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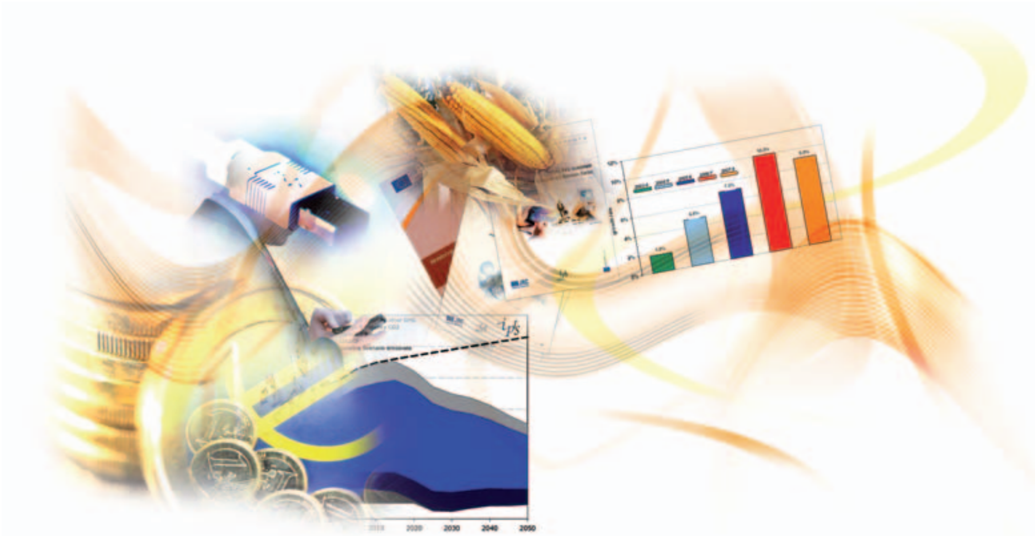
Distilling reality into a manageable form for evidence-based policy

Authors: Cristiano Codagnone and Francisco Lupiañez-Villanueva



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Preface and acknowledgements

This report presents the results of a multivariate statistical analysis performed by the authors on the data from the eHealth Benchmarking, Phase III survey. This survey, funded and managed by Unit C4 of DG INFSO, gathered data from a statistically representative sample of European acute hospitals in order to benchmark their level of eHealth deployment.

The authors, after placing it within the appropriate policy context and within the broader academic debate on benchmarking in a policy perspective as part of the Open Method of Coordination, have rigorously and transparently constructed a composite index of eHealth deployment by hospitals. They have also extensively discussed the results of the analysis and extracted implications and recommendations for benchmarking, evaluation and broader policy agendas in this field.

The topic covered falls within the scope of research activities carried out over the past three years by the Information Society Unit at IPTS[1] in the specific domain of eHealth, as regards its development and innovation dynamics and also benchmarking and evaluation.

The Techno-economic Impact Enabling Societal Change (TIESC) Action of IPTS IS Unit, in fact, manages since 2009 the three-year project Strategic Intelligence Monitor for Personal Health Systems (SIMPHS) and focuses also on issues of measurement and evaluation.[2]

As mentioned, the survey producing the data analysed in this report has been funded and managed by DG INFSO Unit C4. The authors, in representation of IPTS, were part of the steering board of this project and they have the opportunity to access and analyse the data as they became available.

We want, thus, to thank the Head of Unit C4 Lucilla Sioli for providing us such opportunity, the study Project Officer Virginia Braunstein for the support and collaboration during the realisation of this report, and Stefano Abbruzini (also from Unit C4) for useful comments provided on an earlier draft of this report.

We also want to thank Maria Del Mar Negreiro Achiaga, Project Manager of the Deloitte/Ipsos consortium that realised the survey, for her collaboration and availability.

1 IPTS (Institute for Prospective Technological Studies) is one of the 7 research institutes of the European Commission's Joint Research Centre.
2 See the core deliverable of SIMPHS 1: F. Abadie, C. Codagnone et al, (2010), Strategic Intelligence Monitor on Personal Health Systems (SIMPHS): Market Structure and Innovation Dynamics, available at: http://ftp.jrc.es/EURdoc/JRC62159.pdf

1 Introduction

1.1 From eEurope to Digital Agenda for Europe: eHealth remains a priority

In the descriptive and non-taxonomic definition provided in 2004 by the European Commission's eHealth Action Plan, eHealth is defined as referring to "*the application of information and communications technologies across the whole range of functions that affect the health sector' and including 'products, systems and services that go beyond simply Internet-based applications*" [1:4].[3] This definition more or less coincides with what in the US context and in many scientific journal articles is referred to as Health Information Technology (HIT).[4]

eHealth has been high on the European Commission's Information Society policy agenda for a decade: starting with the **eEurope** framework,[5] continuing into ***i2010 strategy*** [7], and today is part of Pillar 7 (ICT for Societal Challenges) of the new ***Digital Agenda for Europe*** (DAE) for the period 2010-2015 [8:29-30]. Actually, Commission support to what today we call eHealth (and earlier went under different names such as health telematics) predates its systematisation into general information society policy as it started in the early 1990s through co-funded research in the framework programmes and has continued since 2007 both through FP 7 and through the Competitiveness and Innovation Programme (CIP) deployment instruments. eHealth in 2007 was included among the ***Lead Market Initiatives*** and in 2011, it will be one of the first DAE Flagship initiatives with the European Innovation Partnership on Active and Healthy Ageing. It must be also stressed that healthcare challenges and the potential of innovation supported by ICT to tackle them, are expressly grounded in the 'smart pillar' of the overall ***EU2020 Strategy*** [9:10].

Stated briefly, the objective pursued by eHealth policy is to '*improve the quality of care'* and at the same time *'reduce medical costs'* [8:29]. This objective summarises eHealth's various promises, heralded for more than a decade (and very effectively reviewed in Lapointe [10]). These include among others:

- Reduce medical errors, drug adverse events and associated costs (i.e. through computerised reporting systems for adverse events, ePrescription of diagnostic procedures, electronic health records, etc);
- Improve adherence to prescriptions (through reminders and telemonitoring);
- Reduce in-patient costs while improving health outcomes (telemonitoring);
- Support and improve the work of professionals in various ways (picture archiving and communication systems, tele-radiology, computerised physician

3 An equally illustrative but more organized definition can be found in the report drafted by the eHealth task force in support of the Lead Market Initiative [2]. In this source, the various items of the Action plan definition are grouped into four categories: 1) Clinical information systems (specialized tools for health professionals within care institutions, tools for primary care and/or for outside the care institutions); 2) Telemedicine and homecare systems and services; 3) Integrated regional/national health information networks and distributed electronic health record systems and associated services; 4) Secondary usage non-clinical systems (systems for health education and health promotion of patients/citizens; specialised systems for researchers and public health data collection and analysis; support systems for clinical processes not used directly by patients or healthcare professionals. For a definition of Personal Health Systems (PHS), a topic that will be taken up again later, see Codagnone [3:8-9].

4 In fact, neither expression transmits its real meaning very well. 'eHealth' suggests only online applications, whereas 'HIT' seems to exclude them. 'ICT for Health' would be a better expression, yet we stick to 'eHealth' and/or 'HIT', given their more widespread usage.

5 This framework, whose opening volley was the 1999 joint European Council and Commission initiative [4], saw the launch of eEurope 2002 [5] in 2000 and then that of eEurope 2005[6] in 2002.

order entry, online transmission of clinical tests results);
- Streamline and make more efficient hospital administration (Integrated computerised systems for billing, order entry, discharging, etc);
- Increase access and convenience for users (eBooking, access to their electronic health records, portability of their information across the system, etc).

Naturally, the Commission is not the only stakeholder focussing on, and prioritising, eHealth and a recent study [11] has shown how an increasing number of Member States have developed their own eHealth strategies and supporting instruments. Industry is also very present with several initiatives and nine European Technology Platforms (ETPs).

These efforts in the domain of eHealth have resulted in increasing funding and investments (see *infra*), which require evidence on:

a) the actual deployment and usage of eHealth infrastructure and applications in the daily practices of the different healthcare system tiers (GPs, hospitals, laboratories, etc); and

b) the contribution of eHealth to the achievement of desirable outcomes (benefits) for a wide range of potential beneficiaries (clinical and health-related quality of life outcomes for end users, improved working conditions for professionals, increased efficiency of healthcare producing units to deal with the imminent scarcity of professionals and to maintain financial sustainability, positive spillover effects such as reduction in productivity loss due to illness or premature mortality, or new market opportunities for innovative ICT companies).

The first kind of evidence falls within the domain of Monitoring and Operational Evaluation (M&OE), whereas the second falls into Impact Evaluation *in the stricter sense*.[6] The M&OE system sets up goals and targets and identifies the indicators (and the corresponding data gathering) needed to verify their achievement. These data can be used in operational evaluation which focuses mostly on outputs. M&OE can also set targets related to the outcomes sought by a policy intervention, but it is outside of their scope to causally attribute such outcomes to the intervention. This would require a systematic and scientific attempt to prove that changes in target outcomes (effects) are due only to the specific intervention being evaluated and not to other causes.

Benchmarking of policy domains in an international perspective is clearly within the scope of M&OE, although in the case of the eHealth deployment index and of the hospital survey data discussed in this report it could potentially contribute, if not to impact evaluation strictly defined, at least to an implicit evaluation of the impact of eHealth (see § 2.2 and § 5.3).

1.2 eHealth in the Commission's benchmarking frameworks and activities

All of the three main phases in the European Commission's Information Society policy – ***eEurope*** for 2000-2005 [4, 5, 6] , ***i2010*** for 2005-2010 [7], and now the ***DAE*** for 2010-2015 – came with their respective benchmarking framework [15, 16, 17]. The treatment of eHealth in these benchmarking frameworks and the actual realisation of benchmarking exercises has not been as systematic as in other areas of the Information Society. In 1999, the following ambitious targets were identified for eHealth [4:14]:

6 See the 2010 World Bank Handbook on impact evaluation for an illustration of this distinction [12:7-22]. A similar distinction between 'Practical Measurement' and 'Scientific Evaluation' was introduced earlier (2009) in the Vienna Study [13:23-24]. See more on this topic also in [14].

By the end of 2000:

- Healthcare best practices in networking, health monitoring, surveillance of communicable diseases and in links between hospitals, laboratories, pharmacies, doctors, primary care centres and homes should be identified;
- The priorities to be agreed for a number of key pan-European medical libraries-on-line and healthcare expertise centres to be operational by the end of 2004;
- The priorities in the field of standardisation of healthcare informatics to be implemented by the end of 2000.

By the end of 2003:

- All European citizens should have the possibility to have a health smart card to enable secure and confidential access to networked patient information.

By the end of 2004:

- All health professionals and managers should be linked to a telematic health infrastructure for prevention, diagnosis and treatment.

Subsequently, when the benchmarking framework for ***eEurope 2005*** was established, not many of the above targets remained in the following two benchmarking indicators selected for the whole eHealth field [15:8]:

- Percentage of population (aged 16 and over) using Internet to seek health information whether for themselves or others.
- Percentage of general practitioners using electronic patient records.

In the next benchmarking framework defined for i2010, eHealth was treated in a somewhat generic fashion. It was mentioned only in the following: *"In the case of e-health, monitoring should be done with indicators developed in consultation with health specialists, as agreed at the first workshop"* [16:16]. In the new benchmarking framework for the period 2010-2015, endorsed in Visby in November 2009, a two-fold approach was envisaged:

a) use of online healthcare services (measured through the traditional Eurostat survey);
b) ad hoc surveys on the use of ICT by the healthcare system [17:11].

This same document mentioned the (at the time future) results of the survey of eHealth deployment in European hospitals that is the object of this report. For the first area of focus on online use of eHealth services, two indicators were selected[17:18]:

- Individuals using Internet to make an appointment with a practitioner;
- Individuals consulting a practitioner online.

No indicators, however, were proposed for the second area of focus on the use of ICT in the healthcare system.

Ever since 2001, the traditional supply-side benchmarking of online public services (eGovernment benchmarking) carried out on behalf of the Commission by Capgemini has included "health related services" among the 20 basic public services, scoring their level of availability and sophistication measured through a web-based assessment (i.e. public websites are scanned and their services given a score on the well-known scale from information to transaction). This cannot, however, be considered as anything close to a benchmarking of eHealth deployment in the healthcare sector, for it basically considers only two issues and measures whether they are mentioned in a website (the survey only checks their presence but does not test the actual functioning of the services). The first *ad hoc* survey producing some evidence on deployment of eHealth in the healthcare industry came in 2006 as part of a special module of the eBusiness

Watch.[7] Only in 2007 was a systematic approach launched and three studies were designed and then realised. One of these studies is the survey producing the results analysed in this report. The first was published in 2008 and provided the first comprehensive EU27 benchmark of the use of ICT among General Practitioners[18]. Then, in 2009, the second study was released, providing a state of the art of benchmarking practices in Europe and beyond on the basis of which a methodology for the benchmarking of eHealth deployment in hospitals was produced[19]. Next came the third study which produced the survey results analysed in depth in this report and more widely and descriptively presented in the Deloitte/Ipsos report [20].

1.3 Objectives and structure of this report

Compared to other areas of the Information Society, where benchmarking has been conducted more systematically for longer (i.e. eGovernment), it is evident that benchmarking of eHealth deployment is lagging behind.

In this context, the results of the eHealth Benchmarking, Phase III survey, carried out by Deloitte and IPSO on behalf of Unit C4 of DG INFSO, with the rich information provided on about 1,000 European acute hospitals, is a strategically important tool to close this gap. As we show in more detail later, this survey sheds light on key issues such as hospitals' deployment of ICT infrastructure, applications, and much more.

The reasons why benchmarking of eHealth deployment is lagging behind are structurally related to the multi-dimensional complexities of this field, to the relatively greater difficulty/costs of getting the data (i.e. data cannot come from web-based measurement, as it can for eGovernment benchmarking), and especially to the challenges of making sense of the data.

This report uses multivariate statistical methods to analyse with a selective but deep vertical focus the results of the above-mentioned survey. The objectives of this exercise are two-fold: a) to make sense of the results by constructing a composite index; b) to extract key policy messages and new directions for future research.

The main objective is the elaboration of a composite index of eHealth deployment with a view to proposing a roadmap towards systematised and replicable benchmarking. In addition, we also explore the possible link between benchmarking and eHealth impact.

Therefore, our focus is much more selective but deeper than the broader descriptive analysis produced by Deloitte and Ipsos [20]. In addition, we do not simply conduct multivariate statistical analysis but we put this into a conceptual and theoretical perspective and we follow it with a discussion of the results and with a set of policy and research recommendations.

This first introductory section is followed by four more. Section 2 provides the general conceptual and theoretical framework for benchmarking within an international policy perspective. Section 3 presents the data and the methodology used. In Section 4, we present and comment on the results of our multivariate statistical analysis. Finally, in Section 5 we discuss these results and extract recommendations for future research and policy making.

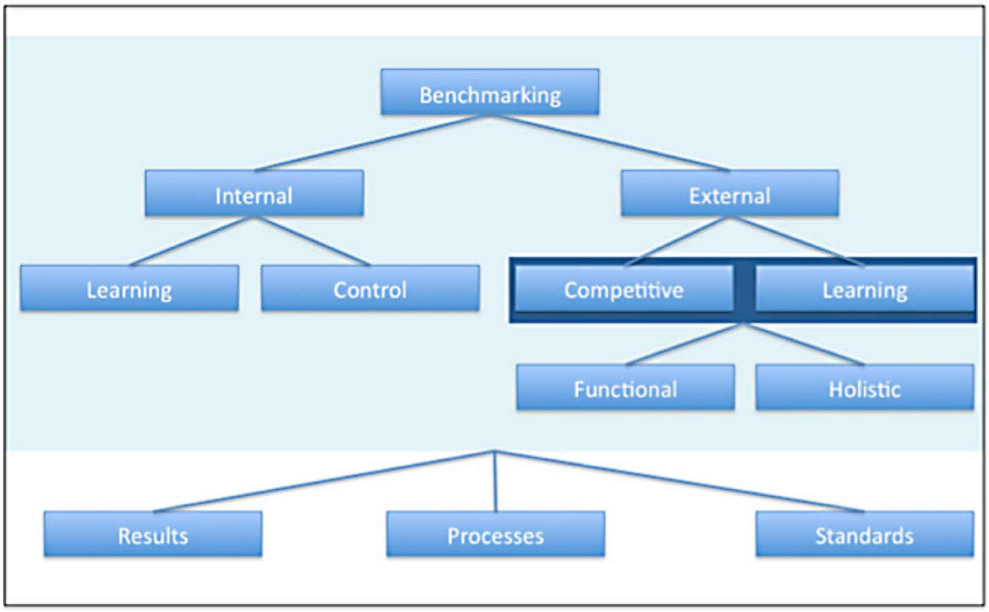
7 http://www.ebusiness-watch.org/

2 Overall conceptual framework

2.1 From management tool to policy instrument: the challenges

Like its predecessor (The Lisbon Strategy 2000-2010), the new ***EU2020 strategy*** will rely on the Open Method of Coordination (OMC).[8] Stated very simply (and possibly simplistically, but this is not a report about the OMC), this method is based on 'non-binding' policy instruments at the European level (i.e. communications, action plans, etc.) plus collective monitoring. The Commission and the Member States (MS) agree goals and targets and then, in the best application of the principle of subsidiary, the implementation of the actions needed to reach these goals/targets are left to the MS. However, steering and monitoring takes place, and periodic benchmarking is one of the tools used. Accordingly benchmarking has assumed a "quasi-regulatory" role and its merits and pitfalls have been widely debated [22, 23, 24, 25, 26, 27, 28, 29, 30]. So, while the use of benchmarking in a public sector context is not new [31], its growing importance at the European level is explained in view of the OMC context.

Figure 1: Benchmarking typology



Source: adapted from several sources [35, 36, 37].

One of the issues is how really applicable and useful, in a policy context, is an instrument that was originally designed and applied as a management technique in the private sector.[9]

8 See for a general introduction and review of this method [21].

9 Benchmarking as we know it today, at least as regards its original and more widespread usage in the private sector, was first formalised in the late 1970s by the Xerox Corporation, as recounted by one of its executives in an article published in 1992 [32]. Xerox used benchmarking to compare key dimensions of its business to those of Japanese firms. As a private sector technique, benchmarking originated mainly as a competitive instrument. The most popular definition in the management literature is that benchmarking is "the continuous process of measuring our products, services, and business practices against the toughest competitors or

Figure 1 summarises and simplifies the various distinctions between different types of benchmarking, which have been developed for the private sector but are also considered applicable to the public sector (for general reviews see for instance [36, 38, 39]). The important distinction, however, is between benchmarking used for competition/control purposes and benchmarking used for learning purposes. The distinction between functional (or specific) and holistic benchmarking refers to the unit of analysis (which organisations we measure). Functional benchmarking focuses on specific issues (task, function, process, product, etc), whereas holistic benchmarking focuses on an organisation as a whole, comparability allowing. Finally at the bottom of the figure we have the object of analysis (what we measure) which traditionally includes: a) results (any end point, be it an output or an outcome); b) processes (broadly defined to also encompass the inputs, tasks, etc; and c) standards or targets (setting a standard of performance or a strategic goal that an effective organisation could be expected to achieve). Please note that the benchmarking of results and of targets often overlap. Leaving aside these distinctions, benchmarking in the private sector is characterised by a number of features that are worth listing as they indirectly identify the differences (and increased difficulties) that emerge when benchmarking is conducted in the public sector, especially at the international level:

1. **Learning versus competition/control**. This distinction is very clear and the management literature cited above increasingly stresses that results benchmarking not matched by process benchmarking is not very useful to really understand what organisations should do to improve their performance and catch up with the 'best in class'.

2. **Comparability fairly easy to achieve**. It is relative straightforward to define comparability (industry, products, size, etc) and to freely select the appropriate sample of comparable units of analysis. It is a very different matter to compare an entire policy domain within countries, where it is not possible to freely select only those countries that are more comparable.

3. **Data constraints not very hard**. Finding the right data for measurement indicators and gathering them is a challenge for any form of benchmarking. In the private sector, however, data are more readily available on several possible objects of analysis (inputs, outputs, outcomes, processes, etc.) and they can rely on one standard and accepted unit of measure: the market price.

4. **Ownership and compliance less of an issue**. It is a voluntary instrument at least from the perspective of top management. Certainly, resistance (from middle managers; or from country branches toward headquarters) may arise and this suggests the need for a consensus building approach. Yet, the bottom line is that there are strong command and control levers in the private sector, not to be found in the same way in any sort of international benchmarking of policies.

5. **Optimal feasibility**. Benchmarking should maximise the relevance and validity of the indicators constructed through the gathered data and at the same time minimise the money/time costs needed to collect this data. This financial consideration is important in the private sector, although when a benchmarking is of strategic importance money and time tend not to be as constraining as they would be in the public sector.

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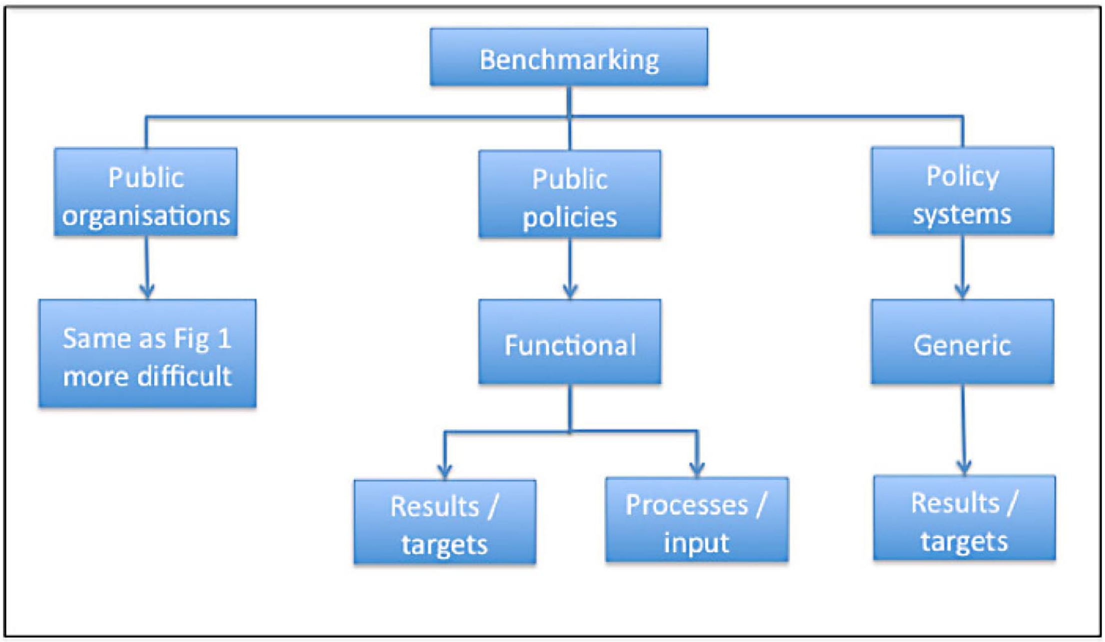
those companies recognized as industry leaders" [33:10]. A more elaborate definition is given by Cowper and Samuels: *"Benchmarking as an efficiency tool is based on the principle of measuring the performance of one organisation against a standard, whether absolute or relative to other organisations"* [34:11].

Figure 2: Public sector and policy benchmarking typology



Source: Elaborated from [39, 40].

In the benchmarking of public sector organisations and public policies, things are more complex as shown in Figure 2 (which cross-references the typology in Figure 1). Benchmarking a comparable sample of public sector organisations with respect to a given object of analysis (i.e. service output) is, from a logical perspective, very like it is in the private sector but with the following differences and increasing challenges ([39:433-435]:

- it is more often an exercise imposed top down (i.e. a Ministry could impose it on the agencies under its jurisdiction) and it has weaker levers (the headquarters of a corporation can obtain compliance from country branches more effectively than a Ministry from its agencies).

- there is much less emphasis on learning in public sector benchmarking, often resulting in ritualisation. Concentration on indicators rather than on 'real' performance will result in dysfunctional behaviour, where producing data becomes an end in itself;[10] and

- the less tangible kind of activities of public sector organisations, the lack of a market prices for the service provided, and the little diffusion of granular accounting systems (i.e. providing data on expenditure broken down into cost centres and attributable to groups of activities) render the measurement of real input, output and outcomes much more difficult and/or controversial.

Benchmarking of policies has no equivalent in the private sector and so we can characterise it in contrast to benchmarking of public sector organisations. The two types of benchmarking (of policy domains and of public sector organisations)

10 This relates to the issue of ownership that is very important and more problematic in the public sector [27:213]. When benchmarking is top down, ownership may be low and result in problems of relevance/validity, compliance, and cooperation. Lack of commitment can result in ritualisation with a focus on measurable results, where 'measurable' is synonymous with 'easy to gather the data', but not necessarily leading to relevance and validity.

can be very different or can, in fact, overlap. More traditionally public sector organisations are benchmarked to consider their performance in terms of service provisions as part of routine internal monitoring and Service Level Agreements linked to funding. Policies, on the other hand, belong to the domain of politics rather than public administration and the data to benchmark them may come from multiple sources, including public sector organisations, and the policy 'takers'. However, in the political domain a policy, once enacted, may be followed by investments to improve the efficiency and effectiveness of public sector organisations. In the latter case, benchmarking of public sector organisations and benchmarking of policy coincides. A big difference remains: while benchmarking of public sector organisations can (if one decides so) include only very similar ones, benchmarking of policy will need to include potentially different types of organisations (all those contributing to the policy being measured). So, benchmarking policy may require the collaboration of very different public sector organisations and of other stakeholders, which may be reluctant to cooperate or have different data and/or measurement systems. All of this is related to the scale of benchmarking: the larger the scale, the greater the collaboration and comparability challenges. It is more manageable to benchmark local labour market policies than national market policies. It is easier to benchmark, for instance, the number of students who graduated from a school system (output) than the level of labour force literacy (outcome). Last but not least, the more complicated benchmarking gets, the more important it is to take into consideration the processes that produce results or targets, yet complexity makes this extremely challenging and leads most benchmarks to stop at results and targets. In this respect, it goes without saying that complexity scales up geometrically when we move from the national level to the international level.

Benchmarking policy systems is possibly even more challenging, since it focuses on objects of analysis resulting from the activity of different policy domains. A case in point is innovation policy that is, in fact, the result of several policies such as educational, scientific, SME, patent, funding, and many others [27]. The issue of where to draw the line between a single policy domain and a policy system may be controversial and subjective. Indeed, we would argue that policies for the Information Society make up a system rather than a single domain. Given the complexity of the sector to which it is applied, we may even go as far as to affirm that eHealth is a policy system where support to the introduction of ICT in hospitals is a policy domain separate from boosting the use of online tools for patients' self-care.

We now sum up the discussion above considering a few important technical and organisational parameters that any benchmarking exercise should take into account, stressing the particular challenges concerning the international benchmarking of policies.

Validity and reliability of selected indicators. According to modern measurement theory, a good indicator needs to have validity and reliability. ***Validity*** has no single agreed definition but generally refers to the extent to which a measurement indicator is well founded, corresponds accurately to the real world and is relevant to the object being measured. In other words, the validity of a measurement indicator is the degree to which the indicator measures what it claims to measure. Unfortunately, it is often the case that more valid indicators are more costly to measure than less valid proxies (which only indirectly reflect the object being measured). For instance, if one is interested in benchmarking the level of social responsibility of large corporations in the environmental field, then focussing on the presence of internal guidelines on energy saving is a less valid measure than focussing on energy consumption (or emissions) data, although it is certainly easier and less costly to find data on the former than on the latter. It goes without saying that when benchmarking a policy domain at international level, the data gathering challenge may force the exercise to rely more on proxies and less on the best valid measurement indicators, also because high validity may be very context specific and pose a trade-off with regard to comparability. ***Reliability*** concerns the consistency, precision and repeatability of the selected measurement indicators (more broadly of the overall benchmarking). In concrete terms, we can look at reliability in two ways:

a) the value of the indicator I_i of phenomenon X measured at time T_i by a research team Y should not be too dissimilar from the value of indicator I_j applied to the same phenomenon X and measured by research team Z at time T_j;

b) if we take the field of benchmarking democracy than the principle of reliability would expect that the three most well-known indicators (Freedom House, Polity IV and Polyarchy) are interchangeable.

Reliability does not imply validity. That is, a measurement indicator may be consistent (reliability), but it may not be measuring what one wants to be measuring. As measurement errors are generally divided into two kinds - random error and systematic error - reliability concerns random error, whereas validity includes systematic measurement error and some random error. In terms of accuracy and precision, reliability is analogous to precision, while validity is analogous to accuracy. It goes without saying than measurement indicators should be selected to achieve both validity and reliability. . It is often the case for international benchmarking of policies, however, that reliability (and comparability) are achieved at the expense of validity.

Comparability. Here political[11] and technical challenges coalesce and pose complex problems, as can be appreciated in contrast with the conditions of private sector benchmarking. In the private sector, it is relative straightforward to achieve comparability by freely selecting the appropriate sample of comparable units of analysis (by industry, products, size, etc) and standard objects of measurement (profits, revenues, processes, costs, etc). This is very different from comparing an entire policy domain (where the selection of reliable and valid indicators is difficult in itself) within countries and one cannot freely select only those countries that are more comparable. Sovereign states want to be compared in ways that reflect their peculiarities, which is also a technically legitimate issue related to the choice of criteria and indicators. This choice is not easy since the definition of policies in terms of input, output, and outcome performance is never intuitive and is affected by national particularities and international trends, which complicate the selection of indicators. In this context, indicators for international benchmarking should be easy to interpret, stable and consistent to monitor and, at the same time, reflect (validity) the complexity of the phenomena they aim to measure [41:352-353]. Comparability must then be achieved by selecting only those indicators that can best reflect the peculiarities of all countries and whose value cannot be criticised by Member State representatives on grounds that they do not reflect country-specific institutional arrangements and various other matters. As anticipated, this search for comparability as a minimum common denominator may result in the selection of less valid measures. We must, however, recall the simple common sense fact that it does not make sense to compare identical things since only what is at least reasonably different is worth comparing. So, the comparability issue will always remain a source of potential ambivalence and debate and will often be used as a criticism from those who do not like the results of the comparison;

Transparency. The methods for gathering the data, calculating the indicators, and creating composite indexes should be fully explicit so that others can re-use them and verify their validity

11 In view of the ranking (and the often associated "naming and shaming") that benchmarking tends to produce, participating states genuinely or tactically raise the comparability issue (selection of one indicator may not reflect a country peculiarity).

and reliability. This is of utmost importance as regards reliability and the objections that could be raised concerning comparability. A very transparent methodological set up will enable other researchers to replicate the approach and, thus, test its reliability. Transparent choices will also provide the grounds for open and rational discussions by others about the comparability of the benchmarking approach selected.

Cooperation and feasibility. International benchmarking of policies entails a complex and time consuming consensual process among sovereign states [38:321]. Once a consensus is reached, then the issue raises of vertical cooperation. Each state has to ensure that the lower levels of the public sector, which deal with the policy being benchmarked, provide the necessary data. In most cases, data from outside the public sector will also been needed. has to impose a request of the needed data on the lower layers of the public sector dealing with the policy benchmarked and in most cases also needs to obtain data from outside the public sector. Since gathering data and measurement is time consuming and requires real commitment and awareness, it would be naïve to expect all relevant lower public sector layers to already have an ongoing system for data gathering and monitoring. Some more sophisticated lower levels may have in place a system of data gathering and measurement, defined for their own purposes - in many cases, before the higher level benchmarking is launched. The chances are very high that the objects, definitions, and data gathered by these micro-level evaluation and measurement systems do not coincide exactly with those of the higher-level benchmarking and differ across different public sector bodies. Under these circumstances, making micro-level data comparable for higher-level benchmarking is a daunting task. So, the costs of such complex international benchmarking tend to be high.

There are several possible solutions to the challenges explained above, which are, however, beyond the scope of this report. We therefore limit ourselves to anticipating the ways in which the survey of eHealth deployment in European hospitals and our analytical approach described in Section 3 should address them.

First, the indicators that we use and re-elaborate in this report come from a very extensive and granular set of questions asked directly to individuals involved in the day-to-day administration and usage of the phenomenon we aim to measure. So, the validity of the base indicators is extremely high. The way we aggregate base indicators into sub-components, dimensions, and finally the composite index (see Section 3) is based on both theoretical/conceptual reasoning and sound multivariate statistical analysis that we claim retain the validity of the base indicators.

Second, our approach to the analysis described later is methodologically sound and should ensure reliability. The detailed illustration of our approach, besides fully meeting the transparency requirement, will enable other researchers to replicate it and eventually test our claims as to the validity and reliability of our measurement.

Third, with respect to the comparability issue, we can repeat that the sample used is representative of the overall universe of acute hospitals in the European countries considered, the same kind of respondents (Chief Information Officers and Medical Directors) were interviewed in all countries in their own native languages, and they were asked the same set of questions. We checked the overall consistency of the answers across different countries and different types of hospitals and found no clear patterns of missing data and/or of counter-intuitive results, which ruled out the possibility that the questions were misinterpreted. In addition, as we show later, we cross-plotted the results of our measurement with external data, obtaining results that corroborate the comparability of our measures (i.e. those countries obtaining a higher score in our composite index are also those where per capita spending on ICT in healthcare is higher).

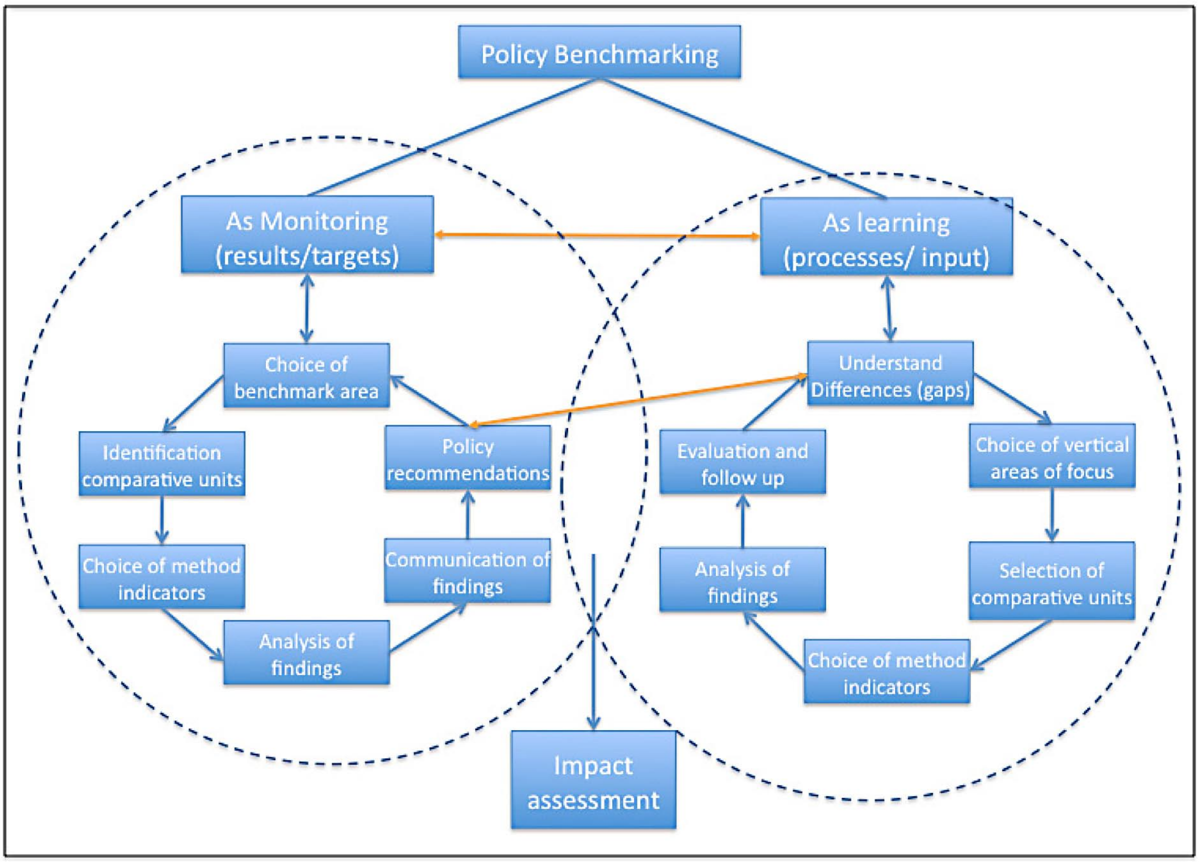
Finally, as to the issue of cooperation and feasibility, it is clear that the decision to outsource an ad hoc survey to a third party was made to avoid problems with gathering administrative data and aggregating them bottom up. As we mentioned later, this decision may be criticised in terms of its future sustainability (if the survey is not repeated) and of ensuring temporal and spatial reliability and comparability (surveys done at different times or in different geographical units may not be fully comparable). This is indeed a topic worth discussing in general (see § 2.3) and as part of the future benchmarking agenda (and we do so in Section 5), but it was something we took as a given and does not affect the quality of the measure we developed using the data that were available to us.

2.2 Holistic international policy benchmarking

Going back to the debate in the literature on benchmarking within the context of OMC, we should also point out that the tendency of international policy benchmarking to focus on results/targets rather than on processes is criticised. Indeed, the goals of this policy coordination mechanism should be both monitoring and policy learning/ transfer [22, 42, 43, 44]. OMC-benchmarking should be, it is argued, not only competitive for control and monitoring purposes, but also cooperative and about learning from others (with focus on what produces results/standards). Because in practice OMC-Benchmarking has been rarely conducted in this way it has been criticised on various counts [30, 36, 38, 40, 45]. The challenges discussed earlier make international policy benchmarking into a lengthy and costly process, which results in the tendency to focus on broad quantitative measures of inputs or outputs rather than on the actual processes involved. So, international policy benchmarking is rarely about learning and continuous improvement and is mostly about target setting and quantitative measurement, which may encourage participants to manipulate the evidence to what is seen to be required. In other words benchmarking can turn into producing self-referentially acceptable images of performance. Evidently, focusing on high level synthetic numbers is much easier than analysing the contingent and multi-dimensional reasons for the differences behind them [46:236]. So, it betrays the promise of a "learning process for all" [22]. As put it by Room "*benchmarking through indicators is severely limited in what it can offer. It may need to be accompanied by 'benchlearning', involving the exchange of narratives, case studies and 'stories', which integrate these indicators into coherent accounts of how change practically occurs*" [30:126]. Following such critiques, one could argue that in the ideal world a full-blown and optimal policy benchmarking system should look like the one portrayed in Figure 3.

The graphic sketch conveys the message that a complete international benchmarking of policy presupposes a clear links and reciprocal feed back loop between benchmarking for monitoring (basically focussed only on high-level quantitative indicators of results/targets) and benchmarking for learning. The latter should focus on further exploring what explains the differences in results identified by ´benchmarking for monitoring´ and especially the point of excellences (best performers) and the gaps (worst performers). This learning (from the perspective of policy) can also be seen as 'understanding', or to put it the other way around analysing the factors producing the results that can help extract the policy learning. In the broadly defined field of ICT adoption and usage, for instance, benchmarking for learning should focus on , among others, the following objects of analysis: a) input (monetary, but possibly also in terms of strategic leadership); b) re-organisation and change management activities (analysed more in depth with qualitative methods for a selected number of cases or assessed with open or structured questions in survey questionnaire leading to quantification through dummy or ordinal scale variables); c) intra and inter organisational integration and joined up delivery.

Figure 3: Holistic approach to policy benchmarking



Source: adapted from [36:25].

From these considerations and from the graph in Figure 3 what is important for us to stress is that linking the two forms of benchmarking can also provide insights into the issue of impact. Alternatively, if a full holistic approach is not possible, at least some questions should be added in ad hoc survey for monitoring benchmarking that would enhance also the agenda of measuring impacts. For instance, in the specific context of this benchmarking exercise on eHealth deployment in hospitals additional questions on relevant parameters (i.e. monetary expenditure for ICT per hospitals, hospitals output, information on re-organisation) could have helped us measure issues of impacts that in Section 4 (§ 4.3) we have touched only in a very preliminary and hypothetical way. In this respect a brief digression is in order here to illustrate how important and urgent is the issue of impact measurement in the eHealth policy domain.

In recent years, throughout the globe we have witnessed an unprecedented effort to affect population health outcomes by leveraging technology in healthcare delivery. According to WITSA data between 2003 and 2011 the USA will have spent approximately $ 500 billion, Western Europe[12] $ 531 billion, Eastern Europe[13] $ 25 billion, and Japan $ 128 billion [47]. Another source[14] indicates that investments in HIT have grown substantially and in most countries account for between 2% and 6% of total healthcare spending, that is to say in many cases more than what is spent for prevention activities. As noted by Christensen and Remler [48:4], the extraordinary potential of ICT in healthcare has been heralded by many

12 Includes Norway, Switzerland and Turkey, but does not include Malta, Cyprus, Luxembourg, and Iceland.
13 Including also Russia and Ukraine.
14 Market research company IDC data reported in [10].

commentators, whereas others bemoan that it is not meeting the expectations. As of today the evidence we dispose of on the impact of eHealth on both quality of care and cost containment is not conclusive and does not allow us to emit a verdict on which of the two sides (optimist and pessimist) is correct. The evidence on eHealth cost-effectiveness is inconclusive as discussed in several reviews and meta-reviews [3, 10, 49, 50, 51], despite the number of studies evaluating eHealth impacts is growing exponentially: in 2002 652 such studies only focussing on telemedicine were identified for the period 1980-2000 [50]; in 2006 252 evaluation studies of more broadly defined eHealth were found for the period 1994-2005 [49]; an additional 1300 such studies published from 2005 until 2009 were identified [10]. Alongside studies reporting improvement on quality of care, for instance, one can find also those reporting zero or even negative impacts [10:2]. Trying to make sense of this situation the "Productivity Paradox" has been applied to healthcare settings [10]. Robert Solow famous quip that "You can see the computer age everywhere but in the productivity statistics"[15] was later systematised into the so called Productivity Paradox [52, 53], the 'paradox' being the remarkable advances in computer power and in IT investments by firms and the relatively slow growth of productivity at the level of the whole economy (at least in the period 1970-1990). The initial main explanations of this `paradox` were measurement errors, and lag in the full manifestation of the benefits of introducing IT in firms, non-distribution of profits. As shown [14], however, subsequent research partially reverse the paradox as after the 1990 productivity resurgence was attributed also to ICT in macro-economic models, and micro-economics studies showed that ICT does increase the productivity of firms especially when occurred together with re-organisation, change management, and re-training of employees. Firms started to really leverage IT when they were fully capable also to capture and mine customers' data and to use ICT to integrate the value chain both upstream (supply chain) and downstream (delivery), as well as to better connect with inter-organisational networks of cooperation. Let us now make a parallel between the world of firms and that of healthcare in order to advance our hypothesis on the Productivity Paradox of HIT. Healthcare, *mutatis mutandis*, must also engage in internal (to the various establishments) re-organisation, change management, training of personnel before ICT will show its full impacts. Yet, full realisation of ICT benefits will come only when the latter will support integration across healthcare tiers and vertical specialities. Healthcare is probably the most information intensive of all industries and the information mostly concerns individuals, their situation, their health status and their response to treatments. Even the good application of drugs and use of medical technology depends on the availability of the relevant information, in the right time, and at the right place. Such information centred on the person comes and is stored in many different places within and outside the healthcare system. It can be found across the different tiers of the healthcare system (primary, secondary and tertiary care) within vertical specialisms. It is also found in clinical guidelines and pathways and in state of the art clinical and biomedical research. Hence, the re-organisation and change management needed to fully exploit HIT must reach out, through integration across tiers and vertical specialties, between practice and research, and also engage the users, who if they could access online their EHR could use it for various purposes and could also add their own data (i.e. about lifestyle parameters[16]). In this respect with agree with the OECD that places users access to their EHR into the impact stage in their model going from eHealth readiness to eHealth intensity up to eHealth impact defined as information and service quality [55:81]. It is our hypothesis that the evidence on eHealth cost-effectiveness is still inconclusive for two

15 R. Solow, We'd better watch out. New York Times, July 12, p. 36.

16 On this see the IPTS report on the health value of crowds sourcing [54].

integrated reasons: a) measurement errors and lag time; but also b) lack of broadly defined re-organisation and change management. The latter may better explain the contradictory finding of cases reporting no or negative impacts and cases reporting full-blown positive impacts.

One may be left wondering how does this apparent digression bears relevance to the topic of this paragraph and to the focus of this report in general. First, it is an illustration of the suggested benefit of linking 'benchmarking for monitoring' to 'benchmarking for learning' for impact assessment (contained in Figure 3). Results of benchmarking also the processes could be crossed with analysis of cost effectiveness to make better sense of them. Second, anticipating the content of § 4.3, the results of the eHealth Benchmarking Phase III survey contains interesting perceptions from hospitals' Medical Directors on the impact of Electronic Patient Records (EPRs) and Telemonitoring that could be better understood If we had had also information on processes and input (see § 4.3.3 and § 5.3).

2.3 State of the art and eHealth benchmarking

In § 1.2 we have already provided a brief overview of the development of eHealth benchmarking within the Commission framework, from which we concluded that the only benchmarking of the health sector available is the survey on ICT adoption and use by General Practitioners[18]. Here we will very briefly extend this overview by selectively and briefly summarising the impressive and extensive work conducted as part of the eHealth Benchmarking Phase II [19], as well as looking at three OECD reports [55, 56, 57].

The eHealth Benchmarking Phase II report overviewed eHealth benchmarking activities in the 27 Member States of the European Union, Iceland, Norway, Canada and the United States and indentified 94 sources [19]. The results from the analysis of these sources have been summarised as follows: a) in 74 cases data came from surveys, in 15 cases from scientific reports, and only 5 case from administrative performance monitoring processes; b) 74 were on availability and use of eHealth in various settings (not only hospitals), 10 on evaluation of eHealth application impacts, 7 on attitudes and perceptions, and 3 on eHealth market development (Meyer et al 2009: p. 2). The OECD analysed the practices in 9 countries (Australia, Canada, Czech Republic, France, Finland, New Zealand, Norway, Sweden, and United States) and then integrated this analysis with the results at the EU level [55].[17] The conclusion is that most OECD countries (except Finland[18]) do not systematically gather data for eHealth benchmarking [55:82] and that more in general considering both OECD and EU27 the situation is far from ideal with various problems including: a) lack of conceptual inter-operability (EHR and other items being defined differently); b) ad hoc basis of surveys limiting comparability of results across time and space; c) the use of very many and different indicators [57, 58].[19] As seen, the eHealth Benchmarking Phase II shows that the overwhelming majority of identified cases (74 out of 94) focussed on availability and use [19:2].

For what concerns our interest here, both from the OECD [57] and from Meyer et al [19], we can derive that there are two main sources of data for benchmarking of eHealth: a) stand alone surveys of healthcare personnel or organisations; b) administrative data. The comparison of the

17 Basically the 2010 OECD [55] report integrates the data presented in the earlier 2008 one[57] with those provided by Meyer et al [19]. So, as it comes afterwards and look in a combined way at a large number of countries, we can say that the 2010 OECD report is more updated in providing conclusive findings on the state of the art.

18 In Finland ICT adoption in the various sub-systems of healthcare has been monitored regularly since 2005, whereas administrative data have also been used (though not in the same systematic fashion) also in Norway, Spain, and Sweden [55:82].

19 Meyer et al report [19:2] have found a total of 4400 indicators from the 94 sources identified and analysed.

two sources in terms of relevance, feasibility, and comparability leads us to conclude that, at least in the short term, surveys are a more viable solution, despite their longitudinal and cross-sectional comparability problem. As we illustrated earlier (§ 2.1), producing international policy benchmarking from data aggregated from lower level administrative units poses serious challenges of cooperation, compliance, and measurement capabilities, which reduce the feasibility of this approach in the short term.[20]

On the other hand, the ad hoc surveys produced so far do indeed show clear limits of comparability. They tend to be commissioned and/or implemented by organisations pursuing different policy and/or research interests, thus, resulting into different focus, operationalisation of the objects of measurement, indicators, not to mention incomparable units of analysis. In addition, rarely such surveys are repeated on a regular basis to allow at least longitudinal comparison. This notwithstanding, we see the survey as a promising approach in the short term also as a way to gradually design and refine a eHealth benchmarking survey model that could be agreed upon and adopted by international organisations such as the European Commission, the WHO, and the OECD. Moreover, the survey approach may enable: a) to combine both results and process as in the overall and ideal policy-benchmarking framework (see Section 2.1); and b) link benchmarking to impact evaluation. With respect to this last point ideally in the mid to long-term surveys and administrative data could be integrated as sources for holistic eHealth benchmarking capturing information about deployment, usage,

20 As we argued earlier, administrative units may gather not the most relevant data (ritualisation) and even if we find administrative unit X and administrative unit Y with state of the art monitoring systems chances are that the data gathered and indicators constructed will be different (especially if they are from different countries).

Singling out from the work reviewed by the OECD [55, 57] and by Meyer et al [19] the contributions strictly focussing on eHealth deployment within hospitals we can characterise them in terms of the typology presented earlier (see Figure 1 and Figure 2). Despite nuances and differences, they all tend to be functional policy benchmarking focussing on results or target (with only very limited cases considering also processes). They focus on one domain of policy (eHealth) and not on an entire policy system and they do it in a more functional (specific) way: considering only one sub-sector (the hospitals) and focussing not holistically on all possible dimensions but simply on the availability and adoption of ICT (hospitals general descriptive data are gathered, but no information on core activities are included). The survey completed by Deloitte and Ipsos as part of the Commission eHealth Benchmarking Phase III study falls also into this typology. As it will become clearer from the presentation of data and results in the next sections, this survey focuses on availability and use of ICT infrastructure, on eHealth applications, on electronic data exchanges functionalities, and on data security and privacy. It predominantly focuses on results, in the sense that by gathering the above mentioned data the main goal is to assess what level of availability and use European acute hospitals have reached after the last decade of intensive investments in ICT. In other words, it is well known that a large number of eHealth implementation projects took place in the past ten years and this survey tells us what are the results in acute hospitals in terms of availability and use of infrastructure and functionalities. In addition, the respondents to the questionnaire were also asked questions about perception of the impacts of using ICT in the hospitals and about barriers to adoption. This was already a very daunting task and produced the best and most update information available today in Europe and represents a great contribution to our understanding of the process of eHealth development. Unfortunately, the survey does not contain information on organisational changes, on the input (monetary and non monetary) behind the registered level of deployment, and on the extent to which these results in ICT adoption and use can be matched to cross-sectional (across the various hospitals) differences in output. As we argue later, these additional elements could be the object of a future follow up.

3 Data and methods

As anticipated, our work focuses on the multivariate statistical analysis of the results of the eHealth benchmarking III survey and more specifically on the construction of a composite index of eHealth deployment and also on the elaboration of cluster analysis from the answers of Medical Directors about eHealth impacts. We will not, therefore, enter into a detailed analysis of descriptive statistics that can be found elsewhere [20]. In this section we first briefly report basic information about the survey implementation parameters, we then discuss generally the debated issue of constructing composite indexes, and conclude illustrating the approach we have followed. The results of the analysis are presented in Section 4.

3.1 Survey data collection, universe, and sample

The data were collected through CATI telephone interviews with representatives of acute hospitals in 30 countries in Europe. The interviews took place between mid-July and mid-September 2010. Two different questionnaires to two different target groups were administered in the survey, one for Chief Information Officers (CIOs for all of the hospitals) and one for Medical Directors (MDs only in 280 hospitals). The interviews lasted an average of 30 minutes.

The CIOs questionnaire included five main blocks related to:

- Characterization of the hospital;
- Infrastructure, availability and connectivity;
- Applications;
- Integration;
- Security and privacy.

The MDs questionnaire also included five main blocks related to:

- Utilisation of applications;
- Investment priorities;
- EPR impact and barriers;
- Chronic disease management programmes impact and barriers;
- Telemonitoring impact and barriers.

The universe of reference was the entire population of acute hospitals (in terms of size, ownership and region) in each of the EU 27 member states as wells Croatia, Iceland and Norway. The national Ipsos network members gathered the latest and most accurate information to identify the full universe of acute hospitals in the 30 countries, from which the sample was extracted.

The sample was extracted randomly with quota stratification by region, size (number of beds) and ownership (private/public). The stratified quota random sample extracted is statistically representative of the universe as previously defined and consisted of 906 hospitals. In all 906 hospitals the CIO was interviewed and in 280 also the MD responded, for a total of 1,186 interviews. It is important to note that all the Medical Directors surveyed belonged to the same hospital as the hospital's CIO, which means that MD and CIO answers can be matched and compared. More detailed information on sampling and other survey implementation issues can be found in the Deloitte/Ipsos report[20].

3.2 The controversy on composite indexes

When benchmarking is applied to complex policy issues it inevitably produces a large number of indicators giving rise to the need of summarising them into a more unified and compact policy message. Composite Indexes (henceforth simply CI even when used in plural) represent a way of providing more compact information from large quantity of data, but their usage in policy benchmarking is surrounded by a never-ending dispute. As put it by Sharpe [59:5]:

> "The aggregators believe there are two major reasons that there is value in combining indicators in some manner to produce a bottom line. They believe that such a summary statistic can indeed capture reality and is meaningful, and that stressing the bottom line is extremely useful in garnering media interest and hence the attention of policy makers. The second school, the non-aggregators, believe one should stop once an appropriate set of indicators has been created and not go the further step of producing a composite index. Their key objection to aggregation is what they see as the arbitrary nature of the weighting process by which the variables are combined."

We have summarised the pros and cons of composite indexes in Table 1 overleaf where the contents of each cell is very detailed and self-explanatory and do not require further illustration and discussion. Despite the controversy on CI and their limits, the complexity of international benchmarking makes them a necessity. Moreover, CI can at time provide effective messages that policy makers can capitalise. The risks and pitfalls may be offset by some theoretical and technical choices, as for instance following the ten steps prescribed and explained for the construction of robust composite indexes in the joint OECD-European Commission-JRC Handbook [60:12-30]. Out of these ten steps we focus more on four of them, since they are very important to illustrate and justify the approach we adopted in analysing the data of the survey.

1. **Apply, if possible, a theoretical/ conceptual framework**. It defines the phenomenon to be measured and its sub-components and the various interactions among them. As such it should shape the selection of the individual indicators (henceforth base indicators or base variable) and in some case can justify a theory based selection of their weights.
2. **Select indicators**. Assuming we have a large set of individual indicators, then we may want to select which ones should go into the construction of the CI (pursuing the objectives of selecting those that are most valid, reliable, and comparable). In general this selection should reflect the theoretical/conceptual framework, but it is nonetheless advisable to make clear to the audience if a peculiar selection may give rise to a possible bias.
3. **Carry out multivariate statistical analysis.** A clear-cut and undisputed theoretical/conceptual framework may not available at all. Or it may be available but applicable only to the level of the policy domain sub-dimensions but not at that of base indicators. With no guidance from theory, if base indicators are selected and weighted arbitrarily and without the analysis of their inter-relations this can lead to misleading policy messages. To offset this risk, one can use various multivariate statistical analysis techniques to explore the underlying structure of the data and possibly inductively obtain those important inputs not coming from the theoretical framework. The two principal techniques for this purpose are Principal Component Analysis (CPA) and Factor Analysis (FA).
4. **Carefully and transparently define Weighting.** This operation should be made carefully and transparently since different weighting can lead to changes in countries rankings (a politically very sensitive issue). Many times no

weighting is presented as a neutral choice but it is not and can produce biases. Equal weights it is equivalent, in fact, to give each component indicator the same weight. If you apply equal weights to two highly correlated component indicators then this is like double counting: 'if two collinear indicators are included in the composite index with a weight of w1 and w2, than the unique dimension that the two indicators measure would have weight (w1+w2) in the composite' [60:21]. Or if the individual indicators (variables) are grouped into sub-components and the CI is constructed from the latter this result into an unbalanced structure: the sub-components including more individual indicators will have more weights without this being justified on the grounds of any theoretical reasoning but only as a result of a not fully thought out technical choice. Equal weighting of individual indicators selected arbitrarily further compound this problem. The handbook considers an ideal practice to use PCA or FA to estimate weights (provided that individual indicators are correlated).

3.3 Our approach to the construction of a composite index

Firstly, we applied insights derived from the scientific literature reviewed [10, 48, 49, 50, 56, 57] to the various block of information gathered through the survey to develop a conceptual-theoretical framework (see Figure 4).

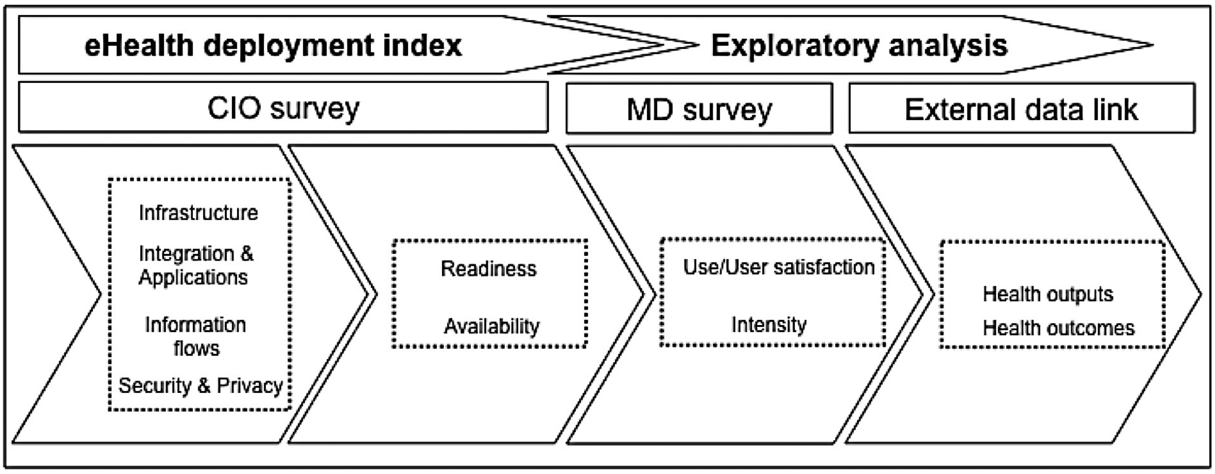
As we argued earlier (§ 2.2), to improve information and service quality and produce effectiveness and efficiency gains in healthcare, integration and exchange of information within hospitals vertical specialists and between hospitals and other healthcare tiers (and also across national borders) is fundamental. Also important is the extent to which such integration and exchange of information directly involve the patient making him/her an active co-producer of the process of delivery healthcare. For this to happen, however, basic and/or more sophisticated ICT infrastructure and connectivity are also needed. Moreover, the integration must also be supported by state of the art eHealth applications, which in turn can eventually produce safe health outcomes for patients when the needed level of data security and privacy is available. Without data security and privacy hospital managers and also physicians may be reluctant to use eHealth application and exchange data for the sake of integration. Also patients may be reluctant in

Table 1: Pros and cons of composite indexes

PROS	CONS
Summarise complex or multi-dimensional issues for decision-makers	If poorly constructed send non-robust policy messages (sensitivity analysis needed to test them)
Provide the big picture and are easier to interpret than trying to find a trend in many separate indicators, so they facilitate the task of ranking countries on complex issues.	"Big picture" may produce simplistic policy conclusions (need to be used in combination CI should be used in combination with sub-indicators to draw sophisticated policy conclusions)
Help attracting public interest by providing a summary figure with which to compare the performance across countries and their progress over time.	Involve the selection of sub-indicators, choice of model, weighting indicators, treatment of missing values etc (these steps should be transparent and based on sound statistical principles)
Help reduce the size of a list of indicators or to include more information within the existing size limit	May cause more disagreement among Member States, selection of sub-indicators and weights may be politically challenging (again need of full transparency)
	Increase quantity of data needed (for transparency and robustness data are required for all the sub-indicators and for a statistically significant analysis).

Source: adapted from [61].

Figure 4: Holistic approach to eHealth hospital benchmarking



Source: Authors' elaboration.

view of the risks that their data may end up in the wrong ends or that breach in security may even produce medical errors. Following this logic, we conceptually grouped ex ante the raw set of questions for which the survey collected answers from hospitals CIO into the following four dimensions:

- Infrastructure,
- Applications and integration,
- Information flow,
- Security and privacy.

These four dimensions capture all the base indicators produced by the survey questions to the CIOs and measure eHealth deployment in acute European hospitals in terms of readiness and availability.

Second, with respect to these four dimensions and their underlying base indicators, we needed to decide whether or not to make other *ex ante* choices based on theoretical reasoning, such as in particular: a) place or not the four dimensions into a sort of linear progression scale (i.e. assigning different weights to the dimensions as to reflect an increasing level of sophistication in deployment); b) select or not only some base indicators from the full set of variables generated by the answers to the survey for each of the four dimensions.

As to the first question we decided not to make an *ex ante* prioritisation for, whereas one could make the argument that infrastructure is a pre-condition (so a less advanced level of deployment pertaining to the initial creation of e-Readiness), we find no strong theoretical backing for deciding a hierarchical order of importance among infrastructure; applications & integration, information flow and legally related issues such as security and privacy. As for the second question we equally to do not find any theoretical model or assumption telling us, for instance, that some eHealth applications are more relevant than others to measure the overall level of deployment, as well as that some form of electronic exchange is more important than others. We, thus, processed through multivariate statistical analysis all of the individual based indicators to increase the robustness of the approach and avoid any arbitrary choice. The four higher level dimensions were weighted equally a choice that, however, does not create the problems of unbalanced structures since the underlying sub-components and base indicators are weighted through factor analysis.

Third, in view of the previous two points, statistical analyses were performed using SPSS version 18.0 to confirm the several internal complementarities of the variables, by checking the means and their significant correlation. Factor analysis was used to assess items correlations and identify common relationships between similar items, enabling their categorisation into various themes or factors. An analysis of the correlation matrix (KMO and Bartlett's test of sphericity) was carried out to check that the correlation matrixes were factorable. Data reductions were undertaken by principal components analysis using the Varimax option to identify possible underlying dimensions. The factor analysis was used to carefully and transparently define the weights of the lower level variables (base indicators) of which the four dimensions identified consist. Each base indicator is weighted according to its contribution to the overall variance in the data. Factor analysis was applied to the subsets of base indicators belonging to the same dimension. The factors identify sub-dimensions, which have been labelled to better understand unobserved themes. The relative contribution of each of the factors identified to the explanation of their variance within each dimension is used as weights. To avoid an unbalanced structure of the overall indicator due to the different number of variables grouped in each dimension equal weight (0.25) was assigned to the four dimensions. This assumption is also justified theoretically as far as each dimension is inter-related to the others. The full process described above is rendered graphically in Figure 5.

It is worth pointing out that our CI was calculated hospital by hospital at aggregate European level and that, therefore, the values of the CI per country are the average of the hospitals within each country. Although each national sample drawn is representative of the acute hospitals in each country, country comparison should be undertaken with caution, the smaller the sample, the larger are the margins of errors.[21] To avoid any misinterpretation of the country results we have developed **Annex 1** "Measurement of dispersion of eHealth Deployment Index by country".

21 See paragraph 2.2.3 in Deloitte/Ipsos report [20] for a full disclaimer on this issue.

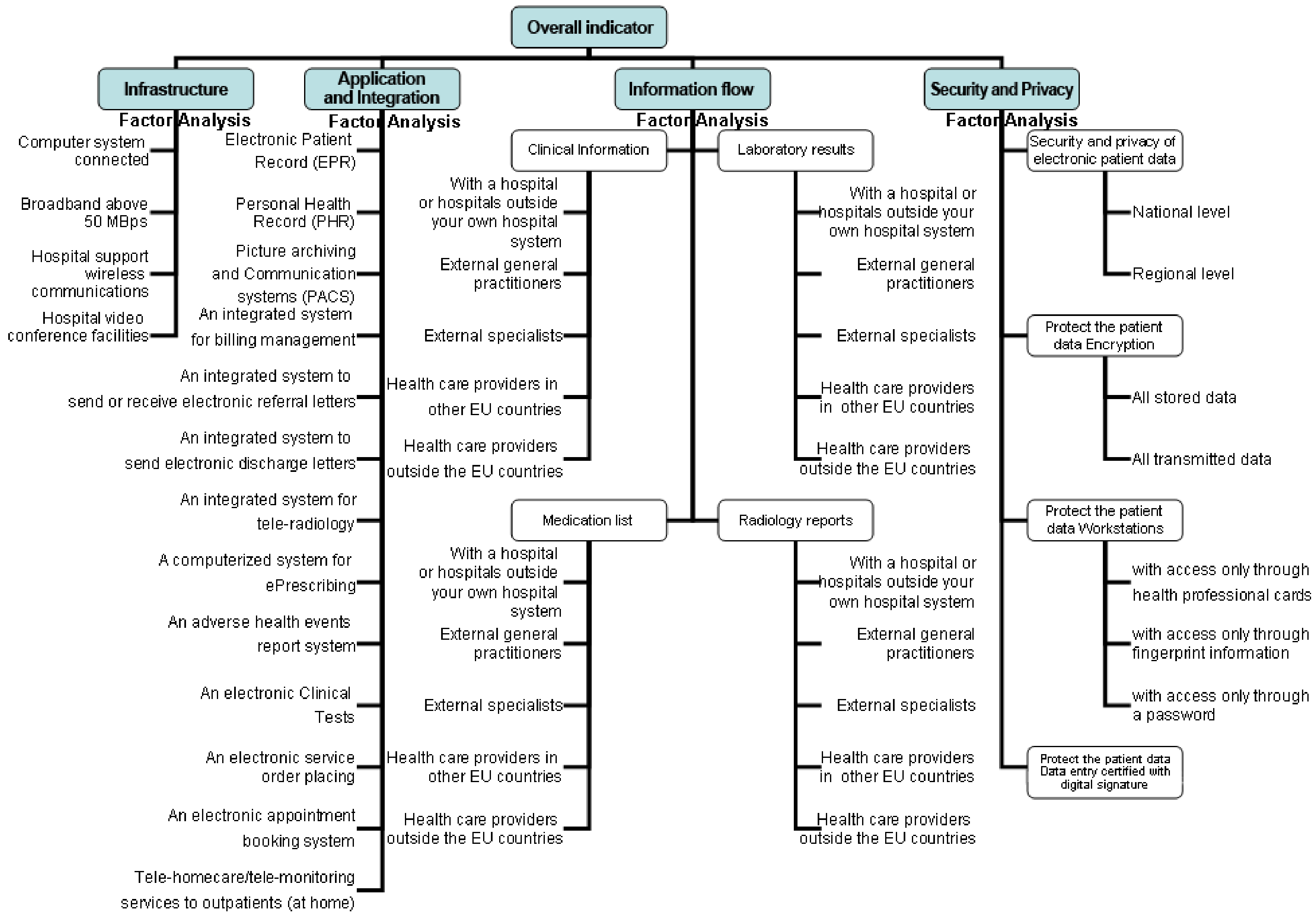
Going back to Figure 4, we now briefly illustrate the following block of the graphs included under the heading of exploratory analysis. The answers from the survey module directed to the Medical Directors (MD) enable us to do two things.

First, some of the answers from MD concerns usage of eHealth infrastructure and applications and, thus, can be used to map the CI of eHealth deployment against intensity of use and explore the reasonable hypothesis that the higher an hospital is ranked in the CI of deployment the more one should expect intensity of use to be. It is exploratory inasmuch as we have MD answers only from 280 of the total of 906 hospitals surveyed and cannot be conclusive. On the other hand, since MD and CIO answers can be matched to the hospitals where both kind of respondents work, we can at least use those of MD to partially check the validity of the eHealth deployment CI.

Second, MD provided answers on their perceptions of the impact that some key eHealth applications have had on strategic outcomes and can be used to perform also an exploratory analysis of this topic, from which we extract insights and recommendations for further work. This analysis was performed by developing different typologies, identifying distinct, yet homogeneous, groups. To this aim a Non-Hierarchical Cluster Analysis of K-means was applied. ANOVA test results showed that the means of contextual variables differed significantly across clusters. To attribute statistical significance to the differences obtained an associated Chi-square test was carried out.

Finally, we linked the eHealth deployment CI to external data on ICT expenditure on healthcare, on several indicator of healthcare output, and on indicator of health outcomes. This was performed at aggregate country level and must also be considered exploratory, yet as we show later such mapping produced meaningful and interesting result strongly suggesting that further work in this direction is worth pursuing.

Figure 5: Overall framework for the construction of a CI of eHealth deployment



Source: Authors' elaboration.

4 Results

In this section we present all the results of the multivariate statistical analysis performed on the data from the survey, which we then further discuss in the next conclusive section.

In § 4.1 we illustrate step by the step how the CI of eHealth deployment was constructed from the CIO's answers to the questionnaire. We analyse each of the four dimensions identified (§ 4.1.1 through § 4.1.4), and in doing so we can also transparently present the reader with the base indicators included under each dimension and the corresponding descriptive results. We also present for each dimension the factor analysis performed. As a result, in § 4.1.5 we illustrate the process followed to construct the CI and briefly comment the results.

In § 4.2 we take the CI and map it against other data: a) other variables extracted from the survey such as the answers from MD reflecting usage of eHealth and hospitals structural characteristics (§ 4.2.1); b) data on country level aggregate expenditure for ICT in healthcare (§ 4.2.2); c) data on country level aggregate supply side healthcare indicators (§ 4.2.3). As stated earlier, this analysis can only be considered explorative given the aggregate level of data crossed against each other, on the basis of which it is important to stress that we will not attempt any causal attribution. This analysis enables us at the same time to test in a certain sense the robustness of CI (check any counterintuitive results) and to identify interesting direction for further research.

Finally in § 4.3 we analyse the answers provided by the Medical Directors on their perceptions of the impact of Electronic Patient and of Telemonitoring.

4.1 Hospitals' eHealth Deployment Composite Index

4.1.1 Infrastructure

More than 80% of the CIOs stated that their hospitals have a computer system connected to an Extranet or Internet connection through a value added network or proprietary infrastructure. More than half of the respondents (53.3%) reported that hospitals support wireless communication, while around 40% stated that hospitals have videoconference facilities and broadband above 50MBps (see Table 2).

To confirm the several internal complementarities of the variables, the means and their significant correlation were checked.[22] Factor Analysis (henceforth simply FA) was performed on the individual variables included in the infrastructure dimension to identify common relationships among them (see Table 3). This analysis yields two statistically significant and conceptually meaningful factors. The first

Table 2: Infrastructure dimension: descriptive summary statistics

Computer system connected	81.5 (706)
Hospital support wireless communications	53.3 (442)
Broadband above 50 MBps	40.9 (371)
Hospital video conference facilities	39.1 (353)

22 See Table 53 in Annex 2.

Table 3: Infrastructure dimension: factor analysis

		Factor 1*		Factor 2*	
Interpretation		**Infrastructure physical oriented**		**Infrastructure service oriented**	
	Commonalities	**Factor loadings**	**Weights of variables in factor****	**Factor loadings**	**Weights of variables in factor****
Computer system connected	.485	0.694	0.381	0.064	0.003
Broadband above 50 MBps	.564	0.746	0.441	0.085	0.006
Hospital support wireless communications	.856	-0.023	0.000	0.925	0.711
Hospital video conference facilities	.561	0.474	0.178	0.580	0.280
Weight of factors in summary indicators***		0.466		0.534	
Selection criteria					
Eigenvalues		1.596		.870	
% Variance explained		39.905		21.756	

Notes: Rotated components matrix; Sampling method: factor analysis by main components; Rotation method: Varimax with Kaiser-Meyer-Olkin 0.630; Bartlett's test of sphericity p=0.000; Convergence in 3 itineration; Minimum eigenvalue 0.87.

** Based on rotated component matrix.*
*** Normalised squared factor loadings.*
**** Normalised sum of squared factor loadings.*

factor has salient loadings on the first two indicators (Computer system connected and Broadband above 50MBps). It may be interpreted as representing 'Physical infrastructure'. The second factor has salient loadings on the last two indicators (wireless communication and videoconference facilities) and may be interpreted as representing 'Services' (i.e. services oriented infrastructure). Therefore, the items in each factor illustrated in the table below provide a fairly intuitive understanding of what we mean by the two labels assigned to the two factors: by 'physical' we refer to the very basic infrastructure (computers connected and broadband), whereas support for wireless and video-conference are more related to the activities and the 'services' springing from them.

Using the identified factors as weights the four base indicators can be aggregated into a country level summary index of the infrastructure dimension (see Table 4 overleaf). The interpretation of these weights, which are obtained by squaring and normalising the estimated factor loadings, is straightforward. The squared factor loadings represent the proportion of the total unit variance of the indicator that is explained by factor. The resulting score by sub-dimension can be aggregated into the summary indicator of 'Infrastructure' dimension according to its relative contribution to the explanation of the overall variance of the two factors: the first explains 39.9% of this variance, while the second factor explains 21.7% of it.

As for the Table 4 we can make the observation that all of the seven top scoring countries (including the Scandinavian and Nordic group, plus the UK a bit below) show a more marked emphasis on service-oriented infrastructure, that is ICT infrastructure more directly instrumental to the internal and external activities of the hospitals (wireless for internal mobile use of applications, videoconferences for

Table 4: *Infrastructure dimension countries index according to the estimated factors*

Summary indicator			
	Dimension	Sub-dimensions	
	Infrastructure	Infrastructure physical oriented	Infrastructure service oriented
DENMARK	.913	.383	.530
ICELAND	.913	.246	.530
IRELAND	.913	.335	.530
FINLAND	.887	.369	.519
SWEDEN	.833	.287	.530
NORWAY	.783	.383	.400
UK	.745	.293	.431
AUSTRIA	.705	.310	.385
NETHERLANDS	.661	.294	.358
LUXEMBOURG	.618	.315	.303
SPAIN	.607	.275	.327
BELGIUM	.604	.259	.341
BULGARIA	.581	.248	.275
FRANCE	.547	.232	.309
PORTUGAL	.533	.238	.292
CROATIA	.496	.383	.113
LATVIA	.490	.187	.303
CZECH REPUBLIC	.486	.213	.233
ITALY	.462	.224	.230
CYPRUS	.456	.159	.303
GERMANY	.451	.242	.199
HUNGARY	.390	.201	.189
MALTA	.373	.196	.177
ROMANIA	.320	.182	.110
SLOVENIA	.313	.187	.127
GREECE	.302	.198	.096
LITHUANIA	.287	.255	.059
ESTONIA	.253	.178	.227
POLAND	.251	.080	.156
SLOVAKIA	.135	.059	.127

See Annex 1. Measurement of dispersion – eHealth Deployment index by country for more detailed information.

external interactions). This finding seems in line with what is well known about both the general and health specific eReadiness level of these countries.

4.1.2 Applications and Integration

More than 70% of acute European hospitals have:

- Electronic Patient Record;
- Integrated system for billing management;
- Electronic appointment booking system;
- Electronic Clinical Tests.

It is important to note that only 4% of hospitals provide their customer with online access to their health records, that is Personal Health Record

Table 5: Application and integration dimension: descriptive summary statistics

Electronic Patient Record (EPR)	81.2 (736)
An integrated system for billing management	76.7 (695)
An electronic appointment booking system	70.8 (640)
An electronic Clinical Tests	70.7 (638)
Picture archiving and communication systems (PACS)	61.7 (557)
An electronic service order placing (e.g. test/diagnostic results)	56.0 (496)
An integrated system to send electronic discharge letters	42.1 (381)
An adverse health events report system	42.1 (354)
An integrated system for tele-radiology	40.0 (362)
An integrated system to send or receive electronic referral letters	33.8 (306)
A computerized system for ePrescribing	29.9 (271)
Tele-homecare/tele-monitoring services to outpatients (at home)	8.7 (77)
Personal Health Record (PHR)	4.4 (40)

(PHR) and only 8.7% provide Telemonitoring services. Among user oriented applications only eBooking (70.8%) seems to be quite widespread. So, at the aggregate level the clinical extramural orientation of eHealth applications in acute hospitals seems still limited (see Table 5). On the other hand, we must point out that an earlier exploratory cluster analysis we had performed identified a clear cluster of 100 hospitals where PHR and/or Telemonitoring were used.

PACS (61.7%), electronic clinical tests (70.7%), and an electronic service order placing (56%), which are application supporting professionals, are fairly widespread.

We proceeded in this case following exactly the same logic and procedure as we illustrated for the infrastructure dimension, which we will no longer repeat here and for the following dimensions.

From FA (see Table 6) we derived weights used to construct a country level summary index of this dimension (see Table 7).

FA[23] identified four meaningful factors, whose labels are abbreviated for reasons of space in the table. Factor 1 includes applications more directed to the professional side of core clinical activities such as: clinical tests; diagnostics results; PACS and teleradiology. Factor 2 captures an orientation to the patient for what concerns his/her intramural management. Factor 3 concerns instead patients demand and safety. Finally, Factor 4 captures items that we can take as a proxy of a more pronounced extramural orientation (i.e. telemonitoring).

The data in the table above tend to confirm the aggregate summary statistics impression that applications mainly supporting the work of the professionals are more widespread, for they tend to be more pronounced regardless of the overall ranking. On the other hand, top scoring countries clearly stand out in terms of more extramural orientation.[24]

4.1.3 Information flows

CIOs were asked about whether their hospitals exchange electronically different types of information (clinical information; laboratory results; medical lists information and/or

23 See Table 54 in Annex 2.

24 The earlier mentioned exploratory cluster analysis had identified a clear cluster of 100 hospitals where PHR and/or Telemonitoring were used that were relatively more concentrated in the top scoring countries of this table.

Table 6: Application and integration dimension: factor analysis

Interpretation	Commona-lities	Factor 1* Emphasis on clinical and image: Factor loadings	Factor 1*: Weights of variables in factor**	Factor 2* Emphasis on EPR and patient management (intramural): Factor loadings	Factor 2*: Weights of variables in factor**	Factor 3* Emphasis on patient demand and safety: Factor loadings	Factor 3*: Weights of variables in factor**	Factor 4* Emphasis on PHR and tele monitoring (extramural): Factor loadings	Factor 4*: Weights of variables in factor**
Picture archiving and communication systems (PACS)	.627	0.784	0.294	0.056	0.002	0.082	0.004	0.045	0.002
An integrated system for tele-radiology	.537	0.712	0.242	0.114	0.006	-0.017	0.000	0.129	0.014
An electronic Clinical Tests	.508	0.480	0.110	0.388	0.074	0.298	0.055	-0.196	0.033
An electronic service order placing? (e.g. test/diagnostic results)?	.462	0.504	0.121	0.306	0.046	0.338	0.071	0.000	0.000
An integrated system to send electronic discharge letters	.591	0.306	0.045	0.683	0.231	-0.075	0.004	0.159	0.022
An integrated system to send or receive electronic referral letters	.591	0.274	0.036	0.672	0.223	-0.033	0.001	0.252	0.055
A computerized system for ePrescribing	.575	-0.215	0.022	0.589	0.171	0.391	0.095	0.169	0.025
Electronic Patient Record (EPR)	.439	0.169	0.014	0.497	0.122	0.333	0.069	-0.229	0.045
An integrated system for billing management	.610	0.045	0.001	-0.092	0.004	0.771	0.370	0.071	0.004
An electronic appointment booking system?	.488	0.447	0.095	0.114	0.006	0.514	0.165	0.107	0.010
An adverse health events report system	.357	0.094	0.004	0.349	0.060	0.473	0.139	0.047	0.002
Tele-homecare/tele-monitoring services to outpatients	.661	0.180	0.015	-0.024	0.000	0.203	0.026	0.766	0.509
Personal Health Record (PHR)	.429	-0.031	0.000	0.327	0.053	-0.039	0.001	0.566	0.278
Weight of factors in summary indicators***		0.314442867		0.296036004		0.211917109		0.17760402	
Selection criteria									
Eigenvalues		3.525		1.237		1.143		.970	
% Variance explained		27.117		9.512		8.794		7.462	

Notes: Rotated components matrix; Sampling method: factor analysis by main components; Rotation method: Varimax with Kaiser-Meyer-Olkin 0,831; Bartlett's test of sphericity p=0.000; Convergence in 15 itineration; Minimum eigenvalue 0.9.

** Based on rotated component matrix.*

*** Normalised squared factor loadings.*

**** Normalised sum of squared factor loadings.*

Table 7: Application and integration dimension countries index according to the estimated factors

	Summary indicator				
	Dimension	Sub-dimensions			
	Application	Emphasis on clinical and image	Emphasis on EPR and patient management (intramural)	Emphasis on patient access and safety	Emphasis on PHR and tele monitoring (extramural)
SWEDEN	.607	.230	.188	.139	.026
DENMARK	.565	.222	.221	.076	.046
FINLAND	.516	.222	.142	.125	.021
NETHERLANDS	.506	.173	.170	.139	.020
BELGIUM	.496	.200	.161	.122	.011
NORWAY	.466	.187	.139	.127	.013
SPAIN	.448	.181	.128	.122	.018
PORTUGAL	.446	.185	.137	.110	.014
UK	.441	.199	.132	.101	.011
ESTONIA	.433	.190	.187	.113	.000
ICELAND	.429	.161	.199	.069	.000
LUXEMBOURG	.426	.190	.093	.143	.000
IRELAND	.424	.180	.082	.139	.023
AUSTRIA	.389	.180	.110	.098	.000
HUNGARY	.365	.151	.117	.073	.028
CYPRUS	.364	.137	.139	.113	.000
MALTA	.354	.197	.069	.087	.000
CROATIA	.346	.093	.120	.121	.012
ITALY	.343	.150	.074	.103	.018
CZECH REPUBLIC	.338	.175	.083	.071	.000
SLOVAKIA	.326	.135	.082	.057	.015
GREECE	.312	.071	.127	.102	.006
GERMANY	.286	.137	.053	.098	.001
FRANCE	.285	.074	.095	.107	.010
LATVIA	.284	.123	.104	.057	.000
POLAND	.231	.093	.068	.065	.005
LITHUANIA	.221	.092	.072	.057	.000
BULGARIA	.194	.077	.069	.036	.009
SLOVANIA	.142	.054	.036	.052	.000
ROMANIA	.123	.067	.060	.024	.005

See Annex 1. Measurement of dispersion – eHealth Deployment index by country for more detailed information.

radiology reports) with different types of external actors (another hospital, general practitioners, specialists, healthcare providers in other EU or non EU countries).

It is evident from the Table 8 that cross border electronic exchange of information is very limited: less than 5% of hospitals exchange information electronically with healthcare providers in other countries and not surprisingly, given the well known advanced development of teleradiology, the highest percentage of cross border electronic exchange concerns radiology reports.

Table 8: Information flows dimension: descriptive summary statistics

Clinical Information	
With a hospital or hospitals outside your own hospital system	32.8 (297)
External specialists	28.0 (254)
External general practitioners	27.6 (250)
Healthcare providers in other EU countries	4.6 (42)
Healthcare providers outside the EU countries	2.1 (19)
Laboratory results	
With a hospital or hospitals outside your own hospital system	30.1 (273)
External general practitioners	26.8 (243)
External specialists	23.6 (214)
Healthcare providers in other EU countries	3.8 (34)
Healthcare providers outside the EU countries	1.7 (15)
Medication lists information	
External general practitioners	13.7 (124)
With a hospital or hospitals outside your own hospital system	13.0 (118)
External specialists	12.0 (109)
Healthcare providers in other EU countries	2.2 (20)
Healthcare providers outside the EU countries	1.0 (9)
Radiology reports	
With a hospital or hospitals outside your own hospital system	33.9 (307)
External specialists	28.1 (255)
External general practitioners	24.6 (223)
Healthcare providers in other EU countries	4.4 (40)
Healthcare providers outside the EU countries	2.3 (21)

A third of the respondents (32.8%) stated that their hospitals exchange electronically clinical information with a hospital or hospitals outside their own system; 28% stated that their hospital exchange clinical information with external specialists and 27.6% with external general practitioners.

In addition to clinical information, CIOs were asked about laboratory results: 30.1% of hospitals exchange this kind of information with a hospital or hospitals outside their won system; around a quarter of them also exchange electronically this information with external general practitioner (26.8%) and with external specialists (23.6%).

Electronically exchange of medication list information with external general practitioners is reported by 13.7% of the CIOs; almost the same proportion reported that their hospital exchange this type of information with a hospital or hospitals outside their own system (13%) and with external specialists (12%). The exchange of this information with healthcare providers in other countries is less than 3%.

Finally, more than 25% of the CIOs stated that their hospitals electronically exchange radiology reports with a hospital or hospitals outside their own system (33.9%); with external specialists (28.1%) and with external general practitioners (24.6%).

In addition to the general comment on the limited cross border electronic exchange we can also point out that such exchanges with primary care (general practitioners) is not as widespread as it could, especially for certain items. This data actually confirms the well-known bottleneck for the development of ICT supported integrated

Table 9: Information flows dimension: factor analysis

Interpretation		Factor 1* Country		Factor 2* Health professionals		Factor 3* Medication list		Factor 4* Hospital	
	Commonalities	Factor loadings	Weights of variables in factor**	Factor loadings	Weights of variables in factor**	Factor loadings	Weights of variables in factor**	Factor loadings	Weights of variables in factor**
Laboratory results Healthcare providers outside the EU countries	.756	0.86	0.149	0.123	0.003	0.019	0.000	-0.037	0.001
Radiology reports Healthcare providers outside the EU countries	.736	0.821	0.136	0.198	0.008	-0.148	0.009	0.02	0.000
Clinical information: Healthcare providers outside the EU countries	.628	0.792	0.126	0.203	0.009	-0.105	0.005	-0.036	0.001
Medication lists information Healthcare providers outside the EU countries	.663	0.779	0.122	0.033	0.000	0.222	0.021	-0.074	0.003
Laboratory results Healthcare providers in other EU countries	.644	0.773	0.120	0.034	0.000	0.173	0.013	0.123	0.007
Radiology reports Healthcare providers in other EU countries	.629	0.758	0.116	0.12	0.003	0.026	0.000	0.199	0.018
Clinical information: Healthcare providers in other EU countries	.567	0.72	0.104	0.09	0.002	0.116	0.006	0.163	0.012
Medication lists information Healthcare providers in other EU countries	.654	0.689	0.096	-0.077	0.001	0.398	0.069	0.125	0.007
Laboratory results External specialists	.736	0.119	0.003	0.804	0.140	0.238	0.025	0.139	0.009
Laboratory results External general practitioners	.718	0.073	0.001	0.796	0.137	0.241	0.025	0.146	0.010
Radiology reports External general practitioners	.731	0.157	0.005	0.792	0.136	0.046	0.001	0.279	0.036
Clinical informacion: External general practitioners	.698	0.083	0.001	0.778	0.131	0.22	0.021	0.195	0.018
Clinical information: External specialists	.674	0.116	0.003	0.74	0.119	0.24	0.025	0.234	0.025
Radiology reports External specialists	.681	0.15	0.005	0.738	0.118	-0.001	0.000	0.337	0.052
Medication lists information External specialists	.821	0.12	0.003	0.461	0.046	0.768	0.255	0.057	0.001
Medication lists information External general practitioners	.830	0.089	0.002	0.481	0.050	0.764	0.252	0.082	0.003
Medication lists information With a hospital or hospitals outside your own hospital system	.777	0.148	0.004	0.165	0.006	0.73	0.231	0.441	0.090
Radiology reports With a hospital or hospitals outside your own hospital system	.754	0.094	0.002	0.435	0.041	-0.018	0.000	0.746	0.257
Clinical information: With a hospital or hospitals outside your own hospital system	.644	0.089	0.002	0.332	0.024	0.19	0.016	0.7	0.226
Laboratory results With a hospital or hospitals outside your own hospital system	.666	0.058	0.001	0.34	0.025	0.247	0.026	0.697	0.224
Weight of factors in summary indicators***		0.413		0.309		0.146		0.131	
Selection criteria									
Eigenvalues		7.742		3.841		1.412		1.064	
% Variance explained		38.712		19.206		7.058		5.321	

*Notes: Rotated components matrix; Sampling method: factor analysis by main components; Rotation method: Varimax with Kaiser-Meyer-Olkin 0.846; Bartlett's test of sphericity p=0.000; Convergence in 5 itineration; Minimum eigenvalue 1. * Based on rotated component matrix ** Normalised squared factor loadings *** Normalised sum of squared factor loadings.*

Table 10: Information flows dimension countries index according to the estimated factors

Summary indicator					
	Dimension	**Sub-dimensions**			
	Information flows	**Country**	**Health professionals**	**Medication list**	**Hospital**
NORWAY	.415	.051	.214	.088	.062
UK	.295	.039	.146	.045	.064
BELGIUM	.286	.016	.195	.020	.055
IRELAND	.283	.089	.122	.018	.054
DENMARK	.277	.007	.157	.040	.073
NETHERLANDS	.273	.035	.152	.037	.049
SWEDEN	.234	.011	.119	.049	.055
SPAIN	.212	.014	.121	.023	.054
AUSTRIA	.211	.000	.129	.036	.046
FINLAND	.205	.003	.089	.028	.084
LATVIA	.201	.103	.066	.000	.031
ESTONIA	.184	.000	.132	.000	.052
ICELAND	.148	.000	.078	.048	.021
LUXEMBOURG	.148	.000	.094	.012	.042
SLOVAKIA	.141	.026	.077	.006	.032
CYPRUS	.120	.050	.041	.013	.015
MALTA	.111	.000	.080	.000	.031
CZECH REPUBLIC	.104	.003	.062	.002	.037
ITALY	.098	.013	.046	.012	.027
HUNGARY	.087	.000	.053	.000	.034
LITHUANIA	.078	.024	.036	.000	.019
FRANCE	.075	.000	.043	.011	.021
SLOVENIA	.075	.000	.054	.000	.021
GERMANY	.071	.000	.040	.008	.023
PORTUGAL	.063	.002	.029	.005	.026
ROMANIA	.059	.012	.028	.005	.014
CROATIA	.046	.000	.038	.000	.008
POLAND	.037	.012	.015	.002	.008
GREECE	.018	.007	.000	.004	.007
BULGARIA	.000	.000	.000	.000	.000

See Annex 2. Measurement of dispersion – eHealth Deployment index by country for more detailed information.

healthcare represented by the sub-optimal collaboration between different healthcare tiers.

FA[25] of the individual variables within the Information flow dimension yields four factors (see Table 9). Factor 1 relates to electronically exchange of information across countries within and outside EU boundaries. Factor 2 is about information flow among doctors. Factor 3 identifies a drugs oriented focus of electronic exchange, and finally Factor 4 captures information flows between Hospitals.

25 See Table 55 in Annex 2.

It is worth noting, as could be expected from the comment to the descriptive statistics presented earlier (§ 4.1.2, about limited diffusion of extramural applications), that we found not factors concerning a focus on electronic exchange of patient centred data and/or on exchanges between hospitals and the patients themselves.

Table 11: Security and privacy dimension: descriptive summary statistics

Protect the patient data Workstations with access only through a password	93.2 (844)
Security and privacy of electronic patient data at national level	62.8 (529)
Protect the patient data Encryption of all transmitted data	62.7 (568)
Protect the patient data Encryption of all stored data	38.3 (347)
Security and privacy of electronic patient data at regional level	36.3 (329)
Protect the patient data Data entry certified with digital signature	28.6 (259)
Protect the patient data Workstations with access only through health professional cards	19.3 (175)
Protect the patient data Workstations with access only through fingerprint information	4.1 (37)

Table 12: Security and privacy dimension: factor analysis

		Factor 1*		Factor 2*		Factor 3*	
Interpretation		Emphasis on encryption		Emphasis on regulation		Emphasis on workstation	
	Commona-lities	Factor loadings	Weights of variables in factor**	Factor loadings	Weights of variables in factor**	Factor loadings	Weights of variables in factor**
Protect the patient data Encryption of all stored data	.727	0.849	0.521	0.047	0.002	0.061	0.003
Protect the patient data Encryption of all transmitted data	.668	0.789	0.450	0.177	0.023	0.118	0.011
Security and privacy of electronic patient data at national level	.707	0.14	0.014	0.829	0.499	0.004	0.000
Security and privacy of electronic patient data at regional level	.652	0.078	0.004	0.784	0.447	0.179	0.026
Protect the patient data Workstations with access only through health professional cards	.708	0.061	0.003	-0.021	0.000	0.839	0.569
Protect the patient data Data entry certified with digital signature	.537	0.108	0.008	0.201	0.029	0.696	0.391
Weight of factors in summary indicators***		0.350		0.340		0.310	
Selection criteria							
Eigenvalues		1.981		1.017		1.002	
% Variance explained		33.013		16.947		16.707	

Notes: Rotated components matrix; Sampling method: factor analysis by main components; Rotation method: Varimax with Kaiser-Meyer-Olkin 0.667; Bartlett's test of sphericity p=0.000; Convergence in 4 itineration; Minimum eigenvalue 1.

** Based on rotated component matrix.*

*** Normalised squared factor loadings.*

**** Normalised sum of squared factor loadings.*

As per the country ranking (see Table 10), produced by using factors as weights to construct a summary index for this dimension, we can notice that at least in the top scoring countries cross border exchanges seem to be a bit more important.

4.1.4 Security and privacy

The use of password to access workstation within the hospital to protect patient data is established in almost all the hospitals (93.2%). Other security measures such as digital signature (28.6%), health professional cards (19.3%), or fingerprints information (4.1%) are less spread among hospitals. Two thirds of CIOs stated that all transmitted data are encrypted and that they follow national level regulation to guarantee the security and privacy of electronic patient medical data. One third stated that all stored data are encrypted and that regional level regulation is followed (see Table 11).

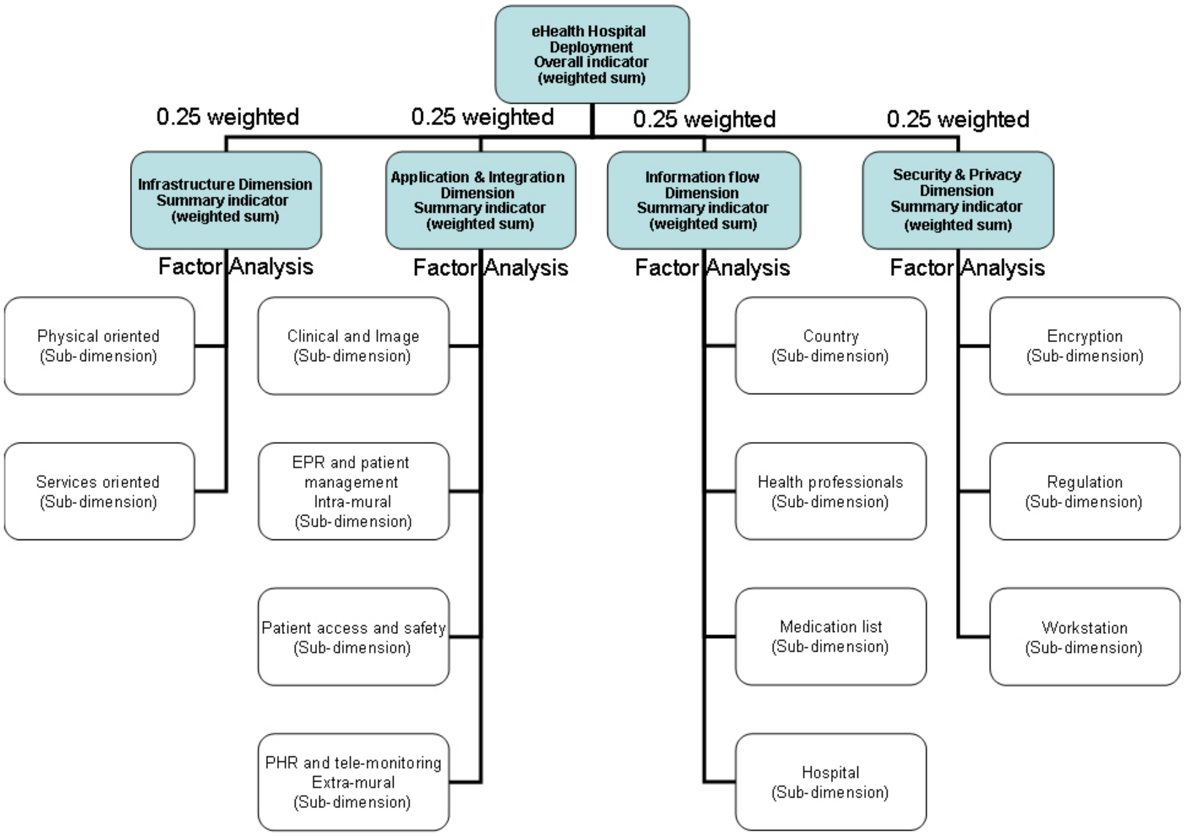
The factor analysis on the individual variables included in the Security and Privacy dimension yield three factors (see Table 12). Factor 1 is about Encryption, Factor 2 about Regulation, and Factor 3 about Workstation.

As per the country ranking (see Table 13), produced by using factors as weights to construct a summary index for this dimension, we can notice that some countries scoring consistently at the top in the other three dimensions seem to place relatively less emphasis on security and privacy issues (i.e. Denmark and Norway).

4.1.5 The Composite Index

The Hospital eHealth Deployment CI has been developed following a multistage approach [60, 62], which is graphically rendered in Figure 6.

Figure 6: eHealth deployment composite index construction



Source: Authors' elaboration.

Table 13: Security and privacy dimension countries index according to the estimated factors

	Summary indicator			
	Dimension	Sub-dimensions		
	Security and Privacy	Encryption	Regulation	Workstation
UK	.671	.262	.248	.161
ESTONIA	.645	.227	.220	.198
IRELAND	.583	.271	.281	.030
SWEDEN	.583	.190	.260	.134
ICELAND	.544	.174	.271	.099
SPAIN	.522	.200	.224	.098
NORWAY	.493	.187	.254	.052
AUSTRIA	.490	.222	.193	.075
DENMARK	.468	.147	.208	.113
PORTUGAL	.464	.141	.218	.104
ROMANIA	.437	.253	.136	.049
ITALY	.434	.156	.177	.100
NETHERLANDS	.431	.160	.210	.061
GERMANY	.418	.187	.179	.052
FRANCE	.398	.173	.147	.079
FINLAND	.359	.112	.180	.067
BELGIUM	.355	.165	.107	.083
CZECH REPUBLIC	.289	.167	.098	.024
POLAND	.275	.158	.089	.028
HUNGARY	.268	.102	.166	.000
LUXEMBOURG	.259	.053	.107	.099
MALTA	.224	.053	.113	.059
LITHUANIA	.211	.052	.117	.042
GREECE	.184	.032	.134	.018
CROATIA	.173	.131	.042	.000
SLOVANIA	.172	.000	.113	.059
SLOVAKIA	.170	.113	.042	.015
CYPRUS	.148	.000	.104	.044
BULGARIA	.061	.045	.000	.016
LATVIA	.057	.000	.057	.000

See Annex 2. Measurement of dispersion – eHealth Deployment index by country for more detailed information.

At this point, partially recalling what anticipated in Section 3, it is worth recalling the various steps involved:

1. Collection and preparation of the basic data.
2. Conceptual identification of the four dimensions and inclusion in them of the base indicators (the lowest level variable resulting from answers to each of the questionnaire questions).
3. Definition of the detailed indicators, which constitute the basis for subsequent estimation.
4. Estimation of the summary index for each dimension and sub-dimension.
5. Estimation of the overall CI, which summarises the features of the various dimensions and sub-dimensions summary indexes and provides the most synthetic measure of eHealth Deployment.

Whereas the completion of steps 2 and 3 two steps entailed some conceptual and theoretical judgement, the fourth step was entirely based on multivariate analysis and the fourth step complements the multivariate analysis assuming that each dimension is equalled weighted so the effect of the number of variables included in each dimension does not influence the final result (as weights have been applied in previous steps). The choice of weighting equally the four dimensions was explicitly made and illustrated with regard to sound reasoning as illustrated in § 3.3. Furthermore, to be fully transparent we have developed Table 14 and 15 summarising the final weights that have been used for each one of the basic indicator:

Table 14: Construction of the detailed indicators

Categorical data	Overall weight dimensions	Dimension	Sub-dimension	Weight of factors in summary indicators*** Sub-dimension	Weights of variables in factor**
Computer system connected	0.25	Infrastructure	Infrastructure physical oriented	0.466	0.381
Broadband above 50 MBps					0.441
Hospital support wireless communications			Infrastructure service oriented	0.534	0.711
Hospital video conference facilities					0.28
Picture archiving and communication systems (PACS)	0.25	Application and Integration	Emphasis on clinical and image	0.314	0.294
An integrated system for tele-radiology					0.242
An electronic Clinical Tests					0.11
An electronic service order placing? (e.g. test/diagnostic results)?					0.121
An integrated system to send electronic discharge letters			Emphasis on EPR and patient management (intramural)	0.296	0.231
An integrated system to send or receive electronic referral letters					0.223
A computerized system for ePrescribing					0.171
Electronic Patient Record (EPR)					0.122
An integrated system for billing management			Emphasis on patient demand and safety	0.212	0.37
An electronic appointment booking system?					0.165
An adverse health events report system					0.139
Tele-homecare/tele-monitoring services to outpatients			Emphasis on PHR and tele monitoring (extramural)	0.178	0.509
Personal Health Record (PHR)					0.278

*** Normalised squared factor loadings.*

**** Normalised sum of squared factor loadings.*

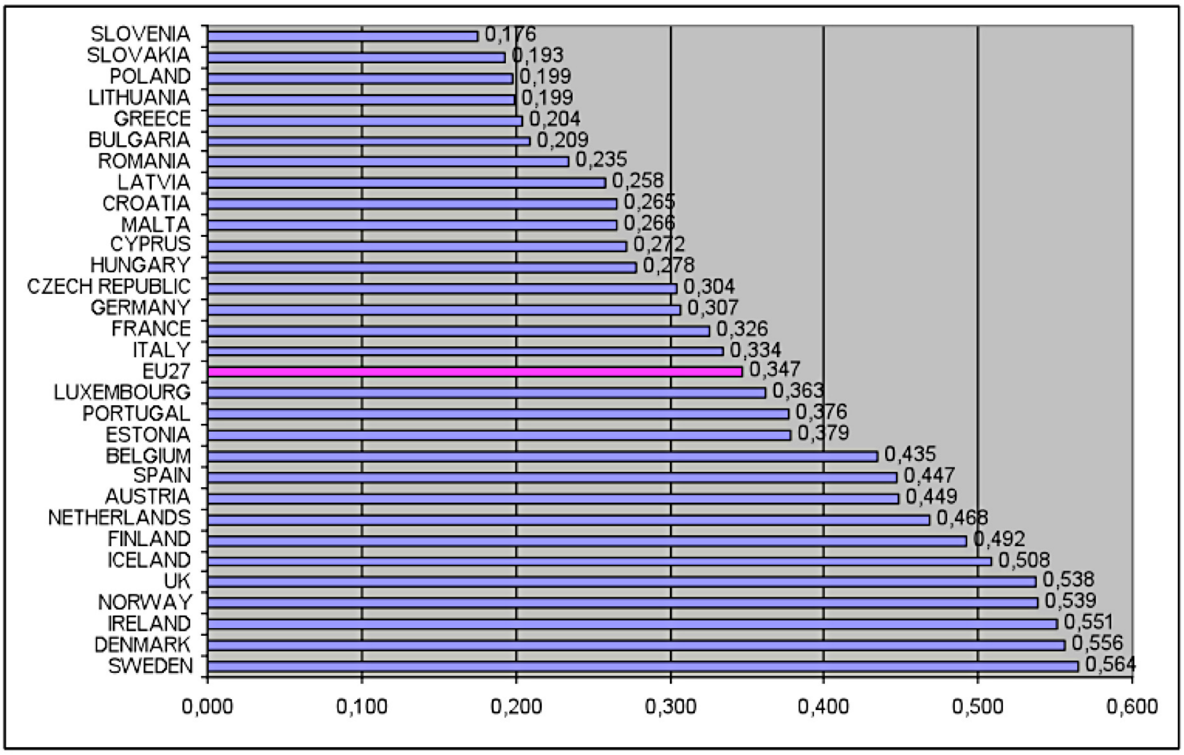
Table 15: Construction of the detailed indicators (cont.)

Categorical data	Overall weight dimensions	Dimension	Sub-dimension	Weight of factors in summary indicators*** Sub-dimension	Weights of variables in factor**
Laboratory results Healthcare providers outside the EU countries	0.25	Information flow	Country	0.413	0.149
Radiology reports Healthcare providers outside the EU countries					0.136
Clinical information: Healthcare providers outside the EU countries					0.126
Medication lists information Healthcare providers outside the EU countries					0.122
Laboratory results Healthcare providers in other EU countries					0.12
Radiology reports Healthcare providers in other EU countries					0.116
Clinical information: Healthcare providers in other EU countries					0.104
Medication lists information Healthcare providers in other EU countries					0.096
Laboratory results External specialists			Health professionals	0.309	0.14
Laboratory results External general practitioners					0.137
Radiology reports External general practitioners					0.136
Clinical informacion: External general practitioners					0.131
Clinical information: External specialists					0.119
Radiology reports External specialists					0.118
Medication lists information External specialists			Medication list	0.146	0.255
Medication lists information External general practitioners					0.252
Medication lists information With a hospital or hospitals outside your own hospital system					0.231
Radiology reports With a hospital or hospitals outside your own hospital system			Hospital	0.131	0.257
Clinical information: With a hospital or hospitals outside your own hospital system					0.226
Laboratory results With a hospital or hospitals outside your own hospital system					0.224
Protect the patient data Encryption of all stored data	0.25	Security and Privacy	Emphasis on encryption	0.35	0.521
Protect the patient data Encryption of all transmitted data					0.45
Security and privacy of electronic patient data at national level			Emphasis on regulation	0.34	0.499
Security and privacy of electronic patient data at regional level					0.447
Protect the patient data Workstations with access only through health professional cards			Emphasis on workstation	0.31	0.569
Protect the patient data Data entry certified with digital signature					0.391

*** Normalised squared factor loadings.*

**** Normalised sum of squared factor loadings.*

Figure 7: Hospitals' eHealth Deployment Composite Index: country ranking



See Annex 2. Measurement of dispersion – eHealth Deployment index by country for more detailed information.

Finally, the next two figures present the results of this process, Figure 7 the CI and Figure 8 the same CI together with the dimension specific summary indexes.

At this point looking at the overall results the traditional questions arise: does it make sense with respect to general background knowledge? Do the differences among countries and between each country and the EU27 average make sense? Does the CI make justice with respect to countries peculiarities?

First, at a strictly technical level, the answer is that the sample is statistically representative of the universe of acute hospitals in each countries, the questions were fully explained and understood by the respondents, the methodology followed and transparently illustrated is sound and not based on any hidden arbitrary choice, a sensitivity analysis (changing the weights of the four dimensions) confirmed the technical robustness of the CI. So, we could simply reply that this is what the data tell us.

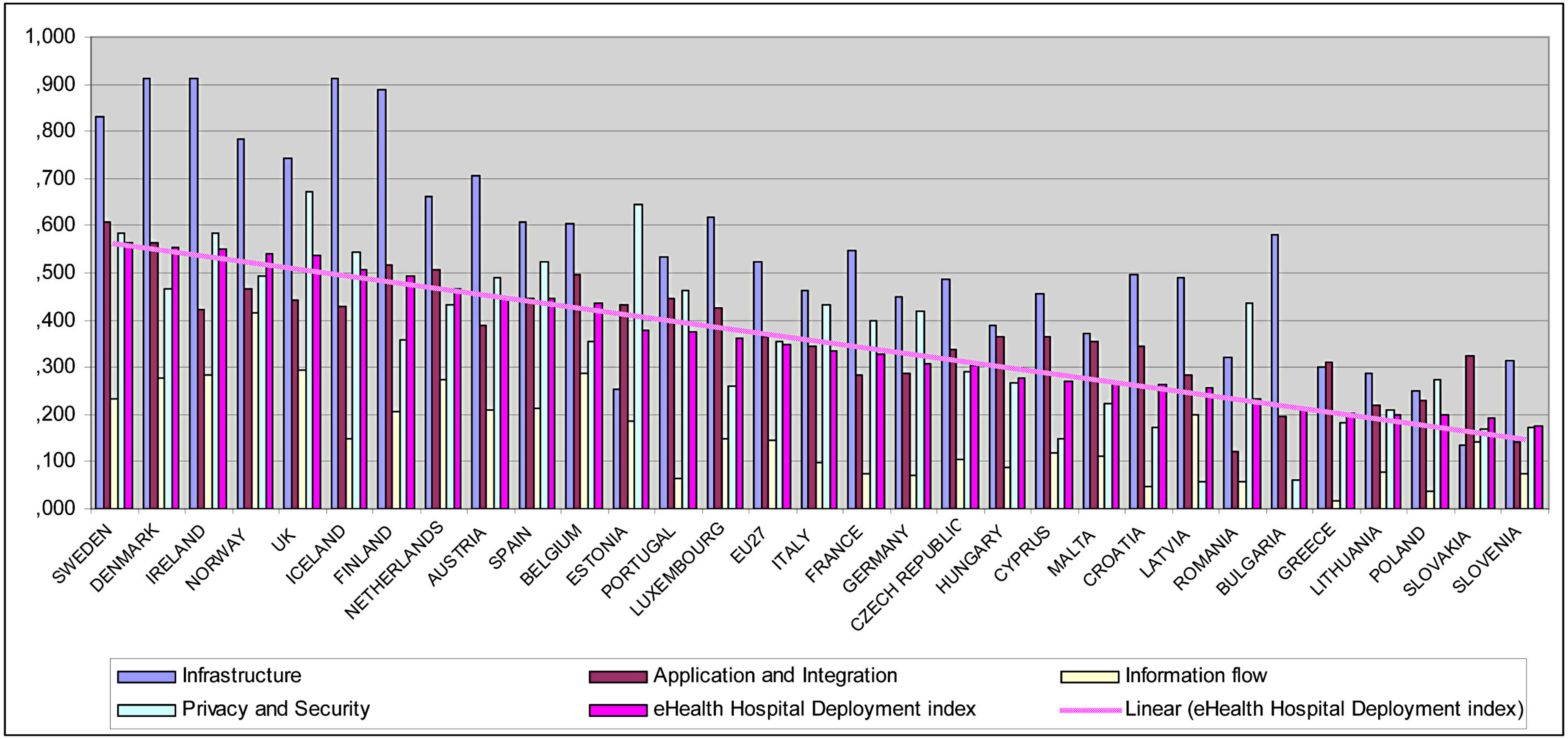
Second, the value of the CI index can be checked against other country level variables to see whether it makes sense (i.e. higher level of ICT spending in healthcare should be reflected in higher score in the CI). We do this substantive robustness check in next paragraph.

Third we can attempt to make some considerations with respect to what is known about countries eReadiness in general and about their eHealth strategies trajectories [11].

With respect to general eReadiness we find that the results below the average toward the bottom and above the average make perfect sense.[26] Countries just below or above the average may raise some questions and particular the relatively low ranking of three big countries such as Italy, France, and Germany. In this respect we must first point out that the larger the countries

26 With the possible surprise of the Ireland where, however, eHealth national efforts have been sustained in recent years [11].

Figure 8: Hospitals' eHealth Deployment Composite Index and dimension indexes: country ranking



the higher was the statistical representativeness of the sample, which in our view rules out a possible biased sample explanation. Furthermore, we can anticipate that the background variables used in next paragraph are aligned in relative terms to such result for these three countries. Finally, the low ranking of these three countries can be partially explained by their eHealth strategy trajectory [11].

What is more interesting to consider from the policy perspective, however, are the value of the CI in general and by country and also how it can be broken down into the four dimensions (Figure 8). From these values key policy messages can be taken away. Below we only make some very brief and general comment, for we will discuss key policy messages in more details in Section 5.

The CI average EU27 value is below 0.5, which means that a lot of progress should still be made and that this index could be used for quite some time in the coming years before it will become saturated (even top scoring countries are just above 0.5). There is quite some nice variability among countries that could be further studies and explored in the future crossing the CI with qualitative evidence and with other quantitative variables (in more granular fashion than those we used in next paragraph).

Looking at the different summary indexes of the four dimensions it is clear that infrastructure is the domain where more progress has been achieved, whereas electronic information flows and exchange lag behind. Application and Integration tend to be relatively well developed and come second after infrastructure, although in some countries security and privacy issues seem to be prioritised over integrated applications (a fact probably deserving some further qualitative country specific analysis).

4.2 Validation: explorative mapping of the composite index against other data

A literature search was carried out to identify external standard that could be used to asses the criterion validity of the CI. Due to the absence of such a standard, following Otieno et al. [63] Two types of correlation analysis were performed. Firstly, One-Way Analysis of Variance (ANOVA) was carried out with our CI as a dependent variable and a list of applications reported by Medical Directors as factors. The same analysis was carried out considering the characteristics of the hospitals (number of beds, structure of property, etc). Both analyses used data gathered in our survey and were performed at a hospital level. Secondly, a more exploratory analysis were developed considering external factors as ICT healthcare expenditure per capita and other supply side healthcare indicators. To enrich our validation, the analysis was performed at a country level.

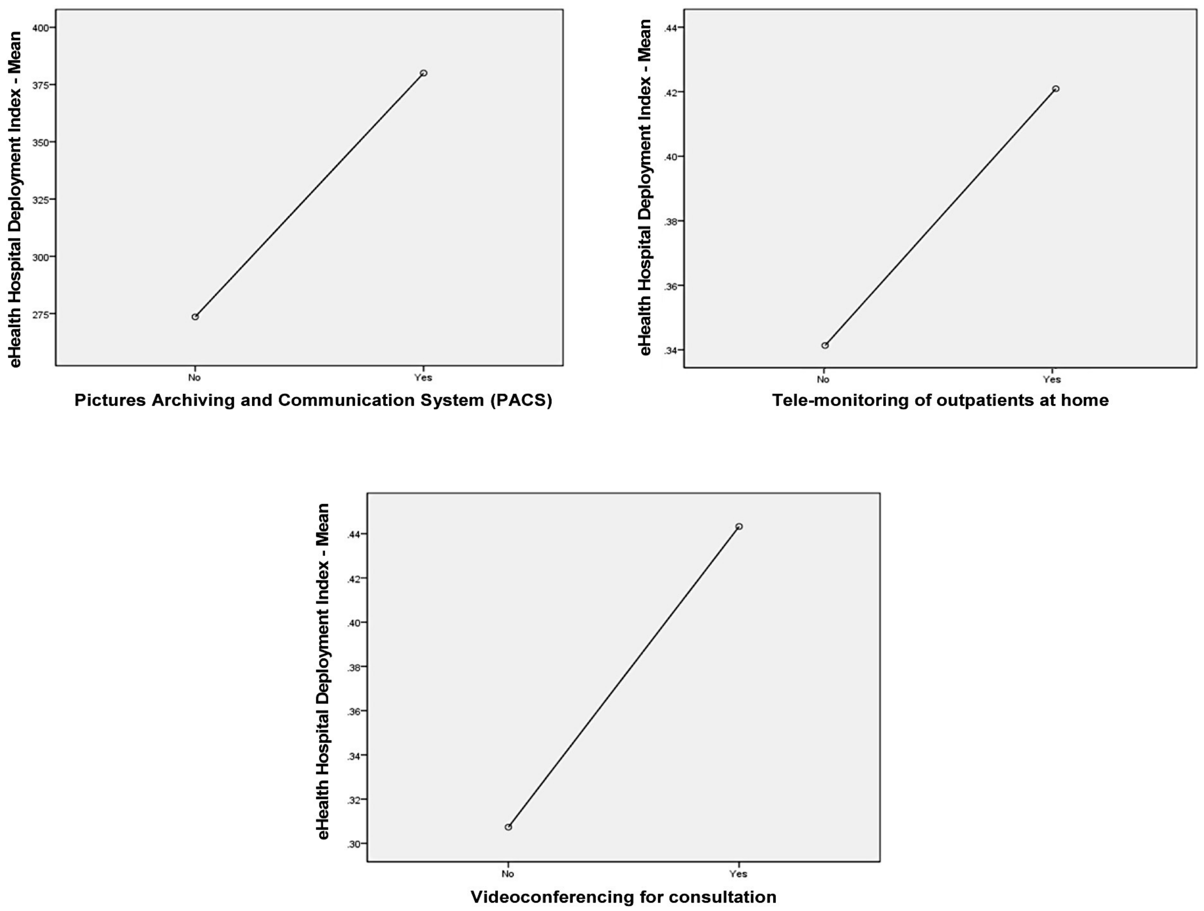
4.2.1 Mapping the CI against other survey data

As explained, in 280 hospitals also Medical Directors (MD) were surveyed and asked, among other things, whether some eHealth applications were actually used by the medical staff under their supervision (see summary statistics in Table 16).

Table 16: Utilisation of eHealth applications by medical staff

Picture Archiving and Communication System (PACS)	67.6
Electronic order communication system for laboratory exams	62.9
Electronic patient record system common to most of the departments	59.9
eAppointment system	54.0
Electronic system to send and receive referral letters	49.6
ePrescription	39.4
Electronic system to send discharge letters to general practitioners	32.6
Videoconferencing for consultation	30.0
Telemonitoring of outpatients at home	8.3

Figure 9: Hospitals' eHealth Deployment CI and application usage

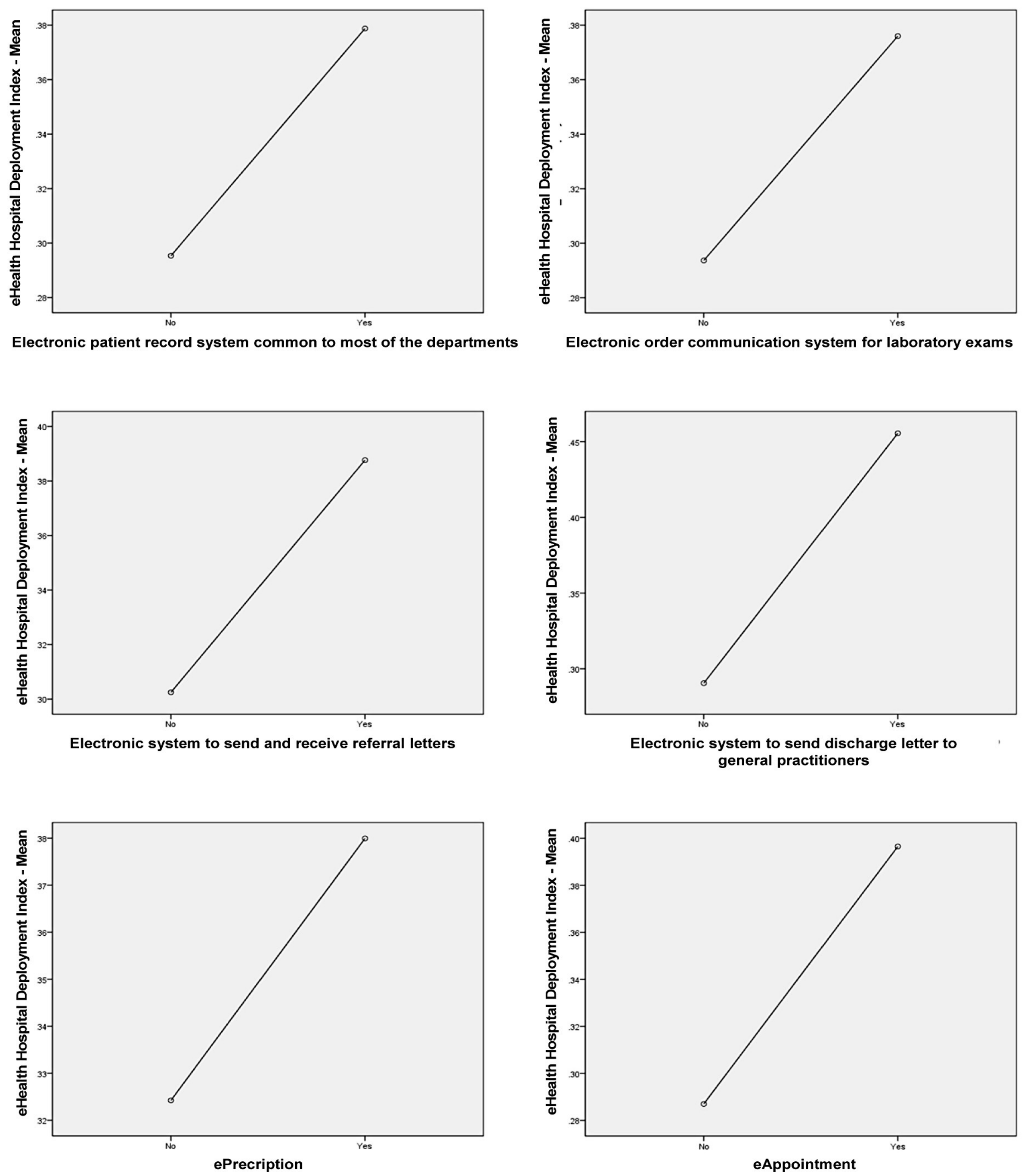


The Table 16 can be interpreted as follows (base on one illustrative item only): 67.6% of the 280 MD reported that their medical staff used PACS in daily work activities. Since MD answers could be matched to hospitals and thus compared with CIOs ones, for a subset of 280 hospitals it was possible to correlate the CI with the level of usage of application by medical staff.

One-Way Analysis of Variance (ANOVA) was carried out with eHealth Hospital Deployment CI as a dependent variable and a list of applications reported by Medical Directors as factors. All factors were statistically significant and reveal a positive relationship between the composite index and the utilisation of each application. This is a very meaningful result as it tells us that the CI is higher in those hospitals where usage of eHealth application is more intense. In other words hospitals invest more in eHealth (and have higher CI) where eHealth is actually used. So, from this first check point the CI seems to come out corroborated. Although it must be stressed, however, that this check has been done using the hospitals and not the countries as unit of analysis (280 hospitals only did not allow us to do a robust country level analysis).

The same analysis, yielding equally comforting results, was replicated correlating the CI with variables characterising the hospitals (number of beds, structure of property, etc). One-Way Analysis of Variance (ANOVA) was carried out with eHealth Hospital Deployment index as a dependent variable and Hospital's characterisation as factors. All factors were statistically significant (see Figure 11). There is a trend showing a positive relationship between our index and: ownership of the Hospital (public or private not for profit); number of beds; structure of the Hospital (part of a group of different hospitals or part of a group of care institutions); computer system externally connected; application integrated in your Hospitals and computer system.

Figure 10: Hospitals' eHealth Deployment CI and application usage



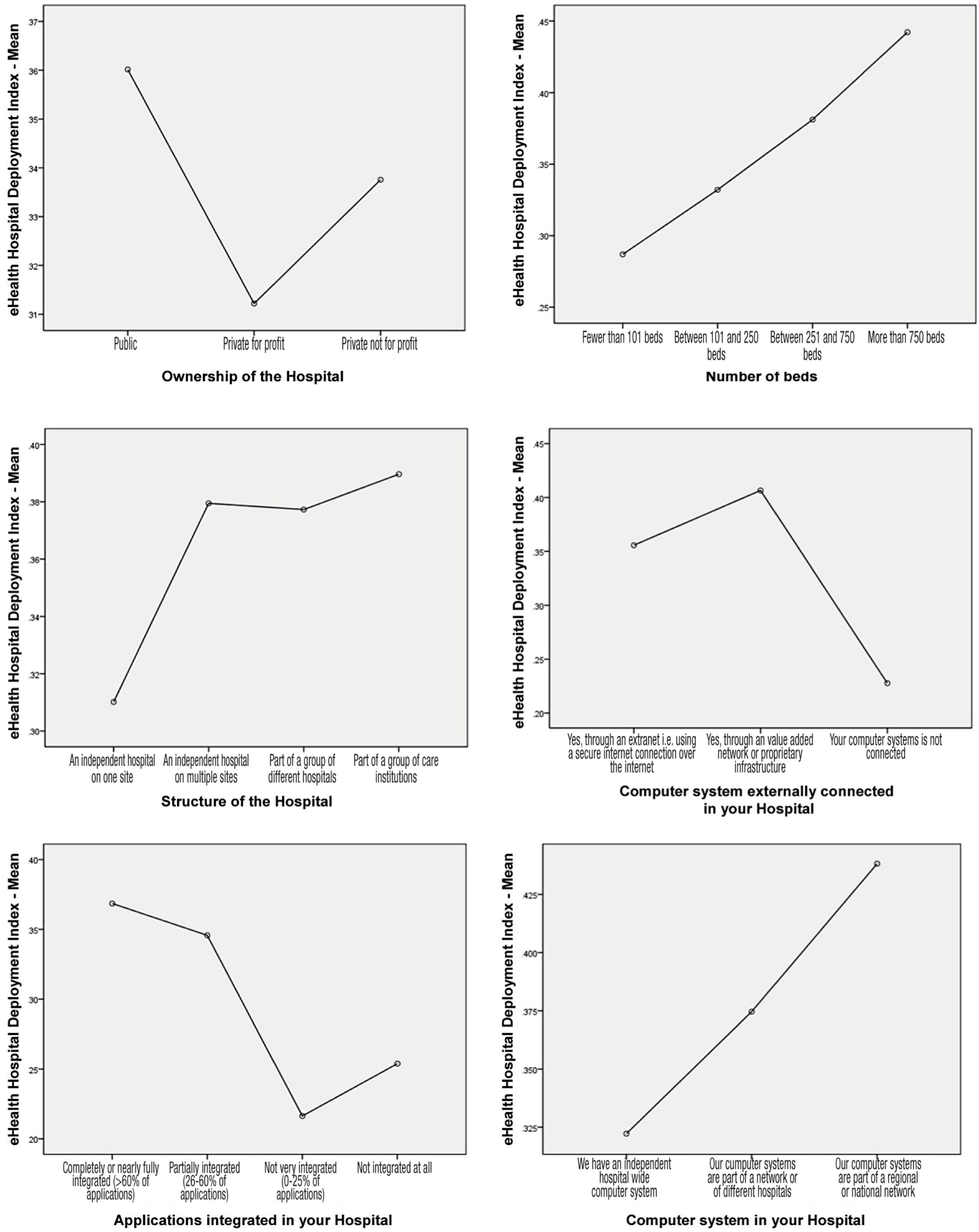
4.2.2 Mapping the CI against country-level ICT per capita spending in healthcare

After mapping our CI against "ICT spending in Health per capita" data from WITSA [47] we get the very interesting explorative association conveyed by the Figure 12.

Countries with more intensive (per capita) healthcare spending in ICT score higher in our hospitals eHealth Deployment CI and it seems now perfectly sound that Italy, France and Germany have lower than expected CI in view of the fact that their ICT expenditure is considerably less intensive than in countries such as for instance Denmark, Sweden, and Norway.

The data used are too aggregate and we do not dare going further than simply pointing out a mere statistical association.

Figure 11: Hospitals' eHealth Deployment CI and characterising factors

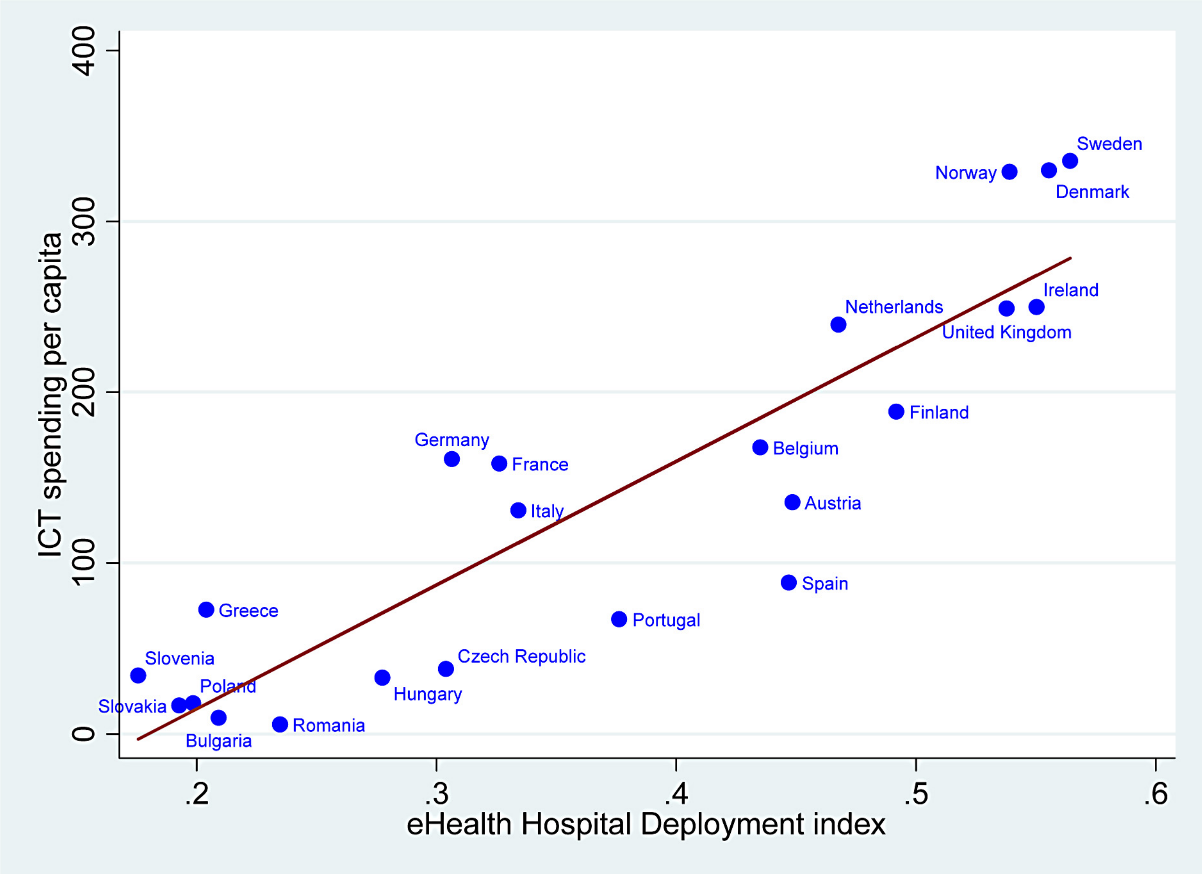


Yet, at least the direction is comforting: if it was negative (high rank in CI associate with low level of spending intensity) than we might have had a problem.

4.2.3 Mapping the CI against country level supply side healthcare indicators

We replicated the operation done with ICT expenditure in healthcare with the following

Figure 12: Hospitals' eHealth Deployment CI and ICT expenditure per capita in healthcare



supply side indicators:[27] "Hospital beds - Per 100,000 of population" (see Figure 13); "Practising physicians - Per 100,000 of population" (see Figure 14); "Number of Computer tomography scanners per 100,000" (see Figure 15).

Again we stress that our aim was explorative and we looked for mere trends and statistical associations, with no claim to demonstrated significant statistical correlations and even less so infer causal relation. Yet, all of the trends illustrated in the following figures are comforting and not counterintuitive with respect to what one would expect as a result of wide introduction of eHealth on the above three supply side indicators: a) it would be counter-intuitive and challenging to find the our CI is higher in countries with the highest number of hospital beds; b) it would be counter-intuitive and challenging to find the our CI is higher in countries with the lowest number of practicing physicians; c) it would be counter-intuitive and challenging to find the our CI is higher in countries with the highest number of computer tomography scanners. The trends in the figures do not support such instances. Naturally, we do not claim that having a higher CI enable to use fewer beds, to support more physicians, and to substitute scanners, for a much more in depth and granular analysis would be needed to substantiate this hypothesis. We simply observe that at least the direction of the trend is in line with what one may expect from relatively higher deployment of eHealth in hospitals.

27 Data were downloaded from Health in Europe: Information and Data Interface (HEIDI) developed by Directorate General for Health and Consumers http://ec.europa.eu/health/indicators/indicators/index_en.htm. We have utilised the last year available 2008.

Figure 13: Hospitals' eHealth Deployment CI and number of hospital beds per 100,000

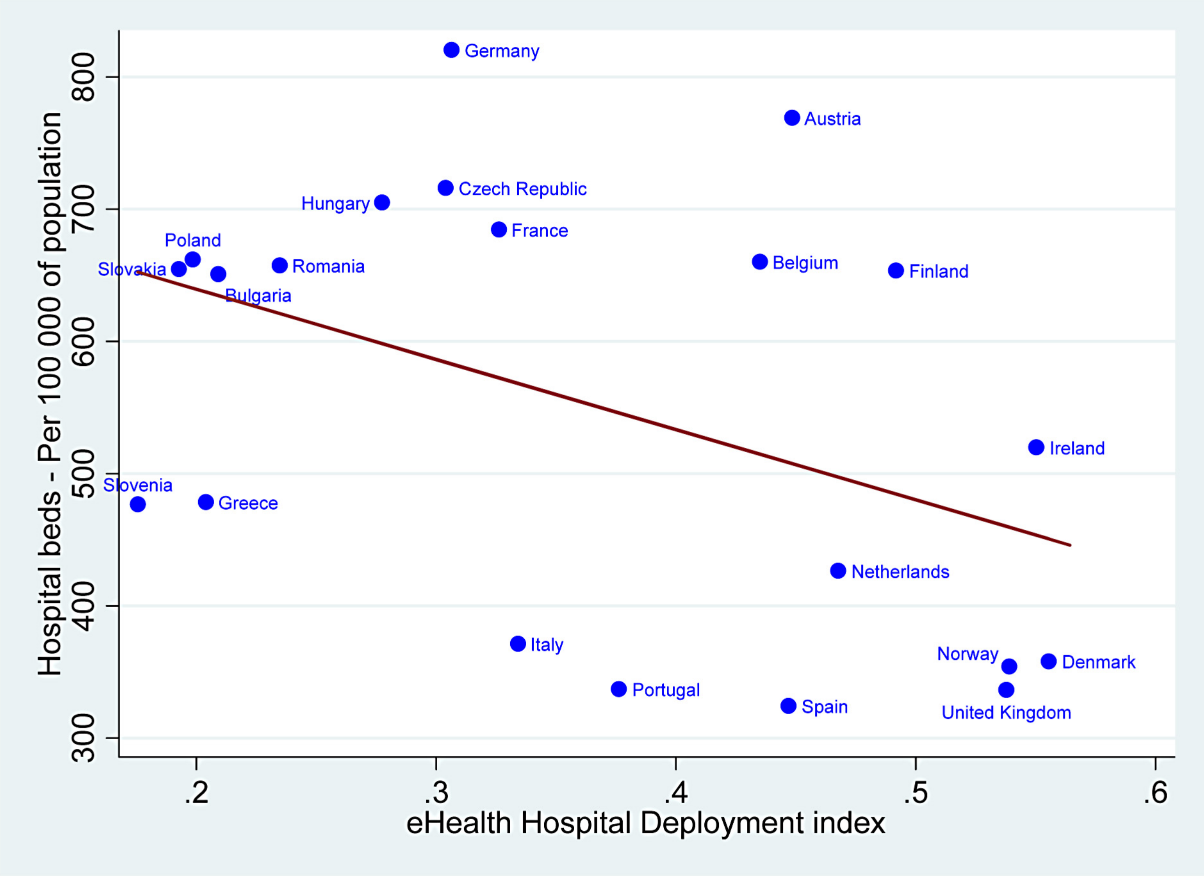


Figure 14: Hospitals' eHealth Deployment CI and number of practising physicians per 100,000

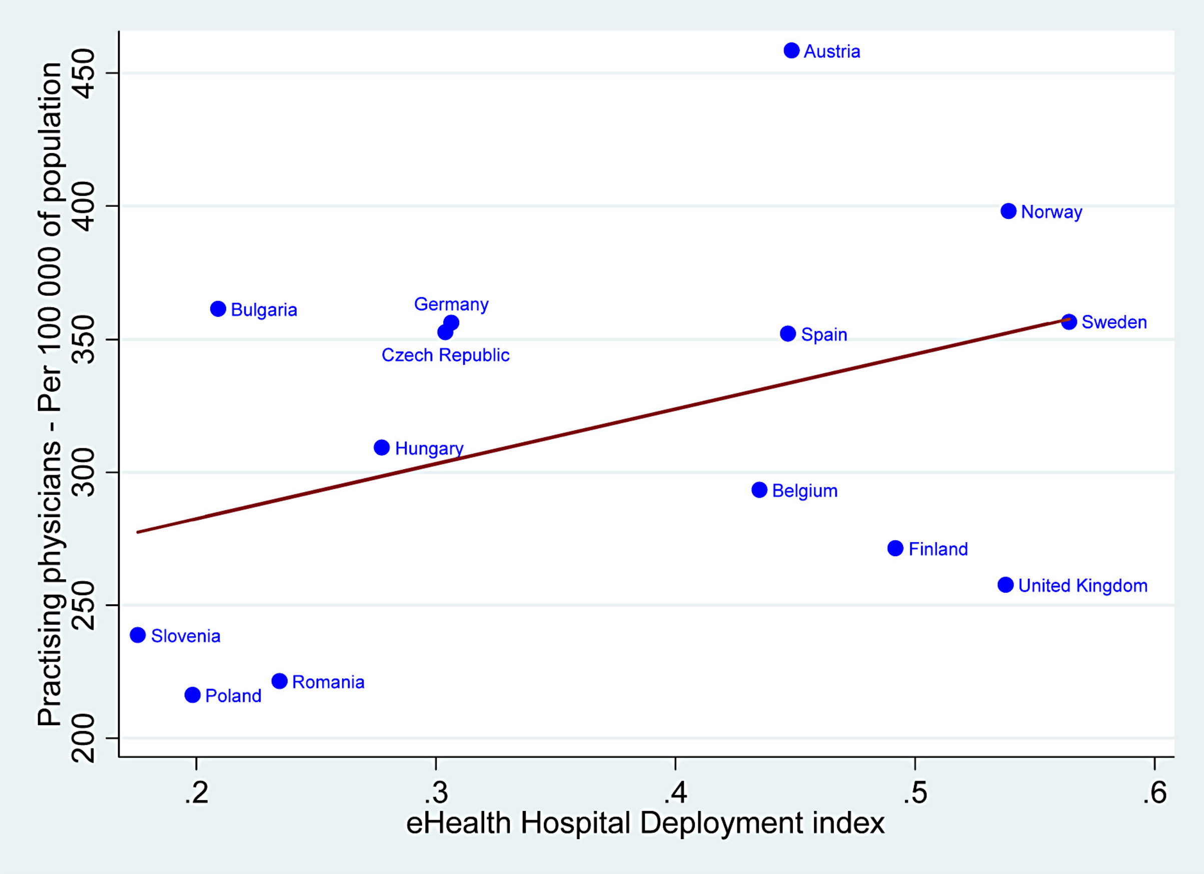
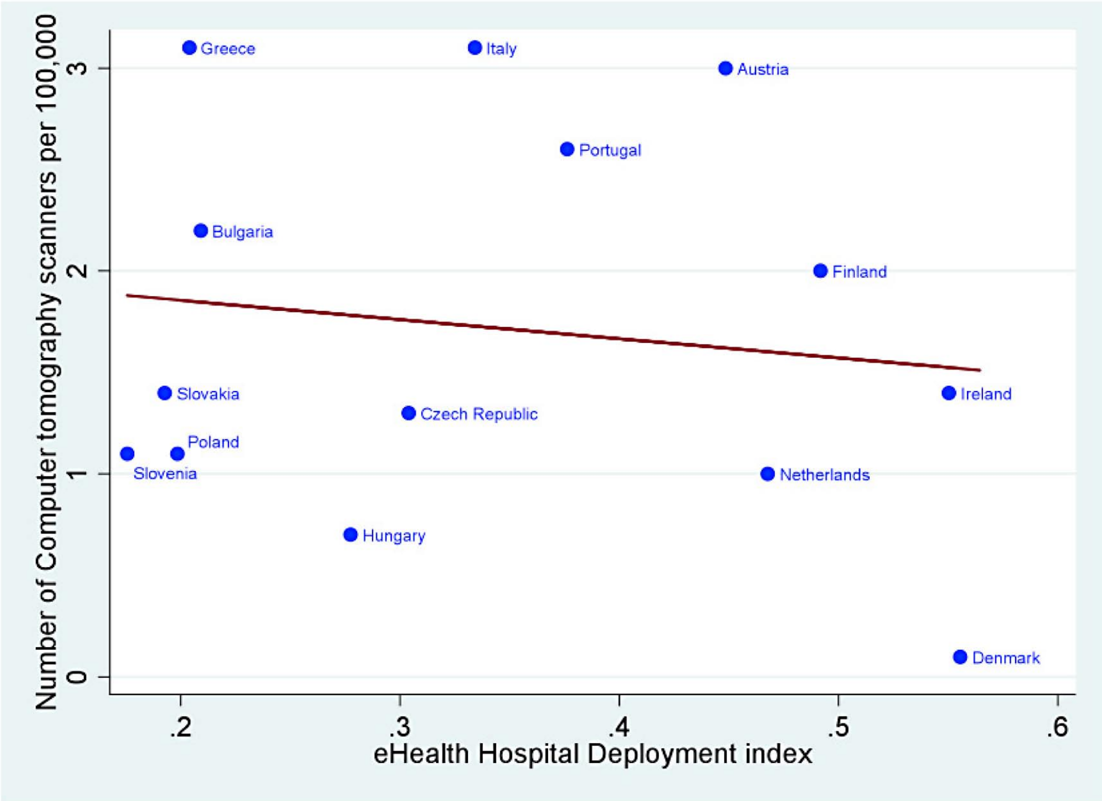


Figure 15: Hospitals' eHealth Deployment CI and number of scanners per 100,000



4.3 eHealth impacts: The view of medical directors

Medical directors were asked their views on the actual and potential impacts that having Electronic Patient Records (EPRs) and providing telemonitoring services at home have had or could have on a number of desirable outcomes. Below we first report the summary statistics on MD answers and then perform a factor and cluster analyses separately for EPRs and Telemonitoring.

Please note that, whereas the answer of CIOs could be taken as objective sources of information about the hospitals, the same cannot be applied to the MD answers on impacts. They represent, in fact, the perception of individuals and, thus, the factor and cluster analyses concern mostly the MD and cannot be taken as representing the factual situation of hospitals (although certainly such perceptions are shaped by such situation). Accordingly, we did not attempt any correlation between the results of the factor and cluster analysis on MD perception of impacts and the hospitals CI, although it would have certainly been of great interest to test whether perception on impact was in any way correlated with the level of eHealth deployment in hospitals. Nonetheless the results of the factor and cluster analysis are quite interesting and suggest important directions for future research.

4.3.1 Descriptive statistics

More than a half of the surveyed MD agreed with the positive impacts that the use of EPR systems may have had on: a) the reduction of waiting lists; b) the average number of patients the hospital can admit; and c) the amount of waste linked to unnecessary repetition of examinations. So, it seems that in the eyes of the MD the EPRs have a positive effects on what we can call operational outcomes (see Table 17).

One the other hand, however, more than 75% of Medical Directors do not think

Table 17: EPRs impacts: MD perceptions

	Totally disagree	Somewhat disagree	Somewhat agree	Totally agree
Medical errors have been reduced	27.7 (43)	58.7 (91)	7.7 (12)	5.8 (9)
The quality of diagnosis decisions has improved	31.3 (50)	43.1 (69)	16.3 (26)	9.4 (15)
The quality of treatment decisions has improved	25.5 (41)	49.7 (80)	13.7 (22)	11.2 (18)
The working processes of medical staff are more efficient	40.7 (68)	43.7 (73)	10.8 (18)	4.8 (8)
Waiting lists have been reduced	15.2 (23)	30.5 (46)	29.1 (44)	25.2 (38)
Average number of patients your hospital can admit during one day has been increased	13.1 (21)	29.4 (47)	25.6 (41)	31.9 (51)
The amount of waste linked to unnecessary repetition of examinations has diminished	27.2 (43)	41.8 (66)	19.6 (31)	11.4 (18)

Table 18: Telemonitoring impacts: MD perceptions

	Not at all	Not much	Some extend	Great extend
Reduction in time for achieving therapy stabilization	29.8 (78)	40.8 (107)	20.2 (53)	9.2 (24)
Improvement in the quality of life of patients	42.0 (113)	38.7 (104)	13.8 (37)	5.6 (15)
Reduction in the numbers and length of hospital stays	39.0 (105)	39.0 (105)	12.3 (33)	9.7 (26)
Reduction in medical errors	15.3 (40)	36.0 (94)	27.2 (71)	21.5 (56)
Improvement in the quality of diagnosis decisions	19.0 (51)	43.3 (116)	27.6 (74)	10.1 (27)
Improvement in the quality of treatment decisions	24.9 (68)	42.1 (115)	22.3 (61)	10.6 (29)
More efficient working processes among medical staff	36.3 (97)	37.5 (100)	19.5 (52)	6.7 (18)
Shorter waiting lists	30.0 (80)	37.1 (99)	18.0 (48)	15.0 (40)
Increased average number of patients receiving help during one day	31.6 (84)	30.8 (82)	22.9 (61)	14.7 (39)

Table 19: MD perceptions on EPRs impacts: factor analysis

	Factor 1. Emphasis on quality impact	Factor 2. Emphasis on throughput impact	Commonalities
Medical errors have been reduced	.661	.185	.471
The quality of diagnosis decisions has improved	.859	.117	.752
The quality of treatment decisions has improved	.813	.156	.685
The working processes of medical staff are more efficient	.625	.185	.424
Waiting lists have been reduced	.059	.810	.660
Average number of patients your hospital can admit during one day has been increased	.198	.836	.737
The amount of waste linked to unnecessary repetition of examinations has diminished	.379	.559	.455
Auto values	3.038	1.147	
% Variance explained	43.399	16.384	

Notes: Rotated components matrix; Sampling method: factor analysis by main components; Rotation method: Varimax with Kaiser-Meyer-Olkin 0.721; Bartlett's test of sphericity p=0.000; Convergence in 3 itineration; Minimum eigenvalue 1.

that an EPR systems has impact on more clinical and strategic patient outcomes such as: a) the reduction of medical errors; b) the improvement of quality of diagnosis; c) the quality of treatment decisions.

Although the specific impacts considered change, the situation emerging for Telemonitoring it is exactly the same as per EPRs (see Table 18). MDs perceive only the contribution of Telemonitoring to operational outcomes but not to clinical and patient strategic ones. The highest proportion of Medical Directors disagreed that Telemonitoring would: a) improve the quality of life of patients; b) result in a reduction in the number and length of hospital stays; and/or c) result in more efficient working processes among medical staff.

4.3.2 EPRs and telemonitoring impact: factor and cluster analysis

A factor analysis was undertaken to identify common relationships between the possible impacts that the use of EPR systems may have had in hospitals. From the analysis two factors emerged: (1) 'emphasis on quality impact' and (2) 'emphasis on throughput impact' (see Figure 19). In order to develop a typology of Medical Directors' perception of impacts, a Non-Hierarchical Cluster Analysis of K-means was undertaken to these factors (see Table 20). These factors were selected due to their significance ($p < .001$) within the cluster analysis (See Table 56 in Annex).

Cluster one (46%, the overwhelming majority) consists of Medical Directors that place emphasis neither on quality nor on throughput. They see no impact at all and we labelled them 'Laggards' only on the basis of a theoretical intuition that will need to be further tested with additional empirical evidence. If they perceive no impacts this may be due to personal and/or hospital characteristics: a) The MDs themselves have a conservative (negative) attitude toward the deployment and usage of eHealth in the hospitals; b) the MDs work in hospitals where eHealth applications have been introduced without the complementary organisational changes and, thus, they objectively see no impacts.

Cluster four, being the exact opposite of cluster one, include those MDs (22%) who perceive both kind of impacts (throughput and quality) and we called them the 'transformers', again on the basis of a theoretical intuition that will need to be further tested. If they perceive both impacts this may be due to personal and/or hospital characteristics: a) The MDs themselves are enthusiast of eHealth deployment and usage in the hospitals; b) the MDs work in hospitals where eHealth applications have been introduced with the needed complementary organisational changes and, thus, they objectively see the impacts.

These two clusters set a continuum in a way that makes perfect sense with the main theoretical and empirical evidence from the general field of the economics of ICT. Within this continuum the other two clusters are

Table 20: MD perceptions on EPRs impacts: cluster analysis

	Clusters				
	Laggards 42% (56)	Rationalisers 25% (34)	Experimenters 11% (15)	Transformers 22% (30)	ANOVA F
Factor 1. Emphasis on quality impact	-.44202	-.65140	1.98303	.57184	103.221*
Factor 2. Emphasis on throughput impact	-.82912	1.04553	-.37188	.54869	80.222*

*p<.001

Notes: Results of K-means - quick cluster analysis. Method of analysis: non-hierarchical cluster. Final cluster centroids.

Table 21: MD perceptions on telemonitoring impacts: factor analysis

	Factor 1. Emphasis on throughout impact	Factor 2. Emphasis on quality impact	Commonalities
Improvement in the quality of life of patients	.632	.373	.538
Reduction in the numbers and length of hospital stays	.690	.363	.608
Reduction in medical errors	.152	.768	.613
Improvement in the quality of diagnosis decisions	.226	.877	.820
Improvement in the quality of treatment decisions	.296	.846	.803
More efficient working processes among medical staff	.645	.350	.539
Shorter waiting lists	.824	.091	.686
Increased average number of patients receiving help during one day	.813	.103	.672
Auto values	4.084	1.195	
% Variance explained	51.046	14.943	

Notes: Rotated components matrix; Sampling method: factor analysis by main components; Rotation method: Varimax with Kaiser-Meyer-Olkin 0.842; Bartlett's test of sphericity p=0.000; Convergence in 3 itineration; Minimum eigenvalue 1.

Table 22: MD perceptions on telemonitoring impacts: cluster analysis

	Clusters				
	Laggards 46% (105)	Rationalisers 19% (43)	Experimenters 17% (40)	Transformers 18% (42)	ANOVA F
Factor 1. Emphasis on throughout impact	-.55736	.83544	-.72465	1.22821	142.466*
Factor 2. Emphasis on quality impact	-.40519	-1.05507	1.28131	.87288	170.231*

**p<.001*

Notes: Results of K-means - quick cluster analysis. Method of analysis: non-hierarchical cluster. Final cluster centroids.

less clear cut but still meaningful. Cluster two (25%) includes those MD who perceive 'throughput impact' but not 'quality impact'. We called them rationalisers in the sense that, either only at intentional /subjective level or on the basis of factual experience, they see in eHealth applications only a way of achieving efficiency outcomes but are sceptical about clinical or patient strategic outcomes. Cluster three (11%) includes those MD who do not perceive 'throughput impact' but do perceive 'quality impact'. Contrary to the rationalisers, either only at intentional /subjective level or on the basis of factual experience, they see eHealth applications mainly as an instrument to increase quality and seem less concerned with efficiency. We called them, thus, the 'experimenter' in that they might have gone into patient and quality oriented applications without having first introduced operational and efficiency oriented tools.

The exact same factor and cluster analysis was applied to MDs answers on Telemonitoring impact and yielded statistically significant factors and cluster along the same line of what emerged for EPRs. From the analysis two factors emerged: (1) 'emphasis on quality impact' and (2) 'emphasis on throughput impact' (see Table 21). In order to develop a typology of Medical Directors' perception of impacts, a Non-Hierarchical Cluster Analysis of K-means was undertaken to these factors (see Table 22). These factors were selected due to their significance (p <.001) within the cluster analysis (See Table 57 in Annex).

Cluster one (46%) includes the 'laggards', cluster two (19%) includes the 'rationalisers', cluster three (17%), includes the 'experimenters, and cluster four (18%) includes the transformers'.

4.3.3 Making sense of perceptions on impacts: the need for further data

As anticipated, technical data conditions do not allow us to correlate these two typologies with the Hospitals eHealth Deployment CI. We tested the extent to which such typologies are correlated with hospitals characteristics (size, forms of property, etc) and we found no statistically significant relation.

The most important and interesting result is that, going beyond the main aggregate message coming from descriptive statistics (MD tend to perceive little impact), there are clearly significant differences if factor and cluster analysis are applied. These differences envisage potentially very interesting and relevant explanations in line with the literature on the economics of ICT and they deserve to be further analysed with additional empirical evidence. The labels we attached to the cluster intuitively convey the underlying hypotheses, that we could not tested for lack of variables on which the survey does not report information, such as for instance: a) individual respondent characteristics (age, experience, expertise, etc); b) information about processes and other input accompanying the deployment of eHealth in hospitals (human resources policy; organisation structure; organisational change).

5 Discussion and recommendations

5.1 Methodological considerations: composite index and benchmarking

We have amply demonstrated that it cannot be decided a priori whether or not a Composite Index approach is appropriate for international policy benchmarking. Instead, it depends on the nature of the topic and of the data available and especially on the robustness and transparency of conceptual-theoretical and methodological choices.

The sheer amount and richness of the data from the eHealth Benchmarking Phase III survey would have been unmanageable from the perspective of making sense of it for policy purposes without the construction of a composite index.

When we set out to construct our CI, we made transparently clear those choices that depended on our conceptual and theoretical reasoning and the results that emerged simply from the multivariate statistical analysis of the data. No issue was left implicit and no arbitrary choices were made. Critics may legitimately challenge our decision to weight the four dimensions equally, but we justified it with sensible reasoning and the weighting of the lower-level base variables. In the methodological and technical process, we followed standard practices from well-established handbooks and practical applications in the construction of CI.

As a result of this, our Hospitals eHealth Deployment CI provides synthetic and interesting insights for policy makers that make sense and are robust, not only from an internal technical perspective but also with respect to the external exploratory checks we presented in § 4.2, of which two will suffice to recall that our CI was strongly corroborated. We showed that greater use of eHealth applications by medical staff is associated with a higher ranking in the Composite Index. We do not claim to have identified a causal relation whereby usage determines higher eHealth deployment in hospitals (or vice versa): more granular analysis controlling for other variables would be needed to make such a causal inference. On the other hand, if the association was negative, the soundness of our CI would have been challenged, but this is not the case. We also identified a clear trend linking higher levels of eHealth deployment in hospitals to more intensity (per capita) in spending on ICT in healthcare. Again, we are not making any causal inference from this trend, but we can certainly make better sense of the low ranking in the CI for countries such as Italy, France and Germany, in view of the fact that their intensity in ICT spending on healthcare is fairly low in relative terms compared to top Scandinavian countries and the UK. This does not necessarily mean that spending more on ICT and having higher levels of deployment of eHealth is better and produces more desirable outcomes. This issue should also be further analysed using the CI in combination with other data (more granular than the country aggregate indicators we used in § 4.2, see more on this in 5.3). It means, however, that for the purposes for which it was constructed, our CI is fairly robust and sound.

As regards the latter, we are fairly confident about the capacity of our CI to meet the criteria of comparability and of accounting for country peculiarities. No doubts that other researchers can in the near future take our results and attempt a more in depth and possibly qualitative interpretation of the CI in view of country specific structural feature and/or short term policy efforts and dynamics. Nonetheless, we can safely affirm that the CI does not show any major bias with respect to comparability and country peculiarities. Moreover, the CI index and the summary indexes of the four dimensions should be read more for the information they provide about gaps than for the country ranking in itself (see more on this in the next paragraph on key policy messages).

In conclusion, the synthetic information that can be extracted from the CI and from the dimensions summary indexes represents a unique contribution to the field of eHealth, which is more complete and exhaustive than any other analysis that has been published in Europe or beyond (including those published by the OECD and WHO) and places the European Commission at the leading edge in this field. In the light of this and also of other potential advancements in our understanding of eHealth that could be gained by linking the CI with other data, it would certainly be worth repeating the survey in the near future in order to develop the CI to benchmark progresses from this 2010 baseline. The approach we have adopted here, opportunely discussed and adapted could also be proposed as a model framework for both surveys and administrative data gathering on eHealth deployment and other relevant data.

5.2 Key policy messages

Despite very relevant comparability problems, we can risk concluding that the results of the eHealth Benchmarking Phase III survey show that progress has been made in Europe with respect to the levels of eHealth deployment registered in previous, less systematic and extensive data gathering activities such as Business Watch and Hine. For instance, the penetration of Electronic Patient Records (EPRs) has increased from the 34% reported for 2006 by Business Watch to the current 81% [20].[28] This 81% penetration of EPRs puts Europe way ahead of Japan and US, where only between 10% and 15% of hospitals have introduced them.

However, there are also several indications of areas in need of policy action, of which we emphasise the following four:

1. **The CI shows large scope for improvement**. The average EU27 CI stands at 0.347, whereas that of top scoring Sweden is just slightly above 0.5. This means that there is still room for general improvement.
2. **Wide variation across countries.** In particular, the lowest deployment measured by our CI is concentrated mostly among the new Member States and candidate countries. Of the bottom 13 countries, 12 are from this group – Greece is the exception. The only new Member State that scores above the EU27 average is Estonia, confirming its excellence in the domain of ICT. This calls for awareness-raising policies and possibly financial support targeting this group of countries.
3. **The summary indexes of the four dimensions identify areas to be prioritised**. Whereas infrastructure deployment is quite high in most countries, electronic exchange of information lags behind fairly generally (across countries). It is important to close this gap, since these exchanges constitute one of the pillars of the vision and promises of ICT-supported integrated personal health services. These services are the key to producing better health outcomes while pursuing system sustainability and they must be developed around a seamless view of the user, for which exchange of information and timely clinical decisions are crucial. Yet, our analysis shows that electronic exchanges are still limited among the potential interacting players. Furthermore, cross-border exchanges are extremely limited, a gap that from the perspective of EU policy should be quickly addressed.
4. **Predominant intramural orientation**. From both simple descriptive statistics and from our multivariate statistical analysis, it emerges clearly that the deployment of eHealth in hospitals has been predominantly focussed on

28 See graph on page 208 of the Deloitte/Ipsos report.

intramural needs and applications. For instance, levels of deployment for Personal Health Records and home-based Telemonitoring are very low. We need to stress that if the objectives and targets of the upcoming European Innovation Partnership on Active and Healthy Ageing are to be realised, much more progress will be needed in terms of both electronic exchange of information and user-oriented applications and services, such as PHR and Telemonitoring.

5.3 Linking hospitals' eHealth deployment to other data

As argued in the OECD-JRC handbook of composite indicators on page 29: "*Composite indicators often measure concepts that are linked to well-known and measurable phenomena, e.g. productivity growth, entry of new firms. These links can be used to test the explanatory power of a composite. Simple cross-plots are often the best way to illustrate such links*"[60]. This is exactly what we have done in § 4.2. The same handbook warns not to infer causal relations from such cross-plots, which we did not do. Instead, we verified that our CI was in line with common sense reasoning: if hospitals deploy eHealth applications in a more sustained fashion, they would spend more on ICT and this would be reflected at aggregate country level in ICT per capita spending on the healthcare system as a whole. This is exactly what we found, thus corroborating the robustness of our CI. Figure 12 shows exactly how most countries are close to the trend line between the CI and ICT expenditure and there are only few outliers. We also used cross-plots with other data, and found trends that, in each case, supported the soundness of our CI.

Linking our CI to other data also alerted us to potential further research questions that could be addressed, should additional data become available by adding new modules to a future survey and/or integrating the survey with administrative data. Several questions arose, that would both advance our scientific understanding of the eHealth domain and contribute to policy making by identifying the impact of eHealth and/or the underlying factors and processes that explain success and should be the object of policy and innovation transfer efforts. We give just two examples below.

Let us assume that, in addition to the data we have analysed, for the same sample of hospitals (so not at aggregate country level) we add only for a cross section also the following data:

a) hospitals' expenditure on ICT;
b) hospitals' output (i.e. number of consultations and/or number of treatments);
c) measures of health status among the population served by these hospitals.

With this data, we could apply a number of sophisticated techniques (such as Data Envelopment Analysis) and, controlling for different variables in different specifications, come closer to identifying causal relations. For instance, we could construct an outcome efficiency frontier using the CI of eHealth deployment while controlling for ICT expenditure and output, or we could construct the frontier crossing the CI and output while controlling for outcomes and other non-ICT input. Should data such as these become available in the future, then we would be able to infer causal relations and estimate the impact of eHealth deployment in hospitals, if any.

In § 4.3, we analysed the answers of the MD when asked for their opinions on the extent to which EPRs and Telemonitoring contributed to achieving desirable outcomes. The simple analysis of descriptive statistics showed that while MD on average perceive some operational impacts which we labelled 'throughput impact' (i.e. increase in average number of patients the hospital can admit during one day), they do not see more strategic clinical and patient outcomes which we labelled 'quality impact' (i.e. quality of diagnosis and treatment). The multivariate statistical analysis, however, identified four significant and meaningful clusters requiring an explanation. We called them: 'laggards' (MD who perceive no impact at all), 'transformers' (MD who perceive both throughput and quality impacts), 'rationalisers' (MD who perceive only throughput impact), and 'experimenters' (MD who perceive only quality impact). These labels intuitively convey an underlying theoretical hypothesis derived from the microeconomics of ICT (i.e. 'transformers' worked in hospitals where eHealth deployment was integrated with organisational restructuring and change management) that, however, the data from the survey did not allow us to empirically test. We could have tested this hypothesis and explained the difference between the clusters had the survey also contained the following:

a) interviews with MD in all the hospitals in the sample;
b) basic information about MDs' personal characteristics (to control for the possibility that their perceptions are shaped by these characteristics rather than by the objective situation in the hospitals);
c) information about re-organisation and change management in the hospitals (yes/no, when, for how long);
d) the history of eHealth deployment in the hospital (to control for the possibility that in some hospitals, MD have not perceived any impact due to the lag time between eHealth implementation and the its effects).

5.4 Final recommendations

After the detailed presentation of results in the previous section and the discussion in the previous three paragraphs, the final policy recommendations should now be evident. We therefore limit ourselves to a brief summary of possible actions under two main headings:

eHealth benchmarking and evaluation agenda

1. **Replicate the survey on hospitals**. The survey should be replicated in 2011 or, at the latest, in 2012 to test the reliability if the CI and to benchmark progress.
2. **Link eHealth deployment to other data**. Future surveys should include new modules to retrieve at least some of the additional data mentioned in § 5.3 in order to tackle wider research questions and contribute to impact evaluation objectives.
3. **Work on Survey Model Framework**. The above mentioned Units C4 and H1 together with JRC-IPTS (and possibly DG SANCO) should engage the OECD and WHO in a joint project to develop such a framework for future use in both survey and administrative data gathering to ensure increased cross-sectional and longitudinal comparability in the future.

eHealth policy agenda

1. **Awareness raising and financial support to low scoring countries**. A targeted awareness raising campaign and new financial support instruments for the new Member States and candidate countries that are positioned at the bottom of our CI could be considered.
2. **Measures to push Member States to close key gaps**. Within the context of the new EIP on Active and Healthy Ageing, all Member States should be made aware of the fact that investment in eHealth within hospitals should give priority to increasing electronic exchanges of information and user-oriented applications and services such as PHR and Telemonitoring.
3. **Cross-border and digital single market**. The information showing very limited deployment of eHealth in support of cross-border exchange should be used to justify placing this topic on the policy agenda within a digital single market perspective.

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ANNEX 1. Measurement of dispersion of eHealth Deployment Index by country

Table 23: Measurement of dispersion – eHealth Deployment Index Austria

	N - Valid	Missing	Mean	Std. Error of Mean	Median	Mode	Std. Deviation	Variance	Range	Min	Max	Sum	Percentiles - 25	Percentiles - 50	Percentiles - 75
Physical oriented (Sub-dimension)	14	1	.3097	.02731	.3831	.38	.10219	.010	.21	.18	.38	4.34	.1775	.3831	.3831
Services oriented (Sub-dimension)	14	1	.3847	.03408	.3797	.38	.12750	.016	.53	.00	.53	5.39	.3797	.3797	.4172
Infrastructure Dimension	13	2	.7049	.05260	.7627	.76	.18964	.036	.74	.18	.91	9.16	.6322	.7627	.7627
Clinical & Image (Sub-dimension)	15	0	.1800	.02129	.2028	.24	.08246	.007	.24	.00	.24	2.70	.1303	.2028	.2408
EPR & patient management Intra-mural (Sub-dimension)	15	0	.1103	.01233	.1045	.10	.04775	.002	.17	.00	.17	1.66	.1045	.1045	.1551
Patient access and safety (Sub-dimension)	14	1	.0982	.01521	.1282	.14	.05692	.003	.14	.00	.14	1.38	.0350	.1282	.1429
PHR & tele-monitoring Extra-mural (Sub-dimension)	15	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Application & Integration Dimension	14	1	.3887	.04237	.4370	.49a	.15853	.025	.52	.03	.55	5.44	.2601	.4370	.5009
Country (Sub-dimension)	15	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Health professionals (Sub-dimension)	15	0	.1290	.02469	.1628	.16	.09562	.009	.24	.00	.24	1.94	.0000	.1628	.2413
Medication list (Sub-dimension)	15	0	.0364	.01224	.0000	.00	.04739	.002	.11	.00	.11	.55	.0000	.0000	.0740
Hospital (Sub-dimension)	15	0	.0457	.01082	.0630	.00	.04191	.002	.09	.00	.09	.69	.0000	.0630	.0926
Information flow Dimension	15	0	.2111	.03986	.2369	.00	.15437	.024	.44	.00	.44	3.17	.0000	.2369	.3490
Encryption (Sub-dimension)	15	0	.2216	.02789	.1575	.16	.10800	.012	.34	.00	.34	3.32	.1575	.1575	.3399
Regulation (Sub-dimension)	15	0	.1930	.02813	.1697	.32	.10894	.012	.32	.00	.32	2.89	.1520	.1697	.3216
Workstation (Sub-dimension)	15	0	.0750	.02189	.0000	.00	.08480	.007	.18	.00	.18	1.12	.0000	.0000	.1764
Security & Privacy Dimension	15	0	.4895	.04399	.4859	.31a	.17038	.029	.67	.17	.84	7.34	.3272	.4859	.6555
eHealth Hospital Deployment Overall indicator	12	3	.4670	.02970	.4809	.22a	.10288	.011	.37	.22	.59	5.60	.4312	.4809	.5470

a. Multiple modes exist. The smallest value is shown.

Table 24: Measurement of dispersion – eHealth Deployment Index Belgium

	N - Valid	Missing	Mean	Std. Error of Mean	Median	Mode	Std. Deviation	Variance	Range	Min	Max	Sum	Percentiles - 25	Percentiles - 50	Percentiles - 75
Physical oriented (Sub-dimension)	23	0	.2592	.02437	.1775	.18	.11689	.014	.38	.00	.38	5.96	.1775	.1775	.3831
Services oriented (Sub-dimension)	22	1	.3411	.04278	.3797	.38	.20068	.040	.53	.00	.53	7.50	.2848	.3797	.5297
Infrastructure Dimension	22	1	.6040	.05390	.5572	.56	.25279	.064	.74	.18	.91	13.29	.3831	.5572	.9128
Clinical & Image (Sub-dimension)	21	2	.2003	.00944	.2028	.20a	.04328	.002	.11	.13	.24	4.21	.1757	.2028	.2408
EPR & patient management Intra-mural (Sub-dimension)	23	0	.1613	.00874	.1705	.17	.04192	.002	.12	.10	.22	3.71	.1045	.1705	.1705
Patient access and safety (Sub-dimension)	23	0	.1217	.00363	.1134	.11	.01741	.000	.06	.08	.14	2.80	.1134	.1134	.1429
PHR & tele-monitoring Extra-mural (Sub-dimension)	22	1	.0109	.00689	.0000	.00	.03231	.001	.14	.00	.14	.24	.0000	.0000	.0000
Application & Integration Dimension	20	3	.4958	.01916	.4868	.41a	.08569	.007	.35	.34	.69	9.92	.4215	.4868	.5598
Country (Sub-dimension)	23	0	.0157	.00742	.0000	.00	.03559	.001	.14	.00	.14	.36	.0000	.0000	.0000
Health professionals (Sub-dimension)	23	0	.1946	.01826	.2413	.24	.08756	.008	.24	.00	.24	4.48	.1641	.2413	.2413
Medication list (Sub-dimension)	23	0	.0203	.00808	.0000	.00	.03874	.002	.11	.00	.11	.47	.0000	.0000	.0368
Hospital (Sub-dimension)	23	0	.0551	.00866	.0630	.09	.04155	.002	.09	.00	.09	1.27	.0000	.0630	.0926
Information flow Dimension	23	0	.2857	.02710	.3339	.33	.12997	.017	.50	.03	.53	6.57	.2413	.3339	.3473
Encryption (Sub-dimension)	23	0	.1651	.02621	.1575	.16	.12571	.016	.34	.00	.34	3.80	.0000	.1575	.3399
Regulation (Sub-dimension)	23	0	.1068	.02196	.1520	.00	.10534	.011	.32	.00	.32	2.46	.0000	.1520	.1697
Workstation (Sub-dimension)	23	0	.0829	.02266	.0000	.00	.10865	.012	.30	.00	.30	1.91	.0000	.0000	.1764
Security & Privacy Dimension	23	0	.3548	.04036	.3339	.16	.19355	.037	.79	.00	.79	8.16	.1575	.3339	.5095
eHealth Hospital Deployment Overall indicator	19	4	.4303	.02504	.4563	.23a	.10914	.012	.35	.23	.58	8.18	.3402	.4563	.5294

a. Multiple modes exist. The smallest value is shown.

Table 25 *Measurement of dispersion – eHealth Deployment Index Bulgaria*

	N - Valid	Missing	Mean	Std. Error of Mean	Median	Mode	Std. Deviation	Variance	Range	Min	Max	Sum	Percentiles - 25	Percentiles - 50	Percentiles - 75
Physical oriented (Sub-dimension)	12	3	.2484	.03718	.1775	.18	.12880	.017	.38	.00	.38	2.98	.1775	.1775	.3831
Services oriented (Sub-dimension)	8	7	.2748	.07015	.3797	.38	.19841	.039	.53	.00	.53	2.20	.0375	.3797	.3797
Infrastructure Dimension	8	7	.5808	.09798	.6600	.76	.27712	.077	.74	.18	.91	4.65	.2664	.6600	.7627
Clinical & Image (Sub-dimension)	14	1	.0769	.02003	.0725	.00	.07493	.006	.20	.00	.20	1.08	.0000	.0725	.1649
EPR & patient management Intra-mural (Sub-dimension)	15	0	.0690	.01660	.0361	.00a	.06430	.004	.17	.00	.17	1.04	.0000	.0361	.1045
Patient access and safety (Sub-dimension)	15	0	.0357	.00974	.0295	.00	.03772	.001	.08	.00	.08	.54	.0000	.0295	.0784
PHR & tele-monitoring Extra-mural (Sub-dimension)	15	0	.0093	.00667	.0000	.00	.02584	.001	.09	.00	.09	.14	.0000	.0000	.0000
Application & Integration Dimension	14	1	.1944	.02992	.1940	.00a	.11194	.013	.42	.00	.42	2.72	.1010	.1940	.2562
Country (Sub-dimension)	15	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Health professionals (Sub-dimension)	15	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Medication list (Sub-dimension)	15	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Hospital (Sub-dimension)	15	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Information flow Dimension	15	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Encryption (Sub-dimension)	15	0	.0453	.03088	.0000	.00	.11958	.014	.34	.00	.34	.68	.0000	.0000	.0000
Regulation (Sub-dimension)	15	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Workstation (Sub-dimension)	15	0	.0162	.01101	.0000	.00	.04265	.002	.12	.00	.12	.24	.0000	.0000	.0000
Security & Privacy Dimension	15	0	.0615	.03114	.0000	.00	.12062	.015	.34	.00	.34	.92	.0000	.0000	.1212
eHealth Hospital Deployment Overall indicator	7	8	.2037	.03483	.2420	.07a	.09215	.008	.24	.07	.31	1.43	.1052	.2420	.2784

a. Multiple modes exist. The smallest value is shown.

Table 26: Measurement of dispersion – eHealth Deployment Index Croatia

	N - Valid	Missing	Mean	Std. Error of Mean	Median	Mode	Std. Deviation	Variance	Range	Minimum	Maximum	Sum	Percentiles - 25	Percentiles - 50	Percentiles - 75
Physical oriented (Sub-dimension)	4	0	.3831	.00000	.3831	.38	.00000	.000	.00	.38	.38	1.53	.3831	.3831	.3831
Services oriented (Sub-dimension)	4	0	.1125	.03751	.1501	.15	.07503	.006	.15	.00	.15	.45	.0375	.1501	.1501
Infrastructure Dimension	4	0	.4956	.03751	.5331	.53	.07503	.006	.15	.38	.53	1.98	.4206	.5331	.5331
Clinical & Image (Sub-dimension)	4	0	.0928	.03886	.0652	.04	.07771	.006	.16	.04	.20	.37	.0380	.0652	.1752
EPR & patient management Intra-mural (Sub-dimension)	4	0	.1198	.01691	.1033	.10	.03381	.001	.07	.10	.17	.48	.1021	.1033	.1540
Patient access and safety (Sub-dimension)	4	0	.1208	.00737	.1134	.11	.01473	.000	.03	.11	.14	.48	.1134	.1134	.1355
PHR & tele-monitoring Extra-mural (Sub-dimension)	4	0	.0124	.01237	.0000	.00	.02474	.001	.05	.00	.05	.05	.0000	.0000	.0371
Application & Integration Dimension	4	0	.3458	.03519	.3544	.25a	.07037	.005	.17	.25	.42	1.38	.2745	.3544	.4084
Country (Sub-dimension)	4	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Health professionals (Sub-dimension)	4	0	.0380	.01604	.0368	.04	.03207	.001	.08	.00	.08	.15	.0092	.0368	.0681
Medication list (Sub-dimension)	4	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Hospital (Sub-dimension)	4	0	.0084	.00842	.0000	.00	.01683	.000	.03	.00	.03	.03	.0000	.0000	.0253
Information flow Dimension	4	0	.0464	.02356	.0368	.04	.04712	.002	.11	.00	.11	.19	.0092	.0368	.0933
Encryption (Sub-dimension)	4	0	.1306	.04391	.1699	.18	.08782	.008	.18	.00	.18	.52	.0394	.1699	.1824
Regulation (Sub-dimension)	4	0	.0424	.04242	.0000	.00	.08483	.007	.17	.00	.17	.17	.0000	.0000	.1272
Workstation (Sub-dimension)	4	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Security & Privacy Dimension	4	0	.1730	.00596	.1760	.18	.01192	.000	.02	.16	.18	.69	.1605	.1760	.1824
eHealth Hospital Deployment Overall indicator	4	0	.2652	.01482	.2657	.24a	.02964	.001	.06	.24	.29	1.06	.2379	.2657	.2919

a. Multiple modes exist. The smallest value is shown.

Table 27: *Measurement of dispersion – eHealth Deployment Index Cyprus*

	N - Valid	Missing	Mean	Std. Error of Mean	Median	Mode	Std. Deviation	Variance	Range	Minimum	Maximum	Sum	Percentiles - 25	Percentiles - 50	Percentiles - 75
Physical oriented (Sub-dimension)	8	0	.1588	.04278	.1775	.18	.12100	.015	.38	.00	.38	1.27	.0444	.1775	.1775
Services oriented (Sub-dimension)	6	2	.3031	.09970	.3797	.00a	.24421	.060	.53	.00	.53	1.82	.0000	.3797	.5297
Infrastructure Dimension	6	2	.4557	.13824	.4684	.00a	.33862	.115	.91	.00	.91	2.73	.1332	.4684	.7587
Clinical & Image (Sub-dimension)	7	1	.1369	.03111	.1485	.07a	.08230	.007	.21	.03	.24	.96	.0725	.1485	.2408
EPR & patient management Intra-mural (Sub-dimension)	8	0	.1394	.01988	.1045	.10	.05624	.003	.13	.09	.22	1.12	.1027	.1045	.2085
Patient access and safety (Sub-dimension)	6	2	.1125	.00834	.1134	.11	.02043	.000	.06	.08	.14	.68	.1047	.1134	.1208
PHR & tele-monitoring Extra-mural (Sub-dimension)	8	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Application & Integration Dimension	6	2	.3637	.03241	.3867	.25a	.07938	.006	.19	.25	.44	2.18	.2747	.3867	.4346
Country (Sub-dimension)	8	0	.0500	.05002	.0000	.00	.14149	.020	.40	.00	.40	.40	.0000	.0000	.0000
Health professionals (Sub-dimension)	8	0	.0409	.03053	.0000	.00	.08636	.007	.24	.00	.24	.33	.0000	.0000	.0642
Medication list (Sub-dimension)	8	0	.0135	.01347	.0000	.00	.03809	.001	.11	.00	.11	.11	.0000	.0000	.0000
Hospital (Sub-dimension)	8	0	.0152	.01163	.0000	.00	.03291	.001	.09	.00	.09	.12	.0000	.0000	.0220
Information flow Dimension	8	0	.1196	.10416	.0000	.00	.29461	.087	.84	.00	.84	.96	.0000	.0000	.0862
Encryption (Sub-dimension)	8	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Regulation (Sub-dimension)	8	0	.1038	.04300	.0848	.00	.12163	.015	.32	.00	.32	.83	.0000	.0848	.1697
Workstation (Sub-dimension)	8	0	.0441	.02887	.0000	.00	.08165	.007	.18	.00	.18	.35	.0000	.0000	.1323
Security & Privacy Dimension	8	0	.1479	.04943	.1697	.00	.13981	.020	.35	.00	.35	1.18	.0000	.1697	.2853
eHealth Hospital Deployment Overall indicator	5	3	.2978	.07428	.2473	.11a	.16611	.028	.43	.11	.54	1.49	.1613	.2473	.4596

a. Multiple modes exist. The smallest value is shown.

Table 28: Measurement of dispersion – eHealth Deployment Index Czech Republic

	N - Valid	Missing	Mean	Std. Error of Mean	Median	Mode	Std. Deviation	Variance	Range	Minimum	Maximum	Sum	Percentiles - 25	Percentiles - 50	Percentiles - 75
Physical oriented (Sub-dimension)	14	1	.2129	.03980	.1775	.18	.14890	.022	.38	.00	.38	2.98	.1332	.1775	.3831
Services oriented (Sub-dimension)	13	2	.2329	.06831	.1501	.00	.24628	.061	.53	.00	.53	3.03	.0000	.1501	.5297
Infrastructure Dimension	12	3	.4859	.09064	.3831	.91	.31400	.099	.91	.00	.91	5.83	.2151	.3831	.8614
Clinical & Image (Sub-dimension)	14	1	.1754	.01931	.1838	.24	.07226	.005	.24	.00	.24	2.46	.1431	.1838	.2408
EPR & patient management Intra-mural (Sub-dimension)	15	0	.0834	.01598	.0361	.04	.06188	.004	.13	.04	.17	1.25	.0361	.0361	.1551
Patient access and safety (Sub-dimension)	14	1	.0714	.01436	.0862	.00a	.05371	.003	.14	.00	.14	1.00	.0221	.0862	.1134
PHR & tele-monitoring Extra-mural (Sub-dimension)	15	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Application & Integration Dimension	13	2	.3379	.03227	.3353	.54	.11634	.014	.38	.16	.54	4.39	.2374	.3353	.4141
Country (Sub-dimension)	15	0	.0032	.00319	.0000	.00	.01237	.000	.05	.00	.05	.05	.0000	.0000	.0000
Health professionals (Sub-dimension)	15	0	.0615	.01528	.0433	.00	.05916	.004	.16	.00	.16	.92	.0000	.0433	.1208
Medication list (Sub-dimension)	15	0	.0022	.00225	.0000	.00	.00871	.000	.03	.00	.03	.03	.0000	.0000	.0000
Hospital (Sub-dimension)	15	0	.0367	.00666	.0337	.03	.02580	.001	.09	.00	.09	.55	.0337	.0337	.0630
Information flow Dimension	15	0	.1037	.01924	.1069	.00	.07451	.006	.23	.00	.23	1.56	.0630	.1069	.1545
Encryption (Sub-dimension)	15	0	.1674	.02883	.1575	.16	.11166	.012	.34	.00	.34	2.51	.1575	.1575	.1824
Regulation (Sub-dimension)	15	0	.0983	.03463	.0000	.00	.13413	.018	.32	.00	.32	1.47	.0000	.0000	.1697
Workstation (Sub-dimension)	15	0	.0235	.01603	.0000	.00	.06207	.004	.18	.00	.18	.35	.0000	.0000	.0000
Security & Privacy Dimension	15	0	.2892	.04394	.3216	.16	.17018	.029	.66	.00	.66	4.34	.1575	.3216	.3520
eHealth Hospital Deployment Overall indicator	10	5	.3141	.04257	.2624	.17a	.13462	.018	.37	.17	.54	3.14	.2059	.2624	.4509

a. Multiple modes exist. The smallest value is shown.

Table 29: *Measurement of dispersion – eHealth Deployment Index Denmark*

	N - Valid	Missing	Mean	Std. Error of Mean	Median	Mode	Std. Deviation	Variance	Range	Minimum	Maximum	Sum	Percentiles - 25	Percentiles - 50	Percentiles - 75
Physical oriented (Sub-dimension)	8	0	.3831	.00000	.3831	.38	.00000	.000	.00	.38	.38	3.06	.3831	.3831	.3831
Services oriented (Sub-dimension)	8	0	.5297	.00000	.5297	.53	.00000	.000	.00	.53	.53	4.24	.5297	.5297	.5297
Infrastructure Dimension	8	0	.9128	.00000	.9128	.91	.00000	.000	.00	.91	.91	7.30	.9128	.9128	.9128
Clinical & Image (Sub-dimension)	8	0	.2218	.01244	.2408	.24	.03518	.001	.08	.16	.24	1.77	.1838	.2408	.2408
EPR & patient management Intra-mural (Sub-dimension)	8	0	.2211	.00000	.2211	.22	.00000	.000	.00	.22	.22	1.77	.2211	.2211	.2211
Patient access and safety (Sub-dimension)	8	0	.0760	.01247	.0644	.06	.03527	.001	.11	.03	.14	.61	.0644	.0644	.1012
PHR & tele-monitoring Extra-mural (Sub-dimension)	8	0	.0463	.01951	.0247	.00	.05517	.003	.14	.00	.14	.37	.0000	.0247	.0906
Application & Integration Dimension	8	0	.5653	.02310	.5756	.53	.06535	.004	.22	.45	.67	4.52	.5264	.5756	.6101
Country (Sub-dimension)	8	0	.0065	.00650	.0000	.00	.01840	.000	.05	.00	.05	.05	.0000	.0000	.0000
Health professionals (Sub-dimension)	8	0	.1573	.02853	.1628	.24	.08069	.007	.20	.04	.24	1.26	.0835	.1628	.2413
Medication list (Sub-dimension)	8	0	.0404	.01972	.0000	.00	.05576	.003	.11	.00	.11	.32	.0000	.0000	.1077
Hospital (Sub-dimension)	8	0	.0726	.01027	.0926	.09	.02905	.001	.06	.03	.09	.58	.0369	.0926	.0926
Information flow Dimension	8	0	.2769	.05079	.3486	.36	.14366	.021	.37	.07	.44	2.21	.1216	.3486	.3803
Encryption (Sub-dimension)	8	0	.1471	.05948	.0788	.00	.16823	.028	.34	.00	.34	1.18	.0000	.0788	.3399
Regulation (Sub-dimension)	8	0	.2077	.02487	.1697	.17	.07035	.005	.15	.17	.32	1.66	.1697	.1697	.2836
Workstation (Sub-dimension)	8	0	.1130	.03272	.1212	.12	.09255	.009	.30	.00	.30	.90	.0303	.1212	.1212
Security & Privacy Dimension	8	0	.4677	.06367	.4429	.29a	.18010	.032	.52	.29	.81	3.74	.2999	.4429	.6004
eHealth Hospital Deployment Overall indicator	8	0	.5557	.02575	.5539	.46a	.07283	.005	.21	.46	.67	4.45	.4887	.5539	.6129

a. Multiple modes exist. The smallest value is shown.

Table 30: Measurement of dispersion – eHealth Deployment Index Estonia

	N - Valid	Missing	Mean	Std. Error of Mean	Median	Mode	Std. Deviation	Variance	Range	Minimum	Maximum	Sum	Percentiles - 25	Percentiles - 50	Percentiles - 75
Physical oriented (Sub-dimension)	2	1	.1775	.00000	.1775	.18	.00000	.000	.00	.18	.18	.36	.1775	.1775	.1775
Services oriented (Sub-dimension)	3	0	.2266	.15764	.1501	.00a	.27303	.075	.53	.00	.53	.68	.0000	.1501	.
Infrastructure Dimension	2	1	.2526	.07503	.2526	.18a	.10610	.011	.15	.18	.33	.51	.1775	.2526	.
Clinical & Image (Sub-dimension)	3	0	.1902	.02533	.1649	.16	.04387	.002	.08	.16	.24	.57	.1649	.1649	.
EPR & patient management Intra-mural (Sub-dimension)	3	0	.1871	.01908	.1850	.16a	.03305	.001	.07	.16	.22	.56	.1551	.1850	.
Patient access and safety (Sub-dimension)	1	2	.1134		.1134	.11			.00	.11	.11	.11	.1134	.1134	.1134
PHR & tele-monitoring Extra-mural (Sub-dimension)	3	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Application & Integration Dimension	1	2	.4334		.4334	.43			.00	.43	.43	.43	.4334	.4334	.4334
Country (Sub-dimension)	3	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Health professionals (Sub-dimension)	3	0	.1324	.07064	.1557	.00a	.12235	.015	.24	.00	.24	.40	.0000	.1557	.
Medication list (Sub-dimension)	3	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Hospital (Sub-dimension)	3	0	.0520	.02733	.0633	.00a	.04733	.002	.09	.00	.09	.16	.0000	.0633	.
Information flow Dimension	3	0	.1843	.09795	.2190	.00a	.16965	.029	.33	.00	.33	.55	.0000	.2190	.
Encryption (Sub-dimension)	3	0	.2266	.11328	.3399	.34	.19621	.038	.34	.00	.34	.68	.0000	.3399	.
Regulation (Sub-dimension)	3	0	.2203	.05066	.1697	.17	.08775	.008	.15	.17	.32	.66	.1697	.1697	.
Workstation (Sub-dimension)	3	0	.1984	.09920	.2976	.30	.17182	.030	.30	.00	.30	.60	.0000	.2976	.
Security & Privacy Dimension	3	0	.6453	.15737	.5095	.47a	.27258	.074	.49	.47	.96	1.94	.4673	.5095	.
eHealth Hospital Deployment Overall indicator	1	2	.3349		.3349	.33			.00	.33	.33	.33	.3349	.3349	.3349

a. Multiple modes exist. The smallest value is shown.

Table 31: *Measurement of dispersion – eHealth Deployment Index Finland*

	N - Valid	Missing	Mean	Std. Error of Mean	Median	Mode	Std. Deviation	Variance	Range	Minimum	Maximum	Sum	Percentiles - 25	Percentiles - 50	Percentiles - 75
Physical oriented (Sub-dimension)	15	0	.3694	.01370	.3831	.38	.05306	.003	.21	.18	.38	5.54	.3831	.3831	.3831
Services oriented (Sub-dimension)	14	1	.5190	.01072	.5297	.53	.04010	.002	.15	.38	.53	7.27	.5297	.5297	.5297
Infrastructure Dimension	14	1	.8874	.01750	.9128	.91	.06547	.004	.21	.71	.91	12.42	.9128	.9128	.9128
Clinical & Image (Sub-dimension)	14	1	.2218	.00771	.2408	.24	.02886	.001	.08	.16	.24	3.11	.2028	.2408	.2408
EPR & patient management Intra-mural (Sub-dimension)	15	0	.1421	.01233	.1705	.17	.04775	.002	.19	.04	.22	2.13	.1021	.1705	.1705
Patient access and safety (Sub-dimension)	14	1	.1250	.01123	.1429	.14	.04201	.002	.14	.00	.14	1.75	.1355	.1429	.1429
PHR & tele-monitoring Extra-mural (Sub-dimension)	13	2	.0209	.01102	.0000	.00	.03973	.002	.09	.00	.09	.27	.0000	.0000	.0453
Application & Integration Dimension	12	3	.5163	.02950	.5463	.55	.10220	.010	.39	.30	.70	6.20	.4344	.5463	.5542
Country (Sub-dimension)	15	0	.0033	.00330	.0000	.00	.01280	.000	.05	.00	.05	.05	.0000	.0000	.0000
Health professionals (Sub-dimension)	15	0	.0894	.02615	.0420	.00	.10129	.010	.24	.00	.24	1.34	.0000	.0420	.2009
Medication list (Sub-dimension)	15	0	.0283	.01057	.0000	.00	.04093	.002	.11	.00	.11	.42	.0000	.0000	.0705
Hospital (Sub-dimension)	15	0	.0845	.00363	.0926	.09	.01405	.000	.03	.06	.09	1.27	.0630	.0926	.0926
Information flow Dimension	15	0	.2054	.03577	.1346	.06	.13854	.019	.38	.06	.44	3.08	.0630	.1346	.3339
Encryption (Sub-dimension)	15	0	.1116	.03567	.0000	.00	.13817	.019	.34	.00	.34	1.67	.0000	.0000	.1824
Regulation (Sub-dimension)	15	0	.1805	.03472	.1520	.32	.13449	.018	.32	.00	.32	2.71	.0000	.1520	.3216
Workstation (Sub-dimension)	15	0	.0669	.02636	.0000	.00	.10210	.010	.30	.00	.30	1.00	.0000	.0000	.1764
Security & Privacy Dimension	15	0	.3590	.06591	.3284	.00a	.25529	.065	.84	.00	.84	5.38	.1575	.3284	.4980
eHealth Hospital Deployment Overall indicator	11	4	.5133	.02882	.5192	.35a	.09557	.009	.31	.35	.66	5.65	.4402	.5192	.5925

a. Multiple modes exist. The smallest value is shown.

Table 32: Measurement of dispersion – eHealth Deployment Index France

	N - Valid	Missing	Mean	Std. Error of Mean	Median	Mode	Std. Deviation	Variance	Range	Minimum	Maximum	Sum	Percentiles - 25	Percentiles - 50	Percentiles - 75
Physical oriented (Sub-dimension)	148	2	.2321	.00987	.1775	.18	.12011	.014	.38	.00	.38	34.35	.1775	.1775	.3831
Services oriented (Sub-dimension)	142	8	.3091	.01695	.3797	.38	.20199	.041	.53	.00	.53	43.89	.0000	.3797	.5297
Infrastructure Dimension	140	10	.5472	.02024	.5572	.56	.23944	.057	.91	.00	.91	76.61	.3831	.5572	.7627
Clinical & Image (Sub-dimension)	144	6	.0745	.00571	.0725	.03	.06856	.005	.24	.00	.24	10.72	.0345	.0725	.1228
EPR & patient management Intra-mural (Sub-dimension)	150	0	.0947	.00528	.0867	.09	.06469	.004	.22	.00	.22	14.21	.0361	.0867	.1527
Patient access and safety (Sub-dimension)	141	9	.1068	.00327	.1134	.14	.03877	.002	.14	.00	.14	15.06	.0784	.1134	.1429
PHR & tele-monitoring Extra-mural (Sub-dimension)	150	0	.0099	.00224	.0000	.00	.02747	.001	.14	.00	.14	1.48	.0000	.0000	.0000
Application & Integration Dimension	137	13	.2848	.01161	.2672	.08a	.13594	.018	.70	.00	.70	39.01	.1872	.2672	.3685
Country (Sub-dimension)	150	0	.0003	.00032	.0000	.00	.00391	.000	.05	.00	.05	.05	.0000	.0000	.0000
Health professionals (Sub-dimension)	150	0	.0425	.00565	.0000	.00	.06917	.005	.24	.00	.24	6.38	.0000	.0000	.0773
Medication list (Sub-dimension)	150	0	.0108	.00230	.0000	.00	.02820	.001	.11	.00	.11	1.62	.0000	.0000	.0000
Hospital (Sub-dimension)	150	0	.0214	.00261	.0000	.00	.03197	.001	.09	.00	.09	3.21	.0000	.0000	.0296
Information flow Dimension	150	0	.0750	.00941	.0000	.00	.11528	.013	.49	.00	.49	11.25	.0000	.0000	.1270
Encryption (Sub-dimension)	150	0	.1729	.01044	.1575	.16	.12782	.016	.34	.00	.34	25.94	.0000	.1575	.3399
Regulation (Sub-dimension)	150	0	.1466	.01086	.1697	.00	.13304	.018	.32	.00	.32	21.98	.0000	.1697	.3216
Workstation (Sub-dimension)	150	0	.0787	.00684	.1212	.00	.08373	.007	.30	.00	.30	11.80	.0000	.1212	.1212
Security & Privacy Dimension	150	0	.3982	.01858	.3520	.00	.22750	.052	.96	.00	.96	59.73	.2773	.3520	.6004
eHealth Hospital Deployment Overall indicator	128	22	.3259	.01064	.3303	.04a	.12041	.014	.59	.04	.63	41.71	.2426	.3303	.4047

a. Multiple modes exist. The smallest value is shown.

Table 33: *Measurement of dispersion – eHealth Deployment Index Germany*

	N - Valid	Missing	Mean	Std. Error of Mean	Median	Mode	Std. Deviation	Variance	Range	Minimum	Maximum	Sum	Percentiles - 25	Percentiles - 50	Percentiles - 75
Physical oriented (Sub-dimension)	144	6	.2416	.00940	.1775	.18	.11280	.013	.38	.00	.38	34.79	.1775	.1775	.3831
Services oriented (Sub-dimension)	140	10	.1991	.01865	.0750	.00	.22063	.049	.53	.00	.53	27.87	.0000	.0750	.3797
Infrastructure Dimension	136	14	.4506	.02178	.3831	.18	.25402	.065	.91	.00	.91	61.28	.1775	.3831	.7073
Clinical & Image (Sub-dimension)	145	5	.1366	.00722	.1649	.24	.08688	.008	.24	.00	.24	19.81	.0380	.1649	.2408
EPR & patient management Intra-mural (Sub-dimension)	150	0	.0526	.00413	.0361	.04	.05054	.003	.22	.00	.22	7.88	.0361	.0361	.0684
Patient access and safety (Sub-dimension)	141	9	.0978	.00344	.1134	.11	.04089	.002	.14	.00	.14	13.79	.0784	.1134	.1134
PHR & tele-monitoring Extra-mural (Sub-dimension)	149	1	.0012	.00086	.0000	.00	.01046	.000	.09	.00	.09	.18	.0000	.0000	.0000
Application & Integration Dimension	138	12	.2863	.01146	.3076	.42	.13464	.018	.58	.00	.58	39.51	.1841	.3076	.3904
Country (Sub-dimension)	150	0	.0003	.00033	.0000	.00	.00405	.000	.05	.00	.05	.05	.0000	.0000	.0000
Health professionals (Sub-dimension)	150	0	.0397	.00557	.0000	.00	.06826	.005	.24	.00	.24	5.96	.0000	.0000	.0773
Medication list (Sub-dimension)	150	0	.0077	.00199	.0000	.00	.02432	.001	.11	.00	.11	1.16	.0000	.0000	.0000
Hospital (Sub-dimension)	150	0	.0229	.00250	.0000	.00	.03063	.001	.09	.00	.09	3.44	.0000	.0000	.0337
Information flow Dimension	150	0	.0707	.00834	.0296	.00	.10217	.010	.44	.00	.44	10.60	.0000	.0296	.1122
Encryption (Sub-dimension)	150	0	.1872	.01040	.1575	.16	.12743	.016	.34	.00	.34	28.08	.1575	.1575	.3399
Regulation (Sub-dimension)	150	0	.1793	.01129	.1697	.32	.13827	.019	.32	.00	.32	26.89	.0000	.1697	.3216
Workstation (Sub-dimension)	150	0	.0519	.00681	.0000	.00	.08345	.007	.30	.00	.30	7.79	.0000	.0000	.1212
Security & Privacy Dimension	150	0	.4184	.01899	.4484	.48	.23253	.054	.96	.00	.96	62.77	.2787	.4484	.6051
eHealth Hospital Deployment Overall indicator	125	25	.3084	.01088	.3000	.05a	.12166	.015	.62	.05	.66	38.55	.2172	.3000	.4015

a. Multiple modes exist. The smallest value is shown.

Table 34: Measurement of dispersion – eHealth Deployment Index Greece

	N - Valid	Missing	Mean	Std. Error of Mean	Median	Mode	Std. Deviation	Variance	Range	Minimum	Maximum	Sum	Percentiles - 25	Percentiles - 50	Percentiles - 75
Physical oriented (Sub-dimension)	24	2	.1982	.02314	.1775	.18	.11335	.013	.38	.00	.38	4.76	.1775	.1775	.1775
Services oriented (Sub-dimension)	26	0	.0958	.03100	.0000	.00	.15807	.025	.53	.00	.53	2.49	.0000	.0000	.1501
Infrastructure Dimension	24	2	.3019	.03945	.3276	.18	.19329	.037	.71	.00	.71	7.25	.1775	.3276	.3831
Clinical & Image (Sub-dimension)	25	1	.0712	.01072	.0725	.07	.05359	.003	.20	.00	.20	1.78	.0345	.0725	.0824
EPR & patient management Intra-mural (Sub-dimension)	26	0	.1274	.01308	.1370	.16a	.06670	.004	.22	.00	.22	3.31	.0684	.1370	.1705
Patient access and safety (Sub-dimension)	24	2	.1019	.00581	.1134	.11	.02844	.001	.11	.03	.14	2.45	.1134	.1134	.1134
PHR & tele-monitoring Extra-mural (Sub-dimension)	22	4	.0064	.00460	.0000	.00	.02156	.000	.09	.00	.09	.14	.0000	.0000	.0000
Application & Integration Dimension	21	5	.3119	.02973	.2835	.41	.13623	.019	.43	.11	.54	6.55	.2092	.2835	.4087
Country (Sub-dimension)	26	0	.0069	.00693	.0000	.00	.03531	.001	.18	.00	.18	.18	.0000	.0000	.0000
Health professionals (Sub-dimension)	26	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Medication list (Sub-dimension)	26	0	.0039	.00215	.0000	.00	.01099	.000	.03	.00	.03	.10	.0000	.0000	.0000
Hospital (Sub-dimension)	26	0	.0071	.00494	.0000	.00	.02517	.001	.09	.00	.09	.19	.0000	.0000	.0000
Information flow Dimension	26	0	.0179	.01256	.0000	.00	.06407	.004	.31	.00	.31	.47	.0000	.0000	.0000
Encryption (Sub-dimension)	26	0	.0322	.01624	.0000	.00	.08280	.007	.34	.00	.34	.84	.0000	.0000	.0000
Regulation (Sub-dimension)	26	0	.1336	.02385	.1697	.17	.12159	.015	.32	.00	.32	3.47	.0000	.1697	.1697
Workstation (Sub-dimension)	26	0	.0182	.01025	.0000	.00	.05226	.003	.18	.00	.18	.47	.0000	.0000	.0000
Security & Privacy Dimension	26	0	.1841	.03918	.1697	.00	.19978	.040	.68	.00	.68	4.79	.0000	.1697	.3216
eHealth Hospital Deployment Overall indicator	20	6	.2102	.02355	.1718	.05a	.10530	.011	.35	.05	.40	4.20	.1350	.1718	.3137

a. Multiple modes exist. The smallest value is shown.

Table 35: *Measurement of dispersion – eHealth Deployment Index Hungary*

	N - Valid	Missing	Mean	Std. Error of Mean	Median	Mode	Std. Deviation	Variance	Range	Minimum	Maximum	Sum	Percentiles - 25	Percentiles - 50	Percentiles - 75
Physical oriented (Sub-dimension)	10	0	.2009	.03505	.1775	.18	.11082	.012	.38	.00	.38	2.01	.1775	.1775	.2289
Services oriented (Sub-dimension)	10	0	.1889	.05793	.1501	.15	.18319	.034	.53	.00	.53	1.89	.0000	.1501	.3797
Infrastructure Dimension	10	0	.3898	.06549	.3553	.33	.20711	.043	.71	.00	.71	3.90	.2901	.3553	.5572
Clinical & Image (Sub-dimension)	10	0	.1514	.03063	.1649	.24	.09686	.009	.24	.00	.24	1.51	.0544	.1649	.2408
EPR & patient management Intra-mural (Sub-dimension)	10	0	.1170	.01674	.1045	.17	.05294	.003	.13	.04	.17	1.17	.0856	.1045	.1705
Patient access and safety (Sub-dimension)	9	1	.0731	.01537	.0350	.03	.04612	.002	.11	.03	.14	.66	.0350	.0350	.1134
PHR & tele-monitoring Extra-mural (Sub-dimension)	10	0	.0280	.01579	.0000	.00	.04992	.002	.14	.00	.14	.28	.0000	.0000	.0598
Application & Integration Dimension	9	1	.3652	.06529	.3926	.07a	.19586	.038	.62	.07	.69	3.29	.2055	.3926	.4587
Country (Sub-dimension)	10	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Health professionals (Sub-dimension)	10	0	.0535	.02293	.0000	.00	.07250	.005	.16	.00	.16	.53	.0000	.0000	.1343
Medication list (Sub-dimension)	10	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Hospital (Sub-dimension)	10	0	.0337	.01064	.0316	.00	.03363	.001	.09	.00	.09	.34	.0000	.0316	.0600
Information flow Dimension	10	0	.0872	.02791	.0590	.00	.08824	.008	.23	.00	.23	.87	.0000	.0590	.1774
Encryption (Sub-dimension)	10	0	.1020	.05191	.0000	.00	.16416	.027	.34	.00	.34	1.02	.0000	.0000	.3399
Regulation (Sub-dimension)	10	0	.1661	.03393	.1697	.17	.10731	.012	.32	.00	.32	1.66	.1272	.1697	.2077
Workstation (Sub-dimension)	10	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Security & Privacy Dimension	10	0	.2681	.07888	.1697	.17	.24944	.062	.66	.00	.66	2.68	.1272	.1697	.5475
eHealth Hospital Deployment Overall indicator	9	1	.2828	.04328	.2821	.10a	.12985	.017	.32	.10	.42	2.55	.1376	.2821	.4023

a. Multiple modes exist. The smallest value is shown.

Table 36: Measurement of dispersion – eHealth Deployment Index Iceland

	N - Valid	Missing	Mean	Std. Error of Mean	Median	Mode	Std. Deviation	Variance	Range	Minimum	Maximum	Sum	Percentiles - 25	Percentiles - 50	Percentiles - 75
Physical oriented (Sub-dimension)	3	0	.2460	.06850	.1775	.18	.11865	.014	.21	.18	.38	.74	.1775	.1775	.
Services oriented (Sub-dimension)	1	2	.5297		.5297	.53			.00	.53	.53	.53	.5297	.5297	.5297
Infrastructure Dimension	1	2	.9128		.9128	.91			.00	.91	.91	.91	.9128	.9128	.9128
Clinical & Image (Sub-dimension)	3	0	.1606	.06379	.2063	.03a	.11049	.012	.21	.03	.24	.48	.0345	.2063	.
EPR & patient management Intra-mural (Sub-dimension)	3	0	.1991	.02200	.2211	.22	.03811	.001	.07	.16	.22	.60	.1551	.2211	.
Patient access and safety (Sub-dimension)	3	0	.0691	.03692	.0350	.03a	.06395	.004	.11	.03	.14	.21	.0295	.0350	.
PHR & tele-monitoring Extra-mural (Sub-dimension)	3	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Application & Integration Dimension	3	0	.4288	.10695	.4969	.22a	.18525	.034	.35	.22	.57	1.29	.2191	.4969	.
Country (Sub-dimension)	3	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Health professionals (Sub-dimension)	3	0	.0785	.04496	.0797	.00a	.07788	.006	.16	.00	.16	.24	.0000	.0797	.
Medication list (Sub-dimension)	3	0	.0483	.03160	.0372	.00a	.05472	.003	.11	.00	.11	.14	.0000	.0372	.
Hospital (Sub-dimension)	3	0	.0211	.02109	.0000	.00	.03653	.001	.06	.00	.06	.06	.0000	.0000	.
Information flow Dimension	3	0	.1479	.09559	.1170	.00a	.16556	.027	.33	.00	.33	.44	.0000	.1170	.
Encryption (Sub-dimension)	3	0	.1741	.09819	.1824	.00a	.17008	.029	.34	.00	.34	.52	.0000	.1824	.
Regulation (Sub-dimension)	3	0	.2710	.05066	.3216	.32	.08775	.008	.15	.17	.32	.81	.1697	.3216	.
Workstation (Sub-dimension)	3	0	.0992	.09920	.0000	.00	.17182	.030	.30	.00	.30	.30	.0000	.0000	.
Security & Privacy Dimension	3	0	.5442	.22878	.5040	.17a	.39625	.157	.79	.17	.96	1.63	.1697	.5040	.
eHealth Hospital Deployment Overall indicator	1	2	.4949		.4949	.49			.00	.49	.49	.49	.4949	.4949	.4949

a. Multiple modes exist. The smallest value is shown.

Table 37: *Measurement of dispersion – eHealth Deployment Index Ireland*

	N - Valid	Missing	Mean	Std. Error of Mean	Median	Mode	Std. Deviation	Variance	Range	Minimum	Maximum	Sum	Percentiles - 25	Percentiles - 50	Percentiles - 75
Physical oriented (Sub-dimension)	8	0	.3352	.04788	.3831	.38	.13543	.018	.38	.00	.38	2.68	.3831	.3831	.3831
Services oriented (Sub-dimension)	7	1	.5297	.00000	.5297	.53	.00000	.000	.00	.53	.53	3.71	.5297	.5297	.5297
Infrastructure Dimension	7	1	.9128	.00000	.9128	.91	.00000	.000	.00	.91	.91	6.39	.9128	.9128	.9128
Clinical & Image (Sub-dimension)	8	0	.1798	.01899	.1649	.24	.05372	.003	.13	.11	.24	1.44	.1323	.1649	.2408
EPR & patient management Intra-mural (Sub-dimension)	8	0	.0820	.02300	.0691	.04	.06504	.004	.17	.00	.17	.66	.0361	.0691	.1540
Patient access and safety (Sub-dimension)	8	0	.1392	.00368	.1429	.14	.01042	.000	.03	.11	.14	1.11	.1429	.1429	.1429
PHR & tele-monitoring Extra-mural (Sub-dimension)	8	0	.0227	.01483	.0000	.00	.04194	.002	.09	.00	.09	.18	.0000	.0000	.0680
Application & Integration Dimension	8	0	.4236	.04640	.4409	.22a	.13125	.017	.42	.22	.64	3.39	.3154	.4409	.4974
Country (Sub-dimension)	8	0	.0888	.05875	.0000	.00	.16617	.028	.40	.00	.40	.71	.0000	.0000	.2326
Health professionals (Sub-dimension)	8	0	.1216	.03136	.1038	.24	.08871	.008	.24	.00	.24	.97	.0501	.1038	.2217
Medication list (Sub-dimension)	8	0	.0181	.01360	.0000	.00	.03846	.001	.11	.00	.11	.14	.0000	.0000	.0276
Hospital (Sub-dimension)	8	0	.0542	.01407	.0631	.09	.03979	.002	.09	.00	.09	.43	.0073	.0631	.0926
Information flow Dimension	8	0	.2826	.10228	.1602	.04a	.28929	.084	.80	.04	.84	2.26	.0785	.1602	.5249
Encryption (Sub-dimension)	8	0	.2715	.03337	.3399	.34	.09438	.009	.18	.16	.34	2.17	.1575	.3399	.3399
Regulation (Sub-dimension)	8	0	.2814	.02637	.3216	.32	.07460	.006	.17	.15	.32	2.25	.2077	.3216	.3216
Workstation (Sub-dimension)	8	0	.0303	.01984	.0000	.00	.05611	.003	.12	.00	.12	.24	.0000	.0000	.0909
Security & Privacy Dimension	8	0	.5832	.05785	.5767	.48a	.16363	.027	.46	.33	.78	4.67	.4791	.5767	.7524
eHealth Hospital Deployment Overall indicator	7	1	.5692	.04561	.5200	.47a	.12067	.015	.33	.47	.80	3.98	.4788	.5200	.6724

a. Multiple modes exist. The smallest value is shown.

Table 38: *Measurement of dispersion – eHealth Deployment Index Italy*

	N - Valid	Missing	Mean	Std. Error of Mean	Median	Mode	Std. Deviation	Variance	Range	Minimum	Maximum	Sum	Percentiles - 25	Percentiles - 50	Percentiles - 75
Physical oriented (Sub-dimension)	86	4	.2238	.01182	.1775	.18	.10964	.012	.38	.00	.38	19.25	.1775	.1775	.3831
Services oriented (Sub-dimension)	80	10	.2299	.02508	.1501	.00	.22434	.050	.53	.00	.53	18.39	.0000	.1501	.5297
Infrastructure Dimension	78	12	.4621	.03082	.5331	.18	.27218	.074	.91	.00	.91	36.04	.1775	.5331	.7073
Clinical & Image (Sub-dimension)	89	1	.1499	.00848	.1649	.24	.08001	.006	.24	.00	.24	13.34	.0923	.1649	.2408
EPR & patient management Intra-mural (Sub-dimension)	90	0	.0741	.00748	.0583	.00	.07098	.005	.22	.00	.22	6.67	.0000	.0583	.1190
Patient access and safety (Sub-dimension)	83	7	.1030	.00408	.1134	.11	.03713	.001	.14	.00	.14	8.55	.0784	.1134	.1134
PHR & tele-monitoring Extra-mural (Sub-dimension)	87	3	.0180	.00399	.0000	.00	.03726	.001	.14	.00	.14	1.57	.0000	.0000	.0000
Application & Integration Dimension	80	10	.3433	.01711	.3439	.08a	.15300	.023	.72	.00	.72	27.46	.2197	.3439	.4482
Country (Sub-dimension)	90	0	.0129	.00595	.0000	.00	.05649	.003	.40	.00	.40	1.16	.0000	.0000	.0000
Health professionals (Sub-dimension)	90	0	.0459	.00850	.0000	.00	.08060	.006	.24	.00	.24	4.13	.0000	.0000	.0732
Medication list (Sub-dimension)	90	0	.0119	.00284	.0000	.00	.02692	.001	.11	.00	.11	1.07	.0000	.0000	.0000
Hospital (Sub-dimension)	90	0	.0271	.00365	.0000	.00	.03464	.001	.09	.00	.09	2.44	.0000	.0000	.0630
Information flow Dimension	90	0	.0978	.01550	.0316	.00	.14708	.022	.84	.00	.84	8.80	.0000	.0316	.1471
Encryption (Sub-dimension)	90	0	.1564	.01514	.1575	.00	.14361	.021	.34	.00	.34	14.07	.0000	.1575	.3399
Regulation (Sub-dimension)	90	0	.1773	.01335	.1697	.32	.12661	.016	.32	.00	.32	15.95	.0000	.1697	.3216
Workstation (Sub-dimension)	90	0	.0999	.01267	.0000	.00	.12021	.014	.30	.00	.30	8.99	.0000	.0000	.1764
Security & Privacy Dimension	90	0	.4336	.03147	.3520	.00	.29853	.089	.96	.00	.96	39.02	.1697	.3520	.6615
eHealth Hospital Deployment Overall indicator	68	22	.3553	.01874	.3291	.04a	.15452	.024	.64	.04	.68	24.16	.2502	.3291	.5092

a. Multiple modes exist. The smallest value is shown.

Table 39: *Measurement of dispersion – eHealth Deployment Index Latvia*

	N - Valid	Missing	Mean	Std. Error of Mean	Median	Mode	Std. Deviation	Variance	Range	Minimum	Maximum	Sum	Percentiles - 25	Percentiles - 50	Percentiles - 75
Physical oriented (Sub-dimension)	3	0	.1869	.00932	.1775	.18	.01614	.000	.03	.18	.21	.56	.1775	.1775	.
Services oriented (Sub-dimension)	3	0	.3031	.15764	.3797	.00a	.27303	.075	.53	.00	.53	.91	.0000	.3797	.
Infrastructure Dimension	3	0	.4900	.16015	.5852	.18a	.27739	.077	.53	.18	.71	1.47	.1775	.5852	.
Clinical & Image (Sub-dimension)	3	0	.1226	.06226	.1649	.00a	.10783	.012	.20	.00	.20	.37	.0000	.1649	.
EPR & patient management Intra-mural (Sub-dimension)	3	0	.1037	.03880	.1045	.04a	.06720	.005	.13	.04	.17	.31	.0361	.1045	.
Patient access and safety (Sub-dimension)	3	0	.0575	.03135	.0644	.00a	.05429	.003	.11	.00	.11	.17	.0000	.0644	.
PHR & tele-monitoring Extra-mural (Sub-dimension)	3	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Application & Integration Dimension	3	0	.2837	.12388	.3998	.04a	.21457	.046	.38	.04	.42	.85	.0361	.3998	.
Country (Sub-dimension)	3	0	.1034	.10339	.0000	.00	.17907	.032	.31	.00	.31	.31	.0000	.0000	.
Health professionals (Sub-dimension)	3	0	.0663	.06633	.0000	.00	.11489	.013	.20	.00	.20	.20	.0000	.0000	.
Medication list (Sub-dimension)	3	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Hospital (Sub-dimension)	3	0	.0309	.03087	.0000	.00	.05347	.003	.09	.00	.09	.09	.0000	.0000	.
Information flow Dimension	3	0	.2006	.20059	.0000	.00	.34744	.121	.60	.00	.60	.60	.0000	.0000	.
Encryption (Sub-dimension)	3	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Regulation (Sub-dimension)	3	0	.0566	.05655	.0000	.00	.09795	.010	.17	.00	.17	.17	.0000	.0000	.
Workstation (Sub-dimension)	3	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Security & Privacy Dimension	3	0	.0566	.05655	.0000	.00	.09795	.010	.17	.00	.17	.17	.0000	.0000	.
eHealth Hospital Deployment Overall indicator	3	0	.2577	.11286	.2768	.05a	.19547	.038	.39	.05	.44	.77	.0534	.2768	.

a. Multiple modes exist. The smallest value is shown.

Table 40: Measurement of dispersion – eHealth Deployment Index Lithuania

	N - Valid	Missing	Mean	Std. Error of Mean	Median	Mode	Std. Deviation	Variance	Range	Minimum	Maximum	Sum	Percentiles - 25	Percentiles - 50	Percentiles - 75
Physical oriented (Sub-dimension)	8	2	.2546	.03760	.1775	.18	.10636	.011	.21	.18	.38	2.04	.1775	.1775	.3831
Services oriented (Sub-dimension)	9	1	.0589	.04338	.0000	.00	.13014	.017	.38	.00	.38	.53	.0000	.0000	.0750
Infrastructure Dimension	7	3	.2871	.05498	.1775	.18	.14545	.021	.36	.18	.53	2.01	.1775	.1775	.3831
Clinical & Image (Sub-dimension)	10	0	.0920	.02256	.0923	.00a	.07133	.005	.17	.00	.17	.92	.0259	.0923	.1657
EPR & patient management Intra-mural (Sub-dimension)	10	0	.0718	.02191	.0841	.00	.06928	.005	.17	.00	.17	.72	.0000	.0841	.1210
Patient access and safety (Sub-dimension)	10	0	.0567	.01321	.0567	.03a	.04176	.002	.11	.00	.11	.57	.0262	.0567	.0872
PHR & tele-monitoring Extra-mural (Sub-dimension)	10	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Application & Integration Dimension	10	0	.2205	.04300	.2261	.03a	.13597	.018	.35	.03	.38	2.21	.0780	.2261	.3560
Country (Sub-dimension)	10	0	.0243	.01169	.0000	.00	.03697	.001	.11	.00	.11	.24	.0000	.0000	.0446
Health professionals (Sub-dimension)	10	0	.0355	.01709	.0000	.00	.05403	.003	.16	.00	.16	.36	.0000	.0000	.0793
Medication list (Sub-dimension)	10	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Hospital (Sub-dimension)	10	0	.0185	.00692	.0147	.00	.02187	.000	.06	.00	.06	.19	.0000	.0147	.0306
Information flow Dimension	10	0	.0784	.02845	.0549	.00	.08995	.008	.23	.00	.23	.78	.0000	.0549	.1671
Encryption (Sub-dimension)	10	0	.0522	.03674	.0000	.00	.11618	.013	.34	.00	.34	.52	.0000	.0000	.0456
Regulation (Sub-dimension)	10	0	.1170	.03504	.1697	.17	.11080	.012	.32	.00	.32	1.17	.0000	.1697	.1697
Workstation (Sub-dimension)	10	0	.0419	.03086	.0000	.00	.09759	.010	.30	.00	.30	.42	.0000	.0000	.0303
Security & Privacy Dimension	10	0	.2111	.07701	.1697	.17	.24352	.059	.78	.00	.78	2.11	.0000	.1697	.2536
eHealth Hospital Deployment Overall indicator	7	3	.1890	.02637	.1717	.12a	.06976	.005	.21	.12	.33	1.32	.1295	.1717	.2165

a. Multiple modes exist. The smallest value is shown.

Table 41: *Measurement of dispersion – eHealth Deployment Index Luxembourg*

	N - Valid	Missing	Mean	Std. Error of Mean	Median	Mode	Std. Deviation	Variance	Range	Minimum	Maximum	Sum	Percentiles - 25	Percentiles - 50	Percentiles - 75
Physical oriented (Sub-dimension)	3	0	.3146	.06850	.3831	.38	.11865	.014	.21	.18	.38	.94	.1775	.3831	.
Services oriented (Sub-dimension)	3	0	.3031	.15764	.3797	.00a	.27303	.075	.53	.00	.53	.91	.0000	.3797	.
Infrastructure Dimension	3	0	.6177	.15588	.5572	.38a	.26999	.073	.53	.38	.91	1.85	.3831	.5572	.
Clinical & Image (Sub-dimension)	3	0	.1902	.02533	.1649	.16	.04387	.002	.08	.16	.24	.57	.1649	.1649	.
EPR & patient management Intra-mural (Sub-dimension)	3	0	.0926	.03448	.0867	.04a	.05972	.004	.12	.04	.16	.28	.0361	.0867	.
Patient access and safety (Sub-dimension)	3	0	.1429	.00000	.1429	.14	.00000	.000	.00	.14	.14	.43	.1429	.1429	.1429
PHR & tele-monitoring Extra-mural (Sub-dimension)	3	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Application & Integration Dimension	3	0	.4257	.01996	.4198	.39a	.03456	.001	.07	.39	.46	1.28	.3945	.4198	.
Country (Sub-dimension)	3	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Health professionals (Sub-dimension)	3	0	.0935	.05839	.0797	.00a	.10113	.010	.20	.00	.20	.28	.0000	.0797	.
Medication list (Sub-dimension)	3	0	.0124	.01241	.0000	.00	.02149	.000	.04	.00	.04	.04	.0000	.0000	.
Hospital (Sub-dimension)	3	0	.0421	.02707	.0337	.00a	.04688	.002	.09	.00	.09	.13	.0000	.0337	.
Information flow Dimension	3	0	.1480	.07436	.2096	.00a	.12880	.017	.23	.00	.23	.44	.0000	.2096	.
Encryption (Sub-dimension)	3	0	.0525	.05250	.0000	.00	.09093	.008	.16	.00	.16	.16	.0000	.0000	.
Regulation (Sub-dimension)	3	0	.1072	.10721	.0000	.00	.18570	.034	.32	.00	.32	.32	.0000	.0000	.
Workstation (Sub-dimension)	3	0	.0992	.09920	.0000	.00	.17182	.030	.30	.00	.30	.30	.0000	.0000	.
Security & Privacy Dimension	3	0	.2589	.25891	.0000	.00	.44845	.201	.78	.00	.78	.78	.0000	.0000	.
eHealth Hospital Deployment Overall indicator	3	0	.3626	.11281	.3074	.20a	.19539	.038	.38	.20	.58	1.09	.2007	.3074	.

a. Multiple modes exist. The smallest value is shown.

Table 42: Measurement of dispersion – eHealth Deployment Index Malta

	N - Valid	Missing	Mean	Std. Error of Mean	Median	Mode	Std. Deviation	Variance	Range	Minimum	Maximum	Sum	Percentiles - 25	Percentiles - 50	Percentiles - 75
Physical oriented (Sub-dimension)	3	0	.1962	.11068	.2055	.00a	.19170	.037	.38	.00	.38	.59	.0000	.2055	.
Services oriented (Sub-dimension)	3	0	.1766	.11040	.1501	.00a	.19122	.037	.38	.00	.38	.53	.0000	.1501	.
Infrastructure Dimension	3	0	.3728	.09463	.3797	.21a	.16391	.027	.33	.21	.53	1.12	.2055	.3797	.
Clinical & Image (Sub-dimension)	3	0	.1974	.02679	.2028	.15a	.04640	.002	.09	.15	.24	.59	.1485	.2028	.
EPR & patient management Intra-mural (Sub-dimension)	3	0	.0689	.05187	.0361	.00a	.08984	.008	.17	.00	.17	.21	.0000	.0361	.
Patient access and safety (Sub-dimension)	3	0	.0873	.02615	.1134	.11	.04529	.002	.08	.03	.11	.26	.0350	.1134	.
PHR & tele-monitoring Extra-mural (Sub-dimension)	3	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Application & Integration Dimension	3	0	.3535	.09004	.3163	.22a	.15595	.024	.31	.22	.52	1.06	.2196	.3163	.
Country (Sub-dimension)	3	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Health professionals (Sub-dimension)	3	0	.0804	.08044	.0000	.00	.13933	.019	.24	.00	.24	.24	.0000	.0000	.
Medication list (Sub-dimension)	3	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Hospital (Sub-dimension)	3	0	.0309	.03087	.0000	.00	.05347	.003	.09	.00	.09	.09	.0000	.0000	.
Information flow Dimension	3	0	.1113	.11132	.0000	.00	.19280	.037	.33	.00	.33	.33	.0000	.0000	.
Encryption (Sub-dimension)	3	0	.0525	.05250	.0000	.00	.09093	.008	.16	.00	.16	.16	.0000	.0000	.
Regulation (Sub-dimension)	3	0	.1131	.05655	.1697	.17	.09795	.010	.17	.00	.17	.34	.0000	.1697	.
Workstation (Sub-dimension)	3	0	.0588	.05880	.0000	.00	.10184	.010	.18	.00	.18	.18	.0000	.0000	.
Security & Privacy Dimension	3	0	.2244	.05474	.1697	.17	.09482	.009	.16	.17	.33	.67	.1697	.1697	.
eHealth Hospital Deployment Overall indicator	3	0	.2655	.02194	.2575	.23a	.03799	.001	.07	.23	.31	.80	.2322	.2575	.

a. Multiple modes exist. The smallest value is shown.

Table 43: *Measurement of dispersion – eHealth Deployment Index Netherlands*

	N - Valid	Missing	Mean	Std. Error of Mean	Median	Mode	Std. Deviation	Variance	Range	Minimum	Maximum	Sum	Percentiles - 25	Percentiles - 50	Percentiles - 75
Physical oriented (Sub-dimension)	29	0	.2938	.02103	.3831	.38	.11323	.013	.38	.00	.38	8.52	.1775	.3831	.3831
Services oriented (Sub-dimension)	27	2	.3584	.03726	.5297	.53	.19359	.037	.53	.00	.53	9.68	.1501	.5297	.5297
Infrastructure Dimension	27	2	.6608	.04967	.7073	.91	.25807	.067	.76	.15	.91	17.84	.5331	.7073	.9128
Clinical & Image (Sub-dimension)	28	1	.1730	.00987	.1649	.16	.05223	.003	.24	.00	.24	4.84	.1649	.1649	.2313
EPR & patient management Intra-mural (Sub-dimension)	29	0	.1704	.00872	.1705	.17	.04694	.002	.19	.04	.22	4.94	.1551	.1705	.2211
Patient access and safety (Sub-dimension)	29	0	.1395	.00249	.1429	.14	.01341	.000	.06	.08	.14	4.04	.1429	.1429	.1429
PHR & tele-monitoring Extra-mural (Sub-dimension)	29	0	.0205	.00773	.0000	.00	.04164	.002	.14	.00	.14	.59	.0000	.0000	.0000
Application & Integration Dimension	28	1	.5064	.02070	.5053	.46a	.10952	.012	.52	.18	.70	14.18	.4485	.5053	.5652
Country (Sub-dimension)	29	0	.0349	.01828	.0000	.00	.09845	.010	.40	.00	.40	1.01	.0000	.0000	.0000
Health professionals (Sub-dimension)	29	0	.1516	.01908	.2046	.24	.10277	.011	.24	.00	.24	4.40	.0212	.2046	.2413
Medication list (Sub-dimension)	29	0	.0372	.00865	.0000	.00	.04660	.002	.11	.00	.11	1.08	.0000	.0000	.0909
Hospital (Sub-dimension)	29	0	.0492	.00710	.0590	.09	.03826	.001	.09	.00	.09	1.43	.0000	.0590	.0926
Information flow Dimension	29	0	.2730	.03854	.2750	.00	.20752	.043	.84	.00	.84	7.92	.0675	.2750	.4151
Encryption (Sub-dimension)	29	0	.1598	.02596	.1575	.00a	.13979	.020	.34	.00	.34	4.63	.0000	.1575	.3399
Regulation (Sub-dimension)	29	0	.2104	.01721	.1697	.17	.09268	.009	.32	.00	.32	6.10	.1697	.1697	.3216
Workstation (Sub-dimension)	29	0	.0612	.01672	.0000	.00	.09007	.008	.30	.00	.30	1.77	.0000	.0000	.1764
Security & Privacy Dimension	29	0	.4313	.03862	.3461	.33	.20795	.043	.84	.00	.84	12.51	.3244	.3461	.6374
eHealth Hospital Deployment Overall indicator	26	3	.4761	.02678	.4429	.20a	.13656	.019	.54	.20	.73	12.38	.4024	.4429	.5691

a. Multiple modes exist. The smallest value is shown.

Table 44: *Measurement of dispersion – eHealth Deployment Index Norway*

	N - Valid	Missing	Mean	Std. Error of Mean	Median	Mode	Std. Deviation	Variance	Range	Minimum	Maximum	Sum	Percentiles - 25	Percentiles - 50	Percentiles - 75
Physical oriented (Sub-dimension)	7	0	.3831	.00000	.3831	.38	.00000	.000	.00	.38	.38	2.68	.3831	.3831	.3831
Services oriented (Sub-dimension)	7	0	.3998	.06773	.5297	.53	.17920	.032	.38	.15	.53	2.80	.1501	.5297	.5297
Infrastructure Dimension	7	0	.7829	.06773	.9128	.91	.17920	.032	.38	.53	.91	5.48	.5331	.9128	.9128
Clinical & Image (Sub-dimension)	7	0	.1866	.02007	.1649	.24	.05309	.003	.11	.13	.24	1.31	.1269	.1649	.2408
EPR & patient management Intra-mural (Sub-dimension)	7	0	.1393	.02755	.1705	.17	.07289	.005	.19	.04	.22	.98	.0361	.1705	.1705
Patient access and safety (Sub-dimension)	7	0	.1267	.01148	.1429	.14	.03038	.001	.08	.06	.14	.89	.1079	.1429	.1429
PHR & tele-monitoring Extra-mural (Sub-dimension)	7	0	.0129	.01294	.0000	.00	.03424	.001	.09	.00	.09	.09	.0000	.0000	.0000
Application & Integration Dimension	7	0	.4655	.05244	.5289	.55	.13874	.019	.34	.23	.57	3.26	.3059	.5289	.5542
Country (Sub-dimension)	7	0	.0510	.04299	.0000	.00	.11374	.013	.31	.00	.31	.36	.0000	.0000	.0520
Health professionals (Sub-dimension)	7	0	.2138	.02199	.2413	.24	.05818	.003	.16	.09	.24	1.50	.2046	.2413	.2413
Medication list (Sub-dimension)	7	0	.0880	.01043	.1077	.11	.02761	.001	.07	.04	.11	.62	.0740	.1077	.1077
Hospital (Sub-dimension)	7	0	.0619	.01356	.0630	.09	.03588	.001	.09	.00	.09	.43	.0293	.0630	.0926
Information flow Dimension	7	0	.4147	.06219	.4080	.22a	.16453	.027	.52	.22	.75	2.90	.3044	.4080	.4417
Encryption (Sub-dimension)	7	0	.1871	.04503	.1575	.16	.11915	.014	.34	.00	.34	1.31	.1575	.1575	.3399
Regulation (Sub-dimension)	7	0	.2540	.04744	.3216	.32	.12550	.016	.32	.00	.32	1.78	.1697	.3216	.3216
Workstation (Sub-dimension)	7	0	.0519	.02449	.0000	.00	.06479	.004	.12	.00	.12	.36	.0000	.0000	.1212
Security & Privacy Dimension	7	0	.4930	.07987	.4791	.16a	.21132	.045	.63	.16	.78	3.45	.3216	.4791	.6615
eHealth Hospital Deployment Overall indicator	7	0	.5390	.03573	.5145	.39a	.09453	.009	.27	.39	.66	3.77	.4895	.5145	.6425

a. Multiple modes exist. The smallest value is shown.

Table 45: Measurement of dispersion – eHealth Deployment Index Poland

	N - Valid	Missing	Mean	Std. Error of Mean	Median	Mode	Std. Deviation	Variance	Range	Minimum	Maximum	Sum	Percentiles - 25	Percentiles - 50	Percentiles - 75
Physical oriented (Sub-dimension)	92	7	.0795	.01178	.0000	.00	.11302	.013	.38	.00	.38	7.32	.0000	.0000	.1775
Services oriented (Sub-dimension)	88	11	.1557	.02041	.0000	.00	.19142	.037	.53	.00	.53	13.70	.0000	.0000	.3797
Infrastructure Dimension	81	18	.2510	.02532	.1775	.00	.22788	.052	.76	.00	.76	20.34	.0000	.1775	.3797
Clinical & Image (Sub-dimension)	99	0	.0929	.00840	.0923	.00	.08356	.007	.24	.00	.24	9.20	.0000	.0923	.1649
EPR & patient management Intra-mural (Sub-dimension)	99	0	.0678	.00668	.0361	.04	.06650	.004	.22	.00	.22	6.71	.0000	.0361	.1045
Patient access and safety (Sub-dimension)	85	14	.0650	.00548	.0784	.00	.05053	.003	.14	.00	.14	5.52	.0000	.0784	.1134
PHR & tele-monitoring Extra-mural (Sub-dimension)	96	3	.0052	.00234	.0000	.00	.02290	.001	.14	.00	.14	.50	.0000	.0000	.0000
Application & Integration Dimension	82	17	.2308	.01805	.1760	.09	.16344	.027	.66	.00	.66	18.93	.0923	.1760	.3849
Country (Sub-dimension)	99	0	.0118	.00506	.0000	.00	.05032	.003	.40	.00	.40	1.17	.0000	.0000	.0000
Health professionals (Sub-dimension)	99	0	.0154	.00401	.0000	.00	.03992	.002	.24	.00	.24	1.52	.0000	.0000	.0000
Medication list (Sub-dimension)	99	0	.0022	.00153	.0000	.00	.01524	.000	.11	.00	.11	.22	.0000	.0000	.0000
Hospital (Sub-dimension)	99	0	.0076	.00184	.0000	.00	.01835	.000	.09	.00	.09	.75	.0000	.0000	.0000
Information flow Dimension	99	0	.0369	.01137	.0000	.00	.11311	.013	.80	.00	.80	3.65	.0000	.0000	.0337
Encryption (Sub-dimension)	99	0	.1583	.01388	.1575	.00	.13809	.019	.34	.00	.34	15.67	.0000	.1575	.3399
Regulation (Sub-dimension)	99	0	.0885	.01132	.0000	.00	.11264	.013	.32	.00	.32	8.76	.0000	.0000	.1697
Workstation (Sub-dimension)	99	0	.0284	.00654	.0000	.00	.06504	.004	.30	.00	.30	2.81	.0000	.0000	.0000
Security & Privacy Dimension	99	0	.2752	.02260	.3216	.00	.22482	.051	.81	.00	.81	27.25	.0000	.3216	.4918
eHealth Hospital Deployment Overall indicator	68	31	.2137	.01491	.1982	.00a	.12295	.015	.62	.00	.62	14.53	.1171	.1982	.3010

a. Multiple modes exist. The smallest value is shown.

Table 46: Measurement of dispersion – eHealth Deployment Index Portugal

	N - Valid	Missing	Mean	Std. Error of Mean	Median	Mode	Std. Deviation	Variance	Range	Minimum	Maximum	Sum	Percentiles - 25	Percentiles - 50	Percentiles - 75
Physical oriented (Sub-dimension)	18	2	.2377	.02684	.1775	.18	.11388	.013	.38	.00	.38	4.28	.1775	.1775	.3831
Services oriented (Sub-dimension)	20	0	.2918	.05104	.3797	.00a	.22824	.052	.53	.00	.53	5.84	.0000	.3797	.5297
Infrastructure Dimension	18	2	.5325	.06625	.5572	.18	.28106	.079	.74	.18	.91	9.59	.1775	.5572	.8002
Clinical & Image (Sub-dimension)	20	0	.1854	.01271	.1838	.24	.05683	.003	.17	.07	.24	3.71	.1649	.1838	.2408
EPR & patient management Intra-mural (Sub-dimension)	20	0	.1368	.01443	.1527	.15a	.06453	.004	.19	.04	.22	2.74	.0867	.1527	.2046
Patient access and safety (Sub-dimension)	20	0	.1097	.00896	.1134	.14	.04008	.002	.14	.00	.14	2.19	.0872	.1134	.1429
PHR & tele-monitoring Extra-mural (Sub-dimension)	20	0	.0144	.00604	.0000	.00	.02699	.001	.09	.00	.09	.29	.0000	.0000	.0371
Application & Integration Dimension	20	0	.4464	.03246	.4799	.60	.14518	.021	.53	.13	.65	8.93	.3353	.4799	.5742
Country (Sub-dimension)	20	0	.0020	.00198	.0000	.00	.00887	.000	.04	.00	.04	.04	.0000	.0000	.0000
Health professionals (Sub-dimension)	20	0	.0294	.01152	.0000	.00	.05150	.003	.20	.00	.20	.59	.0000	.0000	.0640
Medication list (Sub-dimension)	20	0	.0054	.00539	.0000	.00	.02409	.001	.11	.00	.11	.11	.0000	.0000	.0000
Hospital (Sub-dimension)	20	0	.0261	.00754	.0000	.00	.03372	.001	.09	.00	.09	.52	.0000	.0000	.0622
Information flow Dimension	20	0	.0629	.01956	.0148	.00	.08748	.008	.29	.00	.29	1.26	.0000	.0148	.0980
Encryption (Sub-dimension)	20	0	.1413	.03315	.1575	.00	.14824	.022	.34	.00	.34	2.83	.0000	.1575	.3399
Regulation (Sub-dimension)	20	0	.2184	.03135	.3216	.32	.14021	.020	.32	.00	.32	4.37	.0424	.3216	.3216
Workstation (Sub-dimension)	20	0	.1042	.02471	.1212	.00	.11049	.012	.30	.00	.30	2.08	.0000	.1212	.1764
Security & Privacy Dimension	20	0	.4639	.06124	.4795	.17	.27388	.075	.84	.00	.84	9.28	.1697	.4795	.6615
eHealth Hospital Deployment Overall indicator	18	2	.3845	.03176	.3901	.17a	.13474	.018	.45	.17	.63	6.92	.2631	.3901	.4690

a. Multiple modes exist. The smallest value is shown.

Table 47: *Measurement of dispersion – eHealth Deployment Index Romania*

	N - Valid	Missing	Mean	Std. Error of Mean	Median	Mode	Std. Deviation	Variance	Range	Minimum	Maximum	Sum	Percentiles - 25	Percentiles - 50	Percentiles - 75
Physical oriented (Sub-dimension)	31	7	.1821	.01990	.1775	.18	.11078	.012	.38	.00	.38	5.64	.1775	.1775	.1775
Services oriented (Sub-dimension)	27	11	.1095	.03467	.0000	.00	.18017	.032	.53	.00	.53	2.96	.0000	.0000	.3797
Infrastructure Dimension	23	15	.3199	.04151	.3276	.18	.19909	.040	.76	.00	.76	7.36	.1775	.3276	.5297
Clinical & Image (Sub-dimension)	35	3	.0674	.01240	.0380	.00	.07337	.005	.24	.00	.24	2.36	.0000	.0380	.1269
EPR & patient management Intra-mural (Sub-dimension)	38	0	.0599	.00955	.0361	.04	.05888	.003	.22	.00	.22	2.28	.0361	.0361	.1021
Patient access and safety (Sub-dimension)	34	4	.0245	.00646	.0000	.00	.03767	.001	.11	.00	.11	.83	.0000	.0000	.0458
PHR & tele-monitoring Extra-mural (Sub-dimension)	37	1	.0051	.00398	.0000	.00	.02421	.001	.14	.00	.14	.19	.0000	.0000	.0000
Application & Integration Dimension	30	8	.1228	.01846	.1146	.04	.10108	.010	.41	.00	.41	3.68	.0361	.1146	.1630
Country (Sub-dimension)	38	0	.0121	.00590	.0000	.00	.03637	.001	.18	.00	.18	.46	.0000	.0000	.0000
Health professionals (Sub-dimension)	38	0	.0282	.01022	.0000	.00	.06303	.004	.24	.00	.24	1.07	.0000	.0000	.0092
Medication list (Sub-dimension)	38	0	.0047	.00335	.0000	.00	.02063	.000	.11	.00	.11	.18	.0000	.0000	.0000
Hospital (Sub-dimension)	38	0	.0139	.00463	.0000	.00	.02854	.001	.09	.00	.09	.53	.0000	.0000	.0074
Information flow Dimension	38	0	.0588	.02131	.0000	.00	.13135	.017	.62	.00	.62	2.24	.0000	.0000	.0441
Encryption (Sub-dimension)	38	0	.2526	.02128	.3399	.34	.13116	.017	.34	.00	.34	9.60	.1575	.3399	.3399
Regulation (Sub-dimension)	38	0	.1361	.01724	.1697	.17	.10630	.011	.32	.00	.32	5.17	.0000	.1697	.1697
Workstation (Sub-dimension)	38	0	.0487	.01488	.0000	.00	.09170	.008	.30	.00	.30	1.85	.0000	.0000	.1212
Security & Privacy Dimension	38	0	.4374	.03643	.5095	.51	.22459	.050	.96	.00	.96	16.62	.3272	.5095	.6307
eHealth Hospital Deployment Overall indicator	17	21	.2365	.03130	.1808	.06a	.12904	.017	.43	.06	.49	4.02	.1411	.1808	.3616

a. Multiple modes exist. The smallest value is shown.

Table 48: Measurement of dispersion – eHealth Deployment Index Slovakia

	N - Valid	Missing	Mean	Std. Error of Mean	Median	Mode	Std. Deviation	Variance	Range	Minimum	Maximum	Sum	Percentiles - 25	Percentiles - 50	Percentiles - 75
Physical oriented Sub-dimension)	10	2	.0589	.03006	.0000	.00	.09507	.009	.21	.00	.21	.59	.0000	.0000	.1845
Services oriented (Sub-dimension)	12	0	.1266	.05396	.0000	.00	.18694	.035	.38	.00	.38	1.52	.0000	.0000	.3797
Infrastructure Dimension	10	2	.1348	.06302	.0000	.00	.19928	.040	.56	.00	.56	1.35	.0000	.0000	.2490
Clinical & Image (Sub-dimension)	12	0	.1354	.02408	.1377	.07a	.08342	.007	.24	.00	.24	1.62	.0725	.1377	.2054
EPR & patient management Intra-mural (Sub-dimension)	12	0	.0823	.01874	.0691	.04	.06492	.004	.22	.00	.22	.99	.0361	.0691	.1045
Patient access and safety (Sub-dimension)	9	3	.0570	.01654	.0350	.00a	.04963	.002	.14	.00	.14	.51	.0147	.0350	.0959
PHR & tele-monitoring Extra-mural (Sub-dimension)	12	0	.0151	.01018	.0000	.00	.03527	.001	.09	.00	.09	.18	.0000	.0000	.0000
Application & Integration Dimension	9	3	.3256	.04124	.3554	.14a	.12371	.015	.35	.14	.49	2.93	.2125	.3554	.4341
Country (Sub-dimension)	12	0	.0259	.01801	.0000	.00	.06240	.004	.22	.00	.22	.31	.0000	.0000	.0359
Health professionals (Sub-dimension)	12	0	.0773	.02641	.0575	.00	.09150	.008	.24	.00	.24	.93	.0000	.0575	.1403
Medication list (Sub-dimension)	12	0	.0059	.00399	.0000	.00	.01383	.000	.04	.00	.04	.07	.0000	.0000	.0000
Hospital (Sub-dimension)	12	0	.0316	.01010	.0315	.00	.03498	.001	.09	.00	.09	.38	.0000	.0315	.0559
Information flow Dimension	12	0	.1407	.05025	.1165	.00	.17407	.030	.55	.00	.55	1.69	.0000	.1165	.2343
Encryption (Sub-dimension)	12	0	.1133	.03825	.0788	.00	.13250	.018	.34	.00	.34	1.36	.0000	.0788	.1824
Regulation (Sub-dimension)	12	0	.0424	.02215	.0000	.00	.07673	.006	.17	.00	.17	.51	.0000	.0000	.1272
Workstation (Sub-dimension)	12	0	.0147	.01470	.0000	.00	.05092	.003	.18	.00	.18	.18	.0000	.0000	.0000
Security & Privacy Dimension	12	0	.1704	.05932	.0788	.00	.20551	.042	.51	.00	.51	2.04	.0000	.0788	.3508
eHealth Hospital Deployment Overall indicator	7	5	.2065	.05947	.1568	.03a	.15733	.025	.46	.03	.49	1.45	.1102	.1568	.3367

a. Multiple modes exist. The smallest value is shown.

Table 49: *Measurement of dispersion – eHealth Deployment Index Slovenia*

	N - Valid	Missing	Mean	Std. Error of Mean	Median	Mode	Std. Deviation	Variance	Range	Minimum	Maximum	Sum	Percentiles - 25	Percentiles - 50	Percentiles - 75
Physical oriented (Sub-dimension)	3	0	.1869	.00932	.1775	.18	.01614	.000	.03	.18	.21	.56	.1775	.1775	.
Services oriented (Sub-dimension)	3	0	.1266	.12656	.0000	.00	.21920	.048	.38	.00	.38	.38	.0000	.0000	.
Infrastructure Dimension	3	0	.3134	.12216	.2055	.18a	.21160	.045	.38	.18	.56	.94	.1775	.2055	.
Clinical & Image (Sub-dimension)	3	0	.0538	.03787	.0345	.00a	.06558	.004	.13	.00	.13	.16	.0000	.0345	.
EPR & patient management Intra-mural (Sub-dimension)	3	0	.0361	.00000	.0361	.04	.00000	.000	.00	.04	.04	.11	.0361	.0361	.0361
Patient access and safety (Sub-dimension)	3	0	.0523	.02615	.0784	.08	.04529	.002	.08	.00	.08	.16	.0000	.0784	.
PHR & tele-monitoring Extra-mural (Sub-dimension)	3	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Application & Integration Dimension	3	0	.1422	.05936	.1491	.04a	.10282	.011	.21	.04	.24	.43	.0361	.1491	.
Country (Sub-dimension)	3	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Health professionals (Sub-dimension)	3	0	.0543	.05428	.0000	.00	.09402	.009	.16	.00	.16	.16	.0000	.0000	.
Medication list (Sub-dimension)	3	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Hospital (Sub-dimension)	3	0	.0210	.01058	.0293	.00a	.01832	.000	.03	.00	.03	.06	.0000	.0293	.
Information flow Dimension	3	0	.0753	.05925	.0337	.00a	.10263	.011	.19	.00	.19	.23	.0000	.0337	.
Encryption (Sub-dimension)	3	0	.0000	.00000	.0000	.00	.00000	.000	.00	.00	.00	.00	.0000	.0000	.0000
Regulation (Sub-dimension)	3	0	.1131	.05655	.1697	.17	.09795	.010	.17	.00	.17	.34	.0000	.1697	.
Workstation (Sub-dimension)	3	0	.0588	.05880	.0000	.00	.10184	.010	.18	.00	.18	.18	.0000	.0000	.
Security & Privacy Dimension	3	0	.1719	.09990	.1697	.00a	.17304	.030	.35	.00	.35	.52	.0000	.1697	.
eHealth Hospital Deployment Overall indicator	3	0	.1757	.07139	.1472	.07a	.12366	.015	.24	.07	.31	.53	.0688	.1472	.

a. Multiple modes exist. The smallest value is shown.

Table 50: Measurement of dispersion – eHealth Deployment Index Spain

	N - Valid	Missing	Mean	Std. Error of Mean	Median	Mode	Std. Deviation	Variance	Range	Minimum	Maximum	Sum	Percentiles - 25	Percentiles - 50	Percentiles - 75
Physical oriented (Sub-dimension)	90	0	.2753	.01266	.3831	.38	.12007	.014	.38	.00	.38	24.78	.1775	.3831	.3831
Services oriented (Sub-dimension)	86	4	.3273	.02302	.3797	.53	.21351	.046	.53	.00	.53	28.15	.1501	.3797	.5297
Infrastructure Dimension	86	4	.6068	.02777	.5572	.91	.25753	.066	.91	.00	.91	52.19	.3831	.5572	.9128
Clinical & Image (Sub-dimension)	89	1	.1807	.00755	.2028	.24	.07119	.005	.24	.00	.24	16.08	.1377	.2028	.2408
EPR & patient management Intra-mural (Sub-dimension)	90	0	.1285	.00774	.1045	.22	.07341	.005	.19	.04	.22	11.56	.0361	.1045	.2211
Patient access and safety (Sub-dimension)	81	9	.1220	.00304	.1134	.14	.02737	.001	.14	.00	.14	9.88	.1134	.1134	.1429
PHR & tele-monitoring Extra-mural (Sub-dimension)	86	4	.0177	.00396	.0000	.00	.03675	.001	.14	.00	.14	1.52	.0000	.0000	.0000
Application & Integration Dimension	79	11	.4476	.01694	.4325	.60	.15055	.023	.71	.04	.74	35.36	.3524	.4325	.5754
Country (Sub-dimension)	90	0	.0135	.00524	.0000	.00	.04974	.002	.31	.00	.31	1.22	.0000	.0000	.0000
Health professionals (Sub-dimension)	90	0	.1212	.01083	.1187	.24	.10275	.011	.24	.00	.24	10.91	.0000	.1187	.2413
Medication list (Sub-dimension)	90	0	.0227	.00448	.0000	.00	.04251	.002	.11	.00	.11	2.04	.0000	.0000	.0084
Hospital (Sub-dimension)	90	0	.0544	.00412	.0633	.09	.03913	.002	.09	.00	.09	4.89	.0000	.0633	.0926
Information flow Dimension	90	0	.2118	.01874	.1917	.00a	.17774	.032	.64	.00	.64	19.06	.0296	.1917	.3339
Encryption (Sub-dimension)	90	0	.2000	.01307	.1575	.16a	.12399	.015	.34	.00	.34	18.00	.1575	.1575	.3399
Regulation (Sub-dimension)	90	0	.2236	.00906	.1697	.17	.08597	.007	.32	.00	.32	20.13	.1697	.1697	.3216
Workstation (Sub-dimension)	90	0	.0985	.01228	.0606	.00	.11654	.014	.30	.00	.30	8.86	.0000	.0606	.1212
Security & Privacy Dimension	90	0	.5221	.02234	.5068	.33a	.21195	.045	.84	.12	.96	46.99	.3272	.5068	.6307
eHealth Hospital Deployment Overall indicator	77	13	.4426	.01634	.4195	.09a	.14336	.021	.69	.09	.78	34.08	.3512	.4195	.5376

a. Multiple modes exist. The smallest value is shown.

Table 51: Measurement of dispersion – eHealth Deployment Index Sweden

	N - Valid	Missing	Mean	Std. Error of Mean	Median	Mode	Std. Deviation	Variance	Range	Minimum	Maximum	Sum	Percentiles - 25	Percentiles - 50	Percentiles - 75
Physical oriented (Sub-dimension)	8	0	.2873	.03639	.2943	.38	.10292	.011	.21	.18	.38	2.30	.1845	.2943	.3831
Services oriented (Sub-dimension)	7	1	.5297	.00000	.5297	.53	.00000	.000	.00	.53	.53	3.71	.5297	.5297	.5297
Infrastructure Dimension	7	1	.8327	.03792	.9128	.91	.10032	.010	.21	.71	.91	5.83	.7352	.9128	.9128
Clinical & Image (Sub-dimension)	7	1	.2300	.01086	.2408	.24	.02872	.001	.08	.16	.24	1.61	.2408	.2408	.2408
EPR & patient management Intra-mural (Sub-dimension)	8	0	.1875	.01796	.2211	.22	.05080	.003	.13	.09	.22	1.50	.1533	.2211	.2211
Patient access and safety (Sub-dimension)	8	0	.1385	.00437	.1429	.14	.01237	.000	.03	.11	.14	1.11	.1429	.1429	.1429
PHR & tele-monitoring Extra-mural (Sub-dimension)	7	1	.0259	.01671	.0000	.00	.04421	.002	.09	.00	.09	.18	.0000	.0000	.0906
Application & Integration Dimension	6	2	.6068	.03449	.6048	.60a	.08447	.007	.22	.47	.70	3.64	.5450	.6048	.6954
Country (Sub-dimension)	8	0	.0114	.00745	.0000	.00	.02107	.000	.05	.00	.05	.09	.0000	.0000	.0322
Health professionals (Sub-dimension)	8	0	.1191	.03350	.1180	.04a	.09474	.009	.24	.00	.24	.95	.0365	.1180	.2213
Medication list (Sub-dimension)	8	0	.0493	.01661	.0523	.00	.04697	.002	.11	.00	.11	.39	.0000	.0523	.0993
Hospital (Sub-dimension)	8	0	.0547	.01261	.0485	.09	.03567	.001	.09	.00	.09	.44	.0304	.0485	.0926
Information flow Dimension	8	0	.2345	.05399	.2028	.03a	.15270	.023	.46	.03	.48	1.88	.1024	.2028	.3646
Encryption (Sub-dimension)	8	0	.1896	.05964	.2487	.34	.16868	.028	.34	.00	.34	1.52	.0000	.2487	.3399
Regulation (Sub-dimension)	8	0	.2602	.03003	.3216	.32	.08493	.007	.17	.15	.32	2.08	.1564	.3216	.3216
Workstation (Sub-dimension)	8	0	.1336	.05243	.0882	.00	.14828	.022	.30	.00	.30	1.07	.0000	.0882	.2976
Security & Privacy Dimension	8	0	.5835	.08105	.5737	.32a	.22924	.053	.64	.32	.96	4.67	.3536	.5737	.7707
eHealth Hospital Deployment Overall indicator	6	2	.5607	.02516	.5584	.48a	.06163	.004	.16	.48	.64	3.36	.5059	.5584	.6224

a. Multiple modes exist. The smallest value is shown.

Table 52: Measurement of dispersion – eHealth Deployment Index United Kingdom

	N - Valid	Missing	Mean	Std. Error of Mean	Median	Mode	Std. Deviation	Variance	Range	Minimum	Maximum	Sum	Percentiles - 25	Percentiles - 50	Percentiles - 75
Physical oriented (Sub-dimension)	38	0	.2926	.01806	.3831	.38	.11132	.012	.38	.00	.38	11.12	.1775	.3831	.3831
Services oriented (Sub-dimension)	32	6	.4307	.02728	.5297	.53	.15432	.024	.53	.00	.53	13.78	.3797	.5297	.5297
Infrastructure Dimension	32	6	.7448	.03882	.9128	.91	.21960	.048	.74	.18	.91	23.84	.5572	.9128	.9128
Clinical & Image (Sub-dimension)	38	0	.1993	.00784	.2028	.24	.04831	.002	.16	.08	.24	7.57	.1649	.2028	.2408
EPR & patient management Intra-mural (Sub-dimension)	38	0	.1322	.01121	.1551	.17	.06909	.005	.22	.00	.22	5.02	.0983	.1551	.1705
Patient access and safety (Sub-dimension)	37	1	.1010	.00700	.1134	.14	.04260	.002	.11	.03	.14	3.74	.0644	.1134	.1429
PHR & tele-monitoring Extra-mural (Sub-dimension)	37	1	.0111	.00480	.0000	.00	.02920	.001	.09	.00	.09	.41	.0000	.0000	.0000
Application & Integration Dimension	36	2	.4410	.01886	.4604	.48a	.11318	.013	.46	.24	.70	15.87	.3254	.4604	.5282
Country (Sub-dimension)	38	0	.0389	.01614	.0000	.00	.09952	.010	.40	.00	.40	1.48	.0000	.0000	.0000
Health professionals (Sub-dimension)	38	0	.1460	.01570	.1811	.24	.09678	.009	.24	.00	.24	5.55	.0419	.1811	.2413
Medication list (Sub-dimension)	38	0	.0453	.00752	.0337	.00	.04638	.002	.11	.00	.11	1.72	.0000	.0337	.1077
Hospital (Sub-dimension)	38	0	.0644	.00526	.0633	.09	.03244	.001	.09	.00	.09	2.45	.0526	.0633	.0926
Information flow Dimension	38	0	.2946	.03308	.2734	.44	.20394	.042	.78	.00	.78	11.20	.1247	.2734	.4417
Encryption (Sub-dimension)	38	0	.2622	.02018	.3399	.34	.12441	.015	.34	.00	.34	9.96	.1575	.3399	.3399
Regulation (Sub-dimension)	38	0	.2478	.01542	.3216	.32	.09507	.009	.32	.00	.32	9.42	.1697	.3216	.3216
Workstation (Sub-dimension)	38	0	.1610	.01874	.1764	.30	.11551	.013	.30	.00	.30	6.12	.0000	.1764	.2976
Security & Privacy Dimension	38	0	.6710	.03895	.7191	.96	.24012	.058	.96	.00	.96	25.50	.5080	.7191	.8379
eHealth Hospital Deployment Overall indicator	30	8	.5373	.02528	.5534	.24a	.13849	.019	.60	.24	.84	16.12	.4688	.5534	.6341

ANNEX 2. Mean and correlation matrices

Table 53: eHealth deployment Infrastructure. Mean and correlation matrix

	Mean	1	2	3
Computer system connected	.82			
Broadband above 50 MBps	.44	.150*		
Hospital support wireless communications	.54	.143*	.133*	
Hospital video conference facilities	.41	.205*	.266*	.274*

** p<0.01.*

Table 54: eHealth deployment application and integration. Mean and correlation matrix

	Mean	1	2	3	4	5	6	7	8	9	10	11	12
Electronic Patient Record (EPR)	.81												
Personal Health Record (PHR)	.05	.107*											
Picture archiving and communication systems (PACS)	.61	.177*	.053***										
An integrated system for billing management	.77	.153*	.037*	.097*									
An integrated system to send or receive electronic referral letters	.33	.222*	.200*	.248*	.073**								
An integrated system to send electronic discharge letters	.42	.228*	.160*	.223*	.074**	.513*							
An integrated system for tele-radiology	.40	.173*	.121*	.443*	.095*	.204*	.277*						
A computerized system for ePrescribing	.30	.222*	.168**	.056**	.160*	.249*	.256*	.078**					
An adverse health events report system	.42	.199*	.078**	.191*	.159*	.225*	.179*	.171*	.294*				
An electronic Clinical Tests	.70	.327*	.091**	.322*	.154*	.264*	.266*	.287*	.192*	.245*			
An electronic service order placing? (e.g. test/diagnostic results)?	.56	.282*	.077*	.316*	.173*	.318*	.296*	.249*	.157*	.244*	.410*		
An electronic appointment booking system?	.70	.229*	.091*	.325*	.275*	.249*	.251*	.217*	.158*	.230*	.304*	.369*	
Tele-homecare/tele-monitoring services to outpatients (at home)?	.09	.079***	.136*	.130*	.074**	.198*	.145*	.132*	.141*	.131*	.094*	.189*	.160*

**p<.01 **p<.05 *** p<.1.*

Table 55: *eHealth deployment information flow. Mean and correlation matrix*

	Mean	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Clinical information																				
A- With a hospital or hospitals outside your own hospital system	.33																			
B- External general practitioners	.28	.532*																		
C- External specialists	.28	.548*	.769*																	
D- Healthcare providers in other EU countries	.05	.193*	.228*	.260*																
E- Healthcare providers outside the EU countries	.02	.160*	.203*	.217*	.591*															
Laboratory results																				
A	.30	.566*	.440*	.426*	.176*	.105*														
B	.27	.400*	.696*	.565*	.186*	.155*	.536*													
C	.24	.403*	.604*	.688*	.223*	.191*	.513*	.795*												
D	.04	.159*	.164*	.200*	.647*	.457*	.187*	.195*	.232*											
E	.02	.149*	.152*	.169*	.465*	.705*	.141*	.175*	.213*	.657*										
Medication lists																				
A	.13	.442*	.370*	.416*	.273*	.104*	.489*	.365*	.372*	.251*	.155*									
B	.14	.358*	.559*	.488*	.187*	.121*	.403*	.556*	.489*	.192*	.150*	.657*								
C	.12	.363*	.470*	.532*	.209*	.135*	.356*	.465*	.561*	.213*	.165*	.643*	.830*							
D	.02	.167*	.126*	.174*	.539*	.397*	.180*	.146*	.164*	.603*	.510*	.321*	.268*	.291*						
E	.01	.120*	.112*	.136*	.401*	.607*	.104*	.140*	.154*	.507*	.772*	.226*	.219*	.237	.667*					
Radiology reports																				
A	.34	.548*	.435*	.441*	.153*	.139*	.567*	.430*	.431*	.129*	.126*	.409*	.326*	.294	.131*	.093*				
B	.25	.403*	.628*	.556*	.227*	.220*	.440*	.660*	.605*	.197*	.187*	.335*	.503*	.435*	.158*	.149*	.587*			
C	.28	.389*	.509*	.604*	.224*	.200*	.407*	.524*	.617*	.186*	.169*	.327*	.401*	.448*	.140*	.135*	.631*	.782*		
D	.04	.170*	.192*	.213*	.617*	.494*	.152*	.173*	.222*	.636*	.520*	.268*	.196*	.218*	.516*	.412*	.255*	.289*	.296*	
E	.02	.142*	.184*	.181*	.489*	.694*	.091*	.139*	.173*	.510*	.727*	.115*	.131*	.146*	.376*	.576*	.200*	.270*	.246*	.717*

*p<.001.

Table 56: *Possible impacts that the use of EPR systems. Mean and correlation matrix*

	Mean	1	2	3	4	5	6
Medical errors have been reduced	1.93						
The quality of diagnosis decisions has improved	1.98	.426*					
The quality of treatment decisions has improved	2.04	.480*	.652*				
The working processes of medical staff are more efficient	1.81	.276*	.469*	.357*			
Waiting lists have been reduced	2.61	.170**	.227*	.231**	.181**		
Average number of patients your hospital can admit during one day has been increased	2.70	.337*	.201**	.316*	.284*	.483*	
The amount of waste linked to unnecessary repetition of examinations has diminished	2.10	.244**	.421*	.290*	.274*	.265*	.436*

** p<0.01 ** p<0.05 ***p<0.1.*

Table 57: *Possible impacts that the use of telemonitoring. Mean and correlation matrix*

	Mean	1	2	3	4	5	6	7
Improvement in the quality of life of patients	1.82							
Reduction in the numbers and length of hospital stays	1.93	.548*						
Reduction in medical errors	2.56	.310*	.346*					
Improvement in the quality of diagnosis decisions	2.32	.428*	.420*	.573*				
Improvement in the quality of treatment decisions	2.18	.492*	.486*	.524*	.795*			
More efficient working processes among medical staff	1.94	.416*	.542*	.352*	.405*	.451*		
Shorter waiting lists	2.15	.408*	.486*	.247*	.314*	.347*	.481*	
Increased average number of patients receiving help during one day	2.18	.487*	.455*	.279*	.323*	.322*	.427*	.604*

** p<0.01.*

European Commission

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Abstract

Benchmarking is an important pillar of European policy making and has acquired a 'quasi-regulatory' role within the Open Method of Coordination in that it helps the Commission and MS to set target and monitor their achievement. After at least a decade of policy efforts and investments of public money to digitalise healthcare delivery it is a good time to take stock of where we stand in terms of take up, usage and impact. Applying state of the art multivariate statistical analysis to the data of survey of eHealth deployment in Acute European Hospitals funded by Unit C4 of DG INFSO, JRC-IPTS researchers have constructed a composite indicator of take up and usage of eHealth in European hospitals, as well as a typology of impacts. This combined analysis clearly show how, if methodology and substantive policy issues are rightly integrated, benchmarking can really contribute to the policy process and help decision makers fill existing gaps and invest into promising directions.

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