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European Hospital Survey: Benchmarking Deployment of e-Health Services (2012–2013)

Composite Indicators on eHealth Deployment and on Availability and Use of eHealth Functionalities

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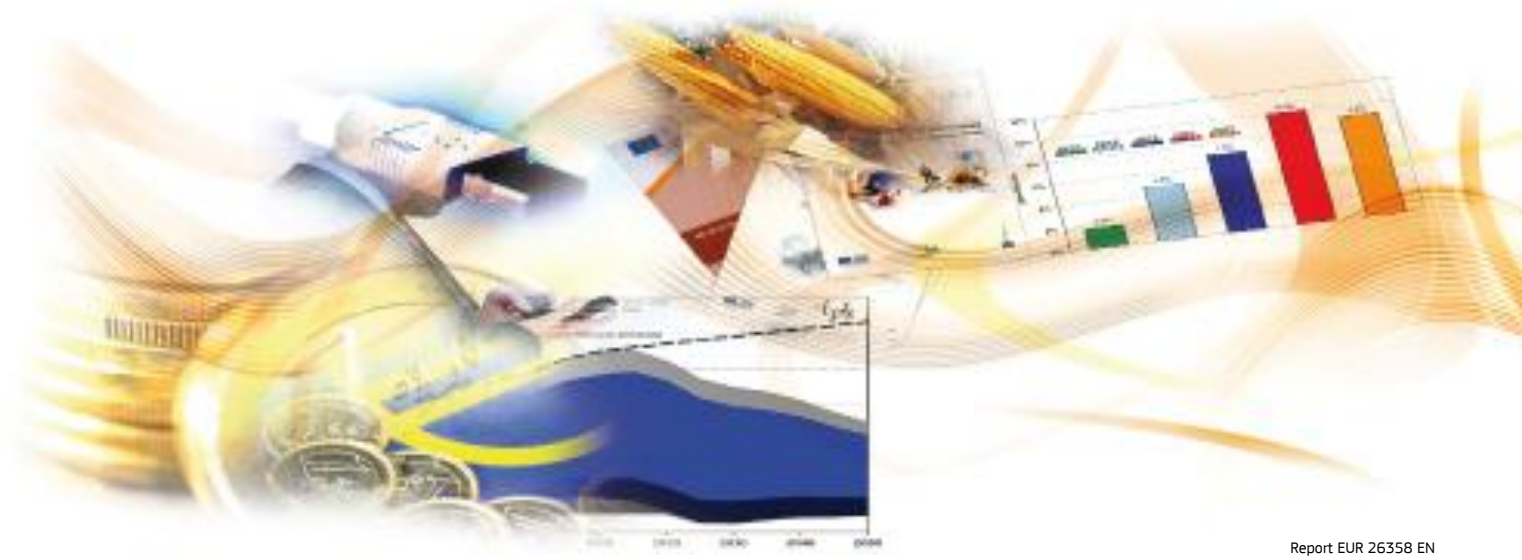

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1. Background

1.1 eHealth

eHealth has been on the European Commission Information Society's policy agenda for more than a decade, from the eEurope initiative(European Commission 1999) to the i2010 Strategy(European Commission 2005), and most recently the Digital Agenda for Europe (DAE)(European Commission 2010), eHealth was also one of the Lead Market Initiatives in 2007. Today it is the focus of one of the two first pilots under the EU2020 Strategy and its Innovation Union flagship initiative – the European Innovation Partnership on Active and Healthy Ageing.

The key strategic orientations of the European Commission eHealth policy are defined in the eHealth Action Plan 2012-2020 where eHealth is referred to as "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"(European Commission 2004). The functions that this definition encompasses might be classified in the following categories (European Commission 2007):

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 health care professionals).

Further, in the Digital Agenda for Europe (DAE) for the period 2010-2015 several actions, targets and objectives relate to eHealth (European Commission 2010):

> Action 75a: Give Europeans secure online access to their medical health data
> Objectives: increase empowerment and quality of life for citizens while contributing to healthcare system sustainability, contribute to EIPAHA
> Target: undertake pilot actions to equip Europeans with secure online access to their medical health data by 2015
>
> Action 75a: achieve widespread telemedicine deployment
> Objectives: increase empowerment and quality of life for citizens while contributing to healthcare system sustainability, contribute to EIPAHA
> Target: achieve by 2020 widespread deployment of telemedicine services
>
> Action 76: Propose a recommendation to define a minimum common set of patient data
> Objectives: establish minimum set of criteria to achieve inter-operability of patient records for cross-border access and/or exchange. Contribute to action 77
> Target: to be achieved by 2012.
>
> Action 77: Foster EU-wide standards, interoperability testing and certification of eHealth
> Objectives: unleash a EU eHealth market by overcoming local and market fragmentation;
> Target: achieve the above by 2015 through stakeholder dialogue.

The focus of the European Commission on eHealth is justified by the potential benefits that it might bring to European healthcare systems(OECD 2010), namely:

- Increasing quality of care and efficiency: for instance reducing medical errors and drugs adverse events through adverse events computerised reporting systems and ePrescription. A more efficient sharing of health information due to electronic health records might have as well a positive impact on the quality of care and efficiency
- Reducing operating costs of clinical services: eHealth functionalities might have a positive impact on these costs through improvement in the way tasks are performed, by saving time with data processing, and by reducing multiple handling of documents.
- Reducing administrative costs: for instance integrated computerised systems for billing, order entry and discharging might make more efficient the administration of hospitals.
- Enabling entirely new modes of care: for instance telemedicine applications combined with Picture Archiving and Communication System can reduce the impact of the shortage of physicians and improve access to care in areas with large rural or remote populations.

Indeed, the European Commission in the above mentioned eHealth Action Plan emphasized how eHealth could cope with the current challenges face by healthcare systems and at the same time create market opportunities (European Commission 2012).

1.2 Benchmarking.

Benchmarking plays a crucial and fundamental role in enabling Member States to monitor actual performance, enhance policy learning and the on-going policy processes. Indeed the three main Information Society policy programmes – eEurope for 2000-2005 (European Commission 1999) , i2010 for 2005-2010 (European Commission 2002), and the DAE for 2010-2015 (European Commission 2010) – came with their respective benchmarking framework (European Commission 2002; i2010 High Level Group 2006; i2010 High Level Group 2009).

Nevertheless, the way eHealth is tackled in these frameworks and the actual implementation of the benchmarking exercises has not been as systematic as in other areas of the Information society (Codagnone and Lupiañez-Villanueva 2010). This was caused by the multi-dimensional complexities of the field and by the higher cost and difficulty of getting the required data in comparison with other fields where web-based measurement is feasible and valid (e.g. eGovernment). However, in 2007 a systematic approach was adopted for the design and implementation of specific surveys and studies for the benchmarking of eHealth in Europe. As of today, two surveys gathering data on the use of ICT among General Practitioners have been carried out (Dobrev A 2008) (European Commission 2013), the latest being under finalisation. As part of this new approach , another document was produced that reviewed the state of the art of benchmarking practices in Europe (Meyer I 2009). In relation to eHealth in hospitals, two surveys have been carried out with the aim of gathering data for benchmarking eHealth in this tier of care; one in 2010 (Deloitte/Ipsos 2011) and the one that collected the data for this report in 2012-2013 (PWC 2013). Indeed, one of the actions highlighted in the latest European Commission eHealth plan is to " enhance work on data collection and benchmarking activities in health care with relevant national and international bodies to include more specific eHealth indicators and assess the impact and economic value of eHealth implementation" (European Commission 2012).

These EC benchmarking activities in the eHealth field are complemented with a multi-stakeholder initiative to improve the availability and quality of health ICT data and indicators. It is led by the Organisation for Economic Co-operation and Development (OECD) with the participation of the European Commission, the World Health Organization and further stakeholders including industry and health authorities representatives. This initiative decided to focus measurement activities on fourteen possible benchmarking sub-indicators, mostly falling into the following four higher level dimensions: a) Electronic Health Records (EHR); b) Health Information Exchange (HIE); c) Personal Health Records (PHR); and d) Telehealth. Furthermore, they have highlighted that availability and use of ICTs are two distinct issues and both need to be captured in measurements (Adler-Milstein,

Ronchi et al. 2013). The design of the questionnaires for the two latest EC benchmarking exercises, both for GPs and hospitals, took account of these recommendations.

1.3 Composite Indicators.

The benchmarking exercises can be based on specific single eHealth indicators obtained through the data collection initiatives mentioned earlier (e.g. whether a hospital/GP uses PACS or speed of the internet connection). However, it is difficult to identify trends and to derive policy implications from many separate indicators. Therefore, it has been argued that the use of composite indicators might help overcome these problems as they ideally measure multidimensional concepts that cannot be captured by a single individual indicator (OECD and European Commission Joint Research Centre 2008). They are obtained through the compilation of individual indicators into a single index on the basis of an underlying model of the multi-dimensional concept that is being measured. The use of these indicators is not free of controversy though as the process of combining single indicators is seen by some researchers as somewhat arbitrary. Others, on the other hand, defend their capacity to capture reality and be meaningful, and their usefulness in attracting media and policy makers attention (Sharpe 2004). The main pros and cons of using composite indicators are summarised in Table 1 below (OECD and European Commission Joint Research Centre 2008)

Table 1: Pros and Cons of Composite Indicators

Pros	Cons
• Can summarise complex, multi-dimensional realities with a view to supporting decision makers. • Are easier to interpret than a battery of many separate indicators. • Can assess progress of countries over time. • Reduce the visible size of a set of indicators without dropping the underlying information base • Thus make it possible to include more information within the existing size limit. • Place issues of country performance and progress at the centre of the policy arena. • Facilitate communication with general public (i.e. citizens, media, etc.) and promote accountability. • Help to construct/underpin narratives for lay and literate audiences. • Enable users to compare complex dimensions effectively	• May send misleading policy messages if poorly constructed or misinterpreted. • May invite simplistic policy conclusions. • May be misused, e.g. to support a desired policy, if the construction process is not transparent and/or lacks sound statistical or conceptual principles. • The selection of indicators and weights could be the subject of political dispute. • May disguise serious failings in some dimensions and increase the difficulty of identifying proper remedial action, if the construction process is not transparent. • May lead to inappropriate policies if dimensions of performance that are difficult to measure are ignored.

2. Objective of this Report

The objective of this document is to present results of a benchmarking exercise on the level of eHealth adoption and use in acute hospitals in all 27 EU Member States and Croatia, Iceland and Norway (EU27+3). This exercise is based on data from two surveys carried out in 2010 (Deloitte/Ipsos 2011) and 2012 (PWC 2013) that gathered data on eHealth indicators in acute hospitals. These indicators have been compiled into two different composite indicators on: 1) eHealth deployment and 2) eHealth Availability and Use. The composite indicators are calculated at Hospital level before obtaining average country values, allowing the analysis to build rankings of countries for both composite indicators.

Given that the mentioned two surveys gathered comparable information in relation to eHealth deployment, it was possible to compute the related composite indicator for both years and therefore explore its evolution over this 2 year period. However, the questions that gathered information on availability and use of eHealth specific functionalities were introduced in the 2012 survey questionnaire which is why no comparison can be made with the 2010 survey.

The structure of the report is as follows. The next section presents the data and methods used. The results section then reports and discusses the main findings. Finally, main conclusions are discussed in the last section.

3. Data and Methods

3.1 Data

Detailed descriptions of the methods of the two surveys can be found in public reports (Deloitte/Ipsos 2011; Deidda and Maghiros 2013; PWC 2013) which is why we only include a brief summary for each survey, highlighting the most relevant issues for the development of the composite indicators.

2010 survey (eHealth Benchmarking III): The universe of reference was the entire population of acute hospitals in each of the EU 27 member states plus Croatia, Iceland and Norway. The latest and most accurate information at the time was gathered to identify the full universe of acute hospitals in the 30 countries, from which the sample was extracted randomly with quota stratification by region, size (number of beds) and ownership (private/public). This sample was statistically representative of the universe as previously defined and consisted of 906 hospitals. The data were collected through Computer-assisted telephone interviews (CATI) that took place between mid-July and mid-September 2010 with Chief Information Officers (CIOs) of the hospitals. The interviews lasted an average of 30 minutes and the CIOs questionnaire[1] included five main blocks related to:

- Characterisation of the Hospital;
- Infrastructure, availability and connectivity;
- Applications
- Integration;
- Security and Privacy.

2012 survey (European Hospital Survey: Benchmarking deployment of eHealth services - 2012-2013): The universe of reference was, as in the 2010 survey, the entire population of acute hospitals in each of the EU 27 member states plus Croatia, Iceland and Norway. However, a census strategy was used to establish the universe and to collect the data. . A census is one of the most viable methods to ensure that every entity within the universe is reached . The census is also the best way to implement a proportional sampling methodology that requires knowledge of the following elements: distribution of hospital size, ownership and region at NUTS level. Then a random sample of acute care hospitals, based on quotas for hospital ownership, hospital size and region (NUTS 2 level), was drawn from the universe. A relevant improvement was the use of screening criteria to determine that only acute care hospital were included in the census and therefore in the survey. This criteria was whether respondents considered that the hospital was an acute or general hospital and in case they did not, whether they reported that the hospital had an emergency department, and *at least one* of the following: a) routine and/or life-saving surgery operating room; and/or b) an intensive care unit. In total 26,551 healthcare establishments were contacted and screened to define a group of hospitals that were as homogeneous as possible. In total, 5,424 qualified as acute care hospitals, and of those 1,717 completed the interview between October 2012 and January 2013. The survey targeted Chief Information Officers (CIOs) and was carried out via Computer-Aided Telephone Interviewing (CATI). The interviews lasted an average of 43 minutes and included seven main blocks related to:

- Characterisation of the hospital;
- ICT infrastructure;
- ICT applications;
- Health Information Exchange;
- Security and privacy;

[1] Two different questionnaires to two different target groups were administered in the survey, the one for CIOs of the hospitals and one for Medical Directors of a subgroup (n=280) of hospitals. We do not use this second questionnaire data for the current analysis.

- IT functionalities;
- Hospital statistics.

Data from the two surveys are fully comparable for the first 5 blocks of the questionnaire. The novelty[2] of the 2012 questionnaire is the inclusion of a block (IT functionalities) with questions that enables measuring and comparing the availability and use of eHealth specific functionalities. This set of questions is compatible with OECD early guidelines, as well as with the equivalent part of the survey among European GPs mentioned earlier..

3.2 Method

The construction of the composite indicators is based on standard methodologies, following recommendations from a specific handbook for this type of indicators (OECD and European Commission Joint Research Centre 2008). Nevertheless, different methodologies were used in the development of each of the indicators. This decision was grounded in the fact that the data available on each of the phenomena to explore (Deployment and Use & Availability) had different characteristics.

Composite indicator on eHealth Deployment: the development of this indicator was mostly based on previous work that analysed the 2010 survey data and built a similar composite indicator (Codagnone and Lupiañez-Villanueva 2010). However, methodological improvements have been introduced in the current study so that the results for the 2010 composite indicator on deployment differ from those published in the previous study. Nevertheless, the justification of the method chosen and the description of the theoretical background are still valid. Therefore, we only present here a brief summary highlighting these improvements.

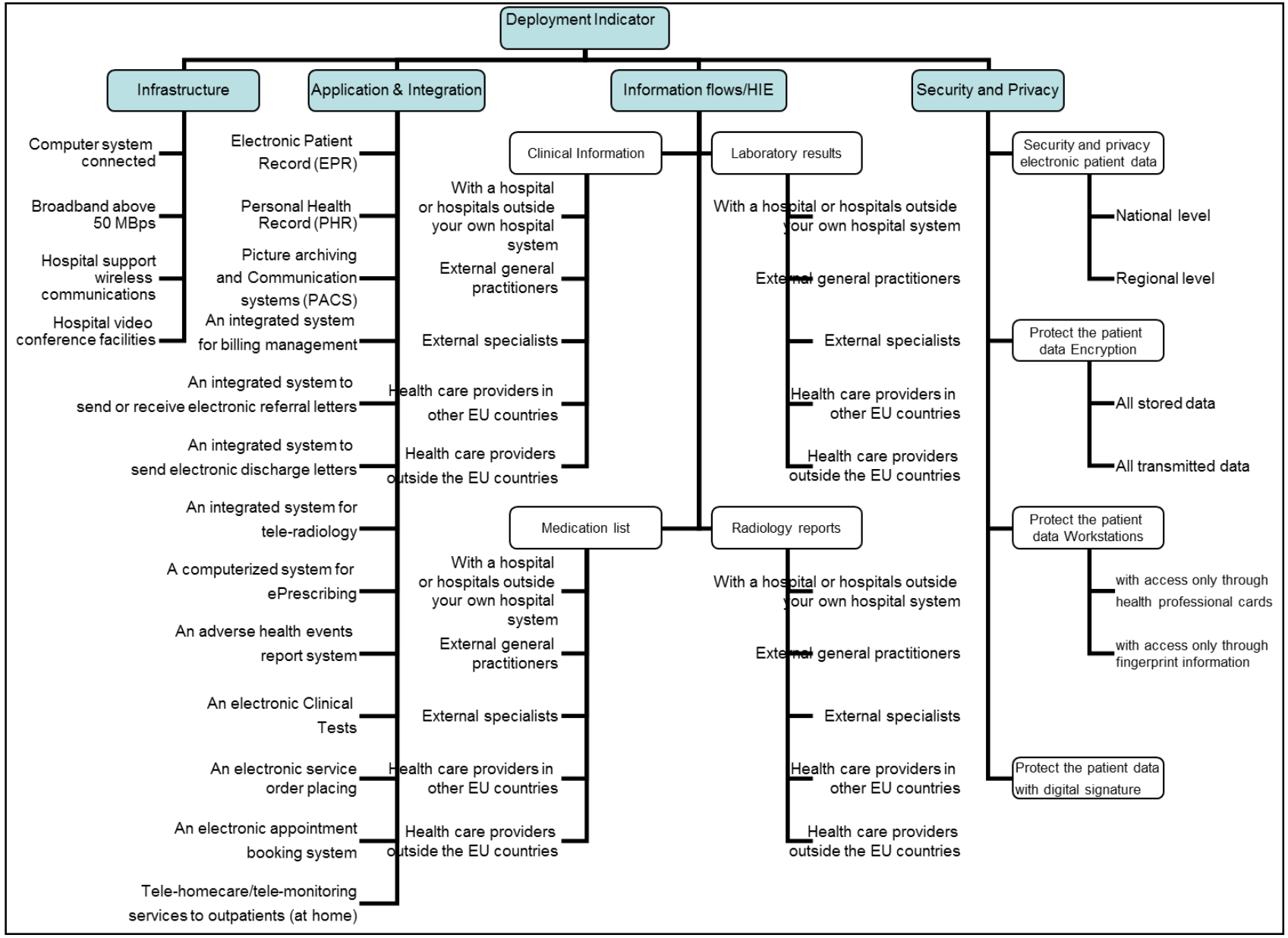
Information related to the deployment of eHealth was available for both surveys. This information can be grouped into four categories or dimensions that correspond to the blocks 2 to 5 of both questionnaires:

- Infrastructure
- Applications and Integration
- Information flow (or Health Information Exchange, HIE)
- Security and privacy

Figure 1 displays the variables used in each of these categories for the development of the composite indicator. The information contained in these variables within each category was of different nature which made it difficult to aggregate them. Furthermore, variables values were highly correlated. For these reasons, and following the OECD/JRC handbook, a multivariate analysis following the factor analysis method was carried out to calculate the values of sub-indicators for each of the dimensions. In order to obtain the final composite indicator on eHealth deployment these values were then aggregated with equal weight. That decision was based on the fact that 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" (Codagnone and Lupiañez-Villanueva 2010) was found.

[2] The "hospital statistics" block was also a novelty in the 2012 questionnaire. However, given the low response rate found to this specific block, its data was not analysed.

Figure 1: Variables used for the construction of the composite indicator on eHealth Deployment.



The factor analysis (FA) method builds on the assumption that the data is based on underlying factors, and that the data variance can be decomposed into that accounted for by common and unique factors (OECD and European Commission Joint Research Centre 2008). Therefore, this method groups together individual indicators which are correlated to form the composite indicator, capturing as much as possible of the information common to individual indicators. The idea under FA is to account for the highest possible variation in the indicator set using the smallest possible number of factors. The indicator was built using the FA method and following the steps below:

1. Checking the correlation structure of the data to determine if the method is appropriate
2. Identifying a certain number of latent factors representing the data through principal component analysis. Each factor depends on a set of coefficients (loadings), each coefficient measuring the correlation between the individual indicator and the latent factor.
3. Retaining a subset of principal components factors that comply with the following characteristics;
    (i) Have associated eigenvalues larger than one;
    (ii) Contribute individually to the explanation of overall variance by more than 10%; and
    (iii) Contribute cumulatively to the explanation of the overall variance by more than 60%.
4. Rotating the factors (with the varimax method) with the objective of minimizing the number of individual indicators that have a high loading on the same factor. In other words, the objective is to obtain a simpler structure of the factors.
5. Constructing weights from the matrix of factor loadings after rotation to calculate the indicator. Each detailed indicator was weighted according to the proportion of its variance explained by the factor it is associated with (i.e. the normalized squared loading), while each factor was weighted according to its contribution to the portion of the explained variance in the dataset (i.e. the normalised sum of squared loadings).

Therefore, and following the explained method, an indicator was built for each of the four mentioned dimensions (Infrastructure; Applications and Integration; Information flow; and Security and privacy) for each hospital. The final compositor indicator on eHealth deployment for each hospital was then obtained adding these four sub-dimensions indicators with the same weight (0.25).

Finally, a couple of important methodological notes about the method employed to develop the composite indicator on eHealth deployment. First, given that the original variables or indicators are binary variables, applying the factor analysis approach directly would have not been correct (Bartholomew, Steele et al. 2002). Therefore, as recommended for this type of variables , the factor analysis was carried out on the matrix of tetrachoric inter-item correlations rather than on the matrix of Pearson correlations as the standard factor analysis approach (Panter, Swygert et al. 1997). Second, as data on eHealth deployment was available for the years 2010 and 2012 it was relevant to explore the evolution of the related composite indicator, which required that the composite indicators results be perfectly comparable. For that reason, it was decided to apply the factor analysis method only to the 2010 data and use the obtained weights for the construction of the composite indicators for both years.

Composite indicator on eHealth Availability and Use: the 2012 survey gathered information on the level of availability and level of use of 39 different eHealth functionalities, grouped in 4 categories:

- View or input information on EHR
- Clinical decision support on EHR
- Health information exchange
- Telehealth

Figure 2 shows these categories and the functionalities included. For each of these functionalities, the level of availability at the hospital was reported by CIOs according to one of the following possible options:

(A) Fully implemented across all units

(B) Fully implemented in at least 50% of units

(C) Fully implemented in less than 50% of units

(D) Not in place

(E) Considering implementing

(F) Don't know

If respondents answered one of the first three, i.e. meaning that the functionality was in place, the CIOs were asked to report on the extent to which health professionals use it selecting one of the following options:

YES, routinely

YES, occasionally

No

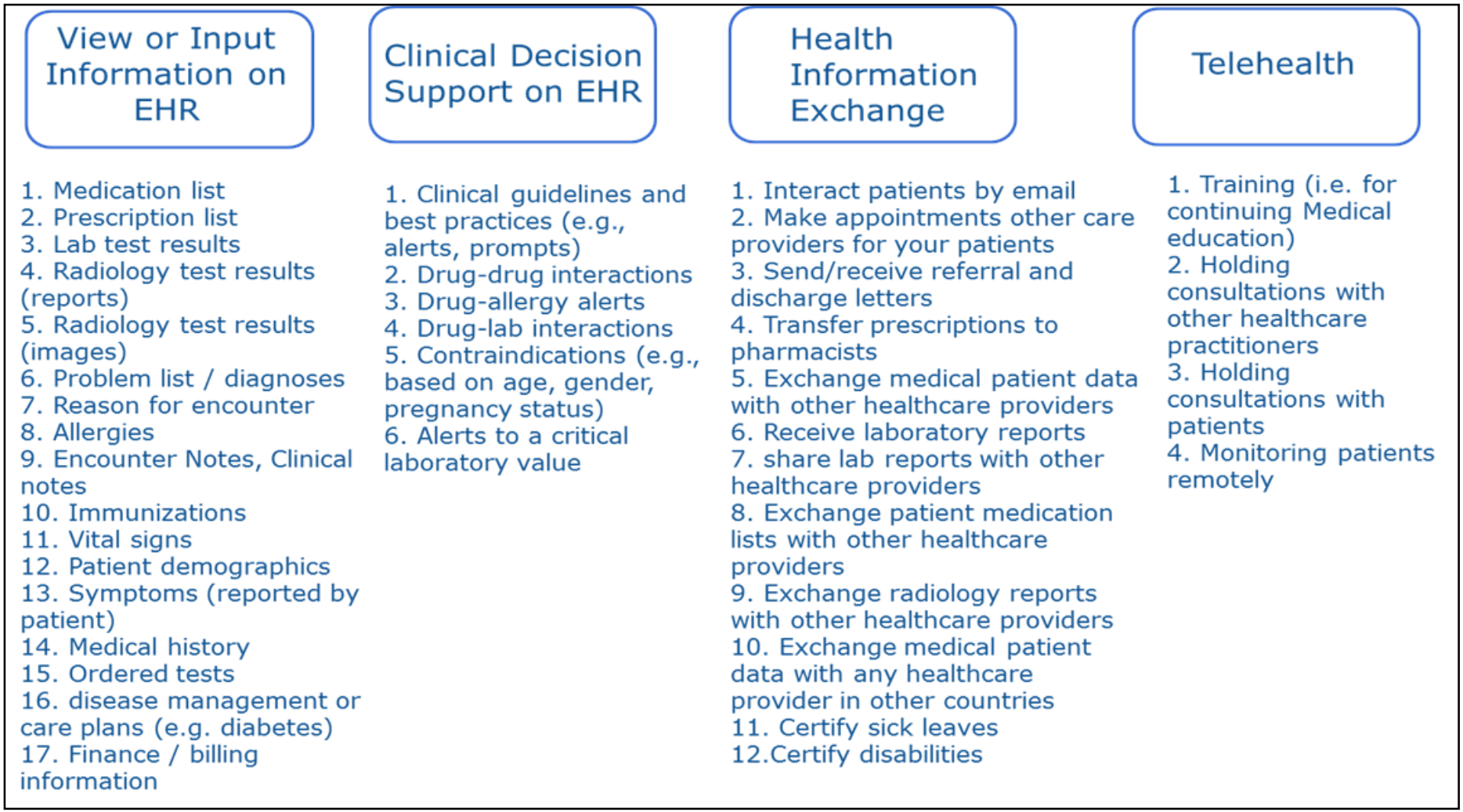
Don't know

This structure ensures that the information available for each functionality is comparable and allows compiling the information on levels of Availability & Use of eHealth functionalities into a composite indicator through the aggregation method of linear summation of weighted and normalised individual indicators (OECD and European Commission Joint Research Centre 2008). However, as a preliminary step, the survey information had to be transformed into numerical terms to allow the construction of the mentioned composite indicator. Thus, a score or weight had to be applied to each of the possible survey answers, with the aim of reflecting the information contained in these answers in relation to the levels of availability and use. The following table shows the scores chosen.

Table 2: weights applied to survey answers on availability and use of eHealth functionalities.

Availability		Use	
Answers	Scores	Answers	Scores
(A) Fully implemented across all units	1	YES, routinely	1
(B) Fully implemented in at least 50% of units	0.75	YES, occasionally	0.33
(C) Fully implemented in less than 50% of units	0.25	No	0
(D) Not in place	0	Don't know	
(E) Considering implementing	0		
Don't know			

Figure 2: Variables used for the construction of the composite indicator on eHealth Availability and Use.



As a result, the composite indicator on eHealth Availability & Use for each hospital is the normalized sum of the multiplication of availability and use scores for each IT functionality as displayed in the following numeric expression.

$$eHealth\_A\&U_j = \frac{\sum_{i=1}^{N} AvailabilityScore_j^i * UseScore_j^i}{N}$$

Where *j=hospital*
i=IT functionality
N= number of IT functionalities (N=39)

3.3 Missing Values

The number of missing values in both surveys is very low. However, there are a significant number of "I don't Know" (DK) answers to the questions. Given the objective of both composite indicators, which is to explore levels of eHealth deployment and Use & Availability of eHealth functionalities, these answers are not valid for the construction of the mentioned indicators. Furthermore, treating DK answers as missing values in the factor analysis would not be feasible. Indeed, this methodology requires considering jointly several variables so that any observation with just one DK answer would not be included in the analysis, thus reducing significantly the number of observations. For instance in the 2010 data there are 34 observations with at least one missing value and 205 with at least one DK answer. Once observations with missing values are not included in the analysis, if DK answers are considered as missing values and therefore dropped from the analysis, it would imply 172 observations less, i.e. 20% of the possible sample. Consequently, in order to increase the sample size, the DK answers have been replaced through the Hotdeck imputation method (OECD and European Commission Joint Research Centre 2008). This method replaces the missing value with the valid value for the relevant variable of the observation most similar according to certain characteristics. It was decided that these characteristics would be country, size and broadband capacity. However, and with the aim of keeping the representativeness of the results, it was decided that observations (hospitals) with "don't know" answers in more than half of the variables in one dimension would not be included in the analysis.

For the construction of the composite indicator on Use & Availability, a different approach was taken to handle the "don't know" answers to the questions used to construct this indicator. Given the characteristics of this block, the following cut-off rule was defined:

For each of the 4 relevant questions that provide information on availability and use of eHealth functionalities (Q41: View or input information on HER, Q42: Clinical decision support on HER, Q43: Health information exchange, and Q44: Telehealth) if an observation (hospital) had a number of "don't know" answers larger than half of the total number of questions, this observation would not be included in the analysis. Otherwise, "don't know" answers would be treated as not in place (availability) or no (usage).

4. Results

4.1 Composite indicator on eHealth Deployment

4.1.1 Samples

After the deletion of the missing values and imputation of "don't know" answers, the final sample used to calculate the composite indicator on eHealth for the year 2010 was consisted of 844 hospitals (93% of the original sample). The corresponding final sample for the year 2012 was composed by 1653 hospitals (94% of the original sample). Table 3 displays the number of hospitals per country included in both years as well as the percentage of variation in the samples.

Table 3: Sample sizes eHealth Deployment indicator

Country	N 2012	N 2010	% Difference
Austria	43	15	187%
Belgium	48	23	109%
Bulgaria	51	11	364%
Croatia	8	4	100%
Cyprus	7	4	75%
Czech Rep.	39	14	179%
Denmark	13	8	63%
Estonia	12	1	1100%
Finland	26	12	117%
France	312	139	124%
Germany	188	148	27%
Greece	63	24	163%
Hungary	41	9	356%
Iceland	8	3	167%
Ireland	22	7	214%
Italy	189	84	125%
Latvia	9	2	350%
Lithuania	30	10	200%
Luxembourg	3	3	0%
Malta	1	3	-67%
Netherlands	25	23	9%
Norway	5	7	-29%
Poland	129	98	32%
Portugal	39	20	95%
Romania	82	32	156%
Slovakia	33	9	267%
Slovenia	6	3	100%
Spain	119	87	37%
Sweden	25	7	257%
UK	67	34	97%
EU27 + 3	1643	844	95%

The total number of hospitals included in the samples has almost doubled from 2010 to 2012. For almost all countries, with the exception of Malta and Norway, the sample is bigger in 2012 although the increase is not homogenous, with smaller increases in some large countries such as Spain, Poland, and Germany.

The two samples are very similar in relation to the main hospitals' characteristics as shown in table 4. Hospitals in the 2012 sample are a slightly larger, with a higher percentage of teaching hospitals than in 2010, the latter being most likely related to the size characteristic.

Table 4: Comparison main hospitals' characteristics between 2012 and 2010 samples

Size	2012	2010
Fewer than 101 beds	18.7%	22.6%
Between 101 and 250 beds	30.6%	32.7%
More than 750 beds	50.7%	44.6%

Part of a group	2012	2010
An independent hospital on one site	41.9%	45.6%
An independent hospital on multiple sites	32.8%	27.4%
Part of a group of different hospitals/care institutions	25.3%	27.1%

Ownership	2012	2010
Private (non-profit and for profit)	29.3%	30.7%
public	70.7%	69.3%

Teaching status	2012	2010
non-teaching	51.4%	56.7%
teaching	48.6%	43.3%

4.1.2 Factor Analysis

As explained in the methods section, the weights for each of the variables in the 4 dimensions were obtained through a factor analysis of the 2010 data. Then, the score in these dimensions indicator were added with equal weight and normalized (i.e. a weight of 0.25 for each dimension). Figure 3 summarizes this process. The number of sub-dimensions in each of the dimensions, and their weights in them were as well determined by the factor analysis, following the criteria determined by the OECD/JRC handbook (OECD and European Commission Joint Research Centre 2008) .

The following tables (5 to 8) provide the information resulting from the factor analysis, with the weights for each of the deployment variables considered. For each variable, 3 different weights are shown: 1) the weight of the variable in the subdimension, 2) the weight of the variable in the dimension indicator (obtained with the multiplication of the previous weight by the weight of the sub-dimension) and finally 3) the weight of the variable in the global ehealth deployment indicator (obtained with the multiplication of the previous weight by 0.25). For the infrastructure dimension, the factor analysis produced only one sub-dimension. Consequently, weights 1) and 2) in this dimension have the same value.

Figure 3: Structure of the eHealth deployment indicator

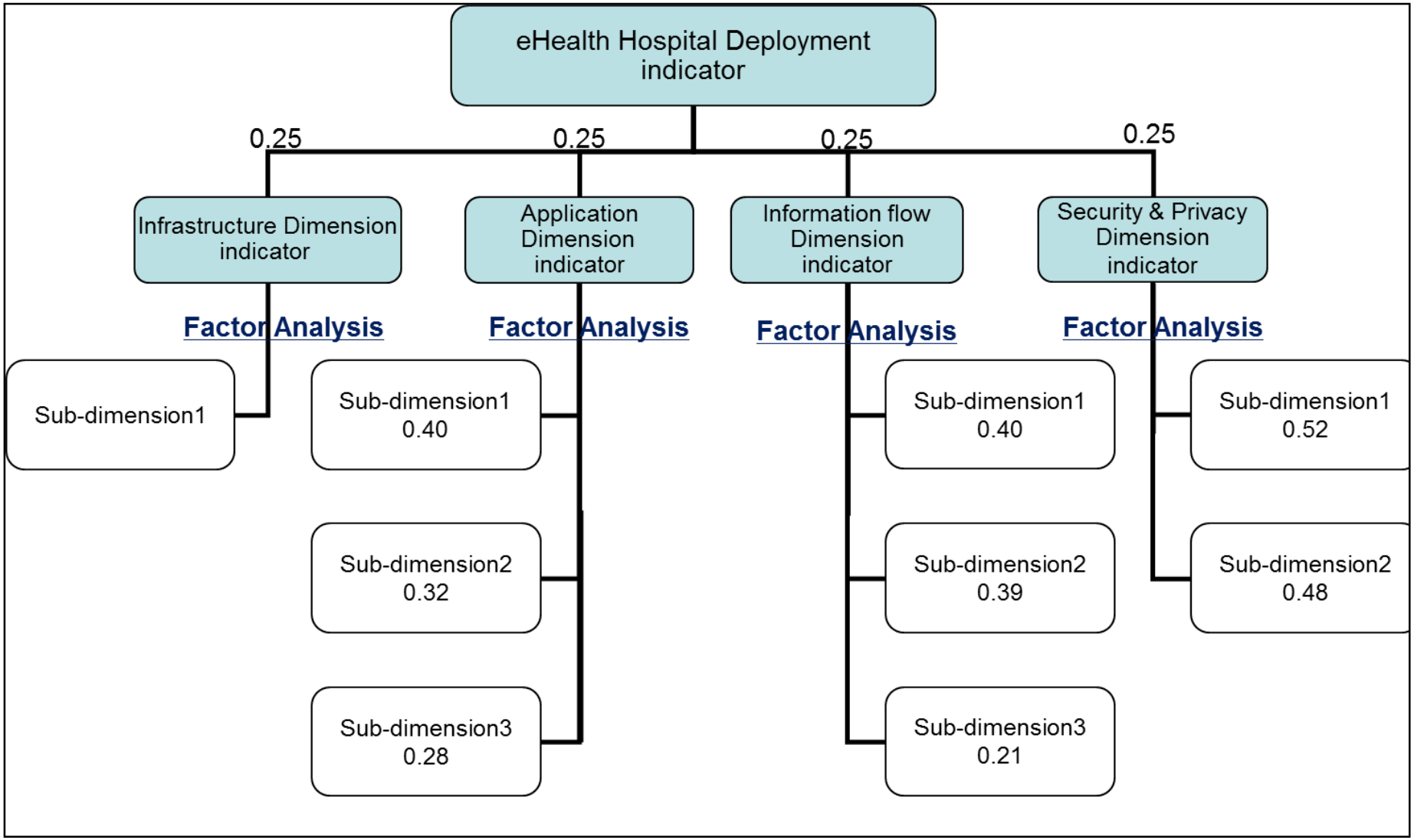


Table 5: Infrastructure dimension: Weights of the variables for the construction of eHealth deployment indicator

Variables Sub-dimension 1 (weight 1)	Weight in sub-dimension	Weight in dimension	Weight in Deployment indicator
Computer system connected	0.231	0.231	0.058
Broadband above 50 MBps	0.205	0.205	0.051
Hospital support wireless communications	0.250	0.250	0.062
Hospital video conference facilities	0.314	0.314	0.078

Table 6: Applications and Integration dimension: Weights of the variables for the construction of eHealth deployment indicator

Variables Sub-dimension 1 (weight 0.400)	Weight in sub-dimension	Weight in dimension	Weight in Deployment indicator
An electronic appointment booking system*	0.094	0.038	0.009
An electronic Clinical Tests	0.121	0.048	0.012
Picture archiving and communication systems (PACS)	0.232	0.093	0.023
An electronic service order placing (e.g. test/diagnostic results)	0.138	0.055	0.014
An integrated system to send electronic discharge letters*	0.093	0.037	0.009
An integrated system for tele-radiology	0.188	0.075	0.019
An integrated system to send or receive electronic referral letters	0.090	0.036	0.009
Tele-homecare/tele-monitoring services to outpatients (at home)*	0.045	0.018	0.004
Variables Sub-dimension 2 (weight 0.322)	**Weight in sub-dimension**	**Weight in dimension**	**Weight in Deployment indicator**
Electronic Patient Record (EPR)	0.310	0.100	0.025
An integrated system to send electronic discharge letters*	0.135	0.043	0.011
An integrated system to send or receive electronic referral letters	0.166	0.054	0.013
Personal Health Record (PHR)	0.389	0.125	0.031
Variables Sub-dimension 3 (weight 0.278)	**Weight in sub-dimension**	**Weight in dimension**	**Weight in Deployment indicator**
An integrated system for billing management	0.328	0.091	0.023
An electronic appointment booking system*	0.156	0.043	0.011
An adverse health events report system	0.222	0.062	0.015
A computerized system for ePrescribing	0.223	0.062	0.016
Tele-homecare/tele-monitoring services to outpatients (at home)*	0.071	0.020	0.005

*variables that are included in two subdimensions given the factor analysis results

Table 7: Information flow dimension: Weights of the variables for the construction of eHealth deployment indicator:

Variables Sub-dimension 1 (weight 0.396)	**Weight in sub-dimension**	**Weight in dimension**	**Weight in Deployment indicator**
Exchange clinical Information with a hospital or hospitals outside your own hospital system	0.096	0.038	0.010
Exchange clinical information with External specialists	0.091	0.036	0.009
Exchange clinical information with External general practitioners	0.093	0.037	0.009
Exchange laboratory results with a hospital or hospitals outside your own hospital system	0.119	0.047	0.012
Exchange laboratory results with External general practitioners	0.089	0.035	0.009
Exchange laboratory results with External specialists	0.095	0.038	0.009
Exchange medication lists information with a hospital or hospitals outside your own hospital system	0.123	0.049	0.012
Exchange medication lists information with External specialists	0.119	0.047	0.012
Exchange medication lists information with External general practitioners	0.122	0.048	0.012
Exchange radiology reports with a hospital or hospitals outside your own hospital system*	0.053	0.021	0.005
Variables Sub-dimension 2 (weight 0.393)	**Weight in sub-dimension**	**Weight in dimension**	**Weight in Deployment indicator**
Exchange clinical information with Health care providers in other EU countries	0.130	0.051	0.013
Exchange clinical information with Health care providers outside the EU countries	0.111	0.044	0.011
Exchange laboratory results with Health care providers in other EU countries	0.146	0.058	0.014
Exchange laboratory results with Health care providers outside the EU countries	0.126	0.049	0.012
Exchange medication lists information with Health care providers in other EU countries	0.139	0.054	0.014
Exchange medication lists information with Health care providers outside the EU countries	0.135	0.053	0.013
Exchange radiology reports with Health care providers in other EU countries	0.122	0.048	0.012
Exchange radiology reports with Health care providers outside the EU countries	0.092	0.036	0.009
Variables Sub-dimension 3 (weight 0.211)	**Weight in sub-dimension**	**Weight in dimension**	**Weight in Deployment indicator**
Exchange radiology reports with a hospital or hospitals outside your own hospital system*	0.228	0.048	0.012
Exchange radiology reports with External specialists	0.397	0.084	0.021
Exchange radiology reports with External general practitioners	0.375	0.079	0.020

*variables that are included in two sub-dimensions given the factor analysis results

Table 8: Security and privacy dimension: Weights of the variables for the construction of eHealth deployment indicator:

Variables Sub-dimension 1 (weight 0.521)	Weight in sub-dimension	Weight in dimension	Weight in Deployment indicator
Security and privacy of electronic patient data at national level	0.197	0.102	0.026
Protect the patient data Encryption of all stored data	0.356	0.185	0.046
Protect the patient data Encryption of all transmitted data	0.447	0.233	0.058
Variables Sub-dimension 2 (weight 0.479)	**Weight in sub-dimension**	**Weight in dimension**	**Weight in Deployment indicator**
Security and privacy of electronic patient data at regional level	0.271	0.130	0.032
Protect the patient data Workstations with access only through health professional cards	0.270	0.130	0.032
Protect the patient data Workstations with access only through fingerprint information	0.284	0.136	0.034
Protect the patient data, Data entry certified with digital signature	0.175	0.084	0.021

These weights, obtained from the factor analysis of the 2010 survey data, were applied to the 2010 and 2012 data to obtain the eHealth deployment indicator for the corresponding years. As explained previously, this approach allows us to compare both indicators.

4.1.3 2010 Composite indicator on eHealth Deployment

As a consequence of methodological improvements and refinements in the calculations, the results for the 2010 composite indicator published earlier (Codagnone and Lupiañez-Villanueva 2010) have been updated . These updated results are shown in table 9. However, they will not be discussed in detail, only when comparing with the 2012 results.

Table 9: 2010 Composite indicator on eHealth Deployment: results (total and by dimension) by country.

Country	Infrastructure	Application & Integration	Information Flow	Privacy & Security	2010 eHealth Deployment
EU27+3	**0.519**	**0.480**	**0.167**	**0.396**	**0.390**
Austria	0.632	0.549	0.276	0.507	0.491
Belgium	0.604	0.685	0.387	0.356	0.508
Bulgaria	0.484	0.300	0.000	0.084	0.217
Croatia	0.672	0.531	0.076	0.176	0.364
Cyprus	0.433	0.535	0.280	0.116	0.341
Czech Rep.	0.490	0.465	0.187	0.310	0.363
Denmark	1.000	0.778	0.372	0.400	0.637
Estonia*	0.231	0.611	0.343	0.521	0.426
Finland	0.948	0.692	0.346	0.395	0.595
France	0.552	0.434	0.099	0.385	0.368
Germany	0.470	0.417	0.108	0.425	0.355
Greece	0.371	0.463	0.026	0.146	0.252
Hungary	0.486	0.572	0.128	0.248	0.358
Iceland	0.487	0.609	0.218	0.461	0.444
Ireland	1.000	0.636	0.377	0.588	0.650
Italy	0.499	0.475	0.139	0.416	0.382
Latvia	0.513	0.354	0.000	0.000	0.217
Lithuania	0.334	0.305	0.104	0.165	0.227
Luxembourg	0.639	0.624	0.221	0.317	0.450
Malta*	0.402	0.487	0.154	0.189	0.308
Netherlands	0.790	0.713	0.446	0.440	0.597
Norway	0.884	0.658	0.541	0.469	0.638
Poland	0.235	0.327	0.052	0.297	0.228
Portugal	0.513	0.639	0.091	0.497	0.435
Romania	0.274	0.241	0.086	0.466	0.267
Slovakia	0.127	0.417	0.181	0.174	0.225
Slovenia	0.306	0.224	0.087	0.112	0.182
Spain	0.689	0.631	0.296	0.495	0.528
Sweden	0.905	0.789	0.375	0.495	0.641
UK	0.772	0.642	0.398	0.656	0.617

*Scores are based on data from only 1 hospital.

4.1.4 2012 Composite indicator on eHealth Deployment

The average score on the eHealth deployment composite indicator of the 1643 hospitals included in the sample is 0.418. By means of illustration, a theoretical hospital with "perfect" eHealth deployment considering the variables included in the indicator (i.e. with positive answers in all the variables) would have a score of 1. Correspondingly, a hospital with negative answers in all variables would have obtained a score of zero in the composite indicator on eHealth deployment. As it is explained before, the score obtained is the result of aggregating with the same weight (i.e. 0.25) the scores of the indicators of eHealth deployment for each of the four dimensions. The average values of these dimensions indicators for the whole sample of EU27+3 hospitals are 0.577

for the Infrastructure dimension, 0.532 for the Application & Integration dimension, 0.202 for the Information flow dimension and, finally, 0.361 for the Privacy & Security dimension. Table 10 displays the results at EU27 + 3 and country level for the dimensions indicators and for resulting the composite indicator on eHealth deployment. It needs to be reminded that the country scores are the average of the scores of the hospitals of each country.

Table 10: 2012 Composite indicator on eHealth Deployment: results (total and by dimension) by country.

Country	Infrastructure	Application & Integration	Information Flow	Privacy & Security	2012 eHealth Deployment
EU27+3	**0.577**	**0.532**	**0.202**	**0.361**	**0.418**
Austria	0.727	0.653	0.378	0.483	0.560
Belgium	0.702	0.644	0.424	0.410	0.545
Bulgaria	0.422	0.398	0.112	0.359	0.323
Croatia	0.629	0.524	0.168	0.195	0.379
Cyprus	0.546	0.452	0.510	0.232	0.435
Czech Rep.	0.422	0.501	0.274	0.269	0.367
Denmark	0.934	0.809	0.430	0.465	0.659
Estonia	0.761	0.793	0.464	0.493	0.628
Finland	0.907	0.728	0.302	0.549	0.622
France	0.611	0.487	0.198	0.331	0.407
Germany	0.529	0.502	0.187	0.375	0.398
Greece	0.338	0.544	0.078	0.133	0.273
Hungary	0.338	0.589	0.118	0.291	0.334
Iceland	0.798	0.656	0.450	0.276	0.545
Ireland	0.773	0.501	0.202	0.393	0.467
Italy	0.599	0.603	0.178	0.439	0.455
Latvia	0.524	0.364	0.220	0.158	0.316
Lithuania	0.505	0.380	0.063	0.244	0.298
Luxembourg	0.895	0.631	0.280	0.461	0.567
Malta*	1.000	0.749	0.607	0.521	0.719
Netherlands	0.866	0.686	0.346	0.393	0.573
Norway	0.887	0.633	0.301	0.311	0.533
Poland	0.277	0.438	0.082	0.216	0.253
Portugal	0.655	0.547	0.182	0.198	0.396
Romania	0.485	0.365	0.101	0.427	0.344
Slovakia	0.341	0.470	0.168	0.243	0.306
Slovenia	0.566	0.338	0.057	0.146	0.277
Spain	0.708	0.615	0.264	0.465	0.513
Sweden	0.899	0.715	0.381	0.492	0.622
UK	0.866	0.604	0.278	0.556	0.576

*Scores are based on data from only 1 hospital.

The same information is displayed graphically in figures 4-8, countries being ordered from highest to lowest scores, so as to facilitate the interpretation of the results,. Figure 8 presents the results for the global composite indicator on eHealth deployment by country displaying the contribution of each of the dimensions to the global composite indicator. The numbers in brackets next to the

country names in the legend are the corresponding sample sizes (i.e. number of hospitals whose scores on the indicators have been averaged to obtain the country results).

The results show that, at European level, the dimensions on Information flow and Privacy & Security are the ones that have more room for improvement. In the case of the former, it seems logical since a smooth exchange of medical information between care providers might improve the coordination of the care received by citizens. Furthermore, the highest (?) scores (?) on the Application & Integration dimension shows that, in most of the cases, the information to be exchanged is available electronically. On the other hand, the result for the Security & Privacy dimension is somewhat surprising given that strict regulatory requirements apply to the handling, storage and transmission of medical information in most countries.

The results at country level display a significant level of variability between average country values in the four dimensions and in the global composite indicator on eHealth deployment. The top performers are Nordic and Central European countries, apart from Malta (where the indicators were built based on data from 1 hospital only meaning that the results might not be representative) and Estonia. The average scores for some of the most populated European countries, and consequently those with more hospitals in the sample (Germany, France, Italy and Spain), are situated in the middle of the ranking. Finally, eastern European countries, Greece and Poland are those with the lowest average scores.

Figure 4: 2012 eHealth deployment: Infrastructure dimension indicator by country

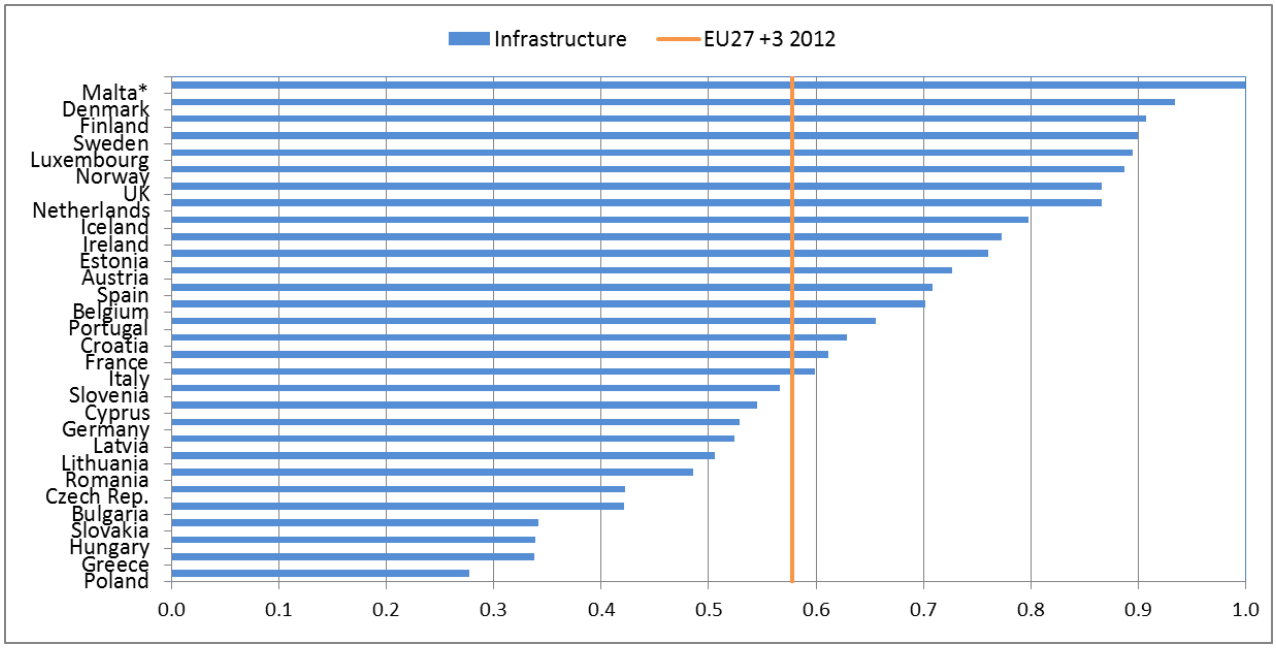


Figure 5: 2012 eHealth deployment: Application & Integration dimension indicator by country

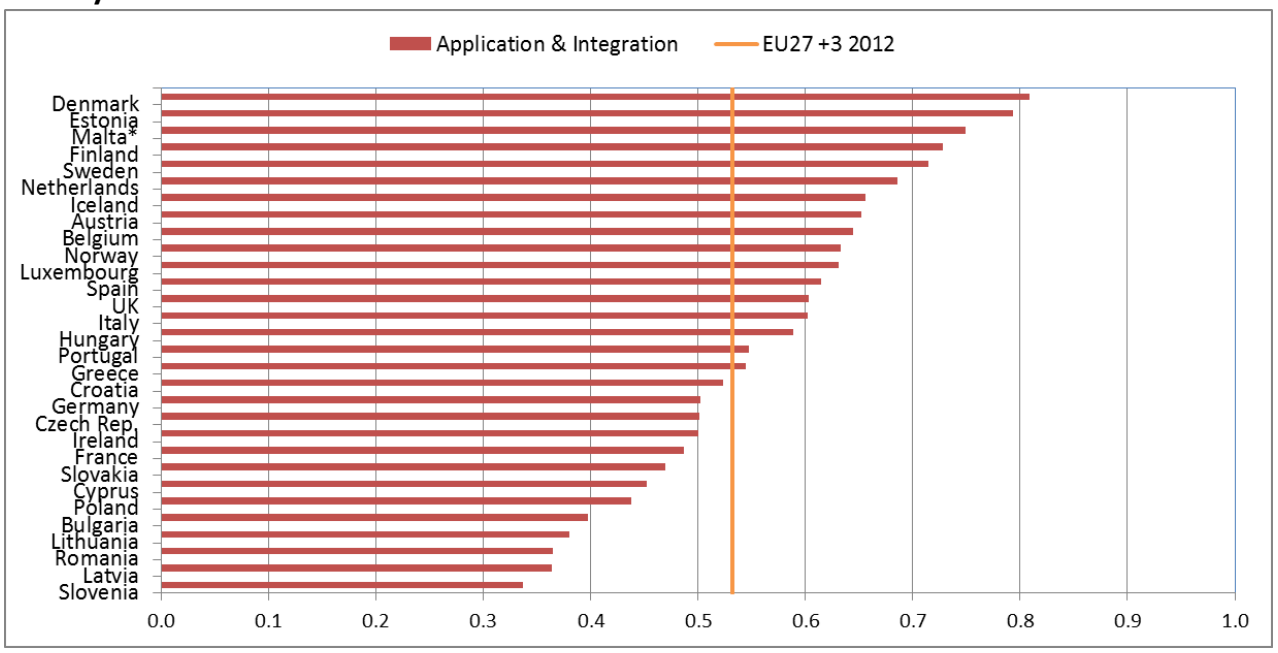


Figure 6: 2012 eHealth deployment: Information & flow dimension indicator by country

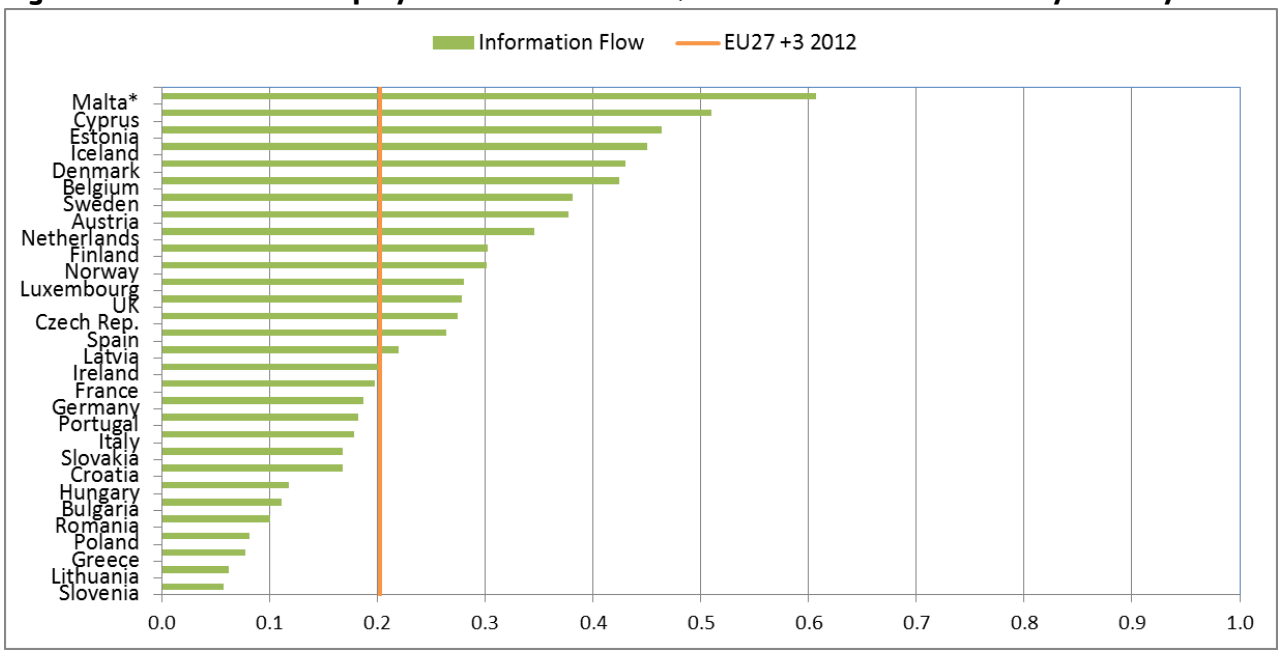


Figure 7: 2012 eHealth deployment: Privacy & Security dimension indicator by country

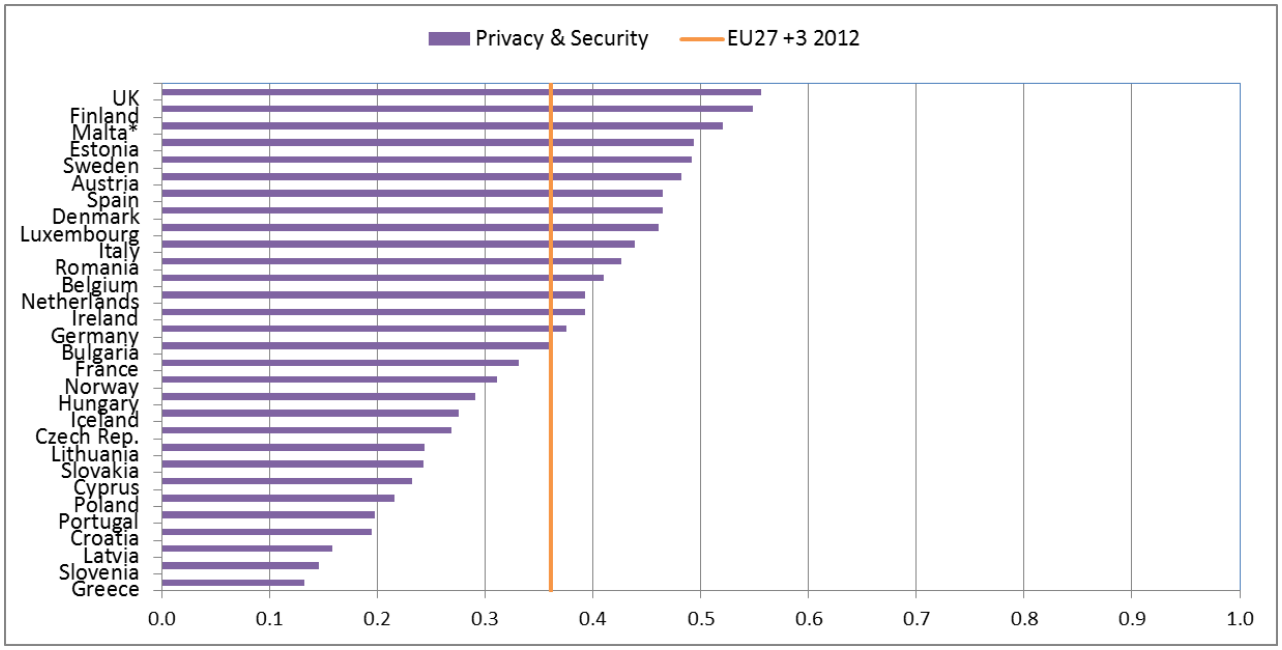
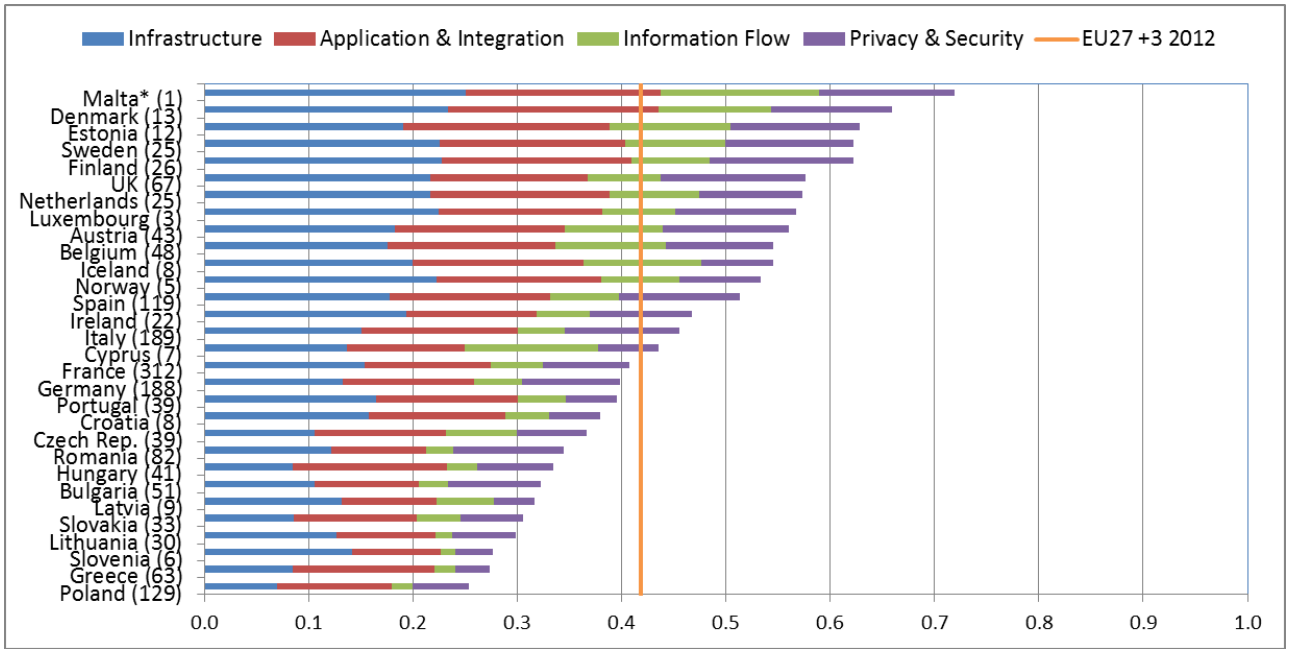


Figure 8: 2012 eHealth deployment composite indicator by country.



4.1.5 Evolution (2012-2010) of the eHealth Deployment in European Acute Hospitals.

There has been an increase in the deployment of eHealth in European acute hospital over the period 2010-2012 as the composite indicator has grown from a value of 0.39 to almost 0.42. The analysis of this increase by dimensions shows that this growth has not been evenly distributed. The dimensions with already higher scores, i.e. Infrastructure and Application & Integration, have grown more while for the one with a lower score (Information flow) the progress has been less important. Surprisingly, the score for the Privacy & Security dimension has suffered a reduction over the considered period (Table 11).

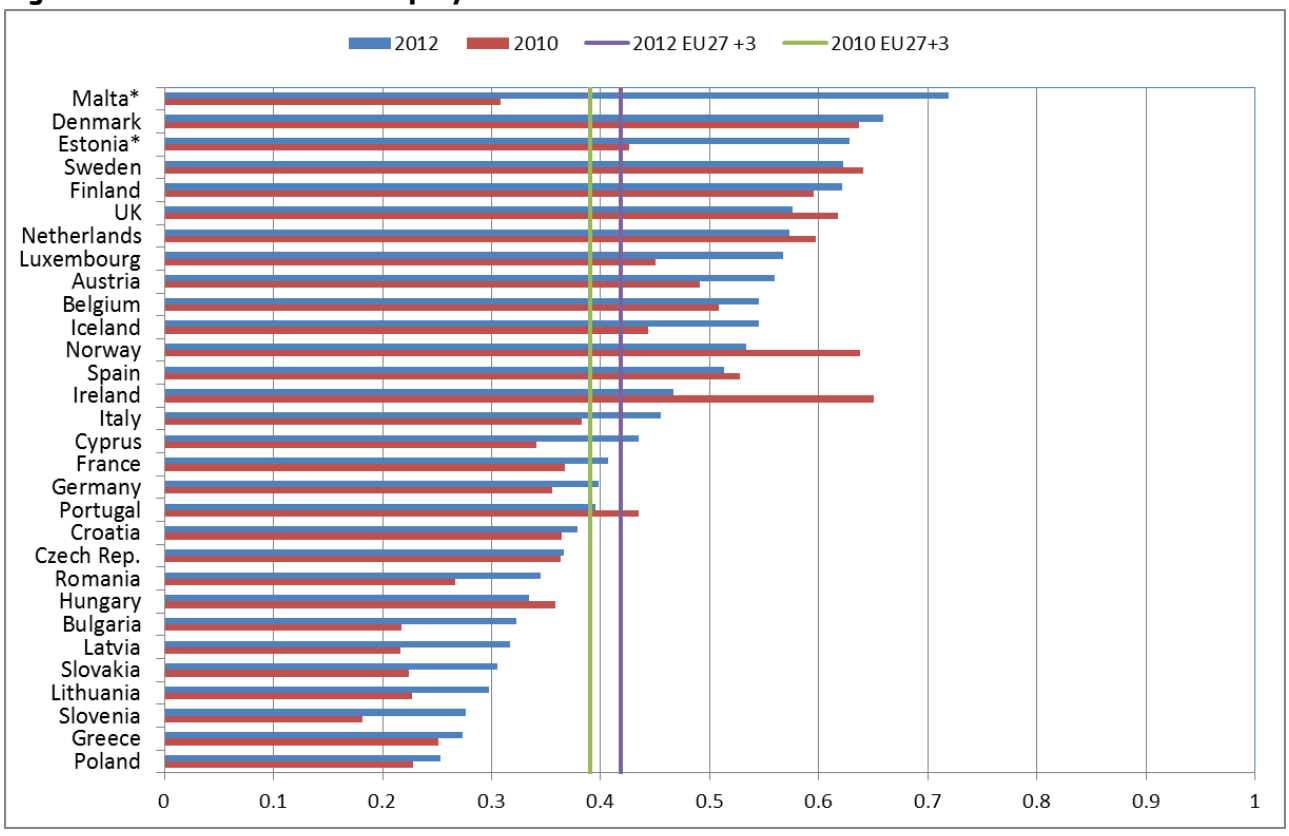
Table 11: Evolution 2012-2010 of the Composite indicator on eHealth Deployment: Absolute variation in the global indicator and variation by dimension by country.

Country	Infrastructure	Application & Integration	Information Flow	Privacy & Security	2012 eHealth Deployment
EU27+3	**0.059**	**0.052**	**0.036**	**-0.035**	**0.028**
Austria	0.095	0.104	0.101	-0.024	0.069
Belgium	0.098	-0.041	0.037	0.054	0.037
Bulgaria	-0.062	0.098	0.112	0.276	0.106
Croatia	-0.043	-0.007	0.092	0.019	0.015
Cyprus	0.113	-0.083	0.230	0.116	0.094
Czech Rep.	-0.069	0.037	0.087	-0.041	0.003
Denmark	-0.066	0.031	0.059	0.065	0.022
Estonia*	0.530	0.182	0.121	-0.027	0.201
Finland	-0.041	0.037	-0.044	0.154	0.027
France	0.060	0.053	0.099	-0.054	0.040
Germany	0.059	0.085	0.080	-0.050	0.043
Greece	-0.033	0.081	0.052	-0.014	0.022
Hungary	-0.147	0.017	-0.010	0.043	-0.024
Iceland	0.311	0.047	0.233	-0.186	0.101
Ireland	-0.227	-0.135	-0.174	-0.196	-0.183
Italy	0.100	0.128	0.040	0.023	0.073
Latvia	0.011	0.010	0.220	0.158	0.100
Lithuania	0.171	0.075	-0.042	0.080	0.071
Luxembourg	0.256	0.007	0.060	0.144	0.117
Malta*	0.598	0.262	0.453	0.331	0.411
Netherlands	0.076	-0.027	-0.100	-0.047	-0.025
Norway	0.003	-0.025	-0.240	-0.158	-0.105
Poland	0.042	0.111	0.030	-0.080	0.026
Portugal	0.142	-0.092	0.091	-0.299	-0.039
Romania	0.212	0.124	0.015	-0.039	0.078
Slovakia	0.215	0.053	-0.013	0.069	0.081
Slovenia	0.261	0.114	-0.030	0.034	0.095
Spain	0.019	-0.016	-0.032	-0.030	-0.014
Sweden	-0.005	-0.074	0.007	-0.003	-0.019
UK	0.094	-0.038	-0.120	-0.100	-0.041

*Scores are based on data from only 1 hospital.

The analysis of this evolution by average country scores shows that European countries have not followed the same trend, as they show different levels of increase. Indeed, for 8 countries (Hungary, Ireland, Netherlands, Norway, Portugal, Spain, Sweden, and United Kingdom) there has been, according to the composite indicator, a reduction in the level of eHealth deployment among its acute hospitals (Table 11 and Figure 9). An interesting result is that out of the top 6 countries according to the 2010 data, all but Norway have experienced a negative growth on their level of eHealth deployment according to the composite indicators. Indeed, the exception, Norway, requires further examination as it is the only country together with Malta that has fewer hospitals in the 2012 sample than in the 2010 one. Portugal and Spain also have lower 2012 average scores, which might be a consequence of the stronger impact of the economic crisis in these countries. Nevertheless, it is not possible to fully attribute these variations to any cause as it is not possible to know whether the same hospitals are included in both samples and given the bigger sample sizes for almost all countries in the year 2012. Finally, it should be highlighted that those countries with higher relative increments in their average scores are those with the lowest scores according to the 2010 data. This means that, even though their scores for 2012 are situated in the lowest part of the distribution, they seem to be catching up in eHealth deployment terms.

Figure 9: Evolution eHealth deployment



4.2 Composite indicator on eHealth Availability and Use.

4.2.1 Sample

The final sample used to calculate the 2012 composite indicator on eHealth Availability & Use consisted of 1533 hospitals (87% of the original sample). This lower number of hospitals in relation to those included in the sample to calculate the 2012 composite indicator on deployment is due to a higher number of "don't know" answers in the survey block on availability and use of eHealth functionalities.

Table 12: Sample size eHealth Availability and Use composite indicator.

Country	N 2012
Austria	35
Belgium	43
Bulgaria	59
Croatia	7
Cyprus	9
Czech Rep.	34
Denmark	10
Estonia	7
Finland	25
France	269
Germany	168
Greece	59
Hungary	42
Iceland	7
Ireland	19
Italy	182
Latvia	15
Lithuania	32
Luxembourg	3
Malta	1
Netherlands	20
Norway	4
Poland	146
Portugal	34
Romania	78
Slovakia	32
Slovenia	6
Spain	112
Sweden	24
UK	51
EU27 + 3	1533

4.2.2 2012 Composite indicator on eHealth Availability and Use: Results

The composite indicator on eHealth Availability and Use in acute hospitals compiles the information from 39 different eHealth functionalities. Nevertheless, and with the aim of exploring differences between types of functionalities, the composite indicator has been divided into four separate indicators, each of them corresponding to one of the four categories of functionalities (View or input information on EHR; Clinical decision support on EHR; Health information exchange; and Telehealth). In the global composite indicator, each of the functionalities considered has the same value or weight (i.e 1/39 or 0.0256). However, as in each category there are a different number of functionalities, if the global composite indicator is obtained through the adding of the categories indicators, then each of these indicator is added with a different weight (Table 13)

Table 13: Number of functionalities and weights of the indicators for each category in the eHealth Availability and Use composite indicator.

Category	Number of functionalities included	Weight of the category indicator in the composite indicator.
View or input information on EHR	17	0.44
Clinical decision support on EHR	6	0.15
Health information exchange	12	0.31
Telehealth	4	0.10

The range of possible scores of the composite indicator on eHealth Availability & Use (and also for the category indicators) is 0-1. A hospital would have a score of 1 in the case that the CIO reports that the 39 functionalities considered are fully implemented across all units and they are being used routinely. Correspondingly, a score of zero means there is no functionality in place or if any is available, it is not being used.

The average score for EU27+3 acute hospitals is 0.295 (table 14), meaning that there is still room for improvement in the availability and use of eHealth functionalities in Europe. In terms of which categories of eHealth functionalities are developed and used in European hospitals, the one that includes functionalities allowing professionals to view or input information on Electronic Health Records is the one with the highest score, with a level of combined availability and use that reaches almost 45% of the maximum possible. On the other hand, this level does not reach 7% for the combination of the 4 functionalities related to Telehealth.

Table 14: 2012 Composite indicator on eHealth Availability and Use: results (total and by category) by country.

Country	View/Input Information on EHR	Clinical Decision Support on EHR	Health Information Exchange	Telehealth	2012 eHealth Availability & Use
EU27+3	**0.448**	**0.240**	**0.181**	**0.065**	**0.295**
Austria	0.615	0.297	0.229	0.059	0.390
Belgium	0.540	0.196	0.314	0.059	0.368
Bulgaria	0.255	0.075	0.102	0.046	0.159
Croatia	0.624	0.458	0.297	0.196	0.454
Cyprus	0.147	0.099	0.197	0.085	0.149
Czech Rep.	0.593	0.237	0.186	0.010	0.353
Denmark	0.691	0.487	0.469	0.089	0.529
Estonia	0.904	0.410	0.685	0.101	0.678
Finland	0.885	0.479	0.438	0.177	0.613
France	0.484	0.355	0.148	0.060	0.317
Germany	0.446	0.262	0.111	0.039	0.273
Greece	0.342	0.085	0.114	0.031	0.200
Hungary	0.724	0.410	0.155	0.053	0.432
Iceland	0.756	0.220	0.431	0.056	0.502
Ireland	0.205	0.107	0.152	0.111	0.164
Italy	0.375	0.185	0.235	0.081	0.273
Latvia	0.226	0.143	0.189	0.212	0.200
Lithuania	0.110	0.020	0.128	0.036	0.094
Luxembourg	0.882	0.667	0.042	0.035	0.503
Malta*	0.358	0.167	0.089	0.021	0.211
Netherlands	0.744	0.400	0.243	0.152	0.476
Norway	0.700	0.260	0.243	0.010	0.421
Poland	0.222	0.044	0.051	0.024	0.122
Portugal	0.577	0.307	0.207	0.049	0.368
Romania	0.317	0.065	0.157	0.067	0.204
Slovakia	0.570	0.326	0.117	0.005	0.335
Slovenia	0.291	0.143	0.076	0.021	0.174
Spain	0.680	0.390	0.296	0.110	0.459
Sweden	0.816	0.526	0.463	0.104	0.590
UK	0.246	0.199	0.217	0.133	0.218

*Scores are based on data from only 1 hospital.

There is a significant level of variability in the average scores by country, with scores below 10% of the mentioned level (Lithuania) and others that exceed 60% (Estonia and Finland). This variability is displayed in figures 10 to 14, where the average country values for the global composite indicator and the categories indicators are displayed in a decreasing order an ordered way, together with the average values for the whole EU27+3 sample. The pattern found in the results for the composite indicator on eHealth deployment in relation to country rankings is somehow replicated for the one on eHealth Use & Availability. Nordic countries have the higher average scores and some eastern European countries as well as Greece and Poland have the lowest. This result is not unexpected given that the level of eHealth deployment conditions the level of availability and use of eHealth

functionalities. However, Croatia and Hungary appear in the top third of the ranking on the Availability & Use indicator while they were in the lowest third on the deployment one. Another result that is similar for both composite indicators is that the average scores for some of the most populated European countries (Germany, France, Italy and UK for this composite indicator), are situated in the middle of the ranking. The first three of these countries have average values close to the one found for the whole sample of acute European hospitals.

Figure 10: 2012 eHealth Use and Availability: View/Input Information on EHR category by country

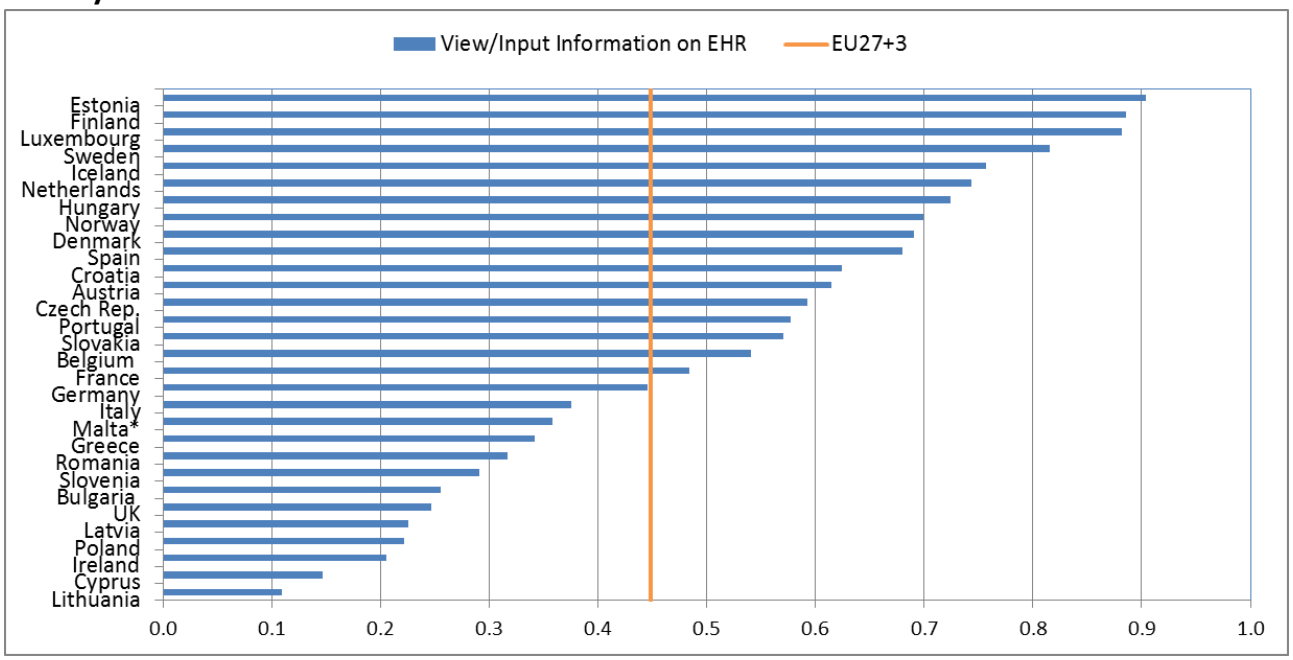


Figure 11: 2012 eHealth Use and Availability: Clinical Decision Support on EHR category by country

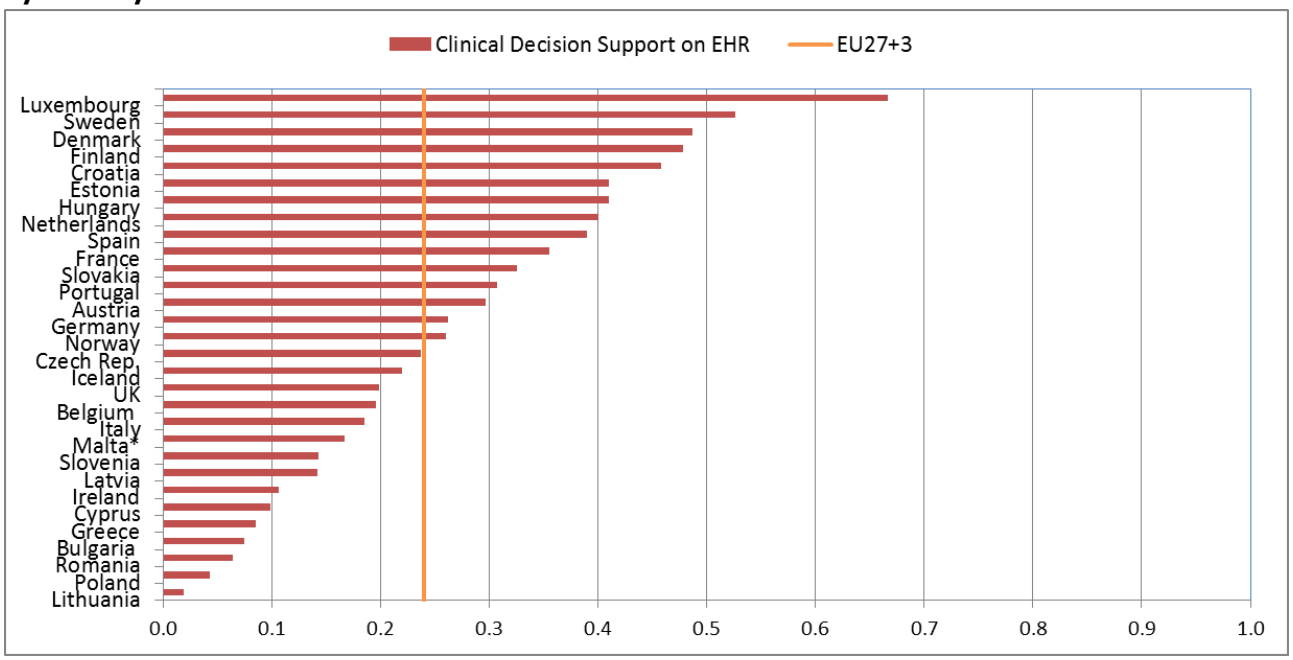


Figure 12: 2012 eHealth Use and Availability: Health Information Exchange category by country

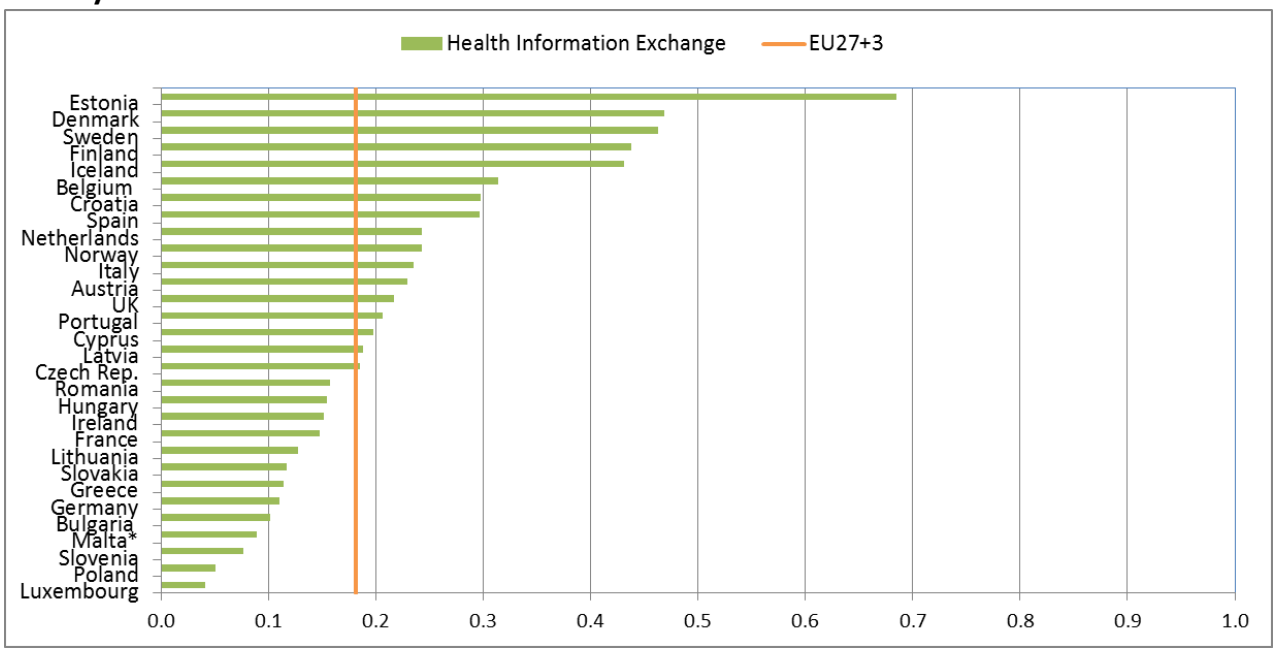


Figure 13: 2012 eHealth Use and Availability: Telehealth category by country

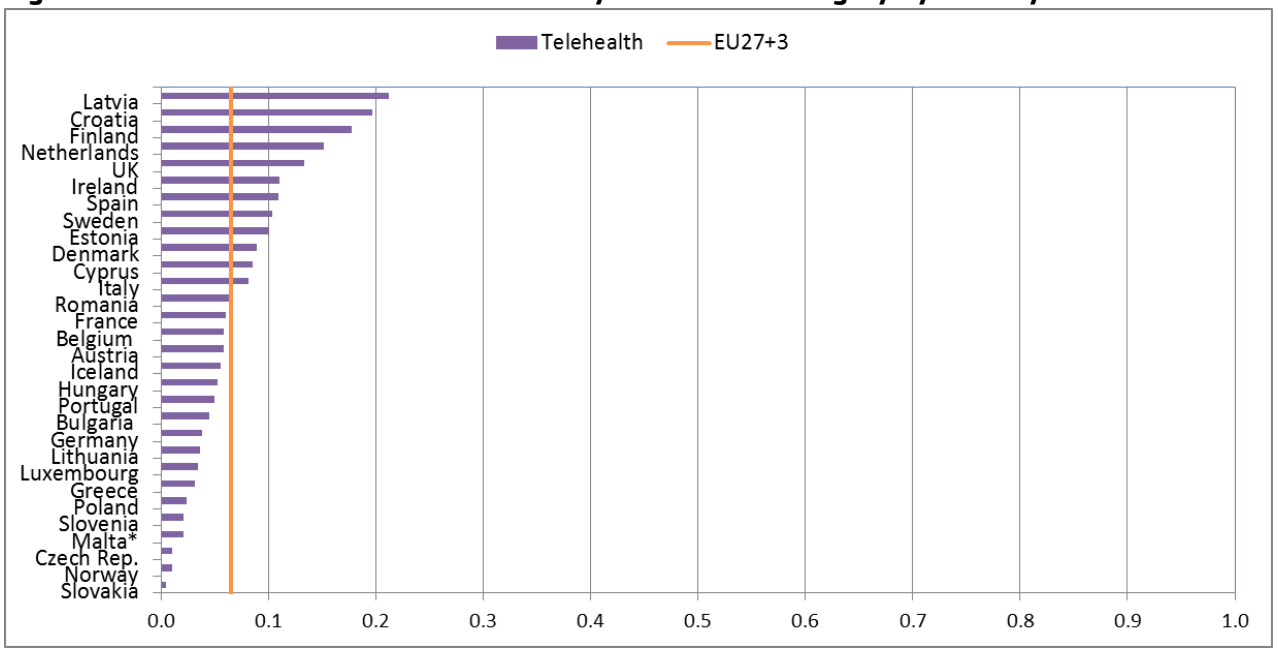
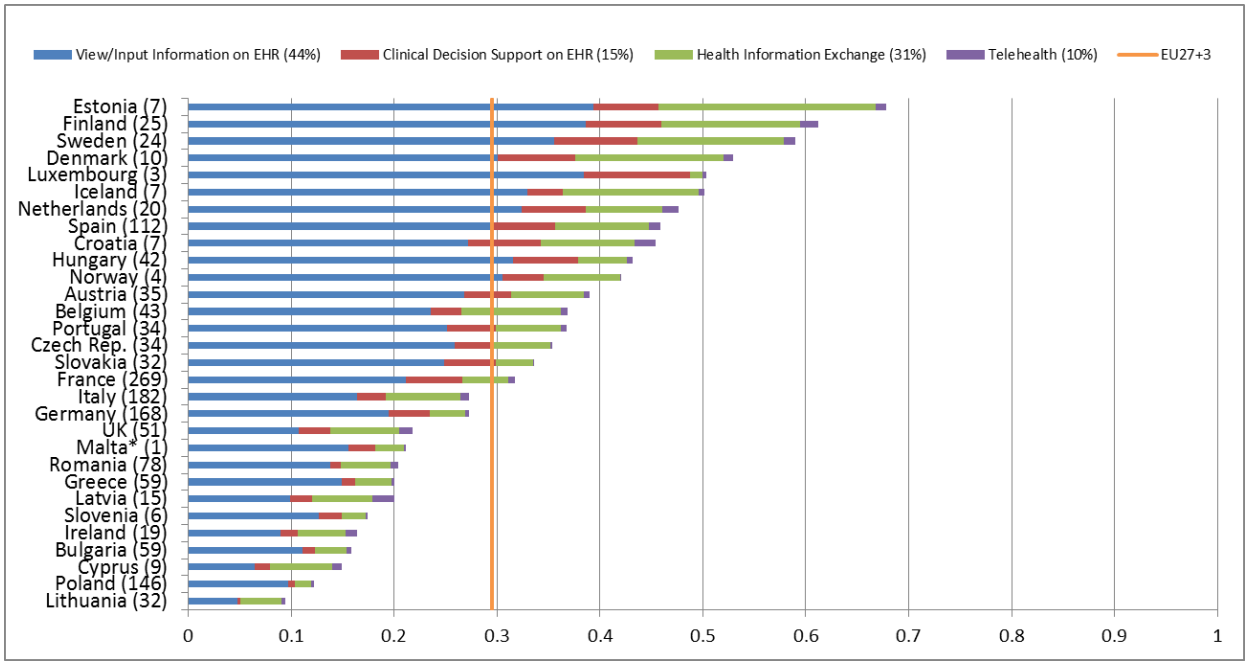


Figure 14: 2012 eHealth Use and Availability composite indicator by country



4.2.3 Analysis independently of Availability and Use of eHealth functionalities

These scores are the result of the combination of availability and use of eHealth functionalities. Therefore it is also possible to explore separately these two components, with the aim of analysing whether the reason for the low values found is that the hospitals do not have these functionalities or the professionals do not use them (or a combination of these two possible explanations). This analysis is displayed in tables 15 and 16. The scores for the use of eHealth functionalities as shown in table 16 take account of the use only when the functionalities are available. It is clear that the low level of availability is the cause of the low scores in the composite indicator on eHealth Use & Availability. In most countries the use is very high, especially for the functionalities grouped in the View/Input Information on EHR and Clinical Decision Support on EHR categories. Even in the case of Telehealth functionalities, when they are available in European acute hospitals, their level of use exceeds 50%. This information is represented graphically in Figure 15, where a positive relationship between levels of availability and use at country level can be observed. However, it is important to highlight the high levels of use for all levels of availability. Another interesting outcome from this analysis is the differences in use found between countries with very similar levels of availability. For instance, the scores of availability of eHealth functionalities for Italy and France are similar (0.35 and 0.37) but France's average score on the use of these functionalities is higher than the Italian one (0.78 vs 0.68).

Figure 15: Availability vs Use of eHealth functionalities: results by country

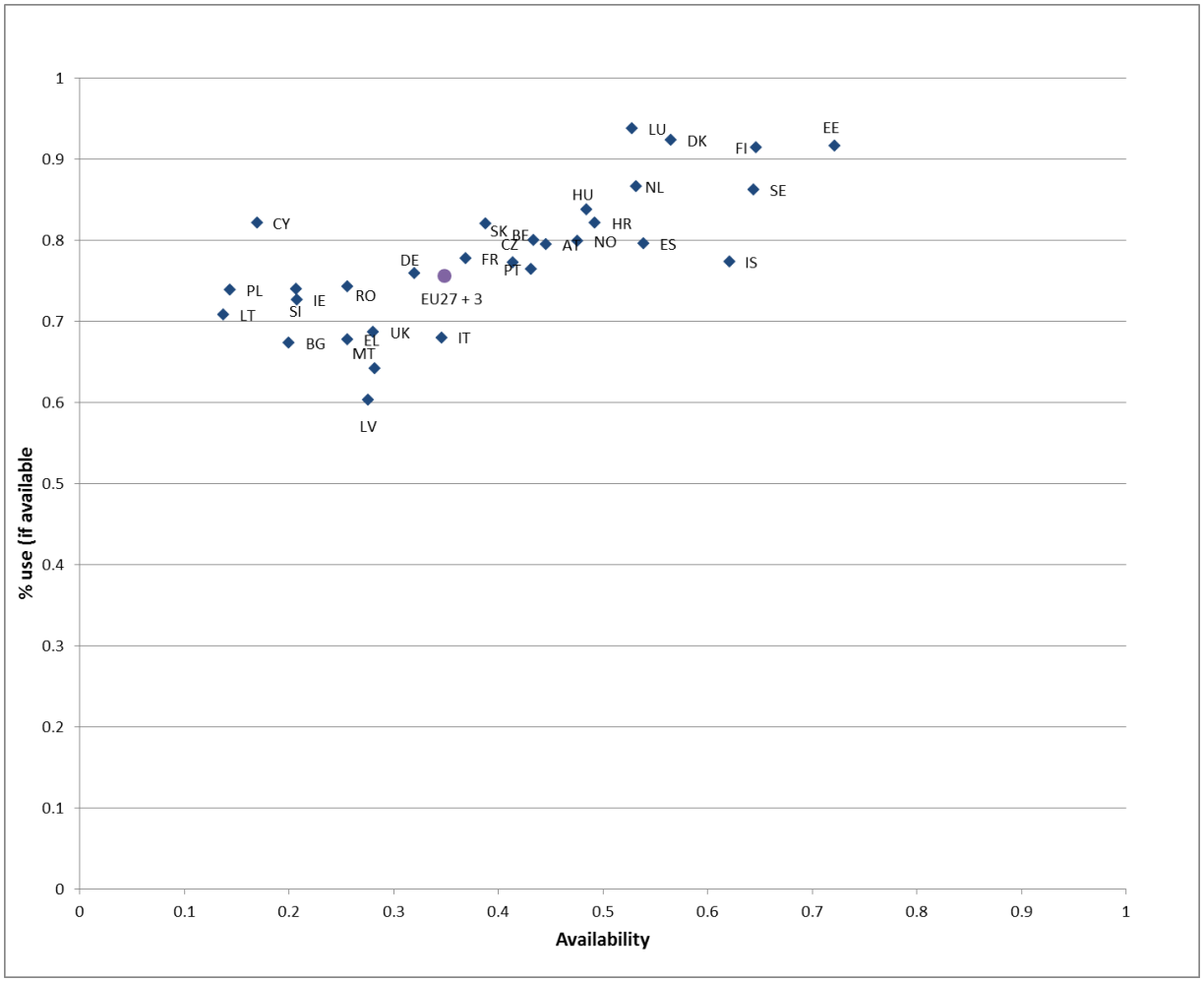


Table 15: Availability of eHealth functionalities: results (total and by category) by country.

Country	View/Input Information on EHR	Clinical Decision Support on EHR	Health Information Exchange	Telehealth	2012 eHealth Availability
EU27+3	**0.504**	**0.280**	**0.243**	**0.108**	**0.348**
Austria	0.660	0.333	0.302	0.136	0.446
Belgium	0.608	0.245	0.396	0.093	0.434
Bulgaria	0.296	0.101	0.161	0.057	0.200
Croatia	0.632	0.506	0.387	0.196	0.493
Cyprus	0.154	0.111	0.238	0.118	0.170
Czech Rep.	0.643	0.281	0.287	0.024	0.414
Denmark	0.716	0.546	0.492	0.175	0.565
Estonia	0.922	0.458	0.744	0.196	0.722
Finland	0.906	0.498	0.493	0.225	0.646
France	0.534	0.402	0.206	0.107	0.369
Germany	0.499	0.300	0.159	0.070	0.320
Greece	0.429	0.109	0.151	0.056	0.256
Hungary	0.786	0.454	0.211	0.070	0.485
Iceland	0.880	0.363	0.539	0.152	0.621
Ireland	0.266	0.138	0.178	0.158	0.208
Italy	0.444	0.234	0.330	0.143	0.346
Latvia	0.294	0.153	0.283	0.358	0.276
Lithuania	0.156	0.025	0.192	0.066	0.138
Luxembourg	0.922	0.667	0.056	0.063	0.528
Malta*	0.382	0.167	0.271	0.063	0.282
Netherlands	0.797	0.469	0.299	0.197	0.532
Norway	0.768	0.271	0.313	0.031	0.476
Poland	0.253	0.051	0.072	0.039	0.144
Portugal	0.633	0.364	0.295	0.086	0.432
Romania	0.392	0.079	0.202	0.107	0.256
Slovakia	0.638	0.376	0.166	0.008	0.388
Slovenia	0.348	0.153	0.090	0.042	0.207
Spain	0.753	0.474	0.385	0.189	0.539
Sweden	0.863	0.566	0.520	0.208	0.644
UK	0.317	0.236	0.288	0.172	0.281

Table 16: Use of eHealth functionalities (only considering when the functionalities are available in the hospital): results (total and by category) by country.

Country	View/Input Information on EHR	Clinical Decision Support on EHR	Health Information Exchange	Telehealth	2012 eHealth Use
EU27+3	**0.843**	**0.802**	**0.684**	**0.516**	**0.756**
Austria	0.899	0.827	0.685	0.376	0.795
Belgium	0.857	0.730	0.751	0.575	0.800
Bulgaria	0.812	0.663	0.637	0.580	0.674
Croatia	0.983	0.867	0.691	1.000	0.821
Cyprus	0.919	0.888	0.504	0.665	0.671
Czech Rep.	0.899	0.820	0.623	0.498	0.772
Denmark	0.959	0.858	0.952	0.390	0.923
Estonia	0.971	0.916	0.890	0.442	0.916
Finland	0.951	0.959	0.862	0.651	0.914
France	0.866	0.826	0.677	0.540	0.777
Germany	0.851	0.825	0.638	0.432	0.759
Greece	0.743	0.687	0.639	0.481	0.677
Hungary	0.911	0.855	0.653	0.541	0.838
Iceland	0.842	0.521	0.761	0.364	0.774
Ireland	0.748	0.770	0.720	0.614	0.727
Italy	0.791	0.758	0.628	0.484	0.680
Latvia	0.678	0.916	0.606	0.640	0.602
Lithuania	0.652	0.866	0.697	0.479	0.708
Luxembourg	0.961	1.000	0.833	0.665	0.938
Malta*	0.791	1.000	0.330	0.330	0.641
Netherlands	0.907	0.788	0.734	0.641	0.866
Norway	0.849	0.667	0.758	0.330	0.799
Poland	0.828	0.789	0.632	0.536	0.738
Portugal	0.876	0.735	0.710	0.458	0.764
Romania	0.792	0.743	0.740	0.428	0.743
Slovakia	0.874	0.863	0.703	0.553	0.820
Slovenia	0.789	0.851	0.754	0.665	0.740
Spain	0.872	0.757	0.739	0.476	0.796
Sweden	0.929	0.853	0.854	0.447	0.862
UK	0.679	0.865	0.712	0.699	0.687

5. Conclusions

The potential of eHealth to both help cope with healthcare challenges in Europe and contribute to innovation and growth by creating new markets explains its importance for the European Commission policy agenda. As part of this agenda, a number of benchmarking projects have been carried out with the objectives of enabling Member States to monitor actual performance as well as enhancing policy learning and the on-going policy processes

Benchmarking eHealth requires indicators on eHealth development that encompass different types of information and aggregately measure eHealth activity. The development of the composite indicators on respectively eHealth deployment and eHealth Availability & Use, and the results presented here fulfil this objective: they offer aggregated and at the same time scientifically sound information to policy-makers to help them monitor and further develop eHealth policy.

Two large and representative surveys of acute care hospitals at European Level have been the basis of the analysis presented in this report. The surveys were designed so as to allow data comparison. As a result it has been possible to provide an understanding of the evolution of eHealth deployment between 2010 when the first survey was undertaken and 2012/2013 which is when the second survey took place. In addition, the number of hospitals included in the samples has almost doubled from 2010 to 2012, increasing the representativeness and validity of the results.

The average score of the composite indicator on eHealth deployment of acute European hospitals, 0.42, indicates that there is room for improvement. Indeed this result is still far from a hypothetically ideal situation where the score would be 1. In spite of this, the analysis shows that things are moving in the right direction at European level, as the value of the composite indicator on deployment of eHealth in European acute hospital has increased over the period 2010-2012. Exploring more in detail these composite indicators results, we find that the dimensions on "Information flow" and "Privacy & Security" are the ones for which there was more room for improvement. On the other hand, dimensions with initially higher scores, "Infrastructure" and "Application & Integration", have increased while those with lower scores show a lesser increase or even a decrease in some cases.

Looking at the results from a country perspective, one can conclude that there is a great variability among average country scores on the composite indicator on eHealth deployment across the four dimensions as well as for the global composite indicator. Nordic and Central European countries are those with the highest scores. The analysis of the evolution of eHealth deployment by average country scores shows that European countries have not followed the same trend, some having increased deployment more than others. An interesting finding is that countries with the highest scores in 2010 are those which increased least over the monitoring period while the countries with the lowest scores in 2010 are those that have had the highest increases in relative terms in 2012. This leads us to two conclusions, namely that: 1) countries which were situated in the lowest part of the ranking in 2010 are catching up in terms of eHealth deployment, altogether an encouraging result, and 2) eHealth deployment levels seem to have slowed down in those countries that had the highest scores in 2010, a somewhat negative trend. Nevertheless, these findings and conclusions should be taken with caution given the difference in sample size between the two surveys. It would be interesting to see whether these findings would be confirmed, should a similar survey that would obtain information from the same hospitals in each country be carried out in 2 or 3 years from now.

In relation to the composite indicator which measures the Availability and Use of eHealth functionalities, the analysis shows that there is still room for improvement in European acute hospitals. This is true for all categories of functionalities which reach relatively low scores on this indicator but more particularly relevant for those allowing health care professionals and care providers to exchange health information electronically and provide Telehealth services. A more detailed analysis reveals that it is the low level of availability of eHealth functionalities which

accounts for the low scores. Indeed, the use of all types of functionalities when they are in place is considerably higher.

The analysis by average country scores of this composite indicator shows a similar pattern to that of the deployment indicator, as Nordic countries have the higher average scores while some eastern European countries as well as Greece and Poland have the lowest.

In conclusion, the benchmarking of eHealth in European acute hospitals over the period 2010-2013 provides interesting insights and confirms the usefulness of repeating such exercises over time to better inform policy making. Indeed while the overall evolution of eHealth deployment is a positive one, with an increase in the value of the corresponding composite indicator, there is still room for improvement in a number of specific areas as well as at country level. In addition for the newly developed indicator on availability and use of eHealth functionalities, there seems to be even more room for improvement, especially on the level of availability of eHealth functionalities in acute hospitals because when they are in place, health professionals use them routinely. This shows that it is important to continue promoting eHealth deployment through targeted EC policy so that both countries lagging behind and those leading continue to progress.

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Abstract

eHealth has been on the European Commission Information Society's policy agenda for more than a decade, from the eEurope initiative(European Commission 1999) to the i2010 Strategy(European Commission 2005), and most recently the Digital Agenda for Europe (DAE)(European Commission 2010), eHealth was also one of the Lead Market Initiatives in 2007. Today it is the focus of one of the two first pilots under the EU2020 Strategy and its Innovation Union flagship initiative – the European Innovation Partnership on Active and Healthy Ageing.

The key strategic orientations of the European Commission eHealth policy are defined in the eHealth Action Plan 2012-2020 where eHealth is referred to as "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"(European Commission 2004).

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