



# **Benchmarking Deployment of eHealth among General Practitioners (2013)**

## **FINAL REPORT**

A study prepared for the European Commission  
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Europe*

**This study was carried out by**



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## **Abstract**

This is the final report of the study "Benchmarking deployment of eHealth among General Practitioners II" funded by Unit F4 of DG CONNECT. A survey of General Practitioners (GPs) was conducted in 31 countries (EU27+ Croatia, Iceland, Norway, and Turkey) to measure and explain levels of availability and use (adoption) of eHealth applications and services. A random sample of 9,196 GPs was interviewed and data was processed using sophisticated multivariate statistical techniques. The survey shows that access to, and use of, basic ICT (a computer connected to the Internet) in the consultation room has become almost universal in all countries (97% of the sample). For more advanced features such as Electronic Health Records (EHR), Health Information Exchange (HIE), Telehealth, and Personal Health Records (PHR), however, the data show that more progress is needed. Although there was progress compared to 2007, adoption of eHealth systems in primary care is still limited for HIE, Telehealth, and PHR. Some basic forms of EHR are now available to about 93% of GPs, but more advanced features are less widespread. Levels of adoption are influenced by GPs individual characteristics and attitudes as well as by country level effects, and by the perception of impacts and barriers. The majority of GPs place more emphasis on barriers than on benefits, and identify lack of financial incentives and resources, lack of inter-operability, and lack of a regulatory framework on issues of confidentiality and privacy as the main barriers. The levels of adoption registered suggest that we are still very far from reaching the target and objectives defined for eHealth both in the Digital Agenda for Europe and in the 2012 eHealth Action Plan, and that more policy efforts are needed to facilitate uptake.

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# 1. Introduction

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## 1.1 eHealth potential and GPs pivotal role

*eHealth can help cope with current challenges and achieve quality of life and sustainability wins in innovative ways*

eHealth – defined broadly<sup>1</sup> as *"the use of Information and Communication Technologies (ICT) across the whole range of healthcare functions"* (European Commission, 2004) – can contribute to cope with the challenges currently faced by healthcare systems in Europe. These challenges include the need to ensure system sustainability while preserving quality in the face of an ageing population. The adoption of eHealth, matched by organisational changes and by other technical innovations, can turn these challenges into the triple wins set as targets of the European Innovation Partnership on Active and Healthy Ageing (EIP AHA): quality of life, sustainability, innovation and growth. The different applications and functionalities that eHealth offers can improve medical practices, assist the decision-making process by facilitating access to guidelines, simplify the prescription of diagnostic procedures, and produce alerts and reminders (Bodell, et al, 2004; Delpierre, et al, 2004; Kaushal, et al, 2006; Koppel, et al, 2005; Øvretveit, et al. 2007; Sidorov, 2006). They can also produce lower rates of medication errors and adverse drug events (Berger & Kichak, 2004; Hillestad et al, 2005). They can increase productivity among professionals, and lower costs (Bodell, et al, 2004; Sidorov, 2006; Walker et al, 2005).

*GPs are a pivotal node and their adoption and use of eHealth is strategic for the realisation of the promises*

Adoption of eHealth in primary care by General Practitioners (henceforth GPs) is pivotal to realise the above mentioned potential. GPs play a crucial role in facilitating access to, and delivery of, care (Atun, 2004; Macinko, et al, 2003). They represent the first point of contact and gather important information needed across the whole of the health and social care systems. Integrated care supported by the potentiality of eHealth is possibly the only way to cope with current challenges; GPs have a pivotal position toward the realisation of a model of care that leverages and shares information across all tiers of the healthcare system and between healthcare and social care<sup>2</sup>. Integrated care needs the full engagement of GPs, and the widespread and effective use of eHealth in primary care. In this sense, GPs can either play the role of catalysts or bottlenecks for ICT-led innovation in health and social care.

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- 1 Alternative expressions include, for instance, 'ICT for Health' or, more commonly in scientific journals, HIT (Health Information Technology). We will most often use the expression 'eHealth' or alternative expressions when needed by the context; we do not enter into conceptual discussion of the relative merits of different expressions and definitions.
  - 2 ICT-enabled integrated care is considered by many the only possible path toward achieving throughput efficiency while preserving quality and safety (Atun, 2004; Brandt, et al, 2010; Burton, et al, 2004; Codagnone, 2009; Codagnone, et al, 2011; Darkins, 2006; Darkins et al, 2008; Dorr, et al, 2007; Grant, 2010; Gress, et al, 2009; Loader, 2008; OECD. 2010; Ouwens, et al, 2005; Piniewski, et al, 2011; Singer, et al, 2011; Young, et al, 2007).



*Need to measure whether the traditional lag in adoption of ICT is being reduced among GPs*

On the other hand, it is amply documented that healthcare organisations and professionals have traditionally lagged behind in terms of introducing ICT supported innovation (Yarbrough & Smith, 2007); this is a trend with common elements across countries that have been amply demonstrated (Murray, 2011). Many theories and hypotheses have been advanced to understand the reason behind such lag, and predict and explain the acceptance and adoption of ICT in healthcare in general and among specific groups of professionals (Kaushal, et al, 2003). As the last measurement of eHealth adoption among GPs in Europe dates back to 2007, the importance of benchmarking adoption of eHealth in primary care is underscored both by the crucial role played by GPs and by the policy need to measure progress and assess the extent to which this lag has been reduced in the past six years.

## 1.2 Policy context and objectives

*Both the Commission and the Member States emphasise the policy importance of eHealth, for which benchmarking is needed to measure progress*

The further adoption of eHealth continues to figure among the key policy priorities of Europe. In the new *"EU 2020 Strategy"* (European Commission, 2010a) the ageing process and healthcare are included among the grand societal challenges Europe is facing and must turn into opportunities. Within the new Digital Agenda for Europe (European Commission, 2010b) eHealth is part of Pillar 7 where a number of actions have been identified, such as for instance action 75: *"Give Europeans secure online access to their medical health data and achieve widespread telemedicine deployment"*. This line of action is presented as strategic to ensure the sustainability of healthcare systems and to respond to increasing demands from patients in the face of scarcer human and financial resources. European Member States have also produced substantial policy efforts in this domain; most of them had already adopted national eHealth strategies and related measures by 2010 (Stroetmann, et al, 2011). More recently, the new *"eHealth Action Plan 2012-2020 - Innovative healthcare for the 21st century"* emphasised how eHealth could at the same time help cope with current challenges and create market opportunities; it set, among others, the objectives of *"achieving wider interoperability of eHealth services"* and *"facilitating uptake and ensuring wider deployment"* (European Commission, 2012, p. 6). These policy efforts clearly need benchmarking measurements to assess progress and spot areas where further policy initiatives and measures are needed<sup>3</sup>.

*The last of a multi-year series of eHealth benchmarking studies*

This study on *Benchmarking deployment of eHealth among General Practitioners II* is the second survey on adoption of eHealth by GPs, and is part of the Commission's multi-year series of eHealth benchmarking studies. The first of these studies was a survey of General Practitioners (Dobrev, et al, 2008), followed by an extensive review of survey methodologies (Meyer, et al, 2009), and finally by

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3 The importance of benchmarking exercises conducted by the Commission within the context of the Open Method of Coordination (OMC) is well understood and amply analysed and commented (Arrowsmith, et al, 2004; Codagnone & Lupiañez-Villanueva, 2011; De la Porte, 2002; De la Porte, et al, 2001; Radaelli, 2003; Room, 2005).

the first survey of acute hospitals (Codagnone & Lupiañez-Villanueva, 2011; Deloitte/Ipsos, 2011).

*The study measures and explains eHealth adoption by GPs in 31 countries through the data gathered with a survey of over 9000 GPs*

The study had the objective to measure adoption of eHealth applications and functionalities among GPs in the EU27+4 (Croatia,<sup>4</sup> Iceland, Norway, and Turkey), while at the same time explaining what drives or hampers it. To this end, a survey was organised in the 31 countries to collect the necessary data directly through interviews with a total of 9192 GPs. The data gathered were processed through multivariate statistical tools and integrated with an extensive review of secondary sources and with focus groups conducted with GPs. The results we are presenting in this report contribute to the described context in several ways. First, the survey measures progress in eHealth adoption by GPs between 2007 and 2013. Second, it provides new data that directly or indirectly can be used to monitor progress toward some of the Digital Agenda and new eHealth Action plan targets. Third, it represents the first piloting of the new measurement indicators that emerged from the combined efforts that the EC, the OECD, and WHO launched in 2010 in Barcelona during the Ministerial Conference on eHealth to establish a standard and common platform for benchmarking eHealth. The four key high-level indicators that we measured are: Electronic Health Records (EHR); Health Information Exchange (HIE); Telehealth; and Personal Health Records (PHR). Last but not least, it is definitely the first study that can analyse data from a sample of more than 9000 respondents in 31 countries using sophisticated multivariate statistical techniques to both measure and explain eHealth adoption levels in primary care.

### 1.3 Scope and structure of this report

*This report is supported by three other documents: A Technical Compendium, 31 Country Profiles, and the Survey Questionnaire*

The study lasted 18 months, required the completion of several tasks and activities, the production of 9 deliverables, and the statistical analysis of large datasets for as many as 31 different countries. It goes without saying that accounting for the output and details of all this work would not fit the space and scope of this report. For this reason, we point readers to three additional documents (also available for download) where technical details and additional information not included in this report can be found: a) a Technical Compendium reporting methodological details, description of the survey development process, analysis of secondary sources, and full transcript of focus groups with GPs; b) 31 country profiles with more detailed summary tables and graphs extracted from the survey; c) the questionnaire used for the interviews with GPs.

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4 Not yet a Member State when the survey was carried out and completed (March 2013).

***This report comprises six chapters and one Appendix. It minimises illustration of technicalities, and focuses its analysis mostly at EU27 +4 level, since countries' details can be found in the 31 Country Profiles***

In this report we only summarise the research design and methodology in chapter 2, since all details and technicalities are fully accounted for in the five chapters of the *Technical Compendium*. In addition we have placed all the technical details concerning the statistical analysis performed in the Appendix of this report (included as chapter 7). The statistical techniques used to perform the analysis are only briefly mentioned in chapter 2, and then simply recalled without much discussion in the three chapters where results are presented. In chapter 3 we present the main and basic descriptive results obtained from the survey with exception of those concerning attitudes and perceived impacts/barriers (placed in chapter 5, see *infra*). In chapter 4 we present the synthetic measurements of eHealth adoption (composite indicators and overall composite index) constructed using multivariate statistical analysis. In chapter 5 we use different instruments and perspectives to explain eHealth adoption levels: a) a qualitative analysis of eHealth adoption variation with respect to contextual parameters (organisational settings and healthcare system models), corroborated with a Multilevel Analysis of Variance; b) a descriptive analysis of the results on impacts and barriers obtained from the survey, integrating them with insights from the two Focus Groups conducted with GPs; c) a cluster analysis presenting different attitudinal profiles of GPs; d) a Structural Equation Modelling explaining the adoption level (using as dependent variable the composite index). In chapter 3 the main focus of our analysis is at aggregate EU27 + 4<sup>5</sup> level, whereas in chapter 4 for the indicators and the composite index we present graphs and table both at aggregate and at country level. The readers can find country level detailed tables and graphs in the mentioned 31 country profiles. In chapter 6 we discuss the findings, and we conclude with a few general considerations both on the policy implications of such findings and on future directions for measuring progress of eHealth adoption in primary care. As anticipated, we included an Appendix (chapter 7) illustrating the technical aspects of the statistical methods used to process the data.

Finally, a few terminological choices and notations must be illustrated for the sake of clarity and ease of reference. First, when referring to the two basic measurements we use the expressions 'availability' and 'use'. We prefer the term 'availability' to 'deployment' for it better reflects the organisational context in which GPs work. In several countries, GPs work in public health centres or in group practices; hence, a particular eHealth application may be available to them as a result of a deployment that is not necessarily their individual decision. In singled-handed or so-called 'solo practice', eHealth functionalities are available possibly as a result of the GP decision to deploy them, but also as a result of administrative mandatory requirements. So, availability is a more general and neutral expression better adapted to the diversity of contexts in the 31 countries surveyed. On the other hand, when presenting the composite indicators and the composite index and

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5 We still refer to EU27 for by the time the survey was completed Croatia had not become yet a Member State.

explaining their levels in terms of other variables, we use instead the term 'adoption', since these summary measures that have been constructed combining availability and use in a such a way as to reflect this broader concept.

Finally, we use repeatedly the acronyms listed and explained in the table below:

<b>Acronym</b>	<b>Explanation</b>
CA	Cluster Analysis
CFA	Confirmatory Factor Analysis
CI	Composite Index
DSS	Decision Support System
EHR	Electronic Health Record
FA	Factor Analysis
GPs	General Practitioners defined as " <i>physicians working in outpatient establishments in specialties such as general practice, family doctor, internal medicine, general medicine</i> "
HCP	Health Care Provider
HCPF	Health Care Professional
HIE	Health Information Exchange
MLA	Multilevel Analysis
NHS <sup>6</sup>	National Health Systems (i.e. UK, Sweden, Italy, etc.)
OERM	Order Entry & Results Management
OLS	Ordinary Least Squares
PCA	Principal Component Analysis
PHR	Personal Health Record
Q	It refers to the Questionnaire
Q1. - QN	Q plus a number refer to a specific item in the questionnaire
SIS <sup>7</sup>	Social Insurance Systems (i.e. France, Germany, NL <sup>8</sup> etc.)
SEM	Structural Equation Modelling
TC	Technical Compendium

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<sup>6</sup> Used to indicate a kind of health system institutional model.

<sup>7</sup> Same as above.

<sup>8</sup> Although the Netherlands are more of a mixed Social Insurance and Private Insurance system.

## 2. Design and Methodology

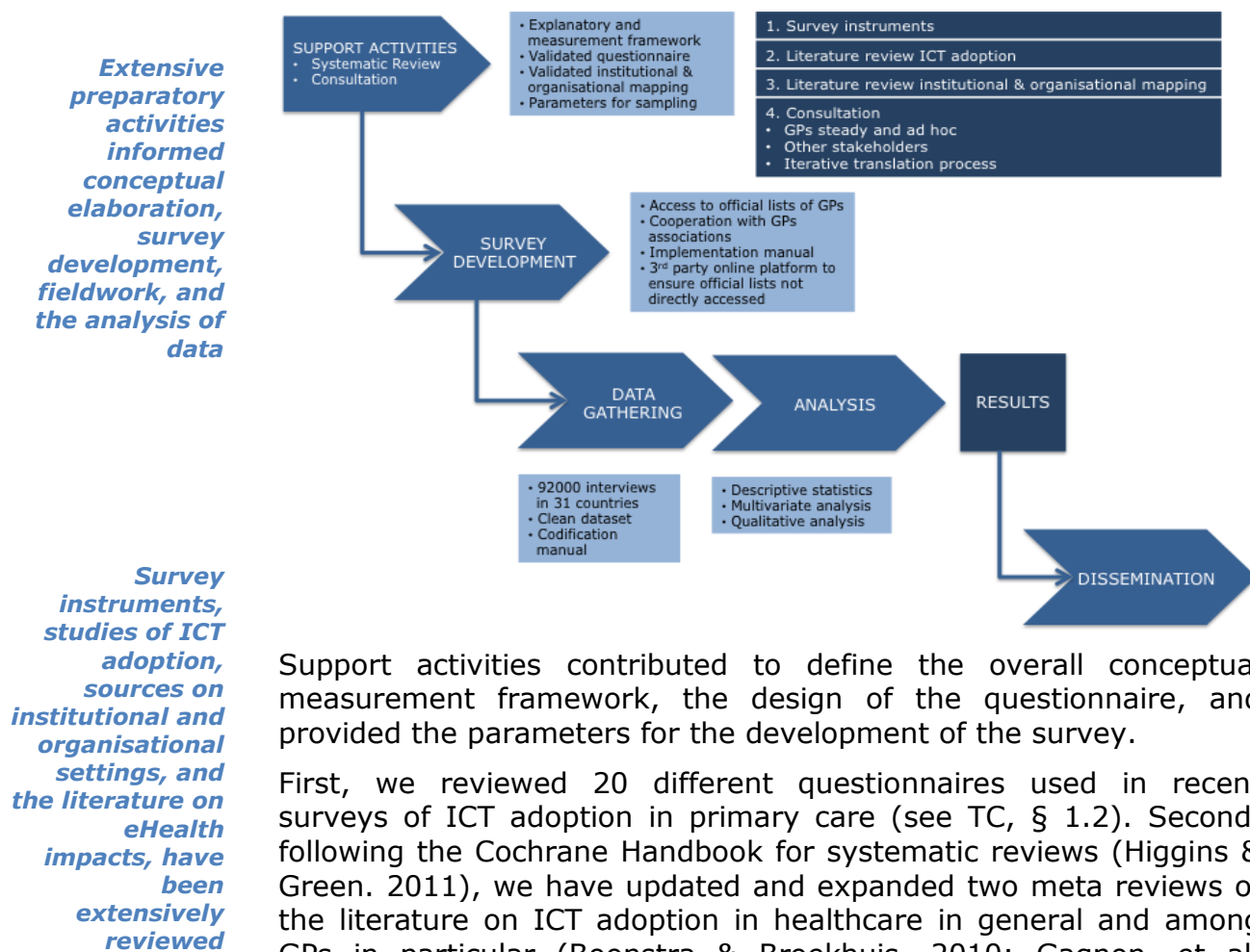
### Box 1 Chapter 2 Roadmap

This chapter briefly summarises the research design, methodology, and the survey development process fully accounted for in the Technical Compendium (TC). In § 2.1 the overall design and development of the study is presented, which is the only element not contained also in the TC. In § 2.2 we illustrate the overall explanatory and measurement framework and how this informs the questionnaire (full details can be found in chapters 1, 2, & 5 of the TC) and the analysis performed (technical details are presented in the Appendix of this report). In § 2.3 we summarise the sampling strategy and in § 2.4 the survey development and data gathering processes (full details are in chapter 3 & chapter 4 of the TC).

### 2.1 Study overall design and development

The figure below summarises the main groups of activities carried out, and shows the logic of the research design.

**Figure 1 Explanatory and Measurement Framework**



Support activities contributed to define the overall conceptual measurement framework, the design of the questionnaire, and provided the parameters for the development of the survey.

First, we reviewed 20 different questionnaires used in recent surveys of ICT adoption in primary care (see TC, § 1.2). Second, following the Cochrane Handbook for systematic reviews (Higgins & Green. 2011), we have updated and expanded two meta reviews of the literature on ICT adoption in healthcare in general and among GPs in particular (Boonstra & Broekhuis, 2010; Gagnon, et al,

2010), reviewing key behavioural, organisational, and institutional theories and models (Davis, 1993; Greenhalgh, et al, 2004; Greenhalgh, et al, 2005; Holden & Karsh, 2010; Holden & Karsh, 2009; Kukafka, et al, 2003; May, et al, 2010; May, et al, 2009; Rogers, 1995; Yarbrough & Smith, 2007). Third, to account for the diversity of primary care institutional and organisational settings (see TC, § 1.4), we have reviewed a considerable set of sources (Atun, 2004; Boerma, 2003; Boerma, et al, 1998; Boerma, et al, 1997; Calnan, et al, 2006; Evans, 1994; Gervas, et al, 1994; Kottnerus, et al, 1990; Kringos, et al, 2010a; Kringos, et al, 2010b; McCallum, et al, 2006; Meads, 2009a, 2009b, 2009c; Meads, et al, 2005; Saltman, et al, 2006; Sheaff, et al, 2006; Soler, et al, 2007; van den Brink-Muinen, et al, 2000; WHO, 2002-2011; Wilkin & Smith, 1987; WONCA, 2002). On the basis of these sources in the TC (§ 1.4) we present a unique overview, from which we extracted the parameters for the definition of the universe and for the extraction of the sample. Finally, we reviewed existing meta-reviews (Chaudhry, et al, 2006; Dixon, et al, 2010; Kazley & Ozcan, 2008; Lapointe, et al, 2011) and selected studies (Berger & Kichak, 2004; Bodell, et al, 2004; Delpierre et al, 2004; Hillestad et al, 2005; Kaushal et al, 2006; Koppel, et al, 2005; Øvretveit, et al, 2007; Sidorov, 2006; Walker, et al, 2005) from the literature on the evaluation of eHealth tangible outcomes and impacts (see TC, § 1.5).

*Focus groups with GPs integrated the analysis of secondary sources*

Finally, the work on secondary sources was integrated through consultation activities and, in particular, through focus groups conducted with 25 GPs in representation of 20 European countries (see full focus groups report in TC chapter 5), and through steady interactions with representatives of national GPs' associations facilitated by UEMO, the European level associations of all national GP associations that is a member of our consortium. On the basis of the input from the support activities, we developed the survey, carried out the fieldwork, and analysed the data we are presenting in this report.

*The study lasted 18 months and unfolded in four mostly sequential phases*

The work lasted about 18 months and can be broadly divided into four phases, the first of which consisted of the analysis of secondary sources and of the consultation activities described above (January-June 2012). On the basis of secondary sources analysis and consultation input, we developed an overall explanatory and measurement framework, both of which shaped the questionnaire, as well as the kind of analysis performed (see § 2.2). Next, using the organisational and institutional parameters extracted from the secondary sources and the consultation, we moved to the survey development phase during which the sources defining the universe in each country were accessed and the sample extracted. This proved quite challenging and lasted several months (April-October 2012), before the data gathering process could start in November of 2012, which was mostly completed between January and March 2013. A preliminary analysis of the data was carried out in March and April, and findings were presented at the joint EC-OECD workshop held in Brussels on 18-19 April 2013. During the workshop, the attending experts and stakeholders validated the

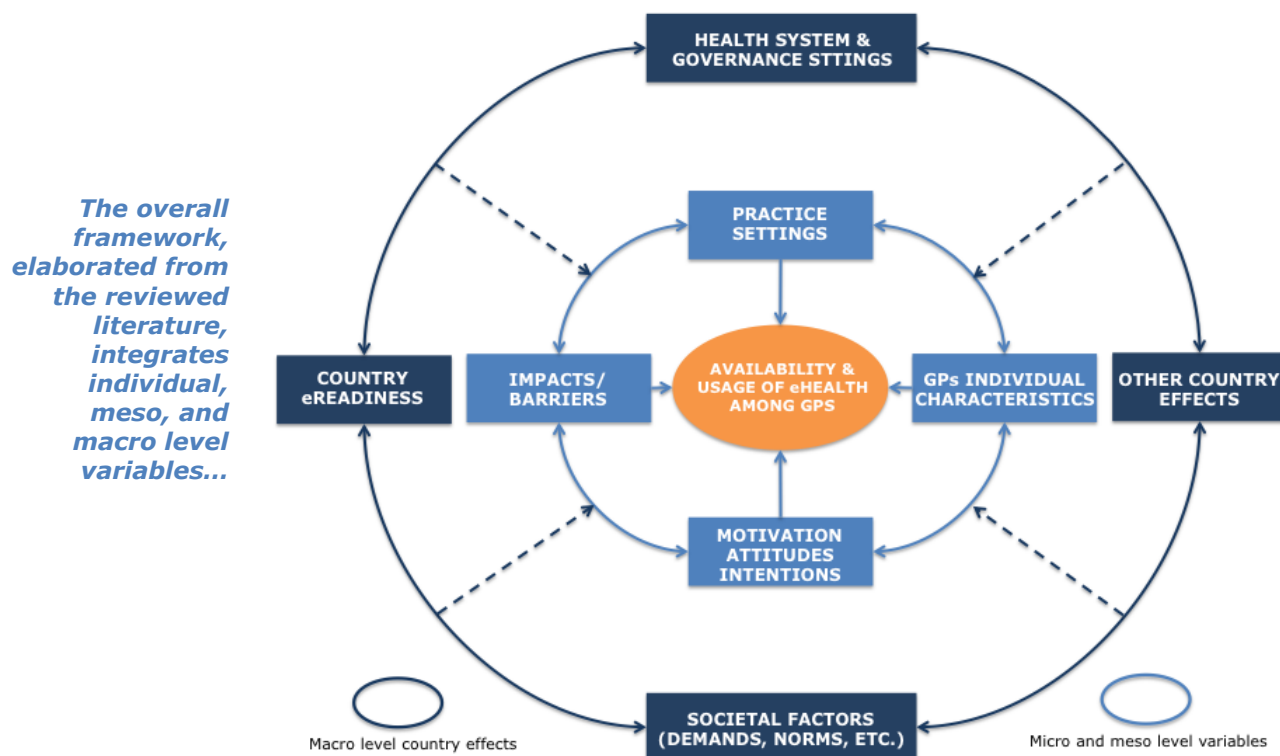


approach and findings we presented. Finally, in the period May-July 2013, a refinement of the analysis and the finalisation of the project were carried out.

## 2.2 Framework, questionnaire, and analysis

The inner ring in the figure below contains individual and meso level variables, and the outer ring the possible macro level country effects (see full analysis in chapter 1 and chapter 2 of TC).

**Figure 2 Overall framework**

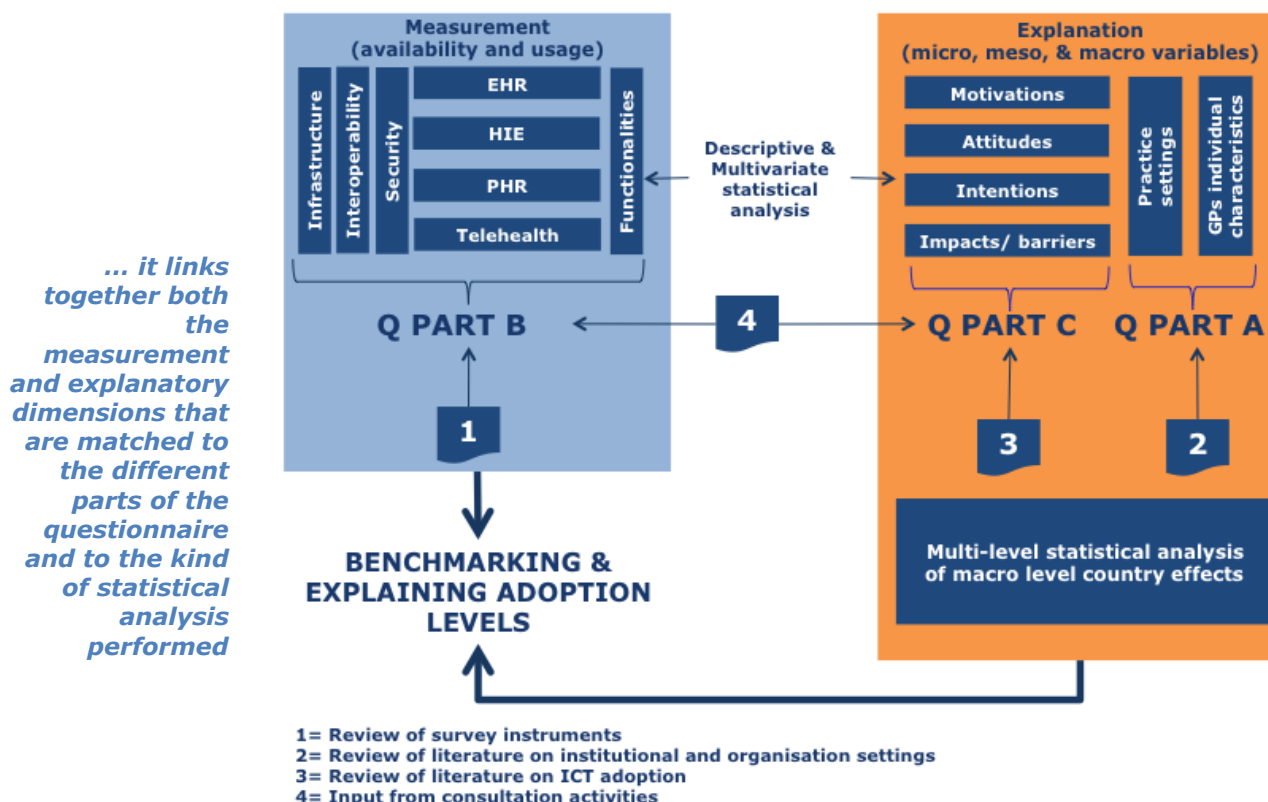


This framework integrates the different strands of models and hypotheses extracted from the reviewed bodies of scientific literature, thus including individual, meso, and country level explanatory variables of the level of eHealth adoption<sup>9</sup>.

<sup>9</sup> Motivations, attitudes, and intentions are considered determinant of adoption in the behavioural models reviewed in the TC (chapter 1 § 1.3.2) such as for instance: a) Technology Adoption Model (TAM) and its revised version (TAM2); b) Universal Theory of Acceptance and Use of Technology (UTAUT); c) Theory of Reasoned Action (TRA); d) Theory of Planned Behaviour (TPB). Following the Innovation Diffusion Theory (IDT, see TC, chapter 1, § 1.3.3) and also the above mentioned behavioural models, we posit that adoption is also a positive function of the perceived/proven relative advantage of introducing an innovation and a negative function of perceived difficulties and barriers. For what concerns the individual characteristics of GPs, the standard hypothesis above all is that age may have an effect in driving or hampering the adoption of new technologies. Various theories of innovation (see TC, chapter 1, § 1.3.4) posit the importance of the organisational context to explain adoption of innovative technology. Finally, system level variables (called country effects) have been widely shown to shape primary care organisational settings and the individual behaviour of GPs (see TC, chapter 1, § 1.3.4. and all contents of § 1.4). Health system characteristics define the structure of incentives, the tasks, and workload of GPs, as well as governance mechanisms within healthcare, and between healthcare

Our overall framework links together the measurement and explanatory dimensions, as can be seen more clearly in the next figure where the two are distinguished and matched to the different parts of the questionnaire, their sources, and the kind of analysis performed. It is important to stress that data on all blue boxes of both figures were obtained through answers provided by the interviewed GPs.

**Figure 3 Framework, questionnaire, and analysis**



The left hand side of the figure above represents the measurement conceptual framework that we elaborated through the review of survey instruments (see TC, chapter 1, § 1.2) and corroborated through a review of the evidence on the impacts of different eHealth functionalities (see TC, chapter 1, § 1.5; and chapter 2, § 2.1). The review on the evidence on impacts ensured that we measured those functionalities that have been empirically shown to produce benefits. Data for measurement come from Part B of the questionnaire, whereas Part A and Part C provide data on explanatory variables at individual and organisational level.

and the wider political and administrative system. For instance, in the focus groups GPs from several countries stated that the introduction of a number of eHealth functionalities (i.e. sick leave certification) was more a decision taken by the government for administrative purposes rather than for clinical objectives. Societal pressures such as demand and expectation from the citizens, norms and cultural value also have an impact on how GPs organise and conduct their work. Social influence can be a catalyser of innovation adoption and here macro level cultural explanations overlap with individual level theories such as for instance Normalisation Process Theory. The level of eReadiness of a country in turn can both determine the availability of ICT and also the cultural attitudes, social norms, and expectation about its usages.



**Part A** of the questionnaire comprises items Q1 to Q10, covering socio-demographics, organisational settings, practice location, description of tasks and workload, and one control question<sup>10</sup>.

**Part B** comprises items Q11 to Q24b (for a total of 23 questions), and represents the core of the survey, for it produces the data for the measurement of availability and usage. After a set of general questions (basic infrastructure. interconnection with other system players. and security. etc.), the core focus is on the following four pillars of measurement presented below with the general definition we adopted:

*Part B of the questionnaire, comprising 23 items, is the source of data for the measurement of availability and usage of basic infrastructure and of the four high level indicators: EHR, HIE, telehealth, and PHR*

- **Electronic Health Record (EHR):** *systems that are used by healthcare professionals (doctors and nurses) to enter, store, view, and manage patient health and administrative information and data.*
- **Health Information Exchange (HIE):** *is the process of electronically transferring / sharing / enabling access to patient health information and data.*
- **Telehealth:** *is the use of broadband-based technological platforms for the purpose of providing health services, medical training and health education over a distance.*
- **Personal Health Record (PHR):** *are electronic systems allowing patients to have secure access to, and manage, their health information.*

Questions were formulated so as to present both the general concept/system and the specific functionalities associated with it. For EHR, a general question (Q19a) ensured comparability with the 2007 EC survey (Dobrev. et al. 2008) and was followed by two additional questions on functionalities (Q20a and Q20b). For Health Information Exchange (HIE), we found instead an effective way to combine the general definition with functionalities (Q21) and the same applies for Telehealth (Q22), whereas for PHRs, due to legal implications in some countries<sup>11</sup>, we used two separate questions based on the functionalities (Q24a and Q24b).

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10 Q9 asks what happens when a patient has seen a specialist or been discharged by the hospital, and can be used as control to answers provided to questions concerning Health Information Exchanges (HIE).

11 In a number of countries, it turned out that GPs are not allowed to provide patients with their medical records. So, during the consultation on the first translation of the English version of the questionnaire we realised that the formulation of the question "PHR are electronic systems allowing patients to have secure access to, and manage, their health information. Does your system allow you..." could have been interpreted as referring to law and regulation rather than to the functionalities of the ICT platform. Accordingly. it was reformulated to accommodate the peculiar country contexts and ensure sample-wide comparability.

*The questions in Part C of the questionnaire reflect the constructs from the reviewed behavioural models*

**Part C** (Q25-Q28) focuses on attitudes, perceived barriers, and perceived impacts. The items included in these questions have been taken from the systematic review of the literature on ICT adoption in healthcare, and modified in view of the inputs obtained from GPs during the focus groups. Q25 contains constructs extracted from behavioural models such as: a) Technology Adoption Model (TAM) and its revised version (TAM2); b) Universal Theory of Acceptance and Use of Technology (UTAUT); c) Theory of Reasoned Action (TRA); d) Theory of Planned Behaviour (TPB). The questions on barriers and impacts are derived from these models, and integrated with insights from Innovation Diffusion Theory (IDT), organisational theories, and Normalisation Process Theory (NPT). As to the overall explanatory power of the data obtained from the survey, a disclaimer is in order here. Following standard methodological principle of measurement<sup>12</sup>, as well as the insights from the study of the cognitive aspects of survey methodology (CASM)<sup>13</sup>, it is good practice in survey research to introduce some level of repetition and redundancy. Using more than one question to measure the same 'thing' serves the purpose both of having more items to run

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12 The use of rephrasing the same survey items in different ways is normally adopted to check the reliability and validity of a measurement (Allen & Yen, 1979). In particular, questions formulated in different ways to measure the same underlying dimension are applied to assess two forms of validity, denominated 'convergent validity' and 'criterion-related validity' (Nunnally & Bernstein, 1994). Convergent validity tests whether constructs that should be related, are, in fact, related. Criterion-related validity is assessed when one is interested in determining the relationship of scores on a test to a specific criterion.

13 CASM researchers share wide agreement that answering a survey question poses several interrelated tasks and can cause 'response effects' that may bias the measurement (see for instance reviews in Schwarz, 2007; Tourangeau, 2003). Respondents need to interpret and understand the question to determine which piece of information they need to retrieve, and then answer. For clearly formulated questions on more 'objective' facts such as if they have and use a particular functionality, the organisational settings of their practices and the likes, it can be reasonably assumed that GPs will process all information and retrieve from memory what needed, then answer the question objectively. When, however, questions concern attitude and perceptions of the respondents, they either retrieve a 'prior' (previously formed judgement) from memory, or they may form a judgement on the spot that will be influenced by whatever information is available and by situational and social aspects. So, the answer may be influenced by previous questions and/or by the underlying hypothesis that the respondent may guess from the narrative and wording of the questionnaire. One of the most well-known response effects is 'social desirability', whereby respondents edit their answers to adjust them to what they perceive as socially accepted in general and adequate to the specific situation. A slightly different form of this response effect is 'hypothesis guessing', occurring when the respondent deduces from the formulation of a question or from the overall narrative of a questionnaire, which are the hypotheses that the researcher is testing, and answer to either confirm or disprove them. These response effects are particularly salient if the questions require the expression of judgement or attitude on something the respondent has not directly experienced. We can anticipate here, for instance, that GPs who use eHealth functionalities less tend to express stronger appreciation of its benefits and to minimise barriers compared to those who use such functionalities more. A way of coping with response effects such as social desirability, besides careful formulation of questions, consists precisely of using different questions to measure the same issue.

*Due to time constraints we had to remove several control questions in Part C, which to some extent limits the explanatory power of our questionnaire*

multivariate statistical analysis on, and of checking coherence in responses by the participants. One wants to have 'dimensions' measured by more than only one question and to have control questions. In our questionnaire, this is particularly salient for Part C (see footnote 10). We originally had several control questions that we were later forced to remove to limit the duration of the questionnaire, while maintaining all of the items of Part B. This limits to some extent the explanatory power of our questionnaire and we come back to it when we analyse the results of multivariate statistical analysis in chapter 5.

*Besides descriptive statistics, we also report the results of several multivariate statistical analyses performed*

As anticipated, the technical details of the statistical analyses performed are reported in the Appendix (chapter 7), which we briefly mention below. Simple descriptive statistics (see chapter 7, § 7.1) for most of the items in the questionnaire have been constructed and are presented in chapter 3. At the end of chapter 3, we also present a comparison of our findings with those obtained in the previous EC funded surveys of GPs (Dobrev et al 2008). In chapter 4, we present the composite measures constructed using Factor Analysis (see chapter 7, § 7.2 and § 7.3), and in chapter 5, the results of several multivariate statistical analyses that we performed on the data. We used a multilevel "Empty Model (ANOVA)" (see chapter 7, § 7.5) to assess the extent to which the variance in the overall composite index of eHealth adoption is explained by either country effects or individual level characteristics. We also performed a non-hierarchical cluster analysis (see chapter 7, § 7.2) to identify different attitudinal profiles of GPs. Finally, we run a Structural Equation Modelling (SEM, see chapter 7, § 7.4) as an attempt to explaining adoption levels in systematic fashion.

## 2.3 Universe and sampling

The table below reports by country and overall the quantification of the universe of GPs<sup>14</sup>, the sample actually reached, what percentage of the universe our sample captured, and the sampling errors.

**Table 1 Universe, sample, and sampling errors**

Country	Universe	Sample	(%) of Universe	Sampling error
Austria	12979	333	2.6%	$\pm 5.41\%$
Belgium	12262	406	3.3%	$\pm 4.88\%$
Bulgaria	4786	310	6.5%	$\pm 5.49\%$
Croatia	2960	250	8.4%	$\pm 6.05\%$
Cyprus	345	50	14.5%	$\pm 13.10\%$
Czech R.	7332	308	4.2%	$\pm 5.58\%$
Denmark	3735	306	8.2%	$\pm 5.48\%$
Estonia	1148	50	4.4%	$\pm 13.84\%$
Finland	5453	283	5.2%	$\pm 5.79\%$
France	104225	401	0.4%	$\pm 4.98\%$
Germany	53719	403	0.8%	$\pm 4.96\%$
Greece <sup>15</sup>	3060	332	10.8%	$\pm 5.18\%$
Hungary	6559	268	4.1%	$\pm 5.98\%$
Iceland	187	53	28.3%	$\pm 11.66\%$
Ireland	2449	200	8.2%	$\pm 6.78\%$
Italy	46661	416	0.9%	$\pm 4.88\%$
Latvia	1315	200	15.2%	$\pm 6.51\%$
Lithuania	2288	212	9.3%	$\pm 6.54\%$
Luxembourg	392	73	18.6%	$\pm 10.57\%$
Malta	286	50	17.5%	$\pm 12.87\%$
Netherlands	8783	400	4.6%	$\pm 4.89\%$
Norway	2309	335	14.5%	$\pm 5.05\%$
Poland	6619	412	6.2%	$\pm 4.77\%$
Portugal	20221	513	2.5%	$\pm 4.36\%$
Romania	27418	403	1.5%	$\pm 4.94\%$
Slovakia	2236	201	9.0%	$\pm 6.73\%$
Slovenia	1012	167	16.5%	$\pm 7.07\%$
Spain	33349	469	1.4%	$\pm 4.59\%$
Sweden	5487	338	6.2%	$\pm 5.27\%$
Turkey	37600	572	1.5%	$\pm 4.15\%$
UK	48543	482	1.0%	$\pm 4.53\%$
<b>TOTAL</b>	<b>465718</b>	<b>9196</b>	<b>2.0%</b>	<b><math>\pm 1.03\%</math></b>

Source: For (1) HFA-DB<sup>16</sup> (corrected and/or validated by UEMO)

14 Available internationally comparable data on GPs do not allow presenting a break down of the universe by age and gender. OECD data provide such break down for the category 'physicians', which is a larger aggregate than strictly defined GPs.

15 In Greece primary care services are provided not only by formally registered GPs, but also by several other players/organisations (Economou, 2010, pp. 111-114). Having recognised this, however, we pragmatically used the universe defined in the HFA-DB and extracted a sample from formally registered GPs (with a sampling error of about 5%) for the simple reason that composing the universe from the various groups of individuals providing primary care services in Greece would have proven not feasible within the limits of this study.

16 European health for all database: <http://www.euro.who.int/en/data-and-evidence/databases/european-health-for-all-database-hfa-db>

**Table 2 Sampling summary parameters**

Universe	Defined as “ <i>physicians working in outpatient establishments in specialties such as general practice, family doctor, internal medicine, general medicine</i> ” <sup>17</sup>
Scope	EU27 countries plus Croatia, Iceland, Norway, and Turkey
Methodology	Mixed (Online, Web-CATI, and Face-to-face)
Sample size	Total N= 9196
Sample extraction	Simple Random Sample
Weighting	Weighting by country to be able to interpret the overall data
Response rate	35% on average
Sampling error	<ul style="list-style-type: none"> <li>• <math>\pm 1.03\%</math> for overall sample (31 countries)</li> <li>• In a range between <math>\pm 4.15\%</math> and <math>\pm 13.84\%</math> for country samples</li> <li>• In all cases, a maximum indeterminate probability (<math>p=q=50</math>), for a confidence level of 95.5% is applicable for each country)</li> </ul>

**A simple random sample of 9.196 respondents was reached, with an overall sampling error of  $\pm 1.03\%$  and an average response rate of 35%**

The *ex ante* target sample was 8.550 with country samples ranging from 400, 300, 200, and 50 so as to maintain the country sampling error around 5%. Exceptions to this rule were countries where the universe is so small that given response rates it would have proven too time consuming to reach a sample ensuring a sampling error below 5%. The overall sampling error is 1.03%, in 20 countries it is around 5%, in six countries it is between 6% and 7%, and only in five countries is it above 10% (for these countries results must be read only as indication of trends). We have reached a larger sample than was planned *ex ante* (9.196 versus 8.550) as a result of more successful data gathering in some countries, which compensated for the fact that in five countries we could not reach the target sample<sup>18</sup>. The technical parameters concerning the definition of the universe and sampling are summarised in the table above. Sampling followed a simple random sample procedure without *ex ante* stratification; weighting was applied *ex post* in order to ensure that the sample is representative for the interpretation of the overall data. Full details on sampling, the overall survey development process, and on data gathering can be found in chapter 3 and 4 of the TC.

17 This is the definition used by: a) European health for all databases (HFA-DB) World Health Organization Regional Office for Europe; b) OECD; and c) EUROSTAT. Such definition includes: (1) District medical doctors; (2) Family medical practitioners; (3) Primary healthcare physicians; (4) Medical doctors (general); (5) Medical officers (general); (6) Resident medical officers specialising in general practice and (7) Medical interns (general). Moreover, this definition excludes the following profiles: (1) Paediatricians; (2) Obstetricians and gynaecologists; (3) Specialist physicians (internal medicine); (4) Psychiatrists; (5) Clinical officers.

18 The decrease in the size of the sample for Austria, Croatia, Finland, Hungary, and Slovenia is not at all significant in terms of statistical robustness, as it impacts sampling error only by 0.73% at most (in Slovenia from  $\pm 6.34\%$  to  $\pm 7.07\%$ ).

## 2.4 Survey development and fieldwork

*The sample was extracted to a very large extent from the official lists defining the universe of GPs. Data gathering was completed in March 2013 and used mixed methods for the interviews*

The sample was extracted directly from the official lists that define the universe of GPs in all of the 31 countries, rather than using the proprietary datasets of market research companies, and this ensured a transparent and replicable sampling strategy. To this end, UEMO, the European level association of national GPs associations, was included as part of our consortium. Despite this, the process proved challenging for various reasons<sup>19</sup> and required the adoption of a contingency plan (see chapter 3 of TC). As a result, we were able to implement the proposed approach for 80% of the universe where we extracted randomly the sample from the official lists; data was then gathered either directly by the consortium partner in charge of fieldwork (Block de Ideas. henceforth BDI), or through the mediation of the representatives of the national GPs associations members of UEMO. For the remaining 20%<sup>20</sup> of the universe, sampling and data gathering was performed by BDI international partners specialised in survey research in the health industry, selected with the criteria that they had access to the official lists and/or that their datasets were large enough and consolidated for at least five years to be considered a good proxy of the universe as defined by the official lists. Respondents have been given the choice of completing the questionnaire online or being interviewed by phone, and, depending on their choice, data were either gathered online or through phone interviewing with real-time online data input ("web-CATI" where CATI stands for Computer Assisted Telephone Interviews). The next table reports summary metrics about the timing and method of data gathering, which started on 25<sup>th</sup> October 2012 and ended on 6<sup>th</sup> March 2013.

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19 Among the reasons we point out the following: a) Not publicly available. In a very few countries lists could be downloaded online (where this was possible we downloaded the lists, extracted the sample, and managed the data gathering) b) Fragmented lists. Official lists are distributed, fragmented, and difficult to get access to. In countries with a more pronounced regional/federal structure, the national body or GP association still needed to gain collaboration from the local level bodies, which increase geometrically the work to convince and then coordinate the different owners of the lists; c) Data protection concerns. Concerns with data protection were very high among GPs associations, and the letter of endorsement from the Commission was not sufficient to address them. In many countries, GPs associations agreed to collaborate only after we asked a software house to develop the online third party platform ensuring that the Consortium could use the lists but not get hold of them. Despite this, several countries refused to participate, which explains the need to allocate 20% of the universe to BDI international partners; d) capacity bottlenecks. UEMO and many (but not all) of the national associations have limited human resources and no experience in collaborating in this sort of survey; e) difficulty to convey purpose and other aspects of the study. It was also difficult to communicate the objectives, purpose and methodology of the study. Individual GPs participating in the focus groups, as well as the national representatives, wondered what would be the practical purpose of having a measurement if no concrete actions would then follow. We explained about the role of benchmarking for European policy making, but they remained sceptical about it.

20 This concerned the following countries: Austria, Belgium, Bulgaria, Cyprus, Estonia, Latvia, Poland, Romania, and Slovakia.



**Table 3 Data gathering timing and method**

Country	Sample	Launch	Completion	Method
Austria	333	15/01/2013	27/02/2013	Online
Belgium	406	06/02/2013	02/03/2013	Online
Bulgaria	310	14/01/2013	29/01/2013	Web-CATI
Croatia	250	10/12/2012	28/02/2013	Web-CATI
Cyprus	50	21/01/2013	01/02/2013	Face-to-face
Czech Republic	308	14/12/2012	03/03/2013	Online
Denmark	306	13/11/2012	25/02/2013	Online
Estonia	50	14/01/2013	23/01/2013	Online
Finland	283	17/12/2012	28/02/2013	Online
France	401	29/10/2012	28/02/2013	Online
Germany	403	25/10/2012	26/02/2013	Online
Greece	332	12/12/2012	28/02/2013	Online
Hungary	268	18/12/2012	28/02/2013	Online
Iceland	53	06/02/2013	06/03/2013	Online
Ireland	200	22/11/2012	03/03/2013	Online
Italy	416	09/11/2012	18/02/2013	Online
Latvia	200	14/01/2013	23/01/2013	Web-CATI
Lithuania	212	07/01/2013	01/03/2013	Online
Luxembourg	73	21/01/2013	11/02/2013	Online
Malta	50	24/01/2013	15/02/2013	Face-to-face
Netherlands	400	20/12/2012	02/01/2013	Online
Norway	335	14/12/2012	12/02/2013	Online
Poland	412	17/01/2013	01/03/2013	Online
Portugal	513	02/01/2013	05/02/2013	Online
Romania	403	15/01/2013	18/02/2013	Web-CATI
Slovakia	201	15/01/2013	14/02/2013	Face-to-face
Slovenia	167	20/12/2012	28/02/2013	Online
Spain	469	14/12/2012	25/02/2013	Online
Sweden	338	03/12/2012	20/02/2013	Online
Turkey	572	24/01/2013	18/02/2013	Online/Web-CATI
United Kingdom	482	16/11/2012	25/02/2013	Online
<b>Total</b>	<b>9196</b>	<b>25/10/2012</b>	<b>06/03/2013</b>	

### 3. Descriptive findings

#### Box 2 Chapter 3 Roadmap

This chapter presents the descriptive results of the survey and, for ease of reference, indicates next to the heading of paragraphs and figures the exact questions from which the presented findings come. In § 3.1 we present a general individual and organisational characterisation of the respondents (taken from Part A of the questionnaire). In § 3.2 we report the findings on access and use of basic ICT infrastructures. The findings on availability and use of the four measurement pillars (EHR, HIE, telehealth, and PHR) are illustrated in the following four paragraphs (§ 3.3 through § 3.6). Finally, in § 3.7 still only at descriptive level we compare the findings of our survey with those from the previous EC funded survey conducted in 2007 (Dobrev, et al, 2008).

Please note that, as anticipated, we look at aggregate level findings and provide country level data only for the composite indicators, the composite index, and the comparison between 2007 and 2013 in chapter 4. The readers are referred to the country profiles for a country's detailed findings.

We clarify here at the very start of this chapter two aspects that are important for a correct reading of the findings. The first concerns the changing base sample (number of respondents) depending on different items of the questionnaire, the second a new variable constructed for what regards the answers on all the four pillars of measurement (Electronic Health Records; Health Information Exchange; Personal Health Records; Telehealth).

**Changing base sample.** When we say that our sample comprises 9196 GPs, this means 9196 respondents who completed the interview. In fact, we started the interview with 9224, but 28 (0.3%) respondents were removed after Q11 because they answered they had no access and did not use a computer. So, our total sample includes 9116 GPs that have and use a computer. In Q19a, these 9196 respondents answered whether they had some form of even basic EHR system. A total of 616 GPs answered no, instance, that when we report in Table 6 that 96.8% have a 'prescriptions and medications' functionality, this percentage is calculated on the N=8580. For the other pillars, the N remains the total sample as defined above (N=9196). On the other hand, for obvious reasons, the base over which percentages of use are calculated varies for each row in each of the four tables reporting on the four pillars. The questions about use were asked only if respondents reported having an item, and thus the base for the calculation of use percentages changes as a function of the answer to the availability question item by item.

*The total sample upon which percentages are calculated changes as a function of filter questions and because answers about use are asked only to respondents who have an item*



*A new base measure of adoption combining availability and use into a 5 points scale was created and will be used for the construction of composite indicators and of the overall composite index*

**New base variable constructed.** As explained earlier and as the readers can verify looking at the questionnaire for the four pillars of measurements (EHR: Q20-Q20b; HIE: Q21; Telehealth: Q22-Q23; PHR: Q24a-q24b) we have asked our respondents whether they have at their disposal a number of functionalities (henceforth referred to also simply as items) and the possible answers were: 'don't know', 'no', 'yes'. To those who answered that they have a given item at their disposal, we then asked about the usage of such item and the possible answers were: 'do not use it', 'use it occasionally', and 'use it routinely'. When we present the descriptive results for these four pillars of measurement (§ 3.3 through 3.6) the first table we bring to the attention of the readers is merely descriptive with answers on availability and usage reported separately. On the other hand, as a first step toward the processing of the data in the direction of making them more intelligible for all of the four measurement pillars we constructed a new base level variable that is a more synthetic measure of adoption combining availability and usage. This new base level measure of adoption has been created combining the answers to both availability and use into a five points scale as described in the box:

**Don't know (not aware)= 0; Do not have it= 1; Have it and do not use it= 2; Use it occasionally= 3; Use it routinely= 4.**

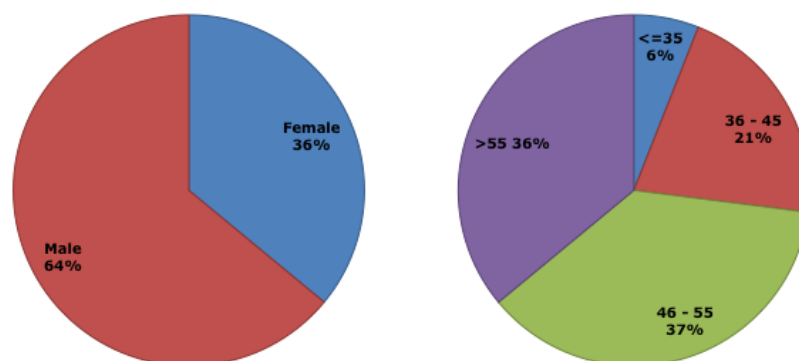
The variable has been constructed and used in the exact same way for all the four measurement pillars: Electronic Health Records (EHR); Health Information Exchange (HIE); Telehealth; Personal Health Records (PHR). We also anticipate here that this new variable is the base upon which the composite indicators and the composite index have been constructed. Since in this chapter we only report descriptive table with percentage of how many respondents fall into the five discrete value of this categorical variable, there is no need to add further explanation of how to interpret this scale. This is instead illustrated at the end of § 4.1 of next chapter on the composite indicators and on the composite index since in this case the scores obtained must be interpreted correctly with respect to the 0 to 4 range of this variable.

### 3.1 General characterisation (Q1- Q10)

The next two figures and Table 4 show the gender and age distribution of our sample.

**Figure 4 Gender (Q1) and Age (Q2)**

*Two thirds of GPs interviewed are males, and the majority (73.2%) are 46 or older, with 20.5% between 36 and 45 years of age, and only 6.4% below 35*



At aggregate sample level we have two thirds of GPs who are males and one third who are females, 6% doctors below 35 years of age, 24% between 36 and 45 years, 37% between 46 and 55 years, and the remaining 36% over 55 years.

**Table 4 Gender and age group (Q1 - Q2)**

Country	Gender		Age			
	Female	Male	<=35	36-45	46-55	>55
Austria	35.4%	64.6%	5.1%	19.8%	39.3%	35.7%
Belgium	27.8%	72.2%	11.8%	22.4%	28.6%	37.2%
Bulgaria	68.1%	31.9%	1.9%	23.9%	54.2%	20.0%
Croatia	76.8%	23.2%	3.2%	23.2%	51.2%	22.4%
Cyprus	42.0%	58.0%	4.0%	14.0%	48.0%	34.0%
Czech R.	61.4%	38.6%	17.5%	29.2%	25.0%	28.2%
Denmark	39.2%	60.8%	1.0%	21.9%	30.4%	46.7%
Estonia	94.0%	6.0%	2.0%	14.0%	46.0%	38.0%
Finland	67.8%	32.2%	19.1%	20.5%	28.6%	31.8%
France	20.4%	79.6%	3.2%	16.0%	45.1%	35.7%
Germany	34.2%	65.8%	1.7%	19.1%	44.4%	34.7%
Greece	32.8%	67.2%	11.1%	56.0%	19.6%	13.3%
Hungary	55.2%	44.8%	11.6%	24.3%	31.7%	32.5%
Iceland	24.5%	75.5%	7.5%	18.9%	32.1%	41.5%
Ireland	34.0%	66.0%	5.0%	18.0%	36.0%	41.0%
Italy	14.2%	85.8%	0.7%	1.9%	28.8%	68.5%
Latvia	92.0%	8.0%	2.5%	18.5%	38.0%	41.0%
Lithuania	82.5%	17.5%	8.5%	25.0%	34.9%	31.6%
Luxembourg	39.7%	60.3%	24.7%	24.7%	23.3%	27.4%
Malta	24.0%	76.0%	4.0%	32.0%	56.0%	8.0%
Netherlands	40.8%	59.2%	10.8%	20.5%	33.2%	35.5%
Norway	41.2%	58.8%	15.5%	25.4%	27.5%	31.6%
Poland	54.4%	45.6%	12.4%	43.0%	28.2%	16.5%
Portugal	55.9%	44.1%	6.4%	13.8%	18.3%	61.4%
Romania	77.2%	22.8%	1.0%	15.4%	38.7%	44.9%
Slovakia	69.2%	30.8%	3.0%	22.4%	25.4%	49.3%
Slovenia	74.3%	25.7%	16.2%	31.1%	38.9%	13.8%
Spain	36.5%	63.5%	4.3%	17.1%	47.3%	31.3%
Sweden	50.0%	50.0%	2.7%	20.4%	23.1%	53.8%
Turkey	26.0%	74.0%	20.3%	47.0%	27.8%	4.9%
UK	39.4%	60.6%	11.4%	28.2%	34.6%	25.7%
<b>TOTAL</b>	<b>36%</b>	<b>64%</b>	<b>6%</b>	<b>21%</b>	<b>37%</b>	<b>36%</b>

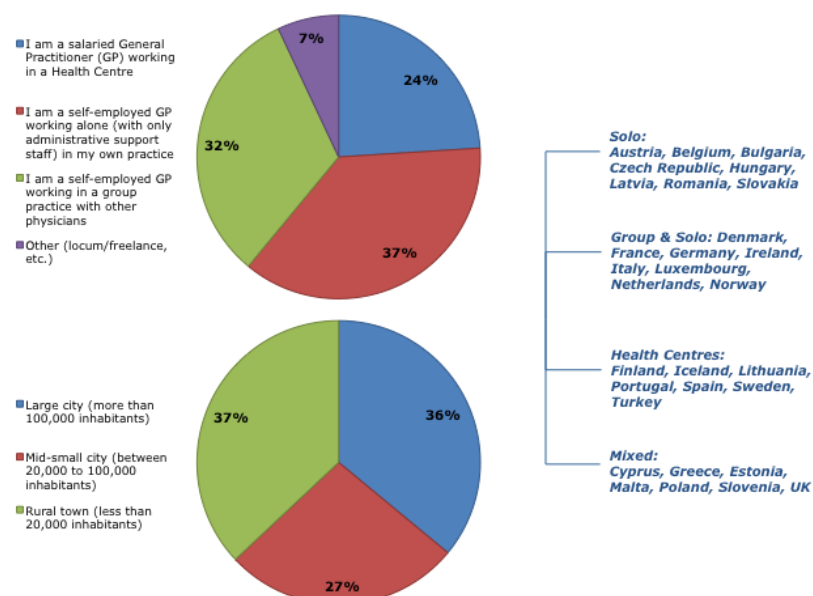
*Deviations from the mean for gender reflect what is known about countries, whereas our sample is slightly older than the population of reference*

The table above, however, shows some remarkable country differences in terms of both gender and age. As anticipated (see footnote 14), we do not have internationally comparable break down of strictly defined GPs in terms of gender and age. Using just as a proxy for this kind of break down for the broader category of 'physicians'<sup>21</sup> we can say that the country specificity in our sample in terms of gender seemingly reflects to a fairly large extent what is known about these countries for the category 'physicians', and from the secondary sources used for the institutional and organisational mapping of primary care. As per the age structure of our sample, we should stress that it appears slightly older than the universe of reference (still using as proxy the statistics on 'physicians') both at aggregate level and for some countries. This is in line with what is well known about response rates to surveys (lower response rates among younger age groups as compared to older ones), and deviation of our mean age with respect to the parameters of the universe of reference are within acceptable levels and aligned to country tendencies. In our sample, for instance, we have a particularly high share of GPs aged above 55 in Italy; in OECD statistics on 'physicians' this country also shows a higher than average percentage of physicians (not only GPs) above 55.

Moving to practices' organisational settings, we can see that almost one quarter of the total (24.4%) works as salaried GPs in a health centre, while more than two thirds (68.7%) are self-employed, either working alone (37%) or in a group practice (31.7%). Only 7% of GPs in our sample develop their activity in other ways, mainly freelance. The distribution of the work place location reveals that 36% of the GPs work in large cities; 27% work in middle or small cities and 37% work in rural towns.

**Figure 5 Type of practice (Q3) and location (Q6)**

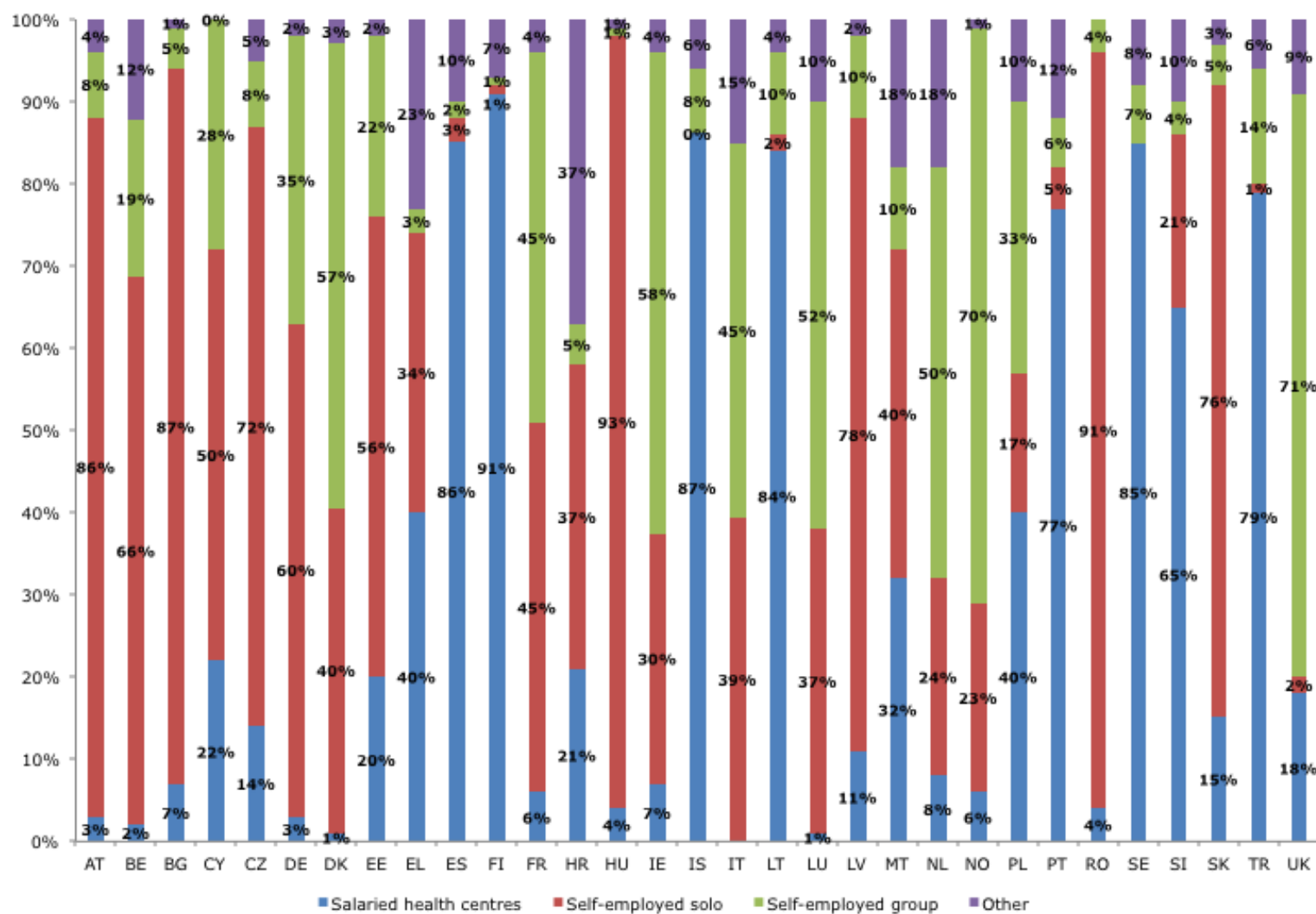
*The split in terms of practice settings and of location reflects well what is known about the universe of reference, which confirms the robustness of our sample*



21 OECD Health Data - Health Care Resources: Physicians by age and gender at <http://www.oecd.org/els/health-systems/oecdhealthdata.htm>

Figure 6 below shows the distribution of the type of practice by country. The first aspect to stress is that our sample almost perfectly reflects the *ex ante* characterisation that is reported in Table 12 of the TC. This is a clear confirmation of the good level of representativeness of our sample, since we did not stratified *ex ante* by practice settings and location. GPs working in cities with more than 100.000 inhabitants are 35.6% of our sample, those in mid-small cities 27.1%, and those in rural towns 37.2%, which represents a good split with respect to the universe of reference.

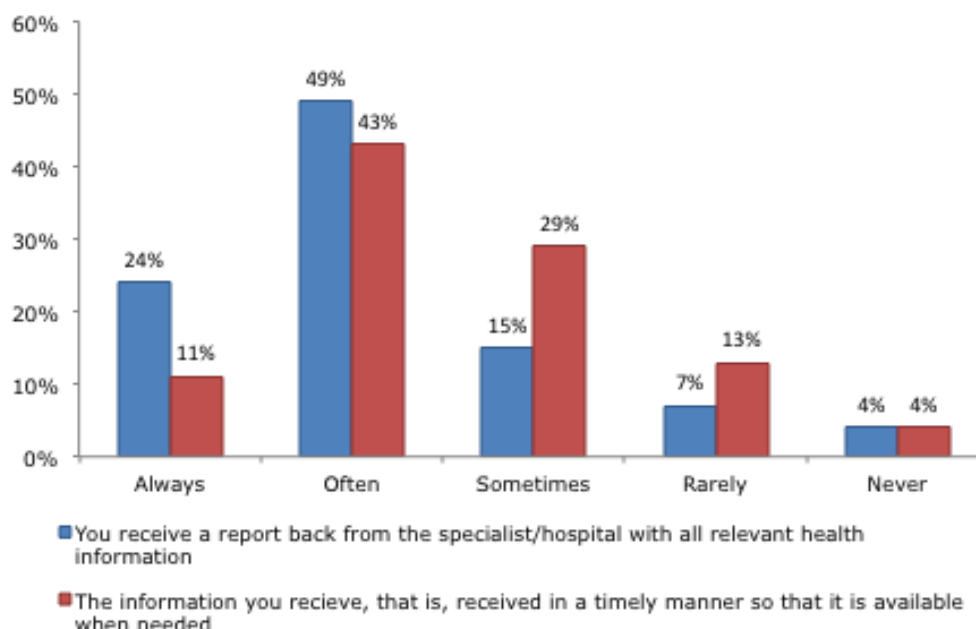
Figure 6 Type of practice by country (Q3)



Finally, let us look at the answers to question Q9 (text reported in full in the figure below) that aimed to assess the extent to which GPs interact with specialists and hospitals. This was asked at the beginning before any question on ICT, and was meant to be a sort of control question especially with respect to HIE.

**Figure 7 Interaction with specialists and/or hospitals (Q9)**

*It seems that GPs interact with specialists and hospitals fairly often ...*



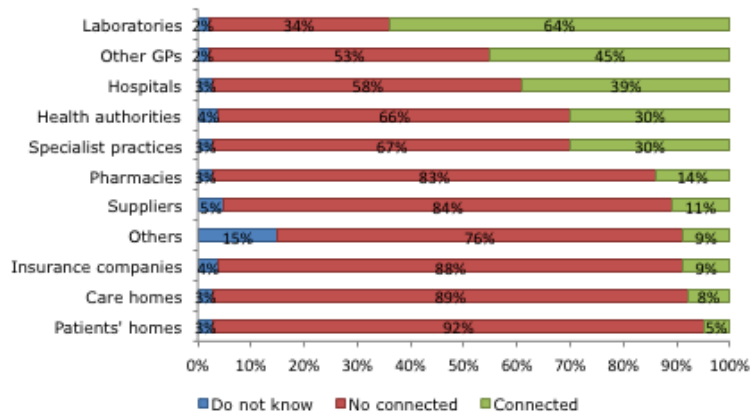
*... but they do so using several channels, of which the electronic one is not predominant*

The data seem to suggest that GPs are in contact with specialists and hospitals fairly often, as about 74% of them answer that they receive a report back often or always. Since, as we show later, ICT enabled system connectivity and availability / use of HIE functionalities are much lower than 74%, the next question (Q10) gives us the answer on how they receive the reports (multiple answers were possible and so percentages do not add up to 100%): by fax 26.8%; by regular mail or courier 50.6%; by electronic mail 30.5%; through remote electronic access 20.5%; the patient hands the report to them 78.1%. So, it seems that GPs interact with specialists and hospitals, but by several means, of which the electronic one is not predominant. This is confirmed by the answers to the additional control question (Q17) where we asked GPs which organisations or persons their office's ICT system is connected to electronically.

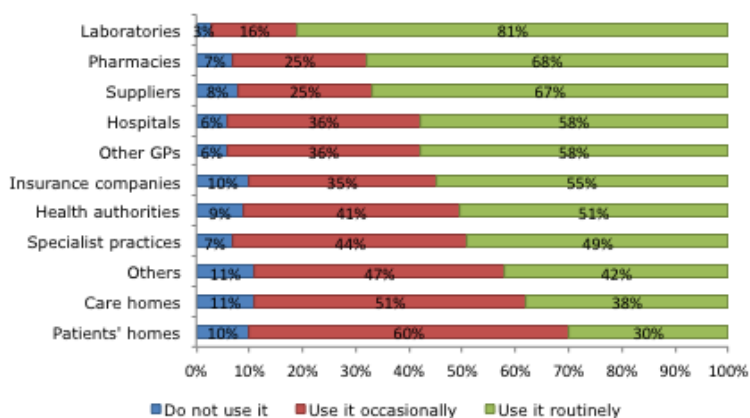
**Figure 8 Office ICT system inter-connection (Q17)**

*... indeed connection via a shared system with other players is rare and on average 10% of GPs do not use such possibility even when it is available*

Being connected  
(n=9196)



Among those being connected, using the connection  
(N depending on having or not)

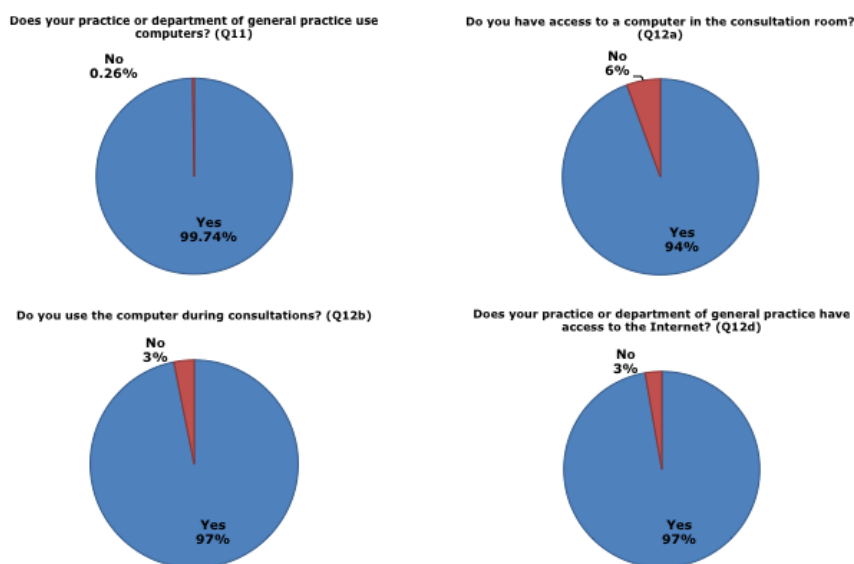


## 3.2 Basic Infra and Info structure (Q11-Q18)

The four pie charts below lead to the following conclusions: a) access to basic ICT is by now universal; b) in future surveys these four questions could be spared and used for investigating other more relevant matters. Reminder: for the data in the top left corner, the base N is 9224; then the 0.3% answering they do not use a computer were removed from the rest of the survey.

**Figure 9 Basic infrastructure availability and use**

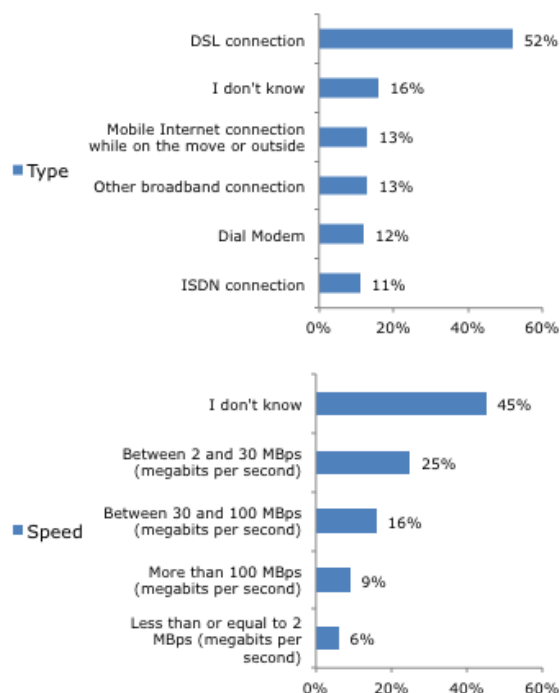
*Access to, and use of, basic ICT is by now almost universal; these items do not need further measurement in the future*



For the type of Internet connection we see that only 65.6% has some form of broadband connection, whereas for speed of connection 45% cannot answer the question and only a small percentage report having high-speed connection.

**Figure 10 Type (Q12e) and speed of connection (Q12f)**

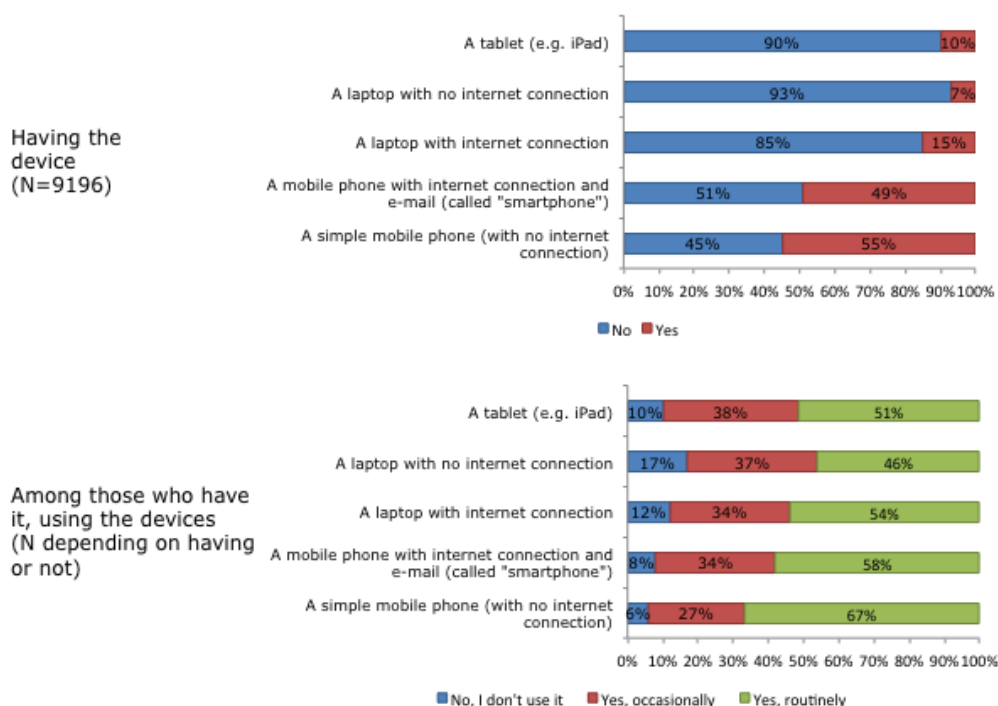
*Broadband connection of some sort is available to 65% of GPs, but only 9.5% report having access to very high speed Internet connection*





The levels of availability and use of mobile devices (for medical purposes) among the GPs in our sample is not as high as for basic ICT devices and infrastructure. The availability of smart phones is below 50% of the sample (49%), that of a tablet just reach 10%, and that of laptops with connection to the Internet just 15%. On the other hand, if these devices are available, their use when visiting patients outside of the office is fairly high.

**Figure 11 Mobile devices when working on the move (Q13)**



**Table 5 Mobile devices when working on the move (Q13)**

	Availability			Use			N
	Do not have it	Have it	N	Do not use it	Use it occasionally	Use it routinely	
<b>A simple mobile phone (with no internet connection)</b>	45%	55%	9196	6%	27%	67%	5058
<b>A mobile phone with internet connection and e-mail (called "smartphone")</b>	51%	49%	9196	8%	34%	58%	4506
<b>A laptop with internet connection</b>	85%	15%	9196	12%	34%	54%	1379
<b>A laptop with no internet connection</b>	93%	7%	9196	17%	37%	46%	644
<b>A tablet</b>	90%	10%	9196	10%	38%	51%	920

The availability of more advanced form of security is not very widespread (multiple answers were possible, so total does not add up to 100%). The most cited feature is a basic password protected access, whereas only 34% and 28% of respondents mentions encryption and electronic signature, respectively.

**Figure 12 Security features (Q15)**

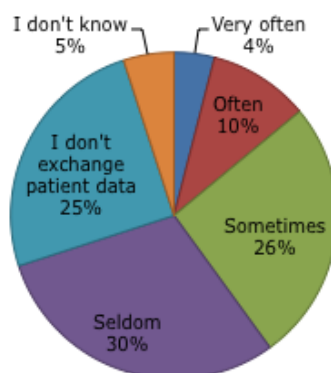
*The majority of GPs have only basic security solutions, with smaller percentages reporting having encryption or electronic signature*



Furthermore, GPs were asked how often they encounter problems of compatibility when exchanging patient data electronically. First, we can see that 25% of the respondents report that they do not exchange patient data. More than 56% of the individuals stated that they have this type of problems sometimes or seldom; just 4% claimed that they encounter this problem very often.

**Figure 13 Compatibility problems for data exchange (Q16)**

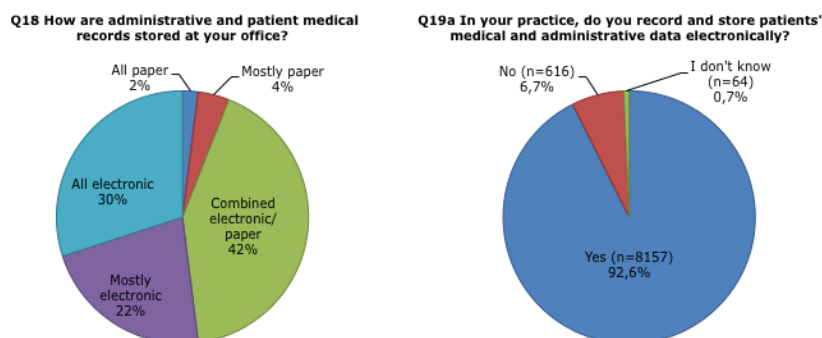
*56% of GPs report having compatibility problems when exchanging patients' data*



Finally, in next two figures we report a control questions (Q18) and the general question we used to measure access to basic EHR (Q19a).

*Almost everyone seems to have a basic EHR system, although digitalisation of records is far from completed*

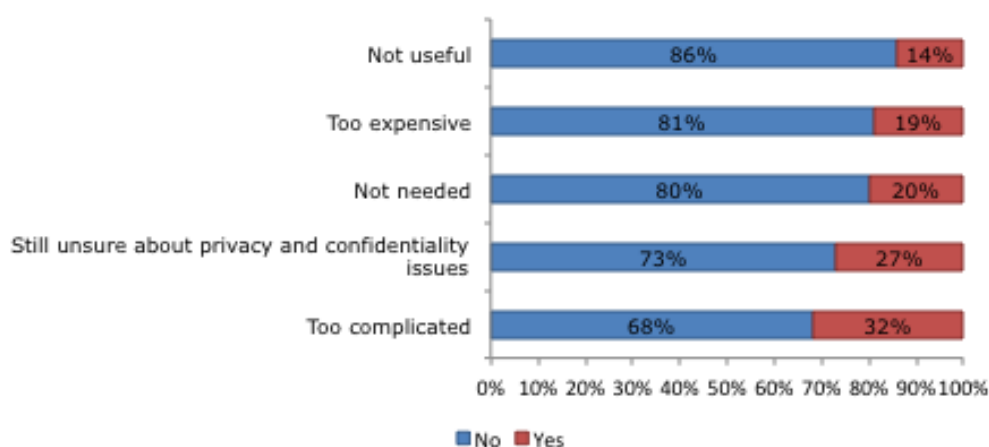
**Figure 14 How records are stored (Q18 vs. Q19a)**



We notice that less than 50% of respondents store records only or mostly electronically, and paper records are still used extensively. This is a result that helps us better interpret the very high level of availability of basic EHR measured by Q19a, showing that 92,6% of the sample report having some system to electronically store patient medical and administrative data.

GPs who stated that they do not record or store patients' medical and administrative data electronically in their practice were asked why their offices do not have these systems. The main reason reported was complexity: 32% of them claimed that these systems are too complicated. The second reason reported is related to privacy and confidentiality: 27% stated that they are still unsure about both issues. Moreover, 20% replied that they do not need them, 19% emphasised that it is too expensive, and just 14% answer that it is not useful.

**Figure 15 Reasons for not having EHR (Q19b)**



*The most cited reason for not having EHR is system complexity, followed by privacy and confidentiality concerns*

### 3.3 Electronic Health Record (Q20a-Q20b)

GPs were asked about availability and use of 25 different functionalities so as to identify their access and use of Electronic Health Records (EHR) within their practice. GPs who claimed that they do not record or store patients' medical and administrative data were not asked about these functionalities (hence the base for percentages calculation is 8580 instead of 9196). Table 6 summarises the frequencies of all items.

**Table 6 EHR Functionalities: availability and use**

Indicator	Availability				Use			
	DK	No	Yes	N	No	Yes, occasionally	Yes, routinely	N
Basic medical parameters	1%	7%	92%	8283	2%	10%	89%	7599
Vital signs	4%	11%	84%	8283	4%	14%	83%	6982
Treatment outcomes	4%	11%	85%	8283	3%	11%	86%	7043
Problem list / diagnoses	1%	6%	92%	8283	2%	9%	89%	7659
Medication list	1%	5%	94%	8283	1%	5%	94%	7813
Immunizations	2%	8%	90%	8283	3%	17%	79%	7452
Medical history	1%	7%	92%	8283	2%	9%	89%	7631
Patient demographics	8%	13%	79%	8283	5%	25%	70%	6558
Lab test results	1%	8%	91%	8283	1%	6%	93%	7547
Radiology test reports	2%	21%	76%	8283	3%	9%	88%	6333
Radiology test images	5%	57%	38%	8283	13%	22%	66%	3147
Symptoms (reported by patient)	1%	10%	89%	8283	3%	8%	89%	7360
Reason for appointment	1%	9%	89%	8283	4%	11%	84%	7383
Clinical notes	2%	8%	91%	8283	3%	10%	87%	7498
Prescriptions / medications	1%	4%	95%	8283	1%	4%	95%	7881
Ordered tests	3%	11%	86%	8283	3%	10%	87%	7127
Create/update disease management/care plan	5%	19%	76%	8283	5%	19%	77%	6263
Finances / billing	11%	29%	61%	8283	17%	17%	66%	5029
Administrative patient data	3%	8%	88%	8283	4%	17%	79%	7330
Clinical guidelines and best practices	8%	56%	35%	8283	4%	29%	67%	2921
Drug-drug interactions	4%	38%	58%	8283	3%	22%	76%	4837
Drug-allergy alerts	4%	34%	62%	8283	2%	14%	84%	5124
Drug-lab interactions	10%	61%	29%	8283	7%	24%	69%	2418
Contraindications	6%	53%	41%	8283	3%	20%	77%	3391
Be alerted to a critical laboratory value	6%	46%	48%	8283	3%	15%	82%	3980

Please note that, as explained at the beginning of this chapter, the N for the use "measures" for each functionality is at least equal to the number of respondents reporting having that functionality. In some cases the N is smaller due to the absence of response in some cases (missing values). We will not repeat this explanation when we present similar tables in the next paragraphs.

*Availability for most functionalities is fairly high on average, and is below 60% only for six of them, with the lowest level being that of 'Radiology test images' and 'Drug-Lab interaction'*

More than 90% of the respondents stated that Immunizations, Clinical notes, Ordered tests, Symptoms, Problem list / diagnoses, Basic medical parameters (e.g. allergies), Lab test results, Prescriptions / medications and Medication list functionalities are available in their EHR system. Moreover, the majority (90% approximately) who have these functionalities use them routinely. Availability is below 60% of GPs for the following functionalities: Finances/billing; Contraindications (e.g. based on age, Gender, pregnancy status); Alert to critical laboratory value; Clinical guidelines and best practices (e.g., alerts. prompts); Radiology images; and Drug-lab interactions. On the other hand, the majority of the GPs who have these functionalities at their disposal use them in their practice routinely. So, what we can call the 'have/use gap' is fairly limited. On the other hand, if we look more closely at the GPs who have access to certain functionalities but do not use them, we can identify the highest gap (have but do not use) in: Finances/billing (14.1%); Radiology images (12.4%); and Drug-lab interactions (7%). All other functionalities are used occasionally or routinely by more than 95% of the respondents.

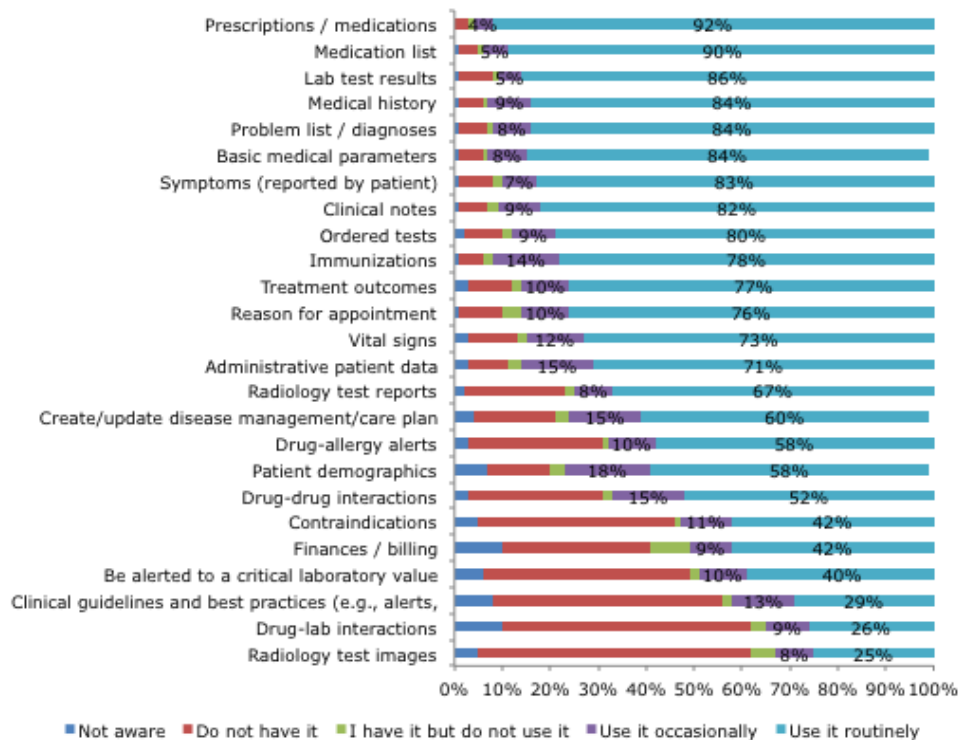
Figure 16 below reports the descriptive statistics for the new measure of adoption that we have illustrated at the beginning of this chapter<sup>22</sup>. For ease of reference we recall that this variable is a five points scale, that combines answers on availability and use, with the following value: 0= don't know (not aware if they have or not an item); 1= do not have it; 2= have it but do not use; 3= use it occasionally; 4= use it routinely). The figure shows the percentage of GP in each category.

*At descriptive level we see that adoption is highest for Prescriptions and Medication lists, and lowest for Drug-Lab interactions and Radiology Test Images*

More than 75% of the GPs routinely use: Reason for appointment; Treatment outcomes; Immunizations; Ordered tests; Clinical notes; Symptoms (reported by patient); Medical history; Problem list / diagnoses; Basic medical parameters (e.g. allergies); Lab test results; Medication list and Prescriptions / medications. On the contrary, less than 30% of the respondents report using routinely: Radiology images; Drug-lab interactions; and Clinical guidelines and best practices. In between, more than 75% and less than 30% routine use we find: Vital sign; Administrative patient data; Radiology tests; Disease management; Drug allergy alert; Patient demographics, Drug-drug interaction; Contraindications;/ Finance/billing; and Alert to critical laboratory value.

<sup>22</sup> Please note that in this figure the percentages have been calculated using as a base the total sample (in this case of those answering Yes or Do not know to Q19a, so N=8581); thus the percentage on occasional use and routine use in the figure do not correspond to those in the table. The same notation applies also to the similar figures reported in the next three paragraphs (where the base is N=9196).

**Figure 16 EHR: from awareness to use**



*It is noteworthy that adoption is the lowest for important functionalities such as 'Drug-Lab Interaction' and 'Radiology Images', while Finance/Billing is the functionality for which the percentage of those who have it but do not use it is the highest*

Although later the Factor Analysis (FA) will show some patterns in the adoption of EHR functionalities (see chapter 4, § 4.1.1), looking only at the descriptive findings it is not easy to spot some sharp differences in availability and usage among different groups of items, as will be the case instead for the other measurement pillars. Nonetheless, it is noteworthy that adoption is lowest for some important functionalities such as 'Drug-Lab Interaction' and 'Radiology Images', while Finance/Billing is the functionality for which the percentage of those who have it but do not use it is the highest. The possibility of accessing radiology images requires a fairly powerful and fast Internet connection, whose availability we saw to be very low. So, this result makes sense though we cannot conclude whether it is not available for lack of access to high speed Internet or because is not considered necessary and useful (in which case there is no drive to deploy more powerful Internet connections)<sup>23</sup>. The low availability of alert on interaction between drugs and laboratory tests may be explained by the lack of inter-connection with different players of the healthcare system. Many GPs have but do not use the finance and billing functionality probably for lack of time and interest, and possibly because such task is delegated to an assistant.

<sup>23</sup> We should not forget that many GPs are not trained to interpret radiology images, so their use is informative rather than diagnostic. They rely on the radiologist's report for diagnosis.

### 3.4 Health Information Exchange (Q21)

GPs were asked whether their ICT systems allow them to transfer/share/enable/access patient data electronically for 15 different functionalities related with Health Information Exchange (HIE). Table 7 summarises the frequencies of all items.

**Table 7 HIE Functionalities: availability and use**

Indicator	Availability				Use			
	DK	No	Yes	N	No	Yes, occasionally	Yes, routinely	N
Receive laboratory reports	3%	29%	68%	9196	4%	12%	84%	3686
Certify sick leaves	5%	35%	60%	9196	6%	14%	80%	4248
Send/receive referral and discharge letters	5%	47%	47%	9196	10%	25%	65%	2636
Patient appointment requests	5%	49%	46%	9196	14%	30%	56%	4364
Interact with patients by email about health-related issues	7%	53%	40%	9196	13%	51%	36%	3222
Exchange medical patient data with other healthcare providers and professionals	7%	55%	39%	9196	12%	39%	49%	3286
Receive and send laboratory reports and share them with other healthcare professionals/providers	8%	54%	39%	9196	12%	33%	56%	3551
Transfer prescriptions to pharmacists	6%	59%	36%	9195	11%	19%	70%	6265
Certify disabilities	9%	55%	36%	9195	7%	22%	70%	3544
Order supplies for your practice	12%	53%	35%	9196	12%	41%	47%	2808
Exchange patient medication lists with other healthcare professionals / providers	9%	61%	31%	9196	13%	34%	53%	2687
Exchange administrative patient data with payers or other care providers	12%	57%	31%	9196	13%	31%	56%	1470
Make appointments at other care providers on your patients' behalf	6%	65%	29%	9196	16%	33%	51%	5535
Exchange radiology reports with other healthcare professionals / providers	8%	63%	29%	9196	12%	35%	53%	3314
Exchange medical patient data with any healthcare provider in other countries	11%	73%	16%	9196	24%	31%	45%	2821

*Availability is clearly lower than for EHR with only two functionalities above 60% and as many as 8 out of 15 below 40%*

Results show that only for laboratory reports and certification of sick leave is availability above 60% (68% and 60% respectively). Less than 40% report having the possibility for: Exchange medical patient data with other healthcare providers and professionals; Receive and send laboratory reports and share them with other healthcare professionals/providers; Transfer prescriptions to pharmacists; Certify disabilities; Order supplies for your practice; Exchange patient medication lists with other healthcare professionals / providers; Exchange administrative patient data with payers or other care providers; Make appointments at other care providers on your patients' behalf; Exchange radiology reports with other healthcare professionals / providers; and Exchange medical patient data with any healthcare provider in other countries. In between availability (above 40% and below 60%) is registered for:

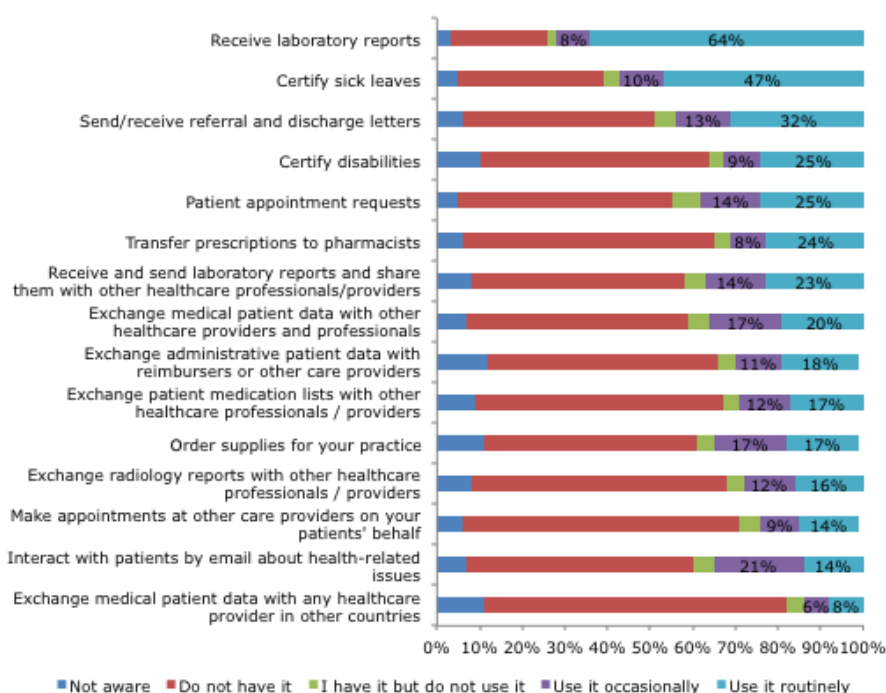


Send/receive referral and discharge letters; Patient appointment requests; and Interact with patients by email about health-related issues.

*The 'having/using gap' is also higher than for EHR with on average 10% of GPs having but not using most of the functionalities*

The analysis of the uses reported by GPs reveals a gap of more than 10% between having and using in the majority of the functionalities available. More than 60% of the respondents stated that they use routinely the following: Receive laboratory reports; Certify sick leaves; and Send/receive referral and discharge letters; Transfer prescriptions to pharmacists; and Certify disabilities. Approximately half of the GPs routinely use the rest of the functionalities with the exception of the email with patient, which is used just by 36% of them.

**Figure 17 HIE: from awareness to use**



The figure above reports the descriptive statistics for the new measure of adoption that we have illustrated at the beginning of this chapter, showing the percentage of GP in each category. More than 46% of the respondents stated that they routinely "Receive laboratory reports" and "Certify sick leaves" using their ICT systems. Approximately only a quarter of GPs routinely use patient appointment request, certify disabilities, transfer prescription to pharmacists, and receive and send laboratory reports. Finally, less than 15% of the respondents interact with patients by email, make appointments at other care providers on patients' behalf, and exchange medical patient data with any healthcare provider in other countries. In the case of HIE, is easier to spot even at descriptive level some clear patterns. It is evident that availability and high adoption is higher for some very simple (laboratory reports and referral/ discharge letters) and/or mostly non-clinical (sick leave and disability certification) activities. Among the HIE functionalities most emphasised by policy makers the availability and adoption of ePrescription remain fairly limited despite the progress that can be

*High adoption is above 40% only for receiving laboratory reports and certification of sick leave*

*Availability and adoption are high only for a few basic functionalities and remain limited for ePrescription*



seen compared to 2007 (see § 3.7). Exchange and sharing of information with other healthcare providers abroad, interacting by mail with patients, and making appointments on patients behalf are not very widespread.

### 3.5 Telehealth (Q22-Q23)

*Availability of telehealth is fairly low and particularly for remote monitoring of, and consultation with, patients*

GPs were asked about availability and use of four different telehealth services. The question was formulated as followed: "Telehealth is the use of broadband-based technological platforms for the purpose of providing health services, medical training and health education over a distance. Which of the following telehealth services do you currently have access to? [For items answered as "Yes"] Do you use the following "telehealth" services?" (Q22). Training and Education was reported as available by 36% of GPs; Consultations with other healthcare practitioners by 16%; Consultation with patients by 10%; and Monitoring patients remotely at their homes by only 4%.

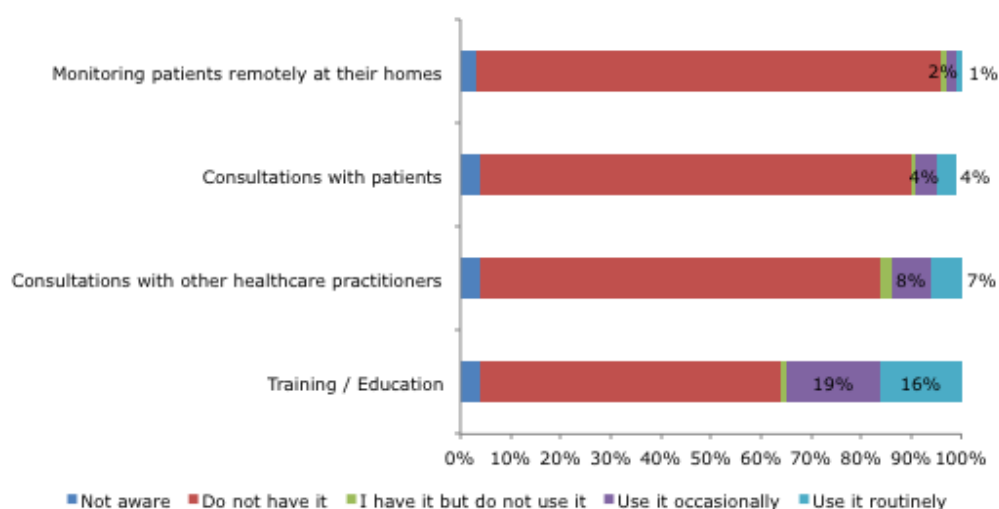
**Table 8 Telehealth Functionalities: availability and use**

Indicator	Availability				Use			
	DK	No	Yes	N	No	Yes occasionally	Yes routinely	N
Training	4%	60%	36%	9.196	4%	52%	44%	3350
Consultations with patients	4%	86%	10%	9.196	14%	43%	43%	912
Consultations with other professionals	4%	80%	16%	9.196	9%	48%	43%	1.506
Remote monitoring	3%	93%	4%	9.196	26%	44%	30%	356

Almost half of GPs who have access to Training / Education, and to Consultations with patients and Consultations with other healthcare practitioners, use it routinely. This percentage decreases to 30% in the case of monitoring patients remotely at their homes.

**Figure 18 Telehealth: from awareness to use**

*Adoption is also very limited, with only consultation with patients reaching some noticeable level of routine usage*



The figure above reports the descriptive statistics for the new measure of adoption that we have illustrated at the beginning of this chapter, showing the percentage of GP in each category. The results

show that high adoption is very limited for three out of four functionalities, and reaches a somewhat noticeable value only for consultation with patients.

### 3.6 Personal Health Records (Q24a and Q24b)

*Availability of PHR services for patients is very limited, although when available GPs reports some level of usage by the patients*

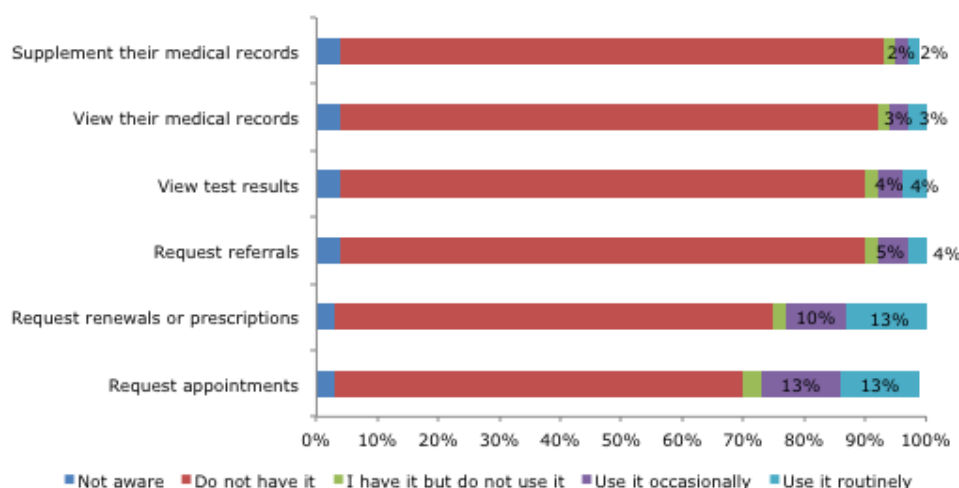
GPs were asked whether their ICT systems give patients the possibility to access/do online six different types of functionality / service (Q24b). More than 80% of the respondents stated that patients do not have the possibility to: 'View test results'; 'Supplement their medical records'; 'View their medical records'; 'Request referrals'. On the other hand, 25% of them reported that patients have access to 'Request renewals or prescriptions', and 30% also reported the availability of 'Request for appointments'.

**Table 9 PHR Functionalities: availability and use**

Indicator	Availability				Use			
	DK	No	Yes	N	No	Yes occasionally	Yes routinely	N
Request renewals or prescriptions	3%	72%	25%	9.196	9%	38%	53%	2.311
Request appointments	3%	67%	30%	9.196	10%	45%	45%	2.702
View test results	4%	86%	10%	9.196	21%	39%	40%	956
Supplement their medical records	4%	89%	7%	9.196	29%	35%	36%	620
View their medical records	4%	88%	8%	9.196	29%	35%	36%	734
Request referrals	4%	86%	10%	9.196	17%	48%	35%	943

In the case of 'View their medical records' and 'Supplement their medical records', 29% of GPs stated that patients do not use them, even though they have access to these applications. Finally, around half of GPs report that patients who have the possibility to request renewals or prescriptions or to request appointments use them routinely. As shown in next figure, high adoption is very limited for four out of six functionalities, and reaches a somewhat noticeable value only for view test result (13% use it frequently) and request referrals (16% use it frequently).

**Figure 19 PHR functionalities: from awareness to use**



### 3.7 Comparison 2007-2013

*Our questionnaire allows for some comparison with the 2007 survey funded by the EC, although there are clear limits in this comparison*

As illustrated in the Technical Compendium (chapter 3, § 3.2.2.3), we designed our questionnaire so as to ensure some degree of comparability with the previous survey funded by the EC and carried out in 2007 (Dobrev, et al, 2008). Below we report two graphs comparing our results with those of 2007 for some selected items, but a few clarifications are in order on the limit of this comparison for the correct reading of the changes in percentages of usage. The limits of the comparability are mainly two, one technical and one substantive. Technically, the two samples have been extracted in very different ways; this may have an impact on the actual degree of representativeness with respect to the universe of reference. As the 2007 survey and our (2013) survey are the only two available measurements, occurring with a six year interval, there is no reference or benchmark against which to assess whether or not a change in use level between 2007 and 2013 can be considered a sufficient level of progress or not. In addition, the six years between 2006 and 2013 perfectly coincide with the ensuing, deepening, and continuation of the financial and economic crisis across Europe; it would be difficult to disentangle from the simple percentages change in use the possible hindering effect of the crisis. Hence, we simply describe the changes without entering into too much discussion of their magnitude, both here, and later when we look at the overall score of use, see § 4.7.

*Both surveys filtered out respondents not having a computer: 12.5% in 2007 and only 0.3% in 2013. This affects the use percentages reported in the two surveys*

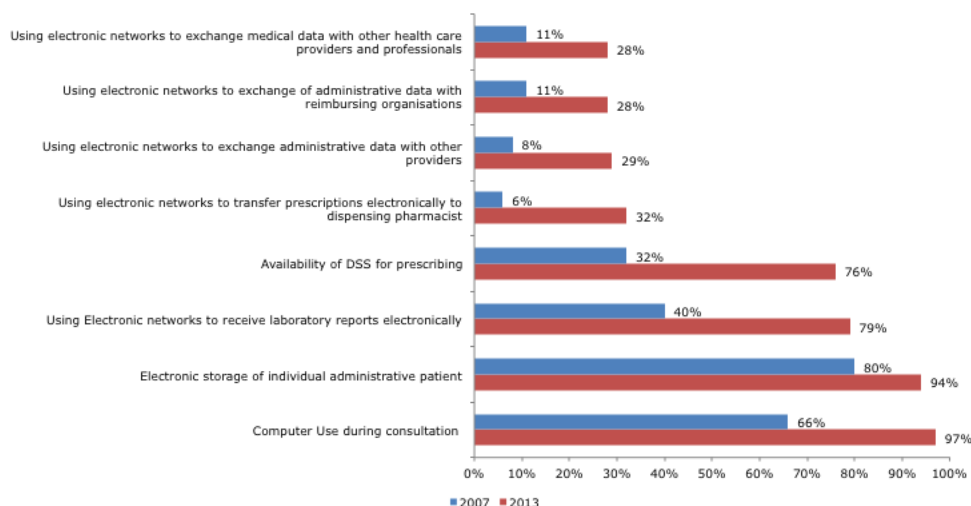
Both questionnaires included a filter question at the beginning asking whether or not computers are available in the practice (Q11 in our survey, R4 in Dobrev et al, 2008, p. 110). If the answer was 'No', in both surveys the interview was finished. The big difference is that in 2013: a) only 0.3% (that is 28 respondents) reported not having a computer in their practice (in 2007 this amounted to 12.5% of the sample; b) the percentages of availability and use are calculated over the total sample (in the 2007 survey the percentages were calculated only on 87.5% of the sample). Net of possible sample effect, we can already conclude that between 2007 and 2013 availability of computers in the practice increased so as to basically fill the entire gap. On the other hand, the implications of this difference is also that the percentage of GPs using the various functionalities in our case are calculated over basically the entire sample, whereas for the 2007 the calculation is over only 87.5% of the total sample. This means that the percentages of use in next figures are somehow inflated for 2007, and thus the change from 2007 to 2013 is partially under-estimated<sup>24</sup>. We did not, however, recalculated the percentages for 2007 and report what we found in the report in this survey. Looking at Figure 20 we can notice a substantial increase in the use of most items, and particularly for ePrescription, and the possibility of receiving electronically laboratory reports, and also for the use of a computer during consultation. On the other hand, for changes in the percentages of

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24 For instance use of EHR is reported as 80% of those having a computer in 2007, which means 70% of the total sample ( $0.8 \times 0.875$ ). In our case is 92.6% of the total sample.

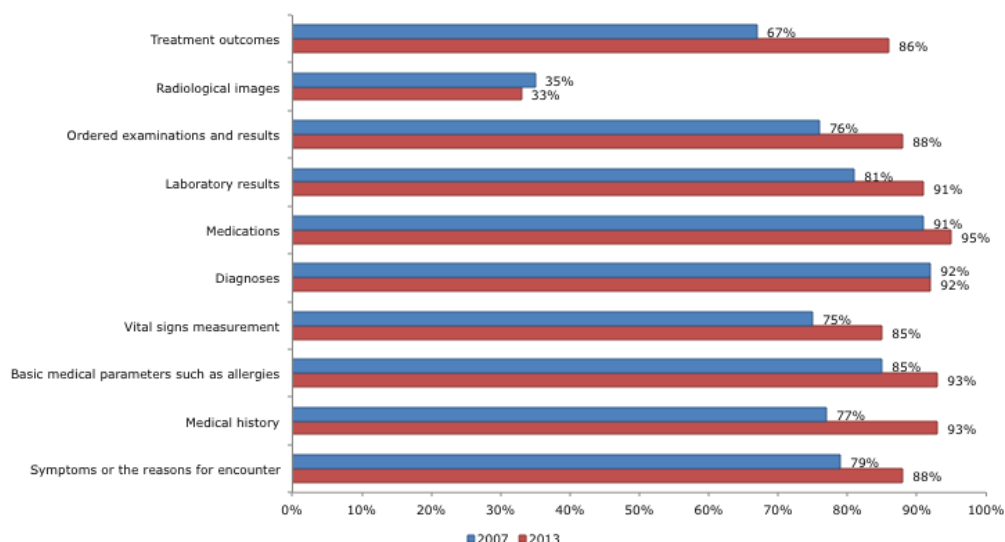
GPs that use functionalities to store individual patient medical data (Figure 21) the differences between 2007 and 2013 seem very small, except for a few items (i.e. treatment outcomes). In the two charts we also see some items where there has been apparently no change during the past six years, yet again we remind the reader about the limits of this comparability and about how percentages are calculated for 2007; we do not comment any further on these data.

**Figure 20 Use of selected functionalities: 2007 & 2013**



*We can notice substantial increases in most items, except for the various functionalities related to storage of patient medical records*

**Figure 21 Storage of patient medical data: 2007 & 2013**



## 4. Composite measures of adoption

### Box 3 Chapter 4 Roadmap

This chapter presents the composite indicators and index of eHealth adoption. In § 4.1 we illustrate very briefly the method by which composite indicators and the overall composite index were constructed. In § 4.2 we present the composite indicators for adoption for Electronic Health Records (EHR), in § 4.3 that for Health Information Exchange (HIE), in § 4.4 that for Telehealth, and in § 4.5 that for Personal Health Records (PHR). In § 4.6 the overall composite index of eHealth adoption obtained combining the previous four composite indicators is illustrated and briefly discussed. Finally, in § 4.7 we present a comparison between 2007 and 2013 obtained fitting the data from our survey into the simple basic score used by Dobrev et al (2008) to summarise the data of the previous EC survey.

For further technicalities on the composite measures, we refer the reader to the Appendix (Chapter 7, § 7.2 and § 7.3).

### 4.1 Outline of methodological approach

*We used Factor Analysis (FA) to construct four composite indicators and one composited index of adoption. Technical details are reported in the Appendix*

In brief we used Factor Analysis to construct four composite indicators of adoption for the four measurement pillars (EHR, HIE, telehealth, and PHR) and the combined these four composite indicators into an overall composite index of eHealth adoption in primary care. In the Appendix we provide: a) a general illustration of Factor Analysis and similar techniques (i.e. cluster analysis that we used for identifying GPs clusters, see later in § 5.3) in § 7.2; b) a general illustration of composite indicators construction in § 7.3; and c) a step-by-step illustration of how we moved from the Factor Analysis (FA) to the construction of composite indicators in § 7.4 (where we also report the Factor Analysis technical tables for all four pillars). Hence, in this paragraph we try and explain the approach in intuitive fashion avoiding as much as possible technical details that are, however, reported in fully transparent way in the Appendix in case interested readers may want to replicate our analysis.

*We used Factor Analysis (FA) to summarise and reduce our variables as a first step to the construction of composite indicators*

Factor Analysis is an interdependence multivariate statistical analysis technique (see § 7.2) that is used for the purpose of data summarisation and data reduction. FA merely identifies the inter-relationship among a large enough set of variables in order to reduce them into a smaller set of latent variables (this is the data summarisation component. It is an exploration of the existence (or not) of an underlying structure of the variables analysed that can justify using a fewer number of variables (called latent variables, or factors). This operation was the first step toward the construction of composited indicators.

For instance, in the case of EHR we have 25 variables that FA shows to be grouped around five factors (latent variable). To make it even more concrete let us consider two of the items asked to respondents for what concerns EHR functionalities: 'finance and billing' and other 'administrative' functionalities. FA shows that our GPs answers to the question on availability and use make these two variables behave similarly and have clear commonalities (in technical terms similar distribution of variance). We can thus replace the two items with the underlying latent variable (or factor) that we call 'administration'. It is important to stress that the statistical commonality proven by FA must lead easily to an intuitive interpretation of the factor, as in this clear example. This is the summarisation part of FA: it derives underlying dimensions that, when interpreted and understood, describe the data in a much smaller number of concepts than the original individual variables. The application of FA identified meaningful factors to reduce the data for all of the four measurement pillars (EHR, HIE, telehealth and PHR). The data reduction part of FA is more technical and it is explained in the Appendix (first in general in § 7.2 and then applied to our composite indicators in § 7.4)

We are fully aware of the limits and controversies (see Table 10) between those in favour and those against using composite indicators and indexes in the context of measurement and benchmarking for policy purposes. However, there is no alternative to using them when one analyses 210 variables for 9196 individuals in 31 countries and wants to send a few clear policy messages. Composite summary measures, when constructed and presented transparently, as we are doing in this report, provide clear input ready to use for policy consumption.

**Table 10 Pros and cons of composite indicators**

PROS	CONS
Summarise multi-dimensional issues for decision-makers	May send non-robust policy messages
Provide the big picture and are easier to interpret	"Big picture" may produce simplistic 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 Codagnone & Lupiañez (2011)

*FA identified commonality in the statistical variability of several variables and grouped them into factors having an intuitive meaning for all four measurement*

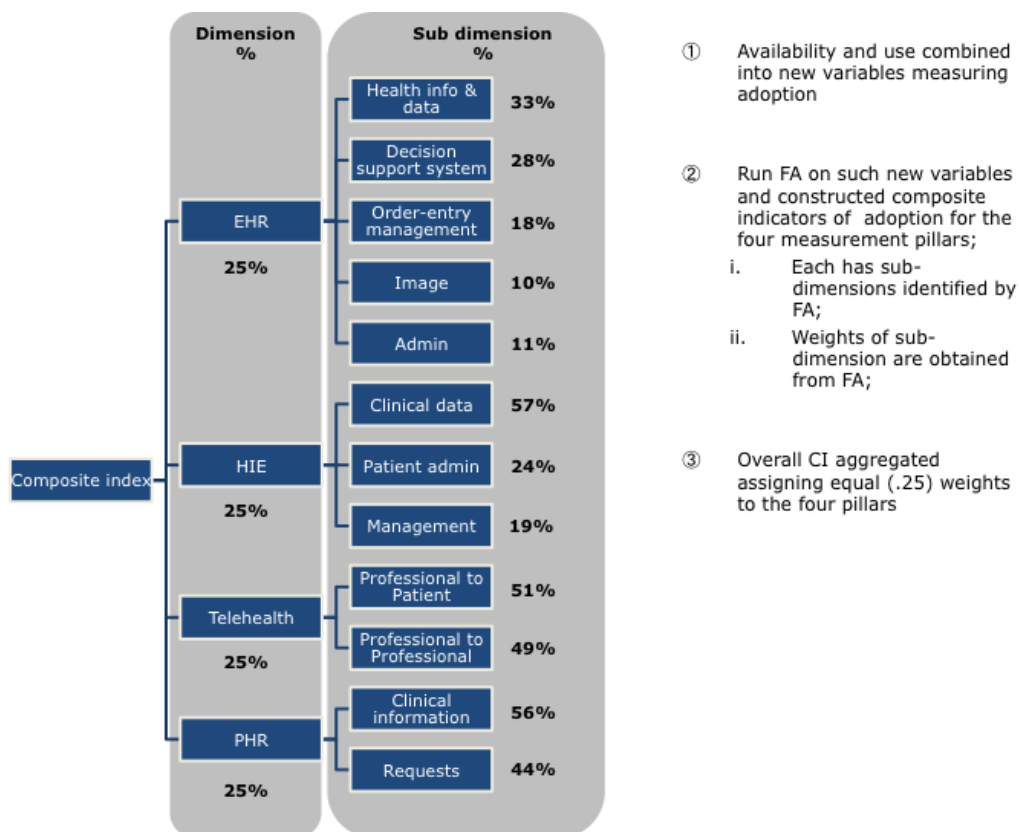
*Our composite indicators and index have been constructed and presented transparently, and summarise efficiently a large dataset for policy consumption*



The next figure summarises fairly well how we proceeded from FA to the construction of composite indicators of adoption for the four pillars of measurement (EHR, HIE, Telehealth, and PHR), and how we combined these four composite indicators into the overall composite index of eHealth adoption.

**Figure 22 From FA to the composite index**

*We used base variables combining availability and use and, through factor analysis, we constructed four indicators of adoption for the four measurement pillars – EHR, HIE, Telehealth, PHR- that were then combined into an overall composite index of eHealth adoption*



We started from the new variables of adoption created for all measurement pillars and described at the beginning of chapter 3 (see more on next page). Next, for each of the four pillars we processed these new variables through FA, which enabled us to construct four composite indicators. Finally, using equal weights (25%) for each of the four composite indicators we combined them into the overall composite index of eHealth adoption<sup>25</sup>.

**Important note on how to interpret the composite scores.** As we anticipated at the beginning of chapter 3, the four composite indicators for the four measurement pillars have been constructed by processing, through the Factor Analysis, the new variable of

<sup>25</sup> We attempted to extract the weights for the four dimensions directly from the data using Structural Equation Modelling (SEM) and Confirmatory Factor Analysis, but this did not work for all dimensions. We tried to use SEM to develop the weights proceeding as follows. We selected one key variable to be explained by the four composite indicators and we tested whether we could obtain statistically significant regression coefficients between them and the items selected dependent variable. We tried with several control variables, and the best fit we obtained was with Q18 (level of digitalisation of record). The problem was, however, that we found significant coefficients that could be used to develop the weights only for EHR and HIE, and so we could not proceed this way if we were to use all of the four pillars within the final composite index.



adoption that combines answers on availability and use (see box below);

**Don't know (not aware)= 0; Do not have it= 1; Have it and do not use it= 2; Use it occasionally= 3; Use it routinely= 4.**

Accordingly, the scores of the four composite indicators (EHR, HIE, telehealth, and PHR), of their sub-dimensions, and of the overall composite index, can range from 0 to 4 within the five points scale that the new variable of adoption embeds. The scores we report for composite indicators (both for sub-dimensions and for the measurement pillar dimension) and for the overall composite index are calculated averaging the corresponding score for each respondent (in the total sample, or per country). In view of this important clarification we can provide below an *ex ante* and hypothetical interpretation of what scoring at one level or the other of the indicators and index *may* mean. We leave out the very 'academic' case of scores around 0 or around 4, since they do not occur. A score of 1 on dimension X tells us that **on average** GPs do not have at their disposal the various functionalities embedded on that dimension. If this score is at aggregate sample level then one needs to look at country level differences before concluding that items in this dimension are not deployed. A value of 1 at country level is instead a more robust indication of widespread lack of availability, although naturally variability will be present across the different respondents. The need to check aggregate sample results also in terms of country results apply also for other scores and we do not repeat this consideration. A score of 2 would mean, still **on average**, full availability but little use. This might mean they consider it useless or are not aware about its potential, or they do not have the skills to use it. As we are talking about average we cannot conclude that 2 means not use at all, for variability will be present at country and at individual level. Clearly, if the score is below or above 2, the characterisation of level of use can change. A score of 3 would mean, still **on average**, full availability and occasional use. Score well above 3 can be interpreted as meaning that for some large number of the GPs the functionalities included in dimension X are part of everyday routine and we can conclude that all GPs have fully appropriate them.

## 4.2 Electronic Health Record composite indicator

Factor Analysis investigates whether a number of variables of interest are related through some linear function to a smaller number of unobservable factors (latent variables). The FA for EHR identified five statistically significant and conceptually meaningful factors (latent variables) that summarise the 25 different functionalities measured for this pillar (Q20a and Q20b). These are:

1. **'Health info & data'**; it includes core functionalities of EHR and accounts for 33% of the totally explained variance.
2. **'Clinical Decision Support System' (Clinical DSS)**; this factor links a number of variables (Contraindications; Drug-drug interactions; Drug-lab interactions; Drug-allergy alerts; Clinical guidelines; alerts to a critical laboratory value) and accounts for 28% of the totally explained variance.
3. **'Order-Entry & Result Management' (OERM)**; it linearly relates to the following group of similar variables: Medication list; Prescriptions / medications; Immunizations; Lab test results; and Ordered tests, and accounts for 18% of the totally explained variance.
4. **'Image'**; The fourth factor has high positive coefficients on Radiology test images and Radiology test reports, and pertains to 10% of the totally explained variance.
5. **'Administrative'** aspects of EHR; accounts for 11% of the totally explained variance.

On very simple terms, one could interpret these findings by saying that if we had asked about these five latent variables instead of about the 25 different functionalities, we would have obtained similar measurements directly from the survey without the need for FA. Yet, *ex ante* we could not know this, and especially without the enumeration of what went into each of the five variable respondents' answers might have been biased. In other words, the FA identified what can be considered as the main sub-components of EHR. These five components of Electronic Health Records are extracted from the data exploration and not conceptually defined *ex ante*. On the other hand, our data empirically confirm and match the conceptual and theoretical work developed by Des Roches et al. (2008) and Jha (2010). Therefore, having an empirical confirmation of a conceptual framework developed in the relevant literature reinforces our conclusion that these are the key five dimensions along which EHR should be measured.

The following table and the next six figures report the results fairly exhaustively, and we limit ourselves to illustrative comments placed on the side. It is worth pointing out that for both the composite indicator and for the measures of the sub-dimension, the value can range from 0 to 4. In both the table and the figures, we present two different aggregate values: EU27 and EU27+4. Our illustrative comments focus just on the EU27 value.

*Factor Analysis found that the 25 different variables measured for EHR are related through linear functions to five conceptually meaningful latent variables that we termed: 'Health Info & Data'; 'Clinical Decision Support Systems'; 'Order Entry & Results Management'; 'Image'; and 'Administrative'*

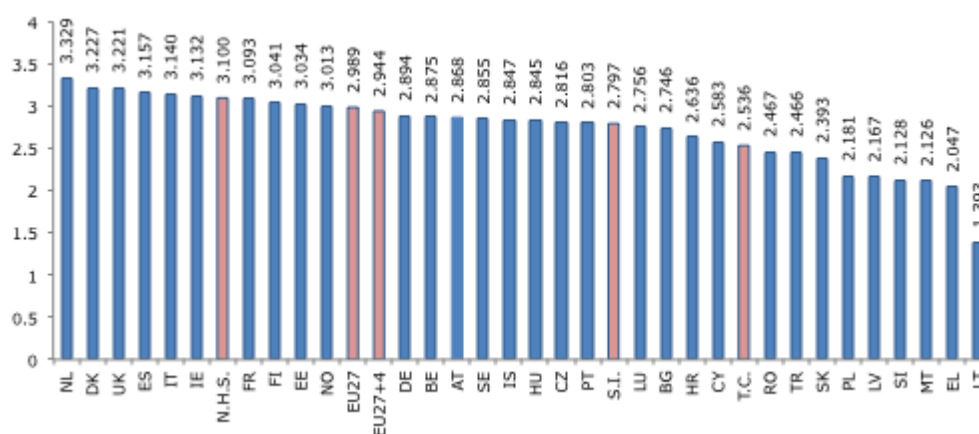
*Our data exploration identified five dimensions of EHR that confirm ex ante conceptualisations available in the literature*

Table 11 EHR summary index by country

Country	EHR CI.	Sub-dimensions composite indicators				
		Info/data	DSS	OERM	Image	Admin
NL	3.329	3.393	3.238	3.593	2.367	3.810
DK	3.227	3.408	2.755	3.859	2.357	3.645
UK	3.221	3.381	3.210	3.907	2.562	2.243
ES	3.157	3.387	2.723	3.865	3.505	2.098
IT	3.140	3.181	3.003	3.918	2.843	2.365
IE	3.132	3.298	2.467	3.921	2.543	3.568
<b>N.H.S.</b>	<b>3.100</b>	<b>3.294</b>	<b>2.731</b>	<b>3.844</b>	<b>2.716</b>	<b>2.590</b>
FR	3.093	3.293	2.553	3.765	2.333	3.457
FI	3.041	3.299	2.265	3.846	3.881	2.165
EE	3.034	3.385	1.887	3.893	3.451	3.117
NO	3.013	3.242	2.201	3.780	2.295	3.794
<b>EU27</b>	<b>2.989</b>	<b>3.176</b>	<b>2.513</b>	<b>3.748</b>	<b>2.483</b>	<b>2.861</b>
<b>EU27+4</b>	<b>2.944</b>	<b>3.151</b>	<b>2.438</b>	<b>3.738</b>	<b>2.414</b>	<b>2.792</b>
DE	2.894	3.035	2.261	3.725	2.023	3.512
BE	2.875	3.198	2.128	3.687	2.746	2.594
AT	2.868	3.111	2.088	3.650	2.317	3.345
SE	2.855	3.030	2.294	3.767	2.880	2.243
IS	2.847	3.373	1.607	3.917	3.098	2.445
HU	2.845	3.254	2.054	3.859	2.244	2.520
CZ	2.816	3.171	1.882	3.722	1.812	3.558
PT	2.803	3.351	1.866	3.821	2.378	2.263
<b>S.I.</b>	<b>2.797</b>	<b>3.040</b>	<b>2.141</b>	<b>3.678</b>	<b>2.066</b>	<b>2.960</b>
LU	2.756	3.259	1.264	3.635	2.539	3.803
BG	2.746	3.213	1.436	3.776	2.427	3.278
HR	2.636	3.132	1.434	3.781	1.688	3.199
CY	2.583	2.818	1.792	3.294	2.941	2.403
<b>T.C.</b>	<b>2.536</b>	<b>2.721</b>	<b>1.848</b>	<b>3.431</b>	<b>2.045</b>	<b>2.715</b>
RO	2.467	2.457	2.083	3.338	2.013	2.459
TR	2.466	2.868	1.721	3.627	1.715	1.939
SK	2.393	2.559	1.622	3.212	1.982	2.896
PL	2.181	2.443	1.361	2.980	1.899	2.427
LV	2.167	2.245	1.501	2.930	2.012	2.516
SI	2.128	2.118	1.203	3.222	1.406	3.380
MT	2.126	2.185	1.557	2.861	2.848	1.536
EL	2.047	2.199	1.456	2.970	1.833	1.781
LT	1.393	1.421	0.958	1.558	2.027	1.571

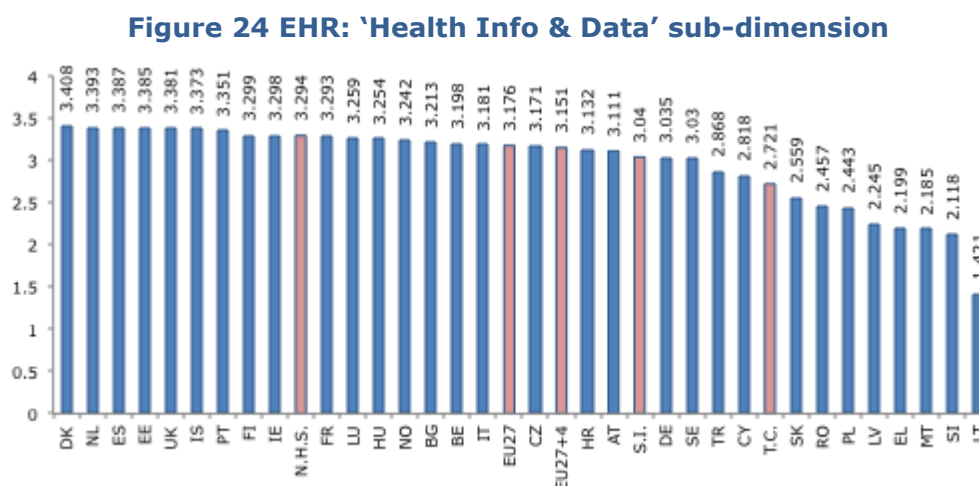
N.H.S.=National Health Service; S.I.=Social Insurance; T.C.=Transition Countries

Figure 23 EHR composite indicator of adoption

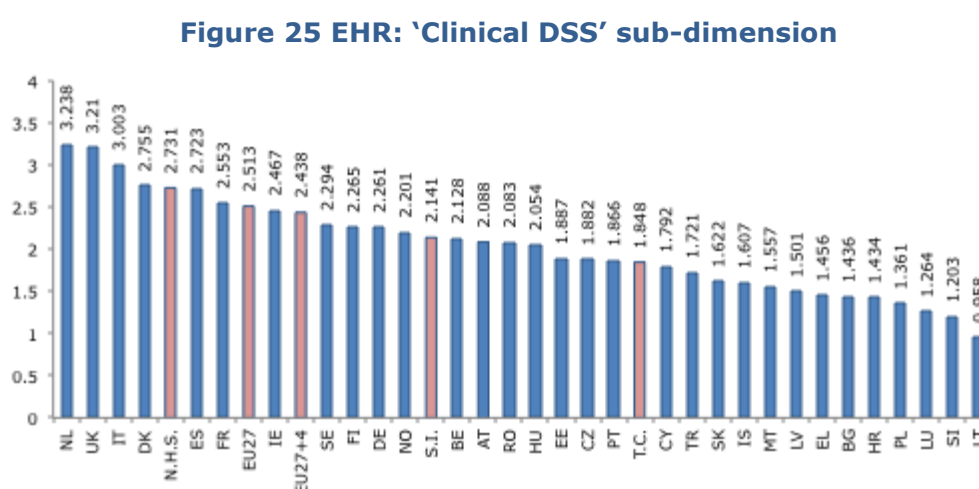


The overall value for EU27 suggests that EHR are fully available but that use remains limited and there is still some way to go for full adoption; Netherlands and Denmark are ranked at the top

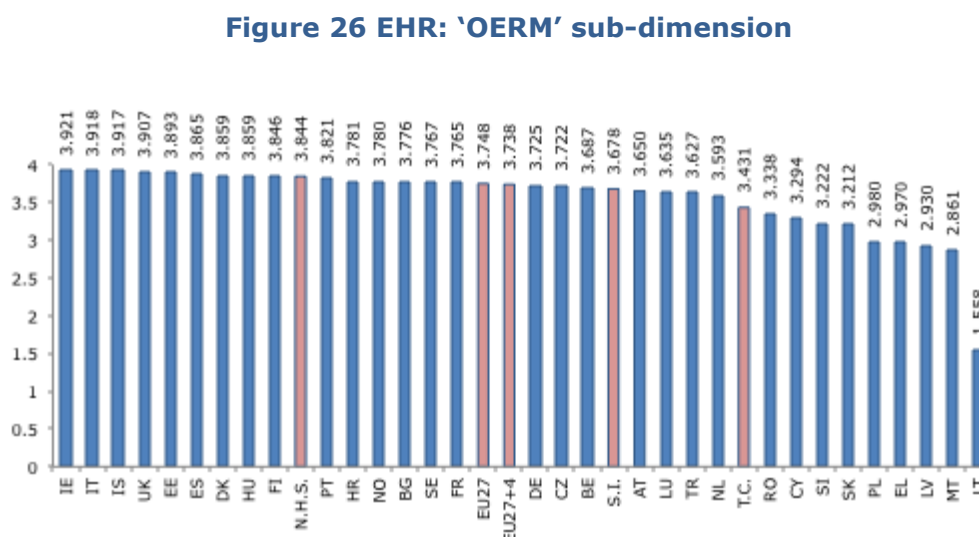
*The Health Info & Data total score for EU27 (3.176) is higher than the total value of the composite indicator (2.989); the country rankings change somewhat, hinting at different priorities in terms of EHR components*



*The Decision Support System total score for EU27 (2.513) is lower than the total value of the composite indicator (2.989), but is quite high in several countries (NL, ES, UK, EE, etc.)*

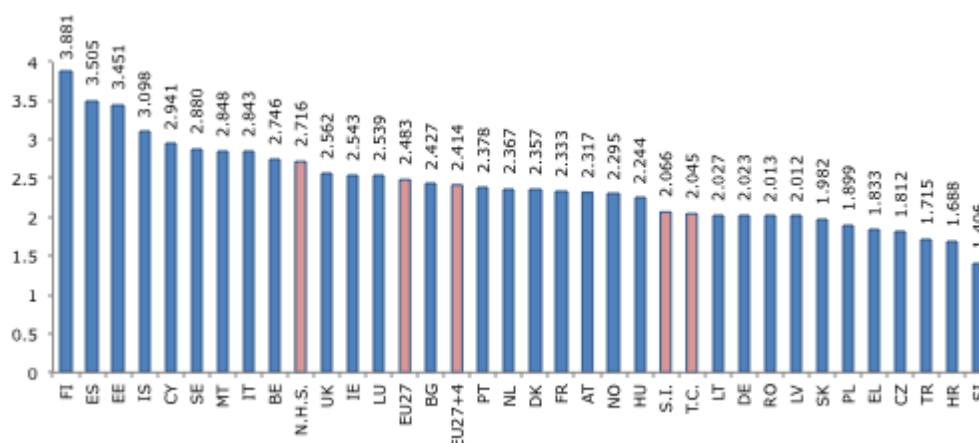


*Order Entry & Results Management at EU27 level score the highest among all the five sub-dimensions (3.748); values are above or around 3.0 for most countries suggesting that this is a basic component of EHR where we are close to full adoption*



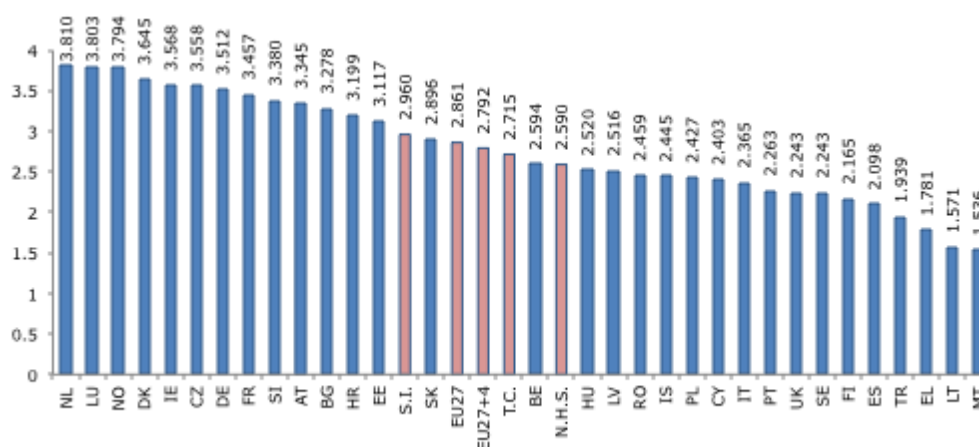
**Figure 27 EHR: 'Image' sub-dimension**

*The score for this sub-dimension is the lowest, which confirms what already observed in the descriptive analysis of findings: availability and use of radiology test images is limited*



**Figure 28 EHR: 'Administrative' sub-dimension**

*The administrative component of EHR scores third and is used more than DSS*



Before moving to the next measurement pillar, a final explanation is in order for a correct reading of the country ranking, so as to avoid misunderstandings. Let us take the example of the Netherlands, which serves very well the clarification we want to make. This country scores at the top of the composite indicator for EHR adoption, but it ranks below in a few sub-dimensions (OERM and Image). On the other hand, it ranks at the top of both DSS and Health Info & Data. Now, the latter two latent factors by themselves accounts for 61% of the totally explained variance, whereas the other three account for 39% of such variance. This basically explains why the NL ranks at the top. Accounting for more share of the explained variance means that the variables are 'more important' in shaping for what differentiates countries in the measure of adoption. Health & Info and DSS by themselves account for a lot of variability in the adoption level; thus one can conclude that they are distinguishing elements in discriminating between different levels of EHR adoption. We can see, for instance, that Clinical DSS scores quite low at EU27 level but it scores quite high for the Netherlands and accounts by itself for 28% of variance. As Clinical DSS is without any doubt one of the most advanced and important features of an EHR, it makes perfect sense that this sub-dimension plays a clearly discriminating role in ranking countries.

## 4.3 Health Information Exchange composite indicator

*The Factor Analysis found that the 15 different variables measured for HIE are related through linear functions to three latent variables: 'Clinical Data'; 'Patient administration'; and 'Management'*

The same logic and procedure for the construction of the composite indicator of EHR was applied for HIE, Telehealth, and PHR. The Factor Analysis for HIE identified three factors that we used as sub-dimensions of the composite indicator of HIE adoption. The three sub-dimension refer to use of HIE for:

1. **'Clinical Data'**: exchange of health related information.
2. **'Patient Administration'**: for certification and other administrative purposes.
3. **'Management'**: for exchange of data with payers (i.e. insurances) and other healthcare providers.

The following table and the next four figures report the results fairly exhaustively; we limit ourselves to illustrative comments on the side. In both the table and the figures, we present two different aggregate values: EU27 and EU27+4, but our illustrative comments focus just on the EU27 value.

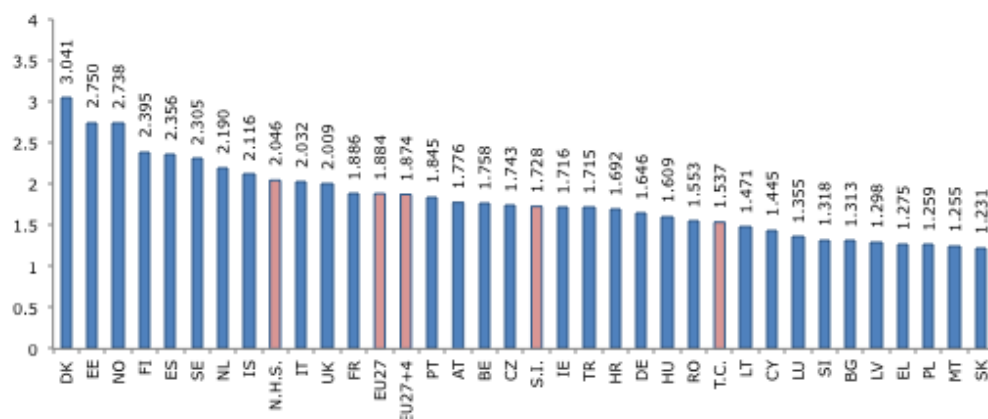
**Table 12 HIE summary index by country**

Country	HIE C.I	Sub-Dimension		
		Clinical data	Patient admin.	Management
DK	3.041	3.286	2.681	2.764
EE	2.750	2.780	3.338	1.917
NO	2.738	2.417	3.669	2.526
FI	2.395	2.628	3.066	0.850
ES	2.356	2.523	2.750	1.358
SE	2.305	2.396	2.405	1.903
NL	2.190	2.666	1.035	2.220
IS	2.116	2.376	2.333	1.062
<b>N.H.S.</b>	<b>2.046</b>	<b>1.953</b>	<b>2.550</b>	<b>1.687</b>
IT	2.032	1.615	3.428	1.521
UK	2.009	2.137	2.117	1.489
FR	1.886	1.673	1.983	2.402
<b>EU27</b>	<b>1.884</b>	<b>1.785</b>	<b>2.225</b>	<b>1.753</b>
<b>EU27+4</b>	<b>1.874</b>	<b>1.781</b>	<b>2.202</b>	<b>1.738</b>
PT	1.845	1.689	2.904	0.978
AT	1.776	1.616	2.236	1.675
BE	1.758	1.722	1.944	1.633
CZ	1.743	1.370	2.012	2.521
<b>S.I.</b>	<b>1.728</b>	<b>1.711</b>	<b>1.831</b>	<b>1.647</b>
IE	1.716	1.684	1.831	1.666
TR	1.715	1.711	1.853	1.550
HR	1.692	1.580	2.135	1.469
DE	1.646	1.579	1.826	1.620
HU	1.609	1.284	2.106	1.955
RO	1.553	1.445	1.865	1.484
<b>T.C.</b>	<b>1.537</b>	<b>1.375</b>	<b>1.847</b>	<b>1.633</b>
LT	1.471	1.168	2.453	1.137
CY	1.445	1.510	1.342	1.381
LU	1.355	1.383	1.255	1.397
SI	1.318	1.024	1.790	1.602
BG	1.313	1.215	1.503	1.368
LV	1.298	1.334	1.105	1.436
EL	1.275	1.315	1.260	1.173
PL	1.259	1.185	1.288	1.447
MT	1.255	1.451	1.009	0.980
SK	1.231	1.095	1.413	1.410

N.H.S.=National Health Service; S.I.=Social Insurance; T.C.=Transition Countries

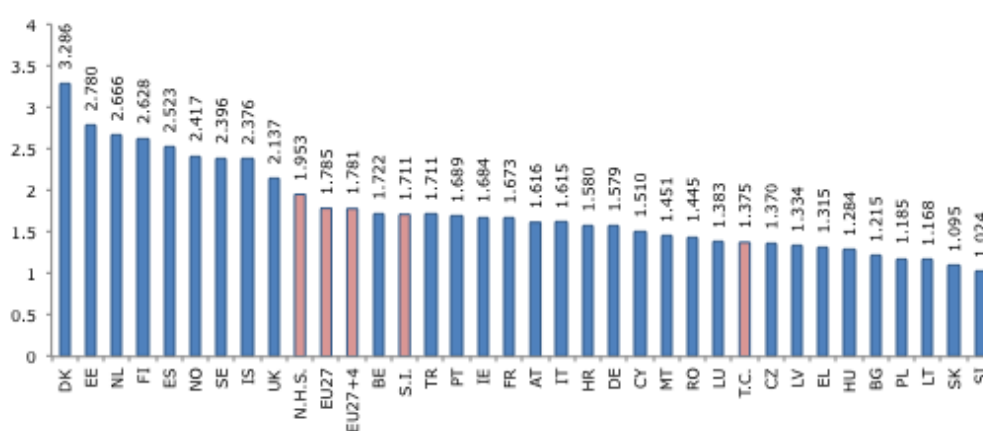
**Figure 29 HIE composite indicator of adoption**

*The overall score for EU27 is below the value of 2, suggesting full availability is not yet reached and usage is modest. Denmark and Estonia score at the top of the ranking.*



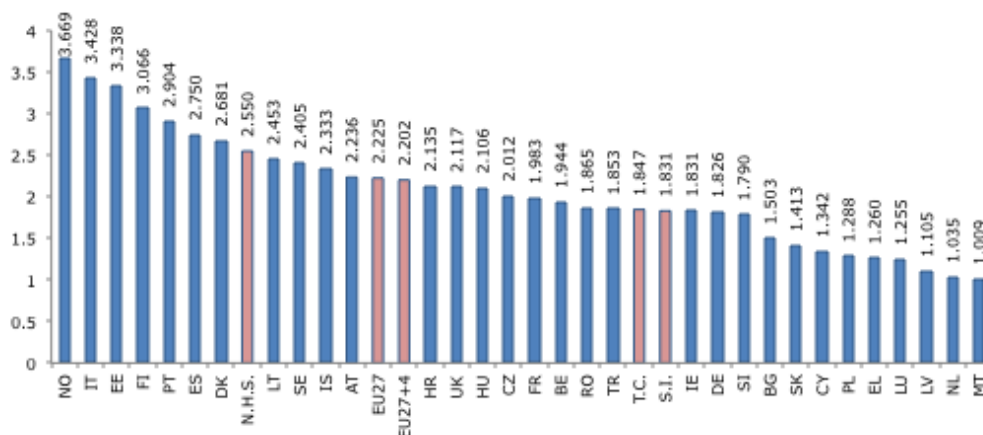
**Figure 30 HIE: 'Clinical Data' sub-dimension**

*The Clinical Data total score for U27 (1.785) is lower than the total value of the composite indicator (1.884); the country ranking change somewhat, hinting at different priorities in terms of HIE components.*



**Figure 31 HIE: 'Patient administration' sub-dimension**

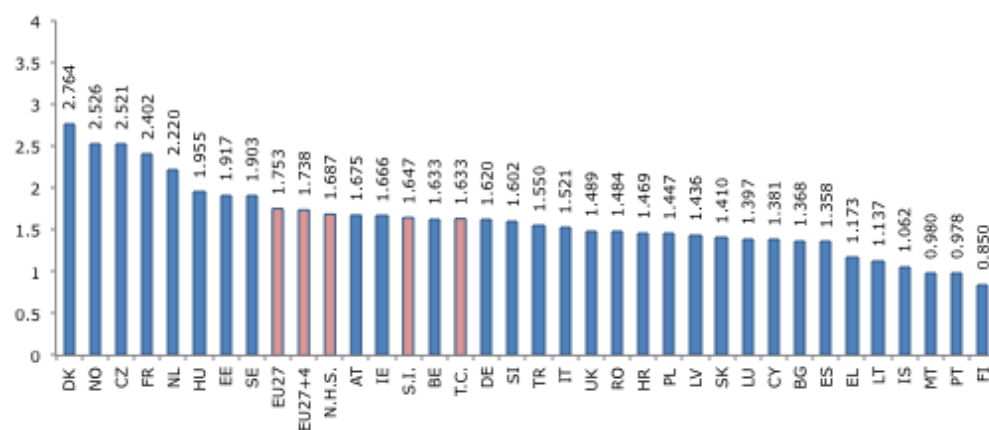
*Patient administration has the highest score; some of the countries position can be explained by administrative changes discussed later (see § 5.2).*





**Figure 32 HIE: 'Management' sub-dimension**

*Information Exchange for management purposes has the lowest score, reflecting the fact that these functionalities are important in Social Insurance systems but less so in NHS*



## 4.4 Telehealth composite indicator

The Factor Analysis for Telehealth identified two latent variables that we used as sub-dimensions for the composite indicator of Telehealth adoption:

*FA found that the four different variables measured for Telehealth are related through linear functions to two latent variables: 'Professional to Patient'; and 'Professional to Professional'*

1. **'Professional to Patient'**: it includes 'Consultations with patients', and 'Remote monitoring of patients at home' (it covers 51% of the total variance explained)
2. **'Professional to Professional'**: it refers to the use of telehealth for professional training purposes and consultation with other healthcare practitioners (it represents 49% of the total variance explained).

The following table and the next three figures report the results fairly exhaustively; we limit ourselves to illustrative comments on the side. In both the table and the figures, we present two different aggregate values: EU27 and EU27+4, but our illustrative comments focus just on the EU27 value<sup>26</sup>.

**Table 13 Telehealth index by country**

Country	Telehealth C.I	Sub-dimensions	
		Professional to Patient	Professional to Professional
HU	1.785	1.191	2.404
FI	1.676	1.077	2.300
TR	1.605	1.144	2.085
ES	1.572	1.087	2.076
CZ	1.567	1.201	1.949
NL	1.537	1.175	1.914
EL	1.528	1.084	1.990
CY	1.494	1.146	1.856
IT	1.476	1.085	1.883
SI	1.467	1.099	1.850
RO	1.464	1.233	1.706
UK	1.458	1.136	1.794
IS	1.456	1.143	1.781
MT	1.452	1.109	1.809
IE	1.443	1.011	1.892
<b>T.C.</b>	<b>1.428</b>	<b>1.153</b>	<b>1.713</b>
<b>N.H.S.</b>	<b>1.415</b>	<b>1.101</b>	<b>1.740</b>
<b>EU27+4</b>	<b>1.395</b>	<b>1.115</b>	<b>1.687</b>
<b>EU27</b>	<b>1.383</b>	<b>1.093</b>	<b>1.686</b>
DK	1.381	1.332	1.432
<b>S.I.</b>	<b>1.373</b>	<b>1.118</b>	<b>1.638</b>
PL	1.350	1.030	1.683
SE	1.322	1.009	1.647
FR	1.312	1.118	1.515
SK	1.304	1.064	1.553
AT	1.284	1.076	1.500
HR	1.260	1.112	1.413
EE	1.251	1.096	1.412
DE	1.239	1.142	1.339
LU	1.232	0.983	1.492
BE	1.215	0.958	1.483
PT	1.179	1.034	1.328
NO	1.151	1.011	1.296
BG	1.138	1.023	1.258
LV	1.081	0.985	1.181
LT	0.955	0.862	1.051

N.H.S.=National Health Service; S.I.=Social Insurance; T.C.=Transition Countries

<sup>26</sup> Please note that in this case the EU27 level indicator is lower than the EU27+4; this is due to the higher than average score by Turkey (in addition to Norway). Yet, the results for Turkey would need to be further explored.

Figure 33 Telehealth composite indicator of adoption

The overall score for EU27 is very low indicating very availability and very little use

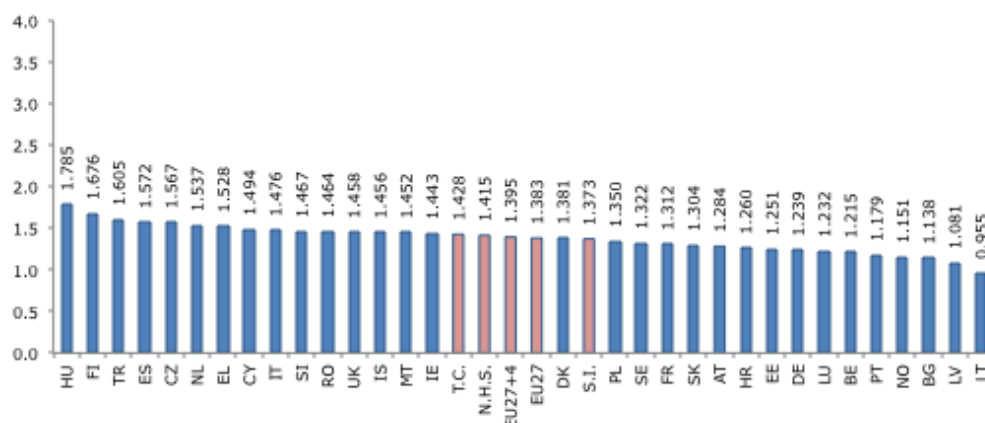


Figure 34 Telehealth: 'Professional to Patient' sub-dimension

The score of 'Professional to Patient' is lower than the total score at EU27 level, confirming the limited take up of applications such as remote monitoring of patients at home

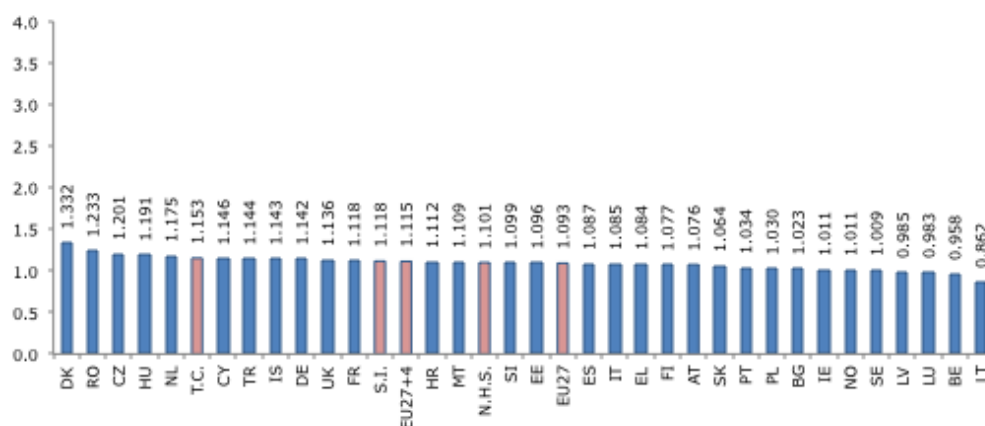
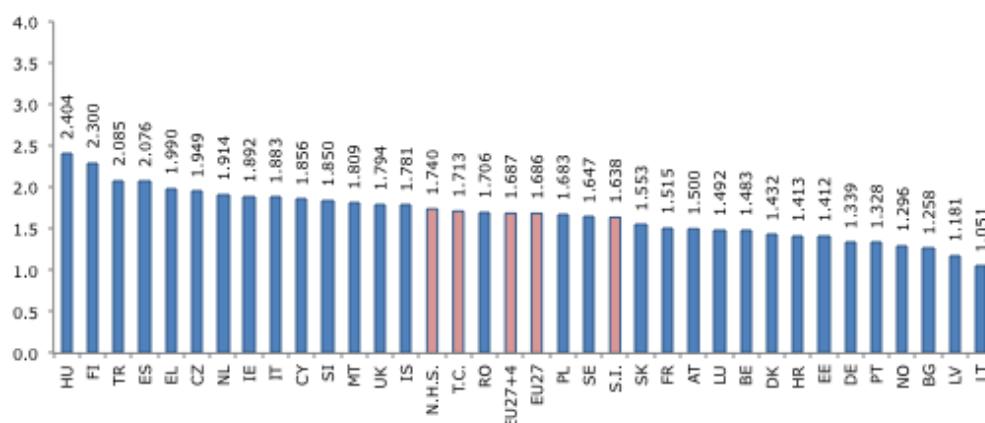


Figure 35 Telehealth: 'Professional to Professional' sub-dimension

Use of Telehealth for training purposes is a bit more widespread



## 4.5 Personal Health Record composite indicator

*FA found that the six different variables measured for PHR are related through linear functions to three latent variables: 'Clinical Information'; 'Requests'*

The FA for PHR identified three latent variables that we used as sub-dimensions of the composite indicator of PHR adoption:

1. **'Clinical information':** including 'View their medical records'; 'Supplement their medical records'; and 'View test results' (it accounts for 56% of the total variance).
2. **'Requests':** including 'Request referrals'; 'Request appointments'; and 'Request renewals or prescriptions' (44% variance explained).

The following table and the next four figures report the results fairly exhaustively, we limit ourselves to illustrative comments on the side.

**Table 14 PHR index by country**

Country	PHR Indicator	Sub-dimensions	
		Clinical Info	Supplement
DK	2.308	1.303	3.588
NO	1.730	1.043	2.605
UK	1.597	1.044	2.300
SE	1.555	1.049	2.199
ES	1.547	1.167	2.030
PT	1.508	0.999	2.156
EE	1.478	1.287	1.722
TR	1.428	1.447	1.403
NL	1.426	1.109	1.830
<b>N.H.S.</b>	<b>1.392</b>	<b>1.094</b>	<b>1.773</b>
<b>EU27+4</b>	<b>1.320</b>	<b>1.137</b>	<b>1.553</b>
<b>EU27</b>	<b>1.319</b>	<b>1.098</b>	<b>1.601</b>
SI	1.308	0.996	1.706
<b>S.I.</b>	<b>1.299</b>	<b>1.208</b>	<b>1.415</b>
DE	1.289	1.153	1.462
CZ	1.259	1.123	1.431
IS	1.251	0.999	1.572
FI	1.242	1.125	1.391
RO	1.232	1.198	1.275
EL	1.229	1.185	1.285
IT	1.223	1.054	1.439
T.C.	1.201	1.144	1.273
PL	1.194	1.169	1.226
FR	1.175	1.144	1.214
HU	1.154	1.086	1.242
HR	1.135	1.067	1.221
BE	1.130	1.006	1.289
BG	1.109	1.120	1.094
AT	1.090	1.044	1.148
LU	1.088	1.015	1.180
LV	1.082	1.058	1.111
IE	1.081	1.002	1.183
SK	1.081	1.067	1.098
LT	1.076	0.933	1.258
MT	1.048	1.018	1.086
CY	1.041	1.000	1.093

N.H.S.=National Health Service; S.I.=Social Insurance; T.C.=Transition Countries

Figure 36 PHR composite indicator of adoption

The overall score for EU27 is very low indicating very little availability and very little use; that Denmark scores at the top is not a surprise, while a few other top rankers are surprising

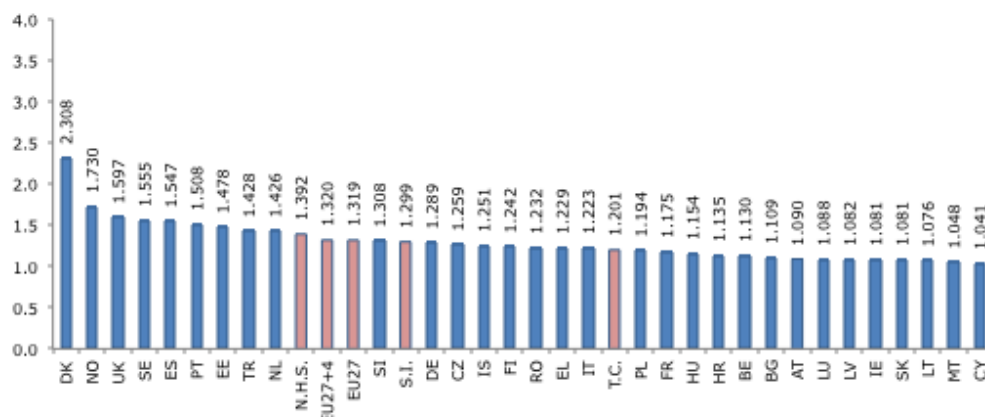


Figure 37 PHR: 'Clinical Information' sub-dimension

Patients' access to their clinical information scores below the total indicator

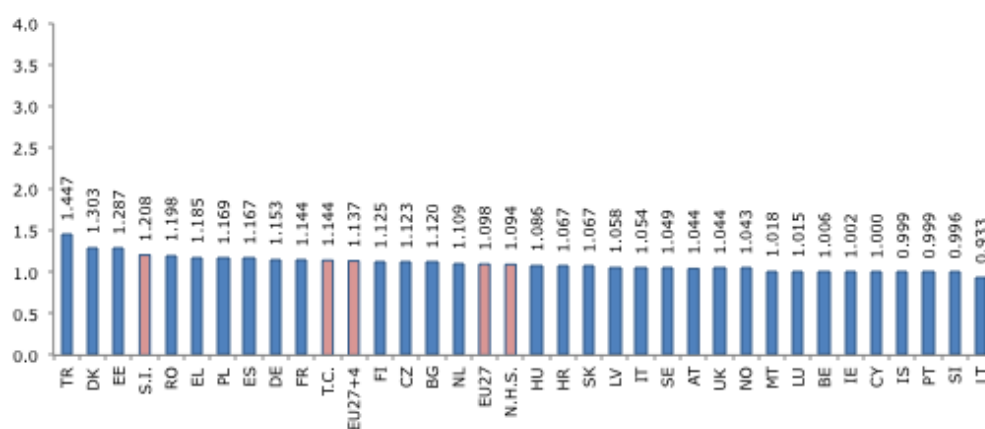
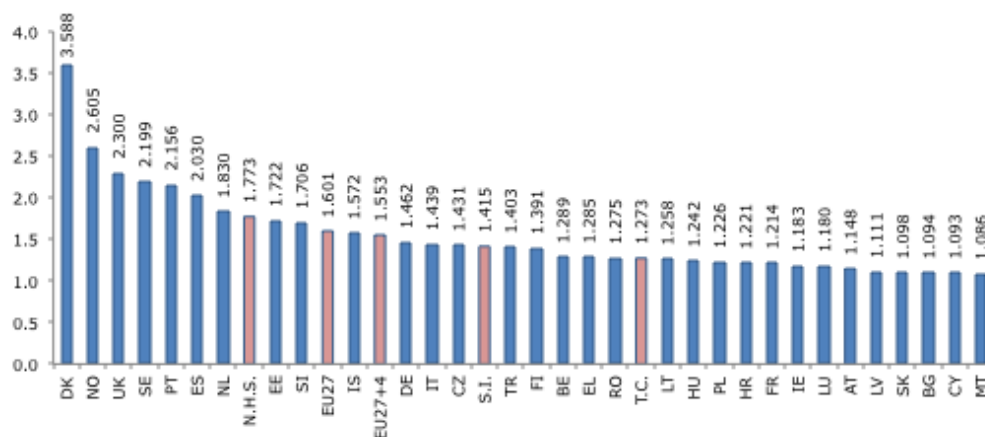


Figure 38 PHR: 'Requests' sub-dimension

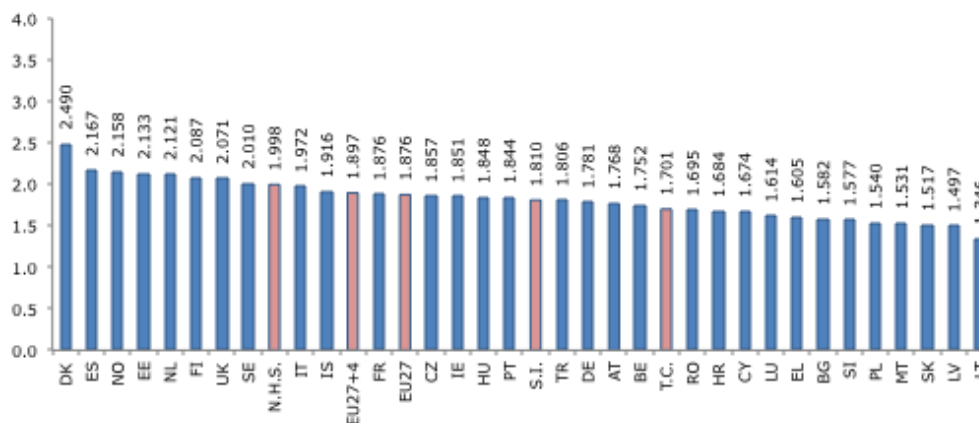
Requests dimensions scores the highest among the sub-dimensions of PHR (1.601)



## 4.6 Overall composite index

As explained in § 4.1 and illustrated in Figure 22, we aggregated<sup>27</sup> the four composite indicators into an overall composite index of eHealth adoption using equal weights for the four measurement pillars (EHR, HIE, Telehealth, and PHR). The results are presented in the next figure and table, with short illustrative comments.

**Figure 39 Composite index of eHealth adoption**



<sup>27</sup> Due to missing observations, the country score for the composite index may differ from the average of the country scores for the four dimensions. The scores in each of the four dimensions and in the composite index are calculated first on a per-practitioner basis and then aggregated per country for all practitioners in that country. Due to missing observations, for some practitioners it may only be possible to calculate the scores for some dimensions. Thus, that practitioner is only considered in the country aggregates for the dimensions for which a score could be calculated. This means in practice that the scores for each dimension and for the composite index for the same country may be calculated based on different numbers of individuals.

**Table 15 Overall Composite index of adoption by country**

Country	Composite index	EHR Dimension	HIE Dimension	Telehealth Dimension	PHR Dimension
EU27+4	1.897	2.944	1.874	1.395	1.320
EU27	1.876	2.989	1.884	1.383	1.319
N.H.S.	1.998	3.100	2.046	1.415	1.392
S.I.	1.810	2.797	1.728	1.373	1.299
T.C.	1.701	2.536	1.537	1.428	1.201
AT	1.768	2.868	1.776	1.284	1.090
BE	1.752	2.875	1.758	1.215	1.130
BG	1.582	2.746	1.313	1.138	1.109
CY	1.674	2.583	1.445	1.494	1.041
CZ	1.857	2.816	1.743	1.567	1.259
DE	1.781	2.894	1.646	1.239	1.289
DK	2.490	3.227	3.041	1.381	2.308
EE	2.133	3.034	2.750	1.251	1.478
EL	1.605	2.047	1.275	1.528	1.229
ES	2.167	3.157	2.356	1.572	1.547
FI	2.087	3.041	2.395	1.676	1.242
FR	1.876	3.093	1.886	1.312	1.175
HR	1.684	2.636	1.692	1.260	1.135
HU	1.848	2.845	1.609	1.785	1.154
IE	1.851	3.132	1.716	1.443	1.081
IS	1.916	2.847	2.116	1.456	1.251
IT	1.972	3.140	2.032	1.476	1.223
LT	1.346	1.393	1.471	0.955	1.076
LU	1.614	2.756	1.355	1.232	1.088
LV	1.497	2.167	1.298	1.081	1.082
MT	1.531	2.126	1.255	1.452	1.048
NL	2.121	3.329	2.190	1.537	1.426
NO	2.158	3.013	2.738	1.151	1.730
PL	1.540	2.181	1.259	1.350	1.194
PT	1.844	2.803	1.845	1.179	1.508
RO	1.695	2.467	1.553	1.464	1.232
SE	2.010	2.855	2.305	1.322	1.555
SI	1.577	2.128	1.318	1.467	1.308
SK	1.517	2.393	1.231	1.304	1.081
TR	1.806	2.466	1.715	1.605	1.428
UK	2.071	3.221	2.009	1.458	1.597

N.H.S.=National Health Service; S.I.=Social Insurance; T.C.=Transition Countries



***The value of the  
CI at EU27  
(1.876) is just  
below 2,  
meaning we are  
close but not  
yet at full  
availability of  
eHealth  
applications  
whereas their  
usage is fairly  
limited;  
This applies also  
for the top  
scoring  
countries that  
do not yet reach  
yet values close  
to 60% (3.0) of  
the adoption  
index***

Some final considerations are in order here on the composite index, before we move onto the next paragraphs that from different angles try to look at the possible explanations of the presented adoption levels. The overall index is quite low and, recalling that a value of 2 means full availability but little usage, seem to that eHealth (as defined by the four measurement pillars) in primary care in EU27 did not yet reach full availability, whereas usage is very modest. On the other hand, we have also shown that adoption levels are fairly different when we look separately at the composite indicators for EHR (2.989), HIE (1.884), telehealth (1.383), and PHR (1.319). As we documented earlier, availability and use of Telehealth and PHR are very limited (see Table 8, p. 41 for Telehealth, and see Table 9, p. 42 for PHR). It is self-evident that removing Telehealth and PHR or assigning weights differently to the four pillars (i.e. 30% to EHR and HIE; 20% to Telehealth and PHR) the composite index and the ensuing ranking would change. Yet, if we look at the top 10 countries we find corroboration for our composite index. The top 10, in fact, include countries that consistently ranked at the top in most of the four indicators. The presence of Spain and Italy in the top 10 is easily explained by the latest policy developments that have pushed adoption of eHealth in both countries. The lower than expected position of Sweden and Finland is explained by less availability and usage of some functionalities due to privacy and confidentiality issues. As we illustrate later, both the Netherlands and Estonia stand out with their ranking compared to other countries with similar institutional characteristics; both are known to have invested a lot of efforts in recent years, not only in eHealth but in most of the ICT applications that make their general eReadiness fairly high.

## 4.7 Comparison 2007-2013

Just for the sake of country comparison between 2007 and 2013, we fitted the data of our survey into the overall score of eHealth use developed for the 2007 survey (Dobrev, et al, 2008). This is a very simple and basic aggregation of variables into an overall score of eHealth usage that did not use multivariate statistical analysis. It is a descriptive way of data aggregation using means, and is in no way comparable to the composite indicators and index we have presented so far. Dobrev et al (2008) explained in page 59 how they calculated their compound indicator: each item was "*standardised to a range of 0 (corresponding to a response rate of 0%) to 5 (corresponding to a response rate of 100%). When more than one component indicator was used, the average value for all components was calculated and standardised to a range of 0 to 5*". This means that if average reported usage of, for instance, 'electronic storage of individual medical patient data' in the 2007 sample taken as a whole was at 80% the score assigned according to this method was 4 (0=0%; 1=20%; 2= 40%; 3=60%; 4=80%; 5= 100%). In the second column of the table below we report the average percentage of use obtained in the 2007 survey for the sample as a whole for the eight dimensions (functionalities) defining the overall score. If you sum the percentages and divide by 8 you get a 42% total average that is equivalent to an overall score for 2007 of 2.1 using the method of calculation applied in Dobrev et al (2008).

**Table 16 Score of eHealth use: 2007 – 2013 (all sample)**

Dimensions of the overall score	% of use of dimensions		Overall score	
	2007	2013	2007	2013
Electronic storage of individual medical patient data	75%	83%	<b>2.1</b>	<b>3.2</b>
Electronic storage of individual administrative patient data	80%	94%		
Use of a computer during consultation with the patient	66%	97%		
Use of a Decision Support System	50%	79%		
Transfer of results from the laboratory	40%	72%		
Transfer of administrative patient data to payers or other care providers	8%	29%		
Transfer of medical patient data to other care providers or professionals	11%	28%		
ePrescription (transfer of prescription to pharmacy)	6%	32%		

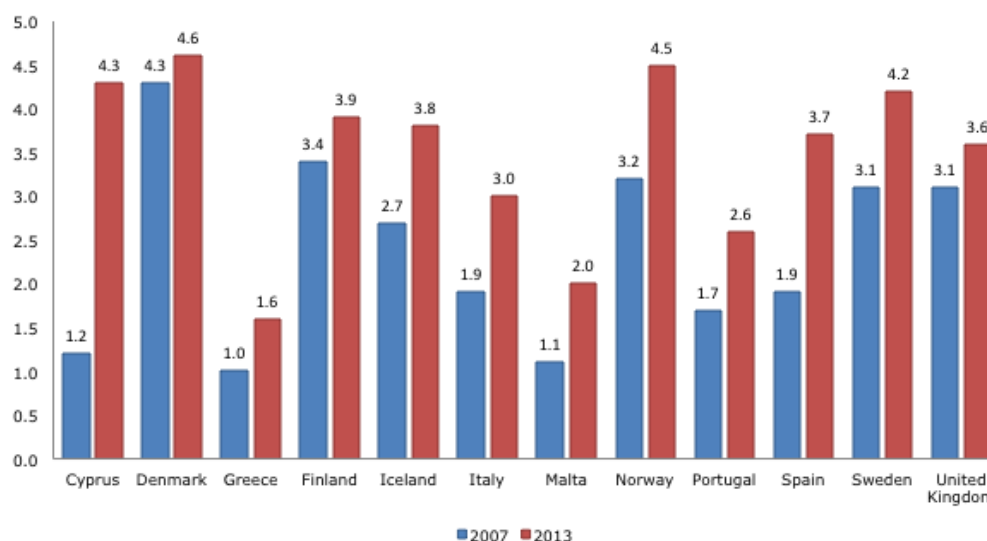
Next, we applied this method to the data we gathered in our survey for 2013. In this respect note the following: a) as illustrated in the Technical Compendium (chapter 3, § 3.2.2.3), we designed our questionnaire so as to ensure some degree of comparability with the 2007 survey, which provides us with the average % use for exactly the same eight dimensions considered in 2007 and we put these percentages in the second column of the table above; b) to ensure comparability we removed the two countries (Croatia and Turkey) that we included in our survey but that were not surveyed in 2007.

Again If you sum the percentages in the third column of the table above and divide by 8 you get a 64% total average that is equivalent to an overall score for 2013 of 3.2 using the method of calculation applied in Dobrev et al (2008).

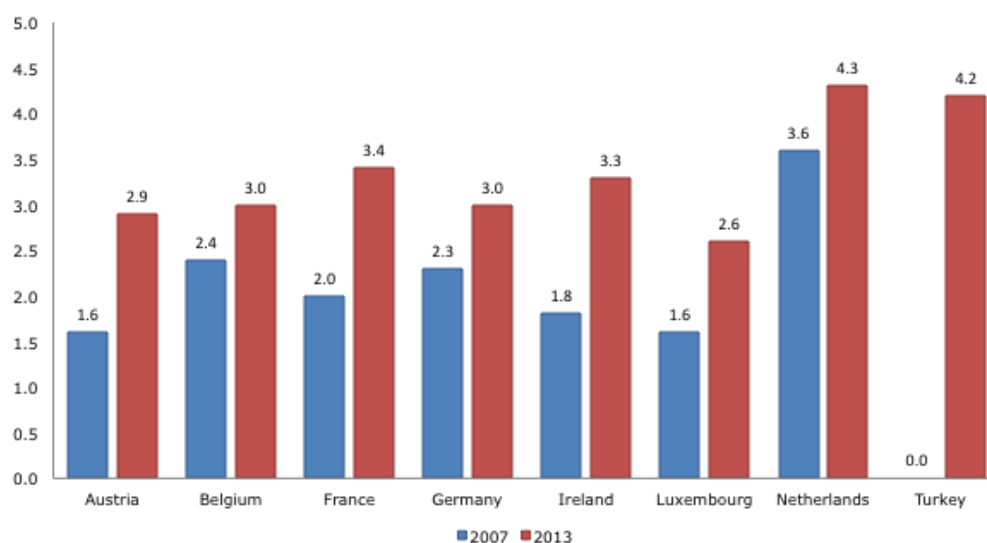
So, at aggregate sample level we observe between 2007 and 2013 a growth from 2.1 to 3.2 in the overall score calculated using the method applied in 2007. In absolute terms the growth in the overall score is sizeable, but considering that it covers a six years period it is not as high as one might have expected.

We then calculated the overall scores country by country using the same procedure illustrated above (and we did also for Croatia and Turkey though in this case we do not have the 2007 term of comparison). As the reader can observe, most countries show a progress in the overall score (calculated using the 2007 method) between 2007 and 2013.

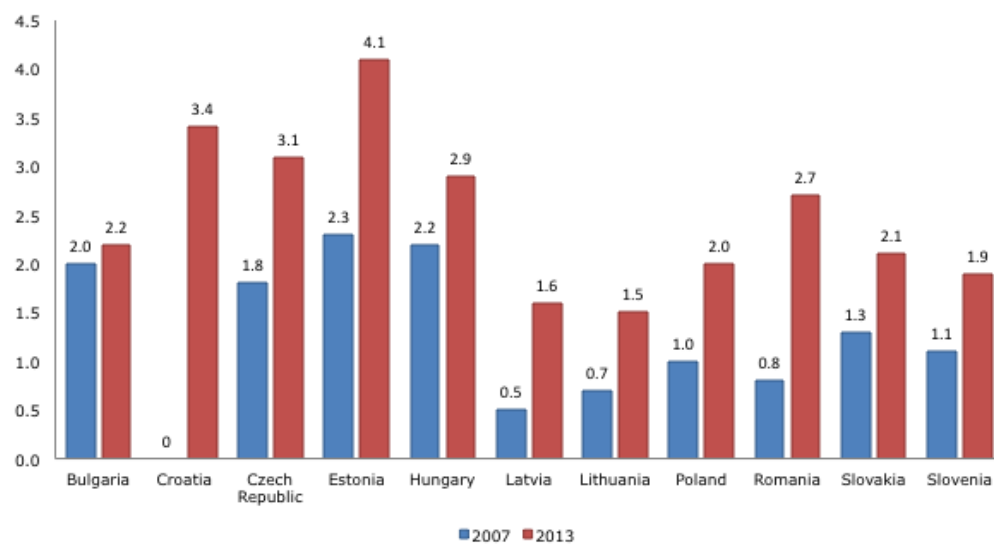
**Figure 40 Score of eHealth use 2007-2013: NHS countries**



**Figure 41 Score of eHealth use 2007-2013: SIS countries**



**Figure 42 Score of eHealth use 2007-2013: other countries**



## 5. Explaining eHealth adoption

### Box 4 Chapter 5 Roadmap

This chapter uses different instruments and presents different ways to explain and interpret the different levels of eHealth adoption. In § 5.1, a qualitative analysis of eHealth adoption variation with respect to contextual parameters (organisational settings and healthcare system models), corroborated with a Multilevel Analysis of Variance is proposed. In § 5.2, we develop a descriptive analysis of the results on impacts and barriers obtained from the survey, integrated with insights from the two Focus Groups conducted with GPs. In § 5.3, four GPs attitudinal profiles, produced through a non-hierarchical cluster analysis, are presented. Finally, in § 5.4 we discuss the results of the Structural Equation Modelling performed to explain eHealth adoption levels (using as dependent variable the composite index) in terms of the latent variables extracted from Part C of the questionnaire.

For the technicalities of the multivariate statistical techniques used, we refer the reader to the Appendix (Chapter 7, § 7.2 for cluster analysis; § 7.4 for Structural Equation Modelling; and § 7.5 for Multilevel Analysis).

*The fewer measures available for independent explanatory variable have limited the results that could be obtained from Multilevel Analysis and Structural Equation Modelling*

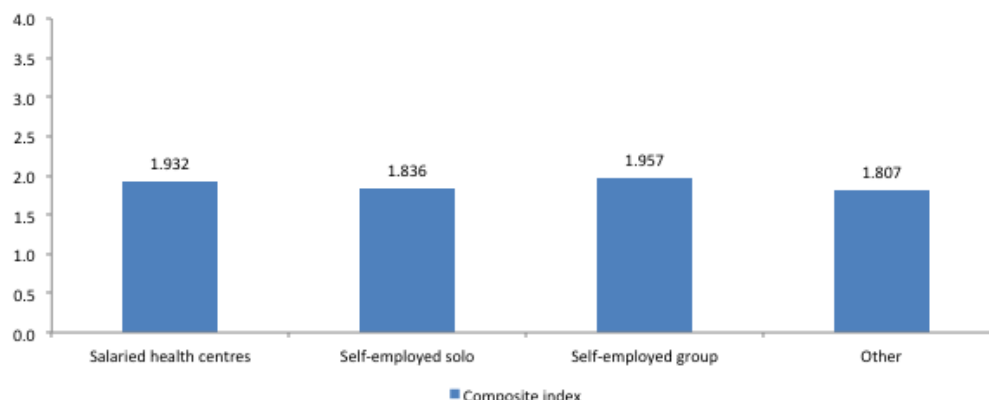
As this chapter focuses on explanation, we must recall the disclaimer we made at the end of § 2.2 on the explanatory power of our survey. Over a total of 39 questions, 10 were in Part A (26%), 23 in Part B (59%), and 6 in Part C (15%). It is thus obvious that our data focus much more on the measurement of availability and use of eHealth (Part B), than on the variables that could explain the different levels of eHealth availability and use (then combined into indicators and index of adoption). In other words, we have much more data on the dependent variable than on the independent variables that could explain eHealth Adoption levels. As a result, the fewer data available on independent explanatory variables clearly limited the results of the Multilevel Analysis and the Structural Equation Modelling that we performed on the data. In the SEM exercise, for instance, the inclusion of manifest variable did not produce significant results, whereas in MLA we could only produce a statistically significant and theoretically meaningful analysis of variance. This, however, does not necessarily mean that eHealth adoption levels cannot be explained by variables other than individual perceptions, but possibly means that we did not have enough data to measure the explanatory independent variables for MLA and SEM to produce more results than those we present.

## 5.1 Adoption and contextual parameters

In the next two figures, we have plotted the value of the overall Composite Index (CI) and of the four composite indicators against the type of organisational settings in which GPs perform their work<sup>28</sup>. Even at this simple qualitative level, it is possible to see that organisational settings influence adoption levels, confirming that GPs in single-handed practices lags behind those working in group practices and in health centres (the only exception is for the composite indicator of EHR).

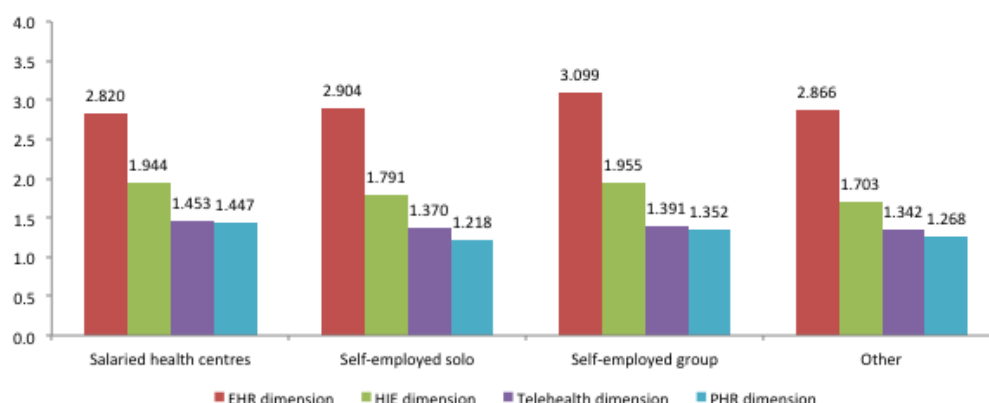
**Figure 43 Overall eHealth adoption by type of practice**

*Overall eHealth adoption is higher for GPs in group practices and health centres as compared to those working in single-handed practices or under other arrangements (i.e. free-lance and others)*



**Figure 44 Adoption of dimensions by type of practice**

*Adoption of PHR and telehealth is higher in health centres, whereas for HIE groups practices and health centres score the same, whereas for EHR Health Centres score the lowest*

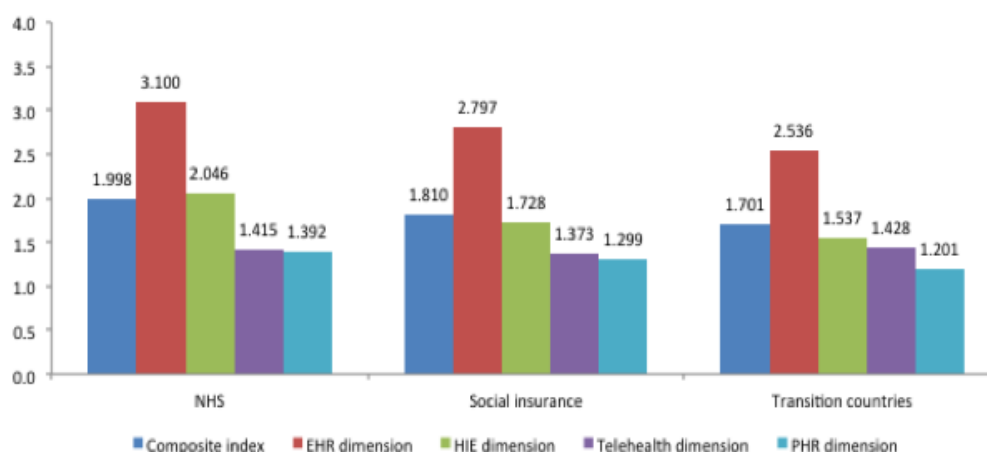


The next figure and the following five tables clearly document that the composite index and the composite indicators vary as a function of the health system types.

<sup>28</sup> To plot these table we have performed Analysis of the variance (ANOVA) test so as to compare multiple means. All the results were statistical significant

*On average,  
the composite  
index and  
indicators  
score higher  
for NHS model  
as compared  
to Social  
Insurance  
model*

**Figure 45 Overall eHealth adoption by health system types**



In this and in next tables we report the values of the Composite Index (CI) and of the four composite indicators that we presented in chapter 4. So, we recall to the attention of the reader that we are back to considering scores ranging from 0 to 4, as a continuous variable capturing from not aware “0” to full adoption “4”.

**Table 17 Composite index and health system**

Countries	CI	Countries	CI	Countries	CI
<b>NHS</b>	<b>1.998</b>	<b>Social Insurance</b>	<b>1.810</b>	<b>Transition countries</b>	<b>1.701</b>
Denmark	2.490	Netherlands	2.121	Estonia	2.133
Spain	2.167	France	1.876	Czech Republic	1.857
Norway	2.158	Ireland	1.851	Hungary	1.848
Finland	2.087	Turkey	1.806	Poland	1.844
UK	2.071	Germany	1.781	Romania	1.695
Sweden	2.010	Austria	1.768	Croatia	1.684
Italy	1.972	Belgium	1.752	Bulgaria	1.582
Iceland	1.916	Luxembourg	1.614	Slovenia	1.577
Portugal	1.844			Slovakia	1.517
Cyprus	1.674			Latvia	1.497
Greece	1.605			Lithuania	1.346
Malta	1.531				
<b>AVERAGE 1.897</b>					



*That adoption is higher in the NHS cluster is also evident when looking at country level scores both for the index and for the four indicators*

Looking at the details in the table above, we can see that, with the noticeable exceptions of the Netherlands and Estonia (substantially outranking countries in their cluster), the rank at average level is mostly reflected at country level. With few exceptions (Cyprus, Malta, and Greece<sup>29</sup>), NHS countries outrank all countries in the other two clusters. The score on the four composite indicators (see the next four tables) both on average and by country, mirrors to a large extent what we have illustrated for the overall composite index.

**Table 18 EHR index by country and health system**

Countries	EHR	Countries	EHR	Countries	EHR
<b>NHS</b>	<b>3.100</b>	<b>Social Insurance</b>	<b>2.797</b>	<b>Transition countries</b>	<b>2.536</b>
Denmark	3.227	Netherlands	3.329	Estonia	3.034
UK	3.221	Ireland	3.132	Hungary	2.845
Spain	3.157	France	3.093	Czech Republic	2.816
Italy	3.140	Germany	2.894	Bulgaria	2.746
Finland	3.041	Belgium	2.875	Croatia	2.636
Norway	3.013	Austria	2.868	Romania	2.467
Sweden	2.855	Luxembourg	2.756	Slovakia	2.393
Iceland	2.850	Turkey	2.466	Poland	2.181
Portugal	2.803			Latvia	2.167
Cyprus	2.583			Slovenia	2.128
Malta	2.126			Lithuania	1.393
Greece	2.047				
<b>AVERAGE 2.944</b>					

**Table 19 HIE index by country and health system**

Countries	HIE	Countries	HIE	Countries	HIE
<b>NHS</b>	<b>2.046</b>	<b>Social Insurance</b>	<b>1.728</b>	<b>Transition countries</b>	<b>1.537</b>
Denmark	3.041	Netherlands	2.190	Estonia	2.750
Norway	2.738	France	1.886	Czech Republic	1.743
Finland	2.395	Austria	1.776	Croatia	1.692
Spain	2.356	Belgium	1.758	Hungary	1.609
Sweden	2.305	Ireland	1.716	Romania	1.553
Iceland	2.116	Turkey	1.715	Lithuania	1.471
Italy	2.03	Germany	1.646	Slovenia	1.318
UK	2.009	Luxembourg	1.355	Bulgaria	1.313
Portugal	1.845			Latvia	1.298
Cyprus	1.445			Poland	1.259
Greece	1.275			Slovakia	1.231
Malta	1.255				
<b>AVERAGE 1.874</b>					

<sup>29</sup> Indeed, the characterisation of these three countries as NHS systems is disputable, for they all have a larger than average (compared to other NHS countries) amount of private healthcare provision and expenditure. For our purpose in this report, however, we did not consider it worth producing a more granular break-down, and separating these three cases from the NHS type.

**Table 20 Telehealth index by health system**

Countries	THLT	Countries	THLT	Countries	THLT
<b>NHS</b>	<b>1.415</b>	<b>Social Insurance</b>	<b>1.373</b>	<b>Transition countries</b>	<b>1.428</b>
Finland	1.676	Turkey	1.605	Hungary	1.785
Spain	1.572	Netherlands	1.537	Czech Republic	1.567
Greece	1.528	Ireland	1.443	Slovenia	1.467
Cyprus	1.494	France	1.312	Romania	1.464
Italy	1.476	Austria	1.284	Poland	1.350
UK	1.458	Germany	1.239	Slovakia	1.304
Iceland	1.456	Luxembourg	1.232	Croatia	1.260
Malta	1.452	Belgium	1.215	Estonia	1.251
Denmark	1.381			Bulgaria	1.138
Sweden	1.322			Latvia	1.081
Portugal	1.179			Lithuania	0.955
Norway	1.151				
<b>AVERAGE 1.383</b>					

**Table 21 PHR index and health system**

Countries	PHR	Countries	PHR	Countries	PHR
<b>NHS</b>	<b>1.392</b>	<b>Social Insurance</b>	<b>1.299</b>	<b>Transition countries</b>	<b>1.201</b>
Denmark	2.308	Turkey	1.428	Estonia	1.478
Norway	1.730	Netherlands	1.426	Slovenia	1.308
UK	1.597	Germany	1.289	Slovakia	1.308
Sweden	1.555	France	1.175	Czech Republic	1.259
Spain	1.547	Belgium	1.130	Romania	1.232
Portugal	1.508	Austria	1.090	Poland	1.194
Malta	1.408	Luxembourg	1.088	Hungary	1.154
Iceland	1.251	Ireland	1.081	Croatia	1.135
Finland	1.242			Bulgaria	1.109
Greece	1.229			Latvia	1.082
Italy	1.223			Lithuania	1.076
Cyprus	1.041				
<b>AVERAGE 1.320</b>					

*This preliminary analysis hints at possible country effects shaping adoption levels, which cannot be seen as depending only on GPs individual characteristics*

The qualitative analysis of variation in the summary measures with respect to organisational settings and health system types clearly hints at the fact that variation in eHealth adoption is shaped not only by GPs individual characteristics and attitudes but also by contextual meso and macro level factors. Since organisational settings are to a large extent related to health system institutional characteristics, we can rephrase the sentence above and conclude that there is preliminary evidence on the possibility that eHealth adoption is shaped also by country level effects.

*Multilevel Analysis of Variance confirms the above hints: country effects account for sizeable share of variability in both the index and the indicators*

This preliminary hint is fully confirmed by the Multilevel Analysis of Variance that we performed, and that is illustrated in detail in § 7.5 of the Appendix. We used a MLA model without explanatory variable called “The Empty Model (random effects ANOVA)” (or alternatively “Unconditional Null Model”). This is basically a MLA Analysis of Variance (ANOVA). As it is interesting in itself to disentangle variability at the various levels, this model can confirm insight as to the presence of ‘supra-individual’ effects (in our case country effects) and suggests further explanation may fruitfully be sought. Without repeating the technicalities explained in § 7.5, we can directly report in very succinct fashion the important results of this analysis showing that country effects account for: a) 30% of the composite index variance; b) 41% of the EHR composite indicator variance; c) 32% of the HIE composite indicator variance; d) 14% of the Telehealth composite indicator variance; and e) 13% of the PHR composite indicator variance. By the standards of MLA, the percentages of variance that country effects account for are fairly high and definitely confirm that eHealth adoption depends also on country level factors. It certainly suggests that further explanatory efforts could be fruitfully pursued to understand the influence of the country effects beyond what was possible to do with the limited number of variables that we have at our disposal. Indeed, we used an empty model with no independent variables for our measures of such variables (Part A and Part C of the questionnaire); these were not enough to run a full MLA model with dependent variables and predictors.

## **5.2 Drivers, impacts, and barriers (Q25-Q28)**

*We present a descriptive analysis of GPs’ perception of drivers, impacts, and barriers from Part C of the questionnaire, integrated with elements from the Focus Groups*

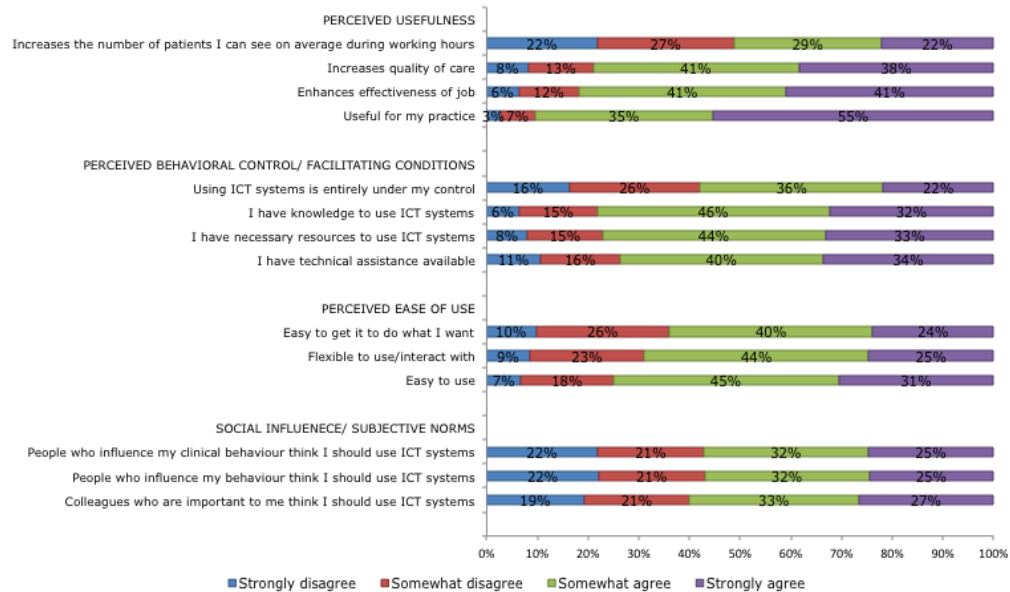
We present here a descriptive analysis of the results obtained from Part C of the questionnaire. We recall that the questions in this part were derived from the scientific literature on ICT adoption by health professionals (see TC, chapter 1, § 1.3) and later went through the scrutiny and validation by 25 GPs participating in the focus groups (see TC, chapter 5, § 5.4). We therefore refer the readers to the indicated parts of the TC and do not illustrate here the rationale and justification for the grouping and formulation of specific items. Most questions were formulated asking respondents to agree or disagree with several statements concerning the use of ICT<sup>30</sup> in their practice. We integrate the presentation of the descriptive findings from the survey with reference to some of the more qualitative insights obtained on drivers, impacts, and barriers from the two focus groups we held with GPs (see chapter 5 of TC).

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<sup>30</sup> It is important to stress that for obvious reasons of space we could not formulate statements for all of the about 50 different functionalities that were measured; we used the generic expression ICT across the 31 countries (also in view of linguistic difference) as it was more widely understood than the expression eHealth.

**Figure 46 Perceived drivers and social influence (Q25)**

*This question reflects the main construct of behavioural models: perceived usefulness, control, ease of use, as well as social influence and subjective norms*



*Strong agreement with generic usefulness and disagreement with visiting more patients*

Looking at **perceived usefulness**, we notice that more than 50% of GPs strongly agree that the use of ICT is generically 'useful for their practice'. This strong agreement somewhat decreases when looking at more specific items: only 22% strongly agree that ICT increase the number of patients they can see on average during working hours, and about 40% strongly agree that use of ICT improves quality of care and the effectiveness of their job. Noteworthy also is that the statement about increasing the patients seen daily meets also with the highest percentage of disagreement.

*GPs report some level of perceived control and ease of use of the technology, but we notice less agreement with the statement that 'ICT is entirely under their control'*

Participants in the focus groups actually claimed that the introduction of ICT in their practice increases the workload in the short-term, and were sceptical about the potential gains in terms of throughput efficiency (patients visited per day). Participants to the focus groups also made general statements about the usefulness of using ICT in their practice and enumerated a number of positive impacts and reasons for using ICT (see later). On the other hand, when listening carefully at the audio-file we realised that their verbalization of drivers and benefits hints at something seen more as a potential than as an actual reality in their daily practice. Moreover, when going into the details of various applications, they voiced several problems and barriers (see later).

*Some participants in the Focus Groups claimed that the introduction of ICT in primary care is increasingly imposed top down for administrative rather than for clinical objectives*

With respect to the drivers for using ICT, also interesting are the following elements from the focus groups. During both focus groups, when the moderators asked about whether in the various countries from which participants came<sup>31</sup> there existed financial incentives for the deployment of eHealth applications, many GPs agreed that the introduction of ICT in primary care practice is mostly becoming a mandatory obligation imposed from the government, mainly for administrative rather than clinical purposes. Rather than speaking about incentives to adopt ICT, many participants mentioned that the system has changed in the past years leading to a compulsory adoption of ICT solutions responding to administrative rather than clinical objectives<sup>32</sup>. Since before and after this theme emerged, GPs nonetheless cited positive drivers (benefits) for adoption; this element and the statements reported in the footnote must be read as saying that no incentives are provided and that administrative drivers make the use of some applications mandatory, although this does not prevent GPs from seeing the actual or potential benefits of eHealth from the perspectives of their own professional interests and objectives.

*Having multiple items and considering inputs from the Focus Groups help us control for possible response effect in the strong agreement on generic usefulness*

Going back to Figure 46, we can now look at the blocks on perceived control over, and ease of use of, the technology, which is posited by most behavioural models to be important factors explaining adoption or non-adoption. Approximately a third of the respondents strongly agree that: they have technical assistance available when using ICT; they have the necessary resources to use ICT systems; and they have the knowledge to use such systems. These percentages decrease, however, to 22% of GPs when they were asked if using ICT system is entirely under their control. More than 70% of the GPs agreed (somewhat or strongly) with statements that these technologies are easy and flexible to use.

*At this preliminary and descriptive level the importance of social influence and subjective norm seem confirmed*

We can notice the contradiction between a somewhat lower level of perceived control as compared to a relatively higher level of self-reported ease of use. Behind this there is probably also some form of 'response effect' such as social desirability, taking into account that the data combine the answers of both those respondents that use ICT routinely and of those who use them more rarely or do not use them at all.

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31 Austria, Belgium, Croatia, Czech Republic, Finland, Hungary, Ireland, Italy, Lithuania, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Turkey, United Kingdom.

32 Here are some of the statement made or examples reported by the participants to the focus groups: a) "GPs are the frontrunners of the EHR without receiving any incentive. Now Government wants to make changes and GPs should pay, this is a financial problem for solo practitioners"; b) "The use of ICT is mandatory and thus not incentivised, we have to actually pay for the eHealth products ourselves"; c) "Use of ICT is supported when social insurances can have some advantages, ICT is about administrative procedures and not just about patients"; d) "We have now a mandatory use of ICT in the practice imposed by the government just in relation to the certification of sick leave for public sector employees".

Finally, behavioural models and innovation diffusion theories also foresee the possibility (hypothesis) that adoption of ICT can be catalysed by social influences and networks and by subjective norms, both of which are measured in the last block of Figure 46. About 25% of the GPs strongly agree that people who influence their clinical and personal behaviours push them to use ICT systems. This percentage increases to 27% with regard to the statement "Colleagues who are important to them think they should use ICT systems". Overall agreement with these two statements is fairly high and confirms that social influence and subjective norms are important.

*During the Focus Groups GPs enumerated a number of positive impacts from ICT, mostly concerning efficient data management*

The next two figures (Figure 47 and Figure 48) report the perceived impacts on activity, efficiency, quality, and working processes. Before looking at the descriptive findings from the survey, however, it is useful to briefly report the qualitative insights from the two Focus Groups. Participants enumerated a number of positive impacts and reasons for using ICT in their practices (drivers) that mostly concerned 'efficient data management and exchange'<sup>33</sup> and 'support to clinical decision'<sup>34</sup>.

*They were more sceptical on other more organisational impacts*

On the other hand, participants in the Focus Groups were sceptical about issues such as throughput efficiency, and reduction of administrative and clinical costs. Also ambivalent were the appraisals of increased patient access to healthcare via ICT, since this could not be denied as a potential benefit but it must be read with GPs concerns about expectations and workload.

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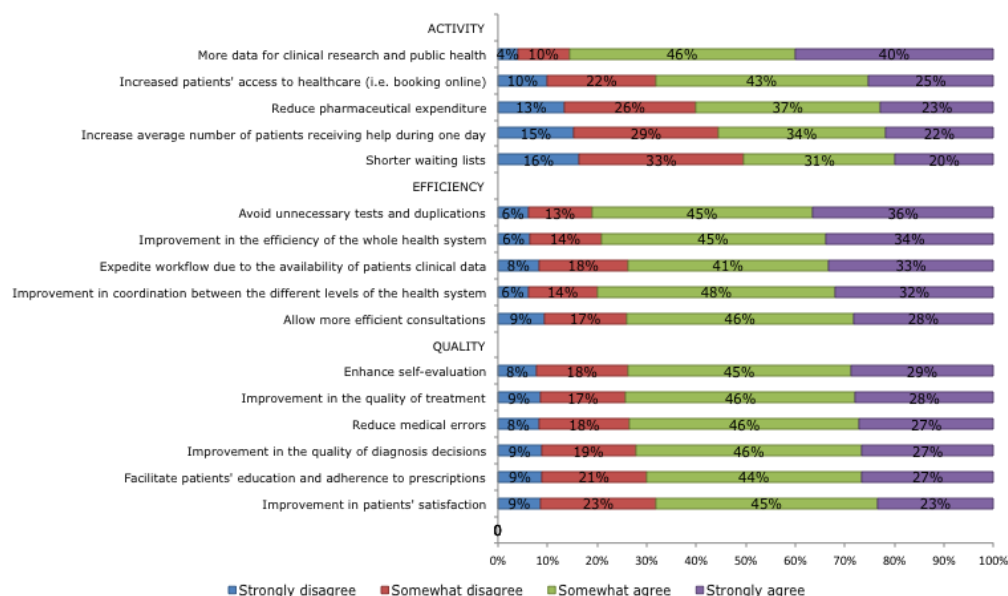
33 Here are some items cited by participants: a) Efficient access to organised (structured) information, potentially including all medical data (from different sources; b) Efficient way of sharing information ("can call the specialist in the hospital and look at, and discuss, the same medical data instantly"); c) Data collection and data analysis, follow clinical parameters, audit of our own work; d) Clinical research with data: Communication among GPs, comparison for example prescription of drugs.

34 Here are some items cited by participants: a) Support clinical decision: getting suggestions and warnings about drugs or other to improve quality and patient safety; b) Drugs interactions – Patient safety, Reminders and alerts Protocols, guidelines to practice Evidence Based Medicine.



**Figure 47 Impact on activity, efficiency, and quality (Q27)**

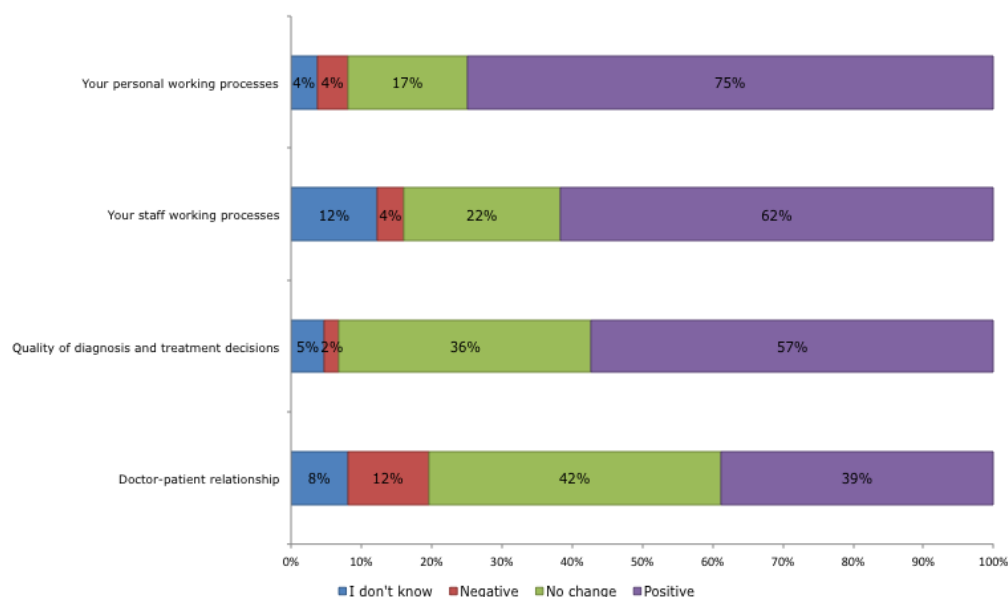
*The items of the survey concerning perceived impact on activity, efficiency, and quality of care confirm to a large extent the picture that emerged from the Focus Groups*



The strongest agreements (Figure 47) are with the positive impact of having more data for their clinical activity, whereas there seems to be more scepticism about impact on patients' satisfaction and on some efficiency impacts.

**Figure 48 Impact on working processes (Q28)**

*This is further confirmed in the perceived impact on working processes where we find the least agreement with the idea that ICT has improved doctor-patient relationship*



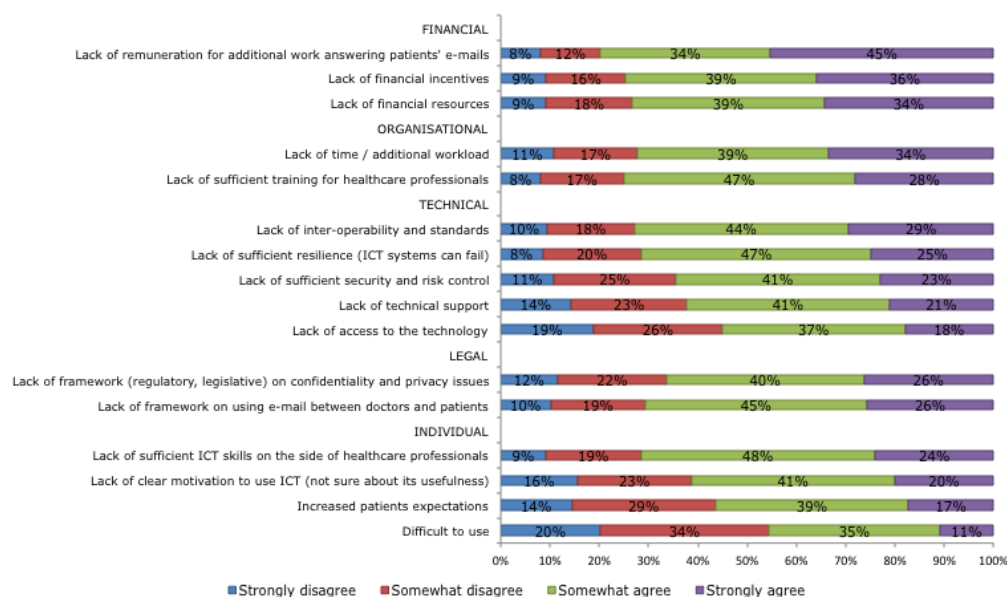
Looking at Figure 48 it emerges that GPs do not see much positive change in terms of doctor-patient relationship, which amply confirms the complaints we heard during the focus groups about how e-mail and the Internet at putting a strain on such relationship (see below). On the other hand, most see positive changes in their working processes and quality of diagnostic decisions.

GPs were also asked about the barriers to the introduction and usage of ICT system in primary care. These barriers were grouped into five different dimensions that are reported in the next figure. In



the case of barriers, we will look at the data from the survey, integrating them with qualitative inputs from the Focus Groups.

**Figure 49 Barriers (Q26)**



**The highest percentages of strong agreement go to financial barriers and problems, followed by inter-operability issues, and by lack of a legal framework on confidentiality and privacy**

**GPs participating in the Focus Groups voiced the concern that the introduction of ICT increases the work load in the transitional phase, and that online interaction with patients changes the latter's expectations and should be better regulated**

**Lack of inter-operability and system resilience and security figure as important barriers both in the survey and in the Focus Groups where they were stressed, especially in relation with Health Information Exchange**

About 45% of the respondents strongly agree that lack of remuneration for additional work answering patients' emails is a barrier to adoption. Lack of financial incentives (36%) and lack of financial resources (34%) were reported also as strong barriers. In addition, also fairly high is agreement on the fact that the lack of a framework regulating e-mail exchange between doctors and patients represents a problem. This data is fully in line with what we heard from the GPs participating in the focus groups. According to these participants, in the short term the use of ICT in their practice produces additional work load for data entry and answering e-mails: "we almost cannot talk to patients during visits because we have to type so much"; "eHealth is a lot of work, working emails is too much, phone call is quicker". While they recognise that work for data entry might be a barrier only during the transitional phase, they are concerned that, as stated by one participant, for some time "we have a transition from good paper records to mediocre electronic records". On the other hand, they see the other face of the coin in the positive appraisal of accessing structured and updated clinical data. One problem that is not transitional and is here to stay is certainly that of e-mails from patients, which calls into question the doctor-patient relation and the corresponding expectations. Online interaction between a GP and patient does imply expectations from the patient side of a faster response than normal. This is seen potentially as a problem because of the consequential increase in the GPs' workload. In this respect, participants at our focus groups agreed that the use of e-mail needs to be regulated with, for instance, the establishment of: a) a response time; b) criteria to account for e-mail exchanges as additional workload to be remunerated. Overall (somewhat and strongly) as many as 73% of GPs agree that (lack of) inter-operability is a barrier, and similar percentages apply to both

*Lack of a legal framework regulating confidentiality and privacy issue was also stressed as an important barrier both in the survey and in the Focus Groups where they were stressed especially in relation with Personal Health Records*

system resilience and security, which confirms the more in-depth and qualitative insights obtained during the focus groups. During the Focus Groups, lack of technical inter-operability and system resilience emerged as the main barriers for Health Information Exchange (HIE), which on the other hand was assessed positively as a potentially efficient way of sharing information and having instant access to medical data produced elsewhere in the system. The problem was particularly voiced by GPs coming from federal and/or decentralised countries, who pointed out that the use of ICT in such systems is really limited to the very local level, as the systems of different territorial units do not talk to each other. This makes the exchange and sharing of data complicated and difficult. According to what was reported by the participants, most countries codify data using a common standard (i.e., UK's Reed Code in the 80s) but then at different levels they use different systems to exchange data. In summary, while reporting high level of computerization participants at the focus groups also indicated clear inter-operability bottlenecks: *"We do everything with computers, but they don't talk to each other"*; *"Technological issues are still problems: too many systems are available within a country that are not inter-operable. This is a big problem for cross-border care"*. During the discussion of HIE, some participants pointed out to how disruptive can be the instances (still frequent) when the system is down: *"with ePrescription application connected with pharmacists and laboratories, when the system is slow or down it becomes a big problem"*. Some GPs stated that eHealth systems for exchanging and sharing information should be as secure, resilient, and redundant as the system now used in Internet banking are, but added that this is still not the case and that there are not enough financial resources to reach this ideal situation. In this respect, one GP affirmed: *"Primary care is different from hospitals. Maintaining secure ICT solutions and quality system (controlling risk) is very difficult in small practices"*.

Overall agreement is also high (76% somewhat or strongly agree) about the fact that the lack of a regulatory framework on confidentiality and privacy is an important barrier. Confidentiality and data protection emerged repeatedly as a topic during the Focus Groups, not only when the talk was specifically on barriers but also when Electronic Health Records (EHR), and Personal Health Records (PHR) were discussed. While participants appraised positively EHR, they expressed uneasiness about the legal grey area surrounding access to the information in existing records<sup>35</sup>. The main concern is about data used by insurances and others, which may undermine the patient-physician trust relation. The issue of confidentiality emerged again very prominently when the discussion moved on to PHR; GPs raised a number of questions: What part of the medical record should the patient see and what not? Who can access that information besides the patient (parents, spouse, employers, etc.)? If patients can access their whole medical record, doctors are very

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<sup>35</sup> For instance, one participant from a country with a Social Insurance model expressed the concerns that health professionals broadly defined (including people from social insurance) can access the HHR.

conscious and leave out some personal (non-medical) information or observations that may be relevant (e.g. child abuse, physical violence, sexually transmitted disease, drug abuse, mobbing, psychological distress, etc.) because patient may misinterpret them and over-react and question the doctor's professionalism (*"We only write clinical information as they will see what we write"*). On the other hand, doctors are also very conscious that other people besides the patient may have access to that information and thus potentially cause the patient trouble, such as with spouse, parents, and employers (*"We are very careful when writing down family circumstances"*). In summary, GPs participating in our focus groups asked for a clear legal framework in which electronic records could be safely used by GPs and their patients.

### 5.3 GPs attitudinal clusters

*A cluster analysis was performed on the data on perceived impacts and barriers to identify attitudinal profiles of GPs*

In this paragraph we present the cluster analysis performed on the data coming from the answers that respondents provided on the perceived impacts and barriers. We used these two variables to construct a typology of GP's attitudinal profiles, identifying four distinct profiles (clusters) that maximise the within-profile similarity and the between-profiles differences. In other words each profile include fairly similar (with respect to their self-reported attitudes and perceptions on impacts and barriers) individual respondents who, in turn, are fairly distinct from the individual respondents grouped in the other profiles the similarities. We constructed the five profiles using a Non-Hierarchical Cluster Analysis of K-means was applied (see details about this procedure and the main technical tables with the results of the analysis at the end of § 7.2). In short we summarise the steps undertaken below:

1. We proceeded first by calculating the average of the grouped items about impact (Quality, Efficiency and Activity) and about barriers (Financial, Organisational, Technological and Individual).
2. We performed a Factor Analysis on these items that yielded two constructs, which we then used to conduct the non-hierarchical cluster analysis producing four attitudinal profiles;
3. We performed an Analysis of Variance (ANOVA) that showed that the means of the factors differed in significantly way across the four clusters;
4. To attribute statistical significance to the differences obtained an associated Chi-square test was carried out and confirmed the goodness of fit of the five identified clusters.

As a result we identified four statistically robust attitudinal profiles that together captures 68% of our sample (i.e. 6242 individuals). Cluster analysis is also a data summarisation and reduction techniques that entails losing some of the original information. In our case 32% of the sample (i.e. 2953 respondents) were not classified with cluster analysis. Hence, below for the sake of full

transparency for each profile we report the share they capture among the classified and of the sample as a whole.

*From the cluster analysis we extracted four attitudinal profiles of GPs: 'Enthusiasts'; 'Realists'; 'Reluctant'; and 'Indifferent'*

The '**Realists**' are the largest cluster (34% of the classified but 23% of our sample) and include GPs that emphasize both impacts and barriers. The '**Enthusiasts**', representing a small minority in the sample (13% of the classified but 9% of our sample), extol the impacts and disregard barriers. The second largest cluster (33% of the classified but 22% of our sample) is represented by the '**Indifferent**' who seem not to care about either impacts or barriers (but are those who use eHealth the least). Finally, we have the '**Reluctant**' GPs who place more importance on barriers than on impacts (20% of the classified but 14% of our sample). We then attempted to characterise the four profiles by mapping them against other variables and checking if they differed in statistically significant ways with respect to the latter. For instance, we took the Composite Index (CI) presented earlier (and ranging on a scale from 0 to 4) and checked whether the value of the index for the four profiles differed in statistically significant ways. We then did the same kind of analysis per country and for some socio-demographic and organisational characteristics <sup>36</sup>.

*The 'Enthusiasts' and the 'Realists' tend to have higher levels of eHealth adoption*

Results in the first table below are all statistically significant, whereas in the next two tables and asterisk (\*) indicate the results that are statistically significant. Table 22 below shows that the overall Composite Index of eHealth adoption is higher among the '**Enthusiasts**' and the '**Realists**' compared to the other two profiles in a statistically significant way. The values in the table below range from 0 to 4 as this is the scale of the Composite Index.

Table 22 GPs clusters mapped against the adoption index

	1. Realistic	2. Enthusiast	3. Reluctant	4. Indifferent
<b>Composite Index</b>	2.00	2.07	1.72	1.92
EHR adoption	3.02	3.05	2.83	3.01
HIE adoption	2.03	2.15	1.62	1.95
Telehealth adoption	1.36	1.44	1.15	1.27
PHR adoption	1.53	1.59	1.23	1.40

\*All results are significant at  $p < .001$ ; the number of GP clustered is 6242 or 68%) of the total sample, whereas 2953 (32%) were non-classified. Percentages in parentheses indicate first the share of each cluster on the total GPs classified and next the share of the total sample.

36 The tests used to check for statistical significance differ depending on the nature of the variable tested. For continuous variables such as the level of the Composite index we used a one-way analysis of variance (ANOVA), whereas for dichotomous (i.e. gender) or categorical (i.e. type of practice) variable we used a chi-square test. In the latter case, to identify the significant difference by cells, we have used the adjusted residual. Under the null hypothesis that the two variables are independent, the adjusted residuals will have a standard normal distribution, i.e. a mean of 0 and standard deviation of 1. So, an adjusted residual that is more than 1.96 (2.0 is used by convention) indicates that the number of cases in that cell is significantly larger than would be expected if the null hypothesis were true, with a significance level of .05. An adjusted residual that is less than -2.0 indicates that the number of cases in that cell is significantly smaller than would be expected if the null hypothesis were true.

**Table 23 GPs clusters by country**

	<b>1. Realistic (34%/ 22%)</b>	<b>2. Enthusiast (13%/ 9%)</b>	<b>3. Reluctant (20%/ 14%)</b>	<b>4. Indifferent (33%/ 22%)</b>
<b>NHS</b>				
Denmark	16%*	51%*	8%*	25%
Norway	31%	26%*	6%*	37%*
Spain	39%	8%*	13%*	40%*
United Kingdom	34%	13%	13%*	40%*
Finland	13%*	9%*	24%	55%*
Sweden	10%*	21%	26%*	43%*
Italy	55%*	11%*	13%*	21%*
Iceland	47%	7%	7%	40%
Portugal	45%*	23%*	8%*	24%*
Greece	61%*	7%*	15%	17%*
Malta	68%	11%	8%	13%
<b>SIS</b>				
Netherlands	16%*	23%*	15%	47%*
France	22%*	5%*	29%*	44%*
Ireland	43%	7%*	18%	32%
Germany	17%*	12%	28%*	43%*
Turkey	55%*	16%	11%*	19%*
Austria	18%*	8%*	46%*	28%
Belgium	21%*	12%	20%	48%*
Luxembourg	18%*	12%	28%	42%
<b>Transition</b>				
Estonia	48%	37%*	0%	15%
Czech Republic	37%	17%	20%	26%
Hungary	56%	8%	19%	17%
Croatia	41%	5%*	41%*	13%*
Romania	43%	31%*	8%*	19%*
Cyprus	34%	38%	7%	21%
Bulgaria	62%*	25%*	4%*	9%*
Slovenia	45%	9%*	23%	23%
Poland	48%	18%	15%	19%
Latvia	29%	8%*	42%*	22%
Slovakia	45%	8%	15%	32%
Lithuania	35%	6%*	45%*	14%*

\* Results are significant at  $p < .001p$ . The number of GP clustered is 6242 or 68%) of the total sample, whereas 2953 (32%) were non-classified. Percentages in parentheses indicate first the share of each cluster on the total GPs classified and next the share of the total sample.

Table 23 shows the four profiles mapped against the variable 'country'. The results match what we have presented with respect to eHealth adoption in that the '**Enthusiasts**' are more concentrated in statistically significant way in countries we have earlier shown to have higher adoption levels. The values in the table above indicate the percentage of classified GPs in each country that belong to each cluster. So, just to make an example: in Denmark out of all respondents that the cluster analysis could classify as much as 51% is part of the enthusiasts. This fact is in line with the evidence that this country has one of the highest levels of both availability and use and, so, it makes sense to find a large number of enthusiast GPs.

Finally, we ran the same kind of analysis to check for the existence of significant differences with respect to a set of individual characteristic and of organisational parameters (see Table 24). As in the previous case, the values in the table above indicate the percentage of classified GPs that belong to each cluster and can

be characterised by the variables in the raw. So, for instance, 34% of the GPs who have been classified by cluster analysis and who are female fall in the 'realistic' profile, and so forth and so on. Female are concentrated more than expected among the '**Enthusiasts**', whereas male are more concentrated among the '**Indifferent**'. In other words females are more likely than males to be '**Enthusiasts**', and males are more likely than females to be '**Indifferent**'. Younger GPs are more likely to be among the '**Realists**' than older GPs, whereas salaried GPs in Health Centres are more likely to be '**Enthusiasts**' and '**Realists**', and less likely to be '**Indifferent**' or '**Reluctant**'. Self-employed working in single-handed practices are less likely to be '**Enthusiasts**' and more likely to be '**Indifferent**'. Finally, GPs working where records are fully or mostly digitalised are more likely to be '**Enthusiasts**' and '**Realists**', while those working where records are still mostly on paper are more likely to be '**Reluctant**'.

**Table 24 GPs clusters mapped against observed variables**

	1. <b>Realistic</b> (34%)/ 23%	2. <b>Enthusiast</b> (13%)/ 9%	3. <b>Reluctant</b> (20%)/ 14%	4. <b>Indifferent</b> (33%)/ 22%
<b>Gender</b>				
Female	34%	16%*	19%	31%*
Male	34%	11%*	19%	35%*
<b>Age</b>				
Less than 36 years old	40%*	14%	13%*	34%
36-45 years old	38%*	15%*	13%*	34%
46-55 years old	32%	11%*	25%*	36%*
More than 55 years old	33%	13%	19%	35%
<b>Professional status</b>				
Salaried, Health Centre	41%*	15%*	13%*	31%*
Self-employed, solo	31%*	12%	23%*	34%
Self-employed, group	32%*	12%	20%	36%*
Other	36%	11%	23%	30%
<b>Location</b>				
Large city	35%	13%	21%	31%
Mid-small city	33%	14%	18%	35%
Rural town	34%	11%**	20%	35%
<b>Digitalisation</b>				
All paper	30%	5%*	42%*	23%*
Mostly paper	27%*	8%*	27%*	38%
Combined electronic/paper	33%*	13%	22%*	32%
Mostly electronic	31%*	12%	19%	38%
All electronic	40%*	14%*	14%*	32%

\*p < .001; \*\*p<.005. The number of GP clustered is 6242 or 68%) of the total sample, whereas 2953 (32%) were non-classified. Percentages in parentheses indicate first the share of each cluster on the total GPs classified and next the share of the total sample.



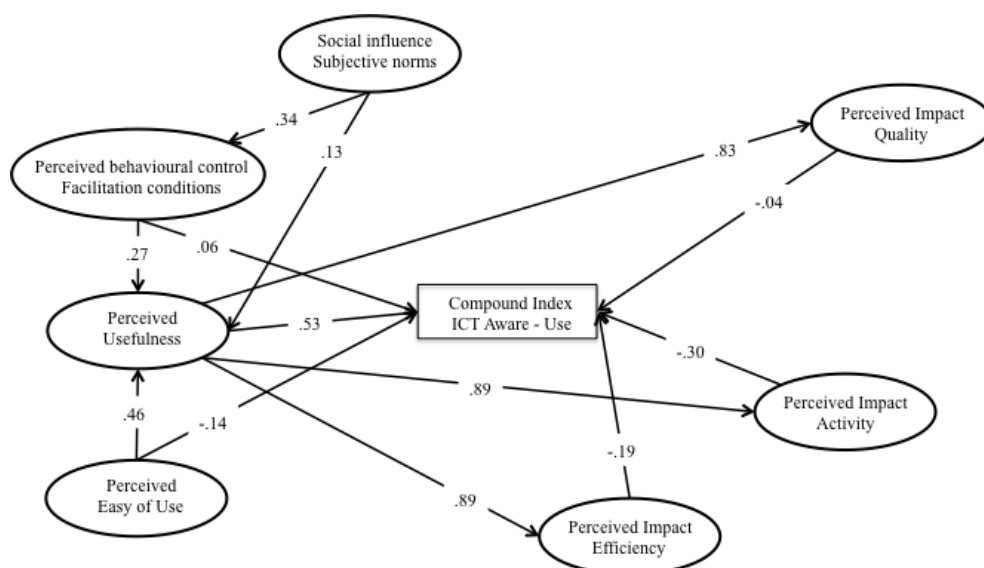
## 5.4 GPs adoption structural model

*We ran a Structural Equation Modelling at aggregate sample level to explain the level of the composite index of eHealth adoption by the latent variables extracted from Part C of the questionnaire*

Let us clarify two important aspects before illustrating the results of the SEM model (summarised in the next figure). As further explained in the Appendix (see § 7.4). SEM is 'causal statistics' technique that allows modelling the relations between a set of independent variables (explanatory variables) and on dependent variable. It must be clarified that this model refers only to GPs and not to countries, and works at aggregate sample level. We do not have a sufficient number of observations to develop country level models<sup>37</sup>. In our context the model depicted in the figure below provides us a causal explanation of the level of eHealth adoption in terms of several independent variables. Since SEM is based on a set of recursive and non-recursive equations, the coefficients indicated in the figure (all of which have been tested and are statistically significant) provide us information on the strength of the relations.

**Figure 50 Explaining eHealth adoption with SEM**

*Perceived usefulness has the strongest effect in increasing eHealth adoption, which is reinforced by ease of use, behavioural control, social influence, and norms*



For instance the figure tells us that the influence of 'perceived usefulness' (.53) is much stronger than that of 'perceived behavioural control' (.06). In other words the level of eHealth adoption increase by .53 for an increase in the usefulness GPs perceive but only by .06 for an increase in the perceived control. The important implication being that the most important factor to increase eHealth adoption among GPs is to increase awareness about how useful they can be for their work and/or to develop applications that better meet their need as to increase the perceived usefulness. Moreover, SEM model also the relationships among independent variables and uncover how certain effect are indirect

<sup>37</sup> The model we present is the one providing the best fit for our data. This model uses as independent explanatory variables only those that we extracted from the questions concerning drivers, barriers, and impact (Part C of the questionnaire). This means we are using as explanation variables measured by the self-reported attitudes and perceptions of respondents. We also tried to use variables from Part A of the questionnaire that concern more 'objective' parameters but this model did not work.



and mediated. We now turn again at the figure summarising the results and we further comment it.

*eHealth adoption is negatively correlated with perceived impacts and positively correlated with perceived barriers*

In the middle of the diagram we have the dependent variable represented by the composite index of eHealth adoption (calculated and processed at the level of each individual GP), placed in the rectangle. All the variables placed in the circles are explanatory variables that affect the composite index directly or indirectly through the mediation of other variables. The numbers placed in the arrows represent the coefficients. For instance, perceived control has a very small impact (.06) on the explanandum, but its impact is also mediated through perceived usefulness of use: its coefficient on perceived usefulness is .27, and the latter has in turn a .53 coefficient on the index. The core result of the model is that the behavioural variables on the left hand side explain to a large extent eHealth adoption by GPs in exactly the same way as predicted by the reviewed behavioural models. Perceived usefulness has the greatest impact on the index, whereas easy of use, behavioural control, and social influence impact on perceived usefulness, and through it the index. The apparently puzzling aspects are the negative coefficients that characterise the relation between the perceived impacts and the index. When we run a model with barriers, we obtained a mirroring paradox with level of adoption showing a positive relation with the perception of barriers. The interpretation of this apparent paradox is two-fold. First, it is possible that respondents who use eHealth routinely are more aware of difficulties and barriers and are growing sceptical about the positive impacts. Conversely, the answers of respondents who use eHealth little and/or not at all are based on social desirability and/or are generically expressed (they are not informed by everyday experience) and somewhat confound the results. Second, as we have seen in the previous paragraph, enthusiastic GPs (high adoption level, emphasis on impacts, and disregard of barriers) are a small minority (13%) and are more than offset by about 54% of the sample who are realist or reluctant. Going back to the model, the relations between the index and the impacts suggest that the heavier users of eHealth among GPs are sceptical about the impact on efficiency and activities, and seem to be a bit less sceptical about those on quality of care, since for the latter the coefficient is negative but very small. From this model we can draw a few main conclusions. First, perceived usefulness is the key explanatory variable for use of eHealth, and it is reinforced by ease of use, behavioural control, social influence, and social norms. Second, even those who use eHealth still do not really see the tangible impacts in terms of efficiency and improvement in activities, whereas they may be starting to appreciate impacts on quality. This can in turn be explained as resulting from lack of evidence on tangible impacts and/or lag times in explication of impacts that have not yet become visible. Third, higher usage comes in many cases (except for a small percentage of the sample) with a stronger perception of barriers; this may mean that a lot more should be done to create the best possible conditions to enable GPs to fully leverage the potentiality of eHealth.

*From the model we conclude that while perceived usefulness is key, much still needs to be done to document impacts and remove barriers*

## 6. Discussion and conclusions

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### 6.1 Measurement of eHealth adoption

We start by recalling and discussing five main findings from the descriptive analysis presented in chapter 3.

#### *A robust sample*

First of all we can conclude (*ex post*) that our sample is fairly representative of the universe both at aggregate and at country level. The age, gender, practice settings, and location (urban/rural) structure of our sample reflect fairly well the picture that could be drawn from secondary sources and from statistics describing the universe. Thus we can conclude that despite the challenges we faced, our approach to the definition of the universe and sampling has resulted in a robust sample.

#### *Access to compute and Internet almost universal...*

Second, it is evident that primary care is reaching almost 100% access to basic ICT: about 97% report having and using a computer connected to the Internet during consultation, which represents a substantial progress compared to 2007 (access to computer 82.5% and to the Internet 66%).

#### *... but still limited for high-speed Internet*

Third, access and use of mobile devices, broadband, and high-speed Internet still present ample margins for improvement. Particularly access to high-speed broadband should increase if use of future bandwidth-demanding applications is to take off. If more GPs adopt Telehealth in the coming years, they will certainly need access to higher speed Internet than they currently have on average.

#### *Inter-connection bottlenecks*

Fourth, we can pinpoint some clear bottlenecks in terms of 'electronically embedded' system inter-connection with other healthcare players, technical inter-operability, system resilience, and security. Electronic access to inter-connection is low, and many GPs still communicate with specialists and hospitals by traditional channels. Lack of inter-operability, and of systems resilience and security were mentioned during the focus groups and were confirmed in the survey. Limited adoption of Health Information Exchange (HIE) is surely also a consequence of such bottlenecks. As put by three of the GPs participating in our focus groups:

*"We do everything with computers, but they don't talk to each other";*

*"Too many systems are available that are not inter-operable both at country and at international level. This is a problem for cross-border care";*

*"With ePrescription connected with pharmacists and laboratories, when the system is slow or down it becomes a big problem".*

#### *Digitalisation of records not completed yet*

Fifth, digitalisation of office records is completed or mostly completed for less than 50% of respondents, and there are many GPs in a mixed situation (both electronically and on paper) or still using mostly paper-based records. This helps us better interpret the very high level of availability of basic EHR (94%) in the sense that it does not mean full digitalisation. It is possible, as phrased by one participant in the focus groups, that in the transitional phase 'we are moving from good paper records to mediocre electronic records',

which would explain the scepticisms of many GPs on the efficiency impacts of eHealth and their concerns about increased work load.

*Overall adoption level in EU27 moderate with very high country differences*

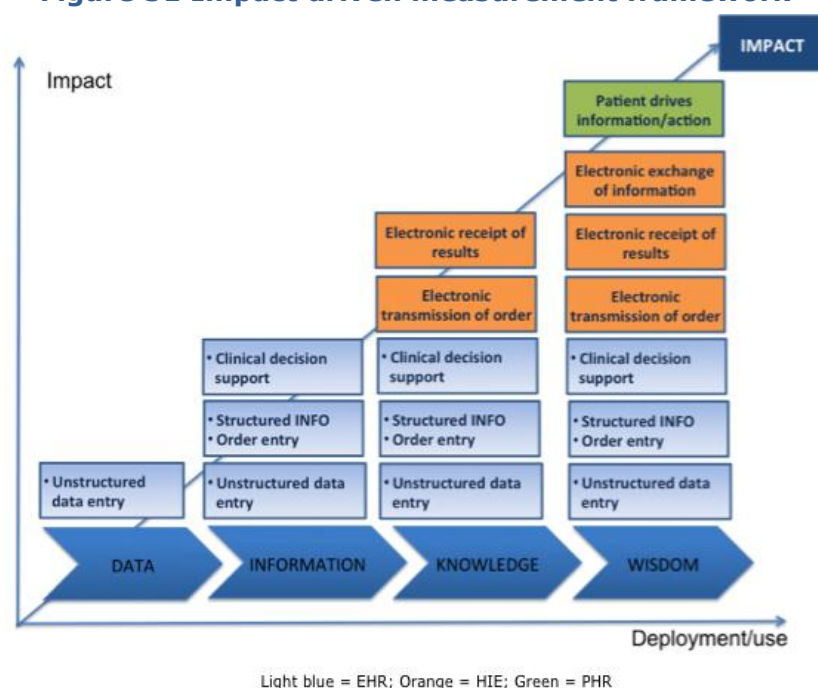
Moving to the summary index and indicators of adoption, we can first say that the EU overall composite index standing at 1.89 on the scale of adoption that ranges from 0 to 4 (0= not aware; 1= do not have it; 2= have it but do not use it; 3= have it and use it occasionally; 4= have it and use it routinely) means that a lot of progress has yet to be made. This score means that on average in EU27 we are close but did not reach yet full availability and that usage is very limited. Naturally there are some sharp country differences considering that the score of the top country (Denmark; 2.60) is almost double that of the bottom one (Lithuania: 1.35). Indeed, differences within EU27 are still substantial both for the overall index of adoption of eHealth and for the composite indicators of Electronic Health Record (EHR), Health Information Exchange (HIE), Telehealth, and Personal Health Record (PHR).

*Adoption of EHR is the highest, moderate for HIE, very low for PHR and Telehealth*

Second, it is clear that the adoption level is much higher for EHR (2.89) and just about fair for HIE (1.88), whereas it is very low for telehealth (1.25) and PHR (1.39). Telehealth and PHR bring down the overall eHealth composite index, and one may be tempted to disregard these two aspects and look at the more positive results for EHR and, to some extent, for HIE. We would not agree, however, with such approach looking at the conceptual and prescriptive impact-driven measurement model presented in the figure below, that plots three of the four pillars (we leave aside Telehealth) against the knowledge management chain<sup>38</sup>.

**Figure 51 Impact driven measurement framework**

*Basic EHR is an important layer, but more advanced features must be adopted for full impacts to unfold*



<sup>38</sup> This is justified, because the bottom line for introducing eHealth is to improve healthcare delivery by turning inert "data" into "structured information", next into "knowledge" (information interpreted and actionable), and eventually into "wisdom" (which knowledge for which action/situation).

This framework posits a linear progression toward producing impacts as adoption moves from basic EHR, to more sophisticated EHR, to exchange and sharing of information, and eventually to full patient empowerment and engagement with the support of PHR. In view of this prescriptive model, high adoption of EHR is a good start and underlying layer, but more progress is still needed in both HIE and PHR for full impact on efficiency, quality, and access.

*More advanced  
EHR features  
less widespread*

Third, looking at the sub-dimensions of the EHR composite indicator, we see much higher adoption for basic functionalities as compared to more advanced one. This can be seen also at a simple descriptive level considering, for instance, that 96.8% of respondents report having 'Medication lists' but only 38% can receive alerts for drug-lab interaction.

*Adoption high  
only for more  
transactional  
and  
administrative  
aspects of HIE,  
but lags behind  
for real  
exchange and  
sharing of  
information*

Fourth, for HIE it is interesting to note that, besides the possibility of receiving laboratory results, the highest availability (and use) level is registered for the 'certification of sick leave'. This result seems to confirm what several GPs lamented during the focus groups and that we reported in § 5.2: that eHealth is being pushed more for administrative purposes than for clinical ones. Indeed, if we look at the sub-dimensions of the HIE composite indicator we see that adoption is highest for patient administration purposes, and much more limited for information and clinical data exchanges and sharing. We can say that on average HIE remains mostly at a transactional level, and is yet far from supporting information sharing across healthcare tiers. For HIE, we notice also a quite sizeable usage gap (percentage of GPs having access but not using functionalities) suggesting either lack of awareness or of interest (usefulness).

*Difficult to  
assess whether  
progress from  
2007 can be  
considered  
satisfactory:  
compute and  
Internet access  
certainly  
registered  
important  
progress*

Finally, looking that the changes between 2007 and 2013, we must first recall the disclaimers presented earlier. The comparability of the results is limited by the differences in the sampling strategy. As our and the 2007 survey are the only two measurements available, we do not have a relative standard to assess whether the increases in availability and usage that occurred during this six-years interval represent or not a good enough amount of progress. In addition, this interval of time overlaps exactly with the ensuing and deepening of the financial and economic crisis; we cannot disentangle the potential hindering effect of the crisis, which may better contextualise the level of progress. Having clarified these limits, we can certainly conclude that computerisation and access to the Internet register a very noticeable increase, leading to close to 100% access to these two basic features. As for the functionalities of eHealth, we can see an increase in all of the most important for most countries, although levels of improvement between 2007 and 2013 differ widely between countries. Countries that stand out in terms of progress include Estonia, Italy, Spain, and the Netherlands, whereas one might have expected higher adoption levels and progress for France and Germany that instead are not in the 10 top ranking countries.

## 6.2 What explains eHealth adoption levels

*Some important insights on what hampers/drives adoption*

The priorities of measurement (producing data basically only on the explanandum) have reduced the amount of data available on the possible explanatory variables, and limited the statistical power we had at our disposal to run multivariate and multilevel causal models to determine what hampers or drives adoption of eHealth in primary care. We nonetheless produced a few important insights that we recall below.

*Country effects explain a considerable level of adoption variability: health system characteristics matter, though strong policy efforts can offset unfavourable conditions*

First, we can safely conclude that levels of adoptions are explained to a considerable extent by country level effects. At a quantitative level, this is shown by the results of the Multilevel Analysis of Variance where the country factor explains as much as 30% in the variability of the composite index of eHealth adoption, and 41% of the variability of the composite indicator of EHR adoption. Looking in qualitative fashion at the results, we showed how on average NHS countries have higher adoption levels on all dimensions, suggesting that institutional settings, funding of healthcare, the entailed structure of incentives and command chain are more favourable to eHealth adoption than, for instance, the Social Insurance model. If we take as correct the feedback from GPs stating that eHealth is becoming a mandatory obligation imposed for administrative purposes, then this is clearly more direct and effective in the NHS model where in relative terms hierarchy prevails over the market as compared to the Social Insurance model. There are clear exceptions to this rule as the cases of Estonia and the Netherlands clearly show. This means that a strong and systematic policy push can offset potentially unfavourable institutional settings.

*Practice settings also matter: solo practitioners lag behind those working in group practices or health centres*

Second, adoption of eHealth is considerably higher among doctors working in health centres and group practices as compare to solo practitioners practising their profession in single-handed practices. It is also evident that solo practitioners face higher financial barriers to deploy more sophisticated ICT systems. So, we can also conclude that organisational settings matter in shaping eHealth adoption, which suggest that solo practitioners might be a privileged target for some form of support from policy makers.

*Only 9% of GPs can be characterised as 'Enthusiasts', whereas the majority still see a lot of barriers and are sceptic about the impacts*

Third, only a minority of GPs (9% of the sample) are '**Enthusiasts**' who use eHealth routinely in their practice, perceive the benefits, and do not place excessive emphasis on the barriers. The majority are either '**Realists**' (emphasis on both benefits and barriers) or '**Reluctant**' (emphasis mostly on barriers), while there is also a substantial share of '**Indifferent**' who do not seem to perceive either benefits or barriers and on average have lower level of adoption. Besides level of adoption, the four attitudinal clusters can also be characterised in terms of individual characteristics and of institutional and organisational clusters. Enthusiasts for instance are more likely to be female, work in health centres or group practices, and come from high adoption countries. These are, however, variables that cannot be impacted through policy. On the contrary, it is noticeable that the majority of the sample (realists and reluctant)



does show some level of adoption but still place a lot of emphasis on barriers.

***A number of barriers are still strongly stressed by GPs: financial, technical, regulatory, and also concerning the doctor-patient relation***

Fourth, moving to the more qualitative and descriptive level of analysis, both in the survey and in the focus groups, doctors on average tend to see more sharply the barriers than the benefits. Financial, inter-operability, and regulatory barriers emerge clearly as very important both from the survey and the focus groups. GPs lament a lack of financial incentives and support, and some claim eHealth is being pushed on them top-down for administrative rather than for clinical goals. They point to a non-remunerated increase in workload, especially for answering patients' e-mails. They further argue that e-mail and other electronic means of interaction are changing patients' expectations, putting the doctor-patient relation at strain. Some participants in the focus groups called for a regulation to fix a time for doctors to respond to patients' mails, and providing remuneration of this extra-work. Inter-operability bottlenecks, lack of system resilience and security are all emphasised in the survey and during the focus groups; they were clearly mentioned as hampering exchange and sharing of information. The lack of regulatory framework concerns above all issues of confidentiality and privacy in relation to EHR and, especially, PHR.

***Access to structured and updated clinical data is considered the most important impact***

Fifth, among the perceived impacts the one that is considered as most important is the possibility to access structured and up to date clinical data. Impacts in terms of efficiency are met with clear scepticism, and clearly GPs do not see much positive change in terms of doctor-patient relationship.

***From the structural model explaining adoption we conclude that perceived usefulness is key, while much still needs to be done to document impacts and remove barriers***

Finally, the structural model of adoption largely confirms the hypotheses of the behavioural models reviewed in the TC and presents us with apparent paradox that the level of composite index of eHealth adoption is negatively correlated with perceived impact and positively with perceived barriers: doctors who use eHealth more place more emphasis on the barriers and less on the impacts (benefits). Perceived usefulness is the key explanatory variable for eHealth adoption, and it is reinforced by ease of use, behavioural control, social influence, and social norms. Second, even those who use eHealth still do not really see the tangible impacts in terms of efficiency and improvement in activities, whereas they may be starting to appreciate impacts on quality. This can in turn be explained as resulting from lack of evidence on tangible impacts and/or lag times in explication of impacts that have not yet become visible. Third, higher usage comes in many cases (except for a small percentage of the sample) with moderate appreciation of impacts and stronger perception of barriers; this may mean that a lot more should be done to create the best possible conditions to enable GPs to fully leverage the potentiality of eHealth. Barriers are still felt strongly, whereas for the positive impacts the law of marginal returns may be kicking in for those GPs who are routinely using eHealth.

## 6.3 Considerations on policy implications

First of all, the data we are presenting concern only doctors working in primary care and we cannot draw from them conclusive generalisations on the status of eHealth adoption in general. Such conclusive generalisations would have to use our data in combination with: a) the results of the 2010 and 2012 surveys of eHealth Deployment in hospitals; b) Eurostat data on use of the Internet for health related purposes; and c) all the results and output produced in the period 2009-2013 by IPTS Strategic Intelligence Monitor on Health Systems (SIMPHS)<sup>39</sup>, which include also an online survey of citizens in 14 European countries reporting their usage of, among others, telehealth services and Personal Health Records. This was beyond the scope of this study is proposed here as a possible development of the analysis.

In what follows, we look at the relevant policy targets in the DAE and the 2012 eHealth Action Plan and provide a few preliminary considerations based only on our data concerning primary care. To this purpose we recall below those targets with respect to which our findings bear some relevance. Among those targets set for eHealth within Pillar 7 of the DAE the three relevant here are:

- *"Give Europeans secure online access to their medical health data and achieve widespread telemedicine deployment" (# 75);*
- *"Propose a recommendation to define a minimum common set of patient data" (# 76);*
- *"Foster EU-wide standards, interoperability testing and certification of eHealth" (# 77).*

The 2012 Action Plan set, among others, the objectives of *"achieving wider interoperability of eHealth services"* and *"facilitating uptake and ensuring wider deployment"* (European Commission, 2012, p. 6).

First, judging from the adoption of Telehealth and PHR registered among GPs in Europe, we can say that the targets in their role as catalyst of efforts are certainly well chosen since more progress is needed in these two domains. In primary care settings for PHRs in primary care settings, even simple availability is below 20% in all countries, whereas the situation for the availability of telehealth by doctors shows that little progress has been made in the past six years. Only about 4% and 10% respectively declare to have the possibility to monitor patients at home and make online consultations with them.

Second, inter-operability still emerges as a key barrier toward the adoption of eHealth from both the survey and the focus groups; together with lack of system resilience and security, it seriously hampers the further adoption of exchange and sharing of

**The situation for Telehealth and PHR requires more efforts and the DAE target can work as catalysts for this**

**Planned efforts on inter-operability are very salient as this is a key barrier toward adoption**

<sup>39</sup> See <http://is.jrc.ec.europa.eu/pages/TFS/SIMPHS1.html> for the output of SIMHS1 and <http://is.jrc.ec.europa.eu/pages/TFS/SIMPHS2.html> for the output of SIMPHS 2.



information. One key problem in this respect is the lack of common standards for the exchange of patient data. Therefore, the parts of targets 76 and 77 of the DAE concerning patient data and interoperability and one of the key objectives of the Action Plan ('wider inter-operability of eHealth services) are very important; policy efforts should concentrate on achieving progress on these that are key enablers for eHealth.

*Much still remains to be done to facilitate uptake of eHealth in primary care*

Third, the Action Plan objective of facilitating uptake is an important priority to stimulate Member States efforts, since adoption levels are on average still limited. Apart from the very low levels mentioned for PHR and Telehealth, adoption levels are very moderate also for Health Information Exchange. For EHR the situation is in general more positive, but not for more advanced features.

*There is still a need for policy targets focussing on enablers*

Fourth, there are still some basic issues to be solved both at technical and regulatory level. Emphasis, for instance, should be placed on achieving higher levels of access to high speed Internet connection if bandwidth-demanding services such as remote monitoring of, and video-consultation with, patients are to be adopted in primary care.

*Awareness and good practice sharing can increase perception of usefulness*

Fifth, since perceived usefulness is a key determinant of adoption, and we noticed among GPs very moderate and sceptical attitudes about the benefits of eHealth, policies should continue to raise awareness, support the production of evidence on impacts, and facilitate the diffusion and sharing of good practices.

*Last but not least institutional conditions should be tackled within the broader domain of health policy*

Finally, our findings underline a number of barriers, which we mention only briefly since they concern health policy and are beyond the mandate of DG Connect. There are barriers clearly related to institutional settings, governance mechanisms, access to financial resources, and structure of incentives. Adoption is lower among doctors working alone in single-handed practices, who could be the target of ad hoc support policies. Doctors perceive that additional workload created by eHealth should be compensated financially. They are concerned about the changing nature of the doctor-patient relation, and about rising expectations from patients.

## 6.4 Final notes on future data gathering

We conclude with a few considerations on future data gathering activity on eHealth adoption in primary care.

First, if we were to repeat this survey, we would certainly remove many of the questions asked at the beginning of Part B of our questionnaire about availability and use of basic ICT. Access to, and use of, these basic ICT is now almost universal, and there is no longer a need to ask this type of questions. Removing them would leave space to add other questions, while keeping the duration of the interview within 20-25 minutes. In addition, we believe that from a policy perspective, understanding what drives and hampers eHealth adoption is as important as measuring it. Therefore, besides removing the question on basic ICT, we would also reduce or remove some of the other items contained in Part B of the questionnaire, and substitute them with more questions measuring the independent explanatory variables (both in Part A and in Part C of the questionnaire).

Second, we believe that the approach to the transparent extraction of the sample from the official list defining the universe could be replicated, provided that: a) one ad hoc self-standing task is included and budgeted to this purpose; b) during the first two months support and buy-in is obtained from the national associations and also by the key governmental body (i.e. Ministry of Health) in each country; c) a small country team of 1-2 professional per country is charged with coordinating the work and help increase response rates. We have reached a satisfactory response rate (30-40%) but increasing it would improve the quality of the sample and reduce bias, especially in terms of having an age structure of the sample that better reflects the situation of the universe. One of the limits of our survey is that on average our sample is a bit older than the universe of reference (response rate, when no incentives are provided, tends to be lower among the younger age groups). In this respect, if possible, more efforts are needed to apply the perspective coming from the methodological literature on Cognitive Aspects of Survey Methodology (CASM) in the formulation and validation of questions so as to ensure that respondents fully understand what is asked of them, and especially that 'response effects' (i.e., social desirability) are controlled for and neutralised.

Finally, it may be worth conducting a feasibility and scoping study to assess what kind of data could be gathered for which countries in less expensive ways through administrative sources scenario. In such a case, part of the needed measurement data for the most advanced countries could be retrieved from online administrative sources and part from a survey that, however, could concern fewer countries and require a shorter questionnaire as to sensibly reduce the budget and the duration of the study.

*Reduce the number of questions on measurement and increase those covering possible explanatory variables*

*The survey can be improved dedicating more resources to replicate the transparent sampling strategy, increase the response rate, and optimise the cognitive aspects of the survey instrument*

*A feasibility study may be used to assess the possibility of using alternative data sources*

## 7. Appendix on statistical analysis

### 7.1 Descriptive statistics

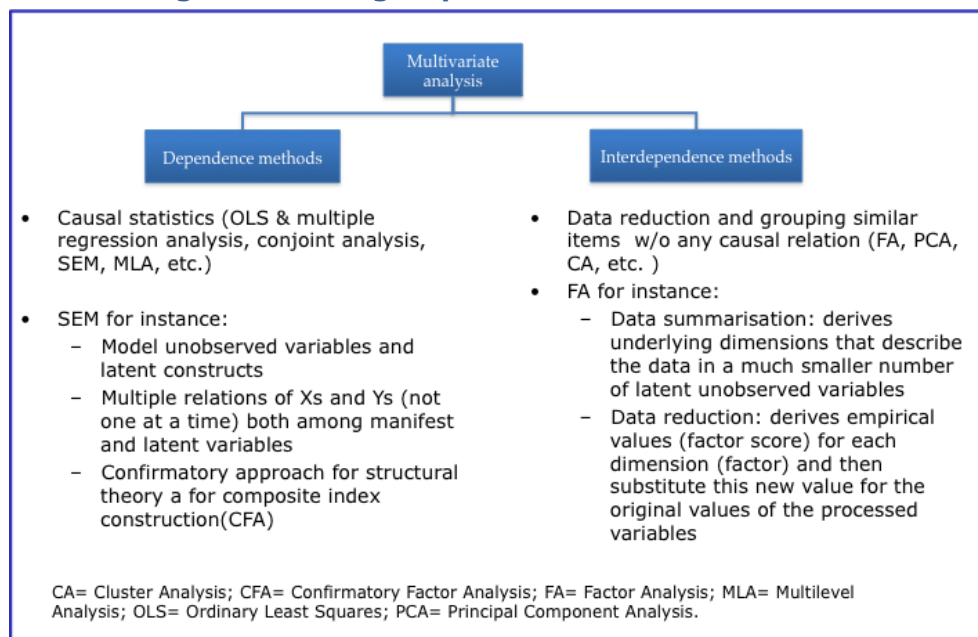
Univariate and bivariate analysis was performed with all items gathered so as to have a first and clear snapshot of the data. Measures of central tendency (mean, median, and mode) and measures of dispersion (such as standard deviation, range, and interquartile range, IQR) were performed. Finally, histograms stem-and-leaf plot or box plots were performed. These analyses were performed to check how variables are distributed and to ensure consistency in data, and spot any anomaly. This analysis provided full confirmation that the data gathered are consistent. We performed analysis of frequencies (**univariate analysis**) on key items (availability of applications; intensity and purpose of usage; motivation; attitudes and intentions; and perceived barriers and impact). These are reported in chapter 3.

To attribute statistical significance to the differences obtained, an associated Chi-square test was checked. These univariate and bivariate analyses mapped against the overall framework shaped our choices for the **multivariate analysis** to develop the composite index and the Structural Equation Modelling (SEM) exercise.

### 7.2 Data summarisation & reduction methods

Factor analysis is one of the most common multivariate techniques. Multivariate analysis could be briefly described as a group of statistical procedures used to simultaneously analyse three or more variables.

Figure 52 Two groups of multivariate methods



These techniques can be classified into dependence and interdependence methods. A **dependence method** is one in which

a variable or set of variables are identified as the dependent variable to be predicted or explained by other, independent variables. Dependence techniques include multiple regression analysis, discriminant analysis, and conjoint analysis. An **interdependence method** is one in which no single variable or group of variables is defined as being independent or dependent. The goal of interdependence methods is data summarisation and data reduction, or grouping things together into latent variables. Cluster analysis, factor analysis, principal component analysis, and multidimensional scaling are the most commonly used interdependence methods. **Factor analysis** is an interdependence technique whose primary purpose is to define the underlying structure among the variables in the analysis. This technique has two main approaches. First, data can be analysed with no preconceived ideas about the underlying constructs (latent variables) defining the structure of the data. This approach is called **Exploratory Factor Analysis** or simply **Factor Analysis (FA)**. Thus, it is considered as an **empirical-driven approach**. Second, when there is an understanding of the constructs underlying the data, and it is possible to place substantively meaningful constraints specifying the number of indicators related with each underlying latent construct, then data can be analysed with **Confirmatory Factor Analysis CFA**. It is confirmatory when a specific test or hypothesis about the structure or the number of dimensions underlying a set of variables is performed. Thus, this approach is a **theory-testing procedure**. CFA is appropriate in situations where the dimensionality of a set of variables for a given population is already known because of previous research.

**Factor Analysis.** For the construction of the composite indexes we used Exploratory Factor Analysis or simply Factor Analysis (FA). This technique is used mostly for data reduction purposes, so as to summarise the information contained in a large number of variables into a smaller number of factors and to create indexes with variables that measure similar things (conceptually). Therefore the outcome of the factor analysis is twofold:

- **Data summarisation:** derives underlying dimensions that, when interpreted and understood, describe the data in a much smaller number of concepts than the original individual variables;
- **Data reduction:** extends the process of data summarisation by deriving an empirical value (factor score) for each dimension (factor) and then substituting this new value for the original values of the processed variables.

Basically, FA investigates whether a number of variables of interest are related through some linear function to a smaller number of unobservable factors (latent variables or constructs). In the special vocabulary of FA, the parameters of these linear functions are referred to as **factor loadings**. Factor analysis usually proceeds in three stages using listwise deletion (the analysis is only run on cases which have a complete set of data). The first stage comprises the analysis of the correlation matrix with two different tests:

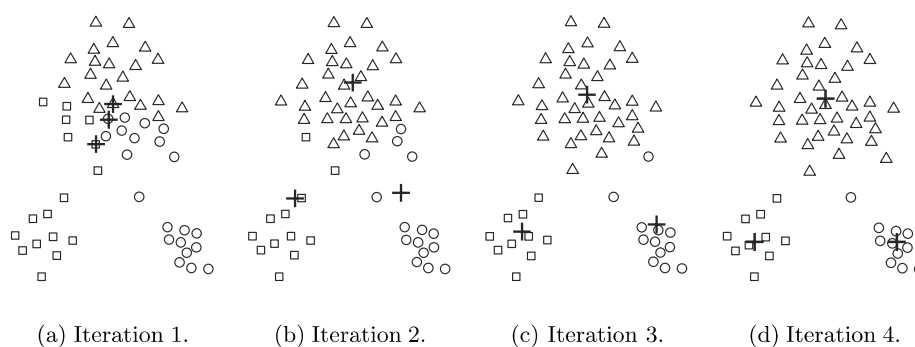
Bartlett's test of sphericity and Kaiser Meyer Olkin. Bartlett's test of sphericity is used to test the hypothesis that the correlation matrix is an identity matrix (all diagonal terms are one and all off-diagonal terms are zero). The significance should be less than .05 because all items should be perfectly correlated with themselves (one), and have some level of correlation with the other items. If they are not correlated with the other items then they cannot be part of the same factor. Kaiser Meyer Olkin (KMO) is a measure of sampling adequacy, and is used to compare the magnitudes of the observed correlation coefficients in relation to the magnitudes of the partial correlation coefficients. Large KMO values are good because correlations between pairs of variables (i.e. potential factors) can be explained by the other variables. If the sum of the partial correlation coefficients between all pairs of variables is small when compared to the observed correlation coefficients, the KMO measure will be close to one. If KMO is below .5, then FA is not recommended. A partial correlation is a measure of the strength of the relationship between any two variables when the other variables are held constant.

In the second stage, one set of loadings is calculated which yields theoretical variances and covariance that fit the observed ones as closely as possible according to a certain criterion. These loadings, however, may not agree with the prior expectations, or may not lend themselves to a reasonable interpretation. Thus, in the third stage, the first loadings are "rotated" in an effort to arrive at another set of loadings that fit equally well the observed variances and covariances, but are more consistent with prior expectations or more easily interpreted. An optimal structure exists when all variables have high loadings only on a single factor. Variables that cross-load (load highly on two or more factors) are usually deleted unless theoretically justified or if the objective is strictly data reduction. A method widely used for determining a first set of loadings is the principal component method. This method seeks values of the loadings that bring the estimate of the total communality as close as possible to the total of the observed variances (the communality of a variable is the part of its variance that is explained by the common factors, while the specific variance is the part of the variance of the variable that is not accounted for by the common factors). Varimax rotation method, the most widely used for rotation, help the detection of factors each of which is related to few variables, and at the same time, it prevents the detection of factors influencing all variables.

**Cluster analysis.** Cluster analysis is an interdependence method that groups data objects based using information present in the data that describes the grouped objects and their relationships. The goal is that the objects within a group be similar (or related) to one another and different from (or unrelated to) the objects in other groups. The greater the similarity (or homogeneity) within a group and the greater the difference between groups, the better or more distinct is the clustering. The attempt is to maximize the homogeneity of objects within the clusters while also maximising the heterogeneity between the clusters. Thus, the resulting clusters should exhibit high internal (within-cluster) homogeneity and high

external (between cluster) heterogeneity. Cluster analysis, like factor analysis, makes no distinction between dependent and independent variables. The entire set of interdependent relationships is examined. Cluster analysis is the obverse of factor analysis. Whereas factor analysis reduces the number of variables by grouping them into a smaller set of factors, cluster analysis reduces the number of observations or cases by grouping them into a smaller set of clusters. Cluster methods can be split in **Hierarchical** and **Non-hierarchical**. A hierarchical clustering method produces a classification in which small clusters of very similar data objects are nested within larger clusters of less closely-related data objects. Hierarchical agglomerative methods generate a classification in a bottom-up manner, by a series of agglomerations in which small clusters, initially containing all data objects (cases), are fused together to form progressively larger clusters. One problem with these methods is how to choose which clusters or partitions to extract from the hierarchy since display of the full hierarchy is not really appropriate for datasets of more than a few hundred compounds. A non-hierarchical method generates a classification by partitioning a dataset, giving a set of (generally) non-overlapping groups having no hierarchical relationships between them. Due to the amount of cases in our dataset and the nature of the variables selected (factors), we have selected K-means, the most common Non-hierarchical method, to perform our cluster analysis. K-means is a clustering technique that attempts to find a user-specified number of clusters (K), which are represented by their centroids, the mean of a group of points, and is typically applied to objects in a continuous n-dimensional space. The operation of K-means is illustrated in the following figure:

**Figure 53 Operationalization of K-means**



In the first step, shown in Figure 53(a), points are assigned to the initial centroids, which are all in the larger group of points (for this example, we use the mean as the centroid). After points are assigned to a centroid, the centroid is then updated. Again, the figure for each step shows the centroid at the beginning of the step and the assignment of points to those centroids. In the second step, points are assigned to the updated centroids, and the centroids are updated again. In steps 2, 3, and 4, which are shown in Figure 53 (b), (c), and (d), respectively, two of the centroids move to the two

small groups of points at the bottom of the figures. When the K-means algorithm terminates in Figure 8.3(d), because no more changes occur, the centroids have identified the natural groupings of points.

We report below the technical tables with the results of the application of cluster analysis to our data for the identification of the four profiles of GPs presented in § 5.3.

**Table 25 Perceived impacts and barriers Factor Analysis**

Items	Perceived Barriers (Factor loadings)	Perceived Impact (Factor loadings)
Perceived Barriers Individual	.857	
Perceived Barriers Technological	.838	
Perceived Barriers Organisational	.828	
Perceived Barriers Legal	.806	
Perceived Barriers Financial	.743	
Perceived Impact Efficiency		.940
Perceived Impact Activity		.937
Perceived Impact Quality		.936
Expl. Var.	3.326	2.648
% Expl. Var.	0.42	0.33

**Notes:**

Rotated component matrix; Extraction Method: Principal Component Analysis; Rotation Method: Varimax with Kaiser Normalization 0.814; Bartlett's test of sphericity  $p=0.000$ ; Rotation converged in 3 iterations; Minimum eigenvalue 1. Values below 0.45 are omitted; Expl. Var. = Variance explained by the factor; % Expl. Var. = % Variance explained by the factor

**Table 26 Perceived impacts and barriers Cluster analysis**

Factors	1. Realists (34%)	2. Enthusiasts (13%)	3. Reluctant (20%)	4. Indifferent (33%)	ANOVA
Factor 1. Barriers	.67089	-1.53881	.69501	-.50889	3617.3*
Factor 2. Impacts	.78378	.85994	-1.19941	-.42328	3784.8*
	n=2135	n=789	n=1221	n=2096	

**Notes:** Results of K-means—quick cluster analysis. Method of analysis: non-hierarchical cluster, final cluster centroids. \* $p < .001$ . The number of GP clustered is 6242 or 68%) of the total sample, whereas 2953 (32%) were non-classified. Percentages in parentheses indicate first the share of each cluster on the total GPs classified and next the share of the total sample.

## 7.3 Composite index

A Composite Index (CI) is formed when individual indicators are compiled into a single index on the basis of an underlying conceptual model with the support of the empirical exploration of the dataset. A CI measures multi-dimensional concepts, which cannot be captured by a simple indicator.

To develop our composite index, we have followed the four steps described in the OECD-JRC Handbook on constructing composite indicators methodology and user guide (2008)<sup>40</sup>.

Firstly, a **theoretical/conceptual framework** was developed that we used to define the phenomenon to be measured (ICT adoption by GPs) and its key dimensions (EHR, HIE, telehealth, and PHR).

40 OECD - JRC. (2008). Handbook on constructing composite indicators methodology and user guide. Paris: OCED.

Secondly, the base level variables (or indicators) produced by the respondents' answers to our questionnaire were grouped within each dimension reflecting the conceptual framework. Our questionnaire captured the availability and use of a wide range of functionalities covered by the different dimensions. As we had answers concerning both availability and use of ICT functionalities, but we aimed to construct one single index of ICT adoption, we have merged Availability and Use and from each base variable we constructed new variables capturing a gradient from 0: Not aware – Do not have it – Have it but do not use it – Use it occasionally – to 4 Use it routinely.

Thirdly, **multivariate statistical analysis** has been carried out as follows. For the new base variables constructed as described above, means and their significant correlation were checked to confirm whether internal complementarities existed among the variables included within each of the four dimensions (EHR, HIE, telehealth and PHR). This step enabled Factor Analysis (FA) to find a smaller set of unobserved variables (also called latent variables, or factors, or sub-dimensions), which can account for the covariance among a larger set of observed variables (also called manifest variables, items or indicators). A factor is an unobservable variable that is assumed to influence observed variables. Therefore, this statistical technique facilitates the categorisation of items or indicators into clear-cut and meaningful themes by identifying common relations between similar variables, uncovering sub-dimensions that were labelled so as to better describe themes not directly observable when looking only at the base variables separately. An analysis of the correlation matrix (KMO and Bartlett's test of sphericity) was carried out to check that the matrixes were factorable. Data reductions were undertaken by principal components analysis using the Varimax option to identify likely underlying dimensions.

Fourthly, a **careful and transparent definition of weights** was performed, squaring and normalising the estimated factor loadings from the factor analysis. The squared factor loadings represent the proportion of the total unit variance of a base variable that is explained by a factor. The resulting score by sub-dimension can be aggregated into the summary indicator of the dimension according to its relative contribution to the explanation of the overall variance of all factors. Thus each sub-dimension could be also considered as a composite index itself.

Finally, to avoid an unbalanced structure of the overall indicator due to the different number of variables grouped in each dimension, equal weights (0.25) were assigned to each dimension. This assumption is also justified theoretically as far as each dimension is inter-related to the others.



## 7.4 From FA to composite indicators and index

For the sake of full transparency we present a very intuitive step-by-step illustration of the procedure used to move from factor analysis to the construction of the composite indicators. We use as an example only the results of FA for her reported in Table 27. The procedure was applied in exactly the same fashion for the other three dimensions and this illustration could be easily replicated for the next three factor analysis technical tables (Tables 28, 29, and 30 in the following pages).

- **Step 1.** From the FA we identify five latent variables (factors) that summarise all the 25 items. These become the 5 sub-dimension of the composite indicator for EHR:
  - We have 8 variables – Using EHR for recording/viewing ‘Symptoms’, ‘Reason for appointment’, ‘Clinical notes’, ‘Vital signs’, ‘Treatment outcomes’, ‘Medical history’, ‘Basic medical parameters (e.g. allergies)’, ‘Problem list / diagnoses’- that ‘behave’ in statistically similar manner and can be summarised into the latent variable renamed “Health Information and Data”
  - The same applies for all other variables that we can summarise with four other latent variables: ‘Decision Support Systems’; ‘Order Entry’; ‘Images’; and ‘Administration’;
  - These five new latent variables summarise the total 25 individual variable that we had obtained from the question on the availability and use of EHR;
- **Step 2.** The factor loadings reported in the first column of Figure 23 characterise the linear relation linking 25 items to these five latent variables (see distribution of factor loadings among items). They are the parameters that enable us to do the operation illustrated in the previous step and furthermore qualify the similar statistical ‘behaviours’ or the items re-grouped into the five latent variables;
- **Step 3.** To transform negative values we have squared the factor loadings (see column 7-11). The sum of factor loadings give us the variance explained by each factor (see row 26). The sum of these variances gives us the total variance explained so as to normalise each of the factors in relation to the total (see row 27). These values are used as the weight for each of the 5 sub-dimensions.
- **Step 3.** To calculate the weight of each variable in each sub-dimension (see column 12-16) we square factor loadings scaled to unity sum.
- **Step 4.** Once we have the weights of each variable and of each sub-dimension we can calculate the score of each respondent within the sub-dimension, multiplying the value of the variable (from 0 Not aware to 4 use it routinely) per its weight.
- **Step 5.** We sum all the variables grouped in each sub-dimension and we multiply the result per each score grouped by sub-dimension (see step 3).

- **Step 6.** The final value of the EHR composite indicator will be the sum of all sub-dimensions.
- **Step 7.** Please note this very carefully: at the end of step six we have a composite indicator for each single respondent on each sub-dimension and on the overall dimension. Evidently it would be impossible to report and visualise this for 9000 and more respondents (at aggregate level, or for 400, more or less, at country level). Hence the scores we report for sub-dimension, dimension, and for the overall composite index is calculated using the mean of the corresponding score for each respondent. It is worth pointing out that the averages presented are calculated using a pairwise deletion. This means that the statistical procedure (mean) uses cases that contain some missing data. The procedure cannot include a particular variable when it has a missing value, but it can still use the case when analysing other variables with non-missing values.

**Table 27 EHR Factor Analysis Technical Table**

		Factor loadings					Square factor loadings					Square factor loadings (scaled to unity sum)				
		Health info & data	DSS	Order -entry	Image	Admin	Health info & data	DSS	Order -entry	Image	Admin	Health info & data	DSS	Order -entry	Image	Admin
Symptoms	for	0,746					0,557					0,153				
Reason appointment		0,727					0,529					0,145				
Clinical notes		0,715					0,511					0,141				
Vital signs		0,713					0,508					0,140				
Treatment outcomes		0,686					0,471					0,130				
Medical history		0,658					0,433					0,119				
Basic medical parameters (e.g. allergies)		0,608					0,370					0,102				
Problem list / diagnoses		0,505					0,255					0,070				
Contraindications		0,8					0,640					0,210				
Drug-drug interactions		0,754					0,569					0,186				
Drug-lab interactions		0,704					0,496					0,162				
Drug-allergy alerts		0,699					0,489					0,160				
Clinical guidelines and best practices		0,675					0,456					0,149				
Be alerted to a critical laboratory value		0,637					0,406					0,133				
Medication list			0,769					0,591					0,289			
Prescriptions / medications			0,762					0,581					0,284			
Immunizations			0,651					0,424					0,207			
Lab test results			0,487					0,237					0,116			
Ordered tests			0,46					0,212					0,103			
Radiology test images					0,837					0,701					0,609	
Radiology test reports					0,671					0,450					0,391	
Finances / billing						0,874					0,764					0,633
Administrative patient data						0,665					0,442					0,367
Variance explained by the factor Expl.Var							3,633	3,054	2,045	1,151	1,206					
Explained variance divided by the total variance of the factors Expl./Tot							0,33	0,28	0,18	0,10	0,11					

**Table 28 HIE Factor Analysis Technical Table**

Factors	Clinical Data		Patient admin		Management	
Items	Factor loadings	Variable Weight in factor	Factor loadings	Variable Weight in factor	Factor loadings	Variable Weight in factor
Exchange patient medication lists with HCPF /HCP	0.809	0.181				
Exchange radiology reports with HCPF/HCP	0.796	0.176				
Exchange medical patient data with HCPF /HCP	0.749	0.155				
Receive and send laboratory reports and share them with HCPF /HCP	0.748	0.155				
Send/receive referral and discharge letters	0.601	0.100				
Appointments at HCP for patients	0.566	0.089				
Exchange medical patient data with HCP abroad	0.546	0.083				
Transfer prescriptions to pharmacists	0.47	0.061				
Certify sick leaves			0.83	0.440		
Certify disabilities			0.813	0.423		
Patient appointment requests			0.463	0.137		
Exchange administrative patient data with payers or HCP					0.787	0.511
Order supplies for your practice					0.77	0.489
Expl- Var	3.609		1.564		1.212	
Expl-/Tot <sup>c</sup>	0.57		0.24		0.19	
<b>Notes:</b> Rotated components matrix; Sampling method: factor analysis by main components; Rotation method: Varimax with Kaiser-Meyer-Olkin 0.892; Bartlett's test of sphericity p=0.000; Convergence in 5 iteration; Minimum eigenvalue 1. Values below 0.45 are omitted. (Expl.Var = Variance explained by the factor. Expl./Tot = Explained variance divided by the total variance of the factors)						

**Table 29 Telehealth Factor Analysis Technical Table**

Factors	Professional to Patient		Professional to Professional	
Items	Factor loadings	Variable Weight in factor	Factor loadings	Variable Weight in factor
Monitoring patients remotely at their homes	0.829	0.687		
Consultations with patients	0.759	0.576		
Training / Education			0.912	0.696
Consultations with other healthcare practitioners			0.603	0.304
Expl- Var	1.263		1.195	
Expl-/Tot <sup>c</sup>	0.51		0.49	
<b>Notes:</b> Rotated components matrix; Sampling method: factor analysis by main components; Rotation method: Varimax with Kaiser-Meyer-Olkin 0.684; Bartlett's test of sphericity p=0.000; Convergence in 4 itineration; Minimum eigenvalue 0.85. Values below 0.45 are omitted. (Expl.Var = Variance explained by the factor. Expl./To = Explained variance divided by the total variance of the factors)				

**Table 30 PHR Factor Analysis Technical Table**

Factors	Clinical		Requests	
Items	Factor loadings	Variable Weight in factor	Factor loadings	Variable Weight in factor
View their medical records	0.884	0.351		
Supplement their medical records	0.876	0.345		
View test results	0.822	0.304		
Request referrals			0.517	0.155
Request appointments			0.873	0.442
Request renewals or prescriptions			0.834	0.403
Expl- Var	2.225		1.725	
Expl-/Tot <sup>c</sup>	0.56		0.44	
<b>Notes:</b> Rotated components matrix; Sampling method: factor analysis by main components; Rotation method: Varimax with Kaiser-Meyer-Olkin 0.684; Bartlett's test of sphericity p=0.000; Convergence in 4 ititeration; Minimum eigenvalue 0.85. Values below 0.45 are omitted. <sup>a</sup> Based on rotated component matrix <sup>b</sup> Normalised squared factor loadings <sup>c</sup> Weight of factors in summary indicators Normalised sum of squared factor loadings (Expl.Var = Variance explained by the factor. Expl./To = Explained variance divided by the total variance of the factors)				

## 7.5 Structural Equation Modelling (SEM)

SEM is a statistical technique that allows researchers to model unobserved variables (Skrondal & Rabe-Hesketh. 2004), but also to model together unobserved and manifest variable. In SEM, however, the interest usually focuses on latent constructs - abstract psychological variables such as "intelligence" or "attitude toward the brand" - rather than on the manifest variables used to measure these constructs. Measurement of such latent constructs is recognised as difficult and error prone. By explicitly modelling measurement error, SEM users seek to derive unbiased estimates for the relations between latent constructs. To this end, SEM allows multiple measures to be associated with a single latent construct<sup>41</sup>.

SEM consists of two components: a **measurement model** linking a set of observed variables to a usually smaller set of latent variables, and a **structural model** linking the latent variables through a series of recursive and non-recursive relationships. The measurement model is developed through Confirmatory Factor Analysis (CFA). This statistical technique is used to test explicitly stated hypotheses. With CFA it is possible to place substantively meaningful constraints specifying the number of indicators related with one latent variable.

Following the reasoning behind the design of the Questionnaire Part C, we have performed CFA to identify the following latent variables: Social influence / Subjective norms; Perceived behavioural control / Facilitating conditions; Perceived Usefulness and Perceived Easy of Use. Moreover, to gain insights into the perceived impact of ICT by GPs, we have also carried out CFA grouping impact indicators in three main latent variables labelled as: Quality, Activity, and Efficiency. Our model tested the relationship of these seven latent variables with the overall composite index of adoption, introduced in the model as an observed dependent variable. We tested alternative models that included as independent variables both the above mentioned latent constructs and other observed variables (i.e. practice settings, GPs characteristics, etc.), but the results did not support such models.

## 7.6 Multilevel analysis

As noted in de Leeuw, & Meijer (2008), much of the development of multilevel analysis (MLA) can be traced to educational research (e.g. Aitkin & Longford 1986; Raudenbush & Bryk 1986). This field has distinctive measurement features: large datasets of outcome measures (students' results in aptitude tests) coming from different

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<sup>41</sup> A structural equation model implies a structure of the covariance matrix of the measures (hence an alternative name for this field is "analysis of covariance structures"). Once the model's parameters have been estimated, the resulting model-implied covariance matrix can then be compared to an empirical or data-based covariance matrix. If the two matrices are consistent with one another, then the structural equation model can be considered a plausible explanation for relations between the measures.

class, schools, and possibly countries (think, for instance, about the PISA scores). So, the data can be nested at different hierarchical level (though MLA was later extended to non hierarchical data): class, school, country. The reasoning that led to the development of MLA is intuitively simple: aren't students within a school more alike than a random sample of students? Or even, aren't students within a country more alike than a random sample of students?

Behind the development of MLA lies also an important epistemological and methodological controversy between methodological individualism and structural approaches, or rather between the 'individualistic fallacy' versus the 'ecological fallacy'. In a ground-breaking article, Robinson (1950) tainted as 'ecological fallacy' the approach that used aggregate or group level data to explain individual level relations. From then on methodological individualism dominated survey research that focussed only on analysis and explanation that could be inferred from the data on individuals, abandoning any contextual and structural explanation. Indeed, if one uses simple regression or multiple regression analysis he/she cannot infer individual-level relationships from group-level relationships, or else it falls into the ecological or aggregation fallacy (Aitkin & Longford 1986)<sup>42</sup>. Yet, school and country effects on scores were and are visible, and a recent revisit of Robison's argument shows that looking only at individual level variables amount to an opposite form of 'individualistic fallacy', and that both individual and contextual variables (that is both within group and between group variation) can be jointly analysed using MLA (Subramanian, et al, 2009).

In order to account for the contextual level into which individual level data are nested, MLA model variances both within groups and between groups, whereas standard regression averages the general relationships. This means, for instance, that MLA can capture how individual house prices vary among each other (within) and between houses of neighbourhood A and those of neighbourhood B, since individual house prices depends on individual property characteristics and on neighbourhood characteristics.

The technicalities allowing MLA to model both individual and contextual aspects are quite complex and tedious, and we will not enter into a detailed illustration here. It suffices to say that the multilevel aspect is tackled by using random or fixed intercept models. Fixed effect models either ignore group (contextual) level or in MLA account for it with a fixed intercept. In random intercept models the intercepts  $\beta_{0j}$  are random variables representing random differences between groups (contexts).

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42 For instance, assume a research on school effects where past scores are used as predictor of current scores in aptitude test where: a) the dependent variable is current score on a test, turned into an average for each of  $j$  schools ( $Y_j$ ); b) the independent variable is past score turned into an average for each of  $j$  schools ( $X_j$ ). If we perform a regression analysis we regress means on means, which is a meaningless kind of analysis. Mean does not reflect within group relationship. In our context, this would be the same as if we regressed the score of the composite index by country ( $Y_j$ ,  $j=31$ ) by the average age of GPs by country ( $X_j$ ,  $j=31$ ).



OLS regression model of Y on X ignoring groups (contexts):

$$Y_{ij} = \beta_0 + \beta_1 x_{ij} + R_{ij} .$$

Group (context)-dependent MLA regressions:

$$Y_{ij} = \beta_{0j} + \beta_{1j}x_{ij} + R_{ij} .$$

i indicates level-one unit (e.g., individual);

j indicates level-two unit (e.g., group). Variables for individual i in group j :

$Y_{ij}$  dependent variable;

$x_{ij}$  explanatory variable at level one;

for group j :  $z_j$  explanatory variable at level two;  $n_j$  group size

In the random intercept model, the intercepts  $\beta_{0j}$  are random variables

Representing random differences between groups:

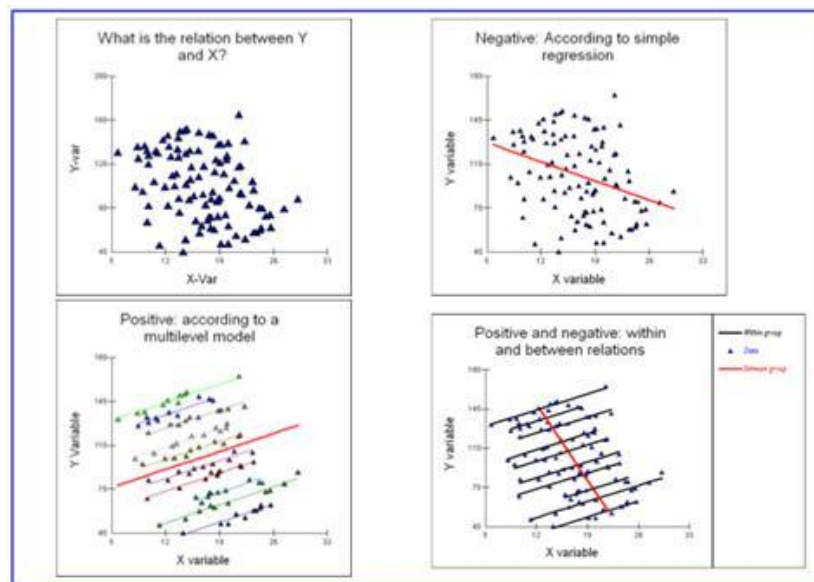
$$Y_{ij} = \beta_{0j} + \beta_1 x_{ij} + R_{ij} .$$

where  $\beta_{0j}$  = average intercept  $\gamma_{00}$  plus group-dependent deviation  $U_{0j}$  :

$$\beta_{0j} = \gamma_{00} + U_{0j} .$$

In this model, the regression coefficient  $\beta_1$  is common to all the groups.

**Figure 54 Single level analysis may be misleading**

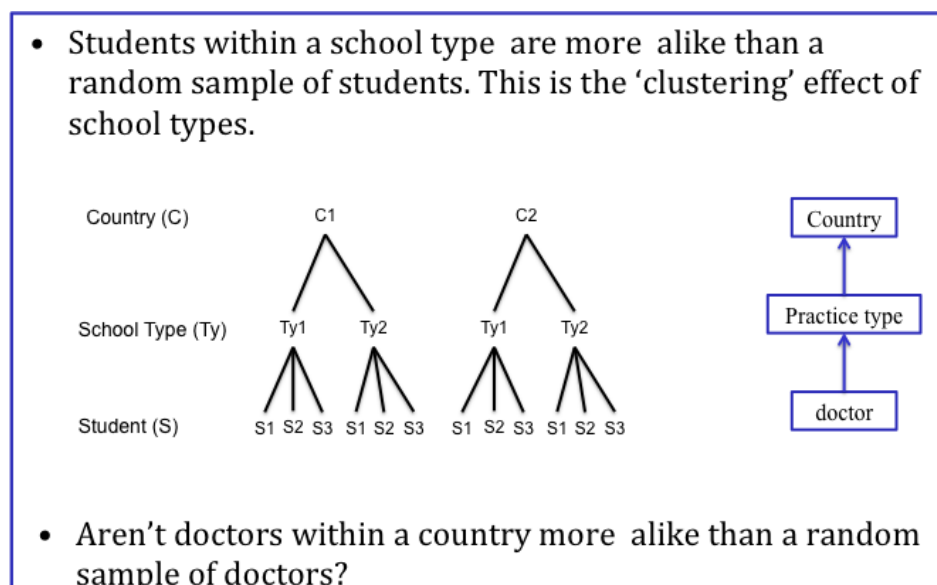


The importance of using multilevel analysis is conveyed by the example graph above.

Next figure convey graphically the idea that MLA analysis can also be applied to the explanation of eHealth adoption levels by GPs. First, the latter work in different organisational settings that may affect the decisions to deploy ICT, and thus availability, as a pre-condition of use. Single-handed practices clearly have less financial resources than group practices and primary care health centres to

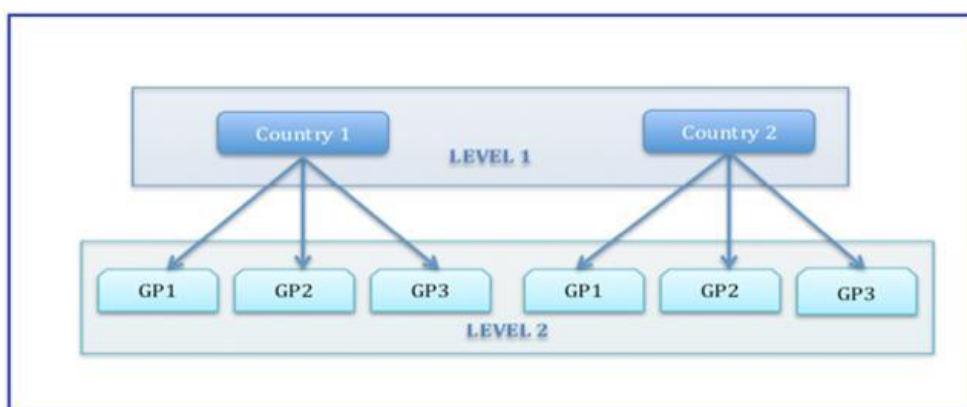
procure sophisticated ICT systems. Second, GPs come from countries characterised by different levels of eReadiness, which affect the diffusion of positive attitude and skills, as well as of expectation, both among the GPs and their constituencies. Last but not least, they work in different healthcare systems that assign different roles to GPs (gatekeeper in NHS, not in SSI), and create different incentives to share and perform additional workloads.

**Figure 55 A parallel between students and GPs**



Not surprisingly, a multilevel approach to health professional adoption of EHR, for instance, has been proposed by Gagnon et al (2010) applying the exact same rationale we exposed above.

**Figure 56 MLA exploration of eHealth adoption**



Besides the two MLA models mentioned above (random and fixed intercept models), there is also a model without explanatory variables called "The Empty Model (random effects ANOVA)" (or alternatively "Unconditional Null Model"). This is basically a MLA Analysis of Variance (ANOVA). Indeed, it is interesting in itself to disentangle variability at the various levels; moreover, this can give insight into where further explanation may fruitfully be sought. We used precisely the Empty Model to perform a preliminary exploration of the extent to which country effects and organisational settings effects shape the overall level of adoption of eHealth. As the model

with organisational settings did not yield significant results, we concentrated on the explanation of variance in the composite index by country effects or individual level variables.

To determine the effect that variable level 1 (country) has in shaping the level of the composite indicators and of the overall composite index, we performed multilevel analysis of variance of a random effect factor. This model ('empty model' or 'unconditional null model'), where are no independent or predictor variables, takes the form:

$$\gamma_{ij} = \beta_{0j} + e_{ij}$$

At this level, the score of a composite indicator or of the overall composite index for any given GP ( $\gamma_{ij}$ ) is interpreted as the result of combining the indicator of the country  $\beta_{0j}$  and the residuals or random variation  $e_{ij}$  around the mean. It is assumed that errors or residuals are normally distributed with mean zero and equal variance. At the country level, the average indicator value is interpreted as the combination of the average indicator in the country ( $\gamma_{00}$ ) and the random variation of each country ( $u_{0j}$ ) around that mean:

$$\beta_{0j} = \gamma_{00} + u_{0j}$$

It is assumed that the random component of the level  $u_{0j}$  has expected value 0 and variance  $\sigma_{u0}^2$ . Substituting this, the combined model is obtained:

$$\gamma_{ij} = \gamma_{00} + u_{0j} + e_{ij}$$

Thus, in the estimates of the covariance parameters, the variance of factor (Country) indicates how the dependent variable varies between countries across the sample and the variance of the residuals indicates how the dependent variable varies within each country. The table below shows the results of the estimated covariance parameters that are the estimates of the parameters with the random effects of the model.

**Table 31 Results of MLA analysis of variance**

Estimates of Covariance Parameters						
	Parameter	Estimate	Std. Error	Z (Wald)	Sig.	ICC
Composite Index (CI)	Residual	0.17	0.003	64.23	0.000	0.298
	Country	0.07	0.191	3.81	0.000	(29.8%)
EHR composite indicator	Residual	0.27	0.004	64.23	0.000	0.414
	Country	0.19	0.050	3.83	0.000	(41.4%)
HIE composite indicator	Residual	0.50	0.007	67.70	0.000	0.318
	Country	0.23	0.061	3.82	0.000	(31.8%)
TLHT composite indicator	Residual	0.32	0.005	67.70	0.000	0.140
	Country	0.05	0.014	3.77	0.000	(14.0%)
PHR composite indicator	Residual	0.25	0.004	67.70	0.000	(0.134)
	Country	0.04	0.010	3.78	0.000	13.4%

In the case of CI, the variance of the factor (Country = 0.07) indicates how the dependent variable varies (CI) between countries,

and the variance of the residuals (residual = 0.17) indicates how the dependent variable varies (CI) within each country. Through these two scores we can calculate the Intra-Class correlation coefficient (ICC) [variance of the factor / (variance of the factor + variance of the residuals)]. This ratio indicates how much of the total variability of the dependent variable corresponds to the difference between mean results in each of the countries. Interpretation of ICC is as follows: a value of 1 would indicate that all the variability is due to the difference between countries, and a value of 0 would indicate that the country effect does nothing to explain the variability of the indicators, meaning that all of the variance is explained by differences within each country, thus, mostly by individual level variables. According to our results, in the case of CI the variability between countries represents  $(0.07) / (0.07 + 0.17) = 0.298$ , or 29.8% of the total variability. This is to say that of the total variability of the CI, approximately 30% is explained by difference between the means obtained in the countries.

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