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Process for Leveraging Enterprise Architecture in Information Systems Strategic Planning: A Case of Developing a Strategy and Master Plan for a National Integrated Health Laboratory Information Management System in Uganda

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Abstract. Effective alignment of institutional processes with digital technologies is imperative for enterprises, including those in healthcare. Unfortunately, in the context of health laboratories, the scope and complexity of existing digital health interventions has not allowed incorporation of all data and information needs for all core functions of the laboratory subsector. Besides, several operational and management issues still hinder the effective management of information on laboratory services at the health facility, sub-national, and national levels in low-income countries such as Uganda. Although approaches that support implementation of digital health interventions exist, there is still limited technical guidance on the strategic planning and implementation of complex systems such as a nation-wide integrated Health Laboratory Information Management System (HLIMS). Therefore, this article demonstrates how the strategic planning process of such systems can be strengthened by adopting the thinking pattern of enterprise architecture, as a holistic approach for aligning business processes with digital technologies. It specifically presents a process for leveraging Enterprise Architecture in Information Systems Strategic Planning (EAISSP). The process was instantiated in Uganda's health laboratory subsector, by using it to formulate an architecture-oriented information systems strategy; and the strategy then guided the design of a master plan for a national integrated HLIMS and its implementation plan. Although EAISSP was tested in the context of the laboratory subsector, it can be contextualized to support other efforts like developing a national e-health strategy or information systems strategy of an enterprise in another sector.

Keywords: Enterprise Architecture, Information Systems Strategic Planning, Laboratory Information Management System.

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1 Introduction

For enterprises to survive in the rapidly changing business and technology environments in which they operate, the issue of aligning their business processes with digital technologies is no longer optional [1]. This also applies to health sector enterprises because the reliability and sustainability of healthcare services largely depend on the availability of quality information that can guide planning and decision-making. To obtain such information, the health sector needs to effectively manage data and information from all its service delivery lines. However, this article focuses on means of effectively managing data and information from the service delivery line of clinical or health laboratories and diagnostic services, which is herein referred to as laboratory information. Laboratory information covers data and information across the full spectrum of laboratory services, ranging from diagnostic services offered at facility-level laboratories and referral or specialized testing services to coordination and regulation services at subnational and national levels.

Several efforts towards improving the quality of laboratory information are reported at an international level (e.g., [2]–[9]) and at a country, e.g., Uganda, level (e.g., [10]–[13]). Yet, the quality of health laboratory services is still affected by several issues [11], [12] that could be avoided if laboratory information was effectively managed and proactively used. This is because the process of strategic planning and implementation of holistic laboratory information management systems that accommodate all data and information needs of the laboratory subsector has not yet been given adequate attention. This can be attributed to two major issues. First, existing efforts in developing Laboratory Information Systems (LIS) intentionally focus on supporting primary functions that directly deliver services to clients in a health laboratory and are silent about capabilities that can support the coordination and regulation of laboratory services at subnational and national levels. Second, the scope and complexity of existing digital health solutions has not allowed comprehensive exploration and incorporation of data and information needs that constitute the full portfolio of health laboratory services and laboratory information management.

To address these issues, there is a need to prioritize the alignment of all processes in the subsector of health laboratories with digital technologies, including Information and Communication Technologies (ICTs). This involves devising laboratory information management solutions that can be categorized into two types, i.e.: a) those that can be deployed at a *health facility level to generate diagnostic information for supporting healthcare decisions*; and b) those that can be deployed at a *health facility level and subnational level as well as national level to support coordination and regulation of laboratory services*. However, existing digital health interventions incorporate the capabilities of the former to some extent but hardly incorporate capabilities of the latter. This prevents health laboratories from effectively and efficiently fulfilling their essential role of providing quality information for proactive and evidence-based healthcare. To fulfil this role, the above two categories of laboratory information management solutions need to be perceived as critical intertwined sub-systems that constitute a broader system – a national integrated *Health Laboratory Information Management System (HLIMS)*. However, there is almost no explicit technical guidance to inform the strategic planning and implementation of a complex and inter-organizational information system, such as the national integrated HLIMS.

A rational approach like enterprise architecture can be leveraged to support the effective alignment of laboratory service delivery processes with digital technologies during the strategic planning and implementation of a national integrated HLIMS. The success of enterprise architecture in business-IT alignment stems from holistically assessing an enterprise's baseline aspects to provide insights into the potential impact of baseline aspects on the desired context [1], [14]. Thus, enterprise architecture can be perceived as a holistic reasoning instrument for streamlining business and ICT alignment and supporting rational thinking towards integrating information systems in a particular context. However, the low adoption of enterprise architecture in aligning healthcare and digital technologies can be attributed to: (1) the limited awareness and involvement of strategic managers in architecture efforts and (2) the lack of adequate knowledge

on enterprise architectures, which implies the need for experts in enterprise architecture to avail free resources to increase awareness [15]. This underpins the need for technical guidance on the process of adopting an enterprise architecture approach in e-health strategic planning and information systems strategic planning in general. Thus, this article addresses this need by providing explicit guidance on how enterprise architecture can be adopted to support information systems strategic planning. Specifically, it answers the research question: *What should constitute a process for leveraging enterprise architecture in information systems strategic planning?* This is answered by presenting a process for leveraging *Enterprise Architecture in Information Systems Strategic Planning (EAISSP),* as shown in Figure 1.

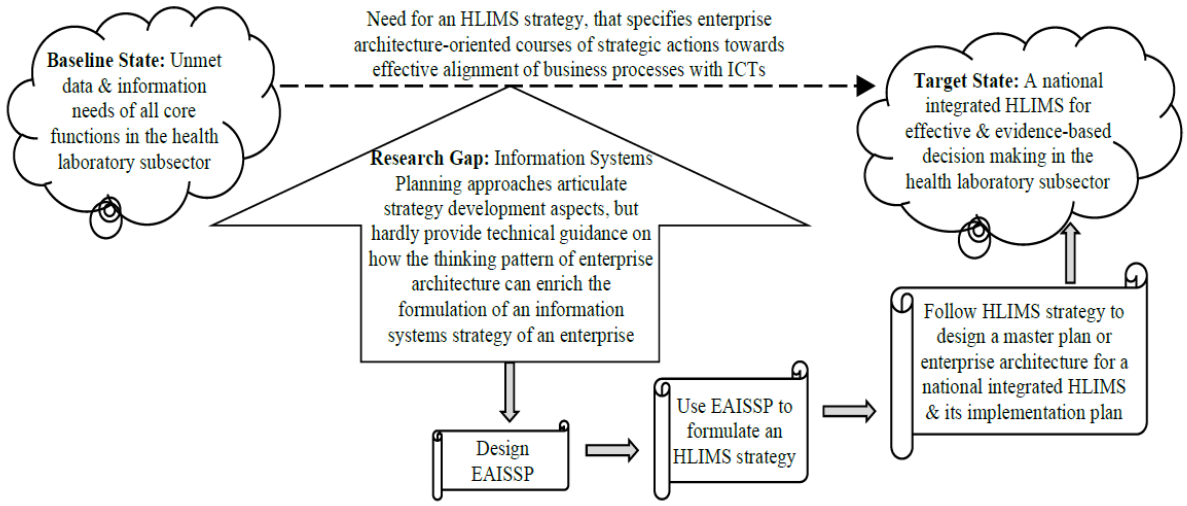

Figure 1. Research Gap and Significance of EAISSP

The EAISSP process was evaluated by using it to inform the formulation of an architecture-oriented HLIMS strategy for Uganda's health laboratory subsector, which was used to guide the design of a master plan or enterprise architecture for a national integrated HLIMS and a corresponding implementation plan.

The article is organized as follows. Section 2 outlines the research method used. Section 3 discusses related work and prevailing challenges in aligning healthcare with ICTs. Section 4 presents the design of EAISSP. Section 5 discusses its evaluation. Section 6 concludes the article.

2 Research Method

EAISSP was developed using the Action Research method because it strongly promotes the comprehensive involvement of subjects or stakeholders in the research. From [16], Action Research requires the researcher to closely engage the subjects of the research to (1) *Perform Diagnosis,* which involves investigating and understanding issues that shape a specific problem context; (2) *Perform Action Planning,* which entails devising an appropriate course of action as a countermeasure to address issues in the problem context; (3) *Perform Action Taking,* which involves the actual implementation or operationalization of the devised course of action to address the problem context; (4) *Evaluate the course of action,* which entails assessing results derived from implementing the course of action; and (5) *Specify Learning accrued from the action,* which involves reflecting on lessons learned from the intervention undertaken in the problem context. In this research, these stages were executed as follows:

- *Diagnosis Stage* involved investigating challenges faced in aligning healthcare and ICTs and identifying gaps in existing approaches for developing laboratory information systems, e-health solutions, e-health strategies, and other approaches. This was done by reviewing existing literature, as elaborated in Section 3.

- *Action Planning Stage* involved designing EAISSP to ensure that it addresses the identified gaps. This was achieved by mutually adopting four approaches that were purposively selected, i.e., two strategic planning approaches and two enterprise architecture approaches. These approaches are elaborated in Section 4.
- *Action Taking Stage* involved instantiating EAISSP by using it, in collaboration with key stakeholders, to guide the development of an HLIMS strategy and initiate its implementation by designing a master plan for a national integrated HLIMS in Uganda. This is elaborated in Section 5.
- *Evaluation and Specifying Lessons Learned Stage* involved eliciting stakeholder feedback on the undertaken effort, reflecting on findings from the above stages, and specifying lessons learned and their implications. This is elaborated in Section 5.

3 Review of Literature on Existing Approaches and Challenges

Literature review efforts are broadly categorized into two types – systematic reviews and traditional narrative reviews [17]–[19]. A systematic literature review involves undertaking and describing the methodical and replicable procedure that is used to search all existing articles and reports on a specific topic of interest, evaluate identified articles, summarize or synthesize findings from the reviewed articles, and condense or use findings to yield new results or knowledge on a specific topic [20], [19], [17]. A traditional narrative review involves providing a descriptive summary or overview or synthesis of evidence from existing articles on a particular topic or theme and appraising contents of the articles with respect to the topic or theme of interest [17]–[19]. The decision on which type of review to conduct depends on the goal and the scope or focus area of the required review, which have to be determined by a researcher [21].

The goal of the review in this research was to execute the diagnosis stage of Action Research, by using findings from existing literature to clarify the research gap specified in Section 1 (see Figure 1). Specifically, the review aimed at determining the extent to which existing approaches for developing laboratory information systems and digital health interventions, can guide the process of using an enterprise architecture-oriented perspective when formulating a complex information systems strategy of an enterprise (such as the HLIMS strategy). Thus, the scope of the review herein did not require summarizing or synthesizing insights or findings from existing approaches but required one to demonstrate the gap that each existing study was not addressing in the context of enriching information systems strategic planning. This implies that the review herein did not require a systematic review approach. Thus, a narrative review was conducted. The narrative review included 35 peer-reviewed articles and technical reports developed by international professional bodies or regulatory bodies. Accordingly, Sections 3.1 and 3.2 give an overview of existing approaches and best practices for planning and implementing Laboratory Information Management Systems (LIMSs), e-health solutions, e-health strategies, and other types of systems. Section 3.3 gives an overview of issues in aligning healthcare and ICTs and requirements for the desired solution.

3.1 Existing Approaches for Planning and Implementing LIMSs

On LIMS implementations, two themes of existing studies were prioritized, i.e.: (A) Instances of LIMSs and other electronic systems that support operations in a health laboratory and (B) Approaches and best practices for planning and implementing LIMSs. Efforts under theme A were reviewed to determine the functionality scope of existing instances of LIMSs, and determine whether attempts have been made to develop a national integrated HLIMS that covers the full scope of core functions offered by the health laboratory subsector. Efforts under theme B were reviewed to determine the scope of existing technical or methodical guidance in developing a national integrated HLIMS. Insights from reviewed efforts under themes A and B are summarized below.

Under theme A on instances of LIMSs and other laboratory support systems, the following efforts were reviewed. First, several LIMSs exist to support the provision of various types of testing services in a health laboratory; and specialized LIMSs exist to support specialized and reference testing services in a health laboratory, such as C4G BLIS [8], [22], OpenLabs [9]; and LACEN laboratory information system [23], [24]. Second, systems for supporting other laboratory processes include the Reqscan solution, which supports the storage and retrieval of paper-based laboratory requisition forms [25], and a system that supports an interpretation of laboratory test results to patients and retrieves diagnosis-related information from a laboratory test report [26]. In addition, guidelines exist for integrating a LIMS with other health information technologies in order to increase utilization of laboratory test results among physicians [27]. *However, reviewed efforts in this theme concentrate on internal operations of a laboratory, and are silent about inter-laboratory operations and coordination as well as regulation of health laboratory services. In addition, the efforts hardly provide technical guidance on how to leverage a LIMS at a specific site or multiple sites, in a way that allows seamless information exchanges with other solutions within and across laboratories at subnational and national levels.*

Under theme B on approaches and best practices for planning and implementing LIMSs, the following efforts were reviewed. Sepulveda and Young [6] articulate specifications of desired functionalities of a LIMS that leverages Artificial Intelligence to manage information at the health facility level proactively, optimize service delivery in a clinical laboratory, and improve clinical care. A catalog exists of data and information needs that LIMS implementation efforts should consider in a health laboratory [28]. APHL [7] provides a description of core laboratory business processes, requirements, and essential elements of a LIMS for managing electronic laboratory information in a health laboratory and guidelines for implementing LIMS projects. A set of indicators exists that should constitute an intelligent dashboard, which addresses the challenges in managing operations in a clinical laboratory [29]. *Insights from these efforts are relevant in the articulation of requirements and functionalities of a national integrated HLIMS. However, the scope or intention of these efforts did not entail providing explicit technical guidance on how specific requirements and functionalities can be operationalized. This implies that if a national integrated HLIMS is to adopt insights articulated in the above efforts, there is a need to first design an architectural blueprint of capabilities that can deliver specific requirements and functionalities and a roadmap for implementing such an architectural blueprint in a low-income country. Yet, there is only implicit guidance on how this can be done during the strategic planning of a national integrated HLIMS and no guidance on how to ensure that service delivery processes in the laboratory subsector are coherently aligned with ICTs. This is due to the lack of customized methodological details or thinking patterns that can be followed to guide the strategic planning of an integrated HLIMS that accommodates the data needs of all core functions in the laboratory subsector.*

The review under theme B further considered the best practices in implementing LIMS, and the following were observed. Guidance exists in the form of factors for managing the logical selection of a LIMS – the profile and performance of a LIMS vendor, portability of a LIMS, provisions for customizing a LIMS, clear specifications of a LIMS, and LIMS scores on issues of reliability and security [30]. Sinard et al. [31] present guidelines for deploying an electronic health record that incorporates a LIMS module and a specialized LIMS solution or an integrated LIMS solution that serves several laboratory departments. Furthermore, Alves et al. [23] present a contextualized evaluation model (based on ISO/IEC 25010 standard) and a questionnaire that end users can use to assess the quality of a LIMS. Moreover, evidence exists on how LIMS implementation impacts the turnaround time of laboratory tests [32] and how prioritizing the reliability of ICT solutions that constitute a LIMS significantly improves laboratory performance and reveals the value of LIMS adoption [33]. *The establishment of a nationally integrated HLIMS can greatly benefit from the mutual adoption of insights from these best practices by rationally determining when and how a specific best practice can be applied. However, a clearly defined approach that can guide the*

mutual adoption of insights from these best practices during the strategic planning of a national integrated HLIMS is not available.

Furthermore, APHL [34] provides a project management framework for supporting resource management during implementation and maintenance of a LIMS at a one or multiple clinical laboratory sites. *However, the use of only the project management approach (without enterprise architecture), insufficiently enables one to ensure that project outputs fully subscribe to enterprise goals and stakeholder concerns* [14], [1].

Despite the existing innovations under themes A and B above, several data and information needs for effective delivery of laboratory services are still not met due to two reasons. First, without detailed and accurate transaction-level data on laboratory services, it is difficult to: (1) Minimize errors in monthly aggregates or reporting of facility-level service statistics, (2) Conduct root-cause analysis geared towards addressing specific problems in laboratory service delivery, (3) Conduct effective monitoring and evaluation of laboratory service delivery initiatives; and (4) Perform quality forecasts on required resources. Second, the lack of timely, complete, and accurate data on program performance and program implementation gaps can hinder evidence-based planning and decision-making. These gaps underlined the need to develop a national integrated HLIMS for Uganda that can improve service delivery at the facility level and coordination as well as regulation of services at the subnational and national levels. Unfortunately, existing efforts under themes A and B can insufficiently provide the technical guidance into the strategic planning and implementation of such a complex solution. *Thus, there is the need for a method that can guide the formulation of a holistic HLIMS strategy through (1) adapting existing LIMS requirements and functionalities (under theme A) to the contextual needs of health laboratories in a low-income country and (2) mutually adopting existing best practices (under theme B). Section 3.2 discusses the extent to which existing approaches for developing e-health strategies and solutions address this need.*

3.2 Existing Approaches for Developing e-Health Strategies and Solutions

On e-health advancement, three themes of existing studies were prioritized, i.e.: (1) Cases of e-health strategy development efforts, (2) Approaches and success factors for developing e-health strategies and e-health solutions, and (3) Efforts on developing enterprise architectures for e-health implementations and other types of systems. Insights from reviewed efforts under themes (1) to (3) are summarized below.

Under theme (1) on cases of national e-health strategy development efforts, instances include Kenya's e-Health Strategy, Uganda's e-Health Strategy, Tanzania's e-Health Strategy, and e-health strategies of other African countries [35]. *However, the incorporation of digital solutions for supporting laboratory processes in existing national e-health strategies is limited to only key processes that deliver laboratory testing and results management services. Herein, it is assumed that the wide scope of health sector functions scarcely gives room for the detailed exploration and inclusion of all core functions in the laboratory subsector.* Moreover, the above e-health strategy documents recommend the development of an enterprise architecture for integrating e-health solutions. *However, they scarcely provide details on how enterprise architecture can be used to support the planning, alignment, and scheduling of various e-health initiatives into long-term, medium-term, or short-term projects that can be coherently implemented. This indicates that there is still only implicit guidance on how the enterprise architecture approach can be leveraged during information systems strategic planning in organizations, including healthcare organizations.*

Under theme (2) on approaches and success factors for developing e-health solutions and strategies, reviewed efforts include the following. WHO [36] presents a framework that specifies seven components that should constitute a national e-health function and encourages countries also to consider developing an e-health enterprise architecture to obtain a comprehensive national e-health strategy and implementation guide. *However, for a national e-health enterprise architecture to be developed, there is a need for explicit technical guidance on how to incorporate the*

enterprise architecture development methodology at the stage of formulating and aligning strategic actions during information systems strategic planning. Indeed, the mutual adoption of enterprise architecture at the strategy formulation stage yields a detailed strategy definition [14], [1], *which has no ambiguities that can mislead the strategy implementation teams. Unfortunately, explicit technical guidance on how this can be realized is scarcely available.*

In addition, WHO [37] provides a comprehensive taxonomy of digital health interventions, however, the mention of laboratory services therein is limited to only a laboratory and diagnostics information system for managing laboratory tests and results and confirmation of suspected cases in disease surveillance. *Other support functions in a health laboratory and coordination and regulation of services across a nationwide laboratory network are scarcely incorporated in the taxonomy of digital health interventions. An enriched taxonomy would help in guiding the strategic planning and coherent implementation of all digital interventions that can support directory of services offered by the health laboratory subsector. However, explicit guidance scarcely exists on how to derive a holistic taxonomy of digital interventions that should constitute a national integrated HLIMS and strategically plan its realization.*

Moreover, WHO [38] provides a guideline that specifies a set of 9 categories of priority digital interventions that are critical in strengthening healthcare, and clearly articulates 18 aspects that are beyond its scope, two of which are: (a) digital interventions for health laboratory services; and (b) mechanisms for enabling data exchange and interoperability across digital health solutions. WHO [38] also articulates the need for an approach that enables stakeholders to implement instances of the different categories of digital health interventions in a unified way that allows coherent and integrated operations instead of parallel or project-specific operations. *The value envisioned from all digital health interventions in the guideline can be achieved if: (a) the information-centric role of health laboratory services in specific digital health interventions is recognized and realized and (b) all specified digital health interventions are implemented in a coherent way by adopting enterprise architecture. However, explicit guidance scarcely exists on how that can be handled during information systems strategic planning, let alone how to derive a holistic taxonomy of digital interventions that should constitute a national integrated HLIMS and strategically plan for its realization.* Further, WHO [39] presents various operational and sustainability issues that are associated with the implementation of 'siloed' digital health interventions, and gives insights into the establishment of an enterprise architecture for an integrated digital health platform. *However, the incorporation of laboratory data and information needs in this effort was also limited to only capabilities of managing laboratory test requests and results in a health facility level LIMS. Also, detailed technical guidance is scarcely provided on how the establishment of the enterprise architecture for an integrated digital health platform can be incorporated in information systems strategic planning.*

On coherent implementations of solutions, Huang et al. [40] also present technical insights into why the interoperability needs of e-health implementations ought to be prioritized, deliberated, and accommodated at the inception stage of an initiative. Also, empirical evidence exists on how the lack of proper alignment of business strategies of healthcare organizations with IT strategies significantly affects the performance of those organizations [41]. *However, it is still methodically implicit how and when insights from these studies can be mutually adopted with other guidelines listed above (and approaches for aligning institutional processes with ICTs) so as to formulate a clear strategy for establishing a national integrated HLIMS.*

Under theme (3) on developing enterprise architectures for e-health implementations, reviewed efforts include the following. Adenuga et al. [42] present a formal model of requirements for successfully implementing e-health solutions and constraints for the vertical and horizontal integration of healthcare and ICT management to achieve interoperability. *However, the model does not go into the thinking pattern that stakeholders must undergo when formulating strategic actions toward achieving requirements and constraints for developing interoperable e-health implementations.* Mwanyika et al. [43] present a method that supports documentation of process workflows and system requirements, which inform the technical design of a health information

system. Mwanyika [44] discusses the role of enterprise architecture in developing e-health solutions that constitute an e-health strategy. *However, the context in which enterprise architecture is used in these efforts is at the solution development level (i.e., when the enterprise architecture approach is used to develop an e-health solution architecture that guides the implementation of specific information systems solutions). Such a context differs from the problem context that this research attempts to address (i.e., when enterprise architecture development needs to be treated as an integral part of the overarching information systems strategic planning framework of an enterprise).* Moreover, Stansfield et al. [45] discuss (a) the relevance of pursuing an architecture-driven mindset in strengthening health information systems, (b) how an enterprise architecture for health information systems can support knowledge sharing on e-health implementations among stakeholders, and (c) critical questions that should be addressed when developing an enterprise architecture for a national health information system. *Insights from this effort scarcely go into detail on how to promote the realization of the enterprise architecture for the national health information system by integrating it into the strategic planning framework of the health sector.*

In addition, Verbeke et al. [46] articulate how the development of a national e-health enterprise architecture for Burundi enabled them to identify solutions that could be implemented to address various issues and coherently specify required actions for advancing the country's e-health initiatives in a 10-year strategy. Le Pape et al. [47] also describe their experiences in undertaking a four-phased procedure to develop an enterprise architecture for strengthening health information systems in Morocco and how the resultant enterprise architecture was used to formulate an 11-year e-health strategy for the country. *First, the inclusion of electronic capabilities for health laboratory services in these efforts is limited to the laboratory testing and imaging functions. Second, these efforts demonstrate a context where an enterprise architecture is first designed, and thereafter it is used to guide the formulation of strategic actions associated with its implementation. Third, these efforts articulate their achievements and provide an overview of the procedures undertaken but scarcely go into detailed activities that constituted their procedures. Such details would enable other countries to adapt their procedures to specific country contexts. Fourth, the e-health national enterprise architectures (developed in these efforts) and e-health solution architectures (developed in the above efforts) are designed to suit the contextual needs of specific countries and cannot be simply adopted and used in contexts of other countries. These issues emphasize the need for an elaborate description of how to formulate an information systems strategy in contexts where an enterprise architecture does not exist or is already existing.*

On developing enterprise architectures for guiding implementations of other types of systems, reviewed efforts include the following. Astri and Gaol [48] give an overview on how the enterprise architecture planning framework guided the development of an enterprise architecture for implementing an integrated information system in an enterprise and present deliverables from the initiative. Riku and Setyohadi [49] also describe how the enterprise architecture planning framework guided the development of an enterprise architecture and its implementation plan in an enterprise and present deliverables from the initiative. *Efforts in these studies aim at describing deliverables from enterprise architecture development initiatives in specific enterprises, but not demonstrating how the formulation of strategic actions during information systems strategic planning can be enriched by using an enterprise architecture-oriented approach.* The former scenario focuses on architecture development but not its general integration with the strategic planning framework of an enterprise. Yet, in the latter scenario, enterprise architecture and information systems strategic planning are treated as complementary approaches for effective business-IT alignment, where an enterprise architecture and its implementation (as well as its maintenance) are envisioned as some of the scheduled strategic actions and target outputs of an information systems strategy. Thus, explicit guidance is needed on how one can devise a long-term information systems strategy that accommodates three critical pillars in business-IT alignment, i.e., (a) creating an enterprise architecture for aligning institutional processes with digital technologies, (b) using the architecture to provide strategic direction of information systems development and implementation efforts in that enterprise, and (c) maintaining the architecture to

ensure that it appropriately supports the strategic drives of an enterprise. Hence this is the motivation to design EAISSP.

3.3 Challenges in Healthcare-ICT Alignment and Required Interventions

Literature was also reviewed on the theme of issues hindering the effective alignment of healthcare and ICTs. Since the laboratory subsector is a critical pillar in healthcare, it was perceived that efforts to align laboratory service delivery with digital technologies are susceptible to challenges affecting healthcare-ICT alignment. Thus, Table 1 presents a summary of challenges derived from existing literature on issues hindering the effective alignment of healthcare and ICTs and their implications on the requirements for EAISSP. The challenges are coded as **Cx** in column 1, and the required interventions to address the challenges are specified in column 2 (with codes **Rx**).

Table 1. Challenges from Literature on Healthcare-ICT alignment and Required Interventions

Challenges in Healthcare-ICT Alignment (from reviewed literature)	Required Interventions to Address the Challenges
C1. Unclear specifications on the scope and architecture of aligning healthcare and ICTs and the scope of automating business processes [50]. • C1.1. Some countries lack a strategic plan for implementing e-health solutions [42].	• R1. Provide guidance on how to formulate an information systems strategy that accommodates all stages in business-IT alignment in a complex organizational setting (such as the laboratory subsector), i.e., (a) deliberating and defining requirements or specifications of an enterprise architecture or master plan, (b) designing the enterprise architecture, (c) implementing it, and (d) maintaining it.
	• R2. Provide guidance on when to schedule, and how to execute, the task of deliberating and specifying the scope of the enterprise architecture development effort with key stakeholders of a complex organizational setting (such as the laboratory subsector).
• C1.2. Limited understanding of how the customization and effectiveness of ICT solutions influence service delivery outcomes and results [50].	• R3 Provide guidance on when to schedule, and how to execute, the task of developing a value proposition or cost-benefits analysis scorecard for an enterprise architecture of a complex organizational setting (such as the laboratory subsector). o The value proposition is envisioned to show how the alignment of the laboratory subsector with ICTs may seem expensive in the short run; yet it is one of the effective ways of reducing operational costs of data and information management in the long run.
• C1.3. High costs (in terms of time, finances, and effort) for starting e-health implementations and sustaining them (by ensuring that target users learn to use them, periodically evaluating them, and upgrade them), yet return on investment is unpredictable [42], [30].	
• C1.4. It is difficult to find and recruit experienced ICT personnel who possesses an adequate and balanced skillset that is required to manage the implementation of e-health solutions effectively [42], [50] in a integrated way.	• R4. Provide guidance on when to schedule, and how to execute, the task of developing, operationalizing, and maintaining guidelines for continuous training and skilling of all human resources to increase capacity for effective management and use of data and information in a complex organizational setting (such as the laboratory subsector).
• C1.5. Privacy, confidentiality, and security concerns that are associated with e-health solutions raise the risk of interception of patient information by unauthorized individuals and effects thereof [42].	• R5. Provide guidance on when to schedule, and how to execute, the task of designing and implementing a security architecture for a complex organizational setting (such as the laboratory subsector)

Table 1. Continued

Challenges in Healthcare-ICT Alignment (from reviewed literature)	Required Interventions to Address the Challenges
• C1.6. Lack of adequate technical support for integration and interoperability of e-health solutions and laboratory information systems, so as to enable exchange of clinical data between laboratories and other departments in healthcare institutions [42]. • C1.7. Replication of systems and discrepancies in reporting due to the existence of information silos at institutional, provincial, and national levels of government; and within departments and programs of health service delivery [42]. • C1.8. Absence of detailed or appropriate designs of e-health implementations [42], which results in systems that do not fully address concerns and needs of key stakeholders. • C1.9. Unclear criteria for prioritizing ICT projects with respect to process and patient needs [50].	• R6. Provide guidance on when to schedule, and how to execute, the task of devising and establishing an architecture governance framework for overseeing aspects of integration and interoperability during the development of an enterprise architecture for a complex organizational setting (such as the laboratory subsector). • R7. Provide guidance on when to schedule, and how to execute, the task of designing and implementing an application architecture for a complex organizational setting (such as the laboratory subsector). ○ The application architecture is envisioned to guide the transition from existing isolated solutions to a national integrated solution that supports information sharing and reuse in the laboratory subsector. • R8. Provide guidance on when to schedule, and how to execute, the task of designing and implementing a technology architecture for a complex organizational setting (such as the laboratory subsector).
C2. Limited organizational governance and low involvement of all departments or stakeholder groups in strategic planning [50]. • C2.1. Unclear specification and demarcation of roles in decision-making when implementing ICT projects leading to a lack of mutual understanding of the roles of each department and inter-linkages across departments [50]. • C2.2. Weak governance mechanisms to ensure compliance with standards and procedures for appropriate management and use of patient-based information and aggregate information [42]. • C2.3. Limited availability of IT-business liaison to coordinate departmental tasks [50]. ***C3. Limitations in communication with and among stakeholders, and inadequate knowledge sharing to prevent miscommunication during e-health implementations [50].***	• R9. Provide guidance on when to schedule, and how to execute, the task of devising and implementing a stakeholder map and corresponding communication plan for the enterprise architecture development effort in a complex organizational setting (such as the laboratory subsector).
• C3.1. It is difficult to overcome conflicting priorities and views across departments [50].	• R10. Provide guidance on when to schedule, and how to execute, the task of conducting a tradeoff analysis of architecture views across domains so as to address conflicting concerns and needs of stakeholder groups during the enterprise architecture development effort in a complex organizational setting (such as the laboratory subsector).
• C3.2. Absence of a mechanism that enables learning from previous experiences [50]. • C3.3. Low readiness to face implied changes from e-health implementations and a lack of a management style that can promote acceptance of change and increase readiness [50].	• R11. Provide guidance on when to schedule, and how to execute, the task of periodically evaluating the performance of the enterprise architecture for a complex organizational setting (such as the laboratory subsector), processing feedback, devising control measures and change management strategies, and maintaining the enterprise architecture.
In a broader context beyond e-health, Azevedo et al [51] argue that institutional strategic plans can initiate and shape or inform enterprise architecture development and recommend that: • **R12.** Enterprise architecture development approaches need to be extended to provide adequate support for (a) planning of scenarios in a specific context and generation of corresponding strategies; (b) generating and elaborating enterprise strategies; and (c) aligning enterprise strategies with enterprise architecture and aligning the mission, vision, goals, and objectives with enterprise architecture elements.	

To rationally address challenges and requirements in reflected in Table 1, there is a need for a holistic intervention that mutually leverages the strengths of existing approaches. This is because none of the existing approaches can serve as a 'silver bullet' that explicitly specifies all mechanisms that are needed to address the above issues, guide the formulation of a complex information systems strategy (such as the national integrated HLIMS strategy), and support coherent implementation of such a strategy. Thus, this research was motivated to address requirements R1 to R12 (in Table 1) by exploring ways through which information systems strategic planning approaches and enterprise architecture approaches can be mutually adopted to reduce the complexity of long-term business-IT alignment efforts.

Design Decisions Taken to Address Requirements R1 to R12 in Table 1. Two major design perspectives were considered when deriving EAISSP as elaborated below. *The first perspective* focused on adopting strategic planning approaches to provide (a) a rational way of structuring the formulation of a complex and long-term information systems strategy and (b) a list of internal and external business and technology aspects that should be investigated and deliberated during the formulation of the information systems strategy. Thus, the scheduling aspect specified in requirements R1 to R12 (in Table 1) was addressed by adopting strategic planning approaches. Such approaches can inform the scheduling and alignment of activities that constitute the designing, implementation, and maintenance phases of its enterprise architecture. *The second perspective* focused on adopting enterprise architecture approaches to invoke an architecture-oriented thinking pattern that helps to investigate and specify the critical business and technology aspects that should be aligned in a complex and long-term information systems strategy. Thus, the technical aspects required to realize R1 to R12 (in Table 1) were addressed by adopting enterprise architecture approaches. These approaches provide technical guidance towards ensuring that deliverables of architecture development activities are used as enablers for delivering the enterprise mission, vision, goals, objectives, and strategic actions. Section 4 describes how these two design perspectives were operationalized.

4 The Design of EAISSP

Following the adoption of the Action Research approach (as specified in Section 2) and the findings from the diagnosis stage (in Section 3), this Section describes how the action planning stage of the research was conducted. Section 4.1 specifies approaches that were adapted to address issues and requirements identified in the diagnosis stage and Section 4.2 presents the structural composition of EAISSP as the desired solution.

4.1 Approaches Adopted to Address Requirements

To holistically realize requirements coded R1 to R11 in Table 1 (Section 3.3), four classical approaches were mutually adopted. These include (1) the Planning Framework for Strategy [52], [53]; (2) the Strategic Alignment Model [54]; (3) the Architecture Development Method of The Open Group Architecture Framework – TOGAF ADM [55], [56]; and (4) the Enterprise Architecture Capability Maturity Model – EACMM [57]. The first two approaches are information systems strategic planning approaches and the last two are enterprise architecture approaches. These were mutually adopted to derive a process, coined herein as EAISSP (as introduced in Section 1). The purpose of EAISSP is to guide the development of an architecture-oriented information systems strategy that can deliver the long-term goal of effective business-IT alignment in a complex organizational setting. As indicated in preceding sections, the setting of interest herein is the context of the health laboratory subsector in Uganda, which required the formulation of an HLIMS strategy that involved (a) designing a master plan or enterprise architecture for guiding decision-making in the establishment of a national integrated HLIMS and (b) designing and operationalizing its implementation plan and maintenance plan to allow continuous evaluation and improvement. For such a long-term and complex initiative to be achieved in a coherent way,

there was a need to adopt the above 4 approaches to support rational thinking among stakeholders. The adopted approaches are defined below, their selection is justified, and highlights are given on how each of them shaped the design of EAISSP.

Adoption of the Planning Framework for Strategy. The Planning Framework for Strategy in [52], [53] articulates three major phases of strategic planning that guide stakeholders to specify the strategic direction of an enterprise (i.e., strategic analysis, strategic choice, and strategy implementation) and provide a basis against which institutional performance and growth is assessed. Thus, it was adopted herein to guide the clustering and scheduling of activities that need to be executed during strategy formulation so as to address issues and requirements specified in Section 3.3. Specifically, this framework was adopted to guide the scheduling of when particular guidelines of enterprise architecture development and aspects from other (strategic planning) approaches can be coherently deliberated during the formulation of an information systems strategy. To constitute EAISSP, activities that make up the three phases of the Planning Framework for Strategy were regrouped into six clusters or steps as shown in Figure 2. This is elaborated in Section 4.2.

Adoption of the Strategic Alignment Model. The Strategic Alignment Model articulates four domains of strategic choice in an enterprise – organizational infrastructure and processes, business strategy, IT infrastructure and processes, and IT strategy [54]. Particular elements that constitute these domains are specified in Appendix 1. This model was adopted herein to give insights into the critical domains (and their corresponding elements) that need to be considered during strategy formulation. In constituting EAISSP, these four domains were adopted to elaborate elements that need to be scanned in an enterprise's internal and external environments. This is elaborated in Sections 4.2.1 to 4.2.3.

Adoption of TOGAF Architecture Development Method. TOGAF is an open standard that guides the development of an enterprise architecture as a business-IT alignment instrument across public and private sector agencies [55], [56]. Since, among the existing architecture frameworks, it is TOGAF ADM that provides a detailed procedure for developing an enterprise architecture [56], it was adopted herein. In constituting EAISSP, three perspectives were taken. First, the guidelines of enterprise architecture development were used to enrich or elaborate specific activities of information systems strategic planning that constitute The Planning Framework for Strategy. Second, the activities of information systems strategic planning were used to guide scheduling of the execution or realization of specific architecture development guidelines. These two perspectives are elaborated in Sections 4.2.4 and 4.2.5. Third, how architecture development guidelines are adopted and implemented varies across agencies, depending on their architecture maturity levels. Architecture maturity is the extent to which business-IT alignment in a particular institution is embraced and practiced. Thus, there was a need to adopt an additional mechanism that enables stakeholders to assess the maturity of business-IT alignment during information systems strategic planning. Hence the adoption of EACMM as specified below.

Adoption of Enterprise Architecture Capability Maturity Model. EACMM is a best practice that is being used to guide process improvement in several enterprise contexts, because it guides assessments that help to specify the baseline and target states of an enterprise, the role of ICTs in realizing the target state, the corresponding strengths and weaknesses, and the roadmap to the desired state [57]. Thus, EACMM was adopted herein to provide insights into how progress during the planning and implementation of a complex information systems strategy (such as the HLIMS strategy) can be directed, monitored, evaluated, and continuously improved. EACMM has three elements – the enterprise architecture capability maturity model; the itemized description of characteristics at different maturity levels, as specified in the capability model; and the maturity model scorecard [57]. Thus, adopting EACMM helps obtain an instrument that enables stakeholders to ensure that an information systems strategy is formulated comprehensively, allowing its elements to be implemented and monitored in an incremental and integrated manner. This is elaborated in sections 4.2.1 to 4.2.5.

4.2 Structural Composition of EAISSP

EAISSP is a process that invokes an enterprise architecture-oriented thinking pattern during the formulation of an information systems strategy to coherently accommodate core aspects in the planning, implementation, and evaluation phases of a complex business-IT alignment initiative. EAISSP comprises 6 steps, coded as S1 to S6. The design of EAISSP, as presented in Figure 2, shows these steps and the relationships between them. Steps S1 to S6 address requirements R1 and R10 (specified in Table 1 in Section 3.3), Step S4 addresses requirements R2 and R3 (in Table 1), Step S5 addresses requirement R11 (in Table 1), and Steps S4 and S5 jointly address requirements R4 to R10 (in Table 1).

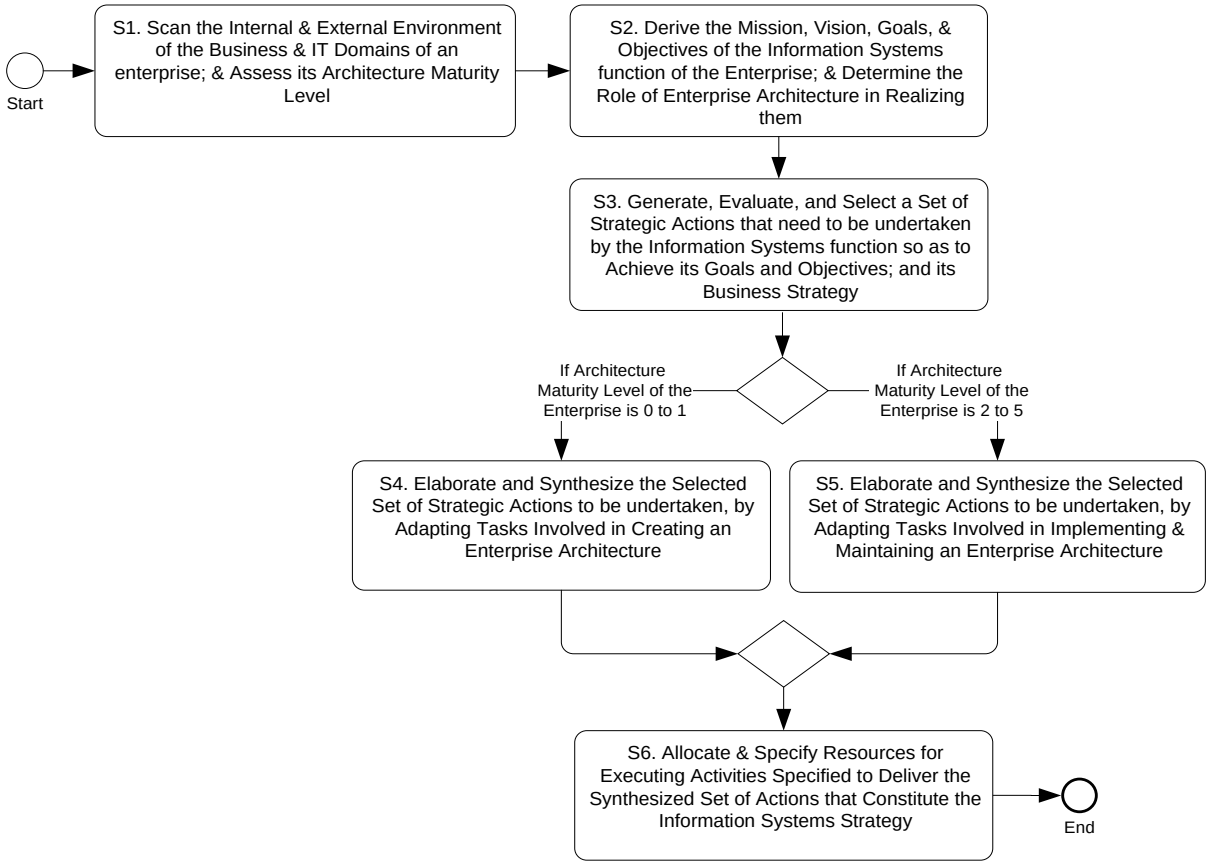

Figure 2. Structural Composition of EAISSP

Each step in Figure 2 comprises several tasks (coded as **Tx**) which are presented in Appendices 1 to 6. The execution of each task involves answering questions (coded as **Qx**), that enable stakeholders to think and generate responses that can be rationally deliberated and harmonized (see Appendices 1 to 6). Thus, three key elements shape the design of EAISSP, i.e., *Steps of the process (S1 to S6), their corresponding Tasks (Tx), and underlying Question prompts for each task (Qx).* These elements enable EAISSP to serve as a guide that addresses the gap of limited technical guidance on how to leverage enterprise architecture during the planning or formulation of an information systems strategy. Sections 4.2.1 to 4.2.6 elaborate steps S1 to S6 of EAISSP, and Appendices 1 to 6 present their corresponding tasks (Tx) and question prompts (Qx).

4.2.1 Scan Enterprise Environment and Assess its Architecture Maturity (S1)

Step S1 in Figure 2 involves scanning the internal and external environment of the business and IT domains of the enterprise and determining its architecture maturity level. This was derived by

mutually adopting the following concepts from three approaches (whose selection is justified in Section 4.1).

The first concept is the strategic analysis phase of the Planning Framework for Strategy in [52], [53], which involves scanning the business environment to understand its occurrences and their possible impact, its stakeholders and their socio-cultural contexts, its internal capabilities and their strengths and weaknesses, the potential economic and competitive changes, and their possible effects in terms of opportunities and threats. These aspects informed the formulation of tasks T1.1 to T1.7 in Appendix 2. However, the critical components and dimensions (that need to be assessed) in the internal and external environments of the enterprise were not explicitly articulated. To address them, the Strategic Alignment Model was also adopted as elaborated below.

Thus, the second concept is on the critical dimensions of business-IT alignment in the internal and external environments of an enterprise, as articulated in the Strategic Alignment Model. According to Henderson and Venkatraman [54], the internal and external environments of the business and IT domains of an enterprise have 4 components or parameters and each of them has 3 dimensions (as demonstrated in Appendix 1). Thus, the components and their dimensions were adopted in step S1 to specify the scope of what should be assessed in the internal and external environments of an enterprise during the formulation of an information systems strategy.

The third concept is on the checklist for assessing the architecture maturity of an enterprise, which is one of the core components of EACMM (as introduced in Section 4.1). EACMM enables stakeholders to determine the extent to which enterprise architecture has been practiced in an organization, as a basis for specifying additional efforts that can be undertaken to advance the practice [57]. Thus, task T1.5 in Appendix 2 prompts that the baseline architecture maturity level of the enterprise is assessed during the internal and external situational analysis so as to ensure holistic assessment and efficient utilization of resources. Results from the architecture maturity assessment are used as input for steps S4 and S5 of EAISSP. Appendix 2 also shows how the above three concepts were adapted to derive questions that key stakeholders need to investigate and deliberate during execution of tasks T1.1 to T1.7 in step S1 of EAISSP.

4.2.2 Derive Mission, Vision, Goals, and Objectives of the IS Function (S2)

Step S2 in Figure 2 involves using an existing business or corporate strategy of an enterprise as a basis for (a) deriving the mission, vision, goals, and objectives of an Information Systems (IS) function in an enterprise so as it can effectively align the business domain and IT domain of an enterprise and (b) determining the role of enterprise architecture in realizing them.

From the Strategic Alignment Model [54], goals and objectives of business-IT alignment are derived from findings of the internal and external environmental assessment of the business and IT domains of the enterprise (see Appendix 1). In addition, Venkatraman et. al [58] indicate that alignment of the business and IT domains of an organization can be guided by four perspectives, i.e., (a) *Strategy Execution perspective,* where aspects of the business strategy influence decision making on the organization infrastructure and processes and the IT infrastructure and processes of an enterprise; (b) *Technology Potential perspective,* where aspects of the business strategy are used as the basis of formulating the IT strategy and deriving the requirements and specifications of the IT infrastructure and processes; (c) *Competitive Potential perspective,* where aspects of the business strategy are formulated basing on the extent to which emerging ICTs can influence the business scope, distinctive competencies, and business governance; and (d) *Service Level perspective,* where the effective use of IT resources is prioritized (instead of the business strategy), so as to enable the organization to swiftly respond to the rapidly changing customer demands.

Based on the above insights, step S2 of EAISSP considers perspectives *(a) and (b) – the strategy execution perspective and technology potential perspective.* Thus, step S2 uses the enterprise's business mission, vision, goals, objectives, and business strategy as a basis to acquire insights into how to formulate the mission, vision, goals, and objectives of the IS function. The derived goals and objectives can be further assessed with respect to the goals of enterprise architecture as an

instrument for business-IT alignment. Enterprise architecture explicitly defines the tactical and operational components or building blocks that can deliver specific objectives and goals of the IS function [14], [56]. Thus, assessing the goals and objectives of the IS function and goals of enterprise architecture helps to determine which aspects of the latter will help to achieve which aspects of the former. This assessment then informs the prioritization of goals and strategic actions or choices that constitute an information systems strategy. Appendix 3 shows that step S2 of EAISSP comprises tasks T2.1 to T2.3, and provides corresponding questions that need to be investigated and answered during the execution of these tasks.

4.2.3 Derive Strategic Actions for Achieving Objectives of the IS Function (S3)

Step S3 in Figure 2 involves generating possible strategic actions for the IT domain of the enterprise, evaluating them, and selecting appropriate strategic actions towards achieving the goals and objectives of the IS function and the business strategy of the enterprise. This is adapted from the strategic choice phase of the Planning Framework for Strategy, which, according to [52] and [53], involves generating possible alternatives of strategic actions for achieving goals and objectives, evaluating the alternatives, and selecting the most appropriate strategic actions. Moreover, to generate the strategic actions the following two thinking patterns can be undertaken.

The first thinking pattern is derived from the two adopted perspectives of business-IT alignment that are mentioned in Section 4.2.3 (i.e., the strategy execution perspective and technology potential perspective). In this pattern, these perspectives were adapted to derive question prompts that guide stakeholders to generate strategic actions from features of elements that constitute the business strategy. This is done basing on findings from the internal and external environmental assessment in step S1 of EAISSP (see Appendix 4 – task T3.1 and its question prompts).

The second thinking pattern is derived from the three major roles of IT in an enterprise. According to Henderson and Venkatraman [54], IT in an enterprise serves 3 roles, i.e., (a) *Administration role,* where IT rationalizes and automates business processes that constitute the accounting and control capabilities of an enterprise; (b) *Operations role,* where IT rationalizes and automates all non-administrative business processes in an enterprise to support the implementation of the chosen business strategy of the enterprise; and (c) *Competitive role*, where IT is not leveraged to yield operational efficiency, but to enable an enterprise to transform its structure and processes in ways that can enable it to acquire unique sources of competitive advantages in the market place. In this pattern, these 3 roles of IT were adapted to derive question prompts that guide stakeholders to generate and evaluate possible strategic actions on how ICTs can be leveraged to achieve the administrative role, operations role, and competitive role of IT in an enterprise (see Appendix 4 – task T3.2 and its question prompts).

Ultimately, these two thinking patterns are expected to yield strategic actions towards achieving the strategic goals and objectives of the IS function and to support the realization of the strategic actions that constitute the business strategy of the enterprise. Besides, step S3 assumes that an enterprise has already formulated its business strategy, thus tasks and question prompts in Appendix 4 focus on providing guidance towards formulating the information systems strategy. However, if there is no existing business strategy of the enterprise, tasks T1.3 and T1.4 in step S1 (see Appendix 2) provide insights into how to define elements of the business strategy that are critical in formulating the information systems strategy.

Reason for the parallel diversion triggered by step S3 of Figure 2. After specifying the set of strategic actions that are envisioned to achieve the goals and objectives of the IS function, the coherent implementation of the selected set of strategic actions can be planned by adopting an enterprise architecture approach to strategy formulation and strategy execution. This is because enterprise architecture is an instrument that helps an organization formulate and assess the impact of a given strategy before implementing or executing it [1]. However, how an enterprise architecture thinking pattern can be adopted during the formulation of an information systems strategy of an enterprise depends on the architecture maturity level of that enterprise. This is

because the architecture maturity level informs stakeholders whether to adopt the architecture thinking pattern through *(a) creating an enterprise architecture or (b) improving an existing enterprise architecture, or (c) implementing an existing enterprise architecture, or (d) maintaining* an already implemented enterprise architecture. Text Box 1 shows the different levels of architecture maturity.

Figure 2 shows that, after step S3, a diversion is made to either step S4 or step S5, depending on the architecture maturity level of an enterprise. This implies that EAISSP is designed to guide the formulation of an information systems strategy in the following two contexts. Context A is when an enterprise has no enterprise architecture and solutions are being implemented in project-specific modes (i.e., enterprises are at maturity level 0 or 1 as defined in Text Box 1). Context B is when an enterprise has an enterprise architecture (i.e., enterprises are at maturity levels 2 to 5 as defined in Text Box 1). Thus, based on findings from step S1 (see Appendix 2 – task T1.5), after step S3 in Figure 2, an enterprise with an architecture maturity level in the range of 0 and 1 executes step S4; and an enterprise at an architecture maturity level in the range of 2 to 5 executes step S5. Steps S4 and S5 are elaborated in sections 4.2.4 and 4.2.5, respectively.

Text Box 1. Architecture Maturity Levels. According to USDoC [57], the six maturity levels of an enterprise architecture capability include:

- *Level 0 – None,* where there is no enterprise architecture and no effort towards developing one;
- *Level 1 – Initial,* where efforts of adopting the enterprise architecture practice are at unit-level or localized and not planned institution-wide;
- *Level 2 – Under Development,* where the enterprise architecture practice is adopted and recognized, and several efforts are ongoing to implement specific components of the enterprise architecture;
- *Level 3 – Defined,* where an enterprise architecture has detailed documentation and fully developed domain architectures or a technical reference model and components of the architecture have been or are acquired in compliance with the architecture;
- *Level 4 – Managed and Measured,* where the established enterprise architecture has quality metrics that are used to track its performance and the practice of architecture-based thinking in solution acquisition has become a culture;
- *Level 5 – Optimizing,* where an enterprise establishes a feedback mechanism geared towards improving the architecture and adopts a uniform culture of not endorsing any unplanned IT acquisition efforts and optimizing or continuously assessing and improving its architecture.

4.2.4 Elaborate Strategic Actions for Agency at Architecture Maturity Levels 0 – 1 (S4)

Steps S4 and S5 of Figure 2 involve elaborating each strategic action for the IS function by specifying how it can be implemented by defining activities that must be executed to achieve its intentions or the enterprise objectives and goals. This is adapted from the strategy implementation phase of the Planning Framework for Strategy, which, according to [52] and [53], involves devising means for operationalizing the selected strategic actions by defining short-term, medium-term, and long-term activities that will help to achieve the underlying intentions of the set of strategic actions and the enterprise objectives and goals.

To derive means of operationalizing the selected set of strategic actions for the IS function, step S4 prompts an enterprise whose architecture maturity level is in the range of 0 to 1 to elaborate strategic actions by adopting an enterprise architecture approach. This is motivated by the four major purposes of enterprise architecture, as specified in Text Box 2.

Text Box 2. Major Purposes of an Enterprise Architecture. From Op't Land et al. [1], an enterprise architecture enables stakeholders to:

a) Elaborate on strategic action and assess its potential impact on an enterprise prior to implementing the strategic action;
b) Specify business and ICT requirements that are associated with a given strategic action;
c) Inform or guide stakeholder deliberations and decision-making on a planned strategic action and/or during an ongoing business transformation or strategic action that is being implemented;
d) Inform (potential) service providers or vendors about enterprise solutions that constitute the target state of the enterprise and contract them to contribute to the target state by building specific solutions as specified in the architecture.

Purposes (a) and (b) in Text Box 2 are vital for an enterprise whose architecture maturity level is in the range of 0 to 1. However, for enterprise architecture to deliver these benefits, it must first be created. Thus, step S4 involves identifying activities that are executed when creating or designing an enterprise architecture, determining which of the architecture creation activities are critical for achieving the selected and elaborated set of strategic actions, and documenting as well as scheduling the activities as initiatives towards delivering the selected set of actions that are envisioned to deliver the enterprise architecture.

Accordingly, to identify activities involved in creating enterprise architecture, TOGAF ADM guidelines for creating or designing an enterprise architecture were adopted to elaborate the selected set of strategic actions toward realizing the specified goals and objectives of the IS function. Specifically, the architecture-oriented thinking pattern was invoked to derive or formulate short-term, medium-term, and long-term activities that can be executed coherently to deliver an information systems strategy. Thus, TOGAF ADM guidelines from the preliminary phase up to phase D (including requirements management phase) were adopted to define the short-term activities of EAISSP in step S4, while guidelines in phases E to H (including requirements management phase) were adopted to define the medium-term and long-term activities of EAISSP in step S4. The long-term activities of step S4 also involve the continuous assessment of the architecture maturity of the enterprise. This is because the enterprise architecture capability maturity model provides a roadmap for undertaking and annually assessing the enterprise architecture development process to ensure that it transforms an institution from operating ad hoc and immature business-IT alignment practices to operating disciplined and mature practices [57]. Appendix 5 shows how these concepts were adapted to derive tasks of step S4 and the corresponding question prompts.

4.2.5 Elaborate Strategic Actions for Agency at Architecture Maturity Levels 2 – 5 (S5)

As introduced in Section 4.2.4, step S5 in Figure 2 prompts an enterprise whose architecture maturity level is in the range of 2 to 5 to elaborate and synthesize the selected strategic actions by adapting tasks involved in implementing and maintaining an enterprise architecture. This is because such an enterprise can use its existing architecture (or deliverables of an ongoing architecture effort) as a basis to derive means of operationalizing the selected set of strategic actions. Such means are derived by defining tasks that adopt TOGAF ADM guidelines in phases E to H. This implies that tasks in step S5 include activities that involve implementing existing architectural designs; maintaining an up to date architecture implementation plan (i.e., architecture migration and transition plan, implementation governance plan, and maintenance plan); continuously assessing the performance of an implemented architecture; and maintaining an existing enterprise architecture with respect to dynamically changing business needs. Moreover, these activities require stakeholders to explore ways through which existing solutions in an enterprise architecture can be optimized, identify innovative options of implementing and maintaining the existing architecture, or identify avenues of acquiring or implementing solutions prescribed in the existing architecture.

The execution of step S5 is informed by the four purposes of enterprise architecture that are specified in Text Box 2 (in Section 4.3.4). From Text Box 2, it can be deduced that purposes (c) and (d) apply to an enterprise whose architecture maturity level is 2; and purposes (a) to (d) apply to an enterprise whose architecture maturity level is in the range of 3 to 5. However, for an architecture to deliver these purposes or benefits to the enterprise, it needs to be either implementing or developing its enterprise architecture (if its architecture maturity level is 2), or monitoring and maintaining its enterprise architecture (if its architecture maturity level is in the range 3 to 5). This implies that step S5 involves two parallel tasks, coded as T5.1 and T5.2 below (and in Appendix 6).

Task T5.1 involves identifying activities that are executed when implementing an enterprise architecture, determining which of the architecture implementation activities are critical for

achieving the selected and elaborated set of strategic actions, and scheduling the activities as initiatives towards delivering the selected set of strategic actions (that are envisioned to enable achievement of the goals and objectives of the IS function). Also, task T5.2 involves identifying activities that are executed when monitoring and maintaining an enterprise architecture, determining which of the architecture monitoring and maintenance activities are critical for achieving the selected and elaborated set of strategic actions, and scheduling the activities as initiatives towards delivering the selected set of strategic actions (that are envisioned to enable achievement of the goals and objectives of the IS function).

To support tasks T5.1 and T5.2, TOGAF ADM guidelines for implementing, monitoring, and maintaining an enterprise architecture were adopted to elaborate the selected set of strategic actions toward realizing the specified goals and objectives of the IS function. Basing on TOGAF ADM guidelines, architecture artifacts that inform the elaboration of strategic actions in step S5 are the existing enterprise architecture, transition and migration plan for the enterprise architecture, implementation governance plan for the enterprise architecture, change management framework for the enterprise architecture, and monitoring and evaluation plan for the enterprise architecture. Accordingly, TOGAF ADM guidelines for phases E to G (including requirements management phase) were adopted to define the short-term activities of EAISSP in sub-pathway T5.1, while guidelines for phase H and phases A to G (including requirements management phase) were adopted to define the medium-term and long-term activities of EAISSP in task T5.1. In addition, TOGAF ADM guidelines for phase H (including requirements management phase) were adopted to define the short-term activities of EAISSP in task T5.2, while guidelines for phases A to G (including requirements management phase) were adopted to define the medium-term and long-term activities of EAISSP in task T5.2. The long-term activities of tasks T5.1 and T5.2, in step S5, also involve the continuous assessment of the architecture maturity level of the enterprise (due to the justification given in Section 4.2.4). Appendix 6 presents the tasks of step S5 and the corresponding question prompts.

4.2.6 Allocate and Specify Resources for Realizing Strategic Actions (S6)

Step S6 of Figure 2 focuses on prompting stakeholders to allocate and specify resources for executing the architecture-oriented activities (derived in Sections 4.2.4 and 4.2.5) envisioned to deliver the selected set of strategic actions that constitute the information systems strategy. This is defined by adapting the strategy implementation phase of the Planning Framework for Strategy, which, according to [52] and [53], involves allocating required resources for delivering the specified set of activities (short-term, medium-term, and long-term activities), to achieve the intentions of the priority set of strategic actions and the enterprise objectives and goals. Step S6 also involves specifying key performance indicators of architecture-oriented activities that are defined to deliver each strategic action. Moreover, data on the key performance indicators can inform subsequent rounds of information systems strategic planning in a specific enterprise. Appendix 7 presents tasks in step S6 and the corresponding question prompts.

5 Application and Evaluation of EAISSP

In the context of the Action Research method as adopted and justified in Section 2, details of what transpired in the diagnosis and action planning stages are presented in Sections 3 and 4, respectively. From *the diagnosis stage (in Sections 1 and 3)*, the core problem was the lack of an effective and efficient mechanism for generating quality data on service delivery from various health laboratories at the facility level and quality data on the coordination and regulation of laboratory services at national and subnational levels. Thus, the required intervention was establishing a national integrated HLIMS that supports service delivery operations in health laboratories across the country and effective coordination and regulation of laboratory services across the health laboratory network in Uganda. However, this was perceived as a complex long-

term intervention, which required the formulation of an enterprise architecture-oriented HLIMS strategy that incorporates 3 levels: (a) the creation or design of a master plan for a national integrated HLIMS, (b) the implementation of the master plan by using it to guide the building and deployment of digital solutions prescribed in the master plan, and (c) the maintenance of the master plan and the corresponding solutions.

Accordingly, the action planning stage (in Section 4) involved devising EAISSP and customizing it to the context of the health laboratory subsector so that it could guide the formulation of an HLIMS strategy. Section 5.1 gives an overview of what transpired in the action taking stage and evaluation stage of this research, and Section 5.2 highlights lessons learned from this research.

5.1 Setup of the Action Taking Stage and Evaluation Stage of this Research

The *action taking stage* involved using EAISSP in the health laboratory subsector to guide the intervention of formulating the HLIMS strategy and executing the initial phase of its implementation (by developing a master plan for a national integrated HLIMS). The intervention was set up as specified below:

a) *Objectives of the Intervention.* The intervention had to fulfill two objectives. The first objective was to execute the steps of EAISSP to formulate an enterprise architecture-oriented HLIMS strategy that addresses the core problem in the laboratory subsector (as specified above). The second objective was to implement the first phase of the HLIMS strategy by creating a master plan for the national integrated HLIMS.

b) *Key Deliverables.* The intervention yielded an explicit HLIMS strategy, a master plan or enterprise architecture for a national integrated HLIMS, and its implementation plan.

c) *Stakeholder Engagement.* Key stakeholder groups were engaged in the execution of specific tasks in EAISSP using three modes, i.e., one-off mode, discrete mode, and continuous mode. This was achieved in two ways. First, a Technical Working Group was constituted to spearhead the entire initiative, and it included representatives of key stakeholder groups who had to be engaged in a continuous mode. Second, a catalog or inventory of subject matter experts was created to include representatives of key stakeholder groups who had to be engaged using any of the above three modes, depending on their roles in executing specific tasks of the customized EAISSP. In addition, the selection of specific key stakeholders from the catalog of subject matter experts and their engagement was purposively done depending on the availability and commitment of a particular stakeholder.

d) *Techniques used to Contextualize the Execution of EAISSP in the Health Laboratory Subsector*. First, a multidisciplinary technical working group was constituted and assigned the responsibility of spearheading the execution of tasks in EAISSP, to achieve the above two objectives of the intervention. Second, interviews were conducted with various (purposively selected) coordinators or managers of programs or projects that support service delivery in the health laboratory subsector to support the execution of specific tasks in EAISSP. Third, technical stakeholder engagement workshops were conducted (involving purposively selected representatives of various actors at national and subnational levels of the health laboratory subsector) to support the execution of specific tasks in EAISSP and validate output obtained from completed tasks. Fourth, stakeholder dissemination workshops were conducted, aiming at sharing deliverables, showing the progress of the intervention, and eliciting feedback on obtained outputs.

e) *Pre and post stakeholder engagements activities.* Before engaging key stakeholders, there was need to customize tasks and question prompts of EAISSP to the context of the health laboratory subsector. After stakeholder engagements workshops, stakeholder responses on specific outputs and deliverables as well as the EAISSP process were compiled, synthesized, and used to generate refined outputs.

The *evaluate and specify learning stages* of this research involved selecting a sample of 20 stakeholders from only stakeholders who were engaged in a continuous mode and prompting them to evaluate EAISSP. The sampling of evaluators was done purposefully, and the selection criterion was the observed level of commitment of a particular stakeholder who supported the execution of EAISSP tasks in a continuous mode. Stakeholders who were engaged in a continuous mode but with a low level of commitment in executing EAISSP activities were not engaged in the evaluation. This kind of classification and prioritization of evaluators was done for two reasons. First, EAISSP is a lengthy process, which can only be appreciated by stakeholders who are committed to effectively executing each task because the output of each task is an input for another task. Second, the intertwined nature of EAISSP tasks and activities and their effectiveness can be comprehended and assessed by stakeholders who are engaged in a continuous mode, instead of those who are engaged in a one-off mode or discrete mode.

Stakeholders who participated in the evaluation were responsible for (a) Reviewing specific thematic areas in EAISSP deliverables, (b) Participating in bilateral structured walkthrough sessions that discussed EAISSP deliverables, and (c) Providing feedback on EAISSP using a self-administered evaluation questionnaire. Findings from the evaluation and lessons learned are summarized in section 5.2.

5.2 Evaluation Findings and Lessons Learned

This section presents evaluation feedback on only EAISSP as a process, but not deliverables that were obtained when it was used in the health laboratory subsector. This is because feedback on the understandability and feasibility of specific deliverables (that were obtained when executing EAISSP) was used to continuously refine the deliverables, which are beyond the scope of this article. The evaluation questionnaire comprised (a) *four closed questions* that required stakeholders to respond to a specific attribute of the EAISSP process, using a Likert scale of 1 to 5 (where 1 represented strongly disagree and 5 represented strongly agree), and (b) *three open ended questions* that prompted stakeholders to share their opinions on the steps and tasks that constitute EAISSP, the understandability and feasibility of EAISSP, and the strengths and weaknesses of EAISSP. Responses to the closed questions were processed using Microsoft Excel, and findings indicate that:

a) At least 75% of the evaluators were satisfied with the final outputs and deliverables generated when EAISSP was used in the health laboratory subsector to guide the formulation of the HLIMS strategy and initiate execution of the strategy by designing a master plan for establishing a national integrated HLIMS.
b) At least 86% of the evaluators were satisfied with how the entire process of the architecture-oriented strategic planning for the national integrated HLIMS was conducted.
c) At least 86% of the evaluators understood why some of their views were adopted in the final outputs or deliverables of the initiative.
d) All evaluators (100%) understood why views of some officers had not been adopted in the final outputs or deliverables of the initiative.

Stakeholder responses to the open-ended questions were processed using content or thematic analysis, and key findings are summarized in Table 2 (see column 1). In column 2 of Table 2, implications of stakeholder comments are coded as **Fx**, because they are treated as additional features for incorporating in EAISSP to improve its design and usability.

Insights F1 to F3 in Table 2 point to the need to amend EAISSP with an explicit user guide, so as to ensure that its tasks are properly executed. Efforts are currently ongoing to extend EAISSP to contain features F1 to F3. Besides the above insights for improving EAISSP, the stakeholders appreciated the interactive nature of tasks that constitute EAISSP, and the mode in which its various tasks and corresponding activities were executed. This is derived from direct quotations of some evaluators, which included the following excerpts: *"The approach of sourcing human resource from different backgrounds and specializations and grouping them to accomplish specific*

tasks was very good… Discussions in small groups were very good… Group work enabled coverage of large volume of work… Assigning work to smaller groups allowed more material to be reviewed… Group discussions allowed people to share their views… Group-based work encouraged good teamwork, enabled better thinking and understanding of concepts, and allowed active and open participation of all members… Grouping created enough time for discussing matters." Some stakeholders further commented that *"the process was interactive, it involved participants or stakeholders from various specialties or thematic areas… Several stakeholders with high levels of expertise gathered for the exercise".*

Table 2. Qualitative Feedback on Gaps Identified in EAISSP

Evaluator Comments on Design Gaps in EAISSP (coded as Gx)	Implications or Additional Features for improving the Design of EAISSP (coded as Fx)
• G1. "*Some activities require more time than the time that was allocated, and this limited comprehensive discussion of some aspects… Allocating more time allows to ensure that all key stakeholders participate and yields exhaustive discussions"*	• F1. EAISSP needs to be amended with a user guide or implementation guide that explicitly provides the recommended ways of executing its tasks. The user guide of EAISSP will need to include operational details such as guidance on techniques to use in task execution and ample time to allocate to specific tasks in EAISSP.
• G2. To reach out to a wide range of individuals in a given stakeholder category, it would be helpful to send out a questionnaire to each stakeholder group (e.g., facility-level staff) to comment or give their input into critical issues about the HLIMS strategy or its implementation roadmap.	• F1.1. The proposed user guide for EAISSP will need to ensure that resolutions about a strategy or its implementation roadmap are cataloged and disseminated to stakeholders in specific categories to elicit additional views (from a wider audience) on their technical and financial feasibility.
• G3. Instructions about executing particular tasks and activities need to be documented (with examples) and shared to avoid all possible forms of misinterpretation among stakeholders.	• F1.2. The proposed user guide for EAISSP will need to ensure that instructions for executing each task are clearly documented and instantiated with real-life examples so as to ensure mutual understanding among stakeholders.
• G4. Some categories of stakeholders should have participated fully in all sessions to ensure that they holistically understand issues and aspects to support their implementation. In other words, some stakeholders who were engaged in the discrete mode should have been engaged in the continuous mode.	• F1.3. The proposed user guide for EAISSP should prompt users to ensure that the criteria for determining engagement modes of key stakeholder groups in a particular context are validated by the technical working group responsible for formulating the architecture-oriented information systems strategy.
• G5. *"Sometimes people would agree from a theoretical point of view rather than practical".*	• F1.4. the proposed user guide for EAISSP should prompt users to ensure that representatives of key stakeholders are individuals who have been involved in the delivery of routine laboratory services and/or in the coordination or regulation of laboratory services at a specific level.
• G6. In some scenarios, *"objectives of the sponsor were used to override the significance or relevance of the technical submissions to some extent".*	• F2. Need to explore ways of strengthening negotiations between donors and beneficiaries during execution of EAISSP tasks to devise strategic actions that yield sustainable but not donor-dependent initiatives.
• G7. When generating and assessing potential strategic actions for delivering the IS strategy, the international standards and national policies should be considered with respect to contextual issues faced by health laboratories in the country (so as to balance objectivity and compliance).	• F3. The proposed user guide for EAISSP should prompt stakeholders to ensure that the existing standards and policies in the business, data, applications, technology, and security domains of an enterprise are specified; so that their key elements are considered when formulating and elaborating strategic actions for the IS function.

6 Conclusion

Existing e-health implementation efforts scarcely address the data and information needs of all core functions of the health laboratory subsector in Uganda. Existing approaches for implementing digital health interventions to a limited extent provide detailed technical guidance on how to

develop a digital health strategy that leverages enterprise architecture to: (a) ensure that data and information needs of all core functions in healthcare service delivery are coherently realized and (b) effectively address prevailing challenges in aligning healthcare and ICTs. Also, existing information planning approaches only focus on strategy development aspects and scarcely provide insights into how the strategy planning and strategy implementation processes can be enriched by aspects from enterprise architecture development approaches. Thus, the realization of digital transformation in the health laboratory subsector was hindered by the lack of explicit technical guidance on aligning processes that deliver all core functions of the health laboratory subsector with digital technologies. Accordingly, a process enabling enterprises to leverage enterprise architecture during information systems strategic planning (EAISSP) was devised and instantiated in Uganda's health laboratory subsector to address the business-IT alignment issues therein. This was achieved by mutually adopting insights from two strategic planning approaches (i.e., the Planning Framework for Strategy and the Strategic Alignment Model) and two enterprise architecture approaches (i.e., TOGAF ADM and the Enterprise Architecture Capability Maturity Model).

EAISSP was instantiated in Uganda's health laboratory subsector by (a) using it to formulate an enterprise architecture-oriented strategy for establishing a national integrated HLIMS and (b) using the strategy to guide the development of a master plan or enterprise architecture for the national integrated HLIMS and the corresponding architecture implementation plan. In a broader context, EAISSP provides technical guidance on how to leverage enterprise architecture during the information strategic planning process in two institutional contexts. The first context is an institution at architecture maturity level 0 or 1 (e.g., the case of the health laboratory subsector). The second context is an institution at the architecture maturity level in the range of 2 to 5 (i.e., whose architecture is being implemented, is established, or is due for maintenance). EAISSP was evaluated by a sample of 20 stakeholders who were continuously engaged in executing its tasks. Evaluation findings (a) reveal its major strength as an approach that can provide technical guidance in architecture-oriented information systems strategic planning and (b) highlight the need to improve its usability by providing a user guide containing illustrative scenarios, which clarify concepts and examples of expected responses to avoid misinterpretations. Accordingly, efforts are ongoing to extend EAISSP by providing a comprehensive user guide that specifies techniques and templates that can be used to effectively execute its tasks and activities. Future efforts will involve instantiating EAISSP in other enterprise settings.

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Appendices

Appendix 1. Adopted parameters and dimensions of the internal and external environments of an organization's business and IT domains by the Strategic Alignment Model (Based on Henderson and Venkatraman[†]).

External Environment of the Business Domain	External Environment of the IT Domain
Business Strategy articulates: • **EB1. Business scope** – choices on product-market offerings of the enterprise; • **EB2. Distinctive competences** – attributes of an enterprise strategy (e.g., pricing, quality, value added service, and superior distribution channels) that enable it to have a distinctive comparative advantage over its competitors; • **EB3. Business governance** – choices of structural mechanisms (e.g., strategic alliances, joint ventures, and licensing) that organize the business operations in a way that recognizes the continuum between markets and hierarchy.	**IT Strategy articulates:** • **ET1. Technology scope** – types and ranges of IT systems & capabilities that are potentially available to the enterprise; • **ET2. Systemic competences** – distinctive attributes of IT systems (e.g., higher system reliability, interconnectivity, and flexibility) that positively contribute to the creation of new business strategies or better support for the existing business strategy; • **ET3. IT governance** – choices of structural mechanisms (e.g., joint ventures, long-term contracts, equity partnerships, and joint R&D) that enable the enterprise to obtain the required IT capabilities; and strategic choices on developing partnerships to exploit IT capabilities & services.
Internal Environment of the Business Domain	**Internal Environment of the IT Domain**
Organization Infrastructure & Processes comprises: • **IB1. Administrative infrastructure** – organizational structure, roles of actors, and reporting relationships; • **IB2. Business Processes** – workflows and the associated information flows in executing key activities; • **IB3. Business Skills** – capabilities of individuals and the enterprise to execute tasks that support a business strategy.	**Information Systems Infrastructure & Processes comprises:** • **IT1. ICT infrastructure** – the architecture showing choices of applications, data, and technology configurations for the enterprise; • **IT2. ICT Processes** – the work processes for managing and operating the IT infrastructure (i.e., developing, monitoring, controlling, and maintaining systems); • **IT3. ICT Skills** – choices of knowledge and capabilities required to effectively manage the IT infrastructure of an enterprise.

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Appendix 2. Tasks and Guiding Questions in Step S1 of EAISSP

S1. Scan Internal and External Environment of the Business and IT Domains of the Enterprise and Determine its Architecture Maturity Level	
Tasks to execute in S1	**Guiding questions for deliberation in S1**
T1.1. Determine key stakeholders of the enterprise and understand their expectations and socio-cultural settings.	Q1.1.1. Who are the key stakeholders of the enterprise?
	Q1.1.2. What social and cultural factors characterize the business or operational environment of key stakeholders?
	Q1.1.3. What are the concerns or issues and expectations or needs of the various key stakeholder groups of the enterprise?
T1.2. Investigate and assess strengths and weaknesses of the business domain and IT domain of the enterprise (i.e., the strengths and weaknesses aspects in SWOT analysis).	Q1.2.1. Which features characterize the following three internal dimensions or elements of the business domain of the enterprise: a) Administrative infrastructure – Management and operational structure of all key stakeholders of the enterprise and corresponding responsibilities? b) Business Processes – Institutional processes and corresponding information exchanges that constitute the primary and support functions of the enterprise? c) Business capabilities and skillsets – Institutional capabilities or resources (physical, financial, social capital, and information or knowledge resources) and individual or human resource skillsets that are critical in delivering the service portfolio of the enterprise?
	Q1.2.2. Which features characterize the following three internal dimensions or elements of the IT domain of the enterprise: a) IT infrastructure – the architecture of the existing and planned data, applications, technology, and security capabilities of the enterprise? b) IT service management processes – the processes for managing (developing, operating, monitoring, controlling, and maintaining) the existing and planned IT infrastructure or systems of the enterprise? c) Institutional IT capabilities and individual IT skills – the acquired and the planned capabilities and skillsets that are needed to effectively and efficiently deliver the IT service portfolio of the enterprise?
	Q1.2.3. What are the strengths and weaknesses that are associated with the features that characterize elements of the business domain and IT domain of the enterprise (as listed in Q1.2.1 and Q1.2.2)?
T1.3. Investigate and assess opportunities and threats associated with the potential business strategy and IT strategy of the enterprise (i.e., the opportunities and threats aspects in SWOT analysis).	Q1.3.1. Which features can characterize the following three external dimensions or elements of the business strategy of the enterprise: a) Business scope or service and product portfolio of the enterprise – range of services or products that the enterprise can choose to offer, so as to appropriately serve the size and demands of its target clientele or market? b) Distinctive competences or performance attributes of the enterprise – management and operational performance attributes that the enterprise can prioritize or pursue, so as to uniquely provide its products or services in ways that can enable it to have a competitive advantage? c) Business governance approach or model of the enterprise – management, operational, and quality assurance mechanisms (or modes of working) that the enterprise can establish to: effectively and/or efficiently execute its business or institutional processes; creatively leverage its partnerships; and ensure that its operations comply with the governing policies, regulations, and laws?
	Q1.3.2. Which features can characterize the following three external dimensions or elements of the IT strategy of the enterprise: a) Technology scope or IT services portfolio of the enterprise – range of IT systems or capabilities that the enterprise can leverage, so as to support realization of its business strategy (or to gain a competitive advantage, or to improve its service delivery, or to improve its customer experiences)? b) Systemic competencies or quality attributes of IT services of the enterprise – quality attributes of IT systems or capabilities that the enterprise can prioritize or pursue, so as to gain a competitive advantage (or to improve its service delivery, or to improve its customer experience)? c) IT governance approach/model of the enterprise – IT management, operational, and quality assurance mechanisms (or modes of working) that the enterprise can establish, so as to ensure that its IT operations comply with the values, principles, policies, regulations, and laws that govern enterprise operations?

S1. Scan Internal and External Environment of the Business and IT Domains of the Enterprise and Determine its Architecture Maturity Level	
Tasks to execute in S1	**Guiding questions for deliberation in S1**
	Q1.3.3. What are the pros (opportunities) and cons (threats) that are associated with the potential features that can characterize the business strategy and IT strategy of the enterprise (as listed in Q1.3.1 and Q1.3.2)?
T1.4. Assess anticipated changes in the business and IT environments in which the enterprise operates; and determine their potential effects (i.e., PESTEL analysis aspects and analysis of competitive forces of an enterprise).	Q1.4.1. What are the anticipated changes in the Political, Economic, Social, Technological, Environmental, Legal, and Competitive contexts within which the business and IT domains of the enterprise operate?
	Q1.4.2. What are the effects of the above envisioned changes (in Q1.4.1) on the following business dimensions or elements of the enterprise? a) Business strategy of the enterprise: i. Business scope or service and product portfolio of the enterprise? ii. Distinctive management and operational competences or performance attributes of the enterprise? iii. Business or institutional governance approach/model of the enterprise? b) Business domain of the enterprise: i. Administrative infrastructure? ii. Business Processes? iii. Business capabilities and skillsets?
	Q1.4.3. What are the effects of the envisioned changes (in Q1.4.1 and Q1.4.2) on the following IT dimensions or elements of the enterprise? a) IT strategy of the enterprise: i. Technology scope or portfolio of IT systems or capabilities of the enterprise? ii. Systemic competences or design and functionality quality attributes of the IT services of the enterprise? iii. IT governance approach/model of the enterprise? b) IT domain of the enterprise: i. Existing IT infrastructure? ii. Existing IT service management processes? iii. Institutional IT capabilities and individual IT skills?
	Q1.4.4. What are the pros (opportunities) and cons (threats) that are associated with the envisioned effects or changes (in Q1.4.1 to Q1.4.3) on the business and IT environments of the enterprise?
T1.5. Assess the architecture capability maturity level of the enterprise.	Q1.5. Using the enterprise architecture maturity assessment checklist and scorecard by USDoC (2007), constitute a team to assess and determine the architecture maturity level of enterprise.
T1.6. Assess and prioritize core problems and required business and technology interventions in the enterprise (using findings from tasks T1.1 to T1.5).	Q1.6.1. Which problems are the root causes of other identified problems in the enterprise, what are the timelines within which they should be addressed, and what are their implied priorities?
	Q1.6.2. What are the implied priorities of business and technology interventions that should be undertaken to address the root causes of the problems?
T1.7. Undertake a benchmarking investigation on best practices associated with elements that constitute tasks T1.3, T1.4, & T1.6.	Q1.7.1. What measures or best practices do other enterprises use to embrace specific types of business opportunities; and to manage threats as identified in task T1.3?
	Q1.7.2. What measures or best practices do other enterprises use to respond to the specific Political, Economic, Social, Technological, Environmental, Legal, and Competitive factors as identified in task T1.4?
	Q1.7.3. What measures or best practices do other enterprises use to address specific types of problematic issues as identified in task T1.6?

Appendix 3. Tasks and Guiding Questions in Step S2 of EAISSP

S2. Derive Mission, Vision, Goals, and Objectives of the Information Systems Function of the Enterprise; and Determine the Role of Enterprise Architecture in Realizing them	
Tasks to execute in S2	**Guiding questions for deliberation in S2**
T2.1. Derive the mission and vision of the IS function of the enterprise.	Q2.1. Based on findings from tasks T1.3 and T1.4 (in Appendix 2), which of the potential features of the business scope (i.e., service and product portfolio and market size of the enterprise) and technology scope (i.e., IT services portfolio of the enterprise) need to be adopted and prioritized in the formulation of the mission statement and vision statement of the IS function of the enterprise?
T2.2. Derive the goals and specific objectives of the IS function of the enterprise.	Q2.2.1. Based on the vision (in task T2.1) and findings from tasks T1.3 and T1.4, which of the potential features of the distinctive competencies of the business domain (i.e., managerial and operational performance attributes) need to be adopted and prioritized in the formulation of goals and specific objectives of the IS function of the enterprise?
	Q2.2.2. Based on the vision (in task T2.1) and findings from tasks T1.3 and T1.4, which of the potential features of the systemic competencies of IT services (i.e., quality attributes of IT systems or capabilities) need to be adopted and prioritized in the formulation of goals and specific objectives of the IS function of the enterprise?
T2.3. Determine the role of enterprise architecture in realizing the goals and objectives of the IS function of the enterprise.	Q2.3.1. Based on the finding from task T2.2, what is the role of Enterprise Architecture in realizing the specified goals and objectives of the IS function?
	Q2.3.2. Which benefits or goals of Enterprise Architecture need to be adopted in order to achieve the specified goals and objectives of the IS function?

Appendix 4. Tasks and Guiding Questions in Step S3 of EAISSP

S3. Generate, Evaluate, and Select a Set of Strategic Actions to be undertaken by the Information Systems function so as to Achieve its Goals and Objectives	
Tasks to execute in S3	**Guiding questions for deliberation in S3**
T3.1. Determine an appropriate set of strategic actions that need to be undertaken by the IS function *if it is to achieve its specified goals and objectives.*	Q3.1.1. Based on findings from tasks T1.3 and T1.4 (in Appendix 2), which of the potential features of the business governance model or approach need to be adopted as drivers when generating strategic actions for achieving the goals and objectives of the IS function of the enterprise (that are specified in task T2.2 in Appendix 3)?
	Q3.1.2. Based on findings from tasks T1.3 and T1.4, which of the potential features of the IT governance model or approach need to be adopted as drivers when generating strategic actions for achieving the goals and objectives of the IS function of the enterprise?
	Q3.1.3. Based on findings from tasks T1.3 and T1.4, which potential features of the business scope (i.e., service and product portfolio and market size) and technology scope (i.e., IT services portfolio) need to be adopted as drivers when generating strategic actions for achieving the goals and objectives of the IS function of the enterprise?
	Q3.1.4. Based on findings from tasks T1.3 and T1.4, which potential features of the distinctive competencies (i.e., managerial and operational performance attributes) and systemic competencies of IT services (i.e., quality attributes of IT systems or capabilities) need to be adopted as drivers when generating strategic actions for achieving the goals and objectives of the IS function of the enterprise?
T3.2. Determine an appropriate set of strategic actions that the IS function needs to undertake to *support the realization of the business strategy of the enterprise.*	Q3.2.1. For the set of strategic actions that constitute the business strategy of the enterprise, what strategic actions need to be undertaken by the IS function to support their realization?
	Q3.2.2. For the defined set of strategic actions that constitute the business strategy: a) How can IT be skillfully adopted to enhance the administrative capabilities of the enterprise (i.e., to strengthen the accounting and control capabilities or functions of the enterprise)? b) How can IT be adopted to enhance operational efficiency (i.e., to support effective and efficient execution of the operational processes that deliver the chosen business strategy of the enterprise)? c) How can IT be adopted to enable the enterprise to gain a competitive advantage (i.e., to enable it to restructure its setup and re-engineer its service delivery processes in ways that enable it to acquire a competitive advantage)?
T3.3. Determine the role of enterprise architecture in realizing the selected set of strategic actions to be undertaken by the Information Systems function of the enterprise.	Q3.3.1. Based on findings from tasks T3.1 and T3.2 (the selected set of strategic actions), which specific actions will require the adoption of Enterprise Architecture to achieve them effectively? **OR** what is the role of Enterprise Architecture in realizing the selected set of strategic actions in tasks T3.1 and T3.2?
	Q3.3.2. Which benefits or goals of Enterprise Architecture need to be prioritized in order to achieve the desired distinctive competencies (i.e., managerial and operational performance attributes) and systemic competencies of IT services (i.e., quality attributes of IT systems or capabilities) of the enterprise?

Appendix 5. Tasks and Guiding Questions in Step S4 of EAISSP

S4. Elaborate and Synthesize the Selected Set of Strategic Actions to be undertaken, by Adapting Tasks Involved in Creating an Enterprise Architecture	
Tasks to execute in S4	**Guiding questions for deliberation in S4**
T4.1. Determine the priority of each action in the selected set of strategic actions for realizing the goals and objectives of the IS function of an enterprise that is at architecture maturity level 0 or 1.	Q4.1.1. Based on findings from assessing the enterprise architecture maturity level (in task T1.5 in Appendix 2), if the enterprise is at an architecture maturity level in the range of 0 to 1, determine which specific strategic actions are prerequisites for realizing other strategic actions in the selected set of actions? **OR** what is the urgency of specific strategic actions, given the context of the business and IT environments of the enterprise (based on findings from tasks T1.3, T1.4, and T1.6 in Appendix 2)?
	Q4.1.2. From the sequencing of strategic actions in Q4.1.1, what is the priority of each strategic action in the selected set of actions?
T4.2. Scope the architecture development effort of the enterprise, depending on the required architecture deliverables for realizing the prioritized set of strategic actions.	Q4.2. Based on findings from task T4.1 and required resources to realize the IS strategy (i.e., the time period within which the IS function should deliver its goals and objectives, existing financial resources, personnel skills, and existing information assets): a) Which business capabilities and technology capabilities need to be considered, in order to achieve the prioritized set of strategic actions within available means? b) Which architecture domains should be considered, in order to achieve the prioritized set of strategic actions within available means? c) Which level of detail of the enterprise architecture is appropriate, in order to achieve the prioritized set of strategic actions within available means?
T4.3. Determine which elements of an enterprise architecture have to be developed, so as to enable the effective and efficient delivery of the prioritized set of strategic actions for achieving the goals and objectives of the IS function.	Q4.3. Given the prioritized set of strategic actions (from task T4.1) and the scope (from task T4.2), which specific strategic actions will be realized by developing which elements of an enterprise architecture? OR, which specific strategic actions (from the prioritized set of actions in T4.1) will be realized by developing which of the following architecture outputs or deliverables: a) Stakeholder and requirements management framework? b) Architecture principles? c) Architecture vision? d) Architecture governance framework or its components? e) Baseline and/or target segment architectures? f) Baseline and/or target domain architectures (i.e., business, data, application, technology, and security architectures)? g) Enterprise architecture implementation roadmap (or transition and migration plan)?
T4.4. Elaborate on each strategic action in the prioritized set of actions by: (i) specifying architecture creation activities that are associated with creating the required architecture deliverables (as specified in task T4.3); (ii) indicating whether they will be executed as short-term, medium-term, and long-term activities towards realizing each strategic action (depending on the available timelines for achieving the goals and objectives of the IS function).	Q4.4.1. Schedule the following as short-term activities towards achieving the particular prioritized strategic actions (with respect to choices in tasks T4.3, T4.2, and T4.1): a) Developing a stakeholder and requirements management framework for the architecture. b) Developing an architecture governance framework. c) Developing architecture principles for the five domains of business-IT alignment. d) Developing the architecture vision.
	Q4.4.2. Schedule the following as medium-term activities towards achieving particular prioritized strategic actions (with respect to choices in tasks T4.3, T4.2, and T4.1): a) Developing detailed baseline and/or target segment architectures that cover particular business functions. b) Developing detailed baseline and/or target domain architectures (i.e., business, data, application, technology, and security architectures) of the enterprise. c) Conducting tradeoff analysis of architecture views across all architecture domains, so as to address conflicting stakeholder views.
	Q4.4.3. Schedule the following as long-term activities towards achieving particular prioritized strategic actions (with respect to choices in tasks T4.3, T4.2, and T4.1): a) Identifying or deriving work packages that are associated with implementing the designed target domain architectures (i.e., business, data, application, technology, and security architectures) or target segment architectures that cover particular business functions or capabilities of the enterprise. b) Creating or deriving solution projects for implementing the architecture by aligning or synthesizing the above work packages into projects and prioritizing them. c) Developing an architecture implementation roadmap (or transition and migration plan) that articulates solution projects (and their constituent work packages) that

S4. Elaborate and Synthesize the Selected Set of Strategic Actions to be undertaken, by Adapting Tasks Involved in Creating an Enterprise Architecture	
Tasks to execute in S4	**Guiding questions for deliberation in S4**
	will deliver the prescribed solutions or components of the created enterprise architecture. d) Operationalizing (implementing and deploying or establishing) specific solution projects (and their constituent work packages) for delivering particular solutions as articulated in the architecture implementation roadmap. e) Developing and operationalizing an architecture implementation governance framework. f) Developing and operationalizing an architecture change management framework and a corresponding architecture monitoring and evaluation framework (for periodic assessment of architecture performance and the architecture maturity level of the enterprise to ensure continuous improvement), and maintenance plan. g) Continuously updating the stakeholder and requirements management framework for the architecture.

Appendix 6. Tasks and Guiding Questions in Step S5 of EAISSP

S5. Elaborate and Synthesize the Selected Set of Strategic Actions to be undertaken, by Adapting Tasks Involved in Implementing & Maintaining an Enterprise Architecture	
Tasks to execute in S5	**Guiding questions for deliberation in S5**
T5.1. Elaborate and synthesize the selected set of strategic actions for an enterprise at architecture maturity level 2	***Based on findings from assessing the architecture maturity level of the enterprise (in task T1.5 in Appendix 2): if the enterprise is at architecture maturity level 2, execute Q5.1.1.1 to Q5.1.4.2***
T5.1.1. Determine the priority of each action listed in the selected set of strategic actions for realizing the goals and objectives of the IS function of an enterprise at architecture maturity level 2.	Q5.1.1.1. Which specific strategic actions are prerequisites for realizing other strategic actions in the selected set of actions? **OR** what is the urgency of specific strategic actions, given the context of the business and IT environments of the enterprise (based on findings from tasks T1.3, T1.4, and T1.6 in Appendix 2)?
	Q5.1.1.2. From the sequencing of strategic actions in Q5.1.1.1, what is the priority of each strategic action in the selected set of actions?
T5.1.2. Determine which solution projects (and corresponding work packages) in the existing architecture transition and migration plan of an enterprise have to be implemented so as to enable the effective and efficient delivery of the prioritized set of strategic actions for achieving the goals and objectives of the IS function.	Q5.1.2. Given the prioritized set of strategic actions for realizing the goals and objectives of the IS function (from task T5.1.1), which specific strategic actions will be realized by developing which of the following architecture outputs or deliverables: a) Specific solution projects (and constituent work packages) that are responsible for delivering particular solutions or components in the existing architecture implementation roadmap? b) An up-to-date design of the enterprise architecture or specific segment architectures or specific domain architectures? c) An up-to-date architecture implementation roadmap? d) An architecture implementation governance framework or its components?
T5.1.3. Prioritize the identified solutions or components of the enterprise architecture or its implementation plan that will enable the enterprise to achieve its prioritized set of strategic actions.	Q5.1.3. What are the priorities of the identified solution projects (and constituent work packages as specified in task T5.1.2) that will enable the enterprise to achieve the prioritized set of strategic actions?
T5.1.4. Elaborate each strategic action in the prioritized set of actions by: (i) specifying architecture implementation activities that are associated with delivering outputs of the required prioritized projects (from task T5.1.2); and (ii) indicating whether the activities are to be executed as short-term, medium-term, or long-term activities toward realizing each strategic action (depending on the timelines specified for achieving the goals and objectives of the IS function).	Q5.1.4.1. Schedule the following as short-term activities towards achieving particular prioritized strategic actions (as specified in tasks T5.1.2 and T5.1.3), i.e.: a) Establishing or creating or updating the architecture implementation governance framework. b) Creating or updating an architecture implementation roadmap (or transition and migration plan) that articulates the scheduled solution projects (and constituent work packages) that are responsible for delivering particular solutions or components as prescribed in the created enterprise architecture. c) Developing and evaluating contracts of internal and external service providers who will implement particular solution projects as articulated in the existing architecture implementation plan. d) Updating the stakeholder and requirements management framework.
	Q5.1.4.2. Schedule the following as medium-term or long-term activities towards achieving particular prioritized strategic actions, i.e.: a) Operationalizing (implementing and deploying or establishing) specific solution projects (and their constituent work packages) for delivering particular solutions as articulated in the architecture implementation roadmap. b) Developing or updating an architecture change management framework, and a corresponding architecture monitoring and evaluation framework (which guides periodic assessment of architecture performance and the architecture maturity level to ensure continuous improvement). c) Developing or updating an architecture maintenance plan. d) Updating the stakeholder and requirements management framework for the architecture.

S5. Elaborate and Synthesize the Selected Set of Strategic Actions to be undertaken, by Adapting Tasks Involved in Implementing & Maintaining an Enterprise Architecture	
Tasks to execute in S5	**Guiding questions for deliberation in S5**
T5.2. Elaborate and synthesize the selected set of strategic actions for an enterprise at an architecture maturity level in the range of 3 to 5	***Based on findings from assessing the architecture maturity level of the enterprise (in task T1.5 in Appendix 2), if the enterprise is at an architecture maturity level in the range of 3 to 5, execute Q5.2.1.1 to Q5.2.4.2***
T5.2.1. Determine the priority of each action in the selected set of strategic actions for realizing the goals and objectives of the IS function of an enterprise at an architecture maturity level in the range of 3 to 5.	Q5.2.1.1. Which specific strategic actions are prerequisites for realizing other strategic actions in the selected set of actions? **OR** what is the urgency of specific strategic actions, given the context of the business and IT environments of the enterprise (based on findings from tasks T1.3, T1.4, and T1.6 in Appendix 2)?
	Q5.2.1.2. From the sequencing of strategic actions in Q5.2.1.1, what is the priority of each strategic action in the selected set of actions?
T5.2.2. Determine which components or solutions in the existing implemented enterprise architecture need to be reconsidered (e.g., monitored, reviewed, upgraded, replaced, integrated, optimized, specialized, or improved) so as to enable effective and efficient delivery of the prioritized set of strategic actions for achieving the goals and objectives of the IS function.	Q5.2.2. Given the prioritized set of strategic actions for realizing the goals and objectives of the IS function (from task T5.2.1), which specific strategic actions will be realized by which of the following architecture outputs or deliverables: a) A specification of measures and metrics for monitoring performance of particular components or solutions in the implemented enterprise architecture? b) An upgrade or replacement, or integration of technologies for designing or implementing specific components or solutions in the implemented enterprise architecture? c) An upgrade, or replacement, integration, optimization, or specialization of specific components or solutions in the implemented enterprise architecture (so as to respond to the dynamics in the business and technology environments of the enterprise)? d) An up-to-date design of the enterprise architecture?
T5.2.3. Prioritize identified solutions or components of the implemented architecture that are to be reconsidered in order to enable the enterprise to achieve its prioritized set of strategic actions.	Q5.2.3. What are the priorities of the identified solutions or components of the implemented architecture (architecture outputs or deliverables specified in task T5.2.2) that are to be reconsidered in order to enable the enterprise to achieve the prioritized set of strategic actions?
T5.2.4. Elaborate each strategic action in the prioritized set of actions by: (i) specifying architecture maintenance activities that are associated with realizing the prioritized set of solutions or components of the architecture that are to be reconsidered (from task T5.2.2); (ii) indicating whether they are to be executed as short-term, medium-term, or long-term activities towards realizing each strategic action (depending on the timelines specified for achieving the goals and objectives of the IS function).	Q5.2.4.1. Schedule the following as short-term activities towards achieving particular prioritized strategic actions (as specified in tasks T5.2.2 and T5.2.3), i.e.: a) Devising measures and metrics for continuous monitoring of the performance of components or solutions in the existing implemented enterprise architecture, and a corresponding architecture monitoring and evaluation framework. b) Continuous assessment of technologies used in designing and implementing components or solutions in the implemented enterprise architecture. c) Determining which specific solutions or components of the implemented enterprise architecture need to be reconsidered (i.e., upgraded, replaced or integrated, or optimized, or extended to enable delivery of specialized services for specific market segments). d) Constituting or updating a catalog of solution projects (and their constituent work packages) that will be responsible for maintaining specific solutions or components of the existing enterprise architecture that need reconsidering. e) Developing or updating an architecture maintenance plan. f) Devising or updating architecture change management framework. g) Updating the stakeholder and requirements management framework. h) Developing and evaluating contracts of internal and external service providers who will implement particular solution maintenance projects (and their constituent work packages) as articulated in the architecture maintenance plan.

S5. Elaborate and Synthesize the Selected Set of Strategic Actions to be undertaken, by Adapting Tasks Involved in Implementing & Maintaining an Enterprise Architecture	
Tasks to execute in S5	**Guiding questions for deliberation in S5**
	Q5.2.4.2. Schedule the following as medium-term or long-term activities towards achieving particular prioritized strategic actions, i.e.: a) Updating architectural designs of specific solutions in the existing implemented enterprise architecture (that need to be upgraded, replaced or integrated, or optimized). b) Updating, replacing or integrating, or optimizing existing solutions or components in the existing implemented enterprise architecture. c) Periodic assessment of the performance of components or solutions in the existing implemented enterprise architecture and the architecture maturity level of the enterprise to ensure continuous improvement. d) Updating the stakeholder and requirements management framework for the architecture. e) Updating the design of the enterprise architecture and the architecture change management framework.

Appendix 7. Tasks and Guiding Questions in Step S6 of EAISSP

S6. Allocate and Specify Resources for Executing Activities Specified to Deliver the Synthesized Set of Actions that Constitute the Information Systems Strategy	
Tasks to execute in S6	**Guiding questions for deliberation in S6**
T6.1. Determine Key Performance Indicators (KPIs) for each activity specified to deliver the prioritized set of strategic actions.	Q6.1.1. For each activity specified to deliver the prioritized set of strategic actions, what are the activity/process indicators, output indicators, and value addition or outcome or impact indicators?
	Q6.1.2. From the indicator listing in Q6.1.1, what are the KPIs for each activity specified to deliver the prioritized set of strategic actions?
T6.2. Determine target outputs for each activity specified to deliver the prioritized set of strategic actions.	Q6.2. For each activity specified to deliver the prioritized set of strategic actions, what are the target outputs with respect to each KPI?
T6.3. Allocate time, financial, human, and social resources required to execute activities specified to deliver the prioritized set of strategic actions.	Q6.3. Depending on the priorities of the selected set of strategic actions and the logical sequencing of architecture development activities that are defined to realize the set of strategic actions, specify the following: a) Time periods within which the short-term, medium-term, and long-term activities can be executed. b) Stakeholder entities or groups responsible for executing and supporting the execution of the scheduled activities. c) Budget required to accomplish the scheduled activities and expected source of finances for facilitating activity execution.