Design propositions for nudging in healthcare: Adoption of national electronic health record systems

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Abstract

Objectives: Electronic health records (EHRs) are considered important for improving efficiency and reducing costs of a healthcare system. However, the adoption of EHR systems differs among countries and so does the way the decision to participate in EHRs is presented. Nudging is a concept that deals with influencing human behaviour within the research stream of behavioural economics. In this paper, we focus on the effects of the choice architecture on the decision for the adoption of national EHRs. Our study aims to link influences on human behaviour through nudging with the adoption of EHRs to investigate how choice architects can facilitate the adoption of national information systems.

Methods: We employ a qualitative explorative research design, namely the case study method. Using theoretical sampling, we selected four cases (i.e., countries) for our study: Estonia, Austria, the Netherlands, and Germany. We collected and analyzed data from various primary and secondary sources: ethnographic observation, interviews, scientific papers, homepages, press releases, newspaper articles, technical specifications, publications from governmental bodies, and formal studies.

Results: The findings from our European case studies show that designing for EHR adoption should encompass choice architecture elements (i.e., defaults), technical elements (i.e., choice granularity and access transparency), and institutional elements (i.e., regulations for data protection, information campaigns, and financial incentives) in combination.

Conclusions: Our findings provide insights on the design of the adoption environments of large-scale, national EHR systems. Future research could estimate the magnitude of effects of the determinants.

Keywords

Health policies, national, information system, multihospital, electronic health records, adoption, healthcare systems

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Introduction

The adoption of digital innovations such as electronic health records (EHRs) is a much-discussed topic in healthcare. EHRs are considered important for improving efficiency and reducing costs of a healthcare system,[1,2] and increasing patient safety if used correctly.[3] Furthermore, EHRs are an important prerequisite for artificial intelligence-based applications such as decision support as they provide the necessary patient data.[4] In this paper, we focus on the adoption of national EHR systems in a top-down approach rather than the bottom-up adoption on a regional, organizational or individual level. Aggregate national EHRs are an accumulation of a large number of individual patient records. The complexity of combining patient records into a national EHR system is a monumental

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challenge for government agencies as well as for healthcare providers. As a result, even in nations with integrated patient records, aggregated national EHRs have not achieved their full potential.[5] Thus, the stimulation of the adoption of national EHR systems is a crucial area of research. While the adoption of EHRs for example by larger healthcare organizations or physician networks has shown progress in the recent past,[6] European countries often struggle with the adoption of a national EHR system.[7] In the German healthcare system, for example, the endeavour to implement a national EHR system has already taken more than 15 years and is still in progress. The adoption and uptake of EHR systems varies substantially between countries as does the way in which individuals decide to participate in and engage with EHRs for electronic health data exchange, depending on how information is presented to stakeholders. On a national level, the presentation of the adoption choice may have a large influence on the percentage of the population that is willing to consent to storing their health-related data in an EHR. In this paper, we focus on the effect of the choice architecture on the adoption of EHRs. Our study aims to link influences on human behaviour through nudging to the adoption of EHRs, providing thereby a fresh perspective on how choice architects such as policy makers can facilitate the adoption of digital innovations such as EHRs in healthcare systems.

In this paper, we consider EHRs as repositories of the patients' medical information across all of their healthcare providers. We focus on top-down national EHRs. The main benefits of national EHRs are potential reduction of costs,[1,2] enhancement of patient safety and quality of care[3] as well as increasing effectiveness and efficiency of care.[8,9]

Of course, all these benefits can only arise if EHRs are widely adopted by health professionals and patients. Motivation to use the EHR is considered both an important barrier as well as a facilitator of adoption. Other factors include cost, governance, end-user involvement, interoperability, privacy and information security, usefulness, and ease of use.[10,11] Unlike electronic medical records (EMRs; for a distinction see Caligtan and Dykes[12]), which as a legal obligation of the hospital or medical practice are always being created and kept up to date, EHRs are voluntary in many countries and must be actively requested by the patients and filled by healthcare providers.

Furthermore, the successful formation and adoption of national EHRs requires all stakeholders of the delivery and consumption of healthcare to contribute to a comprehensive EHR. Thus, all stakeholders (e.g., patients, healthcare providers, and government) in a fragmented sector with public and private actors have to share data with other stakeholders. As a result, each stakeholder's needs and concerns must be addressed in order to motivate them to participate in an EHR. Only that way, the full potential of EHRs can be realized.[5]

The research stream of ***behavioural economics*** is based on social-psychological and cognitive theories and studies how psychological or cognitive factors affect the decisions of individuals or institutions. In that context, Thaler and Sunstein[13] have described *nudging* as a concept that deals with influencing human behaviour. The authors define *nudging* as 'any aspect of the choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives'.[13(p6)] Although stemming from the field of economics, nudging can also contribute to areas such as digital transformation, IT adoption, and IT governance.[14–17] Nudges are based on the use of unreflective thinking or the activation of reflective thinking for decisions that would mostly be made unconsciously.[13,18] As the freedom of choice remains untouched, nudging represents a form of *libertarian paternalism*.[13,14,17,19]

Behavioural economics emphasizes the importance of *choice architecture* for the decision-making behaviour of individuals.[13,20–22] Choice architecture deals with the issue that there are many ways to present a choice to the decision-maker. Thus, the actual choice often depends upon how the choice is presented.[13,23] Various studies have dealt with the significance of standards (defaults) in both the healthcare system and in other areas: Policies that change standards have had a significant impact on important decisions in many areas, such as organ donation (where donation rates were four times higher with opt-out defaults compared to opt-in defaults),[24] tax-privileged savings plans,[25–27] or healthier food choices.[28]

The use of defaults is one of the most popular and powerful tools available to choice architects (i.e., anyone who presents people with choices). Generally, an option will be chosen more often if it is introduced as the default.[23] Thus, choice architects should be mindful of the ethical implications involved in setting defaults[29] and consider the default carefully.

Opt-out policies are very effective for several reasons. Loss aversion encourages adherence to standards, as deviation from the standard usually includes both benefits and losses, although losses are given greater weight. This effect is reinforced by the existence of a status quo bias. In addition, individuals often postpone decisions against a standard because they require an active response, which requires time or includes uncertainty.[13,23,24,30–32] Finally, individuals often opt for the default option because they assume that it was chosen for a specific reason and thus represents an implicit recommendation for action.[33] However, opt-out policies also have some important limitations. Since the decision was only passively taken by inaction, it may result in less satisfaction and commitment than an active choice. Moreover, such opt-out options are less likely to reflect the actual preference of the individual. Finally, opt-out defaults can be counterproductive if the policy maker sees the arrangement as a substitute for

other more substantial interventions, such as educational programs that provide the individual with information that enables an informed choice.[30,34]

Both opt-in and opt-out defaults have distinct advantages and disadvantages in the context of EHRs and electronic data transfer in healthcare, which will be briefly described below.[35] In this context, making health data available online in EHRs and transferring them via computer networks increases privacy and information security risks. Against this background, the decision between an opt-in and an opt-out default is discussed intensively by experts, policy makers, stakeholders, and the public. Information governance is at the heart of this decision.[36] An opt-in policy requires explicit verbal or written consent from the patient, who must be informed about the benefits and risks of participation prior to consent. In contrast, an opt-out default assumes an implicit consent of the patient unless the patient explicitly objects to participation.

The opt-in default imposes the information governance on the patient. In addition, this option can lead to high costs due to patient elucidation and registration. However, opt-in policies strengthen the protection of health data. They give patients control and sovereignty over their health data, and enable adequate patient elucidation and education. However, this may also mean that the achievement of a critical mass is inhibited. As a result, many patients will not be able to benefit from the advantages of a digital health system, and healthcare institutions will not have the necessary data available that would allow for a comprehensive analysis and improvement of care for the population.

An opt-out default shifts information governance to healthcare organizations. As a result, they must take particular care to ensure that potential risks are very low. However, since all patients are automatically registered, opt-out policies facilitate the achievement of a critical mass so that the benefits in terms of better healthcare can be realized more quickly because the data needed to improve the quality and outcomes of care and reduce costs are made available. The opt-out default also reduces the administrative burden, as not every patient has to go through the consent process.

Study aims

To date, there is a lack of empirical research on how the adoption of national EHR systems is influenced by how the adoption choice is presented to the citizens. Extant information systems (IS) research on EHR adoption focused on topics such as changes in institutional logics,[37] institutional forces,[38] risks of breaches of patient information,[39] integration challenges,[5] factors influencing physicians' and hospitals' adoption,[40–44] or IT vendors' legitimation strategies.[45] Thus, we add a new perspective to EHR adoption research on an aggregate national[5] level.

In the context of EHR research, concepts of behavioral economics (i.e., nudging and choice architecture) have only been applied to applications within EHRs such as order-entry systems or vaccination ordering,[46,47] but not to the adoption of a national EHR system. In addition, research on EHRs often focused on the private sector-dominated healthcare system of the US. In contrast, our paper examines public sector-dominated European healthcare systems. That way, we are able to contribute to research in a less studied context.

In this paper, we aim to address these shortcomings in EHR adoption literature. We intend to add to the understanding of how the choice architecture and related design elements affect the adoption of national EHRs. In doing so, we address the following research questions: *How do choice architectures influence the adoption and active use of national EHRs? How do the technical configuration and institutional measures closely related to the choice architecture influence the adoption and active use of national EHRs?*

In order to answer our research questions, we employ an explorative, qualitative case study design. We analyze the choice architecture and adoption of EHRs in four European countries with different configurations: Estonia, Austria, the Netherlands, and Germany. In addition, we apply our findings and derive implications for the ongoing scientific and political discussion about adjusting the EHR configuration and choice architecture in Germany. The findings from our multiple-case study analysis show that the choice architecture (i.e., defaults) is an important determinant of EHR adoption. In addition, the adoption of EHRs is governed by choice architecture-related technical configuration (i.e., choice granularity and access transparency) and additional institutional measures such as regulations for data protection, information campaigns, and financial incentives.

Our contributions to research are two-fold: First, we augment research on digital innovation adoption with the lens of behavioural economics. Our research therefore provides a new theoretical perspective for IS research in digital health. Second, our findings provide input for the design of choice architectures and additional measures for information systems in general and EHRs in particular.

Methods

We conducted an explorative, qualitative study. More precisely, we used a case study approach for our research.[48] In order to strengthen the base of our study, we employed a multiple-case design. The use of multiple-case studies allows for stronger robustness and analytical generalization than evidence from single-case studies.[48,49] We selected four European countries (Estonia, Austria, the Netherlands, and Germany) that have a public sector-dominated, social insurance-funded healthcare system.

That way, we ensured that the main settings of the healthcare system are comparable and that our findings result from similarities and differences in the investigated constructs rather than from differences in the system-level setting. The four countries have national EHRs with varying choice architectures in place, which present our main investigated construct. Thus, we employed a theoretical sampling approach to select the four cases with the goal to illuminate and extend relationships and logic among constructs. These cases provide theoretical insights for developing theory. Furthermore, the four cases offer alternative perspectives and contain sufficient data points, which make them a suitable source for developing theory.[50,51]

Data collection

In order to increase the quality of our findings, we used multiple data sources.[50] We employed the following mixture of primary and secondary data: ethnographic observation, interviews, scientific papers, homepages, press releases, newspaper articles, technical specifications, publications from governmental bodies, and formal studies.

First, one of the authors of this study was immersed in the research context as an expert for 16 years. Besides his context-related position in academia, he is a member of various crucial institutions such as a representative of science on the advisory board of the organisation implementing the eHealth infrastructure in Germany, the digitisation committee of the German Medical Association, and the Working Group Digital Health of the Standing Committee of European Doctors (CPME). In these roles, he attended a large number of committee meetings, workshops, conferences, and presentations. Besides his active role in these events, he has also carried out subject-specific research projects. As a result, he was able to gain valuable insights through ethnographic participant observation.[52] Furthermore, he has conducted various discussions and 15 interviews on our research questions and investigated constructs with clinicians, medical informatics experts, IT industry representatives, members of academia, EU regulators, representatives of political agencies on the state and federal level, representatives of statutory health insurance funds, and key actors for the EHR systems in Austria, Estonia and Germany. This long-term immersion provided us with profound and detailed insights.

Second, we augmented these fine-grained insights by conducting a thorough literature review in order to gain an informed understanding of relevant theoretical concepts. Furthermore, we collected further data from various sources such as scientific papers, homepages, press releases, newspaper articles, technical specifications, publications from governmental bodies, and formal studies in order to build the database for our case studies. In sum, a total of 3,509 pages were analysed.

Data analysis

The data we obtained were consolidated and arranged thematically and chronologically. By doing so, we aimed to increase the reliability of our case studies. Furthermore, the triangulation of different data sources (i.e., ethnographic observation, interviews, scientific papers, homepages, press releases, newspaper articles, technical specifications, publications from governmental bodies, and formal studies) increases construct validity.[48] We employed pattern-matching as well as explanation-building in order to improve internal validity and the understanding of causal relationships. Moreover, the use of a replication approach for exercising cross-case analysis increased external validity.[48,53] In the first step, we analysed each case separately and wrote it up chronologically. In this process, we described the different choice architectures, their development and implementation, additional measures that were put in place, and the adoption rates of the EHRs. In order to analyse patterns, similarities, and differences, we conducted a cross-case analysis in the next step. We created a table that summarized the data from the four individual cases structured according to choice architecture, related technical configuration and additional measures, and EHR adoption, which resulted in the creation of a profile for each case. We employed this display to analyse similarities, conformities, or differences, and to determine the final categories of our study: (a) the choice architecture (i.e., defaults), (b) the technical configuration (i.e., choice granularity and access transparency), and (c) additional institutional measures such as regulations for data protection, information campaigns, and financial incentives. In addition, findings from the case studies were again compared to theory in the process of pattern matching. These iterations help to derive explanations for the findings and increase internal validity.[48,50]

Case study analysis

In the following, we will present the findings of our case study analysis. We investigated the choice architecture for and adoption of EHRs in four European countries: Estonia, Austria, the Netherlands, and Germany.

Estonia

As early as 2005, the Estonian Ministry of Social Affairs developed a strategy for the digital transformation of the healthcare system. In 2007, the implementation of regulations for data protection in electronic transmission set the legal framework for the eHealth system. The eHealth Foundation, the official body responsible for the system, launched the nationwide EHR platform in 2009. The key components of the Estonian e-services ecosystem are the network for safe data exchange, called X-Road and the

e-identity (PKI, public key infrastructure: personal electronic ID card or mobileID). They are used for all eGovernment purposes and the Estonian National Health Information System ('ENHIS'), a network for exchanging health information including a central database that stores all medical documents provided by healthcare service providers in a patient-centred EHR. On the *Patient Portal*, patients are able to gain insight into their EHR created and made available by health professionals, refuse treatment, agree to donate organs, or appoint agents to view the medical data on their behalf. Furthermore, there are additional functions such as online appointments, a list of all prescribed and purchased drugs, or the possibility to inform all care institutions at the same time when changing their personal contact information.

Healthcare providers are legally obliged to submit in- and outpatients care summaries to the central platform. This information has to be sent within five workdays for inpatient and one workday for outpatient care summaries. However, patients are able to restrict access to their documents and data. They can close individual documents or the entire EHR. Access to the so-called time-critical data, which includes the last visit to a healthcare provider, medical procedures in the last month, and allergies, can be regulated separately. The decision is reversible. However, closing the EHR means that reading access to its contents is restricted. Doctors and hospitals are still obliged to store documents in the EHR; i.e., by opting out, no data are deleted. Thus, the accessibility of the data is designed as an opt-out configuration with a certain degree of granularity.[54] Every attempt to view healthcare data is reported to the patients in the *Patient Portal*. Therefore, patients can always see who has accessed which data at what time and submit complaints in the event of suspected unauthorized access.

By January 2019, 40,660,000 medical documents (14 different kinds) were stored on the platform. It contained health information from 1.6 million patients (Estonia has 1.32 million inhabitants). The data encompass, for example, 21 million outpatient and 1.91 million inpatient care summaries as well as 10.5 million diagnostic examination reports. The utilization of the data is increasing. In January 2019, more than 1,750,000 queries were made by patients and more than 2,250,000 by healthcare professionals. More than 1,250,000 different healthcare documents were used for these queries. A total of 99% of prescriptions were issued in electronic form. In the period from 2008 to 2017, less than 500 persons (ca. 0.038%) opted out and had closed their EHR (i.e., restricted access to their data). Thus, the percentage of citizens who are opting out should be negligible.

Austria

At the beginning of the year 2014, an EHR (called *ELGA*) was introduced as an information system for patients and healthcare providers, such as physicians, hospitals, or pharmacies, to provide them with secure, time- and location-independent access to health data such as medical reports, discharge reports, or medication data. The EHR thus provides a platform for health data originating from various healthcare providers and implements the IHE IT Infrastructure Technical Framework (especially the IHE-XDS.b/IHE-XCA Profile principles). Medical documents are stored in decentralised repositories, where they are generated. There are 13 registries in the country, organized as XDS Affinity Domains. The registries hold metadata used for search queries and use a national Master Patient Index. Patients can use the platform to view and manage their own medical data. The EHR supports treatment by providing an improved flow of information, as relevant data are collected and centrally available. The patient receives access to the *ELGA* platform via the Austrian Health Portal (www.gesundheit.gv.at). There are two options for authentication: by mobile phone or with a chip card. Every citizen of Austria who has health insurance possesses the so-called *e-card*. Physicians require the *e-card* to access the patient's medical data or to submit the treatment data to the health insurance. At the same time, the card provides proof to the health insurance company that the patient was present in the care institute in order to receive treatment. By default, physicians have access to the *ELGA* health data for 28 days after identifying a patient by reading the *e-card*. Pharmacies only have access for a 2-hour period and only to e-medication data. Patients can regulate the authorization period via the portal: they can shorten, lengthen, or deny it as required.

All citizens of Austria who have health insurance automatically participate in *ELGA*. However, patients have the opportunity to deregister at any time via the *ELGA* portal or in writing to the *ELGA* opposition office. Thus, participation in Austria's EHR system is designed with an opt-out default. The opt-out can be completely or partially (e.g., only from certain functions such as e-medication) and can be reversed at any time. However, unlike to the EHR policy in Estonia, health data that have been generated in the meantime cannot be included retroactively in the Austrian EHR as the respective index entries are really erased after opting out, i.e., the EHR of the patient is completely erased so that there is no target structure for a healthcare provider to upload any health data. Furthermore, patients have the option of denying a specific healthcare provider access to the data. This applies to an entire practice; individual employees cannot be excluded. In addition, certain data can be blocked for healthcare providers, e.g., individual reports.

A study in 2014 revealed that a majority of the population (91%) had a positive attitude towards the EHR. However, there was opposition from physicians: The heads of the Austrian Association of General Practitioners submitted their resignation from *ELGA*, and the association recommended immediate *ELGA* opt-out to all patients. The

Austrian Medical Association supported this campaign against *ELGA*. Nevertheless, the participation rate was high. In April 2018, only around 269,000 persons (ca. 3% of the population) had opted out of the EHR system. Yet, there was an increase in opt-outs (up to 273,000 in May 2018 and 390,000 in November 2019) due to data security concerns after the government announced the facilitation of access for scientists to the (pseudonymised) EHR data, although it is very unclear if this access can be technically carried out because of the decentralised storage of the data. However, this rate dropped again to around 257,000 persons (ca. 2.84% of the population) having opted out in November 2021. Actual usage of the EHR is also high. As of November 2021, about 56 million documents were registered in the EHR system, and about 300,000 monthly visits to the EHR portal were performed.

The Netherlands

In 2008, the Dutch EHR initially started with an opt-out configuration. Citizens were informed by letter of the advantages and disadvantages of EHRs as well as the possibility of objecting to the use of their data. In 2009, the House of Representatives in retrospect should have legitimized this procedure. However, this process was stopped by the Senate in 2010 and finally rejected in 2011. Since then, the progress of digitalization in healthcare has somewhat stagnated in the Netherlands. The Netherlands have a national infrastructure for data sharing between healthcare providers, called *AORTA*, which was developed under government mandate by the National IT Institute for Healthcare (Nictiz). *AORTA* consists of a national registration system for identification and authentication as well as a reference index system, the National Switch Point (Landelijke Schakelpunt, *LSP*). In order to improve safety and data security, *AORTA* was regionalized instead of a planned centralized approach. The *LSP* was designed as a brokering system to ensure access to the relevant documents. Artificial borders have been added to the system to prevent national data exchange. GPs, hospitals, pharmacies, and patients are still connected to the system, but access is now regionally limited. A move to another region therefore also means the loss of previous data.

Patients must explicitly opt for the new system both in practices and in pharmacies (opt-in). The introduction of the system was slow at first, but public acceptance has grown over the years. In 2014, only 2.3 million citizens were registered, while in 2017, 11.4 million people (66%) gave their consent to data exchange. In 2017, however, only 15% of GPs were aware that it is important to point out to their patients that their consent is needed for the exchange of their medical data. In 2015, that awareness was significantly lower. Patients are often not aware that an opt-in configuration is in place and that they have to give their consent to healthcare providers for them to be able to exchange medical data. Less than a third of patients indicated that their healthcare providers pointed out the option of data exchange among providers. While 52% of the citizens would like to have online access to their medical data from their GP and 46% from their medical specialist, only 2% respectively 8% actually had online access to their electronic records of their GP and their medical specialist. In order to counteract this shortcoming of the opt-in configuration, the Nictiz attempts to launch information campaigns to better inform patients and physicians about the opportunities and benefits of information exchange.

Healthcare providers can decide for themselves whether to connect their health information systems to the *LSP* or not. By the end of 2016, around 92% of the healthcare providers (physicians, hospitals, and pharmacies) were connected via *LSP*. In 2017, 75% of GP practices were connected to the *LSP*, compared to 62% in 2015. Almost all pharmacies in the Netherlands were connected (99%). This high percentage is mainly due to the fact that the health insurance has granted GPs and pharmacists a subsidy for the connection.

Germany

Germany introduced a national EHR system in 2021. However, the journey started already in 2004 with legislation for an EHR introduction in 2006. Germany designed an opt-in policy. The current configuration of the EHR involves an informed consent for initialising an EHR, which can be applied for either in writing or electronically. The EHR shall store data submitted by doctors that cannot be altered but can be deleted by the patients. Patients can also enter own documents into the EHR, which are then labelled as patient-generated. They can use their Electronic Health Cards (EHCs, NFC capable chip cards) together with a PIN in a hospital, medical practice or pharmacy, or a smartphone at home to access their own health data or authorize health professionals and health institutions. However, after 2 years of operation, less than 1% of PINs are rolled out, because a secure identification of the insured person at eIDAS Level of Assurance 'high' is needed for applying for a PIN which generally means registering in person in an office by using an official ID card or passport. Starting from 2024, mobile devices like smartphones or tablets ('Digital Identities')[55] must by law be introduced as authentication means, enabling an easier use of apps for accessing data and authorizing healthcare providers. Authorization of healthcare providers is always explicit (opt-in). The default authorization time range for a health professional or hospital is 1 week and can be shortened by up to one day or prolonged to any other time range.

The EHR rights management implements three levels of granularity. A fine-grained access control provides the patients with the option of applying individual access

rights to each information object in the EHR. However, this could add a vast complexity to the rights management of the EHR by reducing easiness of use, which would thus reduce acceptance, information security, and privacy.[56] The 'medium' granularity level allows for giving access to some groups of documents (e.g., according to the document type or specialty of the doctor). The 'coarse' granularity implements an adapted Multilevel Security access control model where documents are labelled with a classification and healthcare providers are authorised for a clearance level by the patient. Doctors can then access documents classified at their clearance level and below.

Transparency is constituted by logging every access to healthcare data and every change in the rights management of the EHR. The patient can access the logs with his or her mobile device. Pseudonymised EHR data can be used for scientific research purposes but only after active consent of the patient. All health professionals are obliged to support their patients in using the EHR. Their effort shall be remunerated with €10 for the initialization of the EHR. Filling out an initialized EHR with documents is remunerated with €1.67 (max. per patient once per quarter). Further 'incentives' are not planned. Although the EHR has been introduced in January 2021 and after 2 years only 0.7% of the eligible insured persons initiated an EHR, a large-scale information campaign for the public has not yet been specifically planned.

Discussion

In the following, we present and discuss our across-case comparison. We derive design propositions from our data analysis and support these propositions with argumentation based on our across-case analysis. Our analysis shows that despite its great importance, the choice architecture alone is not the only determinant of EHR adoption. Rather, the choice architecture (i.e., consent defaults) (Proposition 1) in combination with the technical configuration (i.e., choice granularity and access transparency) (Proposition 2) and additional institutional measures such as regulations for data protection, information campaigns, and financial incentives (Proposition 3) governs the adoption of EHRs in healthcare.

Proposition 1: Adoption and active use of national EHRs are facilitated by an opt-out consent default.

The opt-in and opt-out default options as well as their advantages and drawbacks have already been described above. Our findings support the notion that an opt-out default may have a positive effect on the adoption of EHRs. Estonia and Austria both use an opt-out default for patients' decision to participate in the EHR system. Thus, patients' consent is automatically assumed unless they decide to opt out of the EHR system. Both countries

show very high adoption rates of the EHR: By January 2019, all Estonian citizens possessed an EHR, and more than 40 million medical documents were stored on the platform. In addition, all healthcare providers are obliged to submit care summaries to the central platform. In Austria, only around 2.84% of the population decided to opt out of the EHR system by November 2021. The Netherlands, in contrast, employs an opt-in default, which requires explicit patient consent to the EHR. The adoption by patients was quite hesitant: In 2014, less than 14% of population were registered to the EHR system. By 2017, the adoption had risen to 66% with the help of additional measures (see below). Due to financial incentives, the adoption by providers is quite high: By the end of 2016, 92% of the healthcare providers and 99% of the pharmacies were connected to the EHR system. In Germany, where an opt-in consent default is applied and no substantial incentives are in place, EHR adoption was less than 0.7% of the eligible population by 2023, after 2 years of operation.

Although in all discussions with key actors, the risk of low user numbers and the need of a high participation in the EHR was confirmed, the appropriate approach to achieve this was very controversial. Some interviewees identified opt-in as the biggest problem and called for opt-out. Others, however, have stressed the importance of data protection and freedom of choice and have called for other ways to achieve high EHR participation. Therefore, we believe that the choice architecture in EHR adoption remains a major issue and requires further detailed investigation in research.

An opt-out choice architecture seems to ensure high participation rates. However, it must be stressed that the notion of adoption cannot only be limited to the participation in the EHR system but must include the active use of EHR. In Austria and Estonia, active EHR usage is high as well. As participation is not necessarily correlated to active usage, other choice architecture factors (i.e., opt-out for accessing EHR by doctors and an obligation for doctors to submit specific classes of documents) and factors besides choice architecture must be considered as well.

Proposition 2: Adoption and active use of national EHRs are facilitated by related technical configuration consisting of granularity of choice architecture as well as access transparency.

Granularity of the choice architecture. Granularity refers to the ability of patients to manage the access to their data (a) by data type, (b) by provider, (c) by time range, and (d) by purpose.[54] Every type of granularity presents certain advantages and drawbacks. There is a trade-off between the acknowledgement of patients' data security concerns and preference for having some choice, and the technical and procedural complexity of data management.

In addition, there may be negative consequences for the provision of coordinated care as well as for liability issues of providers if patients are able to segregate potentially important data from other clinical information. Nevertheless, granularity grants patients more sovereignty over their health data and may thus increase their willingness to accept EHRs and electronic data exchange.

The findings from our case studies show that both Estonia and Austria, which have high adoption rates, not only employ an opt-out default but also allow a degree of granularity in their choice architecture. In Estonia, patients can restrict access not only to the entire EHR but also to individual documents and separately for 'time critical' (emergency) data. In Austria, patients are able to deny certain healthcare providers access to their data, can opt-out from certain functions (e.g., e-medication), and restrict access to individual documents. In addition, the access to an EHR is limited to 28 days for physicians and 2 hours for pharmacies (i.e., granularity by time range). Patients can shorten or lengthen this time range as required. The Austrian case also shows the relevance of granularity by purpose: When the government announced that access to EHRs for scientists had to be facilitated and patients were not able to opt out for just this purpose, there was an increase in overall opt-outs from the EHR system, even though this access was not really implemented. In Germany, three different levels of granularity are provided. Nevertheless, as EHR adoption is very low, the influence of granularity on EHR adoption in Germany cannot be determined. However, the current situation in Germany indicates that granularity of the choice architecture alone is not sufficient for achieving high EHR adoption rates if an opt-in choice architecture is applied. Overall, the existence of granularity in the choice architecture seems to improve patients' acceptance of EHRs and electronic data exchange, and thus facilitates EHR adoption under the condition that adoption is not hindered by an opt-in choice architecture.

Transparency. Besides the choice granularity, transparency also presents an important aspect of the technical configuration that increases patients' acceptance of EHRs. In Estonia, every attempt to view healthcare data is monitored and reported. The same applies to Austria and the Netherlands. Therefore, patients are able to see who accessed their data. In addition, they can submit complaints in the event of unauthorized access. Thus, patients are in control of their data. In Germany, extremely low EHR adoption rates do not yet allow for assessing the effect of transparency.

Proposition 3: Adoption and active use of national EHRs are facilitated by additional institutional measures that encompass regulation for data protection, information campaigns, and financial incentives.

In addition to the choice architecture and the technical configuration, several institutional measures[57] supported EHR adoption in our case studies. First, Estonia set a firm legal framework for its eHealth system by implementing sound **regulation for data protection** as early as 2007. In Germany, new *data protection* legislation (the 'Patients Data Protection Act') specific to the EHR was enacted. This measure can create trust and may help to facilitate acceptance and adoption. This finding conforms to previous findings on the relevance of regulation.[58–60]

Second, the Netherlands countered the low adoption rates with **information campaigns** that informed patients and physicians about the opportunities and benefits of EHRs. This measure is especially important in the context of opt-in defaults, where an active decision for EHRs is required. This finding is supported by findings on heart transplantation: In the US, awareness campaigns that educated the public and healthcare professionals increased donations and organ utilization rates in the context of an opt-in system.[61] In addition, campaigns on social media like Facebook created peer pressure,[57,62] thus significantly contributing to donor registration.[61] Information campaigns, social marketing, and social pressure can provide important additional nudges.[13,17] In contrast, Germany applied an opt-in consent default and deployed no information campaigns. As a result, EHR adoption was extremely low by 2023, after 2 years of operation.

Third, health insurance in the Netherlands stimulated the participation of physicians and pharmacies in the EHR system by granting them **financial incentives** in the form of a subsidy for the connection. Similar effects were observed for the 'Meaningful Use' regulation in the US[54,58] and in the context of organ donation.[61] In contrast, Germany has no substantial incentives in place. Although a subsidy for the connection to the eHealth infrastructure is granted, it hardly covers the connection cost and no incentives are paid to cover the time and financial effort (e.g., for specific software modules) to fill the EHR. As a result, EHR adoption was extremely low (0.7%) after 2 years of operation.

Implications for research and practice

Our contributions to research are two-fold: First, we augment research on digital innovation adoption with the lens of behavioural economics. In doing so, our findings show the relevance of choice architecture for national information systems such as EHR systems. Our research therefore provides a new theoretical perspective for IS research in digital health. Future research could build on our insights and investigate additional areas. There are, for instance, two categories of tools available to choice architects: Tools for structuring the choice task (i.e., what to present) and tools used to describe the choice options (i.e., how to present it).[23] In this paper, we focused on defaults, which are tools for structuring the choice task. Future research could aim at investigating how choice options for EHRs could

be presented to different stakeholder groups in order to stimulate overall EHR adoption.

Though we did not observe them in our case study analysis, there are additional nudges that could facilitate the adoption of EHRs and electronic data, such as social influence, reminders, simplifications (e.g., pre-set granularities), or structuring of complex choices.[13,17] These nudges could provide policy makers with additional tools to facilitate EHR adoption. In addition, digital nudges that are embedded in the digital interfaces[17] may increase patients' and healthcare providers' acceptance and utilization of EHR systems. These digital nudges provide many opportunities for future research.

Second, our findings provide input for the design of choice architectures and institutional elements for information systems in general and EHRs in particular. National information systems such as EHR systems are much more complex than on an organizational level.[5] Our findings show that designing for national adoption should encompass and weigh up (a) behavioural elements (i.e., consent defaults), (b) technical design elements (e.g., choice granularity and transparency), (c) regulatory elements (e.g., regulation for data protection and subsidies), and (d) policy elements (e.g., information campaigns). Our insights provide a starting ground for further research on the design of the adoption environment of large-scale, national systems such as EHR systems, especially in sensitive contexts such as healthcare. Future research could build on our findings and further investigate the augmentation of technical design considerations with the theoretical lenses of behavioural economics and institutional factors (e.g., regulation, policy, and isomorphic pressure).

Our study provides evidence that the choice architecture may be the most important nudge for EHR adoption. Our findings support the notion that opt-out defaults lead to a quicker and higher adoption of EHRs. In addition, related technical configuration consisting of granularity of the choice architecture and transparency can further increase the willingness to adopt EHRs. However, institutional measures also play an important role for EHR adoption. Especially if an opt-in default is used, institutional measures such as regulation for data protection, information campaigns, and financial incentives are needed in order to stimulate the adoption by patients as well as healthcare providers as shown in the case of the Netherlands, however, without been able to reach very high adoption rates as with an opt-out choice architecture. Hence, as a practical implication, policy makers and other choice architects should consider carefully how they structure these measures in order to increase EHR adoption and to find a balanced trade-off of diverse stakeholder interests.

In addition, policy makers, healthcare providers, and IS developers should consider working closely together in order to be able to address behavioural, technical, and institutional challenges simultaneously. In the past, collaboration between policy makers and software industry was mainly limited to policy makers imposing mandatory requirements on information systems that industry had to implement. The arduous adoption paths of our case studies show the importance of co-creation and collaboration between actors in order to address the needs of all stakeholders. Multidisciplinary, diverse steering committees may serve as a coordination unit.

Implications and recommendations for the German EHR configuration

Regarding the choice architecture, on the one hand, an *opt-in consent default* applies in Germany; on the other hand, there are no other specific strong measures yet planned to promote the usage of the EHR. The 'Patients Data Protection Act' stipulates that doctors and hospitals must support their patients in applying for an EHR, and they will be remunerated with €10 for initializing and initially filling out a patient's EHR, and with €1.67 per patient and quarter for writing further documents in the EHR. It is difficult to imagine that these amounts will be sufficient to motivate doctors and thus promote the usage of the EHR in Germany. Thus, the tool *financial incentives* may not be strong enough, and policy makers may consider higher financial incentives or other institutional measures such as *information campaigns* on various channels for healthcare providers and patients. In Germany, new *data protection* legislation (the 'Patients Data Protection Act') specific to the EHR was enacted. This measure can create trust and may help to facilitate acceptance and adoption. The technical configuration supports *transparency* by allowing patients to trace who has accessed their data and when, which can increase patients' acceptance and adoption of the EHR as well. For accessing logs, the PIN of the EHC or a (future) Digital Identity is needed. However, an identification at an eIDAS Level of Assurance 'high' is needed for rolling out PINs or assigning Digital Identities, resulting in a significant barrier. Although all insured persons have an EHC, they cannot use it for transparency purposes yet. In sum, the opt-in choice architecture, insufficient financial incentives, not yet functional transparency measures, and a lack of a substantial information campaign result, up to this point, in a failed EHR adoption of less than 0.7% after 2 years of operation.

With respect to the choice architecture, an opt-out *consent default* could solve this problem but was virtually inconceivable in Germany from a political point of view in the past. Indeed, after 1 year of EHR rollout with very low adoption rates, the political parties forming the 2021 new elected German government are in support of an opt-out solution in their coalition agreements. Supported by our findings, we strongly encourage an opt-out approach not only for establishing an EHR but also for actively using

it, i.e., doctors should by default have access to EHR data and should have the obligation to submit documents to the EHR. The present *granularity of the choice architecture* could still stimulate the adoption of EHRs in Germany by granting patients more sovereignty over their health data, if designed carefully, i.e., by finding a balance between complexity and fine granular design. However, this sovereignty can only be exercised if a functioning and easy-to-use identity management is in place, e.g., for changing access rights or accessing logs. A Digital Identity on a smartphone is the right solution – rather than a chipcard with a PIN – provided that assignment of the Digital Identity will be easy to use as well.

Limitations and future research

Qualitative case studies aim to generate or expand theory, not test it. Hence, our qualitative research provides fine-grained insights and examines relationships rather than statistical effects. As a result, generalization of our findings is limited. Quantitative studies that estimate the magnitude of effects can provide additional insights and thus present an interesting area for future research.

In addition, our study focuses on the choice architecture, the technical configuration, and institutional measures related to the choice architecture such as regulations for data protection, information campaigns, and financial incentives. However, the adoption of national EHRs may also depend on determinants such as culture or technological readiness. Future qualitative and quantitative research could provide valuable insights into additional determinants.

Finally, our research offers guidance on the development of metrics to describe overall participation rates, active usage, and the extent to which entire versus partial EHRs are available to practitioners (based on patient decisions about blocking certain information). These metrics could assist in more efficient benchmarking between nations in future research.

Conclusion

In this paper, we investigate how choice architects can facilitate the adoption of national EHR systems. Our insights from European case studies from Estonia, Austria, the Netherlands, and Germany show that designing for EHR adoption should encompass choice architecture elements (i.e., defaults), technical elements (i.e., choice granularity and access transparency), and institutional elements (i.e., regulations for data protection, information campaigns, and financial incentives) in combination. Our findings provide insights into the design of the adoption environments of large-scale, national EHR systems in general and of the German EHR system in particular.

Future quantitative research could estimate the magnitude of the effects of our propositions.

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