Collaboration across Disciplines for the Health of People, Animals and Ecosystems
L. Stoicu-Tivadar et al. (Eds.)

doi:10.3233/SHTI241073

Utilizing Open Source Clinical Information Systems in European Countries: Potential and Barriers

Fatma-Zahra MAGDUB[a], Sakirnth NAGARASA[a], Florian FRICK[a] and Murat SARIYAR[a,1]
[a]*Bern University of Applied Sciences, Switzerland*
ORCiD ID: Murat Sariyar https://orcid.org/0000-0003-3432-2860

Abstract. GNU Health, an open-source clinical information system, offers a comprehensive solution for managing health records, hospital information, and laboratory data. Despite its robust functionality and cost-effective nature, GNU Health remains underutilized in the European healthcare context. This paper explores the potential benefits of implementing GNU Health in European healthcare systems, emphasizing its capacity for customization, integration, and scalability. We also examine the barriers to its widespread adoption, including regulatory challenges, interoperability issues, and resistance to change from established proprietary systems. Through one case study and expert interviews, we provide insights into why these obstacles can hardly be overcome.

Keywords. Clinical information system, electronic health records, GNU health, hospital information systems.

1. Introduction

Open-source clinical information systems (CIS) are widely adopted in third-world countries due to their cost-effectiveness, flexibility, and comprehensive features tailored to resource-limited settings [1]. These system support various healthcare management needs, including electronic health records (EHR) [2]. For, instance, GNU Health has been implemented successfully in countries such as Paraguay, Kenya, the Philippines, and Bangladesh, where it aids in managing patient records and improving healthcare delivery in rural clinics and enhances the efficiency of hospital administration and patient care in under-resourced medical facilities [3–5].

Despite these advantages, open-source CIS have not gained significant traction in Europe. Several factors contribute to this discrepancy. European healthcare systems often rely on well-established, proprietary clinical information systems with extensive support and compliance with stringent regulatory requirements [6]. These systems are tailored to meet the complex interoperability standards and legal frameworks governing healthcare. Furthermore, the existing healthcare IT infrastructure in Europe is typically more advanced, reducing the perceived need for a shift to open-source solutions. Established vendors offer robust customer support, regular updates, and comprehensive

[1] Corresponding Author: Murat Sariyar, Bern University of Applied Sciences, Quellgasse 21, CH2502 Biel/Bienne, Switzerland; E-mail: murat.sariyar@bfh.ch.

training, which are critical for healthcare providers accustomed to high levels of service reliability and accountability. The potential need for significant customization and the perceived risk associated with transitioning to a less familiar system also deter widespread adoption of open-source CIS in the European context.

To explore the potential of GNU Health as a prominent example of an open-source CIS in the European context, we investigate a simple parametrization use case: post-operative documentation of materials used in surgery. This scenario was chosen because it highlights the system's flexibility and ability to meet specific healthcare needs. Additionally, we conducted five expert interviews with healthcare IT professionals, clinicians, and administrators to gather insights into the practical challenges and opportunities associated with adopting GNU Health in European healthcare settings.

2. Methods

GNU Health is a comprehensive health information system, developed as a free project for doctors, healthcare facilities, and governments [7]. It offers various functionalities including electronic medical records (EMR), hospital management systems (HIMS), and health information systems (HIS). A core component of GNU Health is Tryton, a software for enterprise resource planning that serves as a full-fledged modular application platform [8]. GNU Health adds several modules for different medical domains. For instance, the health module includes patient management, examinations, and appointment scheduling, while the specialized modules cover fields such as surgery, pediatrics, and gynecology. This modularity offers flexibility, allowing users to activate only the necessary modules. Some common installation methods include: (1) Manual Installation: This involves manually downloading the GNU Health source code from the official website or a repository like GitHub. The software is then installed and configured on a server, requiring some technical expertise. (2) Docker Containers: This method is particularly useful for developers and administrators needing an isolated and reproducible environment. (3) Virtual Machine (VM): Pre-built virtual machines can be downloaded and used in virtualization environments like VirtualBox or VMware. This is convenient for quick testing or training purposes.

An agile approach, specifically utilizing a Kanban board, was employed to implement the use case of post-operative documentation of materials in a hospital context using GNU Health. This method facilitates iterative development and continuous feedback, ensuring that the system could be adapted to meet the specific needs and constraints of the healthcare setting. The use of Kanban allowed for real-time tracking of tasks, prioritization of work items, and efficient management of the implementation process. Implementing the use case involved five steps: (i) requirement gathering: detailed discussions with surgeons and administrative staff to understand the precise documentation needs. (ii) identification of key data points to be documented post-operatively, such as types and quantities of materials used, timestamps, and responsible personnel. (iii) system design: designing the database schema to store the documentation data securely and efficiently. (iv) Designing user interfaces for easy input and retrieval of documentation information by medical staff. (v) Training and Deployment: providing training sessions for medical staff to familiarize them with the new system.

To complement the technical implementation, we conducted five semi-structured interviews with healthcare IT professionals, clinicians, and administrators across multiple European healthcare institutions. These interviews provided valuable insights

into the practical challenges and opportunities associated with adopting GNU Health. Key themes explored included system integration complexities, regulatory compliance, user acceptance, and long-term sustainability. The questionnaire included questions on qualification of the individual, CIS user experience, CIS interoperability with laboratory equipment, feasibility of connecting laboratory analysis devices, and pros and cons of Open-source CIS.

3. Results

One challenging step was the installation of GNU Health, as there are many different routes with different degrees of system requirements. We manually installed the system (locally and on a server) as to increase the degree of freedom and adaptability of the system. Figure 1 shows the screen from GNU Health using the activated surgery module, which is used for documenting the details of the surgical procedure after it has been performed. For that module to be activated, login must first be accomplished using an administrator account. After activating the module, corresponding users get access in the "Users" section by updating their roles or access rights to include permissions for the surgery module. The surgery module is used for documenting and managing surgical procedures. In the user view of this case, a male patient with skin tumor having secondary malignancy (coded as C79.2) was scheduled for surgical exeresis (code: SRG-2024-00001). The central tabs for documentation are main, procedures, complications, supplies, team, postoperative, and discharge. In the main section, central procedures are provided (specifically, "under local anesthesia plus sedation", "excision and direct closure of defect or closure with local plasty or closure with skin graft taken"). The supplies section indicates that one scalpel and its blades were used during the surgery, which is crucial for inventory management and ensuring that the operating room is restocked appropriately. Preoperative checklist items such as "Risk of Massive bleeding", "Pulse Oximeter in place", "Surgical Site Marking", "Antibiotic Prophylaxis", and "Sterility confirmed" are present but not checked, indicating that these details need to be filled out as part of the preoperative or intraoperative documentation process.

While the use-case of post-operative documentation is well-supported, there are several challenges in using this solution. First, dedicated IT support is crucial, as the installation and maintenance are as complex as most commercial products. Second, the user is not guided through the process but must quickly navigate the system independently, which can lead to errors. Although customization is possible, it requires significant effort, making it inferior to solutions that include user guidance by design. Effective training and user-friendly guides are necessary to ensure smooth navigation and usage. Once users are trained, the module can significantly enhance efficiency by providing a centralized platform for documenting all aspects of surgical procedures. The system's adaptability, given the option to manually install and configure it, allows further customization to fit the specific needs of different medical institutions.

Now turning our attention to the interviews. Our first interviewee is a senior Swiss health IT professional who appreciates that open-source CIS can be freely expanded and customized, benefiting education by enabling hands-on experimentation and learning. However, maintaining data systems and operating subsystems with open-source solutions demands significant effort and resources. The complexity of managing and updating these systems is comparable to that of commercial products. Thus, a high level of technical knowledge is necessary to effectively use and expand open-source CIS. The

second interviewee, a junior Swiss administrator, echoes these benefits and highlights that the high accessibility of open-source CIS makes it convenient and versatile. However, he expresses concerns about security risks due to the visibility of source code, potentially exposing vulnerabilities. Additionally, while commercial solutions often include default features, open-source CIS may require costly customization. The third interviewee, a senior Swiss IT health professional, emphasizes that open-source solutions can enhance interoperability efforts through transparency. She notes, however, that many open-source systems lack robust laboratory information system (LIS) features and built-in guidance. Our fourth interviewee, another junior Swiss administrator, summarizes the pros and cons discussed previously and advocates for broader adoption of these systems. Lastly, we interviewed Luis Falcon, the founder of GNU Health, who highlighted that a large community provides support, ensuring organizations receive assistance when needed. GNU Health has successfully been implemented in both public and private facilities, receiving positive feedback for its independence from vendors and lack of hidden costs. With over 20 localization teams supporting various languages, GNU Health adapts to different regions, prioritizing comprehensive healthcare needs including physical, psychological, social, and emotional aspects.

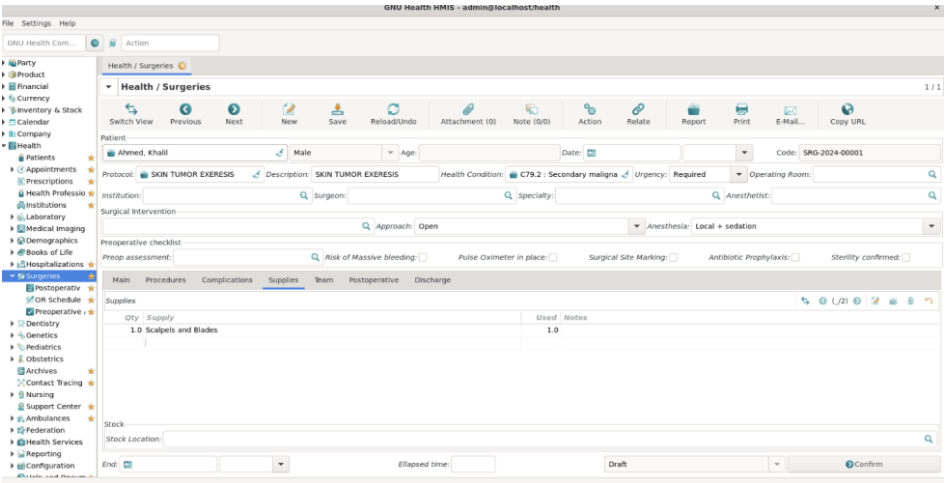

Figure 1. Screenshot of GNU Health with the surgery module activated.

4. Discussion and Conclusions

GNU Health provides several advantages that are particularly relevant in the European context. Its open-source nature allows for extensive customization, enabling healthcare institutions to tailor the system to their specific needs and integrate it seamlessly with existing infrastructure. This flexibility can support interoperability efforts, crucial for managing complex healthcare environments characterized by diverse regulatory requirements and sophisticated data management needs. Moreover, GNU Health's cost-effectiveness presents a compelling case for European healthcare systems facing budgetary constraints. Unlike proprietary systems that incur licensing fees and often require costly customization, GNU Health offers a freely accessible platform with no hidden costs. This affordability is complemented by a vibrant community of developers

and users who contribute to ongoing improvements and adaptations, ensuring the system remains relevant and responsive to evolving healthcare challenges.

Despite its merits, several challenges hinder the widespread adoption of GNU Health in Europe. One significant barrier is the dominance of established proprietary CIS solutions that are deeply integrated into existing healthcare infrastructures. These systems typically offer robust customer support, regular updates, and compliance with stringent regulatory standards, providing a level of reliability and familiarity that can be challenging for open-source alternatives to match. Interoperability remains a critical concern, particularly regarding the integration of GNU Health with existing laboratory information systems (LIS) and medical devices. While GNU Health supports modular expansion into various medical domains, it may lack specialized features required for complex laboratory workflows, posing a barrier to adoption in settings heavily reliant on such functionalities. Security concerns also arise due to the visibility of GNU Health's source code, which, while promoting transparency and community scrutiny, may expose vulnerabilities. Perceptions of higher customization (as experienced in our use case) and maintenance efforts compared to commercial solutions further contribute to resistance among healthcare providers accustomed to streamlined, vendor-supported systems.

In conclusion, while GNU Health offers a promising alternative to proprietary clinical information systems due to its flexibility, cost-effectiveness, and community-driven development model, its broader adoption within European healthcare systems faces several challenges. These challenges include addressing interoperability issues, improving security measures, and establishing robust support structures. To enhance this study, future research should involve the implementation and evaluation of GNU Health across a diverse range of European countries, using statistical methods to capture variability in CIS across the continent. This comprehensive approach will provide a more detailed understanding of GNU Health's potential to transform healthcare delivery in Europe and beyond. Additionally, raising awareness about the existence and successful global use of such open-source systems is essential for broader adoption.

References

[1] Walsham G, Sahay S. Research on information systems in developing countries: Current landscape and future prospects. Inf Technol Dev 2006; 12: 7–24.
[2] Syzdykova A, Malta A, Zolfo M, et al. Open-Source Electronic Health Record Systems for Low-Resource Settings: Systematic Review. JMIR Med Inform 2017; 5: e8131.
[3] Avelino JNM, Hebron CT, Laranang ALE, et al. Requirements gathering as an essential process in customizing Health Information Systems for small scale health care facilities. In: IISA 2014, The 5th International Conference on Information, Intelligence, Systems and Applications, pp. 184–189.
[4] de la Torre I, Martínez B, López-Coronado M. Analyzing open-source and commercial EHR solutions from an international perspective. In: 2013 IEEE 15th International Conference on e-Health Networking, Applications and Services (Healthcom 2013), pp. 399–403.
[5] Karopka T, Schmuhl H, Demski H. Free/Libre Open Source Software in Health Care: A Review. Healthc Inform Res 2014; 20: 11–22.
[6] Reynolds CJ, Wyatt JC. Open Source, Open Standards, and Health Care Information Systems. J Med Internet Res 2011; 13: e1521.
[7] Paton C, Braa J, Muhire A, et al. Open Source Digital Health Software for Resilient, Accessible and Equitable Healthcare Systems. Yearb Med Inform 2022; 31: 67–73.
[8] A prospective interoperable distributed e-Health system with loose coupling in improving healthcare services for developing countries. Array 2022; 13: 100114