

Open Standards for public software used by a National Health Insurance House. A study of EU vs USA standardization approaches

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Information technology improves reliability, innovation, and efficiency in the medical care sector by assisting in coming up with electronic health records. Looking into the interoperability of software and databases is relevant from the perspective of electronic health records. The standardization of processes in the European Union and the United States is diverse, which makes it all the more important to discuss open standards. Software systems create patient-centric medical care services and a platform for management. Thus, they facilitate the formation of functional health information networks and the exchange of information. Therefore, this improves the value proposition for all stakeholders involved. Open-source standards have been found to be developed independently of any single party. They do not have any legal or technical closest that prevent any party to use them. Similarly, they do not have extensions or components with a dependency or being based on preparation standards. Additionally, they are available for full public assessment without any form of constraints. This paper discusses these open standards and how best they have been deployed in the United States and the European Union — understanding that advantages and disadvantages of open standards are also imperative.

Keywords: User as Developer (UaD), Free And Open-Source Software (FOSS), cost-effectively software, EHR, interoperability, software, open standards, databases, security

1 Introduction

The benefits of information technology in the healthcare sector include higher efficiency, innovation, and reliability. Electronic health records (EHR) are currently being adopted in most healthcare facilities to store information related to patients' health. These information systems enable processing, mass storage, secure transmission, and accessibility to multiple stakeholders. Moreover, these information systems are designed to support continued and integrated healthcare services [1]. The information systems are additionally expected to assume a longitudinal form, i.e., to contain long-term patient data while delivering comprehensive functionalities regarding the management of health events and care from diverse service providers and institutions.

The healthcare sector consists of a diverse set of stakeholders, ranging from private hospitals, independent clinics and individually licensed practitioners, to the

Government, research institutions of regulatory agencies. A requirement of contemporary Health Information Systems (HIS) is that they should integrate the operations of these stakeholders in a way that guarantees efficiency and security [13]. This effort requires a guiding framework which can be used by individual players to create their information systems and software. It can be expected that such coordination will facilitate greater integration between all stakeholders, be they large or small.

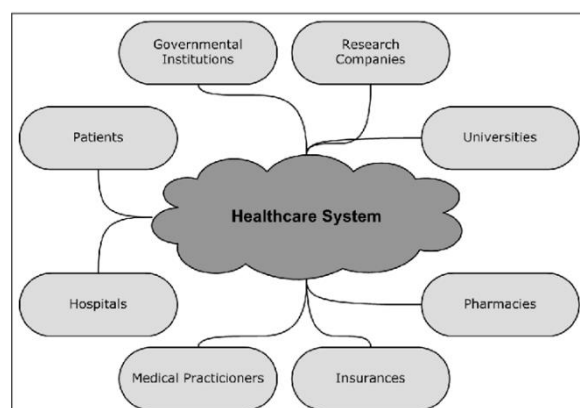


Fig. 1. An illustration of stakeholders in the

healthcare sector [10]

The National Health Insurance House (NHIH) is one of the organizations tasked with regulating the quality and access to healthcare. The organization regulates an industry comprised of a diverse group of service providers in terms of scale and types of health services they offer. It thus requires an information system and technologies that can consolidate the data derived from a broad number of channels. Other agencies with different roles within the healthcare sector often have their independent information systems. However, it is possible that the information collected and produced by the NHIH may also be useful to these organizations. The NHIH may also need to acquire information from the other agencies within the healthcare sector. The increasing connectivity between these agencies validates the debate regarding standards that should be employed in designing the software used by the NHIH and how such standards should be managed. Adopting open standards is the most appropriate approach, as open standards are managed by the community of users, developers, and stakeholder groups.

2 Public software used by aNHIH

In the contemporary operating environment, information systems are a critical component for any organization. The NHIH has a public-facing role that requires extensive environmental awareness and access to diverse data sources. For an information system to be fit for use in such areas of operation, it must be integrative in nature and contain elements that promote and maintain user engagement. These software systems must also maintain a high degree of transparency within the organization, while deriving support from the agency's management structures [8]. Moreover, the modeling strategy used in these information systems must also be accurate and clear. In most cases, the

challenges with the design and implementation of public software in such institutions also include budget and time overruns, as well as failure to deliver features that fully comply with required specifications.

The public software used by the NHIH is required to present comprehensive and updated sets of information to users. This requirement includes the facilitation and support of best practices within and outside the organization. These software applications are required to effectively help users and other stakeholders within the healthcare sector in comprehensively delivering their services and decision-making processes [18]. It can also be expected that the success of the public software used by the NHIH is dependent on its ability to flexibly serve the emerging needs of its users. The systems are required to accommodate future updates at minimal costs in order to serve the future needs and stakeholders who may come into the current operating environments.

Compatibility is a major requirement for software systems used by the healthcare agencies such as the NHIH. To enhance connectivity, stakeholders within the healthcare segment implement information systems that will require interfacing with systems such as those used by the NHIH. Similarly, the agency may also need to receive data feeds from other public and private information sources. This requirement can be effectively delivered by designing information systems that are compatible with the other systems [18]. The achievement of this objective is dependent on the ability of the organization and the stakeholders to use a common framework for design and system implementation.

3 Standardization Strategies

3.1 Using standards

Software systems are essential for the creation of patient-centric healthcare services and management. These systems are required to facilitate the formation of

effective health information networks and exchange of information among independent agencies, as well as stakeholders in the healthcare sector. Organizations such as the NHIH are required to create population databases that contain personal health records that can be used for effective health surveillance. Such systems have a broad range of applications from the delivery of social services to providing defense against bioterrorism. This segment of the paper evaluates the importance of standards in health information systems, the processes used in creating them, as well as how the management of such standards can be effectively achieved.

At the highest level, standardization of systems is considered an important step towards the creation of interoperable infrastructure. The NHIH is expected to handle large volumes of diverse data. This information will be subsequently applied to policy-making, partnerships, governmental and institutional decision-making, as well as accountability to the public. The nature of these applications demands that public software systems have interfaces through which partner and third-party systems can be connected without the need for further design reviews [11]. Interoperability allows other stakeholders in the healthcare sector to innovate and deliver services based on the data provided by the NHIH, while giving the agency an avenue to connect to other regulatory agencies and independent organizations in order to obtain data [5]. This level of communication is only possible if the associated systems operate on the same set of protocols and standards.

The design standards used in the software system have the potential to define how individual elements are designed and implemented. All concepts and applications in which data is used within the NHIH can thus be defined using a specific list of attributes which can be replicated at a future date. From these

basic definitions and the design rules outlined in a standard, the higher-order data structures, process templates and documentation processes can be defined. Affiliated stakeholders can then follow the same standards to design, build, and implement information systems that seamlessly connect to the software system used by the primary agency such as the NHIH. The use of standardized design processes creates the room for future innovations and development of the information systems.

3.2 Creating a standard

The creation and implementation of standardized systems is based on the operational imperative to interface systems made by affiliated stakeholders. The introduction of common protocols and operational procedures has been recognized and implemented in many industries, with its most evident benefit being the creation of diverse business opportunities. The standards to be created must have a direct benefit to the stakeholders involved in its creation [7]. The creation of standards requires the availability of technical expertise within the affected industry. In the healthcare sector, expertise on information systems is likely to be derived from the software engineering community, healthcare managers and regulatory agencies. The standards are thus expected to meet the information sharing and privacy requirements while delivering the highest levels of availability and security.

The creation of open standards requires a majority support within the community of stakeholders that the standards affect. The standard must effectively remain neutral in its technical features and must be passed through an open acceptance process. This process opens up the standards for additional support and implementation by stakeholders. Generally, applications and systems that require data sharing and communication are enhanced in efficiency through the implementation of a common standard. The four basic ways through which a standard

can be created are outlined below:

- A community of interested stakeholders convenes and designs an ad-hoc standard to be used to build varied independent systems.
- The government or a regulatory agency may conceptualize, design, and enforce the implementation of a specific set of standards.
- The economic aspects of an industry, such as competition and technological evolutions, may lead to a natural adoption of a specific set of standards.
- Standards can also be created through a formal consensus process between stakeholders through the mediation of a regulatory committee or agency.

4 Open Standards management

In the contemporary information systems, open standards are protocols for system design, implementation and documentation that are formulated and maintained by a majority of its users and stakeholders. There are open standards that are applied to hardware systems as well as those that apply to software products. The results of using these standards include the elimination of barriers to interoperability and the reduction of switching costs to the end users. Reduced switching cost means that users have a greater number of choices in their product selection [15]. Open standards consist of rules and design methodologies that are created or adopted by a majority of market stakeholders due to their popularity or efficiency. Therefore, there is no need for a governing body since changes to the standards are entirely based on the community consensus. Open standards are available to all the stakeholders free of charge and their modification is based on the community consensus [6].

4.1 User as developer (UaD)

Open standards in the software development process eliminate

restrictions on each of the stakeholders. This allows standardized methodologies and procedures to be implemented in the software product (Fig. 2) without any prior advantage to any of the other stakeholders.

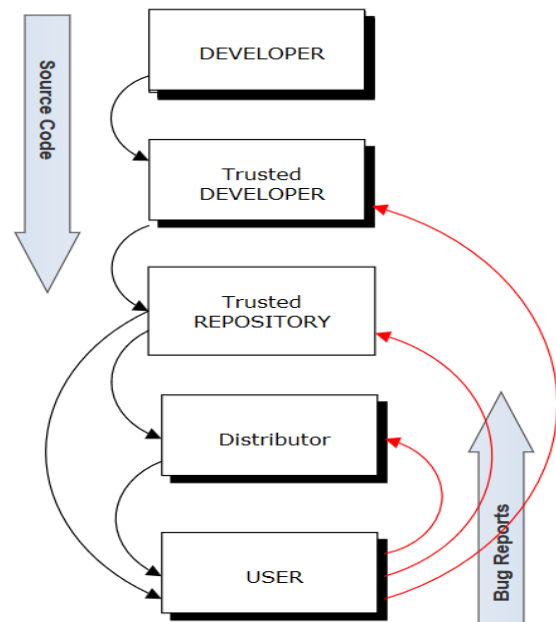


Fig. 2. Improvements (as source code and evaluation results for UaD diagram [2])

Thus, the key features of an open standard are listed below:

- The standard must be available for a full public assessment without placing any constraints on any party.
- It does not have components as well as extensions that are based or have dependencies on proprietary standards, i.e., components that do not meet the open standard requirement.
- It does not have technical or legal clauses that prevent its utilization by any party or environment.
- Further development and management of the open standards are done independent of any single party in a process that is fully inclusive of third parties and competitors.
- The open standard may be available in multiple complete implementations or one complete implementation to all the interested parties.

Open standards are promoted with the aim of fostering competition in the business

environment and to allow a diverse range of applications to interact. Open standards in the software development process enable sharing of data and functions in large systems regardless of the vendor or technical solution used in the individual components [11]. Open standards are required to be minimalistic, i.e., they should be as simple as possible. The minimalist nature of the open standards allows a large number of implementers and other stakeholders to participate in future developments and in the management of the standard. This is in contrast to proprietary standards that often include large numbers of features and components that are rarely used.

Software applications built using open standards, i.e., open source software (OSS) are those that any user can gain access to and modify the source code. The OSS include the license agreement that allows its users to access its source code, make modifications on it, and make new machine code, change any set of areas of applications, and redistribute the products [15]. This is in contrast to proprietary standards where a user can only execute the machine codes while source codes remain hidden or their modification being forbidden in the license agreements. Stakeholders in the software industry are advocating for the adoption of open standards through the Free Software and Open Source Software Movements. These movements are campaigning with a goal of providing developers and users with access to source codes and the freedom to redistribute software built on these standards.

The primary goal of the open standards movement is to shift the focus of competition from platforms towards their diverse implementations. This is based on the assumption that the open standards eliminate the barriers that prevent the entry of new players in any product or service segment. By focusing on the implementation of the same standard, the quality of the output, i.e., the product or

service is anticipated to grow continuously. Additionally, the competing players are limited to the implementation of the same sets of standards, hence they focus on elements such as efficiency and cost considerations. In this regard, open standards lay a foundation for sustainability in design and implementation of systems.

4.2 Open Standards as key feature

Open standards hand the purchaser the capacity to create a strong position. This is because the development process is focused on the user needs and availability of demand. The software development process under open standards can be accomplished by the users themselves or by the developers who wish to use it in their own creations. In this model, users do not have to depend on experienced developers who are likely to demand high costs for such a process. The accessibility of open standards means that individual users, enthusiasts, and inexperienced developers may learn and effectively build the intended product. Product specifications can simply be adapted to meet users' financial capacity and needs.

The use of an open standard eliminates the necessity of an existing market demand for the finished product as is often the case in proprietary systems. This allows for the development of information systems purely for strategic purposes without regard to its immediate financial returns to the organization. The open standards have the characteristic of involving users in the development processes. Developers can further engage the user community in determining the elements of a minimum viable product that can be used to test the usability, reliability, and even the security features of the information systems. Contributions from a community of users, developers, and regulators lead to a superior development process. In such a process, the quality of code and the security of information systems can be checked fast and cost-effectively. The use of an open standard attracts highly motivated individuals and groups to contribute towards system

improvement at zero cost in most cases. The use of open standards in the development of information system software taps into a large pool of community knowledge. Users, vendors, and other stakeholders have the capacity to suggest feature improvements and report errors in the operations of the product [9]. The large number of individuals and stakeholders vetting the source code and the product means that the operator of a system based on open standards has a large repository of quality feedback that can be used to strategically improve it over time. The cumulative learning process associated with communities working on open source projects leads to faster learning and improvement of the target systems or products. This is evident in some of the most popular software products and systems such as the Linux operating system and Android which have gained popular usage across the globe.

5 Advantages of Open Standards to the NHIH

The development of information systems often involves the allocation of large amounts of resources and the development of such systems is often time-intensive. It can thus be expected that the use of open standards and the developer communities that contribute towards their creation will save on costs and the time required to deploy the required system. The use of open standards will encourage the development of complementary and competing systems which further motivates innovation in the sector [19]. The net impact will be that users have superior information systems and access to efficient and reliable services. The use of open standards will also enable NHIH to choose components from a diverse range of competing implementations and, thus, guarantee that the most effective selections.

Healthcare agencies such as the NHIH

have large numbers of stakeholders and roles that are focused on delivering optimal service to the public. Software systems that are used to facilitate operations within the agency and communication to public stakeholders are required to be efficient and error-free. The use of open standards enables individual users and experts to identify software errors as well as possible fixes that may optimize its operation. Such a process using proprietary systems may be nearly impossible as users and the developer communities do not have access to source codes. Users and developer communities may also suggest new features that effectively improve the quality of service NHIH delivers to the public.

The use of open standards reduces the costs associated with developing and maintaining the software. The components and procedures used in developing open source software are continuously updated by the developer and user communities. Using the community feedback and input, the NHIH can reliably use a smaller team of core developers to build and improve the key features of the public software. The open standards also have forums in which vulnerabilities to software components are reported and the mitigation measures are proposed. The use of open standards will guarantee that the NHIH is consistently providing optimal security to its information systems especially with regard to personal data that it may need to collect from its users.

Open standards often have the requirement that the code base remains unchanged in form or structure. This sets a foundation for long-term continuity as technology evolves and users need change. NHIH is expected to serve its users for the foreseeable future. Therefore, the agency needs information systems that will readily incorporate emerging users' needs and technologies in the future. Evidence suggests that open standards have a high degree of flexibility regarding the incorporation of new innovations and components [3]. The updated documentation that accompanies

open standards also mean that the NHIH can deploy other teams of engineers to work on the platform in the future without dependence on the initial developers. The open standards also ensure that the NHA will have continuous access to quality feedback from the user and developer communities to develop a reliable and efficient information system.

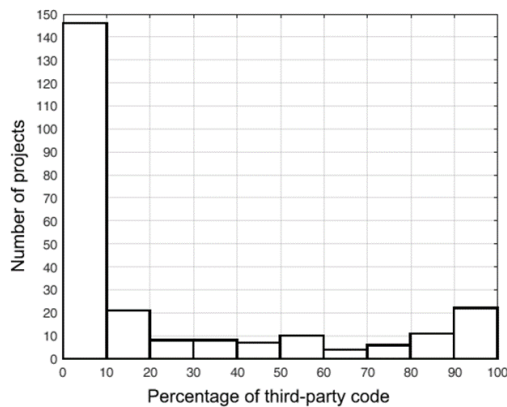


Fig. 3. Graphical analysis showing a high degree of compliance to open standards by stakeholders [14]

Open standards often have a high-level modularity which allows for the incorporation of new features and user needs. A public software used by an organization such as the NHIH is likely to be used by other stakeholders in the healthcare sector to deliver products and services. An example of this is the emerging popularity of connectivity and smart devices used in the healthcare sector. The service providers in these emerging segments, as well as traditional players which are currently digitizing, may need to interface their platforms to the NHIH's public information system [4]. The use of recognized and community accepted standards stands out as an important initial step towards ensuring that the NHIH can partner with the other organizations effectively in delivering healthcare services. The ease of interfacing to other information systems creates the opportunity for the NHIH to explore other commercial and noncommercial partnerships within the

healthcare sector and beyond.

One of the benefits of open standards is the large repository of information that is created and shared by the developer and user communities. The extensive volumes of information that are often available regarding the implementation of open standards reduce the learning time required by developers and users [12]. This effect also contributes towards increasing the amount of qualitative feedback received from the various stakeholders. The NHIH can also use the information on open standards to implement best practices, an approach that minimizes its cost of operating public software. These are features that align with the organizational aim of contributing towards improvements in patient care, enhancing efficiency, and minimizing costs related to its operations.

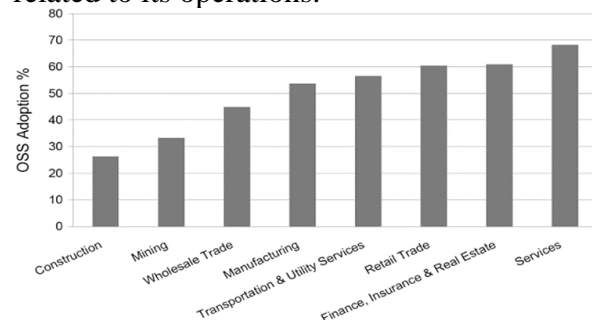


Fig.4 The general trend towards the adoption of open standards in various industries [16]

6 Disadvantages and barriers to Open Standards implementation

A major barrier to the adoption of open standards in public software within healthcare institutions such as the NHIH is the minimal understanding and familiarity with open source platforms. Healthcare institutions have traditionally depended on proprietary systems developed by contracted firms. Private organizations that offer software development services often use proprietary processes that do not conform to the open standards implemented in the broader industry. The implementation of the open standards in the NHIH will thus require the organization to develop its own capacity in terms of human resource or integrate into developer communities that

are working in no-related industries. However, this barrier is likely to be eliminated in the near future as open standards are gaining popularity in many segments of the information technology sector.

There has been a minimal commitment from the government in support of open standards adoption across its institutions and agencies. As a government agency, the NHIH is expected to follow the precedence set by other government departments and agencies. A majority of these institutions depend on proprietary systems both for internal use and in public services. It can be expected that there are powerful lobby groups comprising of proprietary system developers and vendors that depend on large government contracts. The fact that these proprietary system vendors have sufficient capacity and an established track record also minimizes the appeal of adopting open standards where human and resource capacity will have to be developed from the ground-up.

Critics have also argued that the total cost of ownership for a software product based on the open standards is higher than that of proprietary systems. The costs are associated with security considerations and investments in training [12]. The arguments citing security issues in the open source systems are based on the fact that all the stakeholders including hackers have full access to the source code of the software. These malicious agents can thus identify the points of vulnerability and exploit them before they are effectively fixed. The liability exposure of the organization may thus be increased by adopting a public software based on the open standards. However, counter-arguments have indicated that open standards encourage early detection of vulnerabilities and implementation of mitigation measures because of large communities of contributors that evaluate and test all the aspects of the source

codes.

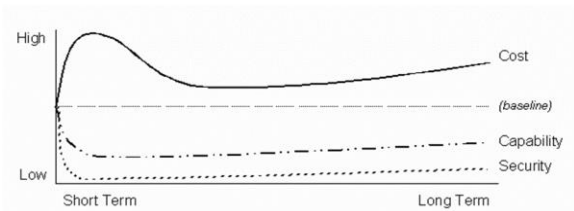


Fig. 5 An analytical illustration by the U.S Department of Defense showing an increase in long-term costs associated with proprietary software [17]

7 Conclusions

Health institutions across the European Union have a responsibility to upgrade their information systems to meet the emerging demands of the current environment. In this age of increasing integration, institutions such as the National Health Insurance House have to develop, implement, and maintain software systems that deliver information to the public and other stakeholders in the healthcare sector. The NHIH has the responsibility to share relevant information with the public and service providers such as hospitals, pharmacies, emergency health services, polyclinics and even the General Practitioners. These service providers also need the means to provide the NHIH with updated service and patient information all of which comprise the holistic service experience that the citizens of the E.U. need in the 21st century.

Information in the healthcare sector is currently generated from diverse sources by many stakeholders. Some of these stakeholders primarily operate in the digital space such as mobile health applications and telemedicine services. These digital services are mostly developed based on open standards and interfacing them to the NHIH information systems will require the adoption of a compatible development approach. The primary advantage of the open standards is interoperability. Innovators, developers, and service providers will have the access needed to develop services that align with the tasks that the NHIH expects to accomplish. The adoption of open standards not only aligns the organization to the general trend of

development in the current information systems industry but also actively promotes innovation in the sector that has both short and long-term benefits.

The NHIH needs to maintain efficiency in conducting its operation with the diverse group of service providers both in terms of scale and types of health services. It thus requires an information system and technologies that can consolidate data derived from a broad number of channels. Other agencies have differentiated roles within the healthcare sector and often utilize independent information systems. However, it is possible that the information collected and produced by the NHIH may be useful to these organizations. The NHIH may also need to acquire information from the other agencies within the healthcare sector. This mutual dependence and increasing connectivity illustrate the need for the open standards that should be used in designing software used by the NHIH. Such standards should be managed by communities of contributors and developers.

The development and use of open standards benefit from the fact that there is a large community of experts, users, and partner institutions that can contribute in the form of feedback and advice. This aspect of the open standard systems has been cited to result in systems that optimally meet the user needs and continuously improve to cover the emerging demands. It can be expected that the NHIH would have to evolve its services in the future to meet new demands from its stakeholders including hospitals, the public, and academic researchers. The organization can effectively prepare for this future by adopting open standards which are highly flexible because of the large communities that continuously contribute to developing them. The widespread availability of information relating to open standards also means that the organization will not have to invest large

volumes of resources in developing new standards for their software solutions or the carry out extensive research that is usually needed to continuously improve them.

References

- [1] Balgrosky, Jean A. "Essentials of Health Information Systems and Technology.", *Jones & Bartlett Learning*, 2015, pp. 172-178.
- [2] CIO U.S. DOD. "Open Source Software FAQ". *Dodcio.Defense. Gov*, 2018, <http://dodcio.defense.gov/Open-Source-Software-FAQ/> [Accessed 17 Apr 2018]
- [3] CIPPM, "An Analysis of the Public Consultation on OPEN STANDARDS: OPEN OPPORTUNITIES FLEXIBILITY AND EFFICIENCY IN GOVERNMENT IT", Centre for Intellectual Property Policy & Management (CIPPM), Bournemouth University for the Cabinet Office of UK HM Government, Centre 2012, pp. 1-83.
- [4] DeNardis L. "Opening Standards: The Global Politics of Interoperability", *The Information Society Series*. MIT Press, 2011, p. 75.
- [5] Garde, Sebastian et al. "Towards Semantic Interoperability for Electronic Health Records". *Methods of Information in Medicine*, vol 46, no. 03, 2007, pp. 332-343. Schattauer GmbH, doi:10.1160/me5001.
- [6] Hammond, W. Ed. "The Making and Adoption of Health Data Standards". *Health Affairs*, vol 24, no. 5, 2005, pp. 1205-1213. Health Affairs (Project Hope), doi:10.1377/hlthaff.24.5.1205.
- [7] HIQA. "Developing National Ehealth Interoperability Standards for Ireland: A Consultation Document." *Health Information and Quality Authority*, Dublin, 2011, pp. 1-27. [Accessed 15 Apr 2018]
- [8] HM Government. "Open Standards Consultation: The Government Response." UK HM Government, London, 2012, pp. 1-20. [Accessed 15 Apr 2018]

- [9] Jakobs, Kai. "Standardization Research in Information Technology" *Information Science Reference*, 2008, pp. 49-65.
- [10] Meier, Andreas. "Open Standards for Data Exchange in Healthcare Systems - Semantic Scholar". *Semanticscholar.Org*, 2007, <https://www.semanticscholar.org/paper/Open-Standards-for-Data-Exchange-in-Healthcare-Meier/4cca0cbb504341d276d9e8abc9249fbdabb1abaa>. [Accessed 17 Apr 2018]
- [11] Moahi, Kgomotso H et al. "Health Information Systems and The Advancement of Medical Practice in Developing Countries", *IGI Global*, 2017, pp. 33-77.
- [12] Reynolds, C.J, and Wyatt J.C. "Open Source, Open Standards, And Health Care Information Systems". *Journal of Medical Internet Research*, vol 13, no. 1, 2011, pp. 1-13. doi:10.2196/jmir.1521.
- [13] Russell, A. L. "Open Standards and The Digital Age." *Cambridge University Press*, 2014, p. 278.
- [14] Shah, A. and Abualhaol. I. "License Compliance in Open Source Cybersecurity Projects". *Timreview.Ca*, 2016, <https://timreview.ca/article/966>. [Accessed 17 Apr 2018]
- [15] Sittig, D. F. and Wright A. "What Makes an EHR "Open" Or Interoperable? Table 1:" *Journal of The American Medical Informatics Association*, vol 22, no. 5, 2015, pp. 1099-1101. *Oxford University Press* (OUP), doi:10.1093/jamia/ocv060.
- [16] Spinellis, D. and Vaggelis G. "Organizational Adoption of Open Source Software". *Journal of Systems and Software*, vol 85, no. 3, 2012, pp. 666-682. Elsevier BV, doi:10.1016/j.jss.2011.09.037.
- [17] The MITRE Corporation. "Use Of Free And Open-Source Software (FOSS) In The U.S.Department Of Defense". *Terrybollinger.Com*, 2003, http://www.terrybollinger.com/dodfoss/dodfoss_html/index.html. [Accessed 17 Apr 2018]
- [18] Wager, K. A. et al. "Health Care Information Systems" *Wiley*, 2013, pp. 312-340.
- [19] Weston S. and Kretschmer M. "Open Standards in Government IT: A Review OfThe Evidence" UK HM Government, Bournemouth, 2012, pp. 1-62. [Accessed 15 Apr 2018]



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