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Digital Health Model for South Africa's National Health Insurance: Addressing Hospital Occupancy and Emergency Care

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Background and Purpose: South Africa will be unifying the current fragmented healthcare system by implementing the National Health Insurance. This poses inevitable challenges to the associated information systems. This research introduces the need for an information systems model to support the Federated Health Information Architecture proposed by the Department of Health.
Methods: The Health Normative Standards Framework documentation was studied in conjunction with the Life Esidimeni Health Ombud report to determine gaps in the proposed architecture.
Results: Five gaps were identified during this research (the view of shared Electronic Health Records (EHR) is oversimplified, key decision makers are not included in the list of stakeholders, emergency services is not adequately supported, medical aid schemes are not included, mature architectural standards need to be developed) and it was determined that a digital health systems model needs to be developed to support the current architecture to assist with resolving some of the identified gaps.
Conclusions: Data synchronisation issues are inevitable with a large project such as the NHI. To minimise mistakes, fewer assumptions regarding the interoperability of systems need to be made. The proposed architecture as it stands may not cater to the needs of the NHI. A new model that can support the NHI especially within emergency care and hospital occupancy monitoring needs to be created.

Keywords: National Health Insurance, Federated Health Systems Architecture, Digital Health Model, Electronic Health Records, Health 4.0

1 Introduction

The purpose of this paper is to introduce the need for a conceptual digital health model that is cognisant of the existing healthcare system constraints in South Africa and contextually relevant to the Department of Health's National Health Insurance (NHI) plan. The effective implementation of the NHI depends on healthcare systems which are sustainable, in other words future fit. The scenario which this research has focused on is emergency care and hospital occupancy.

2 Background

Electronic Health Records (EHRs) have become an integral part of patient care in South Africa [1]. EHRs not only benefit individual patients but can have a positive impact on public health goals [2]. Real time hospital occupancy information across hospitals in Gauteng is not yet available. As a result, paramedics could unknowingly transport a patient to an emergency facility that is at full capacity. In conjunction with addressing these types of scenarios, the Department of Health (DoH) aims to migrate South Africa from the current fragmented healthcare system to the NHI [3]. The NHI aims to unify the healthcare system to benefit all South Africans. This requires a substantial digital health transformation as existing information systems need to connect to each other to provide a seamless experience for healthcare workers and patients.

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3 Materials and methods

This research has considered the Federated Health Information Architecture (FHIA) proposed by the DoH [4] as well as literature published in other developing countries. Since it is important for research and associated scenarios to be contextually relevant [5], The Life Esidimeni tragedy of 2016 which has close links with patient care and transfers was also considered when assessing the future readiness of the FHIA.

4 Literature Review

Globally, healthcare systems are constrained by factors such as aging populations with chronic conditions [6] however, South Africa has an increased burden on emergency services arising from violent crimes [7]. Health 4.0 poses opportunities for the optimisation of healthcare delivery by incorporating familiar technologies such as Cloud Computing (CC), Fog Computing (FC), Internet of Things (IoT) as well as the Internet of Medical Things (IoMT) [8]. To realise the benefits of Health 4.0, an all-encompassing health information systems architecture needs to be designed. South Africa is preparing to migrate the fragmented healthcare system (public and private sectors) to a unified healthcare system. This has necessitated the need for an implementation plan as well as the designing of a future state architecture.

4.1 NHI Implementation Phases

The NHI will be implemented in six phases [4]: (1) Identify national interoperability use cases; (2) National interoperability use cases are evaluated, validated, refined, and prioritised; (3) Identify gaps in the Health Normative Standards Framework (HNSF) and address them; (4) Articulation of related national interoperability specifications; (5) Implementation and informal assessment of national interoperability specifications; (6) Formal conformance assessment and conformance certification. Currently in phase 2 (2022 to 2026) of the implementation plan, the healthcare delivery mechanisms are being reinforced with more resources and the integration of selected private healthcare services [9]. The future state architecture with a focus on the NHI has been designed and is based on the Federated Health Information Architecture (FHIA). This is described in the next section.

4.2 Federated Health Information Architecture

As per step 3 of the implementation plan, the proposed FHIA was assessed, and potential gaps have been highlighted. The "Magnifying the problem" approach was then used to identify architectural gaps [10]. Health Information Architecture (HIA) encourages interactions between users (healthcare workers and patients) and health systems. Federated Architectures (FA) promote interoperability and synchronisation of data between different systems [11]. The blending of the principles of an FA with an existing HIA,

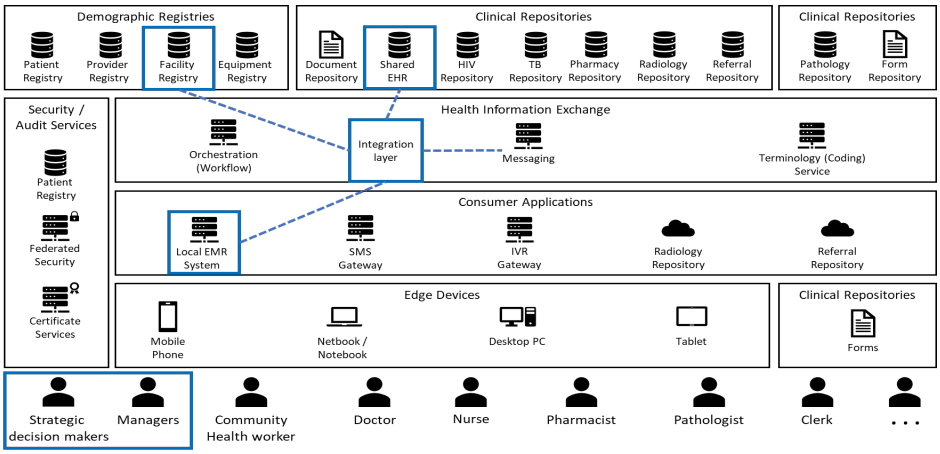

Figure 1: FHIA with highlighted focus areas based on this research. Source (adapted): [4]

results in a FHIA which affords the interoperability and data synchronisation capabilities onto an architecture that already supports interaction between users and systems. The FHIA designed for the NHI is presented in Figure 1. The FHIA was designed by the Department of Health with an objective of ensuring interoperability. Interoperability which supports the synchronisation of data is preferred over integration which focusses on the translation of data between heterogenous systems [12]. The HIE in this architecture is responsible for: Orchestration – management of workflows; Messaging – data flow of shared information; Terminology Service – Data transformation. It can be noted that minimum emphasis has been placed on the synchronisation of data between clinical systems and emergency services.

Medical records are depicted as a shared repository within the clinical repository. This layout therefore implies a consolidation of records [13]. Based on this understanding, the patient records, and by extension the data subsets, describing the overall pulse of the healthcare system will reside physically in a central location. Though there are merits to having a central repository, such as a single version of the data, this would require all facilities to change to the same HIS to be fully interoperable. Within the South African private healthcare system alone, there are no less than five hospital groups: Life Healthcare, Mediclinic, Netcare, Joint Medical Holdings and Lenmed [14]. This excludes the thousands of other smaller private medical facilities. It is reasonable to assume that hospitals in the private and public healthcare systems do not run on the same HIS or at the very least have customised their systems to an extent such that it would require significant effort to consolidate them into a single platform.

Private medical aids, emergency services and healthcare facilities will still feature in some aspects of the NHI. These components however are not adequately catered to within the FHIA. When considering the inevitable heterogenous landscape, an integration layer as suggested in Figure 1 could support the messaging layer. This would be useful in scenarios such as emergency medical care, patient transportation and inter facility patient transfers.

The Life Esidimeni tragedy of 2016 in which more than 100 mentally ill patients died as a result of being transferred to various ill-equipped healthcare facilities [15] has highlighted the following factors (Table 1).

Table 1: Information related factors that contributed towards the Life Esidimeni tragedy of 2016

Contributing factors relating to information processing	**Comments**
Lack of medical authorisation for patient transfer	Insufficient digital records existed for many of the patient transfers between the origin and destination healthcare facilities.
Lack of clinical assessment evidence	There were insufficient digital records of a clinical assessment being performed on the patients prior to being transferred. The follow-on effect resulted in a lack of future or chronic medical records being available.
Lack of patient monitoring	Insufficient digital records existed for the monitoring of patients' conditions during the transfer process.
Receiving staff were unable to interpret the incomplete medical records in cases where they were received	Receiving staff were not trained or did not know how to interpret the medical records received and were thus unable to provide the necessary medical care.
Insufficient handover and control of medical supplies that were received	Insufficient digital records were available to support the control of medical supplies that were received thus leading to deficient patient care.

Source (adapted): [16]

Considering the factors mentioned above, it can be noted that the absence of information (paper-based or digital) can have detrimental consequences. At this point, it might be useful to consider the "poka yoke[1]"

[1] Japanese term meaning to avoid unexpected surprises, poka-yoke is a safeguard that prevents a process from proceeding to the next step until the proper conditions have been satisfied and accepted.

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principle of ensuring that systems and processes are mistake proof [17]. The recommendations in the next section have therefore been created to support the existing architecture and to minimise information inconsistencies.

5 Recommendations

The identification of gaps is a key element of Enterprise Architecture. Step 3 of the NHI implementation plan refers to the identification of gaps in the HNSF. The gaps and recommendations in Table 2 refers to the FHIA proposed by the DoH.

Table 2: Gaps and recommendations relating to the FHIA

Possible gap	Recommendation
Shared EHR is depicted as a single, shared repository. This is an oversimplified view which assumes that the existing and future systems will be interoperable.	An integration layer needs to be considered to ensure that heterogenous systems can share and transmit patient records to healthcare providers at the point of patient care which is an aim of the DoH [18].
The stakeholder list in the FHIA has not included key decision makers.	The stakeholder list should include strategic decision makers who require selected data subsets to make important decisions. Mangers, who require other levels of information and processing should also be included. These additional stakeholder types will assist in revealing related use cases as per steps 1 and 2 of the implementation plan.
Emergency care and patient routing is not adequately depicted.	The HIE should include integration to translate messages between heterogenous EMR systems and healthcare facilities (private and public).
Medical aid schemes are not represented in the architecture	Medical aid schemes will still exist after the NHI has been implemented. These organisations require access to certain EHRs and should therefore be included in the architecture.
Architectural standards not yet as mature as the UK's National Health Service (NHS).	The NHS Architecture Principles should be consulted when creating the frameworks for the NHI [19].

6 Conclusion

It has been highlighted that inefficient health information can have negative consequences particularly during patient transfer, emergency care and facility management. During this research, the lessons learned from the recent Life Esidimeni tragedy were considered when assessing the FHIA proposed by the DoH. This led to recommendations that could ease some of the challenges that are inevitable during a large health information systems project. Future research will focus on creating a health information systems model that can exist on a standalone basis or support the FHIA. This will be achieved through conducting interviews with key stakeholders in the public healthcare system to understand their thoughts relating to current and proposed systems.

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