A Pragmatic Approach to Interoperability Practical Implementation Support (IPIS) for e-Government Interoperability

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Abstract: In recent years, e-Government interoperability has been a fascinating research and development area in order to facilitate the seamless exchange of information across government sectors. Many researchers have focused on the designing/adopting of Government Interoperability Frameworks (GIFs) and of Enterprise Architectures (EAs) for implementing the interoperability. However, merely adopting the GIFs and EAs would be insufficient since there have been several strong obstacles and barriers on the road to its achievement in the field of e-Government, such as human, semantic and technical issues. In fact, the successful implementation in government interoperability needs more practical and implementable approach. This paper firstly describes those obstacles and barriers with the solution and guideline to overcome them. We propose towards more practical approach covering three dimensions of interoperability: Business, Semantic, and Technical. The approach, is called 'Interoperability Practical Implementation Support (IPIS)', considers the adoption/development of integrated three components: a set of tools, an interoperability repository, and a knowledge based system. The set of tools were designed to supporting the three interoperability perspectives; the tool for modeling/specifying business processes of an organization based on UMM, the semantic tool for standardizing/harmonizing data based on UN/CEFACT CCTS, XML Naming and Design Rules, and Recommend 34, and the technical standards usage support tool. For reusability, the IPIS was designed by considering the adaptation of five interoperability repositories: business process, data standardized set, XML Schema standard, web services and technical standards. The knowledge based system integrates the knowledge resources that consist of a collection of best practice cases, ontological concepts in semantic technologies, and the related frameworks. The paper presents the overall methodology and the architecture of IPIS with the three components. By adopting the IPIS, the design, development and implementation of interoperable systems in e-Government can be practically addressed.

Keywords: interoperability, e-government interoperability, interoperability tool, GIF, e-government

1. Introduction

During the last few years, Electronic Government Interoperability has become a vivid and fascinating research and development in order to facilitate the seamless exchange of information across governmental departments. To this direction, several approaches have been proposed through the adoption of frameworks or through architectures to each other and to the environment, and the principles guiding, its design and activity (UNDP, 2006). With regards to the frameworks, Electronic Government Interoperability Framework or e-GIF facilitates this (Archmann, 2003). The e-GIFs are defined as a set of standards and guidelines that set out a common language to ensure coherent flow of information across systems (UNDP, 2007). In many countries, governments have developed their own e-GIFs like UK e-GIF (UK e-GIF, 2005), NZ e-GIF (NZ e-GIF, 2008), European Interoperability Framework (EIF) (IDABC, 2006) and Australian Government Technical Interoperability Framework (AGTIF) (AGTIF, 2007). In addition to the achievement of interoperability of e-GIFs, the architectures have an important role in ensuring e-government interoperability successes. The relevant architecture to Electronic Government Interoperability is Enterprise Architecture (EA), specifically National Enterprise Architecture (NEA). The EA stresses the planning and management of all IS assets and their architecture together with organizational structures and processes (Zachmann, 1987).

However, implementing interoperability in government requires more than just having a common technical standard or using XML to creating technical integration between two applications (Guijarro, 2007) and merely adopting EA with the e-GIFs (Saekow, 2009). The challenges and obstacles that governments face in implementing Electronic Government Interoperability include: 1) bureaucratic challenges due to the nature of bureaucracy and the lack of accountability of different agencies; 2) ensuring compliance or enforcement of the adopted standards; 3) capacity development; and 4) using the right metrics to measure the success of the e-GIF (UNDP, 2007). In fact, the bigger and more complex the bureaucracy, the more difficult it is to be implemented. Many governmental departments have entrenched cultures which avoid openness and cooperation with others. This makes

Reference this paper as:
Saekow, A. and Boonmee, C. "A Pragmatic Approach to Interoperability Practical Implementation Support (IPIS) for e-Government Interoperability." *Electronic Journal of e-Government* Volume 7 Issue 4 2009, (pp403 - 414), available online at www.ejeg.com

implementation in government interoperability become more difficult. Moreover, in complying with e-GIFs, there is no guarantee that other agencies will truly follow. Therefore, merely following the suggested open standards, policies and contexts guideline as well as EA approach is inadequate. The successful implementation in Electronic Government Interoperability needs more practical approach. In this paper, we propose towards more practical approach for Electronic Government Interoperability called 'Interoperability Practical Implementation Support or IPIS'. By adopting the IPIS, we can practically address the design, development and implementation of interoperable systems and can alleviate the problems arise from the gap between the adoption of e-GIFs and EA in e-Government Interoperability implementation. Figure 1 illustrates a basic concept of our practical approach with IPIS.

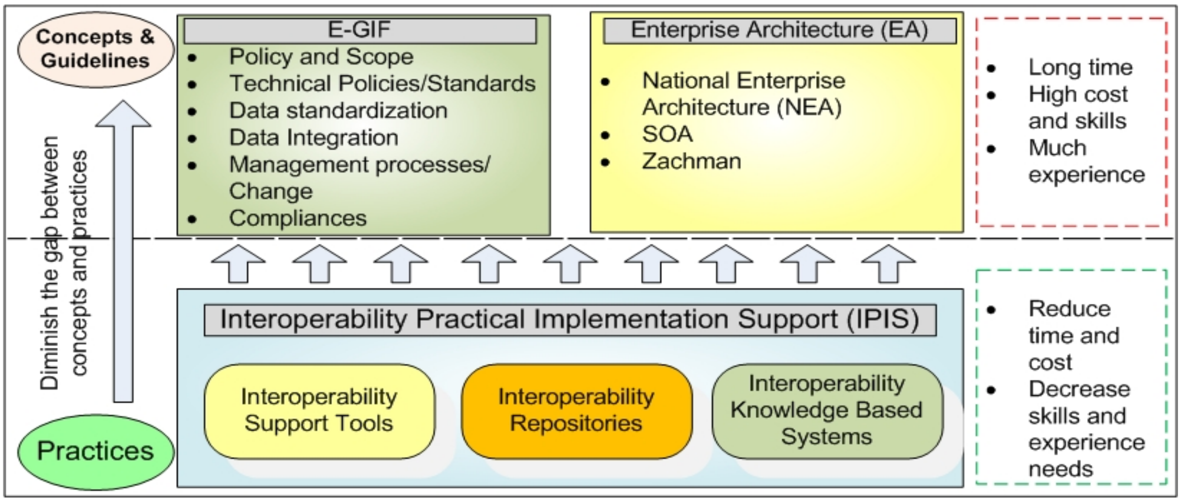

Figure 1: A basic concept of the practical approach with IPIS

The paper is organized as follows: First, relevant research reviews. Then, the basic concepts and backgrounds of IPIS, conceptual model, a methodology are presented. The evaluation and comparison results are described. Finally, the conclusions and future works are presented.

2. Relevant research reviews

2.1 Current proposed strategies for e-government interoperability

Effective e-Government has the objective of enhancing citizen services and government communication as well as reducing the amount of paperwork (Hans, 2005). In order to achieve the goal, e-Government requires interoperability mechanisms that will allow numbers of government agencies to offer online access to their services and to participate in orchestrated procedures involving services provided by multiple agencies (John, 2004). Currently, the e-Government interoperability have emphasized on the strategies covering on three dimensions of interoperability: business process, semantic and technical, by adopting the open/international standards and EA designs (Saekow, 2009). In Germany, governments developed an interoperable approach by including architecture and standards in one document called "Germany Standards and Architecture for e-Government Applications (SAGA)" (Germany, 2003). In a European Union context, they are also endeavoring to adopt e-GIF, including the standards and architectures, to develop pan-European services (IDABC, 2006). In Australia , Brazil (e-Ping, 2006), Denmark (Denmark, 2005), Malaysia (MyGIF, 2003), New Zealand and the UK, the approaches propose interoperability standards by the technical aspects such as interconnection, data integration, metadata, presentation, and security. To enhance business interoperability on a semantic level, the Greek e-GIF (Greek, 2008) and TH e-GIF (first launched in November 2006) (Thailand, 2008) apply the ISO 15005-5 Core Component Technical Specification (CCTS) (UN/CEFACT, 2003) and numerous of closely affiliated standards issued by the UN/CEFACT, as well as the Core Component Library (CCL) (UN/CEFACT, 2008), representing the repository for generic business data components, the so called Core Components for their strategies. At the implementation level, the concept of the repository and ontology is considered as reusable/semantic resources (Yannis, 2007).

2.2 Obstacles and barriers to e-government interoperability

Our literature reviews found that the main obstacles and barriers to e-Government interoperability are derived from technical, semantic and human issues. The technical one refers to the great variety of legacy systems. The systems already installed and running within involved agencies. By replacing these systems for achieving interoperability is not a possibility (Benamou, 2006). The semantic obstacle is concerned on the difference of data/information standards used within organizational services. Understanding the semantics of each service is an important issue. Another important obstacle to the spread of interoperable solutions in e-Government is that of adoption of any new systems by officers. In (Archmann, 2003), the interoperability barriers identified also included cultural differences between governmental departments, issues of trust, timing, collaboration between agencies, unsatisfactory workflows, convincing stakeholders of the importance of the system, legal issues and also the importance of political support and funding.

3. IPIS: Interoperability Practical Implementation Support

3.1 Background

In Thailand, an e-GIF initiative was announced in October 2006 called “TH e-GIF”. It sets out technical policies standards and specifications. It also provides a guideline and a procedure to build and manage XML schema standards. The TH e-GIF incorporates UN/CEFACT Recommendation 34 (UN/CEFACT, 2007), Core Component Technical Specification (CCTS) and UN/CEFACT XML Naming and Design rules (XML NDR) (UN/CEFACT, 2007). However, as an initiative in e-GIF adoption, we have been facing the obstacles and barriers regarding semantic, technical and human issues. Various kinds of officers including IT personnel, system analysts, data owners and data users need to participate in project activities following TH e-GIF guideline. Each process is time consuming. It also requires higher cost and skills as well as much experience. For an e-GIF adoption initiative like Thailand or developing countries, it is an obstacle to satisfying those required factors. Therefore, developing support systems assisted in e-GIF adoption/implementation could be another key success factor for achieving e-Government interoperability in a shorter path. In May 2008, we developed a support system to assist in modeling data, designing XML schema standards and generating web services modules (Boonmee, 2008). By using the support system, data definition, analyzing and reconciling can be performed in shorter times. The participants can introduce their ideas and discuss simultaneously. Agreement on a new data standard can be achieved faster by using the support system. The system utilization was proved by simulating the use in personnel training program. In addition to the project development, in September 2008, we first proposed a more practical approach for electronic government interoperability in (Saekow, 2009). The approach considers the addition of Interoperability Practical Implementation Support (IPIS) into the former interoperability approach under e-GIF. The approach is to fill the gap between concepts and practices. At the time, the IPIS was defined as an integration of support tools. In (Saekow, 2009), it shows significantly a comparison between approaches with and without the IPIS in a case of Thailand e-GIF pilot project building a common XML schema standard for data exchange. In this paper, the progress in IPIS development and architecture design is described.

3.2 Conceptual model

The infrastructure of IPIS is shown in figure 2. It comprises main portions: e-GIF, EA, Interoperability Prospective Governmental Departments (IPGDs), IPIS, Discovery Systems and Change Management. E-GIF is defined as a set of standards and guidelines that set out a common language to ensure coherent flow of information across systems. Enterprise architecture refers to a comprehensive description of all the key elements and relationships that make up an enterprise (Zachman, 1987). It encompasses the interconnectedness of IS applications, and the degree to which individual IS applications need to be integrated. The IPGDs are defined as government agencies preferred to interoperate among their systems. Discovery systems are used to discover the interoperability repositories for existing reusable resources. Change management working group is an organization responding in managing the change of reusable resources in the repository. The most focused portion in this section is IPIS. The IPIS has been designed and developed to support in the implementation of e-Government interoperability. It first was developed as a set or an integration of interoperable support tools based on concepts and guidelines in e-GIF. In order to facilitate the approach, the IPIS has been currently designed with two additional parts: Interoperability Repositories and Knowledge Based System.

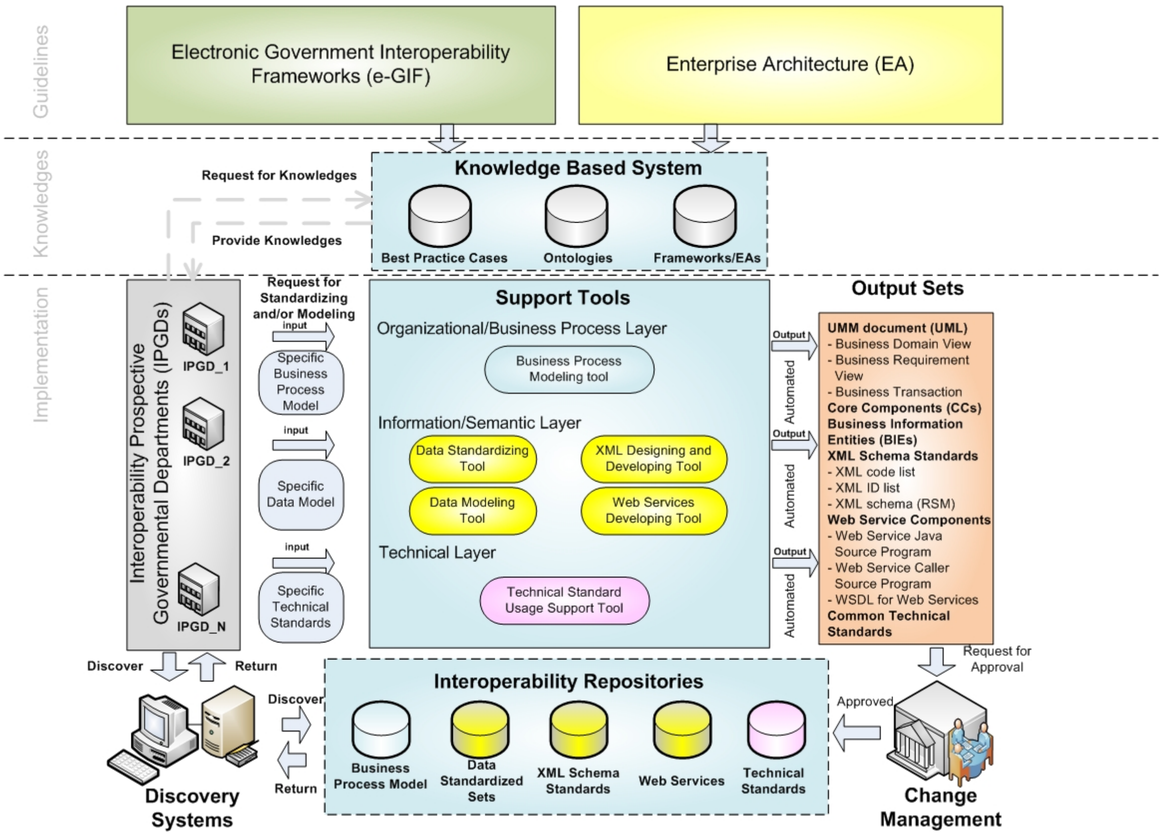

Figure 2: An infrastructure of IPIS approach

Support tools

A set of support tools is one of the components in IPIS. Each tool is defined as “IPIS tool”. The IPIS tool is designed and developed to assist in the implementation of interoperable e-GIF projects. The tools include a business process modeling tool, a data modeling tool, an XML designing and developing tool, a web services developing tool and a technical standards usage support tool.

- *Business process modeling tool:* a tool to support in modeling/specifying business processes of an organization based on UN/CEFACT Modeling Methodology (UMM) (UMM, 2008).
- *Data modeling tool:* a tool to support in standardizing/harmonizing data based on UN/CEFACT CCTS and Recommend 34.
- *XML designing and developing tool:* a tool to assist in designing/generating XML schema standard based on UN/CEFACT XML naming and design rule (XML NDR).
- *Web service developing tool:* a tool to develop web service implementing modules such as SOAP call and service.
- *Technical standards usage support tool:* a tool to describe/demonstrate how to implement/use technical standards in e-GIF.

Interoperability Repositories

The interoperability repository is a part to store and maintain data or specimens for future re-use/reusability. We designed five repositories including Business process model, Data standardized set, XML schema standards, Web services and Technical standards.

- *Business process model repository:* it contains details of business services based on UMM with UML diagrams.
- *Data standardized sets repository:* it comprises a set of data models developed by CCTS such as Core Components (CCs) and Business Information Entities (BIEs).
- *XML schema standards repository:* it contains XML schema standards based on UN/CEFACT XML Naming and Design Rules.

- *Web services repository:* it incorporates a set of functionalities of a typical UDDI repository for finding the prospective services.
- *Technical standards repository:* it contains technical standards guided in technical standards catalogue.

Knowledge based system

The Knowledge Based System (KBS) are designed as a part of IPIS in order to support officers in IPGDs for getting interoperability knowledge as well as experiences. It also contain ontology component for semantic interoperability to mapping meaning of an information items based on ontology approaches. The KBSs are architected with three main artifacts: Best practice cases, Ontologies and Frameworks/EAs.

- *Best practice cases:* it contains successful implementation cases in e-Government interoperability.
- *Ontologies:* they are to facilitate semantic heterogeneity. In a real situation, the problems of semantic heterogeneity arise due to *confounding conflicts*-occurring when information items seem to have the same meaning, but differ in reality, *scaling conflicts*-occurring when different reference systems are used to measure a value, *naming conflicts*-occurring when naming schemes of information differ significantly. In order to fill the gap of unsolvable cases in data standardizing and modeling, the use/development of ontologies has been considered in IPIS.
- *Frameworks/EAs:* it contains interoperability frameworks and enterprise architectures that can be adopted in e-Government interoperability implementation.

3.3 Methodology

In this section, we describe an overall methodology for IPIS approach in order to fully engage the e-Government interoperability. The methodology is designed based on the search steps in Core Components Technical Specification V2.01 (Part 8 of the ebXML Framework) (UN/CEFACT CCTS, 2003). It includes the following nine steps as depicted in Figure 3.

- *STEP 1:* Identifying the specific inputs: Business processes, Unstructured data models and Technical standards usage. The inputs might include either one or two or all depending on the requirements of interoperability projects among IPGDs.
- *STEP 2:* Discovering the repositories for existing reusable components. The reusable components refers to business process models (UMM), CCs, BIEs, XML schema standards, web services and technical standards usage. The returned reusable components are regarded to the requests in *STEP 1*.
- *STEP 3:* Registering the reusable components. When the prospective repositories are found, the components will be registered for re-use. If not found, go to *STEP 4*. The STEP 2 will be repeated for more components.
- *STEP 4:* Applying the IPIS tools to develop new components. Based on the specific inputs, the IPIS tools automatically develop new business process models (UMM), CCs, BIEs, XML schema standards and web services modules.
- *STEP 5:* Approving the new components being registered in the repository. The Change Management Working Group will be in charge of this responsibility. If approved, go to *STEP 6*. Otherwise, go to *STEP 7*.
- *STEP 6:* Registering the new components in the repository. Go to *STEP 2*.
- *STEP 7:* Determining the use of new components without approval. If yes, go to STEP 8. Otherwise, finishing processes.
- *STEP 8:* Registering the unapproved components for re-use. Repeat *STEP 2* for more components.
- *STEP 9:* Applying all of the registered components for the project implementation.

The above steps of the methodology can also be used as references and concepts in other e-Government interoperability implementation.

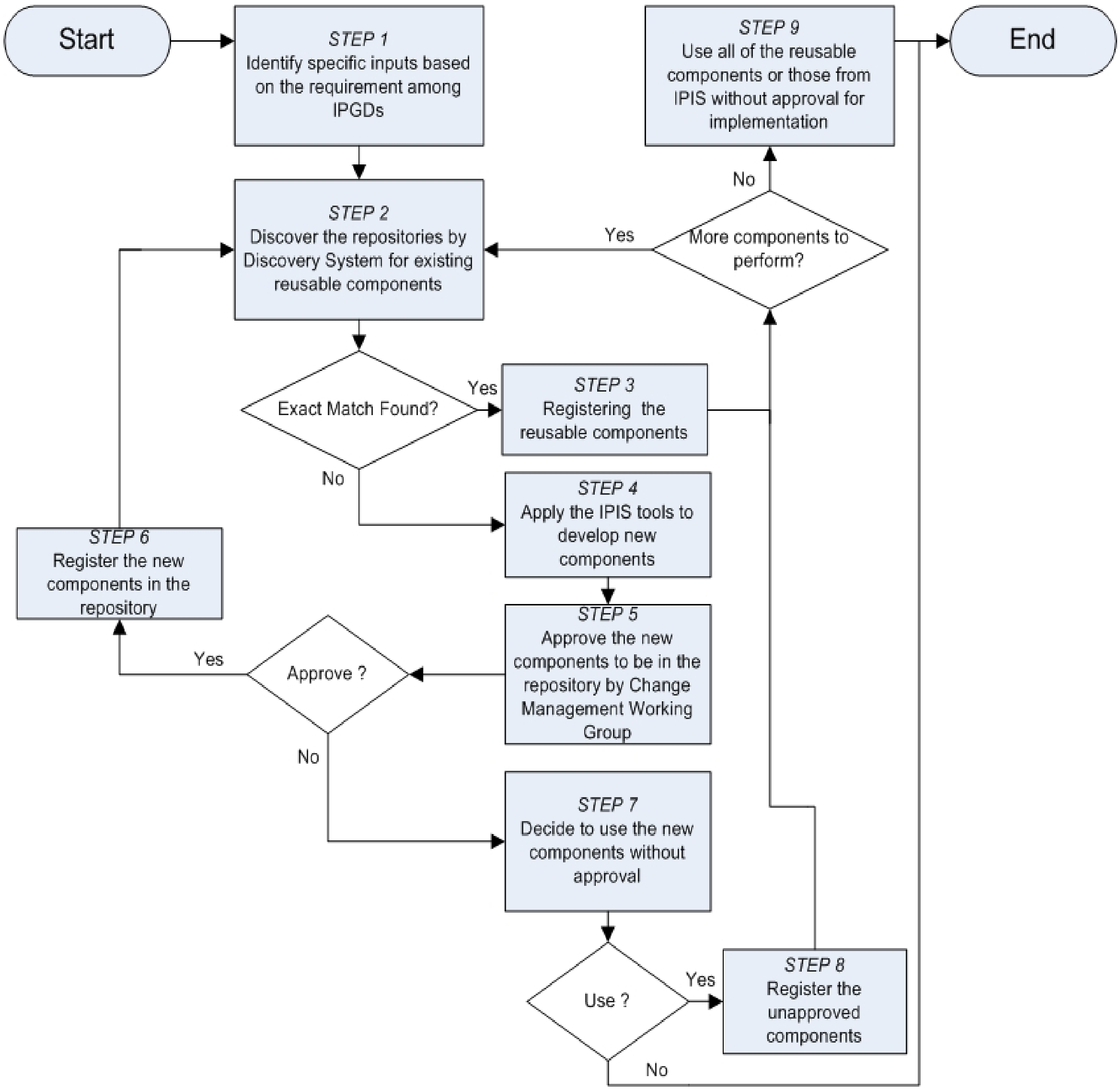

Figure 3: The steps of IPIS methodology

4. Implementation

In this section, we describe the implementation of IPIS. We first implemented the IPIS tool to support e-government interoperability implementation in the project.

4.1 Theoretical tool development architecture

In order to develop the IPIS tools, we design a Model Driven Tool Development (MDTD) based on Model-Driven Architecture (MDA) (OMG, 2003) concept. In MDA, platform-independent models (PIMs) are initially expressed in a platform-independent modeling language. The platform-independent model is subsequently translated to a platform-specific model (PSM) by mapping the PIM to some implementation language or platform using formal rules (OMG, 2003). In this paper, we define the MDTD as a new architectural approach for developing interoperable software tools based on interoperability requirements. The MDTD comprises an interoperability requirement independent model (IRIM), interoperability requirement specific model (IRSM) and software modules. The IRIM is a model of a main requirement of the development tool. The IRSMs are sub-requirements derived from IRIM. The software modules will be designed based on the IRSMs. We then implement them with software technology like Java, .ASP, and .Net.

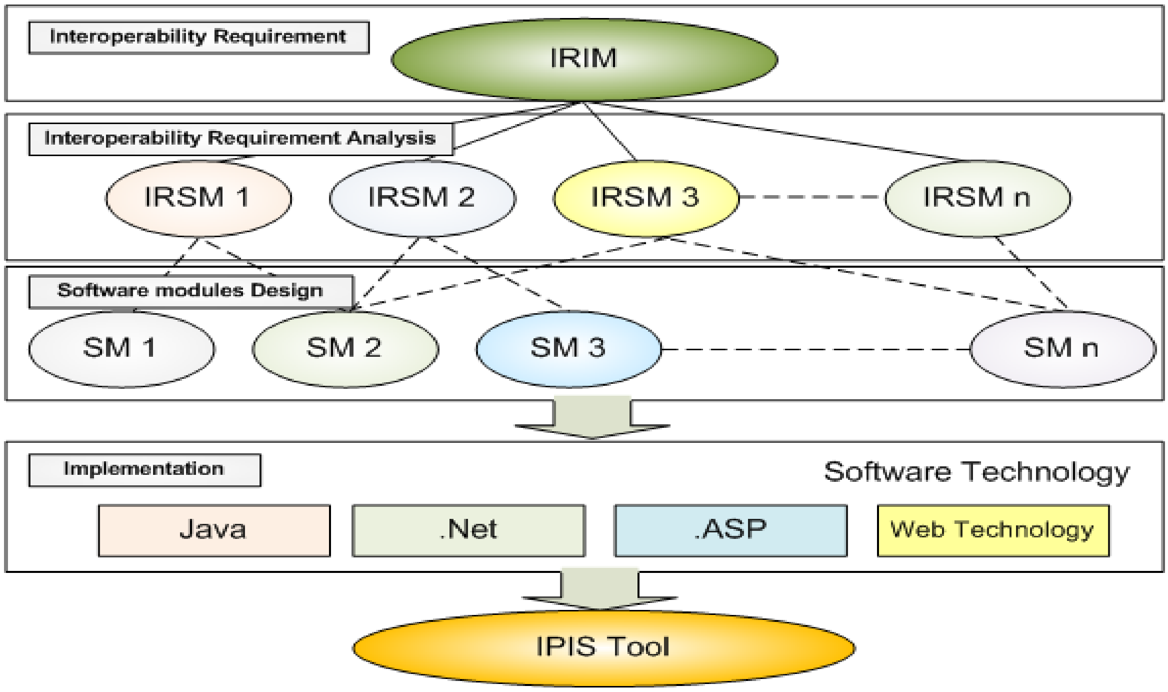

Figure 4: A model driven tool development (MDTD)

4.2 Tool development

This section illustrates how we design and develop the IPIS tool in our pilot project. We first design the tool development architecture following the MDTD. The IRIM is defined as the requirement of the project tool development. It is to develop the IPIS tool that automatically supports in modeling business processes based on UMM and developing CCs, BIEs, XML schema standards and web service components. The expected outputs of the tool include: 1) *UMM document (UML):* Business Domain View (BDV), Business Requirement View (BRV) and Business Transaction View (BTV), 2) *Core Components (CCs)*, 3) *Business Information Entities (BIEs)*, 4) *XML Schema Standards:* XML code list, XML ID list and XML schema (RSM), 5) *Web Service Components:* Web Service Java Source Program, Web Service Caller Source Program and WSDL for Web Services. To achieve the objective, we identified six possible IRSMs. They are IRSM1: UMM design, IRSM2: core components design, IRSM3: core components library, IRSM4: business information entities (BIEs) library, IRSM5: XML schema standards and IRSM6: Web Services components. Based on the IRSMs, we design 10 software modules (SMs): SM1: BRV development, SM2: BRV development, SM3: BTV development, SM4: CC designing (Thai), SM5: CC design (English), SM6: Context designing, SM7: Code list managing, SM8: BIEs designing, SM9: XML schema generator and SM10: Web services developing. Based on the SMs, we implemented them in java technology. With regards to the IPIS tool, in BDV development, a categorization of the business domain (manifested as a hierarchical structure of packages) and a set of relevant business processes (manifested as use cases) are generated. In BRV development, it automatically generates the sub-packages of BRV including Business Process View, Business Entity View, and Partnership Requirements View. Similarly, in BTV development, it automatically produces the sub-packages of BTV: Business Choreography View, Business Interaction View and Business Information View. In the CC design module, the tool allows users to propose their required data model in Thai language. In CC English module, Thai data names are translated to English. In the context design module users can add their required contexts. In the code list manage module users can add and edit code lists. In the BIE design module users can design the required data model based on selected core components and contexts. In the XML schema generation module users can get a XML schema for a given BIE. In the web services developing module users can obtain various source programs for web service components.

5. Application

In Thailand, National Research Council of Thailand (NRCT) is established by the Government in order to provide research resources in various areas for citizens. To provide an effective service, the NRCT needs to gather the resources from different research centers as currently those centers have their own methodology and standards to store and publish their research resources. Therefore, a pilot project on exchanging the research resources across the research agencies was proposed in order to achieve the interoperability. The project aims to develop an interoperated system for exchanging and sharing research resources across twenty three organizations. The project approach is based on TH e-GIF. To achieve semantic interoperability, the process of standardizing and modeling data and XML schema standards is required. In the process, it requires many data owners, data modelers and system analysts. The data owners extensively need to participant in activities based on the four processes in recommendation 34. Several meetings are essential to share, to analyze, to discuss and to reconcile the differences of their data models. It is time-consuming to reach agreement on common standards. Also, the data modelers and system analysts who have high skills and much experience are required. Therefore, we applied the IPIS tool to automatically assist in the process and to generate the components needed in the interoperability implementation. In the project, new data sets were standardized and modeled. They include 15 core components (CCs) and 65 business information entities (BIEs) based on Core Component Technical Specification (CCTS). Based on the data sets, the tool automatically generated the related business process models based UMM, XML schema standards based on UN/CEFACT XML NDR for data exchanges, and web services components. It also automatically generates various kinds of sample programs and scripts. These sample programs and scripts can be used in the interoperability implementation process. They include an XML document manipulation java program, a web service java program, a web service client program using SOAP, an XML digital signature java program, an XML encryption/decryption java program, WSDL specification files, database generation SQL scripts for data storage, and java server page program for managing and manipulating data. Figure 5 shows a part of automatic generated BRV result. Figure 6 shows a part of automatic generated XML schema.

2.1.<<CollaborationRequirementView>>

name: สืบค้นผลงานวิจัย

name: ResearchInformationResourceSearch

baseURN:

urn:th:gov:egif:identifier:standard:MICT:BusinessRequirementView:ResearchInformationResourceSearch

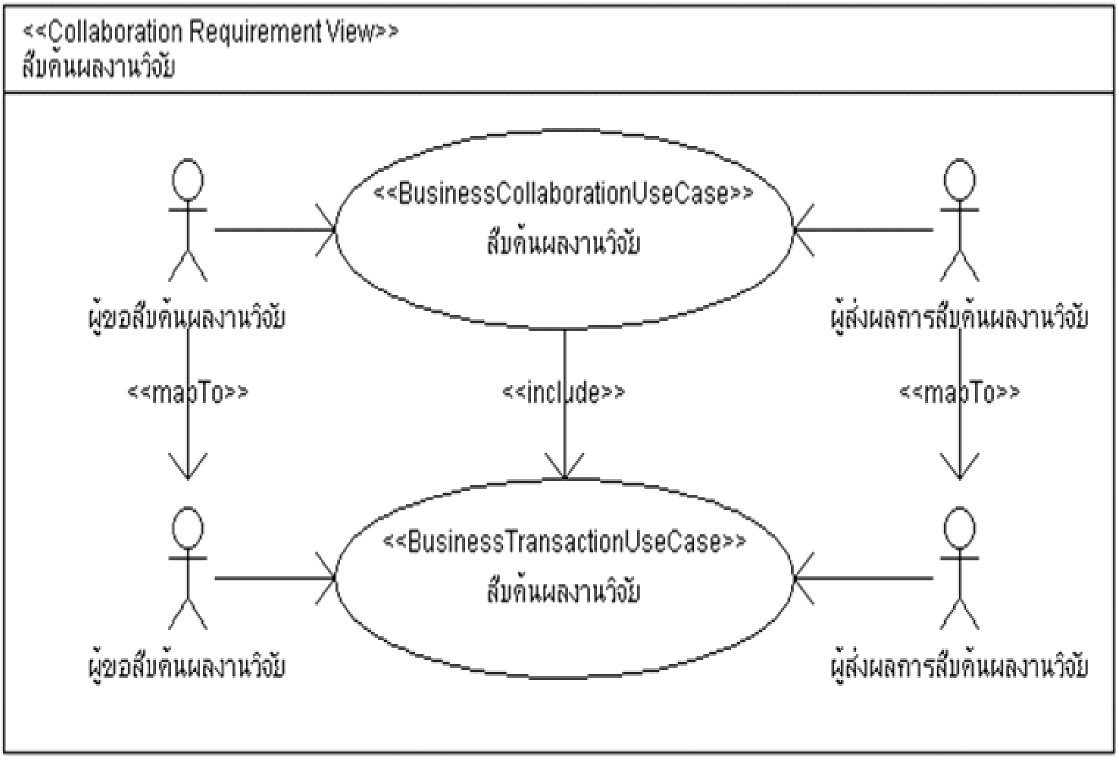

Figure 5: A part of automatic generated BRV result

```
<?xml version="1.0" encoding="UTF-8" standalone="no" ?>
- <xsd:schema xmlns:ccts="urn:un:unece:uncefact:documentation:standard:CoreComponentsTechnicalSpecification:2"
    xmlns:qdt="urn:th:gov:egif:data:standard:QualifiedDataType:1" xmlns:ram="urn:th:gov:egif:data:standard:ReusableAggregateBusinessInformationEntity:1"
    xmlns:udt="urn:th:gov:egif:data:standard:UnqualifiedDataType:1" attributeFormDefault="unqualified" elementFormDefault="qualified"
    targetNamespace="urn:th:gov:egif:data:standard:ResearchInformationResourceNRC:1" version="1.0" xmlns:xsd="http://www.w3.org/2001/XMLSchema">
  - <xsd:complexType name="ResearchInformationResourceNRCType">
      <xsd:import namespace="urn:th:gov:egif:data:standard:UnqualifiedDataType:1" schemaLocation="http://egif.tu-
        rac.com/gov/egif/data/standard/UnqualifiedDataType_1.xsd" />
      <xsd:import namespace="urn:th:gov:egif:data:standard:QualifiedDataType:1" schemaLocation="http://egif.tu-
        rac.com/gov/egif/data/standard/QualifiedDataType_1.xsd" />
      <xsd:import namespace="urn:th:gov:egif:data:standard:ReusableAggregateBusinessInformationEntity:1" schemaLocation="http://egif.tu-
        rac.com/gov/egif/data/standard/ReusableAggregateBusinessInformationEntity_1.xsd" />
    - <xsd:annotation>
      - <xsd:document xml:lang="en">
          <ccts:UniqueID>THRS006005</ccts:UniqueID>
          <ccts:Acronym>ABIE</ccts:Acronym>
          <ccts:DictionaryEntryName>NRC_ Research Information Resource</ccts:DictionaryEntryName>
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      </xsd:annotation>
    - <xsd:sequence>
      - <xsd:element name="ReceiverName" type="udt:TextType">
        - <xsd:annotation>
          - <xsd:document xml:lang="en">
              <ccts:UniqueID>THIE006006</ccts:UniqueID>
              <ccts:Acronym>BBIE</ccts:Acronym>
              <ccts:DictionaryEntryName>NRC_ Research Information Resource</ccts:DictionaryEntryName>
              <ccts:Version>1.0</ccts:Version>
              <ccts:ObjectClassTerm>Research Information Resource</ccts:ObjectClassTerm>
              <ccts:ObjectClassQualifierTerm>NRC</ccts:ObjectClassQualifierTerm>
              <ccts:PropertyTerm>Receiver Name</ccts:PropertyTerm>
            </xsd:document>
```


Figure 6: A part of automatic generated XML schema

6. Evaluation methodology

This section presents an evaluation methodology of the IPIS approach. In order to evaluate the approach, we design the methodology called "IDEA process" shown in figure 7.

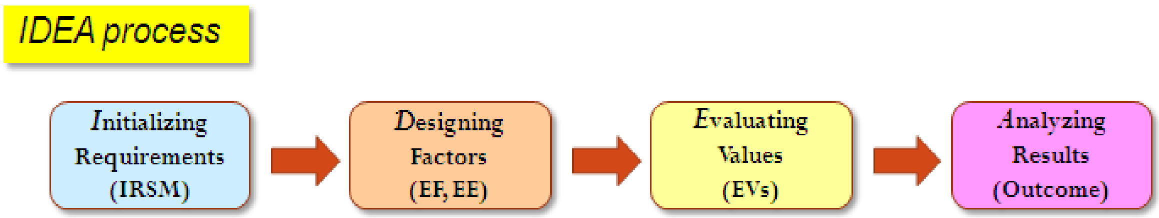

Figure 7: An evaluation methodology of IPIS approach

6.1 IDEA process

The IDEA process includes four main steps: Initializing Requirements, Designing Factors, Evaluating Values and Analyzing Results.

Step1: Initializing Requirements: the first step is to initialize the requirements for the evaluation. We apply the IRSMs generated in the MDTD process as the requirements. In the project case, the requirements include six IRSMs: IRSM1: UMM design, IRSM2: core components design, IRSM3: core components library, IRSM4: business information entities (BIEs) library, IRSM5: XML schema standards and IRSM6: Web Services components

Step2: Designing Factors: the step is to design factors based on IRSMs. The factors consist of evaluation factors (EFs) and Evaluation Elements (EEs). The evaluation factors are designed based on the objectives of evaluation. In this project, the EFs include Skill needed, Experience needed, Time and Cost. The evaluation elements are a set of elements related to EFs and IRSMs. For examples, the EEs of IRSM2 and EF1 are CC designing, CC naming rule, CCTS structuring and CC dictionary entry name as shown in figure 8.

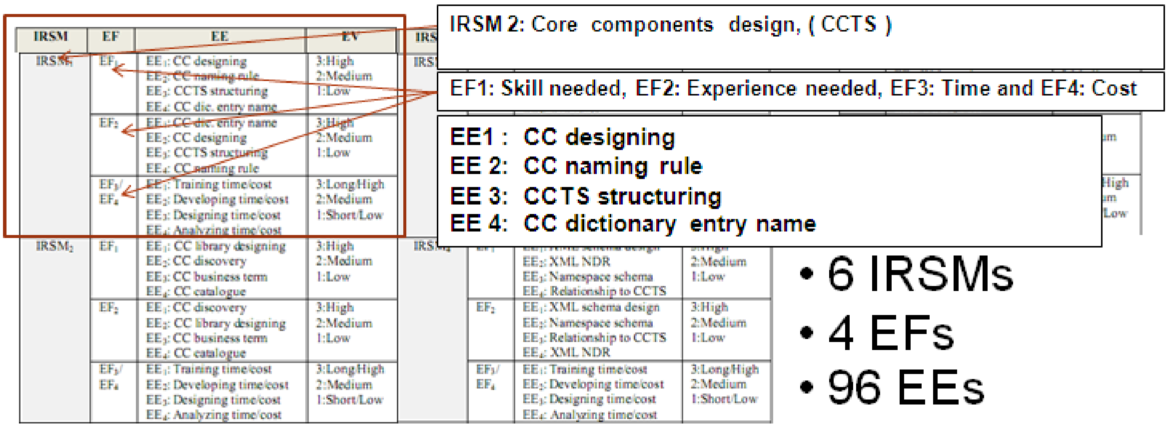

Figure 8: A Sample Lists of IRSMs, EFs and EEs

Step 3: Evaluating Values: this step is to evaluate value from one to three for all of the designed factors in Step 2. The step is performed by the assigned evaluators of the project.

Step 4: Analyzing results: the final step is to analyze all the evaluated value. The methodology of the analysis is based on the following calculation formulas:

The estimate of EV of EF_i is defined as follows:

$$\widehat{EV}_{EE_j}^{EF_i} = \frac{\sum_{j=1}^{N_{EF}} EV_{EE_j}^{EF_i}}{N_{EF}}$$

and the estimate of $\widehat{EV}_{EE_k}^{IRSM_j}$ of EF_i is defined as follows:

$$\widehat{EV}_{EF_i} = \frac{\sum_{j=1}^{N_{IRSM}} \sum_{k=1}^{N_{EF}} EV_{EE_k}^{EF_i\ IRSM_j}}{N_{IRSM} * N_{EF}}$$

where, N_{IRSM}: number of IRSMs (six for this case), N_{EF}: number of EFs (four for this case).

6.2 Evaluation results

The first evaluation of *IDEA* process was performed for the TH e-GIF pilot project in September 2008 (Saekow, 2009). The evaluation compared the evaluated results between the TH e-GIF approach with and without IPIS. In (Saekow, 2009), the results show that the approach using the IPIS tool can assist the pilot interoperability project to achieve objectives more easily and economically. The time spent in the project approximately becomes shorter (65%). The cost estimate also was reduced about 53%. It also indicates that by using the support tool, the officers need less experience and skills to achieve the desired interoperability requirements. With regards to the evaluation of the NRCT project, it has been under process and the significant results will be reported in future paper.

7. Conclusions and future works

This paper presents a practical approach to implementing electronic government interoperability. The approach called “Interoperability Practical Implementation Support or IPIS” was designed and developed as an assisted mechanism for e-government interoperability implementation. The IPIS consists of three main components: support tools, interoperability repositories, and a knowledge based system. As a pilot phase, we first implemented the IPIS tool. The tool can assist in automatically modeling/specifying business processes based on UMM and standardizing and developing data sets and XML schema standards based on UN/CEFACT CCTS and XML NDR. We also proposed interoperability repositories and a knowledge based system as the additional artifacts in the IPIS at the implementation level. The repositories include: business process models, data standardized sets, XML Schema standards, web services and technical standards. With regards to the knowledge based system, it incorporates a collection of best practice cases, ontologies, and interoperability frameworks as well as enterprise architectures. For the IPIS adoption, we designed and introduced the methodology that comprises nine steps. As a result, it significantly indicates that the IPIS can assist the e-Government interoperability project to achieve the objectives more easily and economically. The time spent in the project also becomes shorter. The result furthermore reveals that the successful project needs less experience and skills by using the IPIS tool. Future steps of our work include the implementation of the repositories with the design of discovery approach for reusing resources. The expansion of e-Government interoperability projects adopted by IPIS will be proposed for our further improvement and evaluation.

Acknowledgements

We thank Thammasat University for providing great information and research resources for this project. We also express many thanks to Thai ministry of information and communication technology to provide funding support of the project.

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