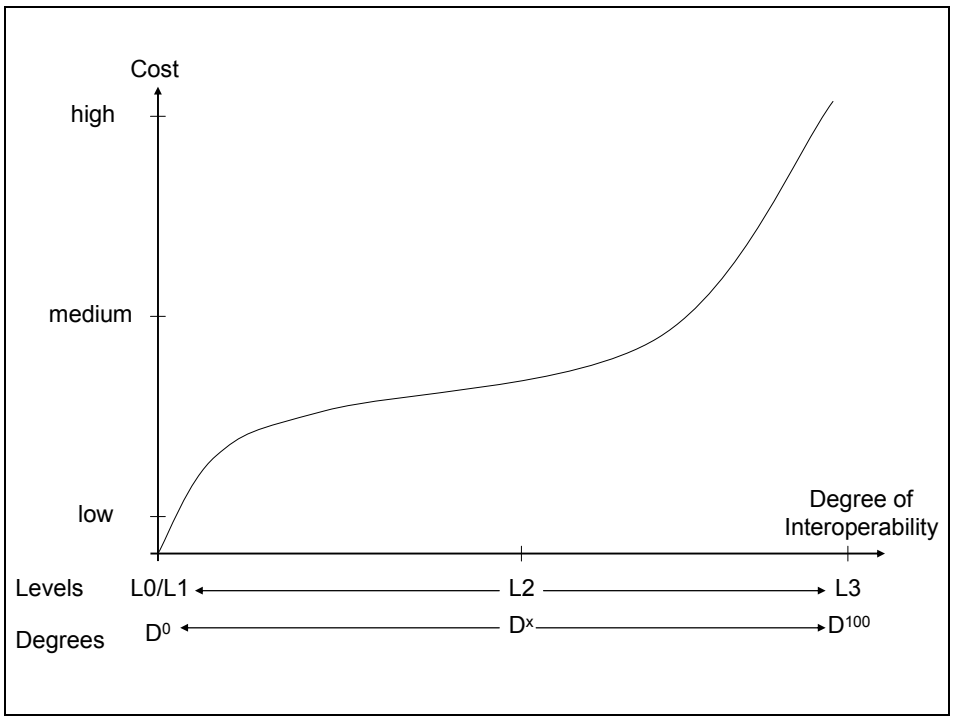
The shape of the cost curve of SIOp is not sensitive to the assumptions regarding utilisation and to whether the model is static or dynamic. It is derived from real-life observations, on which a wide consensus in the research community exists. The easiest way to think about this in a less abstract way is by using the following example: Consider a scenario where members of various institutions and countries come together to try defining an ontology for about 1000

medical concepts. This ontology is being regarded as the core interchange format to seamlessly exchange medical information. The following assumptions can be made:

1. The minimal set of terms includes more than few to allow meaningful semantics.
2. The costs to agree on the first x% of terms is relatively low, as this are the "easy" terms, that do not need long negotiations (this is only an example and the exact value of x is currently unknown). However, even a low number of agreed terms will lead to a considerable benefit increase.
3. The less terms are left to agree on, the more costly (in terms of time and money) it will become to agree. The costs to agree on one more term are increasing with every term already agreed on.

Given the complexity of the topic, the actual cost function is more likely to be exponential rather than quadratic, yet this detail has to be investigated separately. The critical point is that the costs of achieving more SIOp are multifaceted. It starts with a steep rise until a limited but useful degree of SIOp is reached. These initial costs are considerable but level out when the process is well established. However, costs will rise again, this time at an increasing rate, when the "easy" parts of SIOp have been achieved and more controversial aspects need clarification. Whether or not a degree of 100% (equals full SIOp) will ever be achieved, independent of financial sources, remains to be discussed. This yields a cost function of the shape as shown in the graph below. Assuming that zero interoperability does not create a cost, the curve will start at the origin.

GRAPH 1: SHAPE OF THE COST CURVE OF PROVIDING SEMANTIC INTEROPERABILITY



The points on the x-axis in the above diagram are indicators for semantic interoperability levels (L0/L1: no SIOp, L2: varying SIOp and L3: full SIOp) and degrees of varying SIOp, with a range between 0 and 100% (see also chapter 2.2).

3.4 The benefits curve

Estimating the behaviour of the benefits curve is more difficult. The end result is similar – under the assumption that any given degree of available SIOp is used to its full potential (or at least very close to it) the benefits curve will also be a curve (as opposed to a linear function). However, the benefits will eventually increase at a decelerating rate.

Consider the set up described in sections 3.1 and 3.2 above and a world in which there are two well defined levels of SIOp. The first level L2 (L0 and L1 describe levels of no SIOp in our model, see chapter 2.2) is a state of affairs in which a small subset of items in an electronic health record is recorded and understood by all three doctors in one and the same way (partial SIOp). This subset may include, for example, demographic information, allergies and certain vital signs. Various degrees of SIOp $\mathbf{D}^{x}$ ($0\%<x<100\%$) are imaginable, depending on the quantitative support of items. The second level L3 involves a common understanding of the full medical record, including the complete medical history and items that are less common than blood pressure or temperature. Both, costs and benefits of SIOp and information reuse in the levels L3 and L4 have to be evaluated for different purposes, namely

- Creation of a minimal data set (Purpose 1, P1),
- Delivery of direct patient care (Purpose 2, P2),
- Provision of public health (Purpose 3, P3), and
- Research and knowledge sharing (Purpose 4, P4).

In our previous example, all three doctors diagnose a sudden occurrence of a severe disease and record all available information in a semantically consistent and interoperable form. This leads to a public health warning as soon as 3 out of the 10 people in our abstract world suffer from the same disease. For research purposes, not only the population is warned of the danger of a pandemic in time, but selected people from the research community can access and use the information for the discovery of a more efficient drug, or even a vaccination that will virtually kill the severe disease.

The creation of a minimal data set (P1) is the first step in allowing limited data exchange, SIOp and information comparison/analysis. It does by no means allow full SIOp; even the degree of partial SIOp would be very low on the above given scale. However, it is a relatively simple and quick way to establish highly restricted SIOp between a manageable number of participants, especially in domains that are not supported by existing standards, such as palliative care.

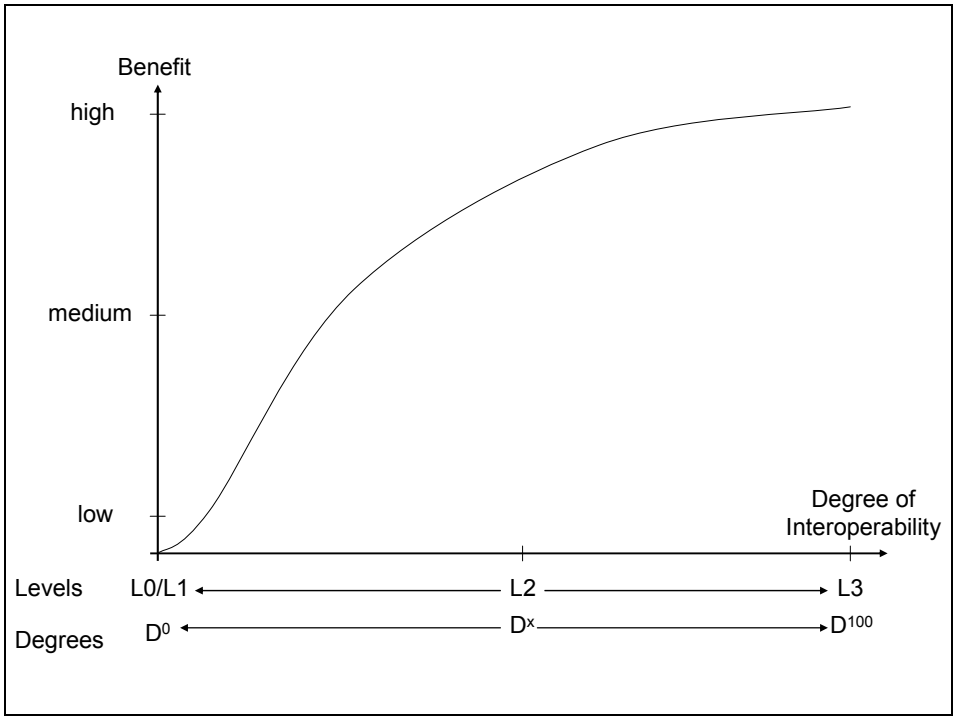
Although it does not require full SIOp by any means either, the benefit from P2 is delivered at the point of care and is shared between the patient and the treating physician. For example, the physician benefits from the time saved by avoiding an allergy test (freeing time for another patient or for leisure); the patient also benefits, as she is treated faster, so suffers less, and is not exposed to the risk of an allergic reaction in case an allergic test is not made when it should have been.

Achieving P3 brings additional benefit. For example, the doctors can now share the information and specialise in certain fields. They can still treat their patients for all diseases, as collaboration with the other physicians is easy. This leads to more effective and more efficient workflows for the doctors. The extra benefits from P4 are even higher – an early warning leads citizens (all but the already diseased 3 who trigger the alarm) avoiding the disease, say by staying at home. Apart from the benefit as citizens, the three doctors also benefit from participation in early detection, as a pandemic leading to several of their patients dying is less likely. Further, the researcher in P4 may already use the available statistic to guide her research.

As already stressed, it is not the exact numbers that are important, but the relative size of the benefits form having a certain level of SIOp. If we plot the benefits against the degrees of SIOp, we can get an impression of the shape of the benefits curve. The benefits curve starts rising with a slight delay as minimal degrees of interoperability will not lead to a significant benefit. However, once the SIOp degree reaches a specific value (which is unknown and has

to be researched), the benefits start raising exponentially before settling on a higher level and slowly increasing while the degree goes towards 100%. Summarising the benefits curve, high benefits can be reached quite quickly already with lower degrees of SIOp; however, increasing the degree of SIOp in the second part of the graph does not increase the benefit at the same rate. This is shown in the graph below.

GRAPH 2: POTENTIAL SHAPE OF THE BENEFITS CURVE OF SEMANTIC ITEROPERABILITY



3.5 Relative position of the cost and benefit curves

The sections above described why we believe that the cost and benefit curves are shaped the way we present them. This section deals with their relative position to one another. The likely positioning is drawn from the knowledge and experience gathered during the eHealth IMPACT study[2] and following private research of the study team. The various levels, ways of achieving, and other characteristics such as symmetry as described in detail in D1.1 make it clear that we can realistically speak of a continuum of development in SIOp, rather than discrete units.

The consensus in the eHealth community, and practitioners do not seem to oppose it, is that the benefits from properly utilised SIOp will exceed the costs, at least on a society, or system level. Thus, we are looking at a benefit function that is eventually above the cost curve on a money-against-SIOp diagram.

However, the specific shape of the curves is essential for constructing a complete picture. Different shapes have different consequences regarding recommendations for further activities. Consider a situation as depicted in Graph 3 below. It clearly shows that very low levels of SIOp are associated with costs that are higher than the benefits, making it very unattractive for consideration. However, the more SIOp is being achieved at slowly rising costs, the higher the benefits are until we reach a stage where the cost increase dramatically and the benefits changes are negligible.

[2] eHealth IMPACT: Study on the economic impact of eHealth, www.ehealth-impact.org

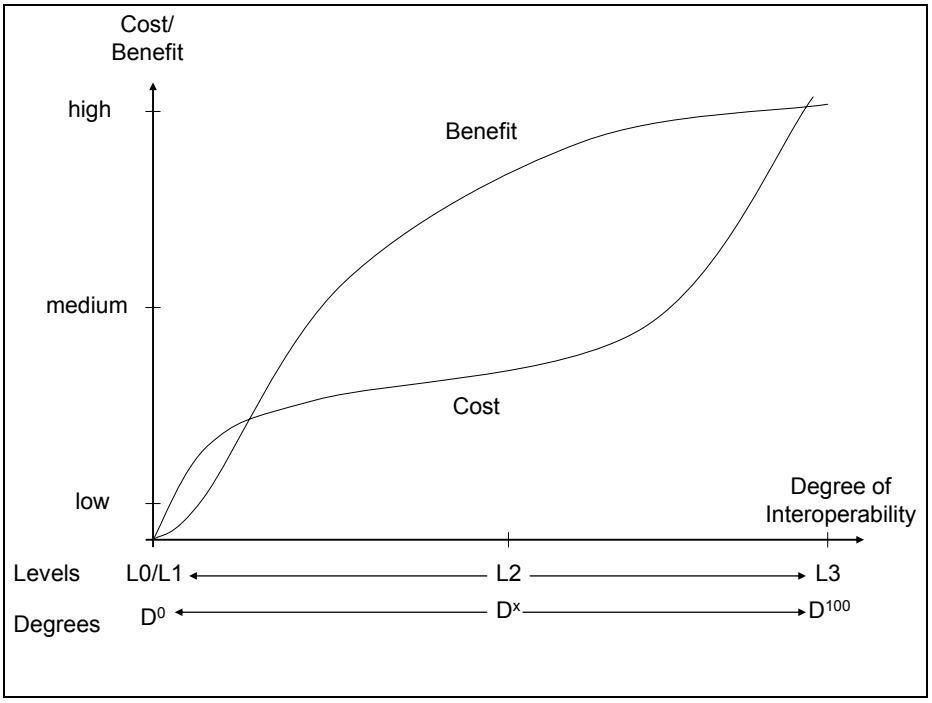
The following table summarises the expected benefits and costs for the three different use cases analysed by this project, elaborated into the four purposes of information use described above, which correspond to work packages 4 to 6.

TABLE 2: SUMMARY OF COSTS AND BENEFITS FOR VARIOUS LEVELS AND PURPOSES

Information Reuse for	Purpose 1: **minimal data set purposes**	Purpose 2: **direct patient care purposes**	Purpose 3: **public health purposes**	Purpose 4: **research and knowledge sharing purposes**
Level 0 No SIOp (**D^0**)	n/a	n/a	n/a	n/a
Level 1 No SIOp but Technical IOp (**D^0**)	Initial Cost: **L** Initial Benefit: **L**	Initial Cost: **L** Initial Benefit: **L**	Initial Cost: **L** Initial Benefit: **L**	Initial Cost: **L** Initial Benefit: **L**
Level 2 Partial SIOp with varying degree of SIOp (**D^x**)	Added Cost: **M** Added Benefit: **H**	Added Cost: **M** Added Benefit: **M**	Added Cost: **M** Added Benefit: **H**	Added Cost: **M** Added Benefit: **M**
Level 3 Full SIOp (**D^{100}**)	Added Cost: **H** Added Benefit: **M**	Added Cost: **H** Added Benefit: **H**	Added Cost: **H** Added Benefit: **M**	Added Cost: **H** Added Benefit: **H**

Given the assumptions made, the resulting benefit and cost curves will be shaped as illustrated in graph 3 below:

GRAPH 3: COSTS AND BENEFITS OF SIOP



A distinct and very important potential feature of SIOp becomes apparent – until a certain degree of SIOp is reached, the costs are higher than the benefits. This would have four implications:

(1) If the degree of SIOp at which benefits exceed costs cannot be reached, there is no case for working towards SIOp at all;

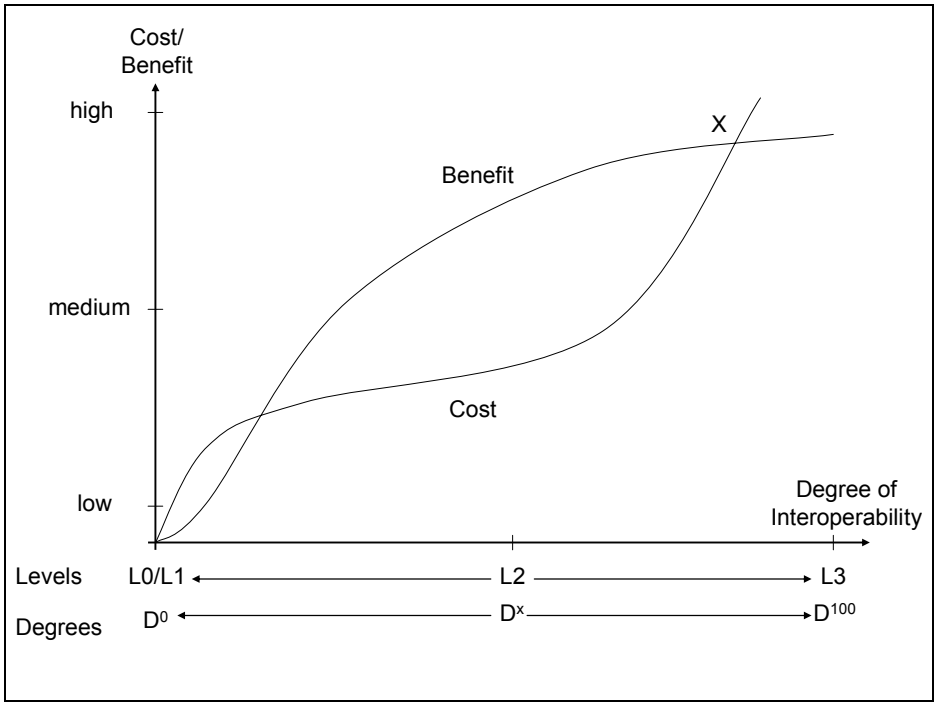
(2) The mathematically calculated optimal degree of SIOp must be higher than the point of intersection of the two curves in order to be an optimal point from an economics point of view;

(3) Every effort should be made to reach the optimal point as quickly as possible, in order to minimise the time during which a negative net benefit is accumulated, i.e. the time during which costs exceed benefits;

(4) As soon as the optimal point is being reached, the increase of costs to provide significant benefit changes is economically not desirable.

As mentioned before, all numbers and curves in the previous diagrams are purely theoretical and lack any thorough foundation due to the many unknown factors and influences which need further research. As a result, a picture depicted in Graph 4 (see below) is another hypothesis, where the costs and benefits curve cross before they reach the highest degree of interoperability. In such a case it is economically not feasible to further force an increase in SIOp as the costs would outweigh the benefits.

GRAPH 4: COSTS AND BENEFITS OF SIOP – OPTIMAL DEGREE



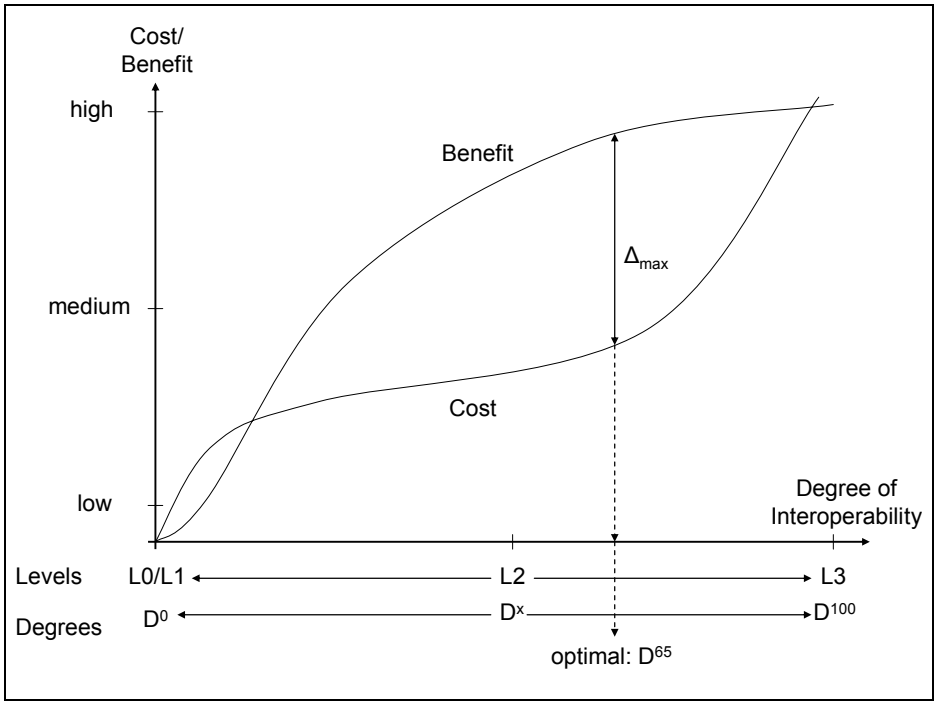
3.6 The optimal degree of SIOp

Given the model presented above, we are now in a position to give some insights on the optimal, or desired, level of SIOp that we should aim for. As already indicated, the optimal degree is not simply where benefits are largest. Neither is the case that we should want more and more SIOp as long as the total benefits exceed the total costs. It is the marginal costs and benefits that are decisive. That is, the additional costs and benefits associated with one extra

'unit' of SIOp. Using the above assumed graphs for costs and benefits, we can clearly identify the optimal degree of interoperability. In the case of Graph 5 (see below), this would be the point were the difference between the costs and benefits graph is highest, in our example at around 65%.

(**Important Note:** It is important to note again that the given numbers are exemplarily in order to demonstrate the above given analysis. The specific number of 65% is in no way accurate, meaningful or even validated.)

GRAPH 5: COSTS AND BENEFITS OF SIOP – OPTIMAL DEGREE



The rationale behind the idea is that as long as it costs less to increase the provision of a service, in this case SIOp, by one 'unit' than is the value of the gain from that same 'unit' extra service, it makes sense to provide it. If the marginal cost exceeds the marginal benefit, then the money is better spent elsewhere.

In economics, "the margin" is a guiding concept of solving optimisation problems. The marginal cost is the change in total cost resulting from increasing output by one unit. In other words, it is the cost of providing one more unit of output. Similarly, marginal benefit is the change in total benefits from increasing output by one unit. The rationale behind marginal costs and marginal benefits is that they define the optimal level of output.

Imagine the following example that illustrates the concepts of marginal cost and marginal benefit:

Example:

A local pottery produces 100 coffee cups every month. The marginal costs are the extra costs to increase the output to 101 cups. Let us assume that these additional costs are 3 euros. Once the output is 101 cups, the marginal cost of production will be the extra cost to increase the output to 102 cups. This time, the marginal cost may be 4 euros, because the firm has to buy an extra box of paint. The 103rd cup will cost an extra 5 euros.

Output	100 cups	101 cups	102 cups	103 cups
Marginal Costs		€3	€4	€5
Total Costs	€100	€103	€107	€112

Similarly, there is an extra benefit by increasing the output from 100 cups to 101 cups, or from 101 cups to 102 cups. Let us assume that the marginal benefit from the 101st cup is 5 euros (e.g. the price for which it can be sold). The 102nd cup can only be sold for 4 euros, the 103rd for 3 euros.

Output	100 cups	101 cups	102 cups	103 cups
Marginal Benefit		€5	€4	€3
Total Benefit	€250	€255	€259	€262

If the company produces the 101st cup, it will gain an extra benefit of 5 at an extra cost of 3 euro. This leads to a net benefit of 2 euro, so it is worth increasing the output to 101 cups. The company should increase output for as long as the extra benefits exceed the extra costs of doing so. If the company produces the 102nd cup, it will gain 4 euros at a cost of 4 euros. This is where the company is indifferent to changing the output, i.e. it does not make a net gain, but it does not make a loss either. The 103rd cup will generate a net loss – it creates additional costs of 5 and a benefit of only 3 euros.

Output	100 cups	101 cups	102 cups	103 cups
Total Benefit	€250	€255	€259	€262
Total Costs	€100	€103	€107	€112
Marginal net gain		€ 2	€ 0	€ -2
Net Benefit	€150	€152	€152	€150

An output of 102 cups in this case is optimal because: If reduced to 101, the extra benefits exceed the extra costs, so it will be beneficial to increase output. If increased to 103 the extra benefits are less than the extra costs, so it is beneficial to reduce the output.

Mathematically, the marginal cost and benefit curves (functions) are the derivatives of the total cost and total benefit curves (functions) respectively. On a money-against-output chart, the optimal output is defined by the crossing of the marginal curves. This is where the difference between total costs and total benefits is largest. If the output is less, the total net benefit (benefits minus costs) will be less because the lost benefit from producing one unit less is more than the costs saved. If the output is increased, the total net benefit decreases again, because the extra costs exceed the extra benefits.

4 Socio-economic issues of semantic interoperability: defining the cost and benefit curves

4.1 Cost Benefit Analysis (CBA) for eHealth in general – not only for SIOp

Reaching high levels of interoperability is a resource-intensive task. It is therefore important to measure the impact of it has on the overall eHealth investments. The general economic challenge of investing in ICT in the health domain is to maximise the benefits from eHealth, given the constraints in resources. Interoperability plays a significant role in this optimisation equation. (S)IOp is often essential in realising the benefits from eHealth investments, but it also consumes a significant share of the available resources. Given this position, the analyses regarding the socio-economic aspects of SIOp should be imbedded in overall CBA that accounts for the impact of eHealth solutions on the quality and effectiveness of, and access to health services and citizen's health. The position of SOIp must then be highlighted in the overall context. As an illustration, consider the example in the box below:

Real Use Case Example[3]: IZIP - Internet Access to Patients Health Records

IZIP is a web-based citizen health record system, active across the Czech Republic. The electronic health record includes relevant information about contacts of the citizen with healthcare services, from regular GP visits to complicated surgery. The principal objective of IZIP is to provide comprehensive 24/7 access to medical data for insured citizens and healthcare providers. Only the citizens themselves can authorise healthcare professionals to view their data, converting citizens to an active participant within the healthcare system and provides him with a gate-keeping role. Data uploaded by authorised healthcare professionals

A socio-economic evaluation showed a strong positive overall economic return. Control and more effective care are the benefits to citizens, estimated at about 10% of total gains. Professionals profit from on-demand information and time savings, some 37% of benefits. The biggest partner of IZIP, the General Health Insurance Company of the Czech Republic benefits from avoided duplicative tests and treatment to 53% of the economic benefits. It took 7 years to achieve a net benefit on an annual, and 8 years on a cumulative basis. The estimated net benefit in 2008 exceeds €60 million.

The main cost factors of developing the system were the costs of organisation and change in working practices. Agreement on the structure of data entry, codification systems, and concepts to be used – all factors of SIOp – was a significant challenge. The technology challenges, although not trivial, did not pose a comparable risk to the success of the system.

The benefits factors identified by the eHealth IMPACT study include:

Benefits for the citizens:

- Control over medical record, better information
- More appropriate treatment - avoiding unnecessary interventions and adverse events
- Time savings - faster treatment and recovery

Benefits to Healthcare Provider Organisations (incl. GPs):

- Improved effectiveness - better results of care

[3] Based on: Mladek et al. (2007) Empowering citizens - assessing the impact of a web-based nation-wide patient record system, Journal of Telecare and Telemedicine; and eHealth IMPACT Case Study report on IZIP, available at www.ehealth-impact.og

- Time saved – preparation, information search, more clients
- Reductions in avoidable errors, e.g. from illegible handwriting

Benefits to third party payers:

- Avoided unnecessary visits and examinations
- Better and more targeted drug prescriptions
- More transparency in the health system, quality control.

Significant success factors were the voluntary involvement and engagement of affected stakeholders; addressing the needs of citizens, including the need for effective healthcare, implying meeting the information needs of professionals; and a pragmatic approach based on patience, achievable short term goals, and a flexible long-term strategy.

As becomes evident from the observations, and the nature of the benefits in the example above, the primary focus of the IZIP system is rightly the improvement of health services, not even an eHealth application by itself. SIOp is necessary feature in such a system, but not a sufficient one. SIOp by itself, i.e. without the technical and organisational development around it, would not have led to these benefits. This shows why we have to think beyond the pure SIOp availability and analyse the impact of semantically interoperable systems. Also, apart from the purely economic or financial implications, we have to take into account a number of related aspects that affect the overall cost-benefit position.

Organisational aspects are a complex dimension. They include:

- Changing care pathways that need new information, skills, knowledge and process in health care providers
- Increased collaborative working and exchange of information between providers
- New relationships between citizens and healthcare professionals and organisations

Such issues will have an impact on whether and how solutions will be implemented, and the potential implementation will often dramatically impact on organisational structures at the level of healthcare provider organisations (e.g. changes in power relationships and hierarchy), at the regional level on relationships and interactions among healthcare provider organisations (HPO), and also at the health system level (like globalisation of healthcare services). And implementations may fail when such considerations are not already part of the RTD and diffusion process.

Looking at another dimension of organisational issues, work flow/process organisation will equally be impacted upon.

It is known that **professional culture issues** are a key factor in health services. This concerns first of all the great diversity of attitudes, behaviour and knowledge exchange among professional and non-professional staff involved in healthcare, and the impact this has on the quality, efficiency and processes of services. Even among wards in the same hospitals this may differ considerably, and it quite often differs already among hospitals in the same region. Differences are more pronounced as a factor of nationality or country, respectively the idiosyncrasies of regional or national healthcare systems. Education and training, professional standards and bodies, rules and regulations, attitudes and behaviour all have an influence here. We may also expect that in future, ethnic diversity will play a larger role than presently in most Member States.

Stakeholder involvement is also a key factor to be considered here. This involves issues such as how to increase awareness of overriding, societal benefits arising form semantic

interoperability and motivate stakeholders to become an active part of relevant processes and organisations to foster interoperability.

4.2 Factors affecting the SIOp cost curve

4.2.1 The underlying problem

The underlying problem to define the characteristics and gradient of the cost curve is that the factors affecting it are rather multifaceted and difficult to predict. Many variables play important roles and affect the curve as semantic interoperability in dissimilar health delivery systems is currently not sufficiently detailed in terms of objectives, timelines, languages and cultures. SIOp in health has to cope with a large number of highly dynamic systems, not only on an international level, but even more on national, regional and even intra-enterprise (e.g. departmental) levels.

To evaluate the total costs to enable various degrees of partial SIOp, estimates of investment sizes are necessary, which are currently highly imprecise within the healthcare domain. On the other hand, estimates of potential ROI (return on investment) by implementing SIOp are unrealistic and have to be further investigated.

Another considerable problem lays in the synchronisation of applications over time and their implementations as well as maintenance tasks such as updates. These are typically not one-off tasks but rather need continuous attention whenever updates are available (e.g. SNOMED update cycles). These synchronisation efforts, including localisation and customisation, have to be coordinated between institution, regions and countries. This adds the dynamics that were left out of the simple model presented in the previous chapter for the purpose of simplicity.

Last but not least, an important aspect that needs to be discussed includes the search for solution providers. Is one global monolithic provider the ideal situation (maybe with local agents or branches) or should independent solution providers be responsible for implementation and inter-provider synchronisation?

4.2.2 Challenges and respective cost factors

To further drive the adoption of SIOp between healthcare systems, the answer to the following questions are of eminent importance:

Implementation of SIOp:

- To begin with, we need to know where we are on the money versus SIOp chart. Similar to the fact that SIOp is a matter of degree (at least at the present moment), to what degree have existing terminologies, classifications and ontologies been integrated to allow for the envisaged degree of SIOp? Working this out requires certain analyses that come at a certain cost.
- What options are available to strengthen (even enforce) political cooperation, especially on the health policy layer? Most ministries have a small team of people and commit resources without a coherent framework. Coordination of these often disparate activities requires appropriate allocation of working time, which is a cost measured in Full Time Equivalents.
- The translation and localisation of terminologies (such as SNOMED) are key to adoption in all countries. Who is paying for the initial service? Terminologies are a dynamic, constantly changing environment; who will take care of the continuing maintenance processes and costs? How large will that contribution have to be, initially and on an ongoing basis? Translation and localisation thus comprise another cost item deserving a prominent place in the cost function.

- To allow SIOp, technical standards and detailed specifications have to be created, implemented and maintained. These are the pre-requisites of SIOp levels L0 and L1. Who pays for these additional costs to allow for seamless connectivity? And again, how much is to be paid?
- Industry involvement is crucial to the deployment of SIOp capable products in health. SIOp and market shares can't bind the customer. There are too many competing initiatives and whoever manages to deploy his standard first gets the big cake. This competition soon becomes a source of unproductive waste, so an effort is required to minimise this waste. This effort will be a cost factor.

Utilisation of SIOp

Given that benefits are related to using semantically interoperable systems, not the mere availability of the latter, efforts related to spreading utilisation should be included into the cost function. This partly deals with the assumption of the model that all available SIOp is utilised to its full potential.

- One of the key aspects in enabling SIOp is change management. How can we influence and support this matter, especially provide system thinking and optimise the care process? Additionally, changing the culture of healthcare is necessary to make the interoperable EHRs and other shared resources part of that culture. Training and education has to be adapted to meet the new challenges in providing SIOp. Evidence suggest that change management can comprise up to 40% of total eHealth investment costs[4], most of which related to assuring utilisation conform to SIOp requirements.
- What are possible (and in particular the right) incentives to those who will have to do the additional work? How much additional work is involved to allow for partial (full) SIOp? And who will most likely do the additional work: industry to implement SIOp, medical staff to provide metadata to allow SIOp and later use SIOp solutions, researchers to define SIOp? The additional work will have to enter the SIOp cost function in a complex way, accounting for all these possibilities.
- All participants in healthcare services have diverse responsibilities and interests. Currently, data collection is goal dependent, which restricts the opportunity for re-use and associated synergies. Typical examples of this aspect include the collection of clinical treatment data that is often different from treatment data for invoicing. The harmonisation of data collection practices will accordingly be a notable cost factor.
- What does SIOp mean for practitioners? Initially, it means that they (or their staff) have to do a lot of data entry for the benefit of others. Will a registration dividend affect the business models within healthcare? There is no immediate benefit for the local doctor to spend extra time, costs and effort to support SIOp. Only if the medical community as a whole embraces the idea of SIOp and collaborative working practices, and agree to take on the additional work, will SIOp become a success for the individual. Overcoming this barrier does not necessarily involve (although it can) direct expenditure, but necessarily comes at a cost – even educational work, explaining the situation and the size of benefits to come involves effort that can and must be measured.

4.3 Factors affecting the SIOp benefit curve

Timely access to accurate and consistent critical clinical patient/person information across the enterprise and healthcare system are a desirable goal. Its achievement will depend on the contribution of SIOp, so the benefit curve will be affected by **speed and consistency of, and timeliness of access to meaningful data**. The following is a preliminary list of issues that should be included in the benefit function that defines the SIOp benefits curve:

[4] based on the eHealth IMPACT study: http://www.ehealth-impact.org/

- The usability of SIOp systems is a key aspect in assuring acceptance by medical staff. SIOp has to facilitate transparency. Ideally, the users do not explicitly notice the extra effort needed to comply with the SIOp guidelines and have the feeling that they have **less work and maybe more time to spend** with patients or family.
- The use of SIOp applications has to lead to a **decrease in reaction time to global threats such as pandemics**. Global pandemics are considered a valid threat anytime soon and only by utilising SIOp based collaboration can we successfully fight the coming challenges.
- SIOp ensures that each doctor, or other medical personnel across discipline boundaries, reads and interprets patient information as well as clinical findings, treatment directives etc. in exactly the same and consistent way. This explicitly includes the conversion of information between different systems and countries (language) and the associated **efficiency and access gains**.
- The collaboration between different treating institutions is largely improved due to the availability of semantically relevant information. Doctors are able to share their results seamlessly and **avoid duplicate investigations**.
- The integration of the individual patient into the care&cure process is of utmost importance in reaping the full advantages of SIOp. Homecare, responsibility, ubiquitous access to health values need the help of the informed patient and close communication with the medical staff. SIOp aimed at the patients **improves the doctor-patient relationship** and is critical in **strengthening the role of the patient in improving health services.**
- Applying SIOp concepts to the daily tasks of medical staff will ultimately lead to **faster implementation and adoption of new treatment guidelines**. Although this is needed immediately, results will only be visible once SIOp applications are used and applied for some time.
- Further benefits from SIOp are derived from being able to use richer clinical detail in electronic records for the purposes of classification, leading to improvement and greater confidence in information used for **audit, planning, and performance management**. Here too, the shape of the benefits curve will be affected by the speed of uptake of SIOp and the scale effects that result from this.[5]

[5] A more comprehensive list of the benefits of semantic interoperability is presented in chapter 3 of the Canada Health Infoway 2005 report: EHR Semantic Interoperability Benefits.

5 Conclusions and policy recommendations

This document introduces a simple economic cost-benefit model intended to assist in decision making. It is a simple model, presenting a first step towards a much needed thorough treatment of the subject. Nevertheless, it does provide the framework in which all economic, social, legal, regulatory, etc. issues affecting the costs of and benefits from achieving SIOp can be investigated, leading to better informed decisions and actions. The analysis presented in the document suggests that considerable improvement of data for research and treatment (viatl for benefit realisation) can only be achieved after high investments in money and effort are made. Also, what seems to be at odds with prevailing opinions, the analysis reveals that at some point the costs of further improving the SIOp of data are not justified by the extra benefits this brings. Currently, activities seem to be far from that point, so the quest for more SIOp is still valid and desirable.

From the view point of this socio-economic factors work package, the recommendations for the further work towards SIOp are three-fold:

a) Recommendations on further work to convert this Cost Benefit Analysis (CBA) model into a realistic and pragmatic tool facilitating policy and other decision making.

b) Recommendations stemming from first generic observations based on the presented model.

c) Recommendations on investigating and adjusting private incentives, in order to ensure sustainable developments in the field of semantic interoperability.

5.2 Recommendations for development of the CBA model

The foremost task in establishing a roadmap for semantically enabled collaboration between professionals in the field of medical treatment, surveillance, and research is the thorough definition and detailed set up and description of a dynamic model for analysing the costs and benefits from SIOp. As mentioned in this document, the earlier given cost and benefit curves are solely for demonstration purposes and are not based on any statistical data. It is strongly recommended to address and include the following issues in the process of model creation. The following issues shall be also considered for the final roadmap:

- **The shape and position of both, the cost and the benefit curves, should be analyses after sufficient data on the factors affecting them is gathered. Ideally, the mathematical functions defining the curves will be calculated on the basis of a sufficiently large data set processed by econometric techniques.**
- **The model has to be further developed to account for the dynamic nature of SIOp. Introducing a time dimension is a challenge, yet not impossible.** Health Information Systems – and in particular Electronic Health Records – are a highly dynamic system in a constantly changing environment. This should be reflected in the CBA model.

As part of the process, the following issues need to be addressed:

  - The size of investment and potential return on investments (as presently assumed) are solely based on imprecise estimates. A more thorough investigation is recommended to provide an empirical basis and rigour to the CBA model.
  - The current problem space is not sufficiently detailed in many aspects including objectives, timelines, language/cultures and dissimilar health systems. Especially the issue of highly heterogeneous language/cultures and varying health systems among the EU Member States is of utmost importance and needs to be discussed in order to be included in the model. This affects mainly the cost curve.

- The issues around legal liabilities, imprecise representation of terminological knowledge are currently unknown and need further investigation. On the one hand, legal and regulatory uncertainty poses a risk, which affects the cost curve. On the other hand, SIOp may help reduce the risk of unsafe expression and/or derivation, which will have a positive impact on the benefits curve.

5.3 Recommendations on the basis of the CBA model

The successful definition of the CBA model is the basis to find the optimal degree of SIOp as described in this document. It is important to mention that it is expected that the optimal degree of SIOp is not equivalent to the maximum level of SIOp. Although maximum interoperability is often considered to be the ideal situation, initial considerations do not support this idealistic view. **The future technical and organisational developments should be guided by the results of the CBA, and in particular the estimation of optimal degree of SIOp.** The following issues are important in this context and should be addresses in the final roadmap recommendations, at least as issues to be further investigated with the support of the CBA model:

- What impact do the initial observations on the basis of the CBA model have on the desired end-point of the SIOp roadmap? Is the proposed path viable and achievable within the given timeframes? Where do we have to adapt and correct in order to make semantic interoperability possible within the given boundaries?
- The synchronisation of implementations and maintenance of SIOp solutions, initially within institutions, but subsequently within regions and nations, is complex but necessary. Semantic interoperability comes at a cost, initial as well as continuous. This cost has to be covered by the various stakeholders. The CBA framework allows allocating this burden in an efficient way.
- There has been a long standing argument whether SIOp is better achieved by a single (centralised) national centre or developing institute or a network of (decentralised) collaborating centres. Solutions and recommendations will be better justified with the help of the above mentioned CBA model and results thereof. The CBA analyses allow direct comparison of these and other options.

5.4 Recommendations for incentives for sustainable deployment

It is understood that developing the CBA model and providing recommendations on the basis of it are only initial, but highly important steps on the way to defining the SOIp roadmap. The above described CBA model can help to provide a basic cost benefit analysis for each stakeholder, which can be used as a foundation for further more-in-depth investigations and analysis of private (individual) incentive structures. Looking further into the future, it is important to understand and take into consideration the workflow and daily routine of medical personnel and to suggest incentives for a successful and sustainable deployment of the roadmap. **The core of the recommendation is to undertake a thorough investigation of incentives for development, implementation, maintenance, and utilisation of SIOp based collaborative practices.** The following questions illustrate the issues to be considered in such an investigation:

- What are the legal restrictions on recording/exchanging certain types of information?
- What are the incentives for the person who enters the data? When are these incentives visible to the person? Are these personal, institutional and or moral/ethical incentives?
- What are the short and/or long term impacts on the existing business/clinical/working practices affecting the stakeholder in question?

- Are effective data entry technologies available to support the techniques described in the roadmap? Are such technologies user friendly? How do the acceptance and learning curves among the medical community affect the potential and actual further development and uptake in the field of SIOp?
- What effects might the various languages and cultures among the Members States have on the sustainability of SIOp based practices?

In order to ensure sustainability of the SIOp developments, continuous cooperation among stakeholders, and thus realisation of benefits over time, individual (private) incentives have to be understood and if necessary adjusted.