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BIG DATA ANALYTICS FOR SUMMIT GROUP HOSPITAL USING ENTERPRISE ARCHITECTURE AS STRATEGIC APPROACH

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ABSTRACT

Healthcare is known for being a highly intensive engagement with a complex organisation, and it involves numerous levels of stakeholders. A big data analytics solution is required to simplify and improve the process's overall data efficacy and flow. However, there are many challenges in implementing big data analytics in a healthcare organisation, as evidenced in some situations. The difficulties that must be addressed are high costs, time-consuming processes in establishing strategic management, and becoming a patient-centred organisation with optimal coordination. As a result, certain studies that have been conducted are suggested a feasible approach for big data analytics is by implementing Enterprise Architecture (EA) in health organisations. The TOGAF ADM model has been chosen as the methodology for implementing EA in a healthcare organisation due to the power of its flexible methods in merging artefacts and its focus on processes. When adopting EA, four architecture layers are examined: Business, Data, Application, and Technology (BDAT). The problems and As-Is environment have been explored, implying that healthcare organisations require EA to assure continuous service delivery. Significantly, the proposed approach will aid stakeholders in quickly adopting the business transformation through the use of EA.

Keywords: *Big Data Analytics, Enterprise Architecture, Healthcare, Health Information System*

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1. Introduction

Globally, healthcare organisations are under pressure to cut costs, improve coordination and outcomes, do more with less, and prioritise patients. Nonetheless, evidence suggests that entrenched deficiencies and inadequate clinical outcomes challenge the industry (Haghighathoseini *et al.*, 2018; Purnawan & Surendro, 2016). Investing in analytics can assist these organisations in harnessing big data to generate actionable insights (Ajer & Olsen, 2018), define their future vision (Nada, Wibowo, & Novita, 2020), improve outcomes (Higman *et al.*, 2019), and accelerate their return on investment (Kitsios & Kamariotou, 2019). In order to

establish a data-driven organisation, Enterprise Architecture (EA) can provide a comprehensive view of data requirements aligned with strategic business goals (Paredes-Gualtor, Moscoso1-Zea, & Luján-Mora, 2018). EA help to design and implement digital-ready organisational structures (Gerber *et al.*, 2020), business processes (Saleem & Fakieh, 2020), information systems (Higman *et al.*, 2019), and digital health infrastructure (Jonnagaddala *et al.*, 2020) by utilising a coherent EA framework, models and principles. Many healthcare organisations are turning to EA to standardise processes, integrate patient data with other providers' medical records, manage complexity, comply with regulatory requirements, and align business and technology strategies (Girsang & Abimanyu, 2021; Verbeke *et al.*, 2017). EA will outline the complexity management and patient safety by enabling the holistic consolidation of multiple healthcare units and components.

Enterprise Architecture (EA) is a discipline that identifies and analyses change implementation concerning the intended business vision and outcomes (Gerber *et al.*, 2020). EA adds value by providing business and IT leaders with ready-to-sign recommendations for changing policies and initiatives to achieve specific business outcomes that capitalise on relevant business disruptions (Rachmandany, Utama, Lubis, & Ambarsari, 2021). EA has emerged to assist organisations in developing new operating models and connecting their current and future business objectives with information technology capabilities (Gong & Janssen, 2021). EA creates guidelines for decision-making within a company or organisation. An EA can transform a business or organisation and seeks to provide a comprehensive picture of how business processes and information technology interact within a framework (Gampfer *et al.*, 2018). By integrating business functions and relevant IT resources, EA strengthens managerial decision-making capabilities and allows the organisation to understand its IT capabilities better (Kitsios & Kamariotou, 2019; Paredes-Gualtor *et al.*, 2018).

Based on the above discussion, this paper aims to identify issues in developing an EA for healthcare providers, Summit Group (SGH). In delivering the aim, this study applied the Open Group Architectural Framework (TOGAF) Architecture Development Method (ADM) to map the enterprise architectural requirements and challenges from the previous studies and findings for SGH As-Is Scenario.

2. Literature Review

2.1 Enterprise Architecture Overview

Since the 1980s, various enterprise architectural principles and frameworks have been developed, with the concept of EA tracing its roots back to IBM's 1960s Business Systems Planning (BSP) methodology (Gong & Janssen, 2021). As a result, EA has evolved into a method for integrating legacy applications with current and future processes, a concurrent implementation that enables an organisation to optimise its business capabilities. EA aims to create a map of information technology assets and business processes and a set of governance principles that will guide ongoing discussions about business strategy and its expression through information technology.

Several popular frameworks for EA include Zachman Framework, the TOGAF, the Federal EA Framework (FEAF), and EA3 Cube. Zachman Framework for EA is originated from John Zachman's "A Framework for Information Systems Architecture" in the 1980s, and EA gained widespread acceptance. Zachman recognised that information systems created complexity that needed to be mapped with more precise classifications and interfaces, a veritable blueprint, or "architecture," of IT components throughout an enterprise. Then, in 1987, the "Zachman Framework" document was published (Zachman, 2016).

The TOGAF is a methodology for EA that provides a high-level framework for enterprise software development. TOGAF assists in the organisation of the development process by utilising a systematic approach that focuses on minimising errors, meeting deadlines, staying within budget, and aligning IT and business divisions to achieve high-quality outputs. TOGAF was created in 1995 and is freely available for internal use by organisations but not for commercial purposes (OpenGroup, 2020).

Federal Enterprise Architecture Framework (FEAF) is a collaborative planning approach that has evolved into a prominent EA model in private organisations (Hsiung, Chen, Tu, & Ho, 2020). It was first developed for the United States government to integrate its federal agencies. While EA3 Cube was developed initially as a teaching framework by Scott A Bernard in 2004, the EA3 Cube is now used in academic and professional EA training programmes in North America, Europe, and Asia-Pacific. The EA Cube Framework is a "physical" cube with six faces: Function, Structure, Risk, People, Products, and Value (Masuda, 2020).

Many frameworks for EA development have been proposed; however, the majority of frameworks include four fundamental layers as follows:

1. Business architecture—defines the organisation and strategy of the business and critical business processes, governance, and standards.
2. Data architecture—describes the physical and logical structure of data assets and any associated data management resources.
3. Application architecture—provides a framework for deploying individual systems, including their interactions with one another and core business processes.
4. Technology architecture—the hardware, software, and network infrastructure required to deploy operation applications.

Establishing and maintaining an EA is a technically complex process involving numerous stakeholders and decision-making processes. EA comprises four primary components, namely Framework, Tools and Repository, Skillset and Notations, to ensure the success of a Big Data Analytics initiative and establish EA as a culture within an organisation (Gerber *et al.*, 2020).

Embracing the appropriate EA Framework enables an organisation to structurally implement, manage, and govern its EA. Furthermore, the EA Framework will simplify the modelling of complex enterprises and ensure that implementation is consistent across the organisation. EAs' development, management, and governance are technically demanding and time-consuming processes. A user-friendly and simple-to-use EA tool and digital repository will enable the organisation to enforce EA governance, compliance, and adherence across business, data, application, and technology. In addition, EA is a continuous cycle that will exist for the duration of the organisation. As a result, having competent and skilled Enterprise Architects on staff is critical to the success of an EA implementation. Finally, the core element in EA is notation. Using the appropriate notational language to describe the organisation's EA landscape reduces the risk of communication and expectation mismatches caused by an inability to comprehend the architecture diagrams used, resulting in consistent communication between all levels within the organisation.

2.2. Enterprise Architecture Best Practice

Due to the sheer sensitivity of the sector, managing healthcare organisations is more challenging than managing any other business sector. Healthcare organisations are highly specialised and have a plethora of service divisions, which adds to their complexity. Several researchers conducted studies demonstrating the deep complexity of healthcare organisations (Jonnagaddala *et al.*, 2020; Júnior *et al.*, 2020; Masuda, 2020). As a result of the digitisation

era and the increased number of organisational divisions, IT infrastructures were pushed to address business challenges.

EA best practices can help health organisations tackle complex problems in a tried-and-true manner. Major EA best practices and their benefits include the ability to involve top management in critical decisions. True value is created when EA perspectives and methods are extended beyond the purview of CIOs and CTOs. Ensuring senior executive buy-in by developing relevant information demonstrating how technology benefits business (Hsiung *et al.*, 2020). EA also help to prioritise strategic planning. No doubt, strategic planning is an excellent tool for effectively allocating resources. Collaboration with business and IT, documentation of roadmaps and target dates, and work programmes will help organisations visualise and communicate their plans (Saleem & Fakieh, 2020). EA can also focus on the business outcome: Organisations can automate anything, but they must always look for business value.

Furthermore, EA can connect business and IT capabilities. Mapping business capabilities to IT operations is one of the simplest ways to initiate communication with diverse stakeholders to comprehend and contextualise portfolios. Undoubtedly, mapping enables a focus on areas critical to the organisation's differentiation and can aid in directing investment opportunities to areas with the most significant impact. Finally, EA indirectly contributes in developing and retaining top talent (Bakar & Hussein, 2018). It is frequently stated that money serves as an enabler rather than an inspirer for people. Once you've hired some exceptional people, the best way to keep them motivated is to provide exciting challenges, a supportive environment, and opportunities to celebrate their accomplishments.

2.3. Adopting Enterprise Architecture as Strategic Solution

When it comes to healthcare ecosystems, as technology improves, information technology (IT) is becoming increasingly integrated into the delivery of healthcare services. These sophisticated technologies are dispersed to expedite and add value to the business plan, with faster replies supporting medical practitioners in making decisions that affect patients directly or indirectly. EA seeks to capture the complexity of information technology systems, which are built of hundreds of components organised in various layers and connected via a myriad of interactions. EA defines the current and future states of an organisation's processes, capabilities, application systems, data, and information technology infrastructure and gives a path for achieving the desired future state from the existing state (Bukowski, 2015).

EA delivers value by providing business and information technology leaders with signature-ready suggestions for changing policies and initiatives to achieve desired business goals while capitalising on relevant business disruptions. EA facilitates business and information technology-driven change (Gregor *et al.*, 2014). Beyond information technology systems, EA's study includes top management connections and endorsement. Thus, EA is primarily concerned with the strategic consequences of its efforts in relation to the Mission, Vision, Strategy, Objectives, Actions, and Operations of the evaluated business solutions.

Numerous EA frameworks are available to aid organisations in managing and governing their operations. Each has distinct properties that make it well-suited for a particular type of organisation and its unique requirements. For example, Haghighathoseini *et al.* (2018) determined that TOGAF (The Open Group Architecture Framework) is the most pertinent EA framework for hospitals in a comparative analysis of many EA frameworks. This framework establishes an architecture for general product descriptions and a set of rules and standards to ensure product consistency, thereby providing a common platform for integrating and comparing systems and their designs. Additionally, the ArchiMate® Specification, an Open Group Standard, is a neutral and open EA modelling language that has been approved by numerous industry-based and consulting businesses. It defines a common language for

planning and implementing business processes, organisational structure, data flow, information technology systems, and technological capabilities. This comprehension enables stakeholders to prepare for analyse and explain the repercussions of business actions and changes inside and across these business domains.

2.4. Identifying Challenges in Hospital Information System

The SGH use of information and digital health technologies is changing dramatically. Many organisations rely on information technology (IT) systems to help them deliver care. On the other hand, this organisation deals with standardisation, integration, and alignment with the business strategy. Several critical issues must be highlighted to establish and develop an organisation-wide view of strategic planning. These concerns revolve around the organisation's definitions, goals, and levels of consideration. Patients and healthcare are the most frequently encountered significant issues. Medical errors are becoming more common due to a lack of interoperability and integration among healthcare systems, as many branches maintain their hospital record systems.

Many systems are fragmented and designed with no regard for the need for information exchange. Siloed processes can develop due to legal requirements prohibiting the sharing of personal data under data protection laws or a rigid institutional setup and routine that creates significant barriers. Furthermore, disconnected information technology systems impede the integration of complementary data within an organisation, necessitating the dismantling of silos or the integration of data and applications. Again, resolving silo issues necessitates balancing integration and privacy protection, compliance, and accountability.

Furthermore, issues arise when valuable and relevant data is stored in disparate locations, such as a distributed database or in contradictory formats, resulting in a data analysis problem. These issues must be addressed to prevent end-users from rejecting IT systems because they are perceived as meaningless in their workplace.

3. Methodology

The TOGAF ADM technique is used for EA implementation in this study. The superfluous or inapplicable elements will be removed as part of the process. Firstly, all documents related to the organisational strategy are collected and analysed. Next, the interview sessions were conducted with the top management and department heads to obtain information on organisational and managerial problems, expected vision and mission of EA, and information technology architecture.

Data is obtained from various sources, including direct data gathered through interviews and conversations and secondary data collected from publications, legislation, benchmarking studies, and other references. This information corroborates the final problem identification and iterates the architectural development process in the following stage. The data are used to generate a blueprint based on the TOGAF ADM framework, as shown in Figure 1.

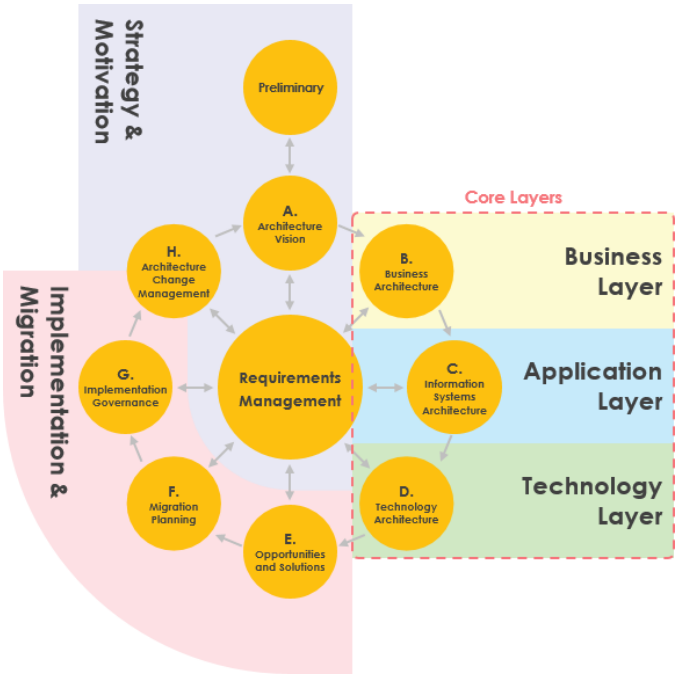

Figure 1. Basic Structure of TOGAF ADM (OpenGroup, 2020)

1. Preliminary: This phase describes the preparation and initiation of EA, including the definition of organisational identity, the destination organisation, the EA organisation model, and architecture principles. The Planning Unit is a subdivision of the CIO in the health organisation, and this unit's function includes developing and empowering healthcare and medical personnel in the health sector. In addition to training and awareness, this section plans the organisation's future, encompassing health services, infrastructure, and digital technology, including the EA. Findings from the interviews and document review are used to with the requirements based on the prescribed business philosophy. This is one of the enablers in effectively changing to a digital organisation, with the eHealth system serving as a centralised application for everybody.

2. Architecture Vision: A high-level overview of the core architecture and design as the foundation for EA implementation. The target architectural vision is provided by a domain that includes business, data, application, technology, value chain, and stakeholder's matrix to achieve a target architecture or a solution idea diagram.

3. Business Architecture: This phase defines the enterprise structure of the organisation for managing the operation. It also has to do with how each function, unit, or actor in the healthcare organisation is distributed, structured, and assigned responsibility. Additionally, at this phase, Business Operations will be defined, representing the interaction between units and functions to achieve the Values described in the Value chain.

4. Information system Architecture: This phase is divided into data architecture and application architecture. This study looks at how healthcare manages data, understanding that data is one of the hospital's most valuable resources, determining the organisation's strategic relevance and long-term viability.

5. The application Architecture phase describes how the healthcare system works, and the architect will compile the existing application Portfolio. Based on a prior understanding of Business Architecture and Data Architecture, this finding will show how the Target Architecture of Applications in Healthcare matches with Business Strategies and Objectives.

6. Technology Architecture: A technology portfolio catalogue and network diagram are generated during this phase to comprehend the as-is architecture. In addition, we describe how technology is used in a healthcare organisation.

7. Opportunity and Solution: Generate the gap analysis from the previous phase and create a report summarising all results.

8. Migration Planning: This phase defines the Target Architecture implementation plan and separates it into several programmes or projects, each with its resources and capabilities.

9. Implementation Governance: The Implementation Governance Phase guarantees that program/project deliverables are regulated within the limits of the healthcare organisation's architectural solution and implementation decision framework.

10. Architecture Change Management: It also covers the change management phase, which focuses on how the organisation recognises and responds to any modifications in the design and implementation plan that are required.

Each deliverable of TOGAF ADM is summarised and sent to healthcare organisation stakeholders. Revision to the prior stage(s) is still available to finish TOGAF ADM comprehensively before going on to the next phase. Only when all changes for each step have been completed will the research move to the end of the EA stage, presented at the final presentation. The deliverables of this research and all related materials are the result of this final step.

4. Results and Discussion

This section discusses the EA implementation challenge findings from the literature review and SGH's current state analysis. The results are summarised in a theme and coded according to the organisation, technology, environment, and organisational concern.

4.1. Organisation

Based on data from prior studies, several organisational issues have been identified, which are leadership, vision, top management buy-in and business leader divergence (Ahmad, Drus, & Bakar, 2019; Hermawan & Sumitra, 2019; Sobri *et al.*, 2019). Furthermore, other studies also stated that financial commitment, communication, and EA knowledge and skill also contribute to organisational challenges in EA implementation (Ajer & Olsen, 2018; Gerber *et al.*, 2020). Other challenges identified are resources, awareness and readiness, and organisational procedure (Gong & Janssen, 2021; Hussein *et al.*, 2020). From our investigation with SGH, the main challenges identified include a lack of resources, a lack of understanding of the EA concept, a lack of EA knowledge and talent, and a lack of EA awareness and preparation.

4.2. Environment

The environment is the next obstacle to overcome. Numerous studies have shown that environmental pressures like governance, competitive concern and economics influence the acceptability and implementation of EAs (Bakar & Selamat, 2016; Hussein *et al.*, 2020). According to the literature, a governance structure should be established early in the EA adoption process to facilitate decision-making and oversight during EA implementation (Girsang & Abimanyu, 2021; Nkundla-Mgudlwa & Mentz, 2017). While there is no EA rivalry in the healthcare sector, organisations compete on customer experience and quality (Jonnagaddala *et al.*, 2020). Governance is crucial, according to the SGH. Recognising that SGH serves the community, collaboration within the organisations must be more efficient using an online system. As a result, SGH will embrace EA values through standardisation, integration, and interoperability.

4.3. Technology

Previous studies have found a link between technological variables such as IT system compatibility, technology readiness, and IT infrastructure complexity (Kitsios & Kamariotou, 2018; Nasef & Bakar, 2020; Sajid & Ahsan, 2016). These technological challenges are also applicable to SGH operations. It is believed that these technical aspects can be resolved once SGH implements EA as the strategic solution to support any digital initiatives.

4.4. Organisational Concern

Previous research has proven that organisational issues can have a sizable impact on EA adoption (Jonnagaddala *et al.*, 2020; Nkundla-Mgudlwa & Mentz, 2017; Paredes-Gualtor *et al.*, 2018). Additionally, time, expense, flexibility, and effectiveness may have impacted the success of the EA adoption (Girsang & Abimanyu, 2021; Higman *et al.*, 2019; Masuda, 2020). SGH findings also confirm that similar challenges occur. Once the detailed EA is implemented, we believe that all challenges mentioned can be further investigated in SGH. Further evaluation will be carried out to confirm the hypothesis. Table 1 summaries the existing challenges of EA implementation.

Table 1. Existing challenges of EA implementation

Categories	EA Implementation Challenges from Previous Studies	Existing Challenges in SGH
Organisation	1. Leadership	X
	2. Vision	X
	3. Top management buy-in	√
	4. Business leader divergence	√
	5. Financial commitment	X
	6. Communication	X
	7. EA knowledge and skill	√
	8. Resources	√
	9. Awareness and readiness	√
	10. Organisation procedure	X
Environment	11. Governance	X
	12. Competitive concern	X
	13. EA Use	√

Table 1. Existing challenges of EA implementation (cont.)

Technology	14. IT system compatibility	√
	15. Technology readiness	√
	16. IT infrastructure complexity	√
Organisational Concern	17. Time	√
	18. Expense	√
	19. Flexibility	√
	20. Effectiveness	√

√ = exist, X = not exist

Consequently, the current study concludes that the initial SGH EA initiative may be readily adopted if the organisation is aware of the hurdles to EA adoption and the factors that influence EA acceptance. Indeed, SGH has solid motivations for pursuing an EA strategy. SGH asserts that they should have an EA to produce a competitive information technology solution centred on their core service. Finally, SGH may examine these influence factors to aid decision-making and limit the risk of future EA adoption. Thus, we articulate a viewpoint to depict the challenges as an overview to establish EA in SGH. As illustrated in Figure 2, the proposed motivation and strategy viewpoint is presented using ArchiMate notation to commence the digital transformation process that include crafting the big data analytics initiatives for SGH and mitigate the risks associated with each stage. The ability to provide insights through EA approach is at the core of the digital transformation and the emerging applications such as big data analytics and services powering it.

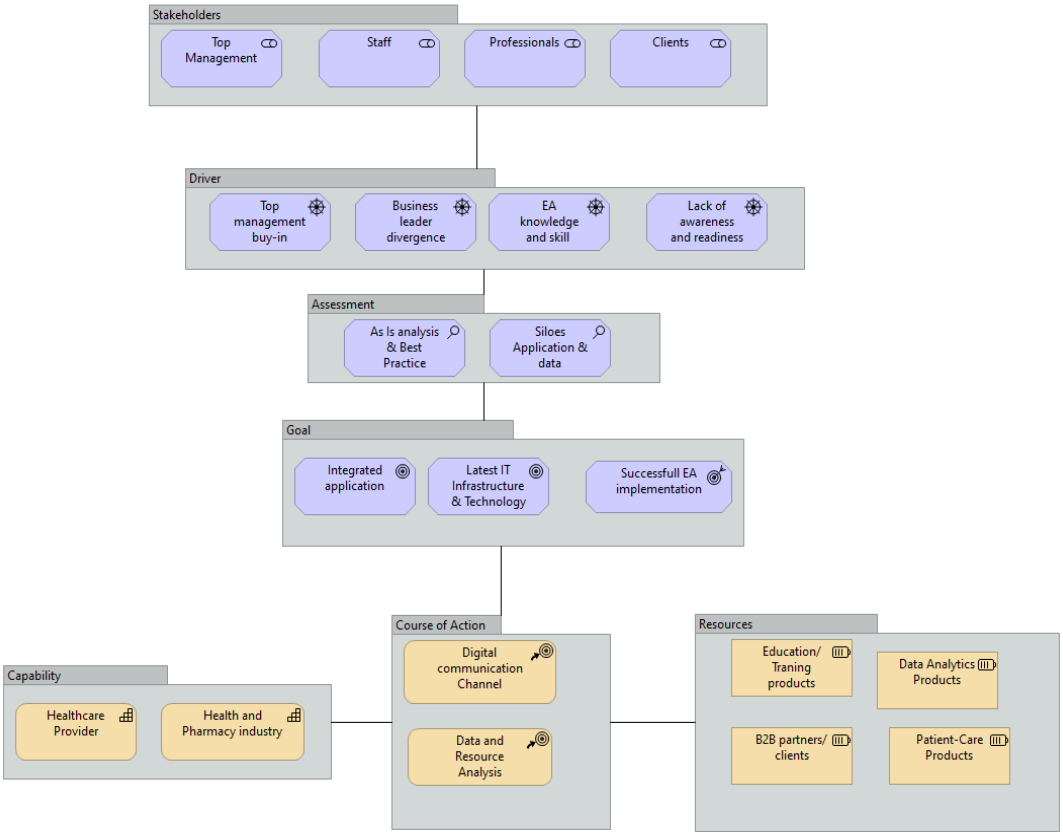

Figure 2. Proposed Motivation and Strategy Viewpoint

5. Conclusion and Future Work

This study is particularly significant in light of the vital necessity of healthcare, rising healthcare expenses, and the importance of technology in achieving effective healthcare delivery. Additionally, there is growing concern regarding the mismatch between the cost of obtaining and implementing information technology and technology initiatives in a healthcare organisation and the advantages realised. This study demonstrates that EA could support healthcare organisations in attaining their goals by serving as an effective tool for project planning, generating digital transformation, bringing corporate objectives and strategy to life, and demolishing organisational silos. Big data analytics is a part of transformation tools towards healthcare digital transformation. The following work will evaluate the development and execution of EA in SGH.

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