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Application of Enterprise Architecture to Guide the Integration of Health Information Systems in Namibia

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ABSTRACT

Namibia is characterized by a fragmented health-care system that has led to data inconsistencies and duplication of efforts. It has also become costly to health-care institutions to maintain these fragmented, standalone systems. This study examined how enterprise architecture (EA) can be applied to guide the integration of health information systems (HISs) in the Namibian health-care context. A qualitative approach was applied to collect data from two cases using semi structured interviews and an interpretive approach in the analysis. From the analysis, the constructs of requirements clarity, information systems and technology (IS/T) project management, systems documentation, and communication were discovered to influence the development and integration of HISs. Applying these constructs, the study developed an EA guide for the development and integration of HISs. The study recommends that future studies consider developing similar architecture using a quantitative approach and possibly validating the developed guide using a quantitative approach.

KEYWORDS

Enterprise Architecture, Health Information Systems, Systems Integration, Developing Countries

INTRODUCTION

The advancement of information and communication technology has influenced the growth of HISs (Adeniyi et al., 2024; Shao et al., 2022). HIS refers to comprehensive systems that integrate information technology (IT) and health-care practices to manage, process, store, and exchange health-related data (Epizitone et al., 2023; Winter et al., 2023). An HIS consists of, but is not

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limited to, electronic health records, clinical decision support systems, health information exchange, telemedicine, health information management, electronic medical records (EMRs), and other specific biomedical, administrative, and financial systems that generate, transmit, and store health-care information (Higman et al., 2019; Ngafeeson, 2014; Winter et al., 2023). According to Bagayoko et al. (2020), HISs have resulted in great improvements to both patient care and workflow by providing huge opportunities to reduce clinical errors such as medication and diagnostic errors and to support health-care professionals by offering up-to-date patient information (Adeniyi et al., 2024). However, health-care facilities still face the challenges of exchanging and managing data due to lack of integrated functionality among the supporting HISs (Fennelly et al., 2024; Guo et al., 2024; Mutasa & Iyamu, 2021; Ojeyinka & Omaghomi, 2024).

HIS integration is considered important because it provides effective communication and improves the performance and service delivery within the health organization (Fennelly et al., 2024; Guo et al., 2024; Organization for Economic Co-operation and Development, 2022;). The integration of HISs minimizes redundancy and the need to input the same information on the stand-alone systems. However, HIS integration is not as easy as it seems. The Organization for Economic Co-operation and Development (2022) highlights that HIS integration is a complex, expensive, and time-consuming process. The use of disparate health-care systems adversely affects service delivery, resulting in the loss of patient data and delays in accessing critical information. According to Popescu et al. (2022), HIS integration and standardization efforts are critical for the improvement of health-care services. Mutasa and Iyamu (2022) explain that HIS integration challenges could be owing to the complexity of health-care processes and the number of actors involved in those processes and that, despite efforts from practitioners, governments, and developers, HISs continue to lack acceptable levels of adoption, particularly in developing countries.

Across Namibia, there are over 400 health-care facilities managed by a variety of authorities, including the Ministry of Health and Social Services (MoHSS), missionary groups, nongovernmental organizations, the Ministry of Defense, private for-profit organizations, and the Namibian police services. Despite the diversity in management, all facilities are required to report to the MoHSS, which oversees and is responsible for all health-related matters across the country (Dlodlo & Hamunyela, 2017).

Health-care facilities in Namibia are challenged by the use of unintegrated systems (Dlodlo & Hamunyela, 2017; Jatileni & Nicol, 2024; Mutasa & Iyamu, 2021). To try and solve the unintegrated health systems challenges, in 2017, Namibia implemented DHIS2, an open-source health management system that is used in over 72 countries. Notwithstanding this, the problem still exists (Angula & Kandjeo, 2020; Jatileni & Nicol, 2024). In some institutions, health workers are still using a paper-based system to collect health data and manually feeding it into DHIS2; sometimes they must travel to the main health office to input the data collected (Angula & Kandjeo, 2020; Mutasa & Iyamu, 2022). The Namibian MoHSS, in its national e-health strategy 2021–2025, reported that although some private and public health institutions in the country have implemented HISs, there is still no integration across the different institutions, including a lack of guidelines on how to have interoperable systems that cover a patient's encounter with different health services. This has led to some patients' care being compromised (MoHSS, 2021).

Existing literature, including that from Wamema et al. (2023), Jonnagaddala et al. (2020), Lu et al. (2020), and Higman et al. (2019), suggests that EA plays a pivotal role in integrating HISs and hence may be among the potential solutions in driving Namibia's unintegrated health systems toward an integrated one. EA serves as a framework for aligning business and IT processes and is instrumental in setting and upholding standards to ensure interoperability among various systems within health institutions (Higman et al., 2019; Towoju, 2024). This is particularly important in the complex hospital environment, where various existing systems with incompatible structures need to be integrated. Jonnagaddala et al. (2020) assert that EA holds a central role in the integration of systems in health institutions. EA proposes how data is presented and communicated, including specifying

the required technology standards for use across diverse health institutions (Luz et al., 2020; Towoju, 2024). It is deemed essential for effectively facilitating medical processes and systems in line with the hospital's strategy and hence the reason why this study considers it a way to enable Namibia to overcome its unintegrated HISs.

This study examined HISs in the Namibian health-care context and the application of EA to enhance HISs and thereafter develop an EA guide for the development and integration of HISs. Based on this aim, the following questions were formulated:

1. How significant are HISs in Namibia's health-care organizations and how can EA enhance the significance?
2. How are HISs developed and implemented in Namibia's health-care organizations and how does EA support and enhance the process?
3. What challenges are encountered in the implementation and use of unintegrated HISs in Namibia's health-care organizations?
4. What suitable EA guide could be developed to enable integration of the unintegrated HISs in Namibia's health-care organizations?

LITERATURE REVIEW

HISs

The advancement and wide use of information and communication technology in the health sector has led to the introduction and utilization of HISs. An HIS is defined as the intersection between health care's business processes and ISs to deliver and manage better health services (Bagherian & Sattari, 2022). Dehnavieh et al. (2019) define HISs as systems that aid in the collection, storage, and management of data and information in health-care settings and in ensuring access for decision-making and provision of service. More broadly, Winter et al. (2023) define HISs as socio-technical subsystems in a health-related setting that consist of data, information, and knowledge processing as well as associated human/technical actors in their respective data-, information-, and knowledge-processing roles. For the purposes of this paper, the definition of Winter et al. (2023) is adopted, as it is all-encompassing and allows more actors involved in HIS to be seen.

Haule and Muhanga (2021) categorized HISs into EMRs and clinical decision support systems (CDSSs). While Samadbeik et al. (2020), Nowrozy et al. (2024), and Alhur (2024) describe an EMR as the electronic format of a medical record that is used by health professionals to document and manage patient information, Sutton et al. (2020), Gomez-Cabello et al. (2024), Abouzahra et al. (2022), and Rosen and Saban (2024) describe a CDSS as a solution that is designed to enhance clinical decision-making by integrating patient information with other medical information. Based on the descriptions of Samadbeik et al. (2020), Nowrozy et al. (2024), Alhur (2024), Sutton et al. (2020), Gomez-Cabello et al. (2024), Abouzahra et al. (2022), and Rosen and Saban (2024), it could be inferred that EMRs and CDSSs work together toward a single goal or that EMRs are an integral part of CDSSs, as EMRs could serve as the input or resultant output of a CDSS. The discussion above seems to indicate that EMRs and CDSSs are integral parts of HISs or individual parts seamlessly interacting together toward a singular health goal. However, this does not seem to be the case for unintegrated health systems that exist in the same health organization, and this is the case in Namibia. Thus, there is a need for a possible solution for integrating these systems and overcoming the challenges that they bring.

In view of the above, Faridah et al. (2020) pointed out that the goal of the HIS is to collect, process, and analyze health-care data to produce correct, relevant, and timely information to be used for evidence-based clinical decisions and interventions (Shama et al., 2021); this is indicative of the

potential benefits of HISs, including streamlining of administrative processes and clinical workflows to minimize errors, reduce paperwork, and improve efficiency (Alabboodi, 2020). Additional benefits of a HIS include its ability to enhance storage and retrieval of health-care records (Adeniyi et al., 2024; Ibor et al., 2023), ability to provide doctors and clinicians with quick and timely access to patient data (Adeniyi et al., 2024; Mucaraku & Ali, 2022), reduction in operational costs, generation of organizational profitability (Al-Marsy et al., 2021), and reduction in fragmentation and gaps in health-care services and delivery (Janett & Yeracaris, 2020). This is possible because it allows doctors to spend more time focusing on patient treatment (to improve the patient care and the quality of health services) instead of spending that time entering patient records.

Notwithstanding the above, the implementation of HISs in some jurisdictions has not translated to increased efficiency. This may be a result of the cultural shift (of policymakers and medical professionals) required, and this is in consonance with the findings of De Almeida Mello et al. (2023). The possible cultural shifts required include change management, relevant experience, skills, and technology know-how of health-care professionals. As indicated by Sembay et al. (2023), lack of these skills and appropriate change management seems to serve as a barrier to HIS success and also contribute to medical professionals reacting negatively to the use of IT. In tandem with this, the study by Jeddi et al. (2020) points out that users' (medical professionals and patients) experience of errors and usability issues led to a low HIS acceptance rate. Inclusive in the change management on the part of patients were privacy and security concerns, as their data may be compromised and exposed to unauthorized users (Alabboodi, 2020; Farayola et al., 2024; Zhan et al., 2024). In view of this, Shojaei et al. (2024) suggest that when HISs are implemented, security and privacy should be core considerations to ensure that patient data is protected so that patients understand that their data is safe and hence are more likely to accept and use HISs. HISs are also considered to be expensive due to the initial acquisition and maintenance costs (Haule & Muhanga, 2021). Therefore, it is crucial to have a well-defined guide for their development to avoid the creation of duplicate systems, which can unnecessarily increase costs. To overcome the challenge of HIS implementation not translating to increased efficiency and the associated challenges leading to that as enumerated above, this study proposes the use of EA, as a number of studies (Ajer et al., 2021; Dumitriu & Popescu, 2020; Girsang & Abimanyu, 2021; Hindarto, 2023; Iyamu, 2024; Jonnagaddala et al., 2020; Towoju, 2024) consider it a framework that could guide the integration of fragmented HISs, as in the case of Namibia.

HIS Integration

HIS integration is an approach to unify fragmented health systems to promote easy accessibility, flexibility, and availability of consistent health information to all relevant stakeholders (Azadi & Garcia-Penalvo, 2023; Fennelly et al., 2024). It is considered the main solution to the communication challenges within the health-care sector, as it has the ability to collect health records from different systems and store them in a health repository in a unified format (Symons et al., 2019). HIS integration aims to share and exchange health-care data across health-care facilities with ease while minimizing data complexities, thereby building efficient and effective health-care systems that are patient focused (Dehnavieh et al., 2019; Guo et al., 2024; Symons et al., 2019). Achieving this requires the implementation or use of appropriate tools. As pointed out by some of the above studies, the use of EA is a possible solution; hence, this study explores this option by examining how EA can be used to guide the integration of HISs in Namibia.

Unintegrated HISs present several difficulties, including compatibility issues, since some fragmented systems run on different interfaces (Fennelly et al., 2024; Negro-Calduch et al., 2021; Ojeyinka & Omaghomi, 2024). According to Mamuye et al. (2022) and Guo et al. (2024), the integration of HISs is complicated due to different data formats being used in different HISs and complex health-care workflows that must be considered. Oleribe et al. (2019) and Luo et al. (2024) argue that politics, resource constraints, lack of computer skills, and diverse interests from stakeholders are some of the factors that challenge the integration of HISs. Furthermore, according to Fanta and

Pretorius (2018) and Aboye et al. (2024), pressure from donors, economic and political difficulties, and other factors split efforts to implement e-health in developing nations. They argue that Namibia is not an exception and that there is evidence that other e-health pilot programs started in developing countries could not be fully realized as a result.

In Namibia, there are various HISs that have been implemented, including a TB tracker that keeps a record of all TB cases in the country and systems that keep track of all births and deaths in the country (Mutasa & Iyamu, 2022). Although these systems work well individually, they are not integrated and there is duplication of data between them. This has resulted in fragmented and decentralized patient data. These data management challenges can lead to duplicated diagnoses and treatments. Such inefficiencies contribute to an increased mortality rate, since gaps and errors in patient information compromise the quality and effectiveness of health-care delivery systems (Dlodlo & Hamunyela, 2017; Jatileni & Nicol, 2024; Mutasa & Iyamu, 2021).

EA

EA is a holistic approach that can assist organizations in planning, managing, and integrating organizational components such as business processes, IT, data, and people (Hindarto, 2023). According to Iyamu (2024), EA is a blueprint that is developed, implemented, maintained, and used to explain and guide how IS/T, information management, and business processes can be used efficiently to accomplish the goals and objectives of an organization. Organizations design and implement EA due to the many benefits it provides. Kotusev (2021a) shared that EA provides effective instruments facilitating communication, collaboration, and mutual understanding among different groups of actors involved in strategic decision-making and implementation of IT systems.

Dumitriu and Popescu (2020) reported that as many organizations, including health care, struggle with the complexity and dynamism of their business environments, they increasingly turn to EA as a means to better manage their capabilities. According to Jonnagaddala et al. (2020), EA has been incrementally adopted in many health-care organizations to manage health IT challenges. This points to the increasing use of EA in the health sector and, in light of the integration challenges of the fragmented HIS as discussed in this study, the application of EA could be a potential solution; hence, this study focuses on the use of EA to support HIS integration.

A number of countries have implemented EA. In Jordan and Taiwan, EA has been applied to specific components of HISs, particularly in the areas of disease surveillance and EMRs (Higman et al., 2019). These countries leveraged EA to enhance their ability to monitor public health concerns and manage patient data more efficiently. In Dharmais Hospital in Indonesia, EA was used to integrate scattered applications with the purpose of increasing data sharing among hospital units (Girsang & Abimanyu, 2021) and has been successful thus far.

As an integration approach, EA enables standardization and consolidation of organizational units and components in a holistic manner (Jonnagaddala et al., 2020). EA provides resources in the form of models and roadmaps and introduces specific directions and constraints to projects (Ajer et al., 2021). In consonance with this approach, Ajer et al. (2021) reported that the hospital environment consists of many IT applications that are often obtained from various vendors with differing properties, thus making integration more challenging. To overcome said challenge, Jonnagaddala et al. (2021) recommend the deployment of EA in health care to enable interoperability through standardization, consolidation, and effective management of complexities that could arise from the fragmented HISs and their integration.

One possible way to do this is to apply existing tools that introduce some simplicity, easiness, cohesion, and practicability of implementation. This is where the EA frameworks play a key role. Although there exist a number of EA frameworks that could be applied to resolve the said challenges, each has some weakness, thus making it challenging to implement them. Among the existing frameworks include The Open Group Architecture Framework (TOGAF), the Zachman Framework,

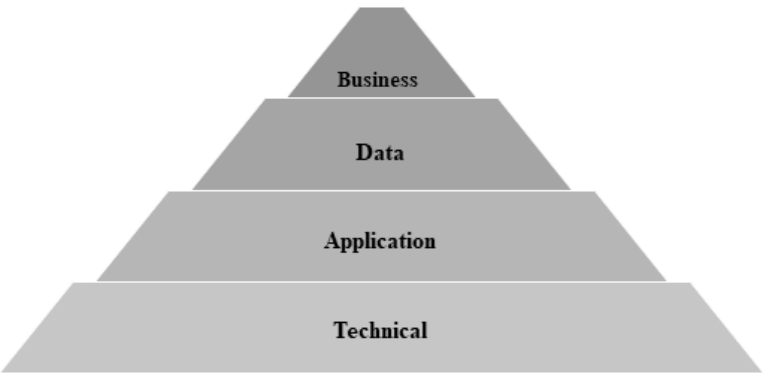
the Federal Enterprise Architecture Framework (FEAF), and Gartner's EA Framework (Bankauskaite, 2019; Essien, 2023; Kotusev, 2021b).

FEAF is tailored for large organizations, particularly in the public sector. According to Gaudêncio et al. (2024), FEAF emphasizes transparency and efficiency by aligning IT investments with mission objectives. FEAF's structured methodology supports government agencies in meeting compliance and regulatory requirements (Bankauskaite, 2019). The Zachman Framework, in contrast, is not a methodology but an ontology. It is a structured grid that categorizes and organizes information based on six perspectives and interrogatives (what, how, where, who, when, and why). It provides a highly detailed and disciplined approach for organizing complex systems but lacks prescriptive implementation guidance (Dumitriu & Popescu, 2020; Gerber et al., 2020; Martínez-López et al., 2024).

Gartner's EA Framework is less rigid than others, promoting a flexible, business outcome–driven approach. It emphasizes the use of EA as a continuous, strategic practice that fosters business innovation (Divatia et al., 2024; Nyale & Karume, 2023). Unlike TOGAF or Zachman, it focuses less on technical frameworks and more on adapting to changing business environments. Each framework serves different needs, with TOGAF and FEAF providing structured methods, Zachman offering classification rigor, and Gartner emphasizing adaptability.

TOGAF is considered the most widely used EA globally and is applicable to different industries, including health (Liu et al., 2021; Wamema et al., 2023; Zemmouchi-Ghomari, 2024). Several studies have shown that TOGAF is more suited to HISs (Bankauskaite, 2019; Liu et al. 2021; Tarenskeen et al., 2018; Wamema et al., 2023). Wamema et al. (2023) argue that TOGAF is more suited to the interoperability of HISs, as it considers all stakeholder requirements and takes into consideration both current and perceived future needs of the organization. TOGAF's focus on ensuring alignment and coherence across different architecture layers also makes it suitable for managing the complexity of integrating health systems. It is based on four primary interrelated architectural domains that are key to EA development, as presented in Fig. 1.

Figure 1. The open group architecture framework (TOGAF) domains



Note. The Open Group (2018).

The business domain has to do with the strategy of the enterprise and overall governance, the application domain determines how applications are deployed to support business processes, the data domain defines how data is stored and managed, and the technical domain defines the IT infrastructure that supports the enterprises' systems (Dumitriu & Popescu, 2020).

Research Approach

Based on the aim of the study, which is to examine how EA can be used as a guide in the development and integration of health-care systems in Namibia, a qualitative approach was employed. Bloomfield and Fisher (2019) explain that the qualitative approach seeks to understand people's views and experiences about the phenomenon. This helps in understanding why things happen the way they do or how they are experienced. Additionally, a multi-case study approach was followed to gain a better understanding of the integration of HISs and the meanings people associate with it. This was based on the argument made by Yin (2017) that a case study enables an in-depth exploration of a phenomenon in its natural setting. Two organizations, HealthBridge Hospital and the MoHSS, were used as cases. The criteria for selecting the cases were based on the critical role they play in the Namibian health-care sector. The MoHSS is the main organization mandated by the government and the law to develop and implement health-care policies in the country, including HIS projects. HealthBridge is one of the main referral hospitals in the country where various HISs are currently used, hence making it most appropriate for this study.

Data was collected through semi structured interviews. The technique was selected based on its flexibility, which provides the researcher an opportunity to probe and rephrase the questions during the interview (Shaanika & Iyamu, 2018), and also because it aligns more with a qualitative approach compared to other techniques. This helped to unearth quality, detailed data. Purposive sampling was also applied to help choose the participants that were more knowledgeable in the context of the study so as to get more relevant data. The criteria for selecting the participants were based on their roles and experience in the organization; the participants should have worked in the organization for at least a year and used HISs to undertake their daily work tasks or routine. For this study, the duration of one year was deemed sufficient time for participants to be knowledgeable about the organization's processes and be in a better position to present or discuss matters about HIS integration or use in the organization. In total, 17 participants were interviewed: eight from the MoHSS, which included HIS systems analysts, national program coordinators, and systems administrators, and nine from the HealthBridge Hospital, which included registered nurses, medical doctors, pharmacists, and radiologists. The principle of point of saturation as used and described by Naeem (2024) and Rahimi and Khatooni (2024) was applied in this study. In the context of this study, the point of saturation was the point where no new data, keywords, patterns, codes, or themes were emerging from the dataset being collected, thus indicating that the data was fully explored, understood, and used to its full potential to achieve the required aim of the study. The saturation process in thematic data gathering and analysis is considered an important concept in the context of this paper, as it shows a representative sample was reached and there was no need for further data to have been collected from further participants. Table 1 outlines details of the participants from whom the data was gathered.

Table 1. Participant representation

	Case 1: MoHSS	Case 2: HealthBridge Hospital	Total
Senior Management	2	1	3
Middle Management	4	6	10
Others	2	2	4
Total	**8**	**9**	**17**

Note. MoHSS = Ministry of Health and Social Services.

DATA ANALYSIS

The collected data was interpretively analyzed. Interpretive analysis is an approach to qualitative research that focuses on studying social life with the assumption that actions taken by humans have intrinsic meaning (Alharahsheh & Pius, 2020). It focuses on uncovering how an individual in a given context uncovers meaning toward a better understanding of the phenomenon involved (Karadayi-Usta, 2019). Scientific research in the information systems (IS) field was once dominated by the positivist and engineering paradigms, but this has since changed (Silva et al., 2014). The change is a result of new topics in IS that need to be studied in depth, such as management ISs and their impact socially; this has resulted in interpretivism in IS research (Silva et al., 2014). Interpretive analysis in IS focuses on getting an understanding of the context of the IS and how the IS is affected or affects its context (Chan & Kwan, 2024).

To achieve the interpretivist analysis, two primary approaches of coding (key point coding and microanalysis coding; Georgieva & Allan, 2008) were considered. While key point coding involves reading text and assigning codes to the main meanings derived from it, microanalysis coding involves analyzing individual words, phrases, or clauses and assigning codes to the generated meanings; hence, it is more labor intensive. In this study, the key point coding approach was employed. Through this, transcripts were analyzed and concepts that emerged from the respondents' descriptions of their experiences within the hospitals and systems, including HISs and EA, were coded without imposing preconceived assumptions. As the researchers read through the transcripts, key sentiments related to participants' lived experiences with the hospital systems were identified and meanings were abstracted from chunks of text. These abstract meanings were assigned words or phrases and renamed as codes. All the transcripts were subjected to this coding process, resulting in numerous codes reflecting different meanings and understandings. The codes from different transcripts were constantly compared for similarities and differences. Similar codes were assigned to the same label, while codes representing different ideas were assigned new labels. Over time, related codes were grouped into concepts, which represented sets of codes with shared attributes, properties, and meanings.

The above thus clarifies the researchers' use of the interpretivist paradigm and thematic analysis of the collected data in answering the research questions and filling the research gap established in the literature. Results of the data analysis are presented per the first three research questions.

Research Question 1

Health-care organizations adopt HISs in order to provide effective health-care services. The adoption of HISs eradicates manual processes that are often slow, erroneous, and inconsistent. When health-care organizations make use of HISs, activities and processes such as data collection, retrieval, and management are automated. Among a number of responses that led to this finding was the response of one participant: "People want things that can make work easier. You know, a manual system is so exhausting in terms of the work that needs to be done or completed. So we are looking for systems that can help us. For instance, if it's quantification: how many medicines can be used and how much can we order?". The automation of health-care processes thus enables ease of data accessibility and transparency of processes.

In terms of what influenced the respondents' attitudes toward the significance of HISs, their responses indicated that they were influenced by how the information was communicated by the promoters to the stakeholders. The promoter's communication was carried out through different mediums such as emails, meetings, and printouts. The communication about HISs was interpreted differently by the health organization employees according to their knowledge. To some, the development and implementation of HISs was viewed as not significant, as it was going to benefit only a few people and not the entire organization. The different views about the significance of HISs often caused conflicts within the health organization business units. These conflicts led to factions, which influenced the overall adoption of HISs in the organization.

EA can play a critical role in addressing these issues by providing a structured approach to HIS integration and aligning HIS with the overall strategic goals of the health-care organization. By implementing EA, organizations can standardize communication channels and promote a shared understanding of HIS benefits across all departments. Additionally, EA can enhance HIS significance by ensuring that system functionalities are accessible and beneficial to the entire organization. This will reduce internal conflicts and increase the system's overall impact on health-care services.

Research Question 2

HISs were developed and implemented from a strategic perspective to enable efficient and effective health-care services in the country. Both development and implementation activities were outsourced due to various reasons such as personal interests and lack of in-house skills. A program manager reported, "All these systems that were outsourced and transitioned to the government never took place, as the ministry does not even host some of the servers".

The development and implementation of the HISs were carried out according to the health-care organization's business requirements. Within the health-care organization, a committee was established to oversee systems development and implementation activities. A participant shared, "We have a technical working group now that control and monitor what systems are implemented in the ministry". The committee was made up of stakeholders from different specializations, which included technical and nontechnical employees. It was important to have a committee of stakeholders with different specializations to ensure business process cohesion.

There was no documented framework or methodology for developing and implementing HISs across health-care organizations. Due to the lack of documented methodologies, the HISs were developed and implemented differently, with no references to existing systems. One of the participants who provided technical support reported, "We have almost close to 60 systems. But I am not saying they are all functioning. But they are being developed so they are not integrated, they are silo systems".

The above points out the need for documenting systems design and development methodology, as it promotes standardization of processes across business units when implementing HISs, especially when different HISs are likely to come up as the institution or organization grows. EA provides this foundation. It helps prevent the development of siloed systems and supports scalable HIS infrastructure that grows with the organization's needs. The lack of documentation and standardization has contributed to HIS infrastructure disparities within and across different health institutions in Namibia.

Research Question 3

Challenges were encountered in the implementation and use of unintegrated HISs. These challenges stem from both technical and nontechnical factors, as indicated by respondents. The technical challenges include lack of standards or methodology to guide the implementation of HISs, and this has resulted in difficulty controlling the quality of the systems being implemented. Consequently, some of the implemented systems were left incomplete, and some modules/portals were nonfunctional. One participant noted, "There was a company that was rolling out the whole systems, but I am not sure what exactly happened; they just left without the system they were implementing working".

To make up for the nonfunctional modules, some processes are manually carried out. Thus, some of the health-care facilities that have the said fragmented systems were operating both manual and automated systems. Among the responses that evidence this is one shared by a participant, who stated, "Sometimes you get some medication, and you want to retrieve it from the system, but you find out that there is no code for that medicine and hence inability to retrieve it. And so now sometimes you have to use a manual system for those particular medicines since there is no code for them". The use of two systems (manual and automated) frustrates employees, as it contributes to data inconsistencies across the various business units. A participant shared her views as follows: "On one side you are using manual and on the other you are using the automated system. This is bad for patients' records retrieval, as we always don't know on which system they were recorded".

The lack of a guiding methodology also contributed to the duplication of development activities. Some business units were implementing systems that were already in existence. Another participant noted, "Sometimes management do not consider agreements they are going into, and then the next thing you see is another system. And sometimes it does not even pass through us, the technical team, so that we can advise to use what is existing".

Nontechnical factors such as inappropriate task allocation and further training, poor communication during the HIS development, and adoption of silo HISs contributed to the HIS implementation challenges. In terms of inappropriate task allocation and further training, based on the organizational structures, employees are usually allocated tasks and sometimes taken for further training (whenever required to improve the employee's efficiency at undertaking the allocated tasks). If not done appropriately, the allocated tasks or further training affect HIS implementation activities. The inappropriateness in task allocation or further training (where required) is because of some management members allocating tasks and making decisions out of personal interests and not for the benefit of the larger organization. Among the responses of participants evidencing this is the response that said, "Management should stop enriching themselves and just try to see the importance of the system being introduced, and they should send the right people for training".

Also, communication is a challenge during HIS development and implementation activities. During HIS development and implementation, communication is carried out through the organization's structure by means of different mediums. Although this happened, critical information about the HIS development was not always communicated on time and resulted in some employees being unaware of the criticality of HIS in the organization. Consequently, these employees do not take the HIS implementation seriously. Included in interviewees' responses that indicated this is the one by a participant that said, "I have no idea why they introduce these systems. It was not communicated to all of us but only to the nurses".

The implementation of silo HISs within different units in the same health organization and also in other health institutions contributed to the challenges of HIS implementation. Due to the unintegrated silo systems, it was impossible for the health-care facilities in the country to collaborate and share information. One of the participants who is a system analyst indicated, "When a patient goes to another hospital, a new medical file/record has to be created. But if our systems were integrated, we can just search up that patient and we can get history and then you treat the patient properly". Collaboration among health-care facilities enables health-care practitioners to share knowledge and insights about patients' conditions. Furthermore, the use of unintegrated HISs leads to data management challenges. Storing patients' data on different systems makes its accessibility and retrieval difficult. Inaccessibility of patients' data (because it is residing in different unintegrated systems) leads to delay in treatment and management decision-making. One participant stated, "We are running different x-ray systems and patients come back looking for their images, but sometimes it is impossible to locate them".

FINDINGS AND DISCUSSION

From the responses of the participants, it was evident that although various HISs had been implemented in different health-care facilities in Namibia, business processes were often carried out manually. Employees preferred using manual systems because the implemented systems are sometimes not fully functional (missing important elements) or unintegrated. The use of both systems has contributed to issues such as repeated efforts and data management challenges, since data is stored in different locations and formats, making its retrieval and accessibility difficult. In consonance with this, Shaanika (2018), Okolo et al. (2024), and Øvrelid (2024) reported that the use of unintegrated parallel systems results in inefficient use of resources, since some data is recorded on paper-based systems and some with the automated system.

The findings of this study also revealed that health-care facilities in Namibia are unable to collaborate and share data and that different business units of their health-care facilities (where

applicable) are also unable to communicate (in real time) with each other. This results in delays in patients' service delivery and treatments as well as hindering evidence-based decision-making (Ndlovu et al., 2021). This study's data analysis attributes the above to the absence of system standards in Namibia for the development and implementation of HISs. The lack of such standards leads to interoperability challenges for the existing and future silo systems. Thus, systems developed by different vendors using and/or for different platforms might not be able to integrate with others; this confirms the findings from Canova-Barrios and Machuca-Contreras (2022). This points to the need for a solution to eradicate the challenges involved in HIS integration. Such a solution would promote easy management, availability, and accessibility of health-care information and processes (De Mello et al., 2022).

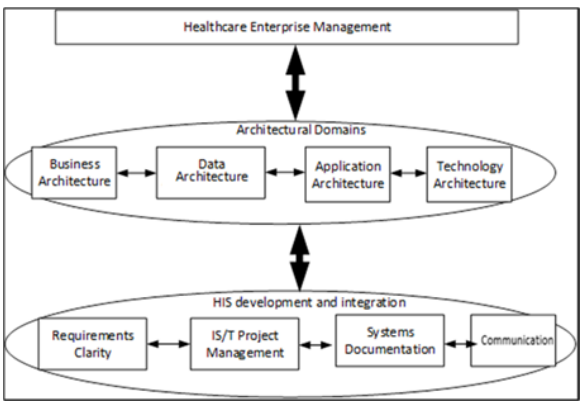
HIS Development and Integration Guide

Research Question 4

The fourth research question of the study, as mentioned previously, was: What suitable EA guide could be developed to enable integration of the unintegrated HISs into Namibia's health-care organizations?

Based on the responses to the three research questions presented previously, an EA guide for HIS development and integration was developed. The components of the guide were arrived at by combining the four EA architectural domains, business, data, application, and technology, that are at the forefront of HIS integration (Wamema et al., 2023; Jonnagaddala et al., 2020; Lu et al., 2020; Higman et al., 2019) and the main themes derived from coding the responses. The researchers reviewed the responses individually to code them and also grouped the codes into different themes. Four themes emanated from the data: requirements clarity, IS/T project management, systems documentation, and communication; these were categorized under HIS development and integration. The last component included in the guide is health-care enterprise management, which provides a broader view of all the operations of public and private health institutions in the country. Therefore, the guide consists of three interrelated categories, namely, health-care enterprise management, architectural domains, and HIS development and integration, as illustrated in Fig. 2.

Figure 2. Enterprise architecture (EA) guide for health information system (HIS) development and integration



Note. HIS = health information system; IS/T = information systems and technology.

Health-Care Enterprise Management

The health-care enterprise provides a broader view of all the public and private health institution operations in the country. Having a broader view of the health-care environment is important for

management to strategize organizational operations. Health-care enterprise management enables the possibility of collaboration with various stakeholders in the country to ensure that quality health-care services are provided. These stakeholders include community members, government, private and public hospitals, and other health-care agencies (Mutasa & Iyamu, 2022). Together with these stakeholders, the health-care enterprise develops and implements health-care policies and standards that govern the interactions among agents within the health-care environment (Gebre-Mariam & Bygstad, 2019). Without policies and standards, it will be impossible for the Namibian health-care environment to achieve its objectives (Mamuye et al., 2022). This shows the criticality of policies and standards in guiding health-care activities and processes to ensure order and transparency and hence why it is the starting point of this guide.

Architectural Domains

To achieve health-care enterprise objectives, there is a need for architectural domain development. The architectural domains are interdependent, as a change to one domain impacts others (Alencar de Medeiros et al., 2021). Through the architectural domains, health-care facilities will develop and implement HISs that speak to the business objectives, thus providing improved health-care services.

Business Architecture

The business architecture is the first domain that needs to be developed. It focuses on establishing the health-care enterprise operating model and short-term and long-term objectives. According to Simon et al. (2014), the business architecture defines an enterprise from a business viewpoint, which includes the business vision and mission needed to guide its strategic and daily operations. In this architectural domain, the management focuses on defining human resources, business processes, policies, and standards for successful health-care organizations' operations. This domain is critical, as it defines the foundation on which the HIS will be developed and implemented (Petersen & Evjen, 2022). Experts in this domain collaborate with organization stakeholders to ensure resources such as skills, financials, technologies, and infrastructures are in place to achieve the strategic intent of the organization (Dumitriu & Popescu, 2020).

Data Architecture

The data architecture defines the types of data required to carry out the business processes defined in the business architecture. Health-care services are sensitive by nature, creating the need for hospitals to have secure mechanisms to protect data from unauthorized personnel. Health-care data also needs to be stored and managed in such a way that it is easily accessible for decision-making. As an architectural domain, data architecture focuses on defining the data structures, its management, and security (Dumitriu & Popescu, 2020).

One of the main challenges across Namibian public hospitals is that patients' data is scattered, making sharing and collaboration among health-care facilities challenging. Patients' files can be impossible to trace and, as a result, medical decisions are delayed as patients are required to undergo medical examinations again (Angula & Kandjeo, 2020). Thus, organizations need to develop and implement data architectures that will guide data management across the hospitals.

Application Architecture

Application architecture focuses on the design and development of applications. Within the Namibian health-care environment, various applications are developed in isolation without collaboration among the business units (MoHSS, 2021). As a result, there is a duplication of effort, as some of the newly developed application functionalities can be achieved with the old applications. The development of applications that do not conform to the business processes and common standards is a costly and ineffective process; as such, it has led to applications not sharing data and some being abandoned (Girsang & Abimanyu, 2021). This has made the retrieval and management of health-care

data difficult. Thus, there is a need for an application architecture that can guide and control the applications development across all business units. Dumitriu and Popescu (2020) noted that the application architecture provides a blueprint for deploying individual application systems, detailing their interactions and relationships with the organization's core business processes.

Technical Architecture

Technical architecture defines the technological systems, such as hardware and network infrastructures, that support the organization's data and applications. According to Lakhrouit et al. (2015), technical architecture describes the logical software and hardware capabilties that are required to support the deployment of business, data, and application services. The Namibian health-care computing environment often operates noninteroperable technical infrastructures such as desktops, computers, printers, firewalls, and servers. The World Bank (2022) asserts that the use of noninteroperable technical infrastructure hinders HIS integration efforts. As a result, health-care organizations operate silo systems that are not sharing data, making collaboration among health-care facilities in the country impossible.

The use of noninteroperable IT systems is caused mainly by the lack of standards and policies that can be used to control and guide the procurement and implementation of IT infrastructures (Kiwanuka et al., 2023; Mayakul & Kiattisin, 2018). Thus there is a need to develop a technical architecture in the Namibian health-care computing environment that will provide guidance and management of the current and future technical needs of health institutions. Having a technical architecture will promote the acquisition and implementation of technological infrastructures that align with business strategy.

HIS Development and Integration

Clarity of Requirements

Clarity of requirements describes the conditions to be met when developing and integrating HISs. There are two types of requirements, business and technical. Both requirements should be clearly defined to ensure business process alignments and quality HIS development and integration. Failure to clearly define business and technical requirements leads to the development of disparate and incompatible HISs, making integration of old and newly developed systems impossible. It also leads to the development of systems that will not be fully utilized in the health institutions, as they will be lacking some functionalities. Nuwangi et al. (2013) state that poorly defined and under-specified requirements cause mismatches in systems development, resulting in application integration challenges. Due to the diverse nature of health-care professionals, each will have their own requirements that need to be incorporated into the HIS. Hence, it is crucial that requirements are well understood before development and implementation of the HIS (Torab-Miandoab et al., 2023).

IS/T Project Management

IS/T project management is the planning, coordinating, and controlling of all project activities (Pinto, 2019). From the analysis, the Namibian health-care environment does not have a documented IS/T project management methodology. As a result, there is no standardization across business units for the IS/T projects being implemented. The lack of IS/T project management standards has led to the development of low quality, incompatible, and in some cases incomplete and nonfunctional HISs (Pinto, 2019).

IS/T project management methodologies are critical to ensure the developed HISs conform to certain standards (Warth & Dyb, 2019). They promote the development of systems that are compatible with one another and thus able to be integrated. To ensure development and implementation of HISs that conform to a set standard, there is a need for communication and collaboration between health-care systems funders, the government, and other stakeholders.

Systems Documentation

Within the Namibian health-care environment, systems development and implementation activities were not documented. Lack of systems documentation contributed to HIS integration challenges. Due to the lack of documentation, it was a challenge for systems developers to study systems' functionalities and develop interfaces for integration. Documentation of the systems' functionalities and processes is important, as it becomes the living document that can be used by employees to gain knowledge about the system operations (Aghajani et al., 2020; Habib et al., 2023). Thus, without systems documentation, training employees about systems functionalities is a difficult process. Most often, the newly appointed employees relied on their colleagues or learned the systems on their own.

Communication

Proper channels of communication need to be set before the implementation of any HIS by having a clearly written communication plan. The success of a HIS is often influenced by how effectively its significance is conveyed to stakeholders. All stakeholders who will be affected by the HIS need to be considered, especially the employees who use the systems on a day-to-day basis (Jeyakumar et al., 2021). Information-sharing sessions with the employees need to be arranged before the HIS implementation can begin so that information regarding the implementation is communicated and everyone is given a chance to ask questions and address any gray areas.

Communication must be consistent and frequent to ensure that all stakeholders are fully informed at every step of the systems development and implementation (Alsalman et al., 2021). Any gap in communication can lead to a HIS not being fully utilized and thus the benefits not being fully realized. Since there are multiple user groups in a HIS, communication that explains why the HIS is being implemented and how this will affect the employees and the health facility as a whole should be tailored to each user group. This will ensure all stakeholders are always in the loop of what is taking place and also assist in making the HIS a success.

To effectively implement EA in Namibian health-care organizations, a structured and phased approach is recommended. First, establishing an EA governance framework that includes key stakeholders, such as health-care professionals, IT managers, and decision-makers, will ensure alignment with health-care objectives and maintain accountability. This is part of the health-care enterprise management. Organizations should then conduct a baseline assessment to identify existing gaps in HIS and IT infrastructure, ensuring EA strategies address specific areas of need. EA implementation should proceed in phases, prioritizing critical systems such as EMRs to allow gradual integration and demonstrate early successes. Training and engagement sessions are also vital, as stakeholder support and understanding of EA's benefits encourage long-term success and reduce resistance to change. Finally, organizations should set clear metrics to monitor progress, continuously evaluating improvements in data accessibility, HIS integration, and system efficiency. This approach not only aligns EA implementation with immediate health-care needs but also builds a scalable and adaptable HIS environment, supporting both present and future demands of Namibian health-care institutions.

CONCLUSION

This study examined HISs in the Namibian health-care context and developed an EA guide for integrating HISs in Namibia to address the challenges that are being faced by the health-care industry. The guide consists of three interrelated constructs: health-care enterprise management, architectural domains, and HIS integration. These constructs address the issues that are currently affecting the integration of HISs in Namibia. To effectively implement the developed guide, a structured phased approach is recommended. First, an EA governance framework that includes key stakeholders, such as health-care professionals, IT managers, and decision-makers, should be established to ensure alignment

with health-care objectives and maintain accountability. Organizations should then conduct a baseline assessment to identify existing gaps in HIS and IT infrastructure, ensuring EA strategies address specific areas of need. EA implementation should proceed in phases, prioritizing critical systems such as EMRs to allow gradual integration and demonstrate early successes. Finally, organizations should set clear metrics to monitor progress, continuously evaluating improvements in data accessibility, HIS integration, and system efficiency. This approach not only aligns EA implementation with immediate health-care needs but also builds a scalable and adaptable HIS environment, supporting both present and future demands of Namibian health-care institutions.

This study is most useful to health-care ministries that have an interest in integrating HISs. This is primarily because of the focus and the importance of using the EA when developing and integrating HISs. Although this study used data from the Namibian context, the resulting EA guide could be used by other developing countries as a reference point for integrating HISs because of the context in which it was developed. The data applied to develop it came from a developing country that has the same or similar culture traits, technological systems, and infrastructure, hence the possibility. This is in consonance with the findings of Bayaga and du Plessis (2023), Ujakpa et al. (2020a, 2020b), and Ujakpa and Heukelman (2018, 2020). However, this must be done with caution considering the contextual nature of the data that resulted in this guide.

This study contributes to the academic domain, since it adds to the existing literature. Future research should consider applying a quantitative research approach to develop a similar architecture, followed by a comparative analysis to determine whether comparable outcomes would emerge. Although expert validation was undertaken to verify the developed EA guide, future research should apply a quantitative approach to validating the guide further.

COMPETING INTERESTS

The authors of this publication declare there are no competing interests.

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