

The Knowledge of Implementation Strategies: Impact of the Installed Base

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Abstract. This study uses three case studies to investigate how the installed base affects Electronic Health Records (EHR) implementation in European hospitals: i) transition from paper-based records to EHRs; ii) replacement of an existing EHR with a similar system; and iii) replacing existing EHR system with a radically different one. Using a meta-analysis approach, the study employs the theoretical framework of Information Infrastructure (II) to analyze user satisfaction and resistance. Results show that the existing infrastructure and time factor significantly impact EHR outcomes. Implementation strategies that build upon the current infrastructure and offer immediate user benefits yield higher satisfaction rates. The study highlights the importance of considering the installed base and adapting implementation strategies to maximize EHR system benefits.

Keywords. Information Infrastructure, Installed base, EHR, Implementation

1. Introduction

Over the past 30 years, digital technologies, such as Electronic Health Records (EHR), has transformed the planning, deliverance, and organization of healthcare services. Despite policies and financial incentives to encourage adoption, the implementation and use of EHRs have been slow and the potential benefits, including increased safety and productivity, have yet to be fully realized. This is partly due to a lack of understanding of the socio-technical aspects, organizational readiness, improper implementation methods, and user resistance to new technology [1]. The objective of the present study is twofold. First, we present three European cases of EHR implementations to put focus on the effect of implementation strategies. The implementation cycles of the three cases differ, and represent outcomes on different stages of the timeline after going live. Second, we compare the three cases and critically evaluate the findings, contributing to the evolution of implementation theory. Our knowledge builds on previous studies in our research community and data from public implementation processes.

2. Method and theoretical background

This study uses a qualitative meta-analysis approach to analyze three previously published case studies [1-4] that examines healthcare professionals' experiences with

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new EHR implementations in hospital settings. Qualitative meta-analysis is an inductive research approach that summarizes findings across qualitative studies on a similar research topic [5]. Its aim is to provide interpretations, analysis, and synthesis of prior qualitative studies, to generate new insight and understanding of phenomena in specific social and cultural contexts. This method contributes to the development of theory and new knowledge, as well as a better understanding of subjective perspectives [6]. The three cases are analyzed, focusing on healthcare professionals' experiences following the implementation of new EHRs in hospitals. Two cases used qualitative research methods based on semi-structured interviews, while the third adopted a mixed-method approach, including qualitative and quantitative questions in a national survey.

The notion of Information Infrastructure (II) has become a pervasive theme in studying development, implementation, and scaling of EHRs [1]. IIs are heterogeneous, sociotechnical networks comprising both physical facilities and interconnected sub-infrastructures. Rather than being isolated entities, systems within IIs are deeply embedded in social, organizational, and technical fabrics and co-evolve with each other [7]. Importantly, IIs develop through extending and improving the installed base, meaning that the existing infrastructure influences the design of new components and systems. When changing an installed base, it is essential to design the new version for usefulness and build upon the existing infrastructure. According to Design Kernel Theories and Principles [8], new systems should deliver immediate benefits to users and gain momentum by being adopted by as many users as possible while incorporating new functionality only when required and supported by a sufficiently large user base. Enabling users to appropriate technology fosters social, cultural, and economic ownership and facilitates reshaping the technology's features and uses in novel and unanticipated ways. However, significant changes to the installed base may require considerable investment in resources and training to ensure effective use, ultimately increasing the risk associated with the system.

3. Results

3.1. Users' perceived usability, user resistance, and productivity five years or more after implementation of Electronic Health Records

The first case is a qualitative multi-center study that examined health professionals' perceptions of the usability, resistance, and productivity of a modern EHR in three European cities [2]. All included sites transitioned from paper-based documentation methods to EHRs. The study found that, despite the increased time spent on documentation work, informants were generally satisfied with the EHR's functionality and usability. Informants emphasized that the EHR's implementation and configuration were more crucial to their satisfaction than specific functionalities. The study also revealed that clinicians did not express notable resistance or reluctance to using the EHR and its functionality, although some users reported initial resistance. The findings suggest that low resistance and high perceived usability of EHRs depend on time, allowing both the system and organization to mature. The study emphasizes the importance of understanding both the long-term impact of EHRs on clinicians' experiences and the immediate benefits of transitioning from paper-based routines to an EHR system.

3.2. *Users' satisfaction with recently implemented electronic health records*

The second case examined the effects of transitioning from an existing EHR version of DIPS to the new version, DIPS Arena, across all hospitals in Northern Norway in 2021 [4]. The study aimed to evaluate the impact on usability, functionality, and user satisfaction while identifying the critical dimensions influencing user satisfaction to enhance the questionnaires for future years. EHR satisfaction was assessed in three categories - overall, generic, and function - through surveys, yielding satisfaction rates of 48.0%, 49.3%, and 52.2%, respectively. Most respondents reported being satisfied or indifferent, reflecting a moderate-to-high level of satisfaction. This finding is noteworthy, as previous research has documented high dissatisfaction among EHR users during transitions to new systems [9]. This study's relatively high satisfaction rates may be attributed to users' positive experiences with the new system, and its similarities with the prior EHR version. It is important to note that satisfaction may initially decline as users become more familiar with the system before eventually increasing again.

3.3. *Short and long term effects after implementing EPIC in the Nordic countries*

The third case involved the implementation of Epic EHR systems in Denmark (*Sundhedsplatformen*), Finland (*Apotti*), and Norway (*Helseplattformen*) [1, 3]. These implementations were characterized by high standardization levels, complex implementation processes, and big-bang launch strategies. In Denmark, *Sundhedsplatformen* was implemented in 2016-2017 and faced criticism due to technical issues, poor usability, and unstable system integration. Although satisfaction with the system has gradually increased over the past six years, a considerable number of users remained dissatisfied, as evidenced by a 2021 survey. In Finland, the *Apotti project* aimed to standardize operational routines and control costs. The Helsinki-Uusimaa region adopted the Epic EHR system in 2016 for shared data use between health and social welfare. Hospital implementations started in 2018, and by 2021, the system was also implemented in social care institutions, family services, child welfare, and social services in three Finnish regions. Preliminary research indicated that the implementation failed to yield economic benefits and negatively impacted work support, usability, and patient safety. In Norway, *Helseplattformen* was introduced in 2016, and implementation started in 2022. The objective was to procure a shared EHR between hospitals and municipalities. User complaints and technical issues impacting patient safety have led to postponement of the system's expansion, and General Practitioners have largely withdrawn from the project. Positive outcomes have been noted for home care services and nursing homes in one municipality. Collectively, these experiences highlight the challenges of large-scale EHR implementation and the importance of careful planning and monitoring for successful adoption.

4. **Concluding discussion**

A synthesis of our results, grounded in Information Infrastructure theory, reveals that the installed base and the time factor play crucial roles in determining the outcome of a new EHR implementation.

In the cases where no EHR was installed previously, the installed base consisted of paper-based records. Users were relatively satisfied five years or more after

implementation, likely due to the immediate effects on quality of care and cost efficiency realized by the EHR [9]. As time progressed, the socio-technical friction that typically follows large-scale EHR implementations seemed to diminish. While the shift from paper-based records to an EHR dramatically altered the installed base, the immediate benefits resulted in relatively high user satisfaction ratings at the time of inquiry [8].

In the cases where a new EHR replaced an existing one, the installed base already consisted of an EHR system. Users rated the new implementation favorably in terms of usefulness and function. User resistance, a common barrier in hospital information system implementation, was minimal in these cases. The new EHR's similarity to the existing system likely contributed to its positive reception. Provided by the same vendor, the new DIPS Arena was built on a familiar platform, which allowed clinicians to adapt more easily as the system did not introduce radical changes to their work routines.

Finally, the Epic implementations in the Nordic countries faced substantial criticism due to the dissimilarities between the new EHR and the existing installed base; developed in a US insurance-driven context, these EHR systems were functionally distant from the installed base prior to implementation. Consequently, they encountered challenges such as unrealized cost reduction, low user satisfaction ratings, and that appears somewhat resistant to the effect of time. These implementations did not effectively build upon the existing infrastructure, making the perceived immediate benefits difficult for users to identify. Our findings provide insights into different implementation strategies and align with the theoretical framework of Information Infrastructure. In cases where the installed base is totally removed, we observe a prolonged time to reach a production level of healthcare services comparable to the pre-implementation situation. Conversely, transitioning from paper-based patient records to EHR systems yields more immediate effects. Although the third case shows positive results, the most challenging part might still lie ahead, highlighting the importance of considering the installed base in EHR implementations.

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