Improving Government Enterprise Architecture Practice – Maturity Factor Analysis

Adegboyega Ojo, Tomasz Janowski and Elsa Estevez
UNU-IIST Center for Electronic Governance
P.O. Box 3058, Macao
{ao,tj,elsa}@iist.unu.edu

Abstract

Recognized as a critical factor for the whole-of-government capability, many governments have initiated Enterprise Architectures (EA) programs. However, while there is no shortage of EA frameworks, the understanding of what makes EA practice effective in a government enterprise is limited. This paper presents the results of empirical research aimed at determining the key factors for raising the maturity of the Government Enterprise Architecture (GEA) practice, part of an effort to guide policy-makers of a particular government on how to develop GEA capabilities in its agencies. By analyzing data from a survey involving 33 agencies, the relative importance of factors like top management commitment, participation of business units and effectiveness of project governance structures on the maturity of the GEA practice was determined. The results confirm that management commitment and participation of business units are critical factors, which in turn are influenced by the perceived usefulness of the GEA efforts.

1. Introduction

Increasingly, Government Enterprise Architecture (GEA) efforts are part of Electronic Government (EGOV) programs conducted by national and other levels of governments. One reason for the increasing prominence of GEA as a management and technology practice in government is its association with the transformational government goals by influential global EGOV policy reports such as the United Nations E-Government Survey [1] and the Waseda University World E-Government Ranking [2]. According to the studies presented in [3][4], many leading countries in EGOV development have GEA programs towards transformational government [5].

GEA can be viewed as a practice or an artifact. As a practice, it enables rigorous description, design and analysis of organizational structures that span the boundaries of different organizations. As an artifact, it comprises principles, methods and models used to design and implement organizational structures, business processes, and information systems and infrastructure of an enterprise [6].

Unlike in the private sector, the GEA practice is relatively recent and existing GEA initiatives show mixed results [7][8][9]. According to [8], over 40% of the GEA programs will be stopped through 2012 due to poor execution. Typical barriers, based on the study of the 27 GEA programs in the US federal agencies are [9]: cultural resistance, organizational parochialism, lack of understanding by top management, and lack of human capital and funds. While the challenges have not reduced the investment in the GEA programs; they caused the repositioning of the GEA practice as a management concern; improvements in the efficiency of the GEA process, methods and frameworks used by architects; and the emergence of performance measures for the GEA practice maturity [10]. Presently, many GEA maturity assessment models are available, in line with the empirical observation that only those organizations that are engaged in a mature GEA practice benefit from good IT management [11].

Lately, various studies have been carried out on how to improve the effectiveness of the GEA practice. These studies examined the impact of the factors such as the organizational culture and design [12][8], stakeholder satisfaction [10] and operating models [13]. In these studies, GEA effectiveness is expressed in terms of explicit maturity models and includes satisfying organizational and stakeholder-specific goals. Other factors like management commitment and leadership, participation of business unit, existence of strong governance structures, and availability of skilled personnel were also highlighted [9][14][10].

However, an empirical investigation of the effects of such factors on the maturity of the GEA practice is yet to be reported. Despite the existence of over 148 conference papers, 66 journals, 29 books and 15 book chapters on EA, EA management is yet to be accepted among the core Information Systems research topics [15], considering that EA is often treated in an enterprise-specific way [16].

978-0-7695-4525-7/12 $26.00 © 2012 IEEE
DOI 10.1109/HICSS.2012.14

This paper addresses this knowledge gap through an empirical study of key maturity factors affecting the GEA practice. The study examines seven factors identified in the literature: 1) availability of external support, 2) availability of technical skills, 3) existence of project governance structures, 4) learning culture, 5) management policies and processes, 6) participation of strategic business units and 7) top management commitment. By analyzing the data gathered through a survey involving 33 government agencies, the relative importance of these factors on the level of GEA maturity is determined. In addition, we investigate how the perceptions on the usefulness of the GEA practice may affect the participation of strategic business units and commitment of top management to EA programs. The results show that management commitment and participation of business units strongly influence the maturity of the GEA practice, both depending on the perceived usefulness of GEA. However, we were unable to conclude on the criticality of the remaining factors based on available data.

Given the lack of theories in the GEA domain, this work contributes to building such a theory and provides a concrete basis for a deeper qualitative investigation of the seven factors. It also suggests plausible relationships between the factors. In particular, it confirms that the availability of skills, management processes, external support and learning culture are mediating factors with respect to the four independent factors for the GEA maturity – management commitment, participation of business units and availability of project governance structures.

The rest of the paper is organized as follows. Section 2 presents a background to the GEA practice, Section 3 documents related research on improving this practice and Section 4 describes the adopted research methodology. Section 5 describes the survey of the GEA practice including data gathering, analysis and results. The results are validated in Section 6, including convergence with existing results. Section 7 contains a discussion and Section 8 provides some conclusions.

2. Background

This section provides a background to GEA. The section describes the GEA practice in Section 2.1, the concept of GEA maturity and its influencing factors in Sections 2.2 and 2.3 respectively, and how the GEA practice supports EGOV initiatives in Section 2.4.

2.1. GEA Practice

Formally, Enterprise Architecture is a holistic set of principles, methods and models used in designing and realizing organizational structures, business processes, information systems and infrastructure of an enterprise [6]. A government enterprise, in turn, is a coordinated set of activities involving one or more public and possibly private or third-party organizations [17].

Among the leading EGOV countries, many have ongoing GEA programs: Australia, Belgium, Canada, Denmark, Estonia, Finland, Germany, Korea, Netherlands, New Zealand, Norway, Singapore, South-Africa, Sweden, Switzerland, United Kingdom and United States [4][17][18]. While specific reasons for EA adoption may vary, common reasons include [3]:

1. Enabling interoperability and providing technical and managerial standards for agencies;
2. Enabling resource sharing across agencies and reducing the cost of IT and business operations by identifying duplications and opportunities for reusing business and IT services; and
3. Enabling the development of shared processes and delivery of seamless services.

These reasons are consistent with the observation that the public sector EA deployment is often aimed at addressing the decentralization of relationships between central and local governments to better manage local IT-related projects and activities [5].

GEA is usually developed based on an existing EA framework. Such frameworks provide methodologies to describe the process of developing and managing EA; languages for modeling human, organizational and technology aspects across various EA perspectives (business, data, application and technology); and enterprise models including reusable reference models and designs [3]. The GEA program analysis reveals typical elements of a GEA framework: EA goals, principles and reference models, and EA methods and interoperability frameworks [17].

Internally, GEA stakeholders include government chief information officers (GCIO), government chief technology officers (GCTO), agency heads and heads of business units, business and information analysts, and project managers and IT officers [10]. Externally, GEA stakeholders include government customers (business and citizens) as well as civil society and private sector organizations [19].

2.2. GEA Practice Maturity

Several models exist for measuring the EA efforts. These models either measure the maturity of the EA practice or the effectiveness of the EA practice on IT management or on the organization as a whole.

Based on Balanced Scorecards, an outcome-based approach for measuring enterprise system benefits is

described in [20] using four perspectives: 1) resource management; 2) internal business processes; 3) people, learning and innovation; and 4) client and community relationships. A foundational framework for measuring the effectiveness of EA (using a set of indicators) on business-technology alignment and agility is described in [21]. Another set of indicators is provided in [10].

By far, available EA measurements models are based on either maturity or efficiency. This can be explained as a certain level of EA maturity is required for any meaningful outcome of the EA practice on organizational goals [8]. One of few theoretical results in EA maturity models, [22] proposes a conceptual framework for analyzing EA maturity models through core focal areas and the corresponding maturity levels.

Considering government-focused EA maturity models, three GEA examples are examined here. The first by the National Association of Chief Information Officers defines the following levels of the GEA practice: architecture planning, architecture framework, architecture blueprint, communication, compliance, integration and involvement [23]. The second by the General Accountability Office is a GEA management maturity framework consisting of maturity stages, GEA management, and critical success attributes [24]. GEA management includes: creating EA awareness, managing GEA maturity, completing GEA products, and leveraging GEA to manage change. Lastly, we also consider the maturity assessment model for the State of Oregon, based on the Gartner's EA Program Maturity Self Assessment Model [25]. The model identifies several assessment areas: architecture context, scope, impact, authority and development; stakeholder involvement and support; business context; future state realization; and architecture team response.

2.3. GEA Practice Maturity Factors

To develop an efficient and effective GEA capability, government agencies must address several environmental and organizational factors. A number of such factors have been suggested in the literature.

For example, based on stakeholder responses, [24] identifies 14 attributes that a GEA function must possess to achieve effectiveness. These attributes include: availability of governance structures, ability of architects to communicate with stakeholders, clear roles, vision, possession of functional knowledge, availability of technology, availability of governance processes and accountability. Employed in [25], the Gartner's EA self assessment tool suggests that the enabling organizational factors for EA maturity include corporate management support, participation of business units, communication with stakeholders on expected benefits and roles in the EA programs, architecture governance, and availability of resources. According to [26], the factors influencing EA program success include: effective project leadership, end user and management participation, management support and commitment, availability of resources, acceptable balance of scope, and trained team of consultants. For Enterprise Resource Planning, 40 critical success factors include [27]: top management support, inter-departmental communication, change and project management abilities, motivation to collaborate, teamwork culture, and clear goals and objectives. In addition, 11 critical success factors for EA include [14]: business linkage, business unit participation, senior management involvement and EA resources. Finally, [9] identifies leadership as the key factor to drive GEA-enabled operational and technology changes in US federal government. Organized into 11 categories, all these factors are shown in Table 1.

Table 1: GEA Maturity Factors

No	Factors	Sources
F1	Management commitment, Top management support, Senior management involvement, Leadership, Corporate support	[9][14] [25][26] [27]
F2	Participation of business units, End-user and management participation	[14][25] [26]
F3	Project governance structures, Effective project leadership, Compliance, Architecture governance	[14][24] [25][26]
F4	Technical skills, Technological knowledge, Training and education	[24][25] [27]
F5	Management policies/processes, EA-related processes	[14]
F6	External support, Availability of consultants	[26]
F7	Learning and change culture, Commitment to change	[27]
F8	Functional knowledge	[24]
F9	Communication, Interdepartmental communication, Communication with stakeholders, EA program communication	[14][24] [25][27]
F10	Availability of resources, EA resources	[26][14]
F11	Clear vision and goals, Realistic EA scope and objectives	[14][24] [27]

2.4. Supporting EGOV with GEA

A major application area for the GEA practice, Electronic Government (EGOV) is defined as strategic use of Information and Communication Technology (ICT) by governments to enable transformation in service delivery, relationships with key stakeholders, and internal working and management in government. The next wave of EGOV is associated with connected government [28], transformational government [29], holistic government [30] and whole of government [31] paradigms. Common features across these paradigms include: the integration of all levels of government, delivery of seamless and joined up services, and flexibility in service delivery. The GEA practice is expected to enable the realization of these features, for instance as a dynamic capability required for inter-organizational integration, service delivery coordination, technology integration, and the overall transformation to a virtual government enterprise [32].

The dependency between EGOV development and the required EA support is presented in Table 2 [28] as a mapping between EGOV and GEA maturity stages. The mapping utilizes the four-level GEA maturity model [11]: Business Silos – optimizing the needs of business units; Standardized Technology – providing IT efficiencies through technology standardization and centralization of technology management; Optimized Core Architecture – providing organization-wide data and process standardization; and Business Modularity Architecture – loosely-coupled, IT-enabled business process components preserving global standards and enabling local differences. Progression from Business Silos to Business Modularity requires addressing the EA maturity factors identified in Table 1.

Table 2: Mapping EGOV and GEA Maturity Levels

		GEA			
		Business Silo	Standardized Technology	Optimized Core Architecture	Business Modularity
EGOV	Web Presence	X			
	Interaction	X	X		
	Transaction		X	X	
	Transformation			X	X

For EGOV development, various staged models are available in the literature. The model applied in [28] consists of four-stages: Web Presence – provision of (non-interactive) websites by agencies, Interaction – enabling two-way communication with citizens and businesses through websites and other channels; Transaction – electronic initiation and completion of requests by citizens; and Transformation – provision of seamless services and integrated policies across sectors and levels of government, and integration with the entities from the private sector and civil society. Table 2 shows the required maturity of the GEA practice for each of the four EGOV maturity levels based on [28].

3. Related Work

This section reviews related empirical or theoretical research aimed at providing a better understanding of how the GEA practice can be improved. Unfortunately from our literature review, few scholarly publications exist that provide quantitative or qualitative analysis of the GEA success factors. Among them, four such publications are summarized below.

The first investigates the relationship between GEA effectiveness and stakeholder satisfaction [10]. By adopting a theoretical framework based on customer satisfaction and cognitive structures and means-ends chain analysis, [10] conducts a qualitative analysis of the agreement between the overall organizational goals for GEA and the goals of individual stakeholders.

The second publication [33] applies an empirical approach to demonstrate the insufficiency of the meta-modeling approach traditionally employed by the EA practice when applied to the government context, due to its complex social and bureaucratic nature. Based on the case of two agencies of Australian Government, the results show a gap between methodology and reality. To improve the effectiveness of the EA practice in the government domain, [33] proposes to rethink the EA meta-modeling framework for government use.

The third publication [7] examines the impact of the EA management on organizational success with IT. EA management is operationalized as the existence of the EA management staff, the maturity of the EA management practice, and the amount of time devoted to it. IT success involves successful execution of IT projects, satisfaction of operational departments with IT and the duration of procurement projects. The results show that the EA management maturity correlates with the duration of the procurement projects and satisfaction of operational departments.

The fourth publication [8] is most related to our work. It describes a qualitative approach to understand the relationship between the EA program maturity and

performance, searching for factors that influence the maturity of the EA programs in government agencies. Relying on organizational theory, [8] considers how organizational culture, structure and design enhance or inhibit EA program performance. In addition, the work studies if technology and organizational environment are moderating variables in this context. Unfortunately, the status and results of this work are not available.

While two of the publications above investigate EA maturity issues in the government context, none of them investigates the impact of organizational factors in Table 2 on the EA practice maturity. The goal of this paper is to address this gap by developing additional understanding of how these factors directly impact the development of the agency EA capabilities.

4. Research Approach

Following the background and related work presented in Sections 2 and 3, we now articulate the theoretical framework (Section 4.1) for our work, and present research questions and hypotheses to be investigated (Section 4.2) and design of our study (Section 4.3).

4.1. Theoretical Framework

A number of important constructs can be identified from the body of the EA literature related to this work. These include EA Effectiveness, EA Maturity, EA Stakeholder Satisfaction, EA Function Design and EA Environment. In this section, we develop a theoretical model to relate these constructs based on related work. The model is shown in Figure 1 and explained below.

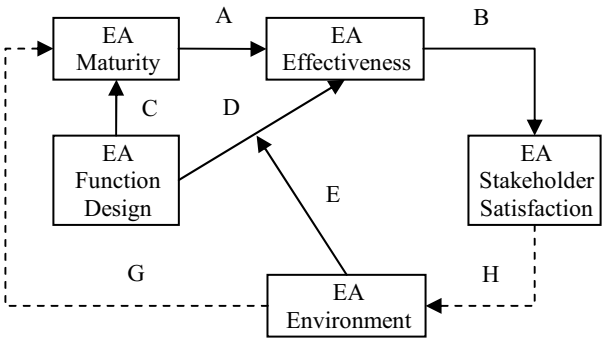

Figure 1: EA Practice Maturity Theory

Rarely defined explicitly, EA Maturity is a measure of development of an EA practice – its capabilities and management in an organization. EA Effectiveness is a measure of the EA impact on organizational goals, or a degree to which the EA objectives are met [10][21]. According to [11][8], EA Effectiveness requires a certain level of EA Maturity. Therefore, the first proposition is that EA Maturity determines EA Effectiveness. This relation is labeled A in Figure 1.

EA Stakeholder Satisfaction is similar to customer satisfaction [10]. Goal attainment or EA Effectiveness influences or is even a precondition to EA Stakeholder Satisfaction. This proposition is labeled B in Figure 1.

An organizational capability responsible for the EA program [10], EA Function consists of EA decision making, EA delivery and EA conformance [12]. According to [8], organizational culture, organizational structure and organizational design may influence EA Effectiveness and EA Maturity. This implies that EA Function Design could influence EA Maturity and EA Effectiveness. These propositions are labeled C and D.

A space outside the EA Function, EA Environment comprises organizational and technology environments [21]. As the fit between structure and technology determines organizational performance [8], we deduce that the EA technology environment is related to EA practice effectiveness via the EA Function Design. In other words, EA Environment mediates the effect of the design of the EA Function on EA Effectiveness [8]. This is shown as the relation E. Since EA Environment is characterized by the maturity factors in Table 1, we add a determinant relation G between EA Environment and EA Maturity. Note that the label F has not been used in Figure 1 as it is already applied in Table 1.

Logically, EA Stakeholder Satisfaction with the EA practice could impact on the EA Environment, for instance by releasing resources or active participation of user departments. Concerning the latter, Technology Acceptance Model and related theories [34] suggest that the perceived usefulness of the EA practice influences participation. Since it is plausible to assume that the stakeholders' satisfaction implies perceived usefulness, we expect EA Stakeholder Satisfaction to influence or impact EA Environment factors, such as participation of user departments in EA or commitment of top management. Thus, we introduce the H relation, from EA Stakeholder Satisfaction to EA Environment.

Since our interest lies in EA Maturity, this paper validates the logically deduced relations F and G. To this end and given available data, we operationalize EA Environment using a subset of the factors in Table 1 (F1 – F7) and EA Stakeholder Satisfaction using the perceived usefulness of the EA efforts by stakeholders.

4.2. Research Questions and Hypotheses

The aim of this research is to determine the major factors affecting EA Maturity in government agencies, driven by two concrete research objectives:

R1. Determine the significance of the factors F1 to F7 in Table 1, selected among F1 to F11 based on data availability, with respect to their impact on the maturity of the government EA practice. This question aims to verify the relation G in Figure 1.

R2. Determine the extent to which the usefulness of the EA efforts perceived by the stakeholders impacts on the factors in R1. This question aims to verify the relation H in Figure 1.

Based on the factors F1 to F7, the questions R1 and R2 are refined into 10 specific research hypotheses in Table 3: hypotheses G_{F1} to G_{F7} and G_{All} seek to answer R1 by verifying the relation G and hypotheses H_{F1} and H_{F2} seek to answer the question R2 by verifying H. In addition, Figure 2 presents a visual representation of the hypotheses. Combining the answers to R1 and R2 provides information on the duality of EA Maturity with respect to the organizational environment.

Table 3: Research Hypotheses – Factor Significance

No	Description
G_{F1}	Agencies with senior management commitment (F1) tends to have a higher EA Maturity
G_{F2}	Increased participation of business units in EA initiatives (F2) positively affects EA Maturity in government agencies
G_{F3}	Strong project governance (F3) positively affects EA Maturity in government agencies
G_{F4}	The availability of technical skills (F4) positively affects EA Maturity in agencies
G_{F5}	The availability of management policies and processes (F5) positively affects EA Maturity in government agencies
G_{F6}	Access to external support (F6) positively affects EA Maturity in government agencies
G_{F7}	Learning culture in government agencies (F7) positively affects their EA Maturity levels
G_{All}	The factors F1 to F7 jointly determine EA Maturity levels in government agencies
H_{F1}	The perception of the usefulness of EA efforts influences management commitment (F1) in government agencies
H_{F2}	The perception of the usefulness of EA efforts affects Business Unit Participation (F2) in government agencies

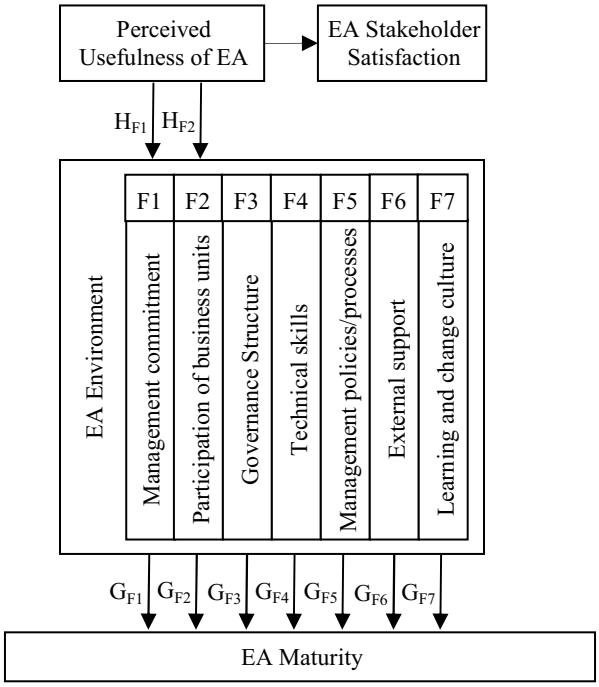

Figure 2: EA Maturity Factors Model

4.3. Research Design

This research applies a post-positive view [35] to empirically verify the relations between the first seven factors in Table 1 and the maturity of EA practice.

The verification is based on the survey of existing EA capabilities, enabling factors and barriers to EA development in a major city government. All 73 agencies of this government were invited to participate. Most of the questions in the survey were close-ended and required Likert-type scale responses.

Given that the independent variables H_{F1} and H_{F2} are of the ordinal type and the dependent variables G_{F1} to G_{F7} are ratio type, we analyze relationships between independent and dependent variables using the Pearson product moment correlation and simple regression analysis. The joint effect of all factors on dependent variables is analyzed using multiple regression analysis (i.e. G_{All}). The relations between independent variables are analyzed using the Pearson product moment correlation and simple regression analysis.

The reliability of our instrument was determined by computing the Cronbach's Alpha coefficient on the set of seven independent variables representing the "organizational enablers" for EA Maturity. In addition, the Cronbach's coefficient was also computed for the four EA Maturity dimensions to determine their internal consistency. To validate our results, we argued for content validity of our instrument and convergent validity of our EA Maturity construct.

5. Survey

This section presents research context (Section 5.1), objectives and elements of the survey (Section 5.2), provides details of the survey instruments (Section 5.3) and describes data analysis and results (Section 5.4).

5.1. Research Context

The research was carried out as part of a project to develop a government-wide EA program for a city government. Part of an ongoing EGOV program, the project aimed at: 1) identifying the required EA capabilities in agencies, 2) determining coordination requirements for the whole-of-government EA, and 3) examining organizational factors for successful EA deployment within individual agencies and across the government. Through the EA program, the government hopes to build the capabilities required for delivering integrated, cross-agency services and enabling sector-wide and cross-sector policy development.

5.2. Objectives and Process

To fulfill project objectives, the survey aimed to: establish the level of awareness about EA in agencies, determine EA adoption drivers by agencies, establish EA capabilities in agencies, determine success factors and inhibitors for government-wide EA adoption and practice, and determine the skill and knowledge needs of the agencies to improve EA adoption and practice.

All agencies were invited to participate in the survey, which lasted for six weeks including one week devoted to pilot agencies. Throughout the exercise, a help-desk was setup to support agencies in answering the questions and completing the survey. At the end, 33 agencies (45% response rate) completed the survey.

5.3. Survey Instrument

The survey instrument comprised five sections:

1. *Strategic Context* – major transformational and strategic activities carried out by the agencies
2. *Drivers for EA Adoption* – important internal and external drivers for developing the EA practice
3. *EA Practice Maturity* – available capability in four EA domains – processes, data, applications and technology and coherency between domains.
4. *EA Maturity Factors* – to what extent the agencies maintain the required organizational environment for developing their EA capability
5. *EA Inhibitors* – what inhibiting factors, with respect to the EA capability, exist in agencies

This paper focuses on the information gathered through the sections 3 and 4: the EA Maturity construct is operationalized in section 3, while EA Maturity Factors are operationalized in section 4. The former, defined using business process, data, applications and technology dimensions, was measured using the variables in Table 4, guided by [26]. The variables also implicitly measure the levels of maturity within each domain. For the latter, the agencies indicated their perception of the organizational environment using seven variables, ranging from very low to very high, that correspond to the first seven factors in Table 1.

To ensure internal consistency in the measurement of both constructs [36], we computed the Cronbach's alpha [37][7] for EA Maturity over its four domains and over the seven EA Maturity Factors. Presented in Table 5, the results show a good degree of internal coherence between the variables for both constructs.

Table 4: Measuring the GEA Maturity Construct

No	Dimensions	Variables
1	Business Process	o service catalog o process documentation o process description standards o shared cross-agency standards o one-stop service support
2	Data	o data dictionary o standards for data definition o shared data standards o defined data ownership o metadata repository o data security policies o cross reference with processes
3	Applications	o application catalog o reference to data/processes o documentation standards o shared cross-agency standards o government-wide application repository
4	Technology	o technology catalog o hardware standardization o standardized documentation o shared cross-agency standards o cross reference to data, processes and applications o shared agency-wide database

Table 5: Reliability of Constructs' Measures

No	Construct	Cronbach's Alpha
1	EA Maturity	0.768662215
2	Maturity Factors	0.883572568

5.4. Results

The relationships between the seven independent variables (Maturity Factors) and the dependent variable (EA Maturity) were analyzed by computing the Pearson correlation (*r*) given respectively the ordinal and ratio variable types [35]. In order to analyze the relationship between one or more Maturity Factors and the EA Maturity, we carried out a regression analysis. All statistical computations were carried out using Microsoft Excel and third-party add-ins.

To determine the significance of the correlation between the variables, we determined the significance level of each computed correlation through a two-tailed test (Sig2). Shown in Table 6, the results demonstrate that only the correlations corresponding to G_{F1}, G_{F2}, G_{F3}, $H_{F1,}$ and H_{F2} are significant at 0.05.

Table 6: Pearson Correlation for Hypotheses

No	Pearson Correlation	Sig2	N
G_{F1}	0.575787	0.000455*	33
G_{F2}	0.547531	0.000974*	33
G_{F3}	0.345621	0.048830*	33
G_{F4}	0.185736	0.300728	33
G_{F5}	0.114384	0.526188	33
G_{F6}	0.131104	0.467076	33
G_{F7}	0.222552	0.213187	33
H_{F1}	0.455645	0.007705*	33
H_{F2}	0.448769	0.008804*	33

Thus, there is strong evidence that Management Commitment (F1), Participation of Business Units (F2) and availability of Project Governance Structures (F3) positively influence EA Maturity. By computing the coefficient of determination for these three factors (r^2), we also know that they account for 12% to 33% of the changes in EA Maturity practice of the agencies.

The tests for hypotheses $H_{F1,}$ and H_{F2} also show that the Perceived Usefulness of EA Efforts by stakeholders is positively related to Management Commitment (F1) and Participation of Business Unit (F2). Up to 20% of the variation in F1 and F2 could be explained by the Perceived Usefulness of EA Efforts.

Since only F1, F2 and F3 are significantly related to EA Maturity, we modified hypothesis G_{All} to only test the joint influence of these factors on EA Maturity. The new hypothesis $G_{F1\text{-}3}$ is tested through a multiple regression analysis with F1, F2 and F3 as independent variables and EA Maturity as the dependent variable.

The results, depicted in Table 7, shows that none of the coefficients for the three factors is significant at a 0.05 (2-tailed) level, although the coefficient of multiple determination (r^2) for all factors is 0.341166. This implies that we cannot conclude on the joint influence of these three variables on EA Maturity. Possible reasons for this are presented in Section 7.

Table 7: Regression Results for Maturity Factors

Factor	Coefficient	Sig2
F1	0.098954	0.192159
F2	0.047903	0.524517
F3	-0.01715	0.760807

6. Validation

Having established in Section 5 the reliability of our instruments and measurements for the EA Maturity and EA Maturity Factors constructs, in this section we put forward the arguments for the content and construct validity [38] of our results.

For content validity, our claim rests on the adopted approach to developing the measures and instruments for the EA Maturity construct. The measures rely upon the well-known checklist [26] for EA planning, covering process, data, applications and technology dimensions. In addition, the instrument was peer reviewed by an experienced practitioner for coverage.

For construct validity, we claim convergent validity of the results since our results confirm the relations with already identified maturity factors [9][27]. In addition, the results for the hypotheses $H_{F1,}$ and H_{F2} are consistent with Technology Acceptance theory [34]. Next, we checked for descriminant validity by testing possible effect of the organizational barriers e.g. lack of experience in IT management, against EA Maturity, and found the relationship significantly negative.

7. Discussion

The results presented in Section 5 and validated in Section 6 strengthen, through empirical evidence, the Program Maturity Theory in Figure 1. Specifically, we accounted for three EA Maturity Factors: Management Commitment (F1), Participation of Business Units (F2) and availability of Project Governance Structures (F3). In addition, consistent with technology acceptance and innovation diffusion theories we showed that Perceived Usefulness of EA – a precondition for EA Stakeholder Satisfaction potentially drives F1 and F2.

However, we are yet to gain a full understanding of these maturity factors, for example if the availability of Technical Skills (F4), Management Policies and Processes (F5), External Support (F6) and Learning

and Change Culture (F7) are intervening factors with respect to the EA Maturity; since it is clear that lacking requisite skills, Management Commitment and user participation would not lead to improved practice. In fact, reasons like this could explain modest values of the coefficient of determination for even the significant variables. Therefore, there is a need for factor, path dependency and other kinds of multivariate analysis [39] to determine how these factors interrelate.

This work did not consider the negative factors that could affect EA maturity, except in demonstrating the descriminant validity. The consideration of such factors as possible intervening factors is required for a more accurate account of EA maturity.

8. Conclusions

The aim of this work is to contribute to establishing empirically-verifiable theories about the EA practice in government and in general. The results reported in this paper provide empirical evidence to support the claims by practitioners on the importance of top-management commitment, participation of business units, and strong project governance in raising the maturity of the EA practice. The paper also shows that maturity factors can be further stimulated by demonstrating the usefulness of EA to the stakeholders, particularly to the senior management and user or business departments. However, we are yet to fully account for most of the EA maturity factors. In general, this work provided a basis for developing "EA Practice Maturity Theory" which relates core EA constructs such as EA Maturity, EA Effectiveness, EA Stakeholder Satisfaction and EA Environment. However, as our theory-building relies upon empirical evidence from a single case, further validation through additional cases is required.

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