2021 IEEE 25th International Enterprise Distributed Object Computing Workshop (EDOCW) | 978-1-6654-4488-0/21/$31.00 ©2021 IEEE | DOI: 10.1109/EDOCW52865.2021.00059

Assessing Readiness for e-Government Enterprise Architecture in a Developing Economy – Towards an Integrated Maturity Model

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***Abstract*— Developing e-government enterprise architectures as a means for acquiring interoperable solutions is being embraced by several developing economies. However, for effectiveness, a government enterprise needs to assess its readiness for both e-government and enterprise architecture. Various studies discuss mechanisms for assessing e-government readiness or e-readiness, while few studies give insight into assessing readiness for enterprise architecture. There are hardly any studies that provide a perspective on readiness assessment, that integrates both e-government and enterprise architecture aspects. Yet, adopting an architecture-driven approach to e-government implementations without assessing readiness for both e-government and enterprise architecture, increases the risk of two issues. Process-related issues arise when the architecture-driven change is not effectively implemented due to flaws in the procedure used, while product-related issues arise when desired changes are not achieved due to flaws in the product. This worsens the 'design-to-reality' gap that is already hindering successful e-government implementation in developing economies. Thus, this paper presents initial results towards an integrated maturity model for assessing readiness for architecture-driven e-government implementations. It synthesizes insights on assessing readiness for enterprise architecture and e-government. The applicability and feasibility of the model was evaluated using a demo that was conducted in a Ugandan public entity.**

Keywords: enterprise architecture, e-government, readiness assessment

I. INTRODUCTION

Enterprise architecture-driven e-government efforts in developed economies (e.g. [1–3]) report benefits such as sustainable alignment of business and IT functions and significant improvement in e-government performance. Thus, the practice of developing e-government enterprise architectures, as a means for achieving interoperability, is embraced by several developing economies, e.g. South Africa [4], Ghana [5], and Egypt [6]. However, undertaking an architecture-driven e-government implementation without assessing readiness for both e-government and enterprise architecture increases the risk of encountering an intertwined process-product problem. Process-related issues arise when the country does not effectively implement the architecture-driven change due to flaws in the procedures undertaken, while product-related issues arise when the desired changes are not achieved due to flaws in the product. Since the 'design-to-reality' gap is already large enough to be a key hindrance to successful e-government in developing economies [7, 8] this intertwined process-product problem worsens it.

Enterprise architecture development often involves re-designing the product and service portfolio of an enterprise, its business processes, its information systems, and technology infrastructure [9]. Thus, the possible resultant changes imply the need to assess readiness for enterprise architecture prior to undertaking its development [2, 10–13]. Yet, also successful e-government demands comprehensive readiness assessment [2, 12, 14, 15]. Thus, for architecture-driven e-government implementations to be effective, a nation or government enterprise must assess its readiness for both e-government and enterprise architecture. There are numerous efforts on assessing e-government readiness in developing countries (e.g. [13–20]. Also, some efforts provide guidance on readiness assessment for enterprise architecture (e.g. [10, 21, 22]. However, there are hardly any studies that provide an integrated perspective of readiness assessment in the context of implementing e-government enterprise architectures.

Thus, this paper presents initial results towards an integrated model for assessing readiness for architecture-driven e-government implementations in a government enterprise (at national, sector, and institution levels). The model for **A**ssessing **R**eadiness to develop an e-**G**overnment **E**nterprise **A**rchitecture (ARGEA), comprises assessment dimensions that synthesize insights on enterprise architecture readiness and e-government readiness. To develop ARGEA, a Design Science approach was adopted. Design Science guides the systematic design of artifacts that address organizational and community problems or improve practice; and gives insights into how various evaluation approaches can be used to incrementally or continously refine the design and performance of an artifact [45].

Design Science involves 3 related cycles, i.e.: a) Relevance Cycle, where the importance of the organizational or community problem is investigated or gaps in practice are identified; b) Rigor cycle, where relevant theoretical frameworks or models and experiences of experts are creatively adapted and to devise a solution for identified gaps; and c) Design Cycle, where an artifact is derived or assembled, the quality of the artifact design and performance is iteratively assessed using a range of evaluation approaches, and the artifact is continously refined to achieve its purpose [45, 48]. These cycles are not executed in isolation, but in a rational way as specified below.

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DOI 10.1109/EDOCW52865.2021.00059

We executed the *Relevance cycle* by: (i) Reviewing literature on readiness assessment for e-government and enterprise architecture, as elaborated in section II; and (ii) Conducting the initial validation of ARGEA, where its design, feasibility, and applicability was evaluated using a demo that was conducted in a Ugandan public entity. This is elaborated in section IV. We executed the *Rigor cycle* by identifying and adopting theoretical or knowledge insights on e-government and enterprise architecture that were relevant for adapting in the Design cycle of the study, so as to address the gaps highlighted in section II. Models or concepts that are adopted are specified in section III. Also, in this cycle, the study or paper extends the theoretical knowledge base by presenting ARGEA and its application context. We executed the *Design cycle* by: (i) Creatively deriving ARGEA through integrating assessment factors or measures of e-government and enterprise architecture; and (ii) Refining the design of ARGEA using findings from the initial validation, as presented in section IV. Accordingly, the remainder of this paper is structured as follows: Section II presents related work, section III presents the design of ARGEA, section IV presents the demo and key findings, and section V concludes the paper and indicates future work.

II. Related Work and Gap Analysis

The literature provides various views on factors for assessing readiness for e-government and assessment tools for measuring such factors (see table I). Also, literature provides views on assessing readiness for enterprise architecture (table II). From the review, two key gaps were identified. The **first gap** is associated with the need to derive a catalogue that can synthesize and holistically classify factors for assessing e-government readiness and factors for assessing enterprise architecture readiness. Such a catalogue would or can allow mutual or integrated assessment of a government's readiness to develop its e-government landscape using an enterprise architecture approach. The **second gap** is in the context of the assessment approach or scale of judgement for assessing readiness, where studies use various scales of assessment. To address this, there was need to adopt and derive an architecture-based maturity assessment perspective, for determining the extent to which e-government factors or elements and enterprise architecture factors or elements are developed across all levels of the government enterprise. Thus, section III presents ARGEA as a solution towards addressing these two gaps, and describes how its design addresses the two gaps.

TABLE I. A SYNTHESIS OF FACTORS FOR E-GOVERNMENT READINESS ASSESSMENT

Categories of factors for assessing e-government readiness (based on Al-Omari & Al-Omari, 2006)	**Sources**
1) Organizational readiness	
Stakeholder/ Personal readiness: Professional growth (*extent to which government values opportunities for skilled growth*); Efficacy (*stakeholder's ability to perform a task to a satisfactory degree)*; Adaptability (*ability of stakeholders to rapidly learn new skills & behaviors in response to the changing environment)*; Influence (*ability for government regulations to influence citizen/ stakeholder's behavior*)	[23–26]
Motivational readiness by leaders and other stakeholders: Skill development and training needs; Pressure for change from internal or external sources; Management support; Need for interaction; Desire for improvement	[23, 24]
Organizational climate factors and technology transfer: Exposure to new technology; Adoption of new technology; Clarity of mission and goals; Staff cohesion; E-communications via internet & emails; Openness to change	[19, 24, 27–30]
Institutional resources: Staffing levels (*number and quality of staff members available*); Physical resources; Training and development resources; Adequacy and use of computers; Adequacy of office and physical space available.	[24, 30, 31]
2) Governance and leadership readiness	
Government commitment: Trust in e-government on issues of security and privacy; Financial support and investment for the development of ICT; E-government system benefits; Trust in technology.	[13, 18, 25, 28, 29, 31–37]
Service quality: Trust in the reliability of enabling technology; Contributors' ability to enhance one's readiness in adopting technology; Inhibitors ability to lower readiness level for adoption & use; Policy discourse culture; Availability of intelligent & informed policies.	
3) Customer readiness – "*condition or state in which a consumer is prepared and likely to use an innovation for the first time*" [25]	
Culture readiness and Culture variables: People culture local language content; Economic costs to access online services; Customer trust in government; Social culture practices; Customer need for interaction; Customer organizational socialization; Customer perceived risk; Customer desire for control; Awareness and Motivation; Customer's ability to acquire necessary skills and confidence to perform a task; Cultural beliefs, values, and norms.	[18, 19, 30, 31, 33, 38]
4) Competency readiness (the existence of qualified personnel in the public sector)	
Demographics (*age, gender, education level*); Human capital (*citizens' education and knowledge on how to use computers and the internet*); User characteristics (*e.g. perceived risk, perceived control, internet etc.*); Citizen experience with internet & e-government websites	[25, 29, 34, 39]
5) Technology readiness – "people's propensity to embrace and use latest technologies for accomplishing goals in home life and at work" [35]	
ICT architecture: Availability of the portal; Focus on business process and information systems; Change management; Security and privacy.	[13, 19, 25, 28, 31, 34-37]
ICT services and support: Perceived system usefulness; Perceived system ease of use; Perceived system quality; Perceived information quality; Perceived service quality; Trust in medium; ICT infrastructure connectivity.	[13, 28, 29, 30, 34, 35,40]
Innovation characteristics: Technology complexity (*extent to which an innovation is perceived to be difficult to use and understand*); Observability (*extent to which results of an innovation are visible to others*); Trialability (*extent to which an innovation may be experimented with on a limited basis*); Perceived risk; Relative advantage (*extent to which an innovation is perceived advantageous*); Compatibility (*extent to which an innovation is perceived as being consistent with existing values, past experiences and needs of potential adopters*).	[13, 33, 40]
Legal readiness	
Legal and regulatory environment: Legal culture (*ability to accommodate the adoption of new paradigm of using the Internet, computer, and digital technologies in domestic & international governmental interactions*); rule of law; Level of censorship	[18, 19, 35]

TABLE II. A SYNTHESIS OF THREE PERSPECTIVES ON FACTORS FOR ASSESSING READINESS FOR ENTERPRISE ARCHITECTURE

Key aspects to consider when preparing for EA development [perspective from 21]	Factors for assessing EA readiness – People, process, technology, & enterprise environment factors [perspective from 10]	Factors for assessing EA readiness [perspective from 22]
Existence of EA Governance framework or mechanisms	EA Management (*existence of a governance structure for change management*); EA Governance *(existence of structure & procedures for business-IT alignment*); Stakeholder support (*ability to sponsor & support EA tasks*); Management commitment (*ability to be involved in execution of EA tasks*)	Senior management support; executive management support
Existence of a reliable capability framework & resources	EA culture *(ability to embrace EA practice)*; EA Resources *(availability of Human Resource & finances resources);* Competency & skills *(ability to execute tasks associated with EA development)*	Existence of: Change management measures; Human resource; & other Resources
Contents in enterprise continuum *(e.g. enterprise strategy, rules, principles, reference models)*	EA vision *(ability to articulate it)*; Communication protocol *(existence of formal information sharing channels)*; Policy & Rules *(existence of decision making guidelines for transparency & objectivity)*; EA Repository *(mechanism for managing & structuring information assets)*; EA Tools *(existence of tools for implementing EA practice)*	Existence of: an organization structure, organization strategy, organization culture
Capabilities in Business & Information Systems Domains	Business motivation (existence of business case & corresponding business requirements)	Available information technology resources
Capabilities in Technology & Security Domains	Security (existence of safety measures for all enterprise assets)	

III. DESIGN OF ARGEA

This study is inspired by the original capability maturity model for software [49] and capability maturity model for IT architecture [50]. These demonstrate that it is possible to have a shared and coherent framework that documents best practices in a given field of practice, such they can be re-used and amended by practitioners in a way that allows assessment and growth. This notion can also be applied in the context of supporting e-government growth, whereby readiness factors and best practices for both e-government and enterprise architecture can be synthesized into a coherent framework that: (a) can guide readiness assessment; and (b) inform the planning to advance e-government architecture development.

Thus, the purpose of ARGEA is to support the assessment of the readiness to use an enterprise architecture approach to achieve e-government interoperability across all levels of the government enterprise. Thus, this section first gives contextual perspectives that shape the design of ARGEA, and then presents its design.

From [41] e-government interoperability issues are classified into three categories, i.e.: (1) legal issues that are concerned with defining and implementing laws and regulations; (2) policy and political issues that are concerned with financing and aligning of stakeholder interests; and (3) social and cultural issues that focus on accommodating heterogeneous aspects of e-government implementation and adoption. These categories are then adopted to derive three strategic requirements for implementing interoperable e-government solutions – Regulation and Governance framework, Sustainability and Capacity Building framework, and Innovation and Adaptation framework [42]. Thus, in this paper we take the position that assessing readiness for architecture-driven e-government implementations needs to be done in line with: (a) the strategic requirements for e-government interoperability; and (b) the core elements of developing an enterprise architecture. The benefits of this position is two-fold. First, it helps to determine the extent to which a government enterprise has undertaken efforts towards achieving the strategic requirements for e-government interoperability. Second, it demonstrates the scope and volume of remaining work towards achieving the desired state of e-government implementation at each level of the government enterprise. Thus, the design of ARGEA is derived by synthesizing views from 5 perspectives, so as to form assessment dimensions A to E (as described below).

- Dimension A draws from the perspective of the three strategic requirements for e-government interoperability – legal and governance, sustainability and capacity building, and innovation and adaptation frameworks.
- Dimension B draws from the perspective of the factors for assessing e-government readiness as catalogued in section II (table I). Where the main categories of factors for e-government readiness assessment (shaded in grey color) are integrated with the strategic requirements in dimension A as follows. First, the Sustainability and Capacity Building framework incorporates factors under Organizational Readiness, Governance and Leadership Readiness, and Competency Readiness in table I. Second, the Innovation and Adaptation framework accommodates factors under Customer Readiness and Technology Readiness. Third, the Regulation and Governance framework accommodates factors under legal readiness in table I.
- Dimension C draws from the perspective of existing views on core elements for architecture development and existing views on factors for assessing readiness for enterprise architecture, as synthesized in table II.
- Dimension D draws from the perspective of the levels that constitute the government enterprise. The government enterprise in various countries comprises at least 3 levels, which are named differently [51]. In Uganda, the three levels are named as national, sector, and institution. Thus, the design of ARGEA first considers a government enterprise that comprises three levels – national, sector, and institution levels. This is done for the purpose of contextualizing aspects associated with the design and applicability of ARGEA. In other words, this dimension can be adapted to suit the type of cascade that characterises the government enterprise in a specific country. The motivation of this dimension is to enable stakeholders to assess and deliberate e-government interoperability provisions and gaps at each level and across all levels of the government enterprise.

- Dimension E draws from the perspective of encouraging an architecture-oriented thinking when assessing the extent of growth or existence of specific e-government provisions or capabilities, so as to determine the extent of required work or effort when developing an e-government enterprise architecture.

Dimensions A to D and their underlying perspectives are holistically represented using Fig. 1. However, Dimension E becomes visible and its application context (as an assessment or response scale for other dimensions) becomes understandable, in the last row of table III. Thus, the intention of providing table III is to clarify the assessment questions in each cell of Fig. 1, show the corresponding response scale (dimension E), and show the need to generate average of response values for each level of the government enterprise.

To synthesize the above concepts or perspectives and dimensions, the following five tasks were executed:

Task 1 involved classifying and synthesizing concepts in dimension B according to the broad categories in dimension A, thereby combining dimensions A and B into one (A x B) as shown in Fig. 1. ***Task 2*** involved classifying and synthesizing concepts in dimension C to form the broad categories presented on the left side of Fig. I. ***Task 3*** involved prompting or indicating that the readiness of each level of the government enterprise in dimension D is assessed with respect to the categories and sub-categories of concepts in dimensions A x B and C. Thus, this forms a cube in Fig. 1 with sides: A x B, C, and D.

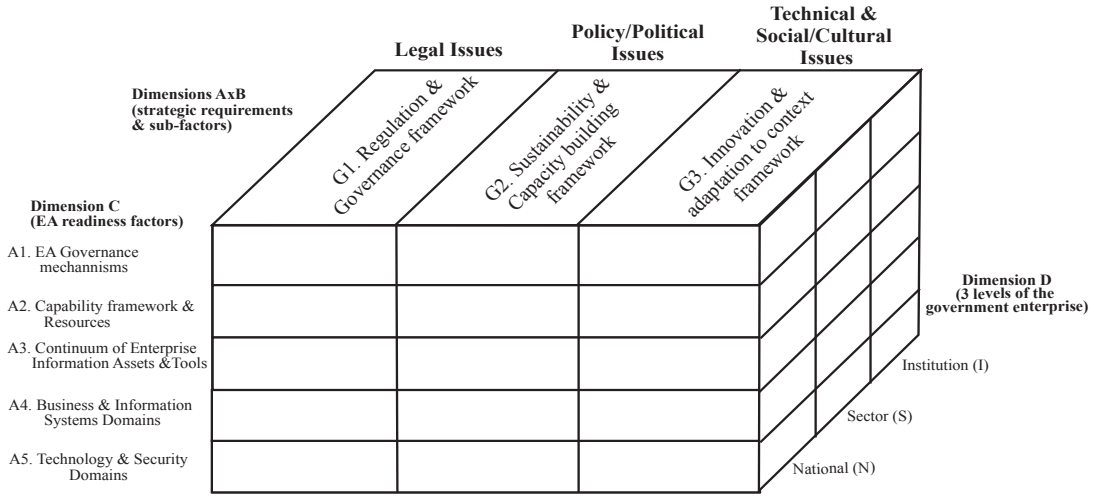

Fig. 1. ARGEA – High Level View

TABLE III. ARGEA VIEW OF ASSESSMENT QUESTIONS, RESPONSE SCALE, AND AVERAGE VALUES

	Legal factors	*Policy/ Political factors*	*Technical/ Social/ Cultural factors*	
eGov't readiness / **EA readiness**	G1. Regulation & Governance framework/ plan	G2. Sustainability & Capacity building framework/ plan	G3. Innovation & Adaptation to context framework/ plan	Levels of the government enterprise ($L_{N.S.I}$): **N**ational, **S**ector, **I**nstitution
A1. EA Governance mechanisms	($G_{1.1}$, $A_{1.1}$, $L_{N.S.I}$) ($G_{1.2}$, $A_{1.2}$, $L_{N.S.I}$)	($G_{2.1}$, $A_{1.1}$, $L_{N.S.I}$) ($G_{2.1}$, $A_{1.2}$, $L_{N.S.I}$)	($G_{3.1}$, $A_{1.1}$, $L_{N.S.I}$) ($G_{3.1}$, $A_{1.2}$, $L_{N.S.I}$)	Avg. of L_N values Avg. of L_S values Avg. of L_I values
A2. Capability framework & resources	($G_{1.1}$, $A_{2.1}$, $L_{N.S.I}$) ($G_{1.2}$, $A_{2.2}$, $L_{N.S.I}$)	($G_{2.2}$, $A_{2.1}$, $L_{N.S.I}$) ($G_{2.2}$, $A_{2.2}$, $L_{N.S.I}$)	($G_{3.2}$, $A_{2.1}$, $L_{N.S.I}$) ($G_{3.2}$, $A_{2.2}$, $L_{N.S.I}$)	
A3. Continuum of Enterprise Information Assets & Tools	($G_{1.1}$, $A_{3.1}$, $L_{N.S.I}$) ($G_{1.2}$, $A_{3.2}$, $L_{N.S.I}$)	($G_{2.3}$, $A_{3.1}$, $L_{N.S.I}$) ($G_{2.3}$, $A_{3.2}$, $L_{N.S.I}$)	($G_{3.3}$, $A_{3.1}$, $L_{N.S.I}$) ($G_{3.3}$, $A_{3.2}$, $L_{N.S.I}$)	
A4. Business & Information Systems Domains	($G_{1.1}$, $A_{4.1}$, $L_{N.S.I}$) ($G_{1.2}$, $A_{4.2}$, $L_{N.S.I}$)	($G_{2.4}$, $A_{4.1}$, $L_{N.S.I}$) ($G_{2.4}$, $A_{4.2}$, $L_{N.S.I}$)	($G_{3.4}$, $A_{4.1}$, $L_{N.S.I}$) ($G_{3.4}$, $A_{4.2}$, $L_{N.S.I}$)	
A5. Technology & Security Domains	($G_{1.1}$, $A_{5.1}$, $L_{N.S.I}$) ($G_{1.2}$, $A_{5.2}$, $L_{N.S.I}$)	($G_{2.4}$, $A_{5.1}$, $L_{N.S.I}$) ($G_{2.4}$, $A_{5.2}$, $L_{N.S.I}$)	($G_{3.5}$, $A_{5.1}$, $L_{N.S.I}$) ($G_{3.5}$, $A_{5.2}$, $L_{N.S.I}$)	

– ***Assessment dimension E shows assessment and response key or scale*** *of responses for questions in each cell, where: 0 = Not applicable; 1 = Applicable but not existing, not documented; 2 = Not documented, but existing informally; 3 = Plan is available to guide implementation, but implementation is yet to begin; 4 = Implementation at preliminary stage; 5 = Implementation in advanced stage; 6 = Fully functional/acquired; and 7 = Monitored, evaluated, & maintained.*

– ***Assessment questions associated with the codes*** *in each of the cells above are presented in Appendix 1.*

Task 4 involved translating concepts in dimension E into a Likert scale to allow assessment of particular entities that constitute specific levels of the government enterprise in dimension D. In this step we adapt the six-step maturity model for enterprise architecture by [44] to the e-government context. According to Op 't Land et al [44], architecture maturity can be measured as follows: level 0 for entities that have no architecture in place; level 1 for entities with ad hoc efforts towards adopting the practice of standardization; level 2 for entities implementing their enterprise architecture; level 3 for entities that have a fully established architecture; level 4 for entities that are maintaining their architectures; and level 5 for entities that are continuously improving their architectures.

In the context of assessing readiness for architecture-driven e-government efforts, we adapt and extend the maturity levels in [44] into the following 8 levels: 0 for 'not applicable'; 1 for 'applicable but not existing, not documented'; 2 for 'not documented, but existing informally'; 3 for 'plan is available to guide implementation, but implementation is yet to begin'; 4 for 'implementation at preliminary stage'; 5 for 'implementation in advanced stage'; 6 for 'fully functional/ acquired'; and 7 for 'monitored and evaluated'. This forms the aspects in dimension E, that is demonstrated in the last row of table III.

Task 5 involved using each cell of the cube in Fig. 1 to prompt assessors to determine the extent to which a specific architecture-related element/factor (from dimension C) is (or can be) accommodated under a particular e-government element/factor (in dimension A x B), at each of the 3 levels of the government enterprise (in dimension D). This forms the front side of the ARGEA cube in Fig. 1. However, conducting the assessment and recording results thereof can be done using the disaggregated view of cells containing question codes $G_{1.1}$ to $G_{3.2}$ and $A_{1.1}$ to $A_{5.3}$ in table III. In each cell of table III, the line of questioning follows the following three-step pattern:

- **G-coded** question is for assessing the extent to which an e-government element (or requirement, readiness factor or sub factor) is developed?;
- **A-coded** question is for assessing the extent to which a specific e-government element accommodates specific elements or sub elements for enterprise architecture?
- $\mathbf{L_{N.S.I}}$ **component** in both the G-coded question or A-coded question is for specifying the existence of an element at a given level of the government enterprise, i.e. National (N), Sector or programme (S), and Institution (I). As mentioned earlier, 3 levels are used for demonstration purposes. The levels can be increased or decreased according to the setup of the governement enterprise in a given country.

Appendix I instantiates the above pattern by generating questions that are associated with cells containing codes ($G_{1.1}$, $A_{1.1}$, $L_{N.S.I}$) to ($G_{3.5}$, $A_{5.2}$, $L_{N.S.I}$). This order of questioning is adopted because in most developing economies, there is some level of already ongoing work on e-government development, and efforts for architecture-driven e-government are being adopted or considered for adoption to streamline e-government development. Thus, this line of questioning helps to determine the extent to which particular e-government elements have been developed, and to determine the entry point and purpose of enterprise architecture in specific contexts.

The alternative line of questioning is to first find out the extent to which an enterprise architecture element is developed at a given level of the government enterprise, and then determine the extent to which that architecture element addresses particular concerns or emerging issues in an e-government effort. However, this alternative line of questioning may be suitable in settings where a (reference) e-government enterprise architecture from a developed economy is being adapted for use in a developing economy, or if a developed economy is exploring ways of 'maintaining' its enterprise architecture to address emerging issues in e-government or digital government.

Column 1 of table III shows elements for assessing architecture readiness, and columns 2 to 4 show elements for assessing e-government readiness. Sub-elements or sub-factors under architecture-related elements in column 1 and sub-elements or sub-factors under e-government-related elements in columns 2 to 4 are used in the formulation of questions that assessors use during the readiness assessment (as elaborated in appendix 1). The assessment is done at each of the 3 levels of the government enterprise (as indicated by the $\mathbf{L_{N.S.I}}$ component of each question).

During assessment each question code obtains a response value. Thus, a set of 3 response values is expected for each given set of questions in the cells of table III. For example, response values for one instance of the question set [$G_{1.1}$, $A_{1.1}$, $L_{N.S.I}$] are represented using a '1 by 3' matrix of response values [4, 1, **S**]. Where 'S' indicates that the *G-value '4'* and *A-value '1'* are for the *'Sector'* level of the government enterprise. Then the *'National'* level instance of the same question set, could yield a set of response values [7, 3, **N**]. Also, the *'Institution'* level instance of the same question set, could yield a set of response values [3, 1, **I**]

After each set of question codes shown in table III has generated a set of response values, the averages of those values is generated with respect to the level of the government enterprise (**N, S, I**). This is indicated by the prompting for row averages of L_N values, L_S values, and L_I values in the disaggregated cells in last column of table III. We generate averages for each full row using the format: [*Average* 'G-values', *Average* 'A-values', Level code]. For example, if values of the question set ($G_{1.2}$, $A_{2.2}$, $L_{N.S.I}$) = (4, 2, **N**); (1, 1, **S**); and (1, 2, **I**). Then the average values from the first cell (corresponding to the intersection of elements G1 and A1) in table III and Fig. 1 would be: Average L_N values [5.5, 2.5, **N**]; Average L_S values [2.5, 1, **S**]; L_I values (2, 1.5, **I**). When generating averages, the 'not applicable' values are not considered. Thus, the averages are taken over a smaller set of 'applicable' values.

The above instances help to demonstrate that: If one chooses to conduct readiness assessment for e-government enterprise architecture at only one level of the government enterprise (e.g. institution level), then the set of response values changes from a '1 by 3' matrix to a '2 by 2' matrix. This implies that the complexity of the response values reduces as one reduces the scope of the readiness assessment from national level to institution level, and vice versa. This is demonstrated in the case used for the initial validation (as described in section IV).

Row averages are then graphically presented (using a radar chart or bar/line graph) to aid decision making on the readiness to develop an e-government enterprise architecture, and the extent of work or effort required to achieve a given state of e-government growth at each level of the government enterprise.

The questions in appendix 1 accommodate specific sub elements or sub-factors for e-government and for enterprise architecture (that are based on categorizations presented in

tables I and II under section II). However, all questions and sub-questions that accommodate all sub elements or sub-factors in the categories under section II can not be presented here. Thus, to manage the scope of ARGEA, appendix 1 shows only questions that assessors can use or follow to generate response values for cells with question codes in table III and the corresponding Fig. 1. Thus, an extract of high level questions is provided in appendix 1. The questions can be used to generate response values for major cells marked ($G_{1.1}$, $A_{1.1}$, $L_{N.S.1}$) to ($G_{3.5}$, $A_{5.2}$, $L_{N.S.1}$) in table III.

IV. INITIAL VALIDATION OF ARGEA

In Design Science, as articulated by Hevner et al [45] and Wieringa [46], the design of artifacts in information systems can be evaluated using: experiment methods (field or lab experiments, lab demo); observational methods (case study, action research, field study, field demo); descriptive methods (bench marking and illustration scenarios); functional and structural testing methods; and analytical methods. The selection of the appropriate design evaluation method depends on: the desired or intended application context of the artifact, the resources available, and the purpose of the evaluation at a given stage of artifact development,

Thus, in this study it was considered appropriate and economical to first evaluate the design, feasibility, and applicability of ARGEA in a setting where researchers use the artifact in a real enterprise (but one that has a relatively smaller scope of coverage). This implies that it was vital to choose an entity/ organization that is considered to be at the 'institution' level of the government enterprise, instead of choosing an entity that is at 'national' level or 'sector' level of the government enterprise.

Experiment methods require the researcher or other people to use an artifact in a controlled environment and simulate it with artificial data, while observational methods require the researcher or other people to use an artifact in a real enterprise environment [45, 46]. For example, using a field demo, a researcher uses an artifact in a real enterprise to demonstrate its usability [46]. Thus, it was appropriate to first use a field demo (with a limited scope) to evaluate ARGEA prior to employing other observational design evaluation methods.

Context of chosen entity: The institution that was chosen is a Public University in Uganda. To make the scope manageable, one College within the Public University was chosen, and one School in that College was chosen as the unit of analysis in the demo. The School was facing a service delivery problem in the coordination of the research programme for its students. The performance of its programme on managing student research was low, characterized by: low number of graduating students due to inefficiencies in the coordination of the research examination process; delays in completion and submission of research reports or dissertations/theses; high level of frustration among students executing their research projects; and high level of frustration among academic staff who supervise and examine student research projects.

To address these issues, an e-government solution was required. e-Government solutions can take three forms, i.e.: i) e-Administration solutions – those that align internal processes of a public entity with digital technologies; ii) e-Citizen and e-service solutions – those that align external processes that support citizen engagements with digital technologies; and iii) e-Society solutions – those that align external processes that support private and other public entities with digital technologies [47]. Thus, a business case was developed for the desired e-government solution of the student research programme in the School.

The business case indicated that it was vital to develop an e-government solution that would have at least 4 modules.

- Module 1 was to be an e-Administration solution for supporting effective management and coordination of the research programme. This module would have to be interoperable with: the university-wide students results management system; and the human resource system that manages promotions of academic staff, who are involved in the supervision and examination of student research projects.
- Module 2 was to be an e-Service solution for supporting the School to effectively interact with students to execute and complete their research projects on time. It would support student-programme interactions from the start of the research project to the end, and subsequent followups associated with alumni management.
- Module 3 was to be an e-Society solution for supporting the School to interact with its public and private partner agencies through dissemination of research innovations of students and academic staff, and management of issues from agencies that sponsor student research projects.
- Module 4 was to be an e-Administration solution that integrates data from modules 1 to 3 to support predictive analysis for organizational learning in the context of the research programme. It would require the School to collect data on students' performance and research contexts, so as to measure improvements over time in student supervison and assess effectiveness of learning during research (learning analytics).

The business case was accompanied with an architecture vision of the desired e-government solution, and a rapid prototype for modules 1 to 4. Prior to fully implementing the desired e-government solution (as documented in the business case), it was vital to assess readiness of the School to undertake an enterprise architecture approach to e-government implementation at 'unit' level. This is because the School (perceived as the 'unit' in this case) is governed by a College in the Public University, which is an 'institution' level entity in the context of ARGEA.

In the context of levels that constitute the government enterprise, the scope of the government enterprise in this initial validation or evaluation scenario has 4 levels – National, Sector, Institution, and Unit. However, to manage the scope of the initial iteration of ARGEA evaluation, only the Unit level was considered. This Unit level imples the need to focus on only the 'institution' component of the ARGEA model. This is elaborated below.

Setup of the evaluation: ARGEA was used as the readiness assessment approach. Its question log in appendix 1 was used to engage two key stakeholders. The coordinator and administrator of the student research programme were engaged as the two key stakeholders/respondents in the readiness assessment exercise. From the question log, only the 'institution' level component of each question was considered or asked due to the nature of entity that was chosen (as elaborated above). One of the researchers was the interviewer, and was able to explain concepts in the question log to the respondents during the readiness assessment exercise. Quantitative responses from the interview were documented using MS EXCEL, which was also used to generate row averages for only the 'institution' level component (as the final assessment values in table III)

Results from Readiness Assessment: For confidentiality reasons and space limitations, the qualitative responses from the readiness assessment in the selected entity can not be disclosed here. Since only 'institution' level component of the questions was considered, response values were generated for only the 'institution' level of the government enterprise, which implies that the '**I'** value in sets of response values was constant. This further implies that the set of response values changed from a '1 by 3' matrix to a '2 by 2' matrix (as discussed in section III).

Consequently, the row averages of the quantitative responses/values (as explained in section III) are presented using the bar graph in Fig. 2. The Y-axis of the graph represents the points in the assessment scale provided in assessment dimension E (shown in the last row of table III). The bars represent the extent to which particular elements for e-government and enterprise architecture are developed or exist within the student research programme. Thus, the bar graph shows that the research programme lacked documentation of aspects that constitute key elements in developing both e-government and enterprise architecture.

Readiness assessment results also indicate that the School was not yet ready to undertake the effort of developing the desired architecture-driven e-government solution that would address the problems faced by its student research programme. From the qualitative responses that underly or justify the scores in Fig. 2, the major two reasons for lack of readiness were: the *absence of a sustainability plan; and a legal/regulatory instrument and governance plan* for supporting and guiding the development, implementation, and maintenance of the desired e-government solution. Thus, the School had to first embark on addressing these gaps.

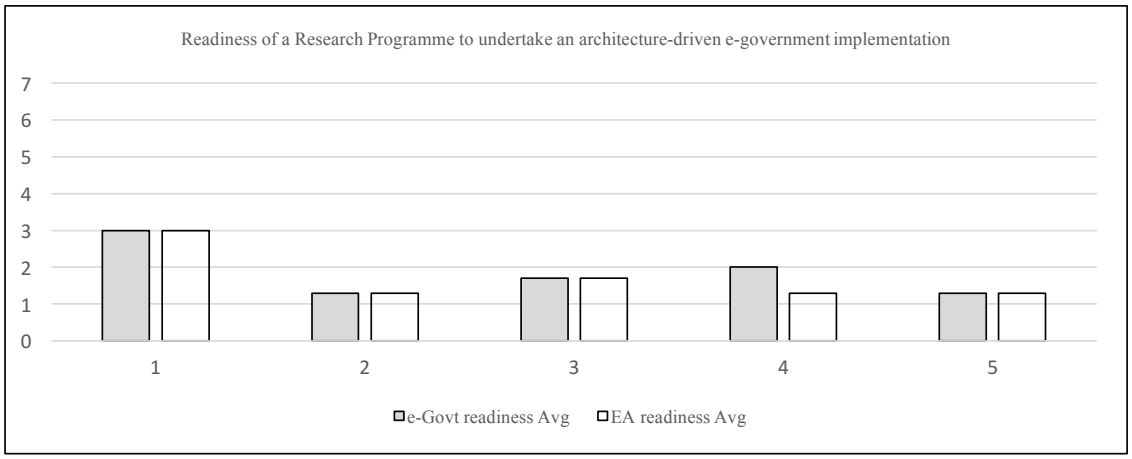

Fig. 2. Graph of Averages from the Readiness Assessment

Findings on the design and feasibility of ARGEA: From the assessment exercise, the following were the key issues and how they were addressed.

First, there was need to add a 'not applicable' option on the response scale in assessment dimension E. This has been rectified in the ARGEA model presented in table III. The way of handling the 'not applicable' values when generating avergares is specified in section III. Also, the wording used in some questions had to be amended for better understanding. For example, questions on 'laws/ regulations/ rules' were first presented as 'laws & regulations'. Then 'rules' was amended to make the sentences easier to respond to especially in terms of internal governing principles of an entity.

Second, in the question log, there was need to first inquire whether a given element or readiness factor of e-government exists prior to asking the extent to which it accommodates an element or sub element in the enterprise architecture dimension. For example, in $A_{1.1}$, before asking whether existing governance mechanisms for the enterprise support management and control roles of architecture development, one would have asked whether a governance mechanism for e-government actually exists. However, implied the need to add the G-coded questions in the cells of table III and in the question log in appendix 1. Thus, the assessor records response value or information on the existence of an e-government element using the placeholder for G-coded question. Also, response value or information on the extent to which an element for enterprise architecture is or can be accommodated in an existing element of e-government is recorded using the placeholder for A-coded response value.

Third, there is need to ensure that the response key (dimension E) accommodates responses associated with both the 'hard' or tangible and 'soft' or intangible aspects in relation to the assessment questions. Also, the current response scale does not cater for the option of a 'plan being available, but not operationalized or adopted for a long time'.

Findings on the applicability of ARGEA: It was successfully applied in an entity at 'institution' level. Findings indicate that if questions are provided with the lowest level of granularity (where they are dissagregated to reflect sub-sub factors under the broad elements of e-government and enterprise architecture), then the usability of ARGEA will improve.

V. Conclusion and Future Work

The aim of this paper was to provide initial results regarding the development of an integrated maturity model for the mutual assessment of readiness to undertake or implement an architecture-driven e-government solution. The focus of the paper was not to 're-invent the wheel' in terms of readiness assessment factors for e-government and for enterprise architecture. However, since several factors and sub-factors are involved in assessing readiness for both e-government and enterprise architecture, we focused on deriving a model that can provide a holistic and integrated perspective of assessing

readiness for enterprise architecture driven e-government implementations. We perceive such a model as an attempt towards having a synthesized catalog of existing views on factors for assessing readiness for e-government and for enterprise architecture.

Future work will involve evaluating ARGEA using other design evaluation methods, so as to comprehensively assess its applicability, usability, performance, effectiveness, efficiency, and generalizability among other quality criteria. The future or additional evaluation iterations will enable: (a) all questions in the ARGEA question log to be further validated; and (b) the use and validation of ARGEA in entities at other levels of the government enterprise – sector and national levels. Also, settings where a government enterprise has more than 3 levels will be considered in future validation iterations.

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APPENDIX 1. HIGH LEVEL QUESTIONS OF ARGEA

Note: From [42], we adopt sub elements of the three e-government core elements or strategic requirements (i.e. *legal & governance framework, sustainability & capacity building, innovation & adaptation framework*), and we use them to formulate questions coded $G_{1.1}$ to $G_{3.2}$ and $A_{1.1}$ to $A_{5.3}$ (in table III) and specified in the following question log.

- Questions with 'G' code help to determine the existence of a specific (sub) element for e-government development. Hence questions $G_{1.1}$ to $G_{3.2}$.
- Questions with 'A' code help to determine whether an existing e-government (sub) element accommodates particular elements for enterprise architecture development. Hence questions $A_{1.1}$ to $A_{5.3}$.

Response key *for questions in the cells of ARGEA: 0 = Not applicable; 1 = Applicable but not existing, not documented; 2 = Not documented, but existing informally; 3 = Plan is available to guide implementation, but implementation is yet to begin; 4 = Implementation at preliminary stage; 5 = Implementation in advanced stage; 6 = Fully functional/acquired; and 7 = Monitored and evaluated.*
Section 1. Assessing the extent to which sub elements in the ***legal & governance framework for e-government*** accomodate the core elements of ***enterprise architecture*** development. • To manage scope, 2 sub elements in this framework are considered and used to derive questions $G_{1.1}$ (rules/guidelines on various aspects such as solution acquisition or selection of standards) and $G_{1.2}$ (governance mechanisms) below
[$G_{1.1}$]. To what extent do laws/regulations/rules/guidelines support or guide e-government implementation at $L_{N.S.I}$ (national/ sector/ institution levels)?
[$G_{1.2}$]. To what extent do governance mechanisms accommodate the management & control responsibilities that are associated with effective e-government development at $L_{N.S.I}$ (national/ sector/ institution levels)?
[$A_{1.1}$]. To what extent do existing e-government laws/regulations/rules/guidelines encourage development of an enterprise architecture (or enforce standardization & integration of e-government implementation) at $L_{N.S.I}$ (national/ sector/ institution levels)?
[$A_{1.2}$]. To what extent do governance mechanisms accommodate the management & control responsibilities that are associated with architecture development, at $L_{N.S.I}$ (national/ sector/ institution levels)?
[$A_{2.1}$]. To what extent do laws/regulations/rules/guidelines support building of skills & competences (of all stakeholder groups) that are required for developing both e-government & enterprise architecture at $L_{N.S.I}$ (national/ sector/ institution levels)?
[$A_{2.2}$]. To what extent are the governance or decision making processes for accessing resources (required to develop an e-government enterprise architecture) streamlined at $L_{N.S.I}$ (national/ sector/ institution levels)?
[$A_{3.1}$]. To what extent do laws/regulations/rules/guidelines support the establishment of a shared repository for all information assets & tools relevant for building an e-government enterprise architecture at $L_{N.S.I}$ (national/ sector/ institution levels)?
[$A_{3.2}$]. To what extent do existing governance mechanisms support the proper management and control of a shared repository for all information assets & tools for the e-government enterprise architecture at $L_{N.S.I}$ (national/ sector/ institution levels)?
[$A_{4.1}$] & [$A_{5.1}$]. To what extent do laws/regulations/rules/guidelines support or enforce the development of architectures for the business, information systems, technology, and security domains (associated with the existing & planned e-government capabilities) at $L_{N.S.I}$ (national/ sector/ institution levels)?
[$A_{4.2}$] & [$A_{5.2}$]. To what extent do governance mechanisms accommodate the management & control support or enforce interoperability of architectures for the business, information systems, technology, and security domains (of existing & planned e-government capabilities) at $L_{N.S.I}$ (national/ sector/ institution levels)?
Section 2. Assessing the extent to which sub elements in the ***sustainability & capacity building framework for e-government*** accomodate the core elements of ***enterprise architecture*** development. • To manage scope, 4 sub elements in this framework are considered and used to derive questions $G_{2.1}$ (PPPs), $G_{2.2}$ (capacity building mechanisms), $G_{2.3}$ (strategic management), & $G_{2.4}$ (risk assessment) below
[$G_{2.1}$]. To what extent have Public Private Partnerships (PPPs) for establishing infrastructure for e-government been developed at $L_{N.S.I}$ (national/ sector/ institution levels)?
[$A_{1.1}$] To what extent do the PPPs for e-government infrastructure support the adoption of an enterprise architecture-driven approach (or the principles of integration and interoperability

for realizing e-government) at $L_{N.S.I}$ (national/ sector/ institution levels)?
[$A_{1.2}$]. To what extent do the PPPs for e-government infrastructure accommodate the management & control responsibilities that are associated with architecture development at $L_{N.S.I}$ (national/ sector/ institution levels)?
[$G_{2.2}$]. To what extent has a capacity building framework for e-government stakeholders been developed at $L_{N.S.I}$ (national/ sector/ institution levels)?
[$A_{2.1}$]. To what extent does the capacity building framework for e-government stakeholders accommodate the skilling needs for enterprise architecture development at $L_{N.S.I}$ (national/ sector/ institution levels)?
[$A_{2.2}$]. To what extent does the capacity building framework for e-government stakeholders accommodate the quality control and assurance needs associated with using an enterprise architecture approach at $L_{N.S.I}$ (national/ sector/ institution levels)?
[$G_{2.3}$]To what extent has an e-government strategic management framework (or government digitalization plan) been developed at $L_{N.S.I}$ (national/ sector/ institution levels)?
[$A_{3.1}$]. To what extent does the e-government strategic management framework (or government digitalization plan) provide strategic insights into the drivers and goals of developing an e-government enterprise architecture at $L_{N.S.I}$ (national/ sector/ institution levels)?
[$A_{3.2}$]. To what extent does the e-government strategic management framework (or government digitalization plan) include key information assets and tools that are useful as inputs for developing enterprise architecture at $L_{N.S.I}$ (national/ sector/ institution levels)?
[$G_{2.4}$] To what extent has an e-government risk assessment & cost benefit analysis mechanism been developed at $L_{N.S.I}$ (national/ sector/ institution levels)?
[$A_{4.1}$] & [$A_{5.1}$]. To what extent has a risk assessment & cost benefit analysis mechanism for e-government been developed, to guide the assessment of **existing/baseline** solutions in the business, information systems, technology, & security domains at $L_{N.S.I}$ (national/ sector/ institution levels)?
[$A_{4.2}$] & [$A_{5.2}$]. To what extent does the risk assessment & cost benefit analysis mechanism accommodate issues associated with assessing the **planned/target** e-government capabilities in the business, information systems, technology, & security domains at $L_{N.S.I}$ (national/ sector/ institution levels)?
Section 3. Assessing the extent to which sub elements in the ***innovation & adaptation framework for e-government*** accomodate the core elements of ***enterprise architecture*** development • To manage scope, 4 sub elements in this framework are considered and used to derive questions $G_{3.1}$ (innovation guidelines), $G_{3.2}$ (public participatory framework), $G_{3.3}$ (adaptation guidelines), & $G_{3.4}$ (interoperability guidelines)
[$G_{3.1}$]. To what extent has a framework/policy/guideline and governance model been developed to promote, coordinate, and harmonize innovations towards enhancing e-government development at $L_{N.S.I}$ (national/ sector/ institution levels)?

[$A_{1.1}$]. To what extent does the framework/policy/guideline for promoting e-government innovations accommodate the governance, quality assurance, and control measures associated with ensuring that e-government innovations are built using an enterprise architecture driven approach?
[$A_{1.2}$] To what extent does the framework/policy/guideline and for promoting innovations streamline/specify the methodology for developing e-government innovations, so that they are in sync with the overarching enterprise architecture development approach for government at $L_{N.S.I}$ (national/ sector/ institution levels)?
[$G_{3.2}$]. To what extent has a public participatory framework or plan for enhancing stakeholder participation in e-government implementations been developed at $L_{N.S.I}$ (national/ sector/ institution levels)?
[$A_{2.1}$]. To what extent does the public participatory framework or plan for e-government accommodate the skilling or training needs (for all key stakeholder groups) that are associated with using an enterprise architecture approach for e-government development at $L_{N.S.I}$ (national/ sector/ institution levels)?
[$A_{2.2}$]. To what extent has the public participatory framework or plan for e-government streamlined the process of acquiring resources for fostering and ensuring adequate stakeholder participation during the development of architecture-driven e-government solutions at $L_{N.S.I}$ (national/ sector/ institution levels)?
[$G_{3.3}$]. To what extent has a framework/policy/guideline been developed to inform, guide, & standardize the process of adapting potentially useful e-government solutions (e.g. frameworks, procedures, models/standards, guidelines) been developed at $L_{N.S.I}$ (national/ sector/ institution levels)?
[$A_{3.1}$]. To what extent does the framework/policy/guideline for adaptations accommodate the need to **adapt existing** reference models for e-government and reference models for enterprise architecture at $L_{N.S.I}$ (national/ sector/ institution levels)?
[$A_{3.2}$]. To what extent does the framework/policy/guideline for adaptations accommodate the need to **develop** new reference models for architecture-driven e-government implementations that can guide e-government adaptations & implementations at $L_{N.S.I}$ (national/ sector/ institution levels)?
[$G_{3.4}$]. To what extent have interoperability principles/guidelines/standards for e-government implementations been developed or customized and shared to all key stakeholders for adoption at $L_{N.S.I}$(national/ sector/ institution levels)?
[$A_{4.1}$] & [$A_{5.1}$]. To what extent do the existing e-government interoperability principles/guidelines (& specifications for integrating heterogeneous applications) accommodate the business, data, application, technology, & security principles that are relevant in using an enterprise architecture approach for e-government at $L_{N.S.I}$ (national/ sector/ institution levels)?
[$A_{4.2}$] & [$A_{5.2}$]. To what extent have the business, information systems, technology, and security domains for existing & planned e-government solutions been documented and shared to all key stakeholders at $L_{N.S.I}$ (national/ sector/ institution levels)?