Exploring the Emergence of Open Platforms in Healthcare: Design Considerations and Experiences from an Initial Case in Norwegian Primary Care

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Abstract

Despite significant efforts on improving interoperability of health information and lowering socio-technical cost of replacing clinical applications, healthcare organizations and professionals struggle with fragmented and non-interoperable Health Information Technologies. This paper describes the emergence of open platforms, which may alleviate challenges related to interoperability issues, weak integrations, siloed data repositories, and numerous legacy systems within healthcare. Using a proposed platform initiative in Norway, we explore the open platform phenomenon with a socio-technical lens, and highlights four key topics that have produced tension and merits consideration from the involved stakeholders: i) Procurement strategy and vendor neutrality, ii) Ability to facilitate flexible use, iii) The use of standards and separation of data and application, and iv) Strategies for development and governance of standards. We further discuss the related implications and design considerations necessary to support complex patient pathways and provide clinicians more flexible and effective systems.

Keywords: Open platform, digital ecosystem, flexibility, electronic patient record, interoperability

1. Introduction

Traditionally Health Information Technology (HIT) is built using primarily proprietary technologies, with technical standards developed, controlled and maintained by the vendor (Malm-Nicolaisen, Pedersen, et al., 2019). Consequently, organizations become heavily reliant on single vendors and siloed 'closed systems' with limited flexibility and a fragmented HIT portfolio (Koppel & Lehmann, 2015). This situation is driven forward also by the heterogenous nature of healthcare work and a strategy where clinicians and vendors designed separate non-interoperable systems for various diseases and disciplines (e.g., radiology, labs, oncology etc.). A key challenge of the rigid portfolio of siloed systems arises when clinicians need to share information and data across applications, specialties, and organizational borders to support comprehensive patient pathways (Bernstam et al., 2022).

The use of open digital platforms for transforming an organizations' complex portfolio of silo HIT systems towards shared digital platforms, represents a new paradigm for the healthcare domain (Bygstad & Hanseth, 2018; Islind, 2018). In the Norwegian public healthcare sector, there is a proposed large-scale project intended at developing a shared national HIT platform, Akson, described to be an 'open platform' in official project documents. Akson stems from the realization that the proprietary and siloed nature of the services' HIT portfolio today, is a hindrance for efficiency, interoperability, and quality in healthcare delivery. The aim of introducing a platform approach, is to establish a more adaptive HIT infrastructure, where clinicians have greater access to decide what applications that best suits their local setting, and the flexibility to change technology according to the heterogeneity of healthcare work. However, based on the proposed architecture and description of the Akson platform, debates surrounding the concept of open digital platforms have developed, and critiques question the potential for flexibility Akson can provide.

Research on open digital platforms has in recent years gained growing interest within the Information Systems (IS) domain, but the relative low maturity of the open HIT platform market limits opportunities for real-world case sampling, and sector-wide open platforms are yet to be successfully implemented in healthcare (Furstenau & Auschra, 2016). Consequently, previous studies on open HIT platforms are often limited to specific technologies, such as mHealth or IoT,

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(see e.g. (Estrin & Sim, 2010) and (Miranda et al., 2016)) or specific disease and use-cases (see e.g., (Rivas et al., 2014)), with some exceptions (e.g., (Fürstenau et al., 2019) and (Rolland et al., 2018)) investigating more comprehensive open platform instances. Further, as healthcare represents a highly regulated market with unique organizational structures and social policy conditions influencing design and implementation strategies, case studies face the limitation provided by their specific context. Altogether, this argues for continued efforts on case studies in diverse settings. Although in its infancy, Akson represents a highly ambitious HIT initiative worth investigating. Thus, with the intent of contributing to a growing body of knowledge on open platforms, the purpose of this paper is to provide empirical insight into the concerns and conflicts emerging from the Akson case, involving a proposed sector-wide open platform initiative in a heterogenous healthcare context.

Theoretically, we apply a socio-technical viewpoint and build on literature on platforms and standards from the IS domain, which has frequently been used to characterize and analyse large-scale HIT instances, and provides an apt theoretical lens for investigating the complexity and heterogeneity of healthcare.

The aim of this paper is: i) A critical assessment of the proposed architecture of the open platform case, as well as the professional discourse concerning the traits and attributes of the platform. We put a specific focus on the design of the platform and use of standards, and their potential implication for flexible future use. ii) A synthesis containing key considerations on a set of open platform aspects that may be considered by stakeholders in the process of designing requirements for a open HIT platform. The study resides within a longitudinal research portfolio following the strategic development of shared large-scale HIT in Norway and related standardization processes.

The rest of the paper is organized as follows. First, we present the relevant literature and the theoretical perspectives. In section 3, we describe the methodology applied in the present study. Section 4 presents the Akson case and empirical findings. In section 5, a discussion emphasizing on identified areas of conflict and concerns regarding strategic design decisions and potential implications is presented. Last, we conclude and introduce future scientific avenues for exploring the topic.

2. Theoretical background

Today, healthcare work is dependent on, and supported by, numerous special-purpose applications. Often, these application portfolios are characterized as being fragmented and silo-oriented, necessitating clinicians to enter the same data in several systems or accessing multiple applications to retrieve information due to limited data interoperability. The lack of interoperability has forced major efforts to integrate HIT systems to each other to support the heterogenous user base and socio-technical workflows. While integrations have been able to address important aspects in this regard, it has at the same time introduced new challenges by increasing the complexity and dependencies between socio-technical systems and multiple local settings (Ellingsen & Monteiro, 2006). Integration of new applications and services have therefore become costly and resource-demanding on both organization and healthcare professionals, and flexibility and interchangeability of applications remains low (Roland et al., 2017). Open platforms are emerging as a new approach for digital infrastructures to mitigate these challenges in the healthcare domain (Benedict et al., 2016). Open platforms can be considered from multiple perspectives; either as a more technical concept as specific system development architectural patterns, or from a functional perspective, where the platform serve an intermediary function between actors interacting on a common platform (Tan et al., 2015). These perspectives are similar to those Gawer (2014) present in a review of platform literature; *the economic perspective* that describes platforms as intermediaries that connect categories of users that else would not connect, and *the engineering perspective* that consider platforms as technical artefacts composed of a modular architecture. However, both of these perspectives have limitations; while the economic perspective lacks an emphasis on the technical architecture and fails to consider how platforms interact with the surrounding context, the engineering perspective offers a view of platforms as relatively stable architectural structures with limited focus on how the platforms evolve within organizations (Vestues & Rolland, 2021). The platform ecosystem stream and socio-technical perspective, views the platform as a set of shared core technologies and standards underlying the surrounding organizational field (Thomas et al., 2014; Tilson et al., 2012). In this study, we adopt this perspective, and consider that the platform is all the technical elements of software and hardware, and the associated organizational processes and standards, and function as an intermediary that support the transaction between different user groups (De Reuver et al., 2018). User groups here refer to the supply-side users (i.e., complementors who provide applications) and demand-side users (i.e., end-users that consume what complementors provide) (Benedict, Herrmann, et al., 2018). Within this understanding, we specify an *open platform* to include that the platform have well-defined, published interfaces that allow interconnection and use

in ways other than as originally implemented or intended, and that complementors can expand the functionality without modification to existing components (Estrin & Sim, 2010). Based on a yet only planned platform case, our focus in this study is the emerging conflicts and concerns stemming from the described openness of the platform. Within the socio-technical perspective, we consider openness primarily in relation to the design of Akson, and how it is *"partitioned into a relatively stable platform and a complementary set of modules that are encouraged to vary"* (Tiwana et al., 2010, p. 676). This implies a modular architectural model consisting of a stable *platform core* and a flexible *platform periphery* connected through *boundary resources*, such as standardized Application Programming Interfaces (APIs) and governance measures. In addition, we therefore consider openness of standards (i.e., interface standards and data content standards) as they impact both complementors ability to interact with the platform (and exchangeability of applications) and the interoperability between applications (Benedict, Kosmol, et al., 2018; Benedict et al., 2016). To develop our theoretical background, we build on Ghazawneh and Henfridsson's (2013) platform concept model as illustrated in Figure 1.

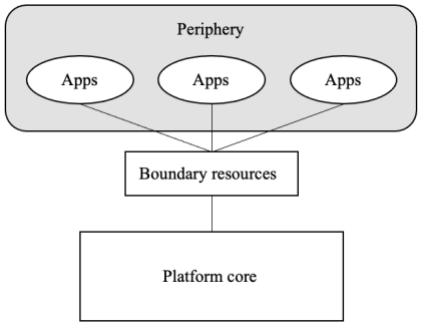

Figure 1. Platform concept model.

Complete openness in open platforms is rare, with the often-applied examples of Linux and open-source communities as exceptions (Furstenau & Auschra, 2016). More common is a *degree* of openness within different platform components. As an example, the now decommissioned Microsoft HealthVault provided access for third-party app developers (complementors) through open boundary resources while still maintaining control over the platform core (Van Gorp et al., 2014). A recent example that offers even larger degree of openness is the HIT platform provided by the HiGHmed consortium (see e.g., (Haarbrandt et al., 2018)), where in addition to open interfaces, all system specifications and data content models (e.g., Clinical Information Models) are made public.

This approach enables multiple complementors to contribute and populate the platform with services, functionalities and applications, so that there is a many-to-many substitutability, without necessitating changes to the platform core (Eisenmann et al., 2009; Gawer, 2014). Prior studies that have investigated openness from the supply and demand-side perspectives argue that on one hand, a platforms' attractiveness for end-users is heavily dependent on the availability of complementary applications, while the value for the complementors to contribute to the platform is reliant on value appropriation and recognition (Benlian et al., 2015; Broekhuizen et al., 2021; Kapoor et al., 2021). This illustrates the purpose of a platform to bring together different stakeholders and facilitate reciprocal value creation, known as network effects. A key concept is to match the participating stakeholder groups so that they are mutually attractive, such as the usefulness of a specific clinical application for a specific group of healthcare personnel. The platforms ability to attract users to adopt new technology, is a challenge that is highly dependent on the ability to design and integrate functionality that addresses actual user needs (Grisot et al., 2014). Likewise, complementors and developers are interested in interfaces and boundary resources that enables more effortless integrations than what often is the case today. The use of open health information standards and structured data format (e.g., openEHR, LOINC and HL7 FHIR) are, with their common language, designed to define a standardized way of how healthcare data should be structured and communicated. These standards and technologies can provide increased capabilities of application exchangeability and semantic interoperability when data is exchanged between applications and across organizational borders (Attallah et al., 2016).

Yet, standardization work is prone to produce tensions between the involved user groups; while a standard developed for one local setting might suit their specific context, it can produce constraints when introduced in another. As future user requirements from the platform usually are unknown, the potential for interoperability and flexibility becomes an important aspect of openness (Benedict et al., 2016), and necessitates the need for standards that can accommodate yet unknown changes and patterns of use. However, openness does not alone represent a 'fast-track to salvation'; decisions should be carefully considered on a case-by-case basis and based on the context the platform exist in; too much openness may result in a large degree of unwanted variation, while too little openness can reduce innovation and adoption (Boudreau, 2010; Nambisan et al., 2018). In their investigation of implementation and scaling strategies for open HIT platforms, Fürstenau and Auschra (2016)

highlight this tension within the highly regulated healthcare domain; while opening platforms for complementors increases the probability that others will build services on the platform, it does at the same time limit control for platform owners, potentializing challenges to comply with institutional requirements, standards, and laws. Hence, the chosen openness approach (e.g. type, degree) may affect innovation and adoption rates, and therefore represents a key strategic consideration for platform providers.

3. Methods and research approach

Empirical methods that focus on human interpretation and meaning is increasingly adopted by IS researchers. Interpretive research aims at understanding human thought and action, and is particularly suited to investigate a phenomenon from the participants perspective within their particular social and organizational settings (Myers & Klein, 2011). The present study is therefore positioned within the interpretive research paradigm, and employs a qualitative approach consisting of semi-structured interviews and document reviews. We first performed extensive document review related to the development and process of Akson. Project documents, including technical descriptions, architectural design, and concept evaluations, were retrieved from the project's website. In instances where documents were exempt from public disclosure, they were obtained through direct contact with the Directorate for e-health. In only one instance were our request for a document denied, despite none of the authors having affiliation to the Akson project. These documents have been extensively used for building the case and background description. There have been a substantial public debate surrounding Akson, including several debate articles, news articles and webcasted debates. These sources have been used to further build the case and background, in addition to inform the development of the interview guide.

Five HIT domain experts and eight clinicians, in total 13 informants, were interviewed. The domain experts were recruited based on their connection and presumed knowledge about HIT in general and Akson specifically. Two of the respondents (I1, I2) had backgrounds from HIT research, while the other three (I3, I4, I5) had backgrounds from HIT development, governance, and decision-making in the public sector. These three had been involved with Akson as municipal representatives. All domain experts were contacted directly and agreed to participate when invited. The eight clinician informants consisted of nurses (I6-I12) and one physician (I13) working within the primary care sector in one Norwegian municipality. Some of the clinicians had participated in workshops regarding Akson, while others had limited knowledge of the process. Municipal healthcare professionals were chosen as they worked in the setting which Akson was intended for, and were recruited by assistance of their manager on our request. Two semi-structured interview guides, one for domain experts and one for clinicians, were developed through an iterative process between all authors and based on the document review. The interview guides were designed to guide the conversation towards the topics of relevance for this study, while allowing the interviewees to expand and introduce new themes. Questions for the domain experts were related to digital platform and openness in general, and specifically design and prerequisites of HIT platforms in the context of Akson. This included the distinction between platform core and periphery, the role of open and proprietary standards and information models, challenges in (open) platform implementations, role of vendor diversity, and challenges faced today. For the clinicians, we focused on clinical workflow and patient pathways, including challenges in daily work inflicted by their current systems, experience with system implementations, and what flexibility in system use they experienced to have. In addition, we were interested in if, and how, they perceived Akson to address these challenges, and what expectations or concerns they had. All interviews were conducted between March and June 2019, and lasted between 60-90 minutes. The interviews were audio recorded and subsequently transcribed verbatim.

The qualitative interview data material was analysed using a simplified procedure of the Framework method (Gale et al., 2013), consisting of three steps. First, the authors reviewed the interview data to familiarize with the material and develop preliminary codes. At this stage we used an inductive approach of open coding, were we developed and applied codes derived from the text, allowing us to discover emergent concepts and their properties (Blair, 2015). The second step consisted of revising and negotiating the proposed codes. This process also included grouping similar codes together and clearly defining them into a working analytical framework that could be applied to passages of text in the transcripts. Finally, when all meaningful passages of text were assigned a code (e.g., 'present challenges', 'data standards and governance', 'skepticism towards Akson') and categorized (e.g., 'Heterogeneity', 'Lock-in', 'platform design'), the material was theoretically thematically analysed (Braun & Clarke, 2006). In addition, we supplemented the analysis with project documents and to gain the best possible outline of the process. This resulted in a synthesis that are presented as four highlighted areas in the discussion.

4. Case description and findings

For primary care, the proposed 2019 HIT initiative Akson, headed by the Norwegian Directorate for E-health, was designed to address national aims of increasing accessibility and usability of HIT and patient information. In line with increased demand for customized and more efficient solutions for the planning, administration, direct patient work, documentation and coordination of health care, Akson was designed provide a shared HIT platform, including a longitudinal EHR, for the whole primary care sector, including GPs (Direktoratet for e-helse, 2020a). Consequently, the proposed Akson platform, which is still in the planning process, contains significantly more functionalities across a broad spectrum of domains than any single HIT used today. For the primary care sector, this entails that the shared EHR will provide functionalities and features for 150 000 healthcare professionals across 16 different clinical domains in 291 municipalities. As of writing, 185 municipalities have signaled that they will support the further work by signing a non-binding declaration of intent.

Following the publication of the project documents and the presentation of Akson, a significant public debate related to terminology and concepts emerged, specifically the use of 'open platform' – a descriptor frequently used by the Directorate for E-health about Akson. Akson has received substantial criticism for the proposed architecture, and critics have questioned whether the operationalization of an open platform actually is realistic based on the directorate's concept (Bygstad, 2020a, 2020b). Key objections are related to the fact that both the platform core and the key application (i.e., the EHR) was to be acquired from the same vendor within a single procurement.

4.1 Potential for vendor diversity and fear of lock-in

A number of professional actors in the sector have communicated skepticism towards Akson; The Norwegian Medical Association, The Norwegian Union of Municipal and General Employees, and The Norwegian Dental Association does not support the project due to the strategy of procuring both platform core and EHR from the same vendor, as illustrated by a quote from their joint statement: *No other (HIT) vendor can therefore compete to integrate their solutions after the main provider has been given the entire assignment* (Finstad et al., 2020 p: 1). The proposed procurement strategy also yielded responses from several Norwegian HIT vendors, ranging from skepticism to statements containing notifications that they would not be competing in any bid for tender (Brandsæter, 2019; DIPS AS, 2019; Mørne, 2020). The vendors struggled to identify a potential place for them given the planned architectural layout and procurement strategy. *"I think the vendors are worried about the approach with one major vendor in Akson, which to me is understandable. They (the Directorate for E-health) need to be more transparent and clearer on the role of different vendors in the ecosystem"* (I1). Between 2018 and January of 2020, the Directorate for e-health conducted two open dialogue meetings with the vendor industry to mend the impression of a one-vendor-platform. However, without changes in the proposed architecture and procurement strategy, these meetings did little to change the stance among the vendors, and the general critique remained the same (Syversen, 2020).

The potential for Akson to result in a one-vendor platform raised the pressing question of how Akson could alleviate the challenge of vendor lock-in experienced in municipalities today. *"One of the major obstacles for innovation in the municipalities today is the vendor lock-in, that makes the process of replacing systems so cumbersome that they rather postpone it for the longest time"* (I3). The costly and complex operations to *replace* systems resulted in clinicians being forced to use old and sub-optimal applications, but the challenge of vendor lock-in extended also to the processes of having *adaptations* made in existing systems. A nurses expressed frustration after having attempted to get the current vendor to add functionality: *"You got to remember, our municipality is a very small customer (to the vendor), so it is very challenging to get them to make any changes"* (I9). The current lock-in situation was less evident amongst GPs, who in Norway are self-employed and more independent in choice of HIT. One of the informants, having previously worked as a GP, stated that *"Most of the GPs are pleased with their EHRs – because they can replace them if they are not"* (I13). The fact that GPs in general was more pleased with their systems was linked to their possibility to replace systems with relative ease, and therefore skeptical to support Akson.

4.2 Heterogeneity in user base and clinical work

The platforms' ability to support existing and future participating actors and emerging user needs was argued to be paramount for its success by multiple informants. The connection between how appropriate an application is in relation to the workflow it is intended to support was further highlighted; to have several competing vendors have been an argument for mitigating this challenge. One informant stated: *"In my opinion, the smaller vendors are better at understanding this context than the large vendors that aim at covering a lot of user*

needs and domains. This results in a disconnect between what the vendors can deliver and the context they are delivering it to" (I1). The concern of a one-vendor scenario was shared also by the clinicians, as illustrated by a physician: *"I imagine that if we continue on this path (Akson) we will get a 22 billion EHR that is good for the nurses, but how they will get the GPs to use it is for me a mystery"* (I13). Patient trajectories within municipal care services are complex and include different and separate actors, each with differing HIT requirements and needs. Knowledge about clinical workflow was therefore described as a prerequisite for designing systems, and they experienced that this perspective was absent in the Akson process. *"To understand the difference between a physician EHR and a nurse EHR, that is the challenge"* (I13). When directly asked about the potential for one common and shared EHR, one informant responded with a rhetorical question: *"One EHR designed for whom?"* (I9). None of the clinician informants expressed enthusiasm over the thought, and described that the heterogeneity and different system needs among healthcare professionals were too large to be supported by one single EHR system.

4.3 Platform core and standards as factors for flexibility

Several of our informants stressed the fact that the platform core should be compact, and that user functionalities and applications should populate the platform outside of the core: *"The central core should consist of two things, namely something that dictates how data is transferred and exchanged, and mechanisms for access control and authentication"* (I4). The platform core both enables and constrains the potential for future innovation and technological development, and dictates to a substantial degree the opportunity to replace applications more seamlessly than today. However, considering the continuum between a minimum platform core and a maximum platform core, it is not obvious what exactly the core should contain. One informant describes this challenge: *"If you have a minimal platform core, you can in theory have several vendors of EHRs. You do not have to procure a system from only one vendor – in principle you can procure from multiple vendors, or at least replace systems"* (I2). While the architectural blueprint for Akson describes a compact platform core (Direktoratet for e-helse, 2020b), concerns about the feasibility of this was questioned due to the procurement strategy, and that this introduces the risk that the EHR vendor can de facto dictate data formatting rules for the whole ecosystem.

Several informants also emphasized the ability to use the systems in different ways depending on local context and specific use-cases as imperative. One informant argued that data-application separation was a prerequisite for such flexibility: *"In an open platform, you have a greater opportunity to say "(major vendor) should no longer have a monopoly to deliver this specific functionality". There can not only be others that can deliver the functionality, but they can do it simultaneously and the vendors can compete. The redemptive factor is that the data the different vendors and applications produce gets stored in the same, standardized database separated from the application that produces the data"* (I5). The Clinical Information Models (CIMs) play a central role in this context: "*It (the platform) should provide standards, and especially a common language, so that an apple is an apple for both a physician at the hospital and a nurse in the municipality. A way to ensure that they are talking about the same thing"* (I3). The informants describe that the current situation in municipal HIT is characterized by the simultaneous use of several vendor controlled CIMs, requiring work to make them interoperable. Several informants raised concerns about the lack of governance structures that could support this approach in a shared, national HIT platform, highlighting one of the major critiques directed towards the project. One respondent working with municipal HIT described the challenge: *"It is important to separate data from the applications, but how and where should the data be stored? Today we have 400 municipalities that each have their own databases, and we cannot even agree on a structure internally in my municipality"* (I3). The Norwegian directorate for e-health have made several attempts at standardizing the use of clinical data standards and APIs, but it is unclear how this process is planned in Akson. Further, the use of open and common data standards and CIMs have yet to be thoroughly incentivized, resulting in low adoption from the established vendor market.

5. Discussion

The assessment for the Akson case, and the implications for future use, indicate that an open HIT platform arguably should facilitate flexibility and evolvability over time. This is important as the platform represents a part of a non-static HIT ecosystem expected to change over time. The modular architecture of the platform should allow for applications to be exchanged in line with newly arising needs, e.g., the organization and users have greater access and flexibility to integrate with vendors and applications that are a better fit, in order to support the heterogeneity of healthcare delivery and individual patient pathways (Boudreau, 2010). The

possibilities of positive network effects also increases by utilizing an architecture that facilitates innovation, dynamic development and implementation of applications that focuses on addressing users' specific problems and providing immediate usefulness and flexibility, both to change the platform and in the pattern of use (Grisot et al., 2014). Within the context of healthcare, the importance of flexibility in system use is made relevant by the heterogeneity of the sector and user groups with different, and often diverging interests (Ulriksen et al., 2017). As a synthesis of the theoretical perspective and empirical findings, we indicate four areas of concern that emerged, and that can be considered by stakeholders when designing the requirements for a HIT platform.

The first identified area of conflict relates to **the procurement strategy and potential for vendor neutrality** provided in the Akson case. These concerns are multifaceted and shared between multiple stakeholder groups; Akson received substantial criticism for the proposed strategy of acquiring too large parts of the platform from the same vendor, mitigating the potential complementors' access to the platform. The proposed Akson platform model, as we illustrate in Figure 2, therefore differs significantly from the traditional model (Fig. 1) characterized by a distinct platform core and periphery, and lies closer to that of a silo-oriented platform architecture (Hanseth & Bygstad, 2018), challenging the claim that Akson is indeed an open platform. The inclusion of a strong vendor presence in the platform core is likely to introduce both technical and organizational dependencies, and create an unclear ownership over fundamental platform components. The proposed architectural model will therefore limit the innovation on the platform to the internal ability of innovation in the main provider.

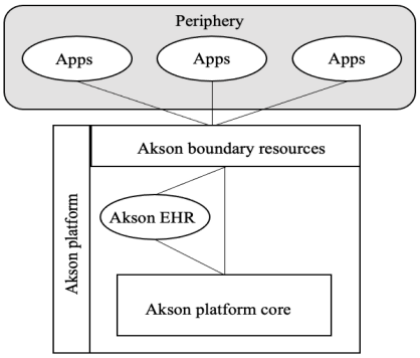

Figure 2. Akson platform model.

The platform architecture thus represents a significant governance measure, as it regulates the balance of control and autonomy between platform owner (i.e. platform core) and the third-party complementors (Ghazawneh & Henfridsson, 2013; Nambisan et al., 2018). Opening specific peripheral components of the platform is also a way for the platform owner to attract complementors without giving up all control (Boudreau, 2010). Allowing for multiple complementors to deliver functionality can incite competition and innovation on the platform, and flexibility to efficiently address new purposes and emerging user needs. Vendor neutrality also facilitates for flexible compositions of applications to increase experienced usefulness and stimulate value creation for both users and complementors. While Akson attempted to manage the relationship with stakeholder groups (e.g., meetings with vendors) they failed to resolve the tension towards the potential complementors and gain legitimacy in the community, reducing the potential to trigger future network effects. The procurement strategy and platform design extended also to healthcare professionals as potential future end-users, who were concerned about **the platforms ability to facilitate flexible use**. Especially highlighted was a concern and skepticism towards the concept of one EHR for all users, and the informants worried how it would inscribe fixed patterns of use. Akson is intended for a heterogenous user group and numerous use-cases, which requires both standardization and flexibility to be able to scale and promote growth, and ensure the capability for users to adapt the platform according to local requirements (Ellingsen et al., 2014; Ulriksen et al., 2017). For shared large-scale platforms, as the case in the present study, the platform's ability to facilitate efficient and appropriate services is arguably essential for stimulating network effects. The heterogeneous nature of healthcare can therefor create tension when a system which is made to fit with specific local practices are to support integration across several other local practices. The design of standards for one local setting can thus affect the introduction of the system in another, and imposing "order" in one local setting, can produce disorder in another setting, for other users (Ellingsen & Monteiro, 2006). This calls for flexible standards that allows for local adaptation and difference in use based on context and use-case, while still ensuring data interoperability across the platform, and can contribute to lowering the socio-technical cost of replacing applications (e.g., data migration).

In extension of the above, the third area of concern that emerged relates to **the use of standards and to separation of data and applications**. Earlier open HIT platform studies have illustrated that platform providers productively can engage the wider ecosystem through endorsement of open standards (Fürstenau et al., 2019), and that this approach potentially mitigates concerns of lock-in, and may enable potential network effects for other users (Furstenau & Auschra, 2016). The Akson architectural blueprint does reference the use of open

API, and specifically the HL7 FHIR API. This interface standard has achieved significant momentum within the vendor industry, but challenges of common adherence to specific data formats and standards, including a lack of consensus on how and when different standards should be used, is identified as a major hindrance for interoperability today (Attallah et al., 2016). As expressed by the informants, the concern of standards moves beyond the point of interfaces, and includes standards also for content representation (i.e., CIMs). These models should facilitate flexible use depending on contextual factors and specific use-cases without ambiguity when data and patient information is transferred between applications. Argumentatively, in an *open* platform, applications should share open information models in a way that preserves the semantics in the data. This is essential as clinical and patient information often exist as dynamic and changing data elements. As emphasized by several of our informants, the separation of data and application is key measure ensuring longevity of data and reduce lock-in scenarios. We find that the proposed architectural and procurement strategy for Akson would complicate any attempts to create a meaningful separation between data and application, as shown in Figure 2, and in extension mitigate the possibility for vendor neutrality. Storing data in a separate and extensible data layer ensures persistence and is an important factor for realizing semantic interoperability. The modular platform architecture allows for standardization of core components that can be kept stable, while peripheral changes can be made without implications for the platform and ecosystem as a whole (Hanseth et al., 2012; Parker & Van Alstyne, 2018). Hanseth et al. (2012) note that since the platform is not optimized for any single application, but rather open and inviting to unexpected and unforeseen growth, innovations are possible without requiring changes in standards. This relationship can, however, possess a bidirectional effect; as standards provide a platform for innovations, the innovation process itself may drive the need for new standards.

Strategies for development and governance of standards therefore becomes essential, and represents the fourth area of concern. The disparity between the necessary standardization work and the lack of related governance models, including the complex longitudinal maintenance throughout future iterations and updates, poses a significant challenge. Efficient use of standards, such as CIMs, depends on sufficient governance and development models; the same clinical concepts may be modelled in different ways, each of which correct (Oniki et al., 2014). Our findings illustrate that the challenges of normalizing data from different sources to facilitate (semantic) interoperability is a concern, and is not addressed sufficiently in Akson, nor does it exist any strategy for mandating use of (a) national CIM(s). The concurrent use of differing CIMs therefore underpins the need for proper governance models for management and control of the technologies (Malm-Nicolaisen, Ruiz, et al., 2019). Experiences from earlier attempts at creating mappings between different CIMs has proven difficult, and the complexity rises as the number of different standards increases (Marco-Ruiz & Pedersen, 2017). Other studies of the consensus driven processes of developing openEHR Archetypes, and the mapping of existing archetypes towards the biomedical terminology SNOMED-CT, indicates the granularity and time consumption of governance work to be performed on a national level, also to secure the involvement of clinicians in these processes (Ulriksen et al., 2017). Standardization work is therefore dependent on the standards ability to account for local adaptation and manage the inherent tensions produced when transforming clinical work practice. One method to mitigate these challenges within HIT development, has been an increasing emphasis on user-driven standardization processes. A fundamental aim of the user-driven approach is to empower clinicians, as domain experts, to define and adapt the way clinical data and workflows are standardized, such as the case with development of openEHR Archetypes (see e.g., (Abril-Gonzalez et al., 2017)). However, clinicians consist of heterogenous actors, often with diverging interests and needs. User-driven standardization therefore requires substantial and complex negotiations regarding clinical content, semantics, terminologies, and technical aspects to reach consensus. Nevertheless, this approach has illustrated the importance of involving clinicians and users to achieve flexible and adaptive standards, integrations, and HIT systems. From a socio-technical perspective, standardization can be perceived as a process of closure, stabilization, and alignment of both technical aspects, such as data modelling, and work practice adaptation (Ulriksen et al., 2017). Knowledge of workflows and clinical practice, and the standards inherent flexibility, therefore stands out as a prerequisite for usefulness in HIT applications.

6. Conclusion

Using a proposed HIT initiative in healthcare to empirically investigate open platforms and heterogenous stakeholders, the paper provides insight on key areas that has resulted in tension and conflict. Given the increased ambitions of interoperability, standardization, and flexibility, it is crucially important to design well-functioning platform instances. Architecturally, we emphasize the importance of true separation between the platform core and platform

periphery as a measure to stimulate vendor diversity and adaptability of the application portfolio for local context and specific use cases, necessary for supporting heterogenous healthcare work and complex patient pathways. An often-seen challenge in HIT development is the rigidity and tensions created by socio-technical standardization. A way to mitigate these issues may be the use of open standards that to a larger degree can facilitate flexible and adaptive platforms. However, this requires user-led development processes and strategies for sufficient longitudinal governance, both of which have proven demanding. While our analysis revealed key areas that merits attention, they do by no means illustrate the complete picture, but are intended to highlight requirements that are characteristic and distinctive of an open HIT platform. Building on an established theoretical lens, the paper contributes to the diversity of case descriptions of open platform research within the IS domain. Although several challenges identified here have been described earlier in other cases, this study confirms their presence and continued topicality also in a Norwegian healthcare context.

Avenues for future research include a more comprehensive investigation of end-user involvement in diverse sector-wide platform development, for example in adoption and development of shared clinical standards, and the specification of functional platform requirements.

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