Requirements for developing interoperable e-government systems in developing countries – a case of Uganda

Agnes Nakakawa* and Flavia Namagembe

College of Computing and Information Sciences,
Makerere University,
P.O. Box 7062, Kampala, Uganda
Email: anakakawa@cis.mak.ac.ug
Email: fnamagembe@cis.mak.ac.ug
*Corresponding author

Abstract: E-government initiatives in developing countries still suffer from lack of interoperability, despite the existence of e-government interoperability frameworks in literature. For example, Uganda's e-government landscape is fragmented within and across agencies. To provide preliminary insights into addressing this, exploratory interviews were conducted to investigate why the e-government interoperability challenge prevails in Uganda, and findings were used with respect to existing literature to specify required strategic interventions. These strategic interventions point to the need for three intertwined capabilities, i.e., a regulatory and governance framework, a capacity building and sustainability framework, and an adaptation and customisation framework for e-government implementations. Therefore, the relevance of this paper is two-fold. First, to give insight into strategic interventions that developing economies (that share Uganda's context) can explore to address e-government interoperability. Second, to stimulate researchers in countries that have attained e-government interoperability to publish detailed technical guidelines on implementing the strategic interventions proposed herein.

Keywords: electronic government; e-government interoperability; developing countries; Uganda; interoperable e-government systems.

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Biographical notes: Agnes Nakakawa is an Information Systems Specialist and Statistician who is often fascinated by research in the areas of e-government, enterprise architecture development, collaborative decision-making approaches, soft systems methodology, e-health, and geographic information systems. She holds a PhD in Information Systems and Master's in Computer Science. She is often motivated by enterprise and community problems or situations that need to be confronted with planning and decision-making approaches that are evidence-based and systemic in nature. She is a Lecturer at the Makerere University in Kampala, Uganda.

Flavia Namagembe is an Information Systems Specialist. She holds a Master's in Information Systems and Bachelor's in Information Technology. Her research interests include e-government service delivery, database systems, enterprise architectures, and geographic information systems. She is an Assistant Lecturer at the Makerere University.

1 Introduction

E-government is the practice of aligning processes executed by agencies in the public sector with information and communication technologies – ICTs (Heeks, 2008). Although this alignment is multidisciplinary, it is dominated by the use of ICTs to streamline and support government actions or processes towards delivering quality information and services to stakeholders and consumers in public service delivery (Luna-Reyes et al., 2008; Reddick and Frank, 2007; Gil-García and Luna-Reyes, 2006). Accordingly, Heeks (2002) articulates that the scope of e-government comprises three domains, i.e.:

a *e-administration* – improving internal processes of public agencies by aligning them with ICTs

b *e-citizens and e-services* – strengthening the relationship between public agencies and citizens (as stakeholders in public service delivery and as consumers of public services) by aligning processes that support citizen/consumer engagements with ICTs

c *e-society* – strengthening the relationship between public agencies and other agencies (i.e., other public agencies, private, not for profit or community-based, and civil society agencies) by aligning processes that involve inter-agency engagement with ICTs.

Instantiating each of these domains provides a wide range of electronic solutions. These solutions are classified into government to government, government to citizen/consumer, government to business, and government to non-profit agencies services (Heeks, 2006; Hiller and Bélanger, 2001; Moon, 2002). These instantiations can be accessible at five different levels, i.e., international, national, regional, provincial, and local levels (Heeks, 2006).

Each e-government domain delivers several benefits. For example, e-administration helps to reduce financial and time costs in operations, enhance performance management, enhance capacity for strategy implementation (Heeks, 2002a, 2002b), and support transformation towards increased productivity (Reddick, 2005). E-citizens and e-services empower citizens by engaging them in deliberations on public sector delivery, increase transparency and accountability of public agencies, deliver quality and responsive services (Heeks, 2002a, 2002b), increase access to government information and services, increase access to consumer information, and increase consumer satisfaction (Reddick, 2011; Reddick and Frank, 2007; Abdul Razak et al., 2017). E-society helps to enhance quality of services between government and business, develop social and economic

capacity of various communities, develop partnerships towards sustainable development (Heeks, 2002a, 2002b), increase quality of information to decision makers and investors (Reddick, 2011), and reduce costs of system development (UNDP, 2007).

The common underlying prerequisite to attaining the above benefits is the synergy of e-government implementation efforts through realising *interoperable* e-government systems. An interoperable e-government landscape enhances information sharing and yields sustainable e-government adoption. Interoperable e-government solutions support data sharing within and among agencies, and this eliminates unnecessary data redundancies, minimises duplications in data collection and management, reduces operational and managerial costs attained through a shared infrastructure for service delivery, and yields quality or coherent information for evidence-based decision making and a responsive service delivery system (Gil-Garcia et al., 2007; Hjort-Madsen and Gøtze, 2004).

Building interoperable e-government systems is a complex initiative (Scholl and Klischewski, 2007; Weerakkody et al., 2007). Accordingly, e-government interoperability frameworks (eGIFs) provide guidance to support such initiatives by articulating:

a policies, standards, and structures for developing e-government systems that enable coherent flow of information

b guidelines for specifying the preferred mode of interaction for government agencies, citizens, and partners (UNDP, 2007).

Examples of eGIFs or related solutions exist for Zambia (Bwalya and Mutula, 2016; Weerakkody et al., 2007), India (Paul and Paul, 2014), Mozambique (Shvaiko et al., 2009), UK, Denmark, New Zealand (UNDP, 2007), European and USA (Guijarro, 2007), among others. Despite the existence of several e-GIFs, e-government initiatives in developing countries still suffer from the interoperability challenge (Saekow and Boonmee, 2009). The e-government landscape of developing countries (such as Uganda) is still characterised by isolated and parallel implementations within and across government agencies (NITA-U, 2012; Matavire et al., 2010).

The purpose of this paper is not to assess gaps in existing eGIFs, but to explore reasons why the e-government interoperability challenge prevails. Such an exploration is expected to:

a give insight into the required strategic interventions towards addressing the e-government interoperability challenge in resource constrained economies that share Uganda's context

b stimulate research towards providing detailed technical guidelines for operationalising the required interventions.

Thus, this paper investigates the research question: what factors contribute to the e-government interoperability challenge in developing countries (particularly Uganda), and what are the strategic requirements to address them? Section 2 explores these challenges, Section 3 presents requirements to address them, while Section 4 concludes the paper.

2 Theoretical classification of hindrances to interoperable e-government systems

Interoperable describes the ability of independent systems and devices to communicate through exchanging data/information and interpreting that shared data (Scholl and Klischewski, 2007). Thus, e-government interoperability is the ability of two or more diverse government information systems or their components, based on ICTs, to meaningfully and seamlessly exchange information and to use the information effectively to improve governance (UNDP, 2007). In addition, e-government interoperability is the ability to define goals, processes, systems, and a shared ICT infrastructure to facilitate collaboration between agencies that have different internal structures through enabling information exchange and mutual understanding of exchanged information (Sarantis et al., 2008). Thus, when implementing ICT projects, government agencies need to prioritise:

a exchange or sharing of data with other government agencies

b re-use of data available in ICT systems of other government agencies in order to avoid fragmented and incompatible ICT solutions that hinder achievement of e-government success (UNDP, 2007).

However, this has not yet been achieved in developing economies, particularly Uganda.

Several studies (e.g., Matavire et al., 2010; Odat, 2012; Alshehri and Drew, 2010; Ndou, 2004; Heeks, 2003) report challenges faced by developing economies during e-government implementation. Other studies (e.g., Bwalya and Mutula, 2016; Otniel, 2015; Novakouski and Lewis, 2012; Habeenzu, 2010; Boughzala et al., 2015; Nkwe, 2012; Janssen et al., 2011; Gil-García and Pardo, 2005; Luna-Reyes et al., 2008) classify such challenges. Although these sources reveal several ways of classifying challenges encountered in implementing e-government, the classification in Novakouski and Lewis (2012) is adopted herein as shown in Table 1. This is because the classification in Novakouski and Lewis (2012) is skewed to accommodate various aspects or perspectives on e-government interoperability which is the focus area of this paper. Table 1 (column 1) shows three classifications, and column 2 shows some instances of each classification.

Research gap: in addition to challenges in Table 1, there was need to investigate the interoperability challenge in a Ugandan context so as to understand specific underlying factors in each of the above categories and consequently suggest possible holistic and strategic interventions to address them. Moreover, insights from the exploration not only benefit Uganda, but also stimulate e-government proponents in countries with similar settings to engage in efforts towards devising focused strategic master plans of action to address e-government interoperability. Accordingly, Sections 2.1, 2.2, and 2.3 present the design or setup details of the exploratory interviews on e-government interoperability issues and findings respectively.

Table 1 Taxonomy of challenges hindering development of interoperable e-government implementations

Classification as recommended by Novakouski and Lewis (2012)	*Challenges reported in literature under each classification*
Legal factors – issues associated with establishment of laws and regulations, and ensuring full compliance.	• Limited enforcement capacity of government workforce to ensure compliance to (existing) laws and regulations on development and use of ICTs and electronic innovations (Habeenzu, 2010; Alshehri and Drew, 2010), and out-dated and redundant regulations (Ramli, 2017).
	• Limited awareness/sensitisation engagements with customers on the benefits of e-government in public service delivery and on knowledge about e-government programmes (Bwalya and Mutula, 2015; Nkwe, 2012; Habeenzu, 2010; Alshehri and Drew, 2010).
	• Lack of integrated e-government implementations (Sta, 2018; Habeenzu, 2010) and integrated strategic planning (Alshehri and Drew, 2010).
Political/policy factors – issues associated with budgeting, financing, coordination of stakeholders, and securing their support and cooperation.	• Lack of functional frameworks for coordinating partnerships and collaborations and for monitoring and evaluation of e-government development (Nkwe, 2012; Alshehri and Drew, 2010; Habeenzu, 2010).
	• Lack of active leadership and management support in e-government initiatives (Ramli, 2017; Alshehri and Drew, 2010) and weak governance or coordination mechanisms (Sta, 2018; Ramli, 2017; Mawela et al., 2016).
	• Limited ICT infrastructure and connectivity (Ramli, 2017; Habeenzu, 2010; Boughzala et al., 2015; Nkwe, 2012; Alshehri and Drew, 2010).
	• Limited resources to enable establishment of incentives for operating public-private partnerships in e-government implementations (Habeenzu, 2010; Ramli, 2017).
	• Inadequate human resource capacity in the public sector to develop e-government solutions that address the local needs (Habeenzu, 2010; Alshehri and Drew, 2010).
Social/cultural factors – issues associated with ensuring that e-government artefacts subscribe to heterogeneous contexts of various stakeholders so as to encourage adoption.	• Limited trust and reluctance of end users to adopt and support e-government implementations for quality issues such as security of information, user anonymity issues (Boughzala et al., 2015; Habeenzu, 2010; Alshehri and Drew, 2010), reliability of services.
	• Limited interoperability of business processes and corresponding data formats (Boughzala et al., 2015).
	• Lack of clearly specified e-government implementations and clearly specified ways of measuring expected impact on enhancing quality of service delivery (Habeenzu, 2010).
	• Cultural differences, resistance to change among key stakeholders in developing e-government initiatives (Alshehri and Drew, 2010), resistant attitude of e-government managers, and conflicting stakeholder goals (Gil-García and Pardo, 2005).

2.1 Setup of the exploratory interviews

To gain deep insight into problematic issues that underlie the e-government interoperability challenge in Uganda, qualitative research was done through conducting exploratory interviews with a sample of key stakeholders involved in strategic management of e-government initiatives. These interviews were conducted from November to December 2014. The interview guide contained questions on three topics:

- *topic 1:* level of e-government maturity in specific ministries, departments, and agencies (MDAs)
- *topic 2:* status of e-government interoperability and extent of information exchange within departments that constitute a particular MDA and between MDAs
- *topic 3:* challenges contributing to the development of interoperable e-government systems and possible solutions.

Questions that underlie the above topics are presented in Appendix A. Table 2 shows key factors that were considered when designing the exploratory interviews.

As shown in Table 2, agencies were chosen using purposive sampling. Prior to selecting the agencies, a 'request for participation (RFP)' was emailed to e-government managers in the 20 agencies that had been sampled out of the 52 agencies using criterion B as indicated in Table 2. Agencies that positively responded to the email were further contacted to set specific dates for the interviews. Agencies that positively responded include regulators of: ICT services, education services, health services, public service and finances, agriculture, social security funds, capital city authority, local government services, trade and industry services, and justice and constitutional services. As indicated in Table 2 (see row 5), data was collected using the guide in Appendix A and responses during the interviews were transcribed using notebooks. Thereafter, content analysis technique was used to process finding as indicated in Table 2. This specifically involved studying notes taken during the interviews and scrutinising them to derive key points, which were further aligned and categorised into themes that provide insight into possible solution interventions. Sections 2.2 and 2.3 present findings.

2.2 Hindrances to interoperable e-government

This section presents findings on topics 1 to 3 as highlighted at the start of Section 2.1.

On topics 1 and 2, findings indicate that: none of the 12 MDAs that participated has achieved full integration of services, several e-government solutions within those MDAs still exist in silos, and information sharing across units in each MDA and between MDAs is still a major challenge. This is in line with findings of a government-wide comprehensive report on the status of e-government implementations in Uganda's MDAs (NIPA, 2012).

Topic 3 resulted in a set of challenges hindering the realisation of interoperable e-government systems in Uganda. These are summarised in Table 3 (column 2). Column 1 shows codes assigned to the challenges so as to easily refer to them in subsequent discussions, and column 3 shows the classification of each challenge with respect to the taxonomy by Novakouski and Lewis (2012) that is adopted herein (see Table 1). The contents of Table 3 are subsequently discussed.

Table 2 Design of the exploratory interviews on challenges of e-government interoperability

#	*Setup parameter*	*Details of how the parameter or factor was addressed in the interviews*
1	Aim of interview	To investigate the characteristics of e-government implementation efforts in Uganda's MDAs and the challenges hindering development of interoperable e-government systems in those MDAs.
2	Target population or respondents/subjects	ICT managers (or focal persons for e-services/ICT/information systems departments) of the 52 MDAs in Uganda.
3	Sample size	• A "request for participation (RFP) in a research interview on business-IT alignment in government service delivery" was sent out to a sample of 20 MDAs. 1 *The RFP indicated the following:* aim of the research, purpose of the interview, and the need to have a face-to-face dialog with the ICT manager or officer responsible for coordinating business-IT alignment aspects in a given MDA. • Out of the sample of 20 MDAs, only 12 ICT managers from 12 MDAs positively responded to the RFP.
4	Sampling method	Purposive sampling was used. Selection criteria for MDAs that participated in the interviews were: A The availability or willingness of a target respondent in an MDA to allocate time to respond to the interview questions through a face-to-face dialog with the researcher. B The existence of one or more implemented or ongoing e-government systems in an MDA.
5	Data collection instrument	• An interview guide (with open ended questions) was used to avoid biasing respondents (see interview guide is included in Appendix 1). • Face to face interviews were conducted (between the researcher and each respondent).
6	Average duration of interview sessions	• In three agencies that had implemented several e-government systems, each session lasted 1.5 hours. • In nine agencies that had few e-government implementations, each session lasted about 45 minutes.
7	Procedure undertaken to conduct the interviews	• An RFP was first sent to a sample of target respondents as specified above in the row on sample size, and a positive response implied setting the actual date and time of the interview. • Proceedings from interview sessions were noted and later analysed using conventional content analysis. This involved: (a) studying the collected data to achieve a holistic understanding of the aspects raised by respondents; (b) categorising of responses into themes that were used to inform the synthesis of the solution proposed herein.

Table 3 Interview findings on challenges hindering development of interoperable e-government systems

Code	*Challenges from ICT managers who participated in the interviews*	*Classification (Novakouski and Lewis, 2012)*
C1	Lack of clear guidelines to enable development of interoperable e-government systems.	Social/cultural
C2	Donor driven e-government systems are complex and overly ambitious to address local needs, and some e-government projects are implemented without a clear national strategic focus.	Political/policy
C3	Liberty to operate applications on different platforms with variations in syntax and semantics.	Legal
C4	Applications are not developed with interoperability in mind and it is hard to consider and address interoperability at later stages.	Social/cultural
C5	Lack of an operational framework for data and knowledge sharing across MDAs.	Legal
C6	Lack of a well established oversight entity or mechanism that guides and supports MDAs to implement integrated e-government systems.	Legal
C7	Limited and relaxed mode of monitoring and evaluating existing e-government systems and implementation efforts that are used by various MDAs.	Social/cultural
C8	Under developed ICT infrastructure in the country limits full establishment of e-government.	Political/policy
C9	Lack of awareness on existence of national ICT standards and the value of ICTs is not yet perceived by some top managers and citizens.	Legal
C10	Autonomy in making ICT investment decisions across MDAs.	Legal

Table 3 shows that social/cultural challenges are C1, C4, and C7. Details of these are discussed below. Phrases that are enclosed in quotes represent direct views of respondents in the interviews.

Lack of clear guidelines to enable development of interoperable e-government systems (C1). Under C1, some respondents indicated that "although authorities [i.e., Uganda's Ministry of ICT and National Information Technology Authority (NITA-U)] are advocating for the development and implementation of interoperable e-government systems, there are hardly any clear detailed guidelines to follow" [interview responses]. In addition, Uganda's e-government master plan emphasises the need for information sharing through interoperability (NIPA, 2012) but does not provide step by step guidelines on how it is to be achieved. As result, "some MDAs opt to use project management methodology to guide their e-government implementation efforts" [interviews]. However, project management methodology lacks guidelines for ensuring coherency of outputs and inputs of activities within and across projects and programmes (Op't Land et al., 2008). Attaining interoperability is uncertain without standards and guidelines (Fenton et al., 2007) that can be mutually adopted by MDAs during the development of coherent e-government solutions.

Applications are not developed with interoperability in mind (C4). Under C4, respondents revealed that: "(a) at the time when some of the e-government implementations were being undertaken, interoperability was not a priority; and (b) sometimes applications are purchased or developed to address an immediate business process need without having a clear picture of whether these applications can 'talk' to other existing applications in the same MDA or in other MDAs. Thus, interoperability issues like identification of common business processes and shared data elements are not considered in the initial stages of e-government system development, yet it is harder to address them at a later stage" [interview responses].

Limited or relaxed mode of monitoring and evaluation existing e-government systems (C7). Respondents noted that "authorities [i.e., Ministry of ICT and NITA-U)] hardly have programmes specifically designed to monitor and evaluate the different ICTs and e-government implementations in MDAs. Thus, there is limited capacity to measure returns from various design choices on interoperability issues which makes it harder to estimate the return on investment with respect to e-government interoperability. For example, transactional-costs and expected-profits are difficult to measure due to the lack of adequate awareness on interoperability issues arising from connectivity, coordination and monitoring activities and their associated costs" [interview responses].

Table 3 shows that legal challenges are C3, C5, C6, C9, and C10. Details are discussed below.

Liberty to operate applications on different platforms with variations in syntax and semantics (C3). Respondents indicated that: "when a particular department within an MDA has an immediate need for an e-government implementation, the ICT team of that MDA has the liberty to purchase or design an application to support a particular process without putting into consideration what other departments are using and how their solutions can be integrated. This practice encourages the use of different development platforms, data formats, and data structures within and across MDAs" [interviews]. Yet using different hardware and software platforms hinders information sharing, coordination and collaboration within and across institutions and threatens technical interoperability (Novakouski and Lewis, 2012; Cheng and Law, 2009) and operational interoperability. This is because, "resultant e-government systems use different terms to explain similar/identical concepts, and use identical terms to explain very different concepts" [interview responses].

Lack of an operational framework for data and knowledge sharing across MDAs (C5). On data sharing, respondents highlighted that: "(a) Uganda lacks a centralized government data pool/center where data needed by most MDAs can be centrally stored, secured and shared; (b) each MDA invests its own internally generated funds to collect its own data hence becomes selfish in sharing it even if this data is needed by other MDAs; and (c) a successful implementation in a given MDA is rarely shared with other MDAs, leading to duplication of efforts and resources. This encourages MDAs to operate in a loosely coupled manner that is characterized by decentralized data stores, disjointed data sets, and independent applications within MDAs" [interview responses]. Hence the challenge of e-government interoperability.

Lack of a well established oversight entity or mechanism that guides and supports MDAs to implement integrated e-government systems (C6). Respondents indicated that: "Uganda's regulators of e-government services are still in the preliminary stages of establishing an oversight entity or mechanism that can guide and support other MDAs to

develop and implement e-government systems in an integrated or coherent way. The absence of such an entity [or a strong and multi-disciplinary national e-government implementation board] that can monitor whether MDAs are designing and implementing applications that adhere to local or international ICT standards and policies, leads to deployment of technologies that cannot 'talk' to each other" [interview responses].

Lack of awareness on existence of national ICT standards and the value of ICTs is not yet perceived by key stakeholders (C9). The country's ICT regulatory authorities have undertaken several advocacy efforts on adoption of ICTs in government service delivery and integration of e-government solutions (NITA-U, 2012; NIPA, 2012). However, some respondents noted that: "some citizens would rather travel to offices to receive services physically than receive them online, and some employees in MDAs would rather stick to accomplishing processes manually rather than adopt the use of systems developed to improve efficiency of processes through ICTs" [interview responses]. This implies that there are underlying socio-cultural dimensions in the local environment that are not being addressed by advocacy campaigns that are conducted by the country's ICT regulatory authorities.

Other respondents indicated that: "before 2010, the low advocacy for ICTs by regulatory authorities created a relaxed mode that did not seize the opportunities of 'seed solutions' generated from research projects of academic institutions. It is only since 2010 that the ICT regulatory authorities started implementing a mechanism of annually sieving, recognizing and nurturing outstanding efforts that innovatively use ICTs to create solutions that address local development issues. This supports innovative students from academic institutions to incubate ideal e-government innovations/solutions or information systems to a stage where they can be piloted and deployed in MDAs to support service delivery" [interview responses].

In addition, there is low awareness on existence of national ICT standards. Uganda's ICT regulators have developed various ICT-related policies and guiding standards (MICT, 2018). However, some respondents noted that they "were not even aware about the existence of any ICT standards set by the country's ICT regulatory authorities" [interview responses], and thus based on this to justify the development of isolated e-government applications. The lack of awareness of appropriate ICT standards among stakeholders encourages unguided procurement and installation of ICT equipment in government institutions (SUA, 2014).

Autonomy in making ICT investment decisions (C10). Some respondents noted that "MDAs currently have the autonomy to make independent ICT investment decisions such as acquiring or buying/building their own applications for supporting particular processes. Although the country's ICT regulatory authorities set national ICT policies, there is hardly an operationalization framework or mechanism to enforce and monitor adherence within various MDAs" [interview responses]. This kind of autonomy leads to a highly fragmented ICT architecture, consisting of legacy systems for each service offered (Janssen and Kuk, 2006). Yet a highly fragmented and heterogeneous architecture within an enterprise with disparate business processes and applications limits interoperability (Janssen and Cresswell, 2005).

Table 3 shows that political/policy challenges are C2 and C8. Details of these are discussed below.

Donor driven e-government systems are complex and over ambitious (C2). Some respondents indicate that "most e-government implementation initiatives in the country are relying on external assistance from donors, aid agencies, vendors and consultants due

to the limited financial and human resources" [interview responses]. However, donor driven e-government implementations encounter situations where: key stakeholders are ignored in planning and this results in overly ambitious complex system designs that are hardly tailored to the local environment and are too expensive to be widely adopted in resource constrained settings (Heeks, 2003; Elder and Clarke, 2007; Young and Jordan, 2008); different agencies are contracted by donors to implement different solutions and this reinforces isolation, fragmentation and duplication of applications (Hanna et al., 2009). Moreover, reliance on external aid for e-government implementations in developing countries threatens the sustainability of those efforts when the external funding ends or becomes uncertain (Furuholt and Wahid, 2008).

Besides, respondents noted that "some e-government projects are implemented without a clear national strategic focus, since some MDAs hurriedly invest resources in e-government projects without first understanding the short-term and long-term direction of these projects" [interview responses]. For example, some respondents did not know about the e-government direction of their MDAs in terms of vision, mission, and objectives; and other respondents affirmed that the e-government direction was not yet specified. The development of e-government projects should begin with an e-government vision, mission, and objectives (Nkohkwo and Islam, 2013) that guide the achievement of the mission and vision (Al-Naimat et al., 2013).

Under developed ICT infrastructure (C8). Some respondents indicated that "the under developed ICT infrastructure in the country is the reason for having e-government systems that are not interoperable; and for the unexploited benefits of ICTs as key drivers for sharing e-government resources country-wide or across MDAs" [interview responses]. Thus, for a country like Uganda where internet penetration is approximately 12% (Biryabarema, 2012), it becomes challenging to acquire the different levels of full interoperability.

2.3 Possible solutions from the interviews

Respondents suggested the following (coded as S1 to S7) as possible solutions to some of the challenges in Section 2.2. These include the need to:

- adopt the practice of in-house system development and customisation of purchased systems to meet organisation needs (S1)
- gradually build capacity for e-government maintenance through constantly training staff (S2)
- use project management methodology jointly with approaches that provide guidance on developing interoperable e-government systems (S3)
- understand the current status of e-government systems in each MDA and devise means and policies on how they can be integrated (S4)
- develop country-specific security and privacy standards for information exchange or sharing (S5)
- involve key stakeholders when initiating an e-government project, during its implementation, and its evaluation (S6)
- conduct an e-government risk assessment and cost benefit analysis (S7).

Since challenges C1 to C10 are intertwined in nature, possible solutions S1 to S7 can be applied to (partially) address a number of challenges. Thus, Section 3 presents a holistic and strategic way of reasoning about mechanisms for addressing C1 to C10 and adopting S1 to S7.

3 Requirements to address the challenges

Interoperability of any computer-based system revolves around three levels, i.e.:

a *data exchange level* for understanding the type and size of data to be exchanged – *technical interoperability*

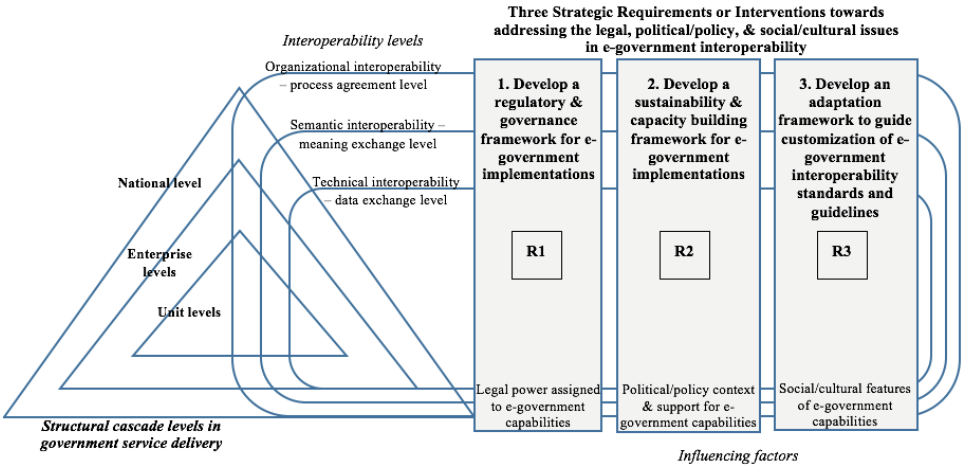
b *meaning exchange level* for ensuring that all actors in the exchange interpret the exchanged data in the same way – *semantic interoperability*

c *process agreement level* for ensuring that all actors in the exchange mutually understand the expected actions on the data after the exchange has occurred – *organisational interoperability* (Novakouski and Lewis, 2012).

Achieving the above three dimensions in the context of e-government is complex because it involves addressing a mesh of three classifications of factors that are situation-specific and apply to any form of e-government system, i.e., legal issues, political/policy issues, and social/cultural issues (Novakouski and Lewis, 2012). These factors were used to classify challenges presented in table 1 and interview findings in Table 3 (see Section 2).

Novakouski and Lewis (2012) devise a generic e-government interoperability model that provides a holistic understanding of the three interoperability levels expected in any e-government undertaking and the three cross-cutting mesh of influencing factors at each level. This paper extends this model by accommodating the cascading or hierarchical structure that is inherent in most government agencies. The cascade structure serves as an interlinking layer for ensuring that the three e-government interoperability levels and the three classifications of influencing factors are recognised at all key nodes in coordinating government service delivery. These nodes are also classified into three, i.e., *national level*, multiple *enterprise or MDA levels*, and multiple *unit levels*. This is because at national level, interoperability aspects of several MDAs have to be accommodated, while at enterprise or MDA level, interoperability aspects of all the different units that constitute an MDA are accommodated as well as interoperability aspects of other MDAs. These nested nodes are represented by three cascading pyramids that are shown on the left side of Figure 1, as a third dimension that has been added to extend the e-government interoperability model that was devised by Novakouski and Lewis (2012). The bold text (on the left of Figure 1) and the cascaded pyramids represent the features that have been added to extend the original model in Novakouski and Lewis (2012).

Figure 1 Three strategic requirements towards enabling e-government interoperability (see online version for colours)



Source: An extension of model in Novakouski and Lewis (2012)

In addition, Table 4 suggests specific requirements that need to be explored by researchers and e-government managers in order to address the challenges and possible solutions presented in Section 2. Like in Section 2, the specific requirements in Table 4 are classified into three strategic requirements or interventions that are motivated and derived from the three classifications of factors influencing e-government interoperability as articulated in Novakouski and Lewis (2012). These three strategic requirements are indicated at the top right part of Figure 1.

Each of the three broad strategic requirements (coded as R1 to R3) in Figure 1 represents a cluster of specific requirements that are presented in Table 4. In order to demonstrate the linkage between the holistic requirements R1 to R3 in Figure 1 and content on specific requirements in Table 4, a discussion is provided below:

- *R1. Develop a regulatory and governance framework for e-government implementations* in order to strengthen the legal power assigned to e-government capabilities and to strengthen enforcement towards compliance to e-government standards and guidelines. R1 in Figure 1 is a composition of specific requirements coded as R1.1 to R1.7 that are presented in Table 4.
- *R2. Develop a sustainability and capacity building framework for e-government implementations* in order to strengthen the political/policy context and support for e-government capabilities. This is done through establishing collaborative, communication, and negotiation mechanisms as well as institutional management and governance mechanisms towards undertaking sustainable e-government implementations. R2 in Figure 1 is a composition of specific requirements coded as R2.1 to R2.4 that are presented in Table 4.
- *R3. Develop an adaptation framework to guide customisation of e-government interoperability standards and guidelines* in order to comprehensively accommodate the social/cultural features of e-government capabilities through customisation of

international solutions to suit country-level contexts. R3 in Figure 1 is a composition of specific requirements coded as R3.1 to R3.5 that are presented in Table 4.

The three strategic requirements/interventions R1 to R3 are multi-dimensional and need to be instantiated or cascaded at the three structural levels represented in the nested pyramid on the left of Figure 1. Also, as shown in Table 4, addressing some challenges implies addressing a combination of specific requirements from each of the three classifications (see requirement codes for addressing problem-solution set [C1, S2, S3, S6] and [C6, C7] in table 4). Codes in column 1 of Table 4 (C1 to C10 and S1 to S7) originate from Section 2, while codes in column 2 represent the detailed requirements for addressing the challenges. Thus, Table 4 is used to enable traceability of requirements with respect to issues from the interviews.

Table 4 Detailed requirements for enabling e-government interoperability in developing countries

Challenge and possible solution codes	*Requirement code*	*Derived detailed or specific requirements to accommodate the challenges and possible solutions from the interviews*	*Novakouski and Lewis's (2012) classification*
C1, S2, S3, S6	R3.1	Develop/adapt localised e-government interoperability standards, principles, and guidelines.	Social/cultural
	R3.2	Adapt an enterprise architecture framework or methodology to supplement project management methodology with mechanisms for planning system integration and cohesion.	Social/cultural
	R2.1	Develop a collaboration framework with universities to facilitate capacity building, recruitment, and continuous professional development of ICT personnel.	Political/policy
	R3.3	Develop a public participatory framework for e-government implementations to enhance stakeholder participation during the planning, implementation, and evaluation of e-government initiatives.	Social/cultural
C2	R2.2	Develop a joint business-ICT strategic management framework for a government and its development partners to specify mutual strategic drivers and sustainability mechanisms of e-government initiatives.	Political/policy
C3	R1.1	Develop standard principles and guidelines for acquisition of ICT solutions and appropriate system development methodologies.	Legal
	R1.2	Develop standard guidelines for e-government readiness assessment of agencies to inform the planning and implementation of e-government initiatives.	Legal
	R1.3	Develop standard principles and guidelines for evaluating, selecting, and adopting of appropriate open standards or open systems.	Legal

Table 4 Detailed requirements for enabling e-government interoperability in developing countries (continued)

Challenge and possible solution codes	*Requirement code*	*Derived detailed or specific requirements to accommodate the challenges and possible solutions from the interviews*	*Novakouski and Lewis's (2012) classification*
C4, S1, S4	R3.4	Specify technologies that can be used to integrate existing heterogeneous applications towards enhancing the return on investment or value addition of existing systems.	Social/cultural
C5, S5	R1.4	Develop/adapt operational and legal principles and guidelines for information sharing, re-use, and archival.	Legal
C6	R1.5	Establish an e-government coordination, governance, and regulatory framework.	Legal
C7, S7	R3.5	Develop a monitoring and evaluation framework for e-government initiatives.	Social/cultural
	R2.3	Develop/adapt an e-government risk assessment and cost benefit analysis methodology.	Political/policy
C8	R2.4	Establish a public private partnerships (PPP) programme towards synergising efforts in developing ICT infrastructure.	Political/policy
C9	R1.6	Establish an awareness and advocacy programme for approved ICT standards and regulatory framework.	Legal
C10	R1.7	Establish a cascaded approval structure for business-ICT investments in government agencies.	Legal

The classification in Table 4 and its summarised theoretical view/model in Figure 1 yield a synthesis that can enable researchers and e-government managers to formulate holistic intervention strategies towards guiding e-government interoperability in resource constrained economies such as Uganda. Sections 3.1 to 3.3 discuss the three strategic requirements or intervention strategies presented in Figure 1 and the underlying detailed specific requirements that constitute them as presented in Table 4.

3.1 Need for a regulatory and governance framework for e-government (R1)

This section discusses specific requirements under R1 coded as R1.1 to R1.7 in Table 4.

R1.1 in Table 4 indicates the need to develop/adapt standard principles and guidelines for acquisition of ICT solutions (hardware and software) and appropriate system development methodologies, as way to extinguish the practice of developing incompatible applications that hinder interoperability of innovations. The development of standards and principles or guidelines for designing, developing or purchasing applications across agencies helps to direct and constrain design decisions during e-government implementation (Janssen and Kuk, 2006).

R1.2 in Table 4 is concerned with the need to develop guidelines for assessing e-government readiness of agencies so as to inform planning and implementation of e-government initiatives, with respect to the gradual development of a shared ICT infrastructure. E-government readiness is the ability of a government to adopt ICTs in transforming services and activities into a new direction (UN, 2013). Prior to implementing e-government, agencies need to take appropriate steps to ensure that the appropriate technology is deployed, ICT infrastructure is adequate, and that people are ready for a technological change (NITDA, 2012).

R1.3 in Table 4 highlights the need to develop/adapt standard principles and guidelines for evaluating, selecting, and adopting appropriate open standards or systems. Development of open systems is an effective way of achieving e-government (Deller and Guilloux, 2008). However, open systems differ from open source as the latter implies software's source code and rights regarding its redistribution. Open systems often have varying functions and manufacturers but can share information through well defined web services and application programming interfaces (APIs) that are built into different software components (TFM, 2013). Although some countries have set up their own ICT standards, GOI (2010) recommends the adoption of appropriate open standards to allow consistent, standardised and reliable implementation of e-government solutions. Hence the need for guidelines for evaluation and selection of open standards.

R1.4 in Table 4 indicates the need to develop/adapt operational and legal principles or guidelines for information sharing, re-use, and archival, in order to avoid duplication of efforts and wastage of resources during data generation. In addition, the application of ICTs in government may encounter legal or policy barriers (Almarabeh and Ali, 2010). Thus, the success of e-government initiatives and processes is highly dependent on government's role in ensuring a proper legal framework for their operation (UNDP, 2007). Strategies need to be devised to ensure confidentiality, integrity and availability of electronically transmitted information or documents within and across government agencies.

R1.5 in Table 4 highlights the need to establish an e-government coordination, governance and regulation enforcement board and forum that has a dual responsibility of:

a coordinating the development of technical and administrative guidelines towards e-government interoperability

b enforcing adherence to these guidelines among government agencies.

Such a board and forum would spearhead e-government initiatives in close collaboration with a nation's ICT regulatory authorities. Specific roles of this board and forum are clarified by R1.6, R1.7, R2.4, R3.5, and R3.3.

R1.6 in Table 4 proposes the establishment of an awareness and advocacy programme in order to overcome the low awareness of ICT standards and limited understanding of the value proposition for e-government. Such an awareness and advocacy programme would engage top management teams of agencies and political leaders to disseminate standards, principles, and guidelines developed in R1.1 in Table 4; and sensitise stakeholders about those guidelines in a bid to enforce adherence among government agencies. Top management support is a very critical factor that involves top managers devoting time to ensure success of an information system initiative through: reviewing plans to track progress, following up on results, and resolving any problems in integrating

ICTs with business processes of an enterprise (Young and Jordan, 2008). This is because top management teams are responsible for:

1 allocating and approving resources for e-government implementations

2 motivating their teams to work harder and derive innovative solutions

3 advocating for technological change and reducing internal resistance (Al-Naimat et al., 2013).

Political leaders would be engaged in such a programme to reinforce public participation in e-government implementations and evaluation of e-government systems as discussed in R3.3.

R1.7 in Table 4 shows the need to establish an integrated approval structure or protocol for business-ICT investments in government agencies in order to overcome the existing autonomy of agencies depicted in C10. Such an approval protocol would help to scrutinise e-government initiatives proposed by agencies to:

a ensure resource optimisation by eliminating duplication of efforts

b to ensure that standards, principles, and guidelines (developed in R3.1 to R3.3) are adhered to.

3.2 Need for a sustainability and capacity building framework for e-government (R2)

This section discusses specific requirements under R2 coded as R2.1 to R2.4 in Table 4.

R2.1 in Table 4 highlights the need to develop a collaboration framework with universities to facilitate capacity building, recruitment, and continuous professional development towards competent ICT personnel. This is because the development and implementation of e-government standards requires recruitment of competent staff and training them through staff development programs to keep their skills and knowledge base up-to-date.

R2.2 in Table 4 highlights the need to develop a government-to-donor business and ICT strategic management framework for specifying strategic drivers and sustainability mechanisms of e-government initiatives. A sustainability framework would encourage donors to build on existing systems and articulate leadership details, encourage commitment of public officials, and specify institutions that are able to lead, coordinate and sustain e-government projects when the donors pull out the financial and human resources (Dzhusupova et al., 2011). The sustainability framework would also be supplemented with strategic management guidelines such that strategic drivers of e-government initiatives are specified and their cohesion determined. A clear vision and strategy for any e-government is a critical factor in implementing e-government (Al-Naimat et al., 2013). Without clear e-government vision and objectives, the formulation of measurable criteria for monitoring and evaluating to the success of e-government initiatives becomes a 'flight of the imagination' (NITDA, 2012).

R2.3 in Table 4 highlights the need to develop/adapt an e-government risk assessment and cost benefit analysis methodology. This is because conducting an e-government risk

assessment and cost benefit analysis helps to deliberate with top managers of government agencies on the value proposition for e-government (as indicated in R1.6).

R2.4 in Table 4 indicates the need to establish a public private partnerships (PPP) programme towards mobilising and synergising resources for developing a country's ICT infrastructure to provide shared infrastructure and technology base for e-government services. PPPs are arrangements between public and private sectors that allow private agencies to provide some services that fall under the responsibilities of the public agencies, with clear agreement on shared objectives in delivering public infrastructure and services (World Bank, 2009).

3.3 Need for an adaptation framework for e-government interoperability standards (R3)

The development of managerial and technical guidelines for e-government interoperability requires careful in-depth understanding of how to apply the essential models of e-government as a strategy and a comprehensive contextual analysis (Bwalya and Mutula, 2016). Thus, this strategic requirement is concerned with all efforts in researching, developing, and adapting technical guidelines towards interoperability of e-government efforts and ensuring that they are up-to-date. This section discusses specific requirements under R3 coded as R3.1 to R3.5 in Table 4.

R3.1 and R3.4: R3.1 in Table 4 indicates the need to develop/adapt localised e-government interoperability standards, principles, and guidelines to facilitate their adoption within and across e-government agencies. For interoperability to be achieved, a set of clearly defined minimum interoperability standards is required along with government policies and standards for achieving interoperability and seamless flow of information within and across government agencies (SITA, 2011).

For already existing e-government systems, *R3.4* in Table 4 indicates the need to specify technologies that can be used to integrate existing heterogeneous applications towards enhancing the return on investment or value addition of existing systems. For example, seamless flow of information can be achieved across applications as long as an API is available for mapping applications (Deller and Guilloux, 2008), or middleware can be used to enable data integration among multiple heterogeneous databases (Fong and Hui, 1999).

R3.2 in Table 4 highlights the need to adapt an enterprise architecture framework or methodology to supplement the project management methodology with mechanisms for planning system integration and cohesion. Such a methodology will result in guidelines for developing reference enterprise architectures for government agencies and demonstrate cohesion of e-government projects within and across agencies.

R3.3 in Table 4 highlights the need to develop a public participatory framework for e-government implementations towards enhancing stakeholder participation during the planning, implementation, and evaluation of e-government initiatives. There is need to adopt or devise strategies for facilitating stakeholder identification in the management of e-government projects (Mishra and Mishra, 2013), so as to allow stakeholder involvement at the start of an e-government project throughout its implementation because this is critical to e-government success (Nkohkwo and Islam, 2013).

R3.5 in Table 4 indicates the need to establish a monitoring and evaluation programme for e-government that would closely engage government agencies in periodic

assessments of e-government initiatives with respect to changes in the environment they serve. This would yield an up-to-date portfolio of e-government initiatives in order to enable effective realisation of all sub requirements that constitute the three strategic requirements presented herein. Moreover, such a programme would articulate criteria and tools/techniques for monitoring and evaluating the extent to which MDAs are implementing e-government systems that subscribe to the stipulated standards.

4 Conclusions and future work

This paper is motivated by the prevalence of isolated e-government systems in developing countries, yet several eGIFs exist. Thus, Uganda was used as a case study to investigate challenges and possible solutions using exploratory interviews. This was done to provide insight into instantiations of the classical challenges of e-government interoperability. This paper presents findings from the exploratory investigation and major implications. First, the findings point to the need to consider three major intervention strategies, i.e., the need to develop and implement:

1 a regulatory and governance framework for e-government implementations

2 a sustainability and capacity building framework for e-government implementations

3 an adaptation framework for guiding customisation of existing and upcoming e-government interoperability standards and guidelines.

Second, the findings imply the need to adopt or instantiate each of the above three strategies/requirements in a cascaded style at national level, agency level, and unit level.

The above three requirements/strategies articulate broad research questions and possible research approaches that need to be explored in a more detailed manner so as to address e-government interoperability issues in Uganda and in countries with similar contexts. A detailed decomposition of the three intervention strategies/requirements as presented herein highlights specific research questions or themes that need to be comprehensively explored, and therefore serve as prompts to stimulate researchers and practitioners to share insights or investigate clear mechanisms of their actualisation. Therefore, this paper points to specific desired research directions towards addressing the e-government interoperability challenge in developing economies. Accordingly, the research herein is being extended by undertaking efforts to address one of the recommended strategic interventions, i.e., the development of an adaptation framework for guiding e-government managers in customising e-government interoperability approaches to address a country-specific context. Other research efforts can be geared towards developing and implementing the sustainability and regulatory frameworks for e-government implementations.

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Appendix A

Interview guide

Position of respondent in the organisation

Baseline situation

1 Is there any documentation that the researcher can get to read information about the organisation's vision, mission, core functions, strategic objectives etc.)
   a Departments or units in the MDA.
   b Which information is input to each MDA in (1) above?
   c Which information is output from each MDA in (1) above?
   d Are there departments that are dependent on each other in regards to information sharing and or task execution? If yes, which ones and how? If no why?
   e Does this MDA have external interactions with other MDAs? If yes, which ones and in which context (giving output and receiving output).

2 Information on existing or ongoing applications in an MDA
   a How many application systems does the MDA have operating or undergoing development?
   b What is the core function of each of the existing application systems?
   c Are these application systems interoperable?
   d If yes (or some) explain/demonstrate how by showing which application system supports which one.
   e If no why aren't they interoperable?
   f Do the applications in this MDA interact with other applications in other MDAs associated with it? If yes, elaborate and give success factors.

3 If no, which challenges does the MDA face that are hindering it from having or developing interoperable systems? (e.g., apps are outsourced or are COTS)

4 What would you recommend as possible solutions to these challenges in (5) above?