



Dimensions for Scoping e-Government Enterprise Architecture Development Efforts

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Abstract. Inspired by developed economies, many developing economies are adopting an enterprise architecture approach to e-government implementation in order to overcome challenges of e-government interoperability. However, when developing an enterprise architecture for a complex enterprise such as the e-government enterprise, there is need to rationally specify scope dimensions. Addressing this requires guidance from e-government maturity models that provide insights into phasing e-government implementations; and enterprise architecture approaches that provide general insight into key dimensions for scoping enterprise architecture efforts. Although such insights exist, there is hardly detailed guidance on scoping initiatives associated with developing an e-government enterprise architecture. Yet the success of such business-IT alignment initiatives is often affected by scope issues. Thus, this paper presents an intertwined procedure that draws insights from e-government maturity models and enterprise architecture frameworks to specify critical aspects in scoping e-government enterprise architecture development efforts. The procedure was validated using a field demo conducted in a Uganda public entity.

Keywords: e-Government maturity · e-Government enterprise architectures

1 Introduction

Integration and interoperability are major drawbacks of e-government growth in developing economies [1, 2]. Literature (e.g. [3–5, 29]) indicates that adopting an enterprise architecture approach to e-government implementation helps to holistically address these issues. Since enterprise architecture steers change and integration in business-IT alignment contexts [6], adopting e-government – a mechanism of business-IT alignment in government service delivery – can be holistically guided by an *e-government enterprise architecture*. Although the success of enterprise architecture development depends on several factors, scope is among the critical ones [7–13]. If scope dimensions are not rationally specified, the success of an enterprise architecture effort is affected [11]. Yet if the enterprise is complex such as the e-government enterprise, defining the scope of its architecture becomes an intertwined problem.

From literature (see Sect. 2), addressing such a problem requires insights from e-government maturity models (because they guide phasing of e-government implementations) and enterprise architecture approaches (because they articulate key aspects that inform the scoping of architecture development efforts). This implies the need to investigate: *how e-government maturity models can supplement enterprise architecture approaches to provide detailed guidance on scoping e-government enterprise architecture development efforts*. Thus, this paper presents an intertwined procedure that can guide stakeholders on key dimensions to consider when Scoping e-Government Enterprise Architecture development efforts (SGEA). Section 2 presents related work and research approach used, Sect. 3 presents the design of SGEA and its instantiation using a field demo, Sect. 4 highlights key findings from the demo, and Sect. 5 concludes the paper and highlights future research efforts.

2 Related Work and Research Approach

Section 2.1 motivates design of SGEA and Sect. 2.2 discusses the research method.

2.1 Related Work on Scoping e-Government and Architecture Development

e-Government maturity models [14–19] provide a phased approach that enables governments to measure the progress in e-government development and to produce a robust citizen-centric and responsive government [20]. e-Government maturity models play a central role by offering generic concepts that inform, shape, and direct e-government deliberations, investments, and research. However, they hardly provide guidance on how to scope efforts towards attaining the specific stages and features of e-government growth that they articulate (as indicated in Table 1).

Table 1. Harmonization of stages in e-government maturity models

Baum & Maio [19]	UN & ASPA [14]	Deloitte & Touché [18]	Layne & Lee [17]	Hiller & Bélanger [16]; Moon [15]
(1) Web presence	(1) Emerging (2) Enhanced presence	(1) Information publishing/dissemination	(1) Catalogue	(1) Simple information dissemination
(2) Interaction	(3) Interactive presence	(2) Official two-way communication	-	(2) Two-way communication
(3) Transaction	(4) Transaction presence	(3) Multipurpose portals	(2) Transaction	(3) Service and final transaction
(4) Transformation	(5) Seamless or fully integrated presence	(4) Portal personalization (5) Clustering of common services (6) full integration and enterprise transaction	(3) Vertical Integration (4) Horizontal integration	(4) Political participation

Since e-Government maturity models use somewhat different terms to refer to specific stages, Table 1 extends the taxonomy in [21] by using specific features to synthesize names of stages with a bias of the naming used in [19] as indicated in column 1. Indicators for achieving each stage are as follows.

Web Presence: websites are used to increase access to formal and catalogued information [14–18] such as agency contacts, frequently asked questions, publications, trends/news updates [19] or dynamic information feeds from active databases [14].

Interaction: portals enable two-way communication [14–16, 18], posting online comments or inquiries, sending and receiving email, downloading documents, submitting forms; and authenticating users to access particular services [19].

Transaction: portals provide services across departments [18], e-forms and e-payment capabilities to allow online completion of transactions [14, 17, 19] on applying and renewing of verification documents and procurement of services [14–17, 19].

Transformation: A universal portal [14] that clusters common services; allows users to customize their views [18]; and enables vertical and horizontal service integration in order to deliver proactive service in a seamless and personalized way, that accommodates needs of specific groups of customers [15–19].

Although indicators for each stage are explicit, detailed guidelines are hardly available on how efforts should be scoped and aligned so as to achieve each stage. Inspired by [3–5, 25], such details can be obtained by designing architecture views as blueprints of capabilities for achieving a desired stage of e-government growth. However, prior to designing such blueprints, there is need to rationally specify their scope. Hence the need to review the extent to which architecture approaches inform scoping.

Scoping Enterprise Architecture Creation. Lack of a clear scope is a major managerial pitfall in architecture development [7, 8, 10]. Yet, on the one hand, architecture maturity models provide indicators for accomplishing specific stages in architecture development [23] without providing guidelines for scoping architecture creation. On the other hand, majority of enterprise architecture frameworks do not adequately address issues on scoping architecture initiatives [9] but emphasize the relevance of scoping and aspects to consider as shown in Table 2.

Overall Research Gap. Existing efforts in Tables 1 and 2 hardly provide detailed guidance on explicitly determining scope of an e-government enterprise architecture. Moreover, instantiating insights in Table 2 when developing an e-government enterprise architecture is not trivial because the e-government enterprise is contextually heterogeneous and multidimensional (Sect. 3.1 elaborates this). Thus, this research is motivated to devise SGEA by blending insights from Tables 1 and 2.

Table 2. Available insights on scoping an enterprise architecture effort

Zachman Framework [13]	<p>Scope/contextual/perspective phase involves establishing:</p> <ul style="list-style-type: none"> • Internal and external limits of an enterprise; goals/scope, strategies, and performance measures of the enterprise; • Elements that need to be considered in other phases; and • Major enterprise timelines
Integrated Architecture Framework – IAF [12]	<p>Manage complexity by using abstraction levels i.e. the “why-what-how-with what” reasoning pattern, but use the “why” and “what” to address scope because:</p> <ul style="list-style-type: none"> • “Why” defines business context/aspects that vary across enterprises (e.g. drivers/strategy/vision, objectives, principles, and scope of a problem), and • “What” specifies services to be supported
The Open Group Architecture Framework – TOGAF [11]	<p>Consider four dimensions when scoping architectures:</p> <ul style="list-style-type: none"> • <i>Enterprise</i> coverage – define all internal and external units of the enterprise and specify those to be considered; • <i>Architecture</i> domains – specify domains relevant in achieving target state; • <i>Level of detail</i> – specify level of abstraction of concepts in architecture views; • <i>Resources</i> (i.e. time, finances, and existing architectural assets of the enterprise) for architecture development

2.2 Research Approach

Design Science supports the development of feasible artifacts that help an enterprise to solve a significant problem or embrace a given opportunity towards achieving effective and efficient operations [22]. Instantiating design science to guide the development of SGEA implied undergoing three cycles. *Relevance cycle* involves highlighting the research gap and potential solutions and verifying applicability of an artifact [22]. Section 2.1 highlights the research gap motivating SGEA design, and Sect. 3 demonstrates its applicability as elaborated below. *Rigor cycle* emphasizes the need to draw from existing foundational approaches when creating an artifact [22]. As indicated in Sects. 2.1 and 3, two knowledge fields indicated in Tables 1 and 2 inform the design of SGEA. *Design cycle* involves building and continuously refining the artifact with respect to the problem context [22]. Section 3 discusses the design of SGEA and Sect. 4 highlights how insights from SGEA validation informed its refinement.

Validation of SGEA in a Developing Country. Design Science artifacts need to be exposed to the problem environment so as to investigate their applicability and use findings to refine them accordingly [22, 33]. Design science artifacts can be validated using lab demos, lab experiments, field demos, field experiments [26], case study, action research [33]. The choice of approach depends on the purpose of the artifact and

the nature of problem it addresses. The purpose of SGEA is to provide systematic guidance on aspects to consider when scoping efforts towards developing an e-government enterprise architecture. Validation of such an artifact requires that it is used at the start of a real-life e-government development project, to specify and document scope dimensions of that project using a scope specification matrix. To achieve this, a field demo is used.

A field demo allows researchers to demonstrate usability of an artifact in practice by instantiating it with respect to problems in the business environment [26]. Thus, to demonstrate the usability of SGEA, a field demo was conducted using one of Uganda’s public entities (as detailed in Sect. 3). The field demo involved three bilateral structured walkthrough sessions, each lasting for at most one-hour. Each session involved the ICT/Systems Manager of the entity and one of the researchers. Subjects of discussion during the sessions and respective instantiations are presented in Sect. 3.

3 Design of SGEA and Its Applicability in a Developing Country

In design science, a feasible artifact is obtained through exploring how available and proven means can be used to achieve a desired solution [22]. Thus, this section demonstrates how existing foundational insights in two fields are adopted and synthesized to design SGEA. First, from e-government maturity models in Table 1, the model in [19] is adopted as justified in Sect. 2.1, while insights from other models are used to elaborate descriptions of specific stages of maturity. Second, from enterprise architecture frameworks, TOGAF [11] is adopted because it provides clearer insights

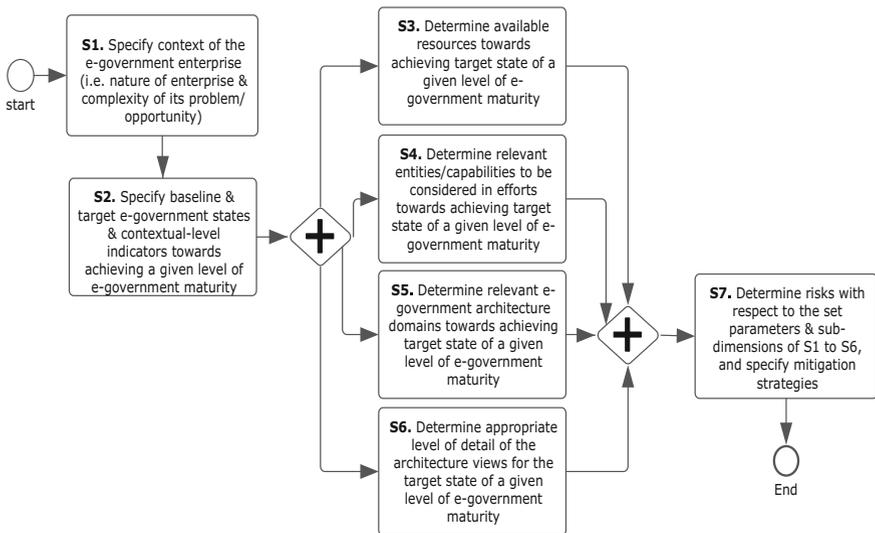


Fig. 1. Dimensions for SGEA

on scoping, while insights from other architecture frameworks or studies are used to elaborate particular aspects of scope dimensions for the e-Government Enterprise (GE) architecture. Thus, SGEA adapts TOGAF’s guidelines on scoping architecture efforts to support e-government realization with respect to insights on e-government maturity. SGEA, shown in Fig. 1, is a high level process for guiding deliberations on scoping GE architectures as blueprints for implementing interoperable e-government solutions. Each step in Fig. 1 is a pointer to detailed aspects presented in Sects. 3.1 to 3.7, with interludes of text boxes representing instantiations from the field demo. Appendix 1 shows a template of the scope specification matrix that can be used to document scope dimensions derived using SGEA. Sections 3.1 to 3.7 discuss SGEA components or dimensions that are coded as S1 to S7 for cross-referencing purposes.

3.1 Specify Context of the GE (S1)

An enterprise architecture development effort should be tailored to the enterprise context, planned scope of architecture engagement, and enterprise goals [9]. Thus, S1 indicates the need to define contextual features of the GE using two sub-dimensions (i.e. S1.1 and S1.2) that shape deliberations on other dimensions as shown in Fig. 1.

S1.1. Nature of the GE. Understanding the nature of an enterprise implies specifying the “gross size” of that enterprise [13] or defining entities that constitute the full breadth and depth of its operations [11]. The *gross size* of the GE comprises three parameters (i.e. S1.1.1 to S1.1.3) below.

S1.1.1. Structural Nature of the GE. Government is a large and highly complex enterprise characterized by conventionally interconnected sectors [25], which fulfill their specific mandates by establishing agencies, departments, and units. Thus, aligning ICTs with capabilities of such an enterprise yields the GE [30], which structurally comprises three tiers (i.e. national, sector, and unit tiers) with each tier having seven scope dimensions that stakeholders need to consider when planning the development of the GE architecture to enable e-government interoperability. In Fig. 2, a heptagon shape is used to illustrate these tiers and the seven scope dimensions of each tier are represented at the vertexes of Fig. 2 and elaborated in Fig. 1 and its discussions. *National level* in Fig. 2 comprises entities mandated as overall regulators of e-government implementation in a country. *Sector level* comprises entities mandated to regulate and deliver specific services towards economic growth. Sector-specific e-government implementations are regulated by the national level. *Unit level* comprises

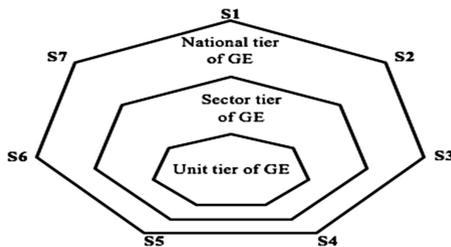


Fig. 2. Three levels/tiers that constitute the GE

agencies/departments/units within a particular sector, and directly interact with each other to deliver a wide range of e-government services.

Specific questions that prompt actors to specify values for S1.1.1 are provided in the text box below, and clarified using an instantiation from the field demo.

Question S1.1.1: What is the composition of the national/sector/unit tier of the GE in a given country? How many entities are at any/each GE tier and what are their key mandates? Which of these entities should be focused on in a given e-government enterprise architecture development effort?

Instantiation: *The national tier of Uganda's GE comprises Ministry of ICT and the sector tier comprises 30 entities [27], each comprising several agencies/ directorates/departments that are perceived as unit tier entities of the GE. However, in the field demo validation of SGEA, an entity at unit level was purposively selected due to resource limitations. Thus, the Directorate of Revenue Collection (DRC) of Kampala City Council Authority was selected due to the swiftness it exhibited in responding to the call for participation that was sent out to a sample of unit level entities in Uganda's GE.*

S1.1.2. Service Portfolio of the GE. The full scope of the e-government landscape comprises three categories of e-government solutions, i.e.: e-administration suite with solutions that support internal processes of a public entity; e-citizen or e-service suite with solutions that support engagements between a public entity and its customers; and e-society suite with solutions that support engagements between a public entity and other public, private, not for profit, or civil society entities [32]. Accordingly, these solutions support electronic transactions and interactions that yield Government to: Government (G2G) services, Citizen/consumer (G2C) services, Business and non-profit agency (G2B) services [31], and Employees (G2E) services [2]. These services are accessible by international, national, regional, provincial, and local communities [31]. These classifications imply that each tier in Fig. 2 delivers three categories of services that need to be considered when deliberating on the scope of the GE architecture for a specific entity at any tier. Questions for deliberation under S1.1.2 and corresponding instantiations from the field demo are provided in the text box below.

Question S1.1.2: What is the composition of the service portfolio for the chosen entity/entities at any/each GE tier in terms of e-administration (e.g. G2E), e-customer or e-service (e.g. G2C), and e-society (e.g. G2G, G2B)? Which of the three categories of e-government services should be focused on in a given e-government architecture development effort?

Instantiation: *DRC service portfolio comprises all services that involve sensitization of taxpayers and establishment of strategic and operational policies to guide mobilization and collection of revenue from all types of businesses in Uganda's capital city, so as to promote economic growth [28]. Thus, the GE service portfolio of DRC includes three categories of e-government services, i.e.: e-administration, e-services, and e-society. The field demo focused on the e-services category.*

Question S1.1.3: What are the socio-cultural and political concerns or priorities of the chosen entity/entities at any/each GE tier, and what are the implications of these on choices in S1.1.1 and S1.1.2?

Instantiation: *Specifications on this are intentionally excluded for confidentiality reasons.*

S1.1.3. Socio-Cultural and Political Environment of the GE. The operational environment of a specific entity at any/each GE tier in Fig. 2 comprises social, cultural, and political factors that have a bearing on the success of e-government implementation and enterprise architecture development. Thus, inter and intra environmental scanning of the enterprise helps to understand the organizational structure, culture, level of commitment, and nature of politics in the enterprise as well as the implied or possible obstacles that may arise [8]. For instance, the level of management commitment and

support has a direct bearing on the assurance of: resources for enterprise architecture development, and guidance on enterprise-specific protocols for successful collaboration of all key stakeholders [10]. Thus, S1.1.3 not only involves understanding socio-cultural and political factors and their implications on scoping GE architecture development efforts, but also helps to acquire indicators or implicit information for gauging resource availability levels in scope dimension S3 (Sect. 3.3). The text above shows specific questions for eliciting specify values for S1.1.3.

S1.2. Complexity of Problem or Opportunity of the GE. Complexity of a problem/opportunity is specified using two parameters (i.e. S1.2.1 and S1.2.2).

S1.2.1. Type of Problem/Opportunity in the GE. This parameter indicates the need to: (a) classify a problem/opportunity of an entity at any/each tier of the GE with respect to the three categories of e-government services offered by the GE as indicated in S1.1.2; and (b) determine which category of e-government service should be actualized in order to address the problem or seize the opportunity. Understanding S1.2.1 when scoping the GE architecture effort helps to obtain information relevant for: determining target state of e-government maturity in scope dimension S2 (in Sect. 3.2); and selecting reference models/architectures that can be adapted in scope dimension S5 (in Sect. 3.5). The text box below shows specific questions for eliciting specify values for S1.2.1, and corresponding instantiation.

Question S1.2.1: What is the problem/opportunity of the entity at any/each tier of the GE, and which category of e-government service(s) should be implemented by the GE so as to overcome or seize the opportunity?

Instantiation: *DRC faced a problem of overwhelming client volumes and operational complexity, that called for the need to streamline management of revenue collection through re-engineering existing business processes and developing a supporting e-government solution. Categorically, based on [6,23], this is a problem of establishing IT-reliant business processes and implementing quality management systems respectively. Thus, the categories of e-government services required to address the problem are e-administration and e-services.*

S1.2.2. Magnitude of Problem/Opportunity in the GE. Any enterprise transformation prompts stakeholders to seek information on the part of the enterprise that is to be impacted, corresponding boundaries of the impact, and other related projects that are to be indirectly affected [23]. Therefore, S1.2.2 indicates the need to identify internal and external entities at any/each GE tier that are directly and indirectly affected by the specified problem or opportunity; or that support the achievement of the category of e-government service specified in S1.2.1. Understanding S1.2.2 when scoping the GE architecture effort helps to obtain information relevant for decision making in scope dimensions S4 and S6 (in Sects. 3.4 and 3.6 respectively). The following text box shows specific questions for eliciting specify values for S1.2.2.

Question S1.2.2: Which internal capabilities within the chosen entity/entities in S1.1 and external entities or capabilities are (or are to be) directly and indirectly affected by the issues or specified category of e-government service(s) in S1.2.1?

Instantiation: *DRC comprises 3 business capabilities (i.e. Valuation and Revenue Collection; Compliance and Inspectorate; Research and Business Analysis), and all were directly affected by the problem. Also, out of the 10 sister directorates to DRC, 8 were indirectly affected by the problem in DRC.*

3.2 Determine Baseline and Target State of e-Government Maturity (S2)

This involves sub-dimensions S2.1 to S2.3 below. Specific questions for eliciting values for S2.1 to S2.3, and field demo instances are provided in the text boxes below.

S2.1. Specify baseline e-government maturity level. This indicates the need to assess maturity level of e-government establishment of the focus entity/entities specified in dimension S1. This can be done by using the e-government maturity models in Table 1 (Sect. 2.1) to derive an e-government maturity assessment checklist. However, while deriving such a checklist, there is need to ensure that maturity assessment features accommodate the three categories of services that constitute the service portfolio of the GE (as indicated under S1.1.2). This is because e-government maturity models summarized in Table 1 emphasize maturity assessment features for initiatives under e-citizen/e-service category and some instances under e-society category. They are silent about maturity assessment features for initiatives under e-administration category and some instances under e-society category. However, designing the assessment checklist that addresses this gap is beyond the scope of this paper.

Question S2.1: Using e-government maturity models in [14 - 19], what is the maturity level of the e-services/e-citizen category of e-government services in the entity/entities chosen in S1? What is the maturity level of the e-administration and e-society categories of e-government services?

Instantiation: *Baseline target state of DRC was one-way interaction stage because the DRC website had forms for business people to download and apply for various services.*

S2.2. Specify legally acceptable level and affordable target level of e-government maturity. The target state of e-government maturity in a given entity may depend on the laws and unique constraints associated with exercising the mandate of that entity. In other words, complexities and governing laws in delivering a particular service may not permit implementation of e-government solutions beyond a given stage of maturity. Thus, this sub-dimension indicates the need to: (a) assess complexities and risks associated with implementing each stage of e-government maturity in the focus entity/entities specified in dimension S1; (b) determine the legally acceptable level of e-government maturity for the focus entity/entities specified in dimension S1; and (c) determine the affordable or appropriate target state of a given level of e-government maturity in the focus entity/entities specified in dimension S1. Managerial issues in enterprise architecture efforts such as restricted rules in enterprise operations, ambiguity of goals and strategies [8], and rapidly changing operational conditions [10] are accommodated by specifying both the legally acceptable level of e-government maturity and the affordable target state of e-government maturity. This is because an entity may be legally cleared to achieve a given level of e-government maturity, but resources and situational context may not allow in a given period. Such an entity can then determine and pursue the affordable target state. The affordable or appropriate target state is specified by considering the urgency required in addressing the GE problem in S1.2 and existing legal framework in S3.1 or resources in S3.

Question S2.2: What are the risks associated with implementing each stage of e-government maturity in the entity/entities chosen in S1? What is the legally acceptable level of e-government maturity for the entity/entities chosen, and why? Given existing resources, what is the affordable/ appropriate target state, and why?

Instantiation: *Although the legally acceptable level of e-government maturity for DRC is “transformation” stage, the affordable/appropriate target state was “two-way interaction” level due to two reasons: urgency in streamlining processes towards effective delivery of its mandate and limited resource envelop to support attainment of target state.*

S2.3. Specify context-specific indicators for the e-government target state. This sub-dimension indicates the need to specify explicit indicators/milestones towards realizing the target state of e-government maturity for the focus entity/entities specified in dimension S1. These milestones inform/guide the selection of features associated with other dimensions in scoping the GE architecture (that are discussed in Sects. 3.3 to 3.7). The contextual indicators are derived by instantiating a given stage of an e-government maturity model with respect to the service portfolio (specified in S1.1.2) of the focus entity/entities specified in dimension S1. In addition, these context-specific indicators are not only for the e-government solutions as end products, but also for the operational and governance framework associated with delivering a given level of e-government maturity in the GE (as elaborated below).

If target state is web presence stage across any/all GE tiers, should the operational and governance framework have centralized or decentralized policies and procedures for web content management aspects such as: type of content, language and cultural constraints for content generation, update frequency, feedback and risk control/mitigation strategies, reliability/continuity strategies)?

If target state is interaction stage across any/all GE tiers, which categories of services should be partially completed online and which ones should not as per the operational and governance framework, what is the appropriate extent of online engagement for either categories, and the appropriate feedback and risk control/mitigation strategies?

If target state is transaction stage across any/all GE tiers, which categories of services should be fully handled online and which ones should not as per the operational and governance framework, what are the corresponding feedback and risk control/mitigation strategies, are the legal capabilities established to support full transaction handling for all entities at each GE tier?

If target state is transformation stage across any/all GE tiers, which category of services quality for vertical integration in each GE tier and for horizontal integration across all tiers as per the operational and governance framework, and what are the corresponding legal capabilities?

Question S2.3: What are the entity-specific indicators/milestones towards realizing the target state of e-government maturity in the entity/entities chosen in S1?

Instantiation: *To achieve two-way interaction state in DRC, indicators include: an e-government capability that allows business owners to register businesses online, appear at DRC offices for identity verification, receive a token number for making online payments of licenses and other fees.*

3.3 Determine Available Resources for e-Government Implementation (S3)

Resource-related problems in enterprise architecture development include: outdated legal/regulatory documents and infrastructure; limited capabilities/expertise in management/leadership, change management, enterprise architecture, human resource establishment; and limited budget to provide mitigations for the resource gaps [8]. Therefore, this dimension helps to obtain relevant information for planning the development of the GE architecture with respect to contents in the “*resource envelop*”. To achieve this, two perspectives apply. From an *e-government perspective*: OECD [24] articulates that the success of e-government implementation requires resources such as a comprehensive legislative and regulatory framework, financial sustainability framework, and a strategic-operational framework for reducing digital divide and establishing shared technology infrastructure. From an *architecture perspective*: TOGAF (2009) emphasizes that when securing finances to facilitate architecture development and when determining the appropriate time required to deliver architecture products (to respond to a situation), it is vital to consider all possible ways of reusing existing enterprise resources (such as preliminary/earlier architecture products, reference models, available human resource skillset, and enterprise-wide awareness levels among key stakeholders on enterprise architecture development).

Accordingly, five sub-dimensions (i.e. S3.1 to S3.5) that shape the GE resource envelop are derived from the above two perspectives. For each sub-dimension, there is need to specify the strengths and gaps with respect to achieving the target stage of a given level of e-government maturity (as specified in scope dimension S2) and the magnitude of the identified gaps. The text boxes below show questions that prompt entity-specific values for S3.1 to S3.5 and related instantiations from the field demo.

S3.1. Information Resources. Baseline information resources (such as management frameworks, policies/regulations, principles, tools) need to be identified, updated, and re-used during enterprise architecture development [11]. In addition, the constraints that existing information resources imply on efforts towards achieving the target state specified in S2 need to be determined.

Question S3.1: What are the existing information resources in the entity/entities chosen in S1, and what constraints do they imply on efforts towards achieving the target state specified in S2?

Instantiation: Existing information resources in DRC included: process flow models of the DRC operational framework, website with service portfolio information, data requirements for the DRC operational framework, downloadable application forms that request for DRC services

Question S3.2: What are the existing skills among all key stakeholders in the entity/entities chosen in S1 with respect to undertaking activities required to achieve the target state specified in S2?

Instantiation: Although there was high level of awareness on the use of system engineering and project management approaches in e-government adoption in DRC, there was limited expertise in enterprise architecture adoption in e-government implementation.

S3.2. Human Resources. There is need to determine existing technical and other skills or capacity (among all internal and external stakeholders of the GE) with respect to designing, implementing, adopting, and maintaining capabilities relevant in achieving the target state specified in S2.

S3.3. ICT Infrastructure. Existing e-government solutions and ICT infrastructure and their functionality status need to be determined in order to devise mechanisms and

strategies of realizing the required synergy and interoperability towards achieving the target state specified in S2. For example, it is vital to specify the: existing technology infrastructure, legacy systems with respect to rapidly changing technologies; the extent to which IT infrastructure is shared; the extent of cohesion of existing e-government solutions; and the extent of the digital divide problem [24]. Therefore, S3.3 enables entities at any GE tier to implement e-government solutions (for achieving the target state specified in S2) that are consistent with existing, ongoing, or planned e-government solutions.

Question S3.3: What are the existing e-government solutions and ICT infrastructure, what is their functionality status, and what is their role in efforts achieving the target state specified in S2?

Instantiation: *Existing e-government solutions and infrastructure were being used by sister directorates to DRC*

S3.4. Finances. Finances available to facilitate the achievement of the target state of a given level of e-government maturity depend on the country-specific programmatic planning and partnership funding programme [24]. S3.4 indicates the need to specify the mode of funding and peculiarities that shape its availability to facilitate efforts towards achieving the target state specified in S2.

Question S3.4: What are the funding sources to facilitate efforts towards achieving the target state specified in S2, and what are the availability constraints?

Question S3.5: What is the timeframe for achieving the target state specified in S2 with respect to constraints implied by S3.1 to S3.4?

Instantiation: *S3.4: Since this was a field demo, the finances dimension was not considered comprehensively. S3.5: The duration to conduct the scoping demo was one week because the duration of the larger project that had to use scope specifications from SGEA was two months.*

S3.5. Time. Time available to achieve the target state of a given level of e-government maturity depends on: (a) the urgency required in resolving the challenge or embracing an opportunity of the GE; or (b) country-specific funding mechanisms and donor conditions in terms of financial planning periods or mode of sponsoring/funding as indicated in S3.4. Thus, S3.5 indicates the need to specify the timeframe for achieving the target state specified in S2 with respect to constraints implied by S3.1 to S3.4.

3.4 Determine Suitable Extent of Engagement in the GE (S4)

Defining the scope of enterprise architecture development involves determining all internal and extended units of an enterprise, units that are to be impacted by the architecture initiative, and units that are within and those that are outside the scope of the initiative [11]. SGEA adapts this principle using two aspects that are explored at different levels/steps due to contextual and understandability issues. The first aspect is discussed in Sect. 3.1, where all entities that are to be directly and indirectly affected by the problem and solution/opportunity experienced by an entity at any/each GE tier in Fig. 2 are specified under parameter S1.2.2. However, due to resource constraints, it may be difficult to afford accommodating all entities listed under S1.2.2.

Thus, the second aspect is accommodated in this dimension, which indicates the need to specify a fraction of those entities that can be engaged in efforts towards

achieving particular milestones associated with the target state of a given level of e-government maturity (as specified in Sect. 3.2), with respect to contents in the resource envelop (as specified in Sect. 3.3). Also, given the complex contextual nature of the GE, it is imperative that the extent of intervention in developing the GE architecture is specified at each tier with respect to target state and resource envelop. This can take a top-down approach (from national-sector-unit levels) or bottom-up approach depending on output from dimensions in Sects. 3.1, 3.2 and 3.3. Sub-dimensions S4.1 to S4.3 apply as discussed below. Specific questions and field demo instances for S4.1 to S4.3 are provided in the text box below.

S4.1. National extent of engagement. This indicates the need to determine a fraction of existing sectors in a country and a fraction of partners at national, regional, and international levels that are relevant in achieving the target state of a given level of e-government maturity at national level.

Question S4.1: Which sectors in a country and which partners at national, regional, and international levels are relevant in achieving the target state specified in S2?

Question S4.2: Which existing and planned units/departments/agencies in a given sector, partner sectors/entities, and specific partner entities at national, regional, and international levels are relevant in achieving the target state specified in S2?

Question S4.3: Which internal and external/partner entities of a given unit, and existing/planned business capabilities are relevant in achieving the target state specified in S2?

Instantiation: S4.1 & S4.2 do not apply due to the selection of DRC as indicated in S1.1.1.

S4.3: All the three business capabilities (listed in S1.2) were considered in designing the e-government business architecture for DRC. However, the 8 sister/affiliate entities/directorates (listed in S1.2) could not be considered due to scope values chosen under S1 to S3

S4.2. Sector level extent of engagement. This indicates the need to determine: a fraction of existing and planned units/departments/agencies that constitute a given sector, a fraction of partner sectors/entities, and a fraction of specific partner entities at national, regional, and international levels that are relevant in achieving the target state of a given level of e-government maturity at sector level.

S4.3. Unit level extent of engagement. This indicates the need to determine a fraction of internal and external/partner entities that constitute a given unit and a fraction of their existing and planned business capabilities that are relevant in achieving the target state of a given level of e-government maturity at unit level.

Specifying governance structures in the enterprise architecture process helps to: (a) exhaustively identify all relevant stakeholders because missing some key stakeholders may cause questioning of architecture deliverables; and (b) appropriately articulate responsibilities of key stakeholders and implied measures of engagement [10]. Thus, specifying entities to be considered at any/each GE tier in a given period of developing GE architecture helps to specify the roles and responsibilities of specific key stakeholder groups and the GE architecture governance team.

3.5 Determine Relevant Domains of the e-Government Architecture (S5)

Managerial architecture development challenges such as fuzzy strategies for actualizing enterprise goals [8] are addressed through specifying architecture domains that are relevant in delineating the implementation of each e-government implementation

strategy/goal. An enterprise architecture comprises five architecture domains (i.e. business, data, application, technology, and security), but limitations in enterprise resources may not permit all the domains to be developed at once [11]. Hence the need to specify relevant architecture domains for guiding e-government implementations in a specific entity at any GE tier. S5 comprises sub-dimensions S5.1 and S5.2 as discussed below. Specific questions and field demo instances for S5.1 and S5.2 are provided in the text boxes below.

S5.1. Determine overall purpose of the GE architecture. This indicates the need to specify the purpose of the GE architecture in realizing the target state of a given level of e-government maturity (that was specified in Sect. 3.2). An enterprise architecture is an instrument for: (1) assessing impact of a strategy before actual implementation of a strategy; (2) specifying business and ICT requirements for realizing a transformation; (3) informing and contracting service providers of specific capabilities towards realizing the desired state; and (4) guiding decision making during a transformation [23]. Thus, specifying any/all of these purposes as the overall purpose of the GE architecture in achieving the target state of e-government helps to guide decision making on SGEA dimensions that are discussed in Sects. 3.3, 3.4, 3.6, and 3.7.

Question S5.1: What is specific purpose/role of the GE architecture in achieving the target state specified in S2?

Instantiation: *General purpose of the GE architecture is to specify business and ICT requirements for the e-government capability that enables features specified in S2.3.*

S5.2. Determine relevant domains at any/each GE tier that should be considered in designing the e-government architecture for achieving the target state of a given level of e-government maturity. Relevant domains are selected based on: the overall purpose of the GE architecture (specified in S5.1), the specified extent of engagement (in Sect. 3.4), resource envelop (in Sect. 3.3), desired target state of e-government maturity (in Sect. 3.2), the GE nature (in Sect. 3.1), and the focus area of each architecture domain. In determining the focus area of each architecture domain, the following definitions are derived based on TOGAF [11] and coded as follows.

S5.2.1. *e-Government Business Architecture:* specifies business capabilities (and their interrelationships) that are needed in a specific entity at any/each GE tier, so as to establish a responsive operational framework for delivering the full landscape of e-administration, e-citizen/e-service, and e-society services and to realize the e-government implementation and governance strategy.

S5.2.2. *e-Government Data Architecture:* specifies the logical and physical data capabilities that are needed in a specific entity at any/each GE tier to support S5.2.1.

S5.2.3. *e-Government Application Architecture:* specifies a suite of specific electronic solutions that need to be deployed/realized in a specific entity at any/each GE tier in order to provide agile e-administration, e-citizen/e-service, and e-society services; and the interoperability implications of these solutions towards reliably supporting S5.2.1 and S5.2.2.

S5.2.4. *e-Government Technology Architecture:* specifies the suite of software and hardware capabilities that are needed in a specific entity at any/each GE tier to support S5.2.1 to S5.2.3 and S5.2.5.

S5.2.5. e-Government Security Architecture: specifies the range of all security-related mechanisms and provisions that need to be established in a specific entity at any/each GE tier to protect all resources in S5.2.1 to S5.2.4, so as to increase reliability and agility of e-government services.

Question S5.2: How relevant is the GE business architecture, GE data architecture, GE application architecture, GE technology architecture, and GE security architecture in fulfilling the specific purpose of the GE architecture as specified in S5.1?

Instantiation: *The e-Government Business Architecture domain was selected to show the cohesion of revenue with other departments, in order to determine the scope of access or use of the e-government solution and implied information exchanges.*

3.6 Determine Fitting Level of Detail of the e-Government Architecture (S6)

Understanding architecture descriptions is usually difficult because builders and users/consumers/implementers thereof are often different people [10]. To improve understandability of architecture descriptions, this dimension indicates the need to specify the appropriate level of detail that should be considered in designing the selected domains for the GE architecture (as specified in Sect. 3.5). The level of detail in enterprise architecture views can be at *high/vision level* – showing only major capabilities; *medium/moderately detailed level*, or *extremely detailed level* – showing capabilities in a fine granularity mode [11, 13]. Accordingly, the appropriate level of detail for specific domains of the GE architecture may vary across entities and GE tiers because it is determined basing on: the purpose of the domain (in Sect. 3.5), entities selected at each GE tier (in Sect. 3.4), size of resource envelop (in Sect. 3.3), target state of e-government maturity (in Sect. 3.2), and nature of a given GE tier (in Sect. 3.1). For example: at national level, level of detail for selected domains of the GE architecture could be vision level; at sector level it could be intermediate detailed level; and at unit level it could be extremely detailed level. The text box below shows questions that prompt deliberations and responses on this dimension.

Questions S6: What is the appropriate level of detail that should be considered in designing the selected domains for the GE architecture with respect to choices arising from dimensions S1 to S5?

Instantiation: *The appropriate level of detail for the e-government business architecture for DRC was vision level due to resource limitations and other aspects arising from choices in S1 to S5.*

3.7 Assess Risks in the Specified Scope of the e-Government Architecture (S7)

The scope of an architecture effort and the existence of several enterprise architecture approaches with limited procedural and consistent guidance, have a bearing on the complexity involved in creating and maintaining architecture models for heterogeneous and dynamic social systems [10]. Thus, risk analysis is not only a vital step in the enterprise architecture development process [11], but also crucial in specifying the scope of efforts on developing enterprise architectures. Sections 3.1 to 3.6 attempt to curb the complexity by providing procedural insights into scope dimensions S1 to S6

that require deliberation when planning architecture development efforts for the GE. Thus, basing on output or specified features for dimensions S1 to S6, this dimension indicates the need for two sub-dimensions S7.1 and S7.2 as discussed below.

S7.1. Evaluate possible risks in adopting the proposed concatenations. It is vital to assess risks of specific contextual values/features for each scope dimension and its corresponding parameters in Sects. 3.1 to 3.6. Thus, this sub-dimension indicates the need to: (a) compare possible risks of proposed scope dimensions with envisioned risks in adopting the concatenations of alternative contextual values/features for each scope dimension and corresponding parameters; and (b) determine corresponding risk mitigation strategies for the proposed scope and alternative scope and the implications of these on the resource envelop dimension in S3 (discussed in Sect. 3.3). This may result into feedback loops in dimensions S1 to S6 to address concerns raised from risk analysis.

S7.2. Choose and document the appropriate concatenation of values for all scope dimensions. This sub-dimension indicates the need to: (a) specify selected features/values for each scope dimension of the GE architecture from Sects. 3.1 to 3.6; (b) provide justification for each selected value/feature with respect to a given concatenation of scope values; and (c) document alternative concatenations of scope values along with reasons why they have been deemed inappropriate. The chosen scope values are represented using a scope specification matrix for the GE architecture. A template for this is provided in Appendix 1.

Questions S7.1: What are the possible risks of the proposed features of scope dimensions S1 to S6? What are the envisioned risks in adopting the concatenations of alternative contextual values/features for scope dimensions S1 to S6? What are the risk mitigation strategies for the proposed scope and alternative scope dimensions? What are the implications of the mitigation strategies on the resource envelop in dimension S3?

Questions S7.2: Based on findings in S7.1, what is the justification for each selected value/feature of a given scope dimension and the concatenation thereof? What is the reason why the alternative concatenations of scope values are inappropriate?

Instantiation: *Scoping started at unit tier, thus chances of not engaging key stakeholders in S4.1 and S4.2 were high, and this would affect the quality of the GE architecture in terms of interoperability.*

4 Key Insights from the Field Demo on SGEA

From Sect. 2.2 and text boxes in Sects. 3.1 to 3.7, this section highlights how the field demo helped to refine SGEA. SGEA was used at the start of a larger e-government project to specify and document scope dimensions of the project using the template in Appendix 1. This yielded the italicized instantiation phrases presented in text boxes in Sects. 3.1 to 3.7. The actual e-government architecture views that were obtained after the scope specifications can not be included herein because they are beyond the scope of SGEA and the focus of this paper. The field demo yielded three major aspects.

First, parameter S1.2.2 was originally part of dimension S4 (i.e. level of detail for the GE architecture views), but during the field demo it was noted that it has to be shifted to be part of dimension S1 to allow proper reasoning on parameters and values associated with dimensions S1 to S3. *Second*, parameter S7.2 had to be amended in

order to ensure that values chosen under each parameter of a given scope dimension are justified. This amendment has been addressed as indicated in Sect. 3.7. *Third*, further research needs to be done to: (a) derive a comprehensive checklist that assesses the baseline maturity level of an entity with respect to all the three categories of e-government services as specified in Sects. 3.1 and 3.2; (b) derive a comprehensive documentation framework of findings resulting from the risk-mitigation analysis of scope dimensions as discussed in Sect. 3.7; and (c) derive additional standardized formats/templates (that serve as feeder templates to the scope specification matrix/template in Appendix 1) for documenting the specific features/values of the scope dimensions, sub-dimensions, and parameters across e-government projects. Aspects (a) to (c) arose as mechanisms to address use-related challenges that were faced when instantiating SGEA scope dimensions during the field demo.

It was noted that if each e-government project in a given entity at any/each GE tier has such a scope specification matrix, it helps to provide early insight into possible counts of integration and interoperability that should be accommodated between and among e-government projects.

5 Conclusion and Future Work

This paper demonstrates that scoping an e-government enterprise architecture development initiative is not a trivial task, but a multi-layered iterative procedure that considers a number of intertwined aspects in order to obtain a well thought out scope specification. This multi-layered synthesis, coined herein as SGEA, draws from the field of e-government maturity models and scoping insights from the field of enterprise architecture development. SGEA not only guides scoping, but allows a specific entity at any GE tier to implement e-government solutions that are interoperable with e-government solutions that are existing, ongoing, or planned within that entity or in other GE entities/tiers. A field demo validation of SGEA revealed the need to underpin some SGEA dimensions with supporting tools or frameworks to allow systematic assessments to be done. Accordingly, future developments of SGEA include development of a comprehensive context-specific checklist for assessing all categories of e-government maturity, standard templates for documenting values for scope dimensions and parameters, and a framework for supporting risk assessment of selected features or values of SGEA scope dimensions.

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Appendix 1. Template for the Scope Specification Matrix of SGEA

Dimension	Sub dimension	Parameters	Scope dimensions of the GE architecture
S1	S1.1	S1.1.1	

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