Advancing Government-wide Enterprise Architecture – A Meta-model Approach

Young-Joo Lee*, Young-Il Kwon*, Shinae Shin**, Eun-Ju Kim*

*Department of Information Resource Service, **Department of National DB Project,
NIA(National Information society Agency), Seoul, Korea

lyj@nia.or.kr, kyi@nia.or.kr, sashin@nia.or.kr, outframe@nia.or.kr

Abstract— **Enterprise Architecture (EA) is regarded as one of the means to ensure information technology interoperability, standard and reuse within an organizational boundary. In the public sector, however, there rises another kind of issues on how to integrate agency EA practices into the whole of government view. The conception of Government-wide EA (GEA) is the results of this consideration, and how to implement GEA has become a major challenge among IT policymakers form many countries. The present article deals with the applied case of modeling EA in the public sector. More specifically the article focuses on the methods and applications of modeling information integration architecture at government-wide level. A meta-modeling approach is used to design GEA database and to communicate with agencies regarding how they should manage agency-level EA information. The article consists of brief history of the EA program of the Korean Government, introduction of the KGEA Meta-model and its evolutionary history, and current status with some major outcomes. Methodological and managerial implications are also discussed.**

Keywords— **e-Government, Enterprise Architecture, Public Service, Meta-model, Information Integration**

I. INTRODUCTION

Beginning with the development of the Technical Architecture Framework for Information Management (TAFIM) by the US Department of Defence in 1992, 67% of countries in the world are in the process of developing Enterprise Architecture (EA) or similar programs in order to improve interoperability among public administration information systems, mitigate project duplication, and maximize the return on investment [16].

Most countries promote their departmental agencies and local governments to introduce Enterprise Architecture, with developing standard principles, frameworks, and reference models. Meanwhile, some other advanced countries have been making an effort to develop national level enterprise architecture which is aimed to provide an integrated view of agencies enterprise architecture.

In this regard, Government-wide EA (GEA, also known as National Enterprise Architecture, NEA) is aimed at ensuring interoperability, avoiding the duplication of efforts and enabling government-wide reuse by integrating agencies EA into a single repository [14].

However, there are challenges in the GEA programs related to integration and interoperability within and between public agencies. Some researchers find these challenges very hard to overcome [8]. Other researchers observe that EA in the public sector has yet to be transformed from an IT-centric to a business-centric, and a governance system at the entire national viewpoint is often times seen as unattainable [7][10]. These schools of thought are often associated with the loss of confidence that many countries are not confident especially in terms of realizable benefits and performance of EA [17].

The objective of this article is to describe how Korean government designed and developed GEA though many years of efforts. More specifically the article focuses on the methods and applications of modelling information integration architecture at government-wide level, which we will later in this article, the Korean EA Meta-model.

In the following section, we will review brief history of the EA program of Korean Government and discuss why we need Government-wide Enterprise Architecture. And the next, we introduce the first version of KGEA Meta-model, how it was designed and used, and what was the problem so as to apply in integrating agencies EA information. In the next chapter we introduce the second version of KGEA Meta-model and how we solved the problem using the version. Nest we describe how it is implemented in the KGEA management system as well. Finally we discuss some methodological and managerial implications as to the utilization of enterprise architecture in the public sector.

II. OVERVIEW OF KOREAN GOVERNMENT EA

A. Brief History

The Korean Government enacted a law to mandate the adoption of EA in 2005 to efficiently manage the complex and vast information resources in the public sector and

induce methodical approach for information technology planning. In the following year, the 1st Phase EA Master Plan (2007~2009) was established, which contained directions and objectives for public sector in adopting EA.

The first work in accordance with the 1st EA Master Plan was to develop EA standard, guidelines and assessment tools, which mostly benchmarked the US Federal EA (FEA) practices. Also the training program for the agency personnel in charge of EA management was developed and initiated. Based on the master plan, agencies including central departments and local governments have been actively adopting EA since 2007.

As a result of consistent efforts of the public sector for EA introduction, currently 100 public agencies have adopted EA and the rest are preparing for adoption by 2015. In 2009 alone, 27 agencies adopted EA as the 1st EA Master Plan ended. As intended by the government's EA initiatives, agencies began to build capacity in managing IT resources and related projects using EA and several best practices were identified. However, from a government-wide perspective, duplicated systems were still being developed and operated by different agencies, and investment in information technology were planned in the interest of each agency not aligned with government-wide policy goal. As an example, The Board of Audit and Inspection of Korea reported in September 2009 that agencies wasted KRW 50 billion on 11 duplicated investments after a large-scale audit of agencies' investments in information technology projects.

As such, the KGEA program was initiated to eliminate cross-agency duplication of information systems and related resources as well as to improve services for citizens and increase efficiency of national IT projects. In this context, the program designed the initial architecture model so as to view all agencies' IT resources. The model provides the whole view of as-is architecture, to-be architecture and corresponding transition plan of the whole government business by abstracting currently operating public service, supporting information systems, transactional data, including software and hardware of each agency.

In 2008, the KGEA program was crystalized into the Government EA management system, which was then renamed to Government EA Portal (GEAP) in 2010. Every agency EA was integrated into the GEAP by providing agency's current EA information in compliance with the KGEA Meta-model, whose details will be introduced later in this chapter.

As of the end of 2010, the Government EA portal stores the latest information of 809 agencies' IT resources. These data are shared over the website among stakeholders concerned with national IT policy. The portal also provides information for IT portfolio and its progress status in a dashboard format. Stakeholders can browse current status of IT projects aligned with national IT agenda, and oversee which agenda are being supported by which agency's IT investments. Consequently, GEAP is now being widely used by administrations for management of IT investment such as identification of duplicate IT projects among agencies, discovery of new public IT initiatives for seamless public service to taxpayers, and maintaining interoperability of applications. Below is the detailed description of current KGEA implementation.

B. Governance Structure

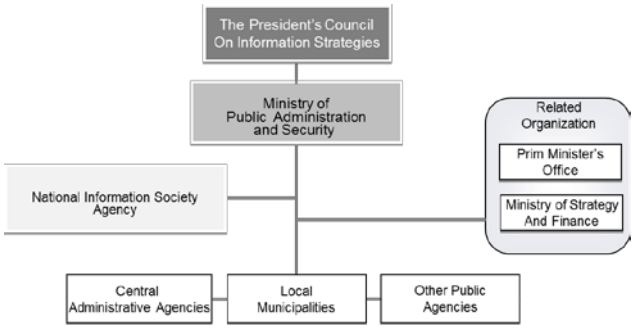

Figure 1. The governance structure of KGEA program

The EA policy resides in the structure of national IT investment decision-making. The President's Council on Information Strategies (CIS) which oversees the national IT policies has the highest decision-making authority. The council reviews and endorses the national EA master plan. Ministry of Public Administration and Security (MOPAS) is responsible for execution of the national EA program, development and distribution of EA guidelines, and evaluating the performance of agency's EA. On a yearly basis, MOPAS reports to the council regarding the current state of national EA progress. The National Information Society Agency (NIA) is an organization designated as an EA facilitator and provides specialized expertise in developing and implementing the national EA program as well as consulting service to agencies.

All of the central administrative agencies and local municipalities are subject to the provision of mandatory adoption of EA. Public agencies whose previous three-year's average IT budget exceeds KRW 2 billion or one year's budget exceeds KRW 5 billion are subject to mandatory adoption. However, there is no penalty clause for not adopting EA. Agencies can still choose when to adopt EA or just not adopt.

C. Framework and Methodology

Figure 2 depicts the conceptual framework of KGEA. It defines every component that needs to be considered related to the development, operation and management of government-wide EA. Under the GEA strategic objectives, common principles, guidelines and reference models are defined by MOPAS and updated by NIA. Under the common

standards, the hierarchical structure presents the government-wide EA and agency-level EA which are closely connected with each other by institutional settings such as regulative maturity assessment, education and training program, and other mutual communications. Specifically KGEA Meta-model acts as a guidance of abstraction level with which aspects can be captured at agency-level architecture information.

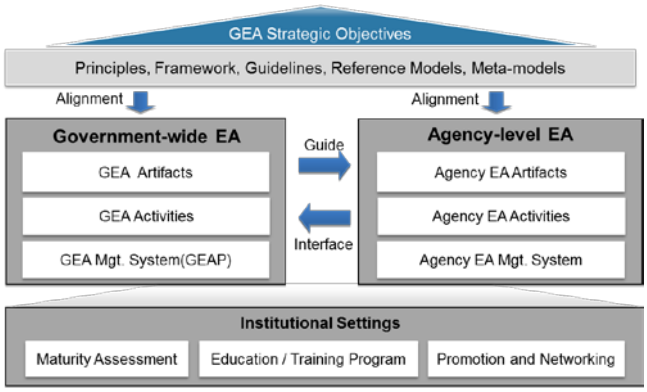

Figure 2. The conceptual Framework of KGEA

The KGEA methodology is defined as a set of processes, activities, and recommendations for public agencies to successfully introduce agency-level EA. The methodology also provides information on how to comply with regulations and standards required by the government. The methodology was developed from the need to maintain a certain level of self-reliance on the part of agency users and limit excessive reliance on EA vendor's methodologies. Therefore in order to maximize ease of use, it focuses more on the processes rather than the artifacts or deliverables

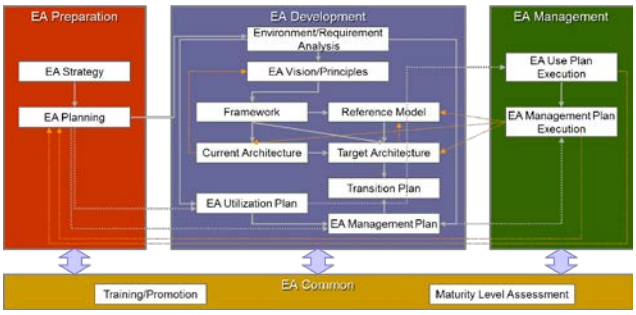

Figure 3. The KGEA methodology for agency-level EA

All phases in the EA lifecycle are covered in the methodology with which every agency can implement EA through a systematic approach by providing step-by-step guidance, forms, examples, detailed techniques. Under the GEA methodology the Guideline on the Adoption and Operation of the Information Technology Architecture describes the activities and consideration needed for each life cycle of EA implementation by each agency (figure 3). In the Preparation Phase, activities are defined related to setting a strategic direction of EA and organizing a team for preparing EA introduction. In the Development Phase, various activities are defined related to actual implementation of agency-level EA including definition of the agency-level framework, redefinition of agency reference models by inheriting from GEA reference models, establishment of as-is and to-be architecture, transition plan. In the Management Phase, activities related to communication with internal stakeholders in order to plan EA management are described.

D. Architectural principles and standards

The guiding principles of KGEA implementation has been characterized as alignment, integration, and transformation. Alignment refers to the defining and managing of the government IT strategy and IT investment allocation to each agency to be aligned through the KGEA. Integration refers to the connection and integration of the businesses, services and data of agencies so as to improve the efficiency of government process and the service provided to the taxpayers. Transformation refers to the continuous enhancement of the business process and IT based on KGEA.

In order to uphold these principles, MOPAS provided the relevant standards such as the GEA reference model, meta-model and maturity model, on which each agency develops and manages its EA.

GEA reference model includes Performance Reference Model (PRM), Business Reference Model (BRM), Service Component Reference Model (SRM), Data Reference Model (DRM), and Technical Reference Model (TRM). PRM defines a framework to assists in visualizing cause-and-effects of IT investments and generating performance indicator on each IT projects for better decision making on strategic IT planning and day-to-day IT management. By providing a clear line-of-sight from IT project performance to business performance, PRM helps predict and manage the outcomes of IT investment. BRM is a model that classifies and defines business functions and related information. BRM provides standards to serve as a guideline for government and agencies in identifying redundancies or affinities in their business functions. SRM is a model that lists business/agency-independent service components, providing a unified and comprehensive component classification for the government's services to citizens. In the KGEA case, SRM combined with BRM plays a key role in promoting service integration and reuse by identifying redundant or correlated services among agencies. Specifically, Shared Service Component in the SRM facilitates a service component marketplace where all types of agencies develop, store, and distribute reusable application components. DRM is a model that classifies data and defines standard data structures to support development of data architecture (DA), and it promotes data standardization and reuse, as well as effective

data management. TRM is a model that classifies and defines technologies and technical standards/specifications which provides a comprehensive list of unit technologies, technical standards, and commercial products. It also provides an IT resource classification to support agency's systematic IT resource management.

Finally, the KGEA Meta-model is a set of standard EA deliverables required by agencies to create and report for the sake of the government-wide EA success. It is a backbone model used to construct an agency's EA, by defining required architectural information and their relationships. Agencies can develop its own EA by defining architecture model or meta-model aligned with the agency's EA objectives, however, agencies' model must include the information required by the KGEA Meta-model.

From the GEA implementer's view, the KGEA Meta-model acts as a linkage between GEA standards and agency EA artifacts. The model guides how agency EA managers process their EA information and relate them to the GEA standards: PRM, SRM. DRM, TRM and other pre-defined attributes in the model. In the next chapter we discuss the detailed structure and characteristics of the KGEA Meta-model.

III.KGEA META-MODEL 1.0

The first version of KGEA Meta-Model was developed in 2005 when the conception of government-wide EA had not been crystalized. Therefore the model was aimed to suggest every agency's EA artifacts standards so as to assure consistency and commonality throughout governmental organizations [15].

The principles of the model, therefore is defined to guide how each agency create and manage agency level EA artifacts. The initial objectives of KGEA Meta-model ver. 1.0 are listed as:

- Enhance business efficiency
- Assist planning enterprise information strategy and investment
- Assist information resources reuse
- Assure interoperability and shared use of information technology
- Standardize information technology

The model followed commonly used EA frameworks and applied case at that time such as Zachman model, TEAF(Treasure Enterprise Architecture Framework), DOI(Department of Interior) in the United States. It contains standards definition of EA artifacts in the forms of graphics, text, and tables. Also it defines how these artifacts are viewed and applied at each level of abstraction. All artifacts are classified by common layer, business layer, application layer, data layer, technical layer, and security layer. In the figure 4, every artifact is interrelated in order to be shared through the organization. Different actors have different view to the each level of EA artifacts. In this way, the higher the viewers in the level of organizational structure, the more abstracted types of artifacts they will see with the appropriate information needs.

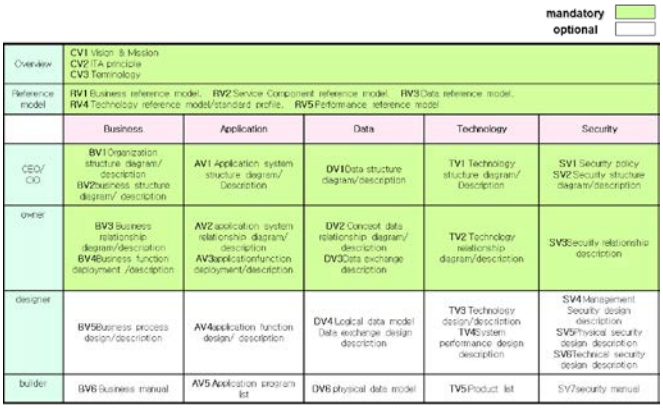

Figure 4. KGEA Meta-Model ver. 1.0 [15]

IV.KGEA META-MODEL 2.0

A. Problems of the KGEA Meta-model 1.0

As discussed in the brief history section, when the Korean government realized the needs of introducing government-wide level enterprise architecture, the previous version of KGEA Meta-model could not satisfy the information needs from government-wide IT policymakers. For example, at the government-wide level, IT policymakers are not concern with how each agency produces EA deliverables, but concern how national IT strategy is aligned and populated in the form of IT projects, information systems, and other IT assets throughout all agencies. That is, agency EA artefacts needed to be integrated into one more abstraction towards higher national level.

On the other hand, to the agency level, although the initial meta-model helped agencies to adopt EA without much confusion, it had a weakness of directing every types of agencies to homogeneous EA artifacts without taking the heterogeneous circumstances of regional agencies sufficiently into consideration.

In order to address these problems, developing the KGEA Meta-model ver. 2.0 was initiated in 2009. It was needed to allow autonomy to agencies and at the same time to require compliance to a set of common requirement of government-wide enterprise architecture. In the next chapter we discuss how we designed new version of meta-model in order to address information requirements from government-wide level and to secure flexibility to the agency level.

B. Designing a new meta-model

In the design phase, we decided to discard any prevalent methods or frameworks, with which mostly adapted to design previous version of KGEA Meta-model. Then we followed general database design approach in order to reflect various government-wide level information needs. Figure 5 shows parsimonious stages about the approach.

1) Regulatory requirement and stakeholder analysis: In this stage, we analyzed related acts and regulations that describe how government-wide IT policy demands EA provide with appropriate information in order to guide IT planning processes, i.e. budget planning, public service integration, information share, and performance review. Likewise, we analyzed how national IT policymakers process information regarding execution of e-government acts and related regulations.

2) Use Case Analysis: From the Regulatory requirement and stakeholder analysis, we could derive seven use cases that are the most significant for government-wide EA contribution. Derived use cases are; Justification of IT investment, IT Budgeting and Performance Review against planning, Government Transformation, Integration and sharing IT resources, IT Asset Management, Standardization of IT service and technology, and Business Process Management

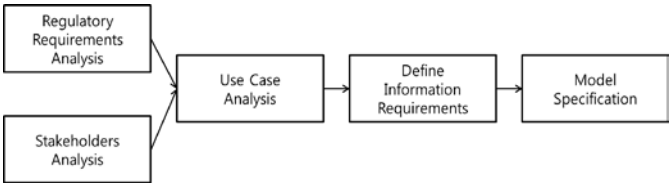

Figure 5. Design Methodology for new version of KGEA Meta-Model

3) Define Information Requirements: Through the Use Case Analysis, we defined information requirement details along with KGEA objectives and principles. Next, information requirements are detailed with regard to who has an ownership and populate data. The first components are grouped into Government-wide Standard, i.e. Government-wide EA define and update in order to maintain consistency. The second components group is Agency EA information, i.e. the least mandatory information each agency should manage through agency EA and provide KGEA with relevant information. Finally relation should be established between components of Government-wide Standards and components of Agency EA information. Relations among intra group components are also established. Table 1 shows details of elements and related EA information.

TABLE 1. LIST OF KGEN META-MODEL COMPONENTS

Group	Components
Government-wide Standards	National IT Agenda, National IT Strategic Plan, KGEA Transition plan, Agency, Customer, Common Software, Common Components. KGEA Reference Models(PRM, SRM, DRM, TRM)
Agency EA information	As-is architectural information (Current Information system, Application Functions, Hardware, Software, Networks, Security) To-be Architectural information(Target Information System, Target Application Functions,) Agency-level Transition Plan(Agency Transition Plan, Agency Transition projects, IT Projects, Performance Index)
Relations	Government-wide Standards vs. Government-wide Standards, Government-wide Standards vs. Agency EA information. Agency EA information vs. Agency EA information

4) Model Specification: Finally, detailed information requirements are translated into the database taxonomies. Each component is specified as a form of database tables and populated into the relational diagram. In Figure 6. is the results of new version of KGEA Meta-model.

C. KGEA Meta-model ver. 2.0

As seen in figure 6, current meta-model is composed of attributes GEA standards and agency's EA information, not specifying EA artifacts as in the initial model. Now each agency has flexibility to develop its own EA framework and model as long as it meets GEA meta-model requirements. In addition, the model provides a whole view of GEA in a single diagram overarching reference models, as-is and to-be architecture, government-wide EA components and agency-level EA components, thus making it easy for every EA stakeholders to be able to forge a common understanding.

Functionally, enterprise architecture explains how all agencies' information technology (IT) elements work together as a whole. When enterprise architecture needs to encompass the various perspectives and abstractions of different stakeholders within the enterprise, a system of systems (SOS) approach is required [17]. The KGEA Meta-Model ver. 2.0 is built in this concept by using service-oriented use case analysis.

D. Government-wide EA artefacts and use

The KGEA Meta-model exists as not just a standard and guideline for government-wide EA, but exists with actual contents that are populated during government-wide and agency EA activities. Therefore KGEA management system needed to be developed so as to store all aspects of GEA information and detailed data.

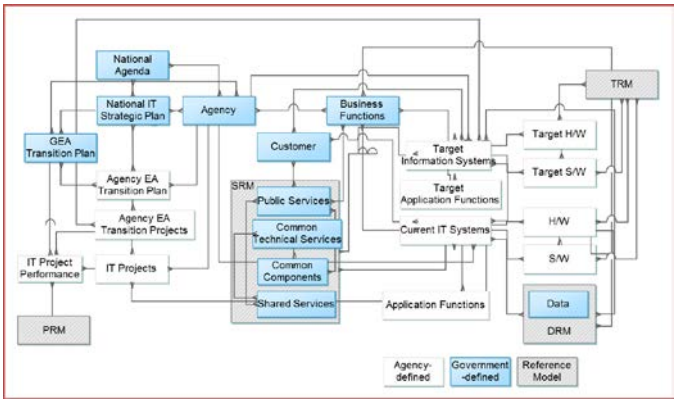

Figure 6. The relational diagram of KGEA Meta-Model ver 2.0

As a result, the KGEA management system successfully addresses the complexity of nationwide IT projects, resources, and assets by incorporating hierarchical levels of the architecture. As defined in the KGEA Meta-model ver. 2.0, the management system has a two-level structure of agency-level EAs and government-wide EA that abstracts agency EA elements. Such a structure requires the government-wide EA to not only present common guidelines and a set of reference model but also to mandate the agencies to generate and manage the EA information to substantiate the model.

As shown in the figure 7 and 8, the contents of meta-model are stored in the KGEA repository by the input from agencies. And, the government EA management system (GEAP, Government Enterprise Architecture Portal) provides processed information in a dashboard format in which combinations of meta-model components are visualized. The comprehensive information from GEAP is used for identification of duplicated IT investments, current status information systems, data and so forth. Each agency can directly input agency EA information through the portal website or install an application program interface (API) that automatically updates whenever agency EA information is changed. Through such a process, the GEAP currently stores the installed base of 809 agencies' 13,700 information systems, 68,406 hardware devices, 62,157 software programs, and 12,619 IT projects throughout the public sector, all of which relation are linked to upper level IT agenda (www.geap.go.kr; Figure 7) Information is disseminated from the portal to not only top-level stakeholders for reviewing current state of national IT investments but also to agency-level practitioners for exploring opportunities of sharing IT services and related resources. For example, based on the information from GEAP, MOPAS evaluates every year IT investment plan submitted by the central administrative agencies to eliminate duplicated IT projects among agencies and suggest inter-agency collaboration to enhance service quality. In 2010, MOPAS proactively identified twenty areas of Public Services and ten types of data that should be integrated or merged, and also funded agencies to execute integration initiatives. Even when an agency voluntarily identifies new e-government program which can integrate siloed services, it should be reviewed whether it corresponds with the targeted service integration model guided by the to-be architecture of GEA.

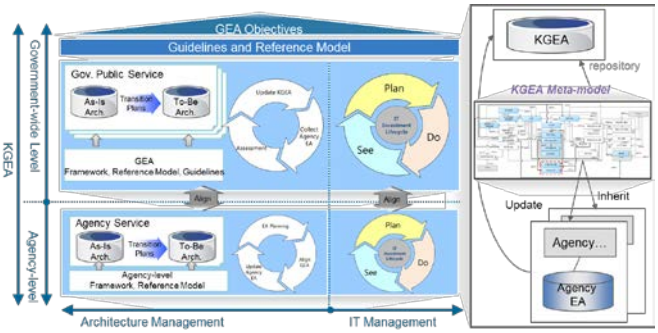

Figure 7. The operational structure of KGEA

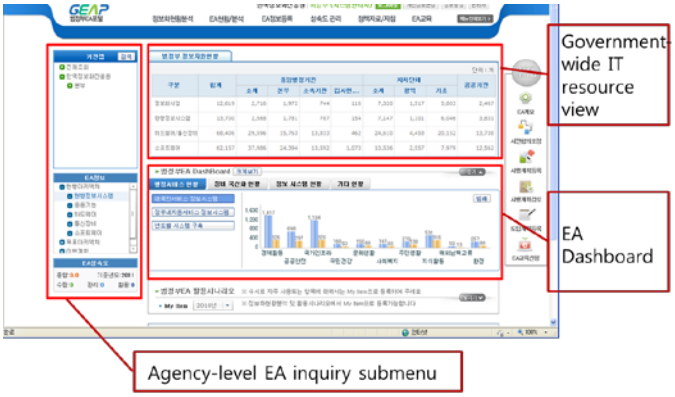

Figure 8. The KGEA web portal(illustrative)

V. CONCLUSIONS

So far we discussed a brief history of the Korean government-wide enterprise architecture and how it has been evolved. In the first phase of the KGEA history, a meta-model initially guided agencies how to design and frame agency-level EA. And the second phase, a different approach to the meta-model lead to the most advanced and realized outcome of GEA in the world that addresses government-wide EA needs.

The case study highlights the research need to the new modeling approach when you consider government-wide level EA because with traditional EA frameworks we couldn't address various information requirements from IT policymakers which will also be changing in the future along with environmental turbulences. In this sense we mean that higher level model should be designed which focus more information-oriented and allow flexibility throughout agencies. Future research are also needed how we make it a concrete methodology to design a government-wide EA and activities and tasks are defined in order to be used common.

REFERENCES

[1] Aagesen ,G., Veenstra, A.F., Janssen, M., Krogstie, J. (2011). The Entanglement of Enterprise Architecture and IT-Governance: The Cases of Norway and the Netherlands, Proceedings of the 44th Hawaii International Conference on System Sciences.

[2] Armour, F. (2003). A UML-driven Enterprise Architecture Case Study, Proceedings of the 36th Hawaii International Conference on System Sciences.

[3] Biggert, T. & Suryavanshi, K. (2008). Using Enterprise Architecture to Transform Service Delivery: The U.S. Federal Government's Human Resources Line of Business. In Saha, P (Ed.), Advances in Government Enterprise Architecture. IGI Global Information Science Reference, Hershey, PA, 2008.

[4] Boh W., & Yellin, D. (2007). Using Enterprise Architecture Standards in Managing Information Technology, Journal of Management Information Systems, 23, 163-207.

[5] DeSanctis, G., & Jackson, B.M. (1994). Coordination of information technology management: Team-based structures and computer-based communication systems. Journal of Management Information Systems, 10(4), 85–110.

[6] Hjort-Madsen, K. (2006). Enterprise Architecture Implementation and Management: A Case Study on Interoperability, Proceedings of the 39th Annual Hawaii International Conference on System Sciences, HICSS 39, Jan.4-7, Kauai, Hawaii.

[7] Hjort-Madsen, K., & Gotze, J. (2004). Enterprise Architecture in Government – Towards a multi-level framework for managing IT in government, Proceedings of European Conference on e-Government, Dublin, Ireland, 365-374.

[8] Hjort-Madsen, K., & Burkard, J. (2006). "When Enterprise Architecture Meets Government: An institutional case study analysis", Journal of Enterprise Architecture, 2(1), 11-25.

[9] Hjort-Madsen, K. (2007). Institutional patterns of enterprise architecture adoption in government, Transforming Government: People, Process and Policy, 1(4), 333 – 349.

[10] Isomäki, H., & Liimatainen, K. (2008). Challenges of Government Enterprise Architecture Work – Stakeholders' Views, In M.A. Wimmer, H.J. Scholl, & E. Ferro (Ed.), International Conference on Electronic Government, LNCS 5184, 364–374.

[11] National Information Society Agency (NIA). (Ed.). (2010). Information White Paper 2010.

[12] Janssen, M., & Hjort-Madsen, K. (2007). Analyzing enterprise architecture in national governments: The cases of Denmark and The Netherlands, System sciences, 40th Annual Hawaii International Conference on System Sciences, 218a.

[13] Lagerström, R., Sommestad, T., Buschle, M., & Ekstedt, M. (2011). Enterprise Architecture Management's Impact on Information Technology Success, Proceedings of the 44th Hawaii International Conference on System Sciences 2011.

[14] Lee, Y., & Shin, S. (2012). Integrating Agency Enterprise Architecture into Government-Wide Enterprise Architecture: The Case of Korean Government Initiatives. In P. Saha (Ed.), Enterprise Architecture for Connected E-Government: Practices and Innovations (pp. 105-120). Hershey, PA: Information Science Reference. doi:10.4018/978-1-4666-1824-4.ch004

[15] Shinae Shin, Hun-Joong Lee, Hyungjin Kim. (2006). A Study on Government IT Architecture Artifacts Metamodel, Journal of Information Technology and Architecture

[16] Liimataine, K., Hoffman, M. & Jukka, H. (2007). Overview of Enterprise Architecture work in 15 countries, Finnish Enterprise Architecture Research Project, Finance.

[17] Morganwalp, J., & Andrew P. (2003), A System of Systems Focused Enterprise Architecture Framework and an Associated Architecture Development Process, Information, Knowledge, Systems Management 3 (2002/2003), Sage, 87–105.

[18] Pulkkinen, M. (2006). Systemic Management of Architectural Decisions in Enterprise Architecture Planning. Four Dimensions and Three Abstraction Levels. Proceedings of the 39th Hawaii International Conference on System Sciences 2006.

[19] Saha, P. (Ed.). (2008). Advances in Government Enterprise Architecture. IGI Global Information Science Reference, Hershey, PA.

[20] Saha, P. (2009). Architecting the Connected Government: Practices and Innovations in Singapore, Proceedings of the 3rd International Conference on Theory and Practice of Electronic Governance (ICEGOV2009), Bogota, Colombia.