The characteristics and capabilities of the available open source health information technologies supporting healthcare

Citation for published version:

Digital Object Identifier (DOI):
10.14236/jhi.v25i4.1022

Link:
Link to publication record in Edinburgh Research Explorer

Document Version:
Publisher's PDF, also known as Version of record

Published In:
Journal of Innovation in Health Informatics

General rights
Copyright for the publications made accessible via the Edinburgh Research Explorer is retained by the author(s) and / or other copyright owners and it is a condition of accessing these publications that users recognise and abide by the legal requirements associated with these rights.

Take down policy
The University of Edinburgh has made every reasonable effort to ensure that Edinburgh Research Explorer content complies with UK legislation. If you believe that the public display of this file breaches copyright please contact openaccess@ed.ac.uk providing details, and we will remove access to the work immediately and investigate your claim.
The characteristics and capabilities of the available open source health information technologies supporting healthcare: a scoping review protocol

Ather Akhlaq
Centre for Health Informatics, Department of Health and Hospital Management, Institute of Business Management, Pakistan

Brian McKinstry
Centre for Medical Informatics, Usher Institute of Population Health Sciences and Informatics, The Medical School, The University of Edinburgh, UK

Aziz Sheikh
Centre for Medical Informatics, Usher Institute of Population Health Sciences and Informatics, The Medical School, The University of Edinburgh, UK

ABSTRACT

Introduction Due to the many advantages of open source software (OSS), including reduced cost of licensing, more flexibility in terms of customisation and redistribution, better quality and no vendor lock-in, OSS in healthcare is increasingly gaining importance. Various open source health information technologies (OS-HITs) are continuously being designed and developed for different areas of healthcare to increase organisational efficiencies and quality of care at minimum costs. The objective of this scoping review is to identify the kinds of existing OS-HITs, their characteristics (e.g. functions) and capabilities (e.g. advantages/disadvantages) for various healthcare stakeholders (physicians and patients) and healthcare sectors (e.g. clinical, administrative).

Methods We will conduct a scoping review to identify the range of available OS-HITs in international literature from 1980 to September 2018. Searches will be conducted in six major international databases, namely: Cumulative Index to Nursing and Allied Health Literature Plus, Excerpta Medica Database, Global Health, Library Information Science and Technology Abstracts, Medline and Web of Science to identify relevant published research. We will also search the Google search engine and Google Scholar for on-going and unpublished work and the grey literature. Searches will be peer-reviewed by two independent reviewers and will not be limited by methodology or language. Next, selected references will be tabulated for study characteristics by author affiliation, country of origin, the name of OS-HIT, healthcare area/sector, system requirements, stakeholders, complete solution and web link. Furthermore, functions, benefits/advantages, disadvantages and outcomes (e.g. usability) of OS-HITs will be extracted. Narrative and interpretative synthesis of data will be undertaken.

Results We will report our findings in a peer-reviewed journal.

Keywords: health information technology, open source, systematic scoping review
BACKGROUND

Source code of open source software (OSS) is publicly available for end-users who can examine, add, modify or distribute it, whereas source code of proprietary or ‘closed source’ software is only available to the person or vendor who developed it, and users are solely dependent on the vendor for any modification. Due to the many benefits of OSS, such as low cost of licensing, flexibility (can be easilycustomised and redistributable), reliability (abundant support from peer developers), enhanced quality (patchwork for bugs) and no vendor lock-in, OSS in healthcare is increasingly being adopted worldwide.2–4

Healthcare leaders are showing keen interest in open source health information technologies (OS-HITs) [an array of technologies (licensed software with its source code available and with the rights to modify, distribute and study) to save, exchange and analyse health information], such as electronic health/medical records (EHRs/EMRs) [e.g. United States’ Veterans Health Information Systems and Technology Architecture (VistA) and Canada’s OSCAR], district health information systems (DHIS) [e.g. DHIS2 (www.dhis2.org)] and Picture Archiving and Communication Systems (PACS), for example, Dicoogle5 to avail themselves of the advantages of OSS.2,6–8 For example, VistA, a free and OS EHR built and maintained by the United States Department of Public Health Services is considered to be the largest health information systems acquired globally.9 It has been used extensively by the Indian Health Services, Mexican Government and many other healthcare facilities around the world.2,9

Moreover, National Health Service (NHS) England recently supported an initiative called Code4Health, which is an OS platform, a community and a learning tool, which aims to deliver safe and improved patient outcomes by enabling the use of OS digital technology and tools.10–12 By using Code4Health, NHS England intends to create workable OS solutions, ensure to reuse and share all code created in the NHS through a library of assets, provide evidence of value of OSS to the health and social care community, achieve a self-sufficient eco-system of communities and provide equal opportunity for infrastructure services and OS commodities.11

Another example is the study on the availability of OS-HITs commissioned by the Office of the National Coordinator for Health Information Technology under the terms of the Health Information Technology for Economic and Clinical Health (HITECH) Act.13 This study focused on the availability of the OS EHRs for community clinics and safety-net providers (providers in the United States which offer access to healthcare to low-income people, including those who are uninsured and/or have limited or no access to healthcare); the comparison of total cost of OS EHR and the proprietary system; the ability of OS EHR to meet the needs of diverse populations (such as disabled, elderly and children); its interoperability with other disparate systems (such as claims processing systems and practice management system) and its conformity to the Meaningful Use requirements as per HITECH legislation. The authors concluded that OS EHRs can provide cost-effective and reliable solutions for safety-net providers, maintaining the same level of functionality required for Meaningful Use when compared with proprietary systems. Moreover, it can be customised efficiently by creating templates and modules to address and capture the various specific needs of the community.13 In addition, the OS community and developers can offer substantial support to the community health centres as they continuously improve their products.13 Finally, the deployment of OS EHRs may provide the most suitable solutions maintaining pace with the evolving requirements of Meaningful Use and changes in the health industry.13

In a survey conducted by GatePoint Research, more than 100 healthcare executives affirmed that OSS, unlike proprietary software, can be created with the collaboration of thousands of developers and people from the healthcare industry, such as clinicians who can use, improve and modify the OSS according to their needs.2,14 According to a survey conducted by the World Health Organization,2 OS-HIT is also gaining popularity in economically-developing countries due to the unaffordability of propriety systems and the fact that these often do not offer solutions for local health problems. OSS has strengthened the innovative capacity of HIT in many areas of healthcare in low- and middle-income countries. Biometric attendance monitoring of tuberculosis in India; mobile supply chain management tool for logistic management in Ghana and Tanzania; rapid short messaging service (SMS) to provide availability of essential medicines in Malawi and a telemedicine network in Congo, Egypt and Mali are a few examples of several OS-HITs used in developing countries.15 Low cost or free OSS is beneficial for resource-constrained countries, however, countries with ageing population (over 65 years) such as Germany, Greece Italy, Japan and the UK are considering/planning lowering healthcare costs with better treatment options by adopting OS-HITs.16–18

OS-HITs are also being used in fighting viral outbreaks such as Ebola.19 The available commercial EHRs were not appropriate to use by clinicians in the Ebola outbreak but required a customisable software that could be used in the Red Zone (units to hold patients in isolation suspected with the Ebola disease20) while wearing protective suits with minimal typing, high contrast colour schemes, large touch buttons for gloved hands and large fonts to see clearly within the protective masks.19 Moreover, paper prescriptions and medical notes cannot be carried out to the treatment centre in the Red Zone as the virus can live on hard surfaces, which made it difficult for healthcare professionals to collect and manage information.19 The OpenMRS community in collaboration with Save the Children and ThroughtWorks and partnership with Google Doctors Without Borders responded to the Ebola epidemic and provided data management and reporting solutions according to the needs of clinicians and staff.19,21 Fortunately, this Ebola OS project, which can be easily customisable, can also become the groundwork for any subsequent solution required for another disease outbreak in future and could be deployed in days than in weeks.19

These strengths, amongst others, have increasingly led the development and adoptability of OS-HITs. It is thus...
METHODS

A scoping review is a technique used to map the current literature in a field of interest, the key concepts underpinning a research area and the main sources and kinds of evidence available. It was first defined by Mays et al. noting that a scoping review aims to map rapidly the key concepts underpinning a research area and the main sources and types of evidence available. It has become an increasingly popular method for synthesising research evidence, which can be of particular use when the topic is of complex and heterogeneous nature or has not been comprehensively studied.

There are different ways of conceptualising scoping reviews. For example, according to Arksey and O’Malley, a scoping study seeks to provide the broad coverage of the existing literature with varying degrees of depth to investigate the extent, range and nature of research activity; determine the value and potential cost of undertaking a full systematic review; summarise and disseminate research findings to the interested readers and identify research gaps in the existing literature. Another purpose is ‘literature mapping’ to describe the literature and to synthesise findings from different types of studies; or ‘conceptual mapping’ to establish how a particular term is used by whom, for what purpose and in what literature or ‘policy mapping’ to identify the relevant documents from government and professional agencies. According to the National Institute for Health Research Service Delivery and Organisation Research and Development Programme, it is also useful for the elucidation of working definitions and conceptual boundaries of a particular topic area, conducted systematically, but explicitly excluding quality appraisal (which is an integral component of a systematic review), to establish a frame of reference. It can also be used as a preliminary step to a systematic review as it provides a rigorous and transparent approach for mapping areas of research.

The scoping review is registered with the Open Science Framework. It can be accessed at the following URL: https://osf.io/rvfwm/

We will use a six-staged scoping review framework developed by Arksey and O’Malley and further built by Levac et al. to accomplish the objective of this scoping review (see also Preferred Reporting Items for Systematic review and Meta-Analysis Protocols) 2015 checklist in Appendix 1.

The six stages are described as follows:

Stage 1: Identifying the research question

Research questions for scoping reviews should be broad so as to summarise the breadth of available evidence. The research question for this review is ‘what are the characteristics and capabilities of different kinds/types of OS-HITs (such as PACS, health information systems and DHIS) available internationally in various healthcare areas (such as clinical, healthcare administrative and radiology) and/or for specific diseases (such as diabetes and dengue)?’ For details on the characteristics and capabilities of OS-HITs, see Stage 4 (charting the data) below.

Stage 2: Identify the relevant studies

Stage 2 involves developing a robust search strategy and identifying relevant studies. We used the Peer Review of Electronic Search Strategies 2015 Guideline statement to develop and test search strategies for different databases to search literature from 1980 till September 2018 (see Appendix 2 for MEDLINE search strategy). This starting date has been chosen because the term ‘OS’ was coined in February 1998 during a strategy session in Palo Alto, CA when Netscape announced the release of its source code.

Six scientific databases will be searched for published work on OS-HITs, namely:

- CINAHL Plus,
- EMBASE,
- Global Health,
- LISTA,
- Medline and
- Web of Science.

Searches in the academic databases will not be limited to methodology (such as qualitative, quantitative, mixed methods and implementation studies) and language. References will be scanned from included studies to identify additional potentially eligible papers.

We will also search the Google search engine and Google Scholar [first 100 results being considered for each phrase/term searched (see Appendix 2 for search terms)] for grey literature that may include websites and reports.
Appendix 3 for pilot data extraction forms).
formance) of OS-HITs will be abstracted for analysis (see and outcomes (such as efficient workflow and optimised per-
port), disadvantages (such as insecurity of data, incompatible 
speed, availability of tutorials and information system sup-
functions, benefits/advantages (such as low maintenance cost, 
able), complete solution and web link. Furthermore, func-
tions will be useful for healthcare managers and admin-
strators to select from and implement the most appropriate 
OS-HIT that support their healthcare services. In addition, 
healthcare managers will be able to compare the available 
OS-HITs with their proprietary HITs, if any, running in their 
facilities. Third, this review will identify saturation of specific 
OS-HITs, such as EHRs and will identify needs and gaps for 
software developers to design OS-HITs for unsaturated areas 
of HIT. Fourth, this scoping review will help map the litera-
ture on OS-HITs and will catalyse subsequent more focused 
systematic reviews on specific OS-HIT in specific healthcare 
domains. For instance, one anticipated systematic review will 
be to assess the challenges and benefits of using OS PACS. 
Finally, this review will be valuable for policymakers involved 
in the planning, evaluation and procurement of HIT.

CONCLUSION
Results of this review will be published in a peer-reviewed jour-
nal. This scoping review will raise awareness of OS-HITs and 
benefit healthcare stakeholders to make informed judgements 
based on the characteristics and capabilities of OS-HITs when 
deploying or developing them in their healthcare facilities.

Funding
Research is supported by the Institute of Business 
Management, Karachi, Pakistan.
A. S. is supported by the Farr Institute.

Contributorship statement
Study conception and design: Ather Akhlaq, Brian McKinstry and Aziz Sheikh
Drafting of the manuscript: Ather Akhlaq
Critical revision: Ather Akhlaq, Brian McKinstry and Aziz Sheikh

Conflict of Interests
No, there are no competing interests.
REFERENCES


30. Anderson S, Allen P, Peckham S, Goodwin N. Asking the right questions: scoping studies in the commissioning of


---

**APPENDICES**

### APPENDIX 1

**PRISMA-P (Preferred Reporting Items for Systematic review and Meta-Analysis Protocols) 2015 checklist: recommended items to address in a systematic review protocol**

<table>
<thead>
<tr>
<th>Section and topic</th>
<th>Item No</th>
<th>Checklist item</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Administrative information</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Title: Identification</td>
<td>1a</td>
<td>Identify the report as a protocol of a systematic review</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The characteristics and capabilities of the available open source health information technologies supporting healthcare: A systematic scoping review protocol</td>
</tr>
<tr>
<td>Update</td>
<td>1b</td>
<td>(NA) If the protocol is for an update of a previous systematic review, identify as such</td>
</tr>
<tr>
<td>Registration</td>
<td>2</td>
<td>If registered, provide the name of the registry (such as PROSPERO) and registration number</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Registered with Open Science Framework</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="https://osf.io/rvfwm/registrations/">https://osf.io/rvfwm/registrations/</a></td>
</tr>
<tr>
<td>Authors: Contact</td>
<td>3a</td>
<td>Provide name, institutional affiliation and e-mail address of all protocol authors; provide physical mailing address of corresponding author</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ather Akhlaq¹, Brian McKinstry² and Aziz Sheikh²</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 Centre for Health Informatics, Department of Health and Hospital Management, Institute of Business Management, Korangi Creek, Karachi, Pakistan.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 Centre for Medical Informatics, Usher Institute of Population Health Sciences and Informatics, The Medical School, The University of Edinburgh, Edinburgh, Scotland, UK.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dr Ather Akhlaq</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Room 218,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Centre for Health Informatics,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Department of Health and Hospital Management,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Institute of Business Management, Korangi Creek, Karachi, Pakistan.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Phone: 0092 21 111 002 004, Extension: 433</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Email: <a href="mailto:ather.akhlaq@iobm.edu.pk">ather.akhlaq@iobm.edu.pk</a></td>
</tr>
<tr>
<td>Contributions</td>
<td>3b</td>
<td>Describe contributions of protocol authors and identify the guarantor of the review</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Study conception and design: Ather Akhlaq, Brian McKinstry, Aziz Sheikh</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Drafting of manuscript: Ather Akhlaq</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Critical revision: Ather Akhlaq, Brian McKinstry, Aziz Sheikh</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Guarantor: Institute of Business Management, Karachi, Pakistan</td>
</tr>
<tr>
<td>Amendments</td>
<td>4</td>
<td>(NA) If the protocol represents an amendment of a previously completed or published protocol, identify as such and list changes; otherwise, state plan for documenting important protocol amendments</td>
</tr>
<tr>
<td>Support: Sources</td>
<td>5a</td>
<td>(NA) Indicate sources of financial or other support for the review</td>
</tr>
</tbody>
</table>
Akhlaq et al. The characteristics and capabilities of the available open source health information technologies supporting healthcare: a scoping review protocol

| Sponsor | 5b | Provide name for the review funder and/or sponsor: Institute of Business Management, Karachi, Pakistan |
| Role of sponsor or funder | 5c | (NA) Describe roles of funder(s), sponsor(s) and/or institution(s), if any, in developing the protocol |

Introduction

Rationale

Objectives

Methods

Eligibility criteria

Information sources

Search strategy

Study records:

Data management

Selection process

Data collection process

Data items

Outcomes and prioritisation

Risk of bias in individual studies

Data synthesis

Meta-bias(es)

Confidence in cumulative evidence

*It is strongly recommended that this checklist be read in conjunction with the PRISMA-P Explanation and Elaboration (cite when available) for important clarification on the items. Amendments to a review protocol should be tracked and dated. The copyright for PRISMA-P (including checklist) is held by the PRISMA-P Group and is distributed under a Creative Commons Attribution Licence 4.0.


APPENDIX 2

Medline

1. (eHealth or e health or e-health).mp. [mp = title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]
2. telemedicine/
3. Telehealth.mp. or telehealth/
4. Telehealthcare.mp.

5. Telecare.mp.
6. (Electronic Prescribing or ePrescribing or e-prescribing).mp. [mp = title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]
7. Electronic precri*.'mp.
8. Health information technology.mp. or Medical Informatics/
9. Hospital information systems.mp. or Hospital Information Systems/
10. information systems.mp. or Information Systems/
11. Medical Records Systems, Computerised/ or medical records systems.mp.
12. Medical information system*.'mp.
13. Health information system*.'mp.
15. (Management information systems or management information system*).mp. [mp = title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]
17. Electronic health records.mp. or Electronic Health Records/
18. Computerised patient record*.'mp.
20. Decision support system*.'mp.
21. Computerised decision support.mp.
22. Computerised order entry.mp.
23. Electronic patient record.mp.
24. Computerised decision support system*.'mp.
25. Medical order entry systems.mp. or Medical Order Entry Systems/
26. Medical Records Systems, Computerised/medical records systems.mp.
27. Computerised physician order entry.mp.
28. Computerised physician order entry system*.'mp.
29. Computerised provider order entry.mp.
30. (Picture archiving and communication system*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]
31. Health information management system*.'mp.
32. Health management information system*.'mp.
33. Decision Support Systems, Clinical/
34. Health information exchange.mp. or Health Information Exchange/
35. Open source software.mp.
36. Open source technology.mp.
37. Open source hardware.mp.
38. Open source information technology.mp.
39. Free software.mp.
40. Open source healthcare.mp.
41. Open source.mp.
42. (m health or m-health or mHealth).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]
43. Mobile health.mp.
44. Mobile healthcare.mp.
45. Geographic Information Systems/geographical information system*.'mp.
46. Global positioning system*.'mp.
47. Open-source.mp.
48. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 43 or 44 or 45 or 46 or 50 or 48 and 49
51. limit 50 to yr = ‘1980–2017’
Free Field Format/Web of Science
[(eHealth) or (e-health) or (telemedicine) or (telehealth) or (telecare) or (telehealthcare) or (electronic prescri*) or (e-prescribing) or (eprescribing) or (health information technology) or (medical informatics) or (medical information system*) or (health information system*) or (health informatics) or (computerised medical record* system*) or (computerised medical record* system*) or (hospital information system*) or (management information system*) or (electronic health record*) or (computerised patient record*) or (computerised patient record*) or (personal health record*) or (decision support system*) or (clinical decision support system*) or (computerised decision support) or (computerised decision support) or (computerised decision support) or (computerised order entry) or (computerised order entry) or (computerised order entry) or (computerised order entry) or (computerised order entry) or (computerised order entry) or (electronic patient record*) or (medical order entry system*) or (computerised physician order entry system*) or (computerised provider order entry) or (computerised provider order entry) or (computerised provider order entry) or (computerised provider order entry) or (computerised provider order entry) or (computerised provider order entry) or (picture archiving and communication system*) or (health information management system*) or (health information management system*) or (health information system*) or (health information exchange) or (m health) or (m-health) or (mHealth) or (mobile health) or (mobile healthcare) or (geographic information systems) or (geographical information system*) or (global positioning system*)]
And
[(open source software) or (open source technology) or (open source hardware) or (open source information technology) or (free software) or (open source healthcare) or (open source)]

Google search engine and Google Scholar
Open source OR open-source OR health information technology* OR health communication technology* OR open source healthcare OR free software OR open source clinical care OR open source health systems OR open source health information

APPENDIX 3

Data extraction forms

A. Characteristics of studies

<table>
<thead>
<tr>
<th>Author/year</th>
<th>Country of Origin</th>
<th>Study design</th>
<th>Name of OS-HIT</th>
<th>Intervention for specific disease</th>
<th>Intervention for specific healthcare sector</th>
<th>System requirements</th>
<th>Complete solution</th>
<th>Web link</th>
</tr>
</thead>
</table>

B. Capabilities of OS-HITs

<table>
<thead>
<tr>
<th>Author</th>
<th>Name of OS-HIT</th>
<th>Functions</th>
<th>Benefits/Advantages</th>
<th>Outcomes</th>
<th>Disadvantages</th>
</tr>
</thead>
</table>