Enhancing Transparency In Land Transaction Process By Reference Architecture For Workflow Management System

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ENHANCING TRANSPARENCY IN LAND TRANSACTION PROCESS BY REFERENCE ARCHITECTURE FOR WORKFLOW MANAGEMENT SYSTEM

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Abstract

Transparency has been attracting attentions of public management especially in land administration. Land transaction is function of land administration and highly demands transparency as much as other types of transaction. On the other hand, technological world has been supporting a lot for enhancing transparency in administrative field. One of them is Workflow Management System (WfMS) which has been supporting for transaction process not only for private sector but also for public sector. This study aims to develop high level of abstract architecture of WfMS – Reference Architecture (RA) for enhancing transparency in land transaction process.

In land administration, there are functional and structural requirements for transparency. On the other hand, transaction process has four properties which are atomicity, isolation, consistency, durability (ACID). All of these requirements are believed to bring transparency for land transaction but which ones are needed to impose in reference architecture for WfMS. They were defined by theory and practice in Netherlands case dealing about WfMS and transparency. The paper found that, besides ACID in theory and practice, there should be incorporation of functional and structural requirements for designing RA.

The study based on the case of Netherlands and qualitative method to analyze and conclude theoretical and practical lessons for design stage; also test the design whether it can enhance transparency in land transaction. Several design elements pointed out from the lessons were embraced in the designed reference architecture. The design has three layers: client, server and database. For higher level of detail, architecture was developed from the reference architecture with organizational, computational, engineering and information viewpoints. Each of components supposes to show several transparency criteria. The architecture was implemented in WfMS based Geo-information system (GIS) software environment. Based on transparency criteria, implementation and verification was conducted and proved that reference architecture can enhance transparency but depend on implementation architecture and chosen software.

Keywords: WfMS, Reference architecture, architecture, transparency, land transaction.
1 INTRODUCTION

Transparency is routed by *trans* and *parent* where *trans* means movement and *parent* means visible (Oliver, 2004). So transparency is making every movement visible, understandable and predictable. Particularly on land transaction, the transparency is about making all information about rules, regulations, decisions, procedures, and movements of object parcel visible, predictable and understandable for all the parties involved. Though transparency and corruptions do not have straight relationship; they have cause and consequence relationship. So the consequences of lacking transparency in land administration as well as land transaction have been mentioned a lot in terms of governance such as tenure insecurity, high transaction cost, inefficiency service, informal market, investment reduction, land grabbing, limited local revenue and others (Zakout et al., 2009). Transparency is necessary in all the administration processes especially when it deals with public administration. Land administration deals with the immovable resource (land) whose area is always constant (neither increase nor decrease) and directly linked with public sentiments since it's their only immovable assets. Thus transparency in land administration is necessary to provide efficient service for the public. The study focuses on land administration sector and particularly interested in transparent land transaction process.

Recently, business process management (BPM) and Workflow Management System (WfMS) has been noticed by public administration (Becker et al., 2007; Corradini et al., 2011). Business processes are unit of logical works which are initiated, carried out and completed (Vintar, 1999). Transaction process can be considered as business process because it is serial tasks conducted to get the goal of exchange. In case of land transaction, exchange is between land rights and money. Besides, workflow is referred as automation or computerized facilitation of business process to achieve business goals (Aalst et al., 2002). It can be seen that WfMS has mostly applied on banking (ING) or online transaction (Amazon). Transparency issues are usually not mentioned directly or clear but they do perform hidden behind words such as public availability, openness, security and efficiency. On the other hand, WfMS has been introduced to land administration system and promising for better efficient cadastre (Osch et al., 2004). Land transaction differs from other transaction at only public administration and spatial management. Therefore, there are possibilities that WfMS can enhance transparency in land transaction process.

WfMS is “a system that completely defines, manages, and executes workflow through the execution of software whose order of execution is driven by a computer representation of workflow logic” (David, 1995). However, to develop a flexible system which enables to apply on any real cadastre, the study needs to carry out a structural framework for the system which is called Reference Architecture (RA). RA is reference for developers working with mapping functionalities onto the system (Putman, 2000). Nevertheless, to gain the purpose of transparent land transaction, the study defines specific requirements for transparency from land administration and transaction.

The main objective is to develop a RA for WfMS enhancing transparency in land transaction. The paper respectively discusses about transparency concept in land transaction and the requirements, lessons from theory and practice of WfMS, and then using these lessons to develop RA and higher level of detailed architecture, then after implementation on GIS based software and verification with the transparency criteria.

2 RESEARCH METHODOLOGY

The study had been done in four main stages. First stage is findings from literature review about transparency requirements for land transaction. Then the author incorporated literature review and case study in Netherlands to find out which requirements are relevant for embracing in RA and which lessons learnt from related RA for WfMS. From those lessons and requirements, the RA was designed and described in detail about functionalities. To prove the design applicable, implementation and verification stage was carried out. Before that, WfMS architecture was taken out from the RA and fit with the case study. Implementation was carried out with Enschede cadastral data and based on GIS-workflow environment. Verification could not be done by quantitative method but qualitative one. The study made several implementations on all functionalities and components of architecture then verified it and discussed the results.
3 TRANSPARENCY REQUIREMENTS

Transparency in land administration has three aspects: legal, structural and functional. Legal aspect is about rules, regulations and policies which should be publicity (Danilo R. A., 2010). Though legal issue plays very important part to enhance transparency in land administration, there is some study which has been trying to incorporate legal and technologies. However, this study more focuses on using technologies to enhance transparency. As discussed above, the RA and WiMS are mainly focusing on structural and functional aspects. The author believes that laws and regulation are powerful but it takes time to apply it in reality while technologies with function and structure can rapidly change performance of a system. On the other hand, transaction process has four main properties which are atomicity, isolation, consistency and durability. These properties are requirements for any kind of transaction and ensure transaction executing transparently. Structural, functional and transactional requirements are discussed as following.

3.1 Structural requirements

Structural aspect is about organizational set-ups, institutional arrangements, and tiers of decision making process which should be clear and predictable.

- Clarity of roles and responsibilities is mentioned as guidelines of IMF (International Monetary Fund) (Oliver, 2004, p. 5). Within organization or among stakeholders, who do what and what are responsibilities of each actor should be clear.
- The role of senior leadership in organization is important in leading the organization to commit to openness and transparency (Oliver, 2004, p. 31).
- Integrity (Kötter et al., 2010; Oliver, 2004; UN/Habitat and TI, 2004): clarifying what is expected from professionals and including monitoring mechanisms (Lonski et al., 2002).
- Established means of proactive communication to the organization’s important stakeholders (Oliver, 2004, p. 31): with involvements of variety of external users, the communication among them should be maintained in consistency and mediated exchange updates.
- Training of counter fraud staff and establishing central units responsible for identifying and tackling fraud (provide advice and guidelines)(Kötter, et al., 2010)
- National and international cooperation: sharing intelligence between organizations, responsible authorities (Kötter, et al., 2010)
- Institutional reforms: This strategy includes both the streamlining and simplification of administrative procedures as well as structural innovations to promote participation and accountability (UN/Habitat and TI, 2004, p. 27).

3.2 Functional requirements

Functional aspect is about information on who does what? Who is responsible for what? Who processes application?

- Public availability of information: the openness of information is mentioned as new concept of transparency (Oliver, 2004).
- Programs and processes that encourage and ensure openness at every level, that reward transparency and mete out quick and decisive punishment for opacity, obfuscation, and fraud (Oliver, 2004, p. 31)
- Access to information: This encompasses measures to improve stakeholders’ access to information so that they may participate more effectively in decision-making (UN/Habitat and TI, 2004).
- Assessment and monitoring: the types and scale of corruption and the degree of transparency in local governance, baseline against which progress in improving transparency can be measured.
- Procedural checks and controls: in Germany public notary checks the identity of both parties in a property transaction process (Kötter, et al., 2010).
• Accessibility restrictions: verification of applicants and limits to anonymous users, or grant limited rights to user.
• Technological security measures: access control, encrypted communication, electronic signatures, monitoring system.

3.3 Transactional property requirements

These transactional properties called shortly ACID are realized mainly at database level (Gupta, 1999) and also at workflow level (ERCIS-European Resource Centre Information System).

• Atomic: a transaction has all or nothing semantics, either it completes or is undone.
• Consistent: a transaction performs a correct transition resulting in a correct state.
• Isolated: the intermediate results of a transaction are only visible when it commits.
• Durable: the committed results of a transaction are permanent.

Relationship among ACID: In long transaction, ACID is required strictly to follow while in short transaction, the system requires relaxed properties. In long transaction, atomicity and isolation usually conflict each other (Grefen et al., 1999). Locking mechanism is applied to ensure serializable (Bernstein et al., 2009). This mechanism is used in long transaction such as land transaction which is difficult to complete and takes long time. So the solution for this issue needs to be defined. Versioning management in database was introduced as a one of the solution (Batty, 2011).

4 LESSONS FROM THEORY AND PRACTICE

This section used theory and practice to finalize whether ACID requirements are enough or have to include functional and structural requirements. Also the section pointed out which elements from related works are relevant for the design.

4.1 Theory

The literature review looks for works related to RA for WfMS of land transaction and how these works have done so far in enhancing transparency and which elements are important for design. The first and very prior work on RA for WfMS is Workflow Management Coalition (Aalst & Hee, 2002) which defines essential components for the system such as administration and monitoring, workflow engines, process definition tools and workflow client application. Administration and monitoring plays role of clearly defining responsibilities of users and control the system in case of faults and frauds. Process definition tool defines workflow logic and also assign task for user. Client application is the interface for user access in public information of process. The second work is by Grefen and de Vries (1998) which give very much emphasis on designing RA for WfMS at high level of abstract but there is no specifications for land transaction. The work has brought a frame of RA that is designed as three layers: client, server, and database. This element is also recognized in later described works. WIDE architecture (Ceri et al., 1997) is more supportive for transaction process with basic access database component which allocates appropriate data source to the workflow engine. Besides, Schulz & Orlowska (2004) focus on safe gateway between two or more organizations’ WfMS. The mediator here plays important role in transparent communication among parties involved to the process. Transparency is referred with a way of transparent access to the resources (Haring et al., 1998). User interface also can enhance transparency a lot in communication with the public. In conclusion, there are several elements such as three layers, mediators, user interface, allocating resources component. In land transaction, transparently allocating resources is significant especially when the transactions happen concurrently and isolation is threatened.

4.2 Practice

Case study was conducted with land transfer in the Netherlands because Netherlands has high score of transparency in public management according to Transparency International (2011) and was introduced WfMS in early stage of WfMS age. Several observations and interviews in cadastral offices and other offices were conducted in Netherlands. The main findings shows that among ACID
elements, isolation and consistency play important roles in enhancing transparency and there should have co-operation of ACID and functional and structural requirements which need to be embraced in the RA. The case shows that land transaction is long transaction and need to be divided into sub-processes to increase atomicity. It also proves that user interface play important role in making the process and system open to public. Besides, the RA should take these in account: tracking histories, two set of database (parcel, workflow), client scheduler for allocating requests to workflow engine, version management for allocating data resource to workflow engine and update changes, mediators for workflow and database exchange.

5 REFERENCES ARCHITECTURE FOR WFMS

5.1 Reference architecture

Based on the lessons from theory and practice of WFMS, the reference architecture was designed as Figure 1:

5.1.1 Client layer

- Client interface: this component is open interface for public access to information and acquires services.
- Client scheduler: this component collects, analysis, and distributes the request from client interface to workflow server.

5.1.2 Workflow server layer

- Administration and monitoring: the component defines process and activities, defines users and manages database.
- Workflow engines: logically running jobs which are distributed by client scheduler with process definition.
- Control flow mediator: between internal and external workflow engines, control flow mediator helps to transparently navigate workflow logic and secured the information system by authorization.
- Version manager: this component replaces workflow scheduler which has functions of distributing appropriate piece of data to running processes.

5.1.3 Database layer

- Database management system (DBMS): this component stores, manages data of object and workflow. It also defines users of database.
- Data flow mediator: between internal and external DBMS there is data flow mediator for secured exchange data flow.

5.2 WFMS architecture

Reference architecture is a high level of abstract architecture. In order to implement in the real world, it should have a higher level of detail zooming in with specific viewpoints and embraced tightly the transparency requirements. According to TOGAF (The open group, 2009) and Putman (2000), there are several viewpoints that should be considered to develop architecture.

Enterpriser/business viewpoint: the architecture should present roles of user in the system especially roles of manager, hierarchy of administrative offices, which components are implemented in which office and communication with external stakeholders. Computational and engineering viewpoint: the architecture is developed by constraints, interfaces and components which present all functions of the system. The functions should contain open access to information, assessment and monitoring, security issues. Data/information viewpoint: the architecture should illustrate which data the system needs, which data is using for processing the workflow. Especially, versioning concept should be taken into
care by this viewpoint and elaborated with ACID elements. The principles are followed but the reference architecture is not layered as the reference model of open distributed process (RM-ODP) (Putman, 2000).

![Reference Architecture for WfMS of Land Transaction](image)

**Figure 1: Reference architecture for WfMS of land transaction**

The architecture for WfMS as Figure 2 is designed for cadastre organization which has central and local offices. Central office controls local offices. There are customer service, distributor, and head manager in central office. In local office, there are surveyor, administrator, auditor and manager.

Head manager is in charge of defining workflow (business definition), managing human resource, allocating human resources to appropriate workflow, and granting privileges to users. At the same time, the head manager monitors whole process. If some failures or errors happen, the head manager will track history of workflow and see who is responsible for that so that the head manager can ask that person to correct or fix the failures. Customer service can be considered as front office. This part of central office has responsibilities of collecting requests and queries information from customers which are general user or professionals and experts. Distributor receives jobs from customer service and geographically distributes surveying jobs.

The manager in provincial office has same responsibilities as head manager but in different level of administration and the manager don’t manage and monitor process definition. Auditor is the one who controls quality of editing from administrator and surveyor. Administrator has roles of processing deed and editing attribute data. Surveyor is responsible for checking the provisional boundary and edit spatial data.

In the architecture Figure 2, the green components are presented that it will be implemented in central office. Blue one belongs to local office. The dash trigger presents for dependency of data.

Each components of the architecture should satisfy the following transparency criteria in Table 1. If the architecture can fulfil all of these criteria, it will enhance transparency.
Table 1: Architecture component and expected transparency criteria

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Component</th>
<th>Transparency criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Customer Service</td>
<td>Public availability of information</td>
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<tr>
<td></td>
<td></td>
<td>Access to information</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Consistency</td>
</tr>
<tr>
<td>2</td>
<td>Scheduler</td>
<td>Clarity of roles and responsibilities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Integrity</td>
</tr>
<tr>
<td>3</td>
<td>Administrator and monitoring</td>
<td>Clarity of roles and responsibilities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Accessibility restrictions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tracking histories</td>
</tr>
<tr>
<td>4</td>
<td>Workflow engine</td>
<td>Atomicity, consistency and isolation</td>
</tr>
<tr>
<td>5</td>
<td>Other workflow engine</td>
<td>Integrity</td>
</tr>
<tr>
<td>6</td>
<td>Mediators</td>
<td>Integrity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Means of proactive communication to the</td>
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<tr>
<td></td>
<td></td>
<td>organization’s important stakeholders</td>
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<tr>
<td></td>
<td></td>
<td>Tracking histories</td>
</tr>
<tr>
<td>7</td>
<td>DBMS</td>
<td>Security</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clarity of roles and responsibilities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ACID</td>
</tr>
<tr>
<td>8</td>
<td>Version Manager</td>
<td>ACID</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Technological security</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tracking histories</td>
</tr>
</tbody>
</table>

6 IMPLEMENTATION AND VERIFICATION

Among several open sources Business Process Model (BPM) such as j-BPM or Bonita, the chosen software is ArGIS package with PostgreSQL for DBMS because ArcGIS can provide efficient tools not only for WFMS (ArcGIS Workflow Manger, ArcGIS Workflow Administrator) but also for working with geo-information (ArcMap) and version management (ArcSDE).

Parcel subdivision process is chosen for implementation within Enschede (Netherlands) area. The process is defined into four stages: provisional boundary and making deed, process deed, surveying and quality assurance. Each stage was created by one workflow and each workflow was assigned to one job type and one group owner. Following parts are described each of job type. The implementation and verification are described in following components of the architecture.

6.1 Client layer

6.1.1 Customer service

Customer service is supposed to be an open online source so that citizens can easily access information. However, this function is limited in ArcGIS. In another way, citizens can send email with basic information such as parcel id, object id, address and receive results.

Customer services component not only provides information about parcel and ownership to citizens but also consistent information with what happened in real world. After each stages of process, auditor is required to update changes to supply data version as described in implementation of each workflow. So the citizens can see the transaction is on which stage of subdivision.

In conclusion, customer service was partially implemented and showed enhanced transparency criteria of consistent information to public. The component has not provided appropriate interface for public. So criteria of access to information and promoting participation and accountability were unable to execute.
Figure 2: WfMS Architecture
6.1.2 **Scheduler**

Scheduler includes time manager, event analyzer and job handler. Workflow Manager Administrator has time manager for each type of jobs such as process deed is 1 day since started day, surveying 20 days since started day.

Job handler and event analyzer are not supported automatically by ArcGIS because the customer service is not complete. However, it can be done manually. Cadastre receives the job mails then they send job request to appropriate person and that person can start his own workflow which is defined in job type.

Even when responsible group starts job, they can still assign to specific person in that group. It is accessibility restricted but also enhances responsibilities of user. In order to distribute geographically, distributor can check job query window. Each job was defined by area of interest (AOI). In conclusion, scheduler was partially successful implemented and enhance two transparency criteria which are defining roles and responsibilities and integrity job request between client and server layer. Time manager was unable to warn job for due date and event analyzer was absent. Therefore criteria of integrity and consistent are not well performed.

6.2 **Workflow server layer**

6.2.1 **Administrator and monitoring**

This component is most successfully implemented component by ArcGIS Workflow Administrator. It provides tools to define each type of step and customize it to define workflow and job types with specifications for data workspace, duration and assigning to specific group of users and version of database. It is also able to define the users (including contacts of users) and privileges for each group of users. The following figures show four workflows for each stage:

**Provisional boundary and making deed** (Figure 3)

Provisional boundary has been proposed since the cadastre needs new parcel id and boundary for subdivision before updating attribute data and consistency in database, and once the provisional boundary is updated in cadastral database, other people such as neighbour of this parcel can see that the parcel is selling to others.

At this stage, Notary plays significant legal role. Notary is representative for the buyer and seller. Besides making deed and handling legal issue of deed, Notary helps buyer and seller in preparint provisional boundary. So this job type is assigned to notary group but with indirect involvements of buyer and seller.

![Provisional boundary and making deed workflow](image)

**Process deed** (Figure 4)

Process deed stage is executed after Notary notifies that provisional boundary and deed preparation are completed. In previous stage, former parcel was divided into two new parcels. In database, one more row of new parcel was added. So administrator now can edit attribute data according to parcel id (objectid). At this stage, administrator is the one who own the job type – process deed.
Executing surveying job (Figure 5)

Execution of surveying job is conducted after receiving notification from administrator. Even there is provisional boundary, surveyor still has to go to the field because surveyor plays important role in maintain correct geometry of cadastral database. Surveyor has to guide legally about boundary and measure boundary in the field. Then surveyor goes to office and edits the formal boundary.

Quality assurance (Figure 6)

Quality assurance stage is processed after surveying stage. This stage which is controlled by auditor mostly aims for checking the quality of updates from notary, administrator and surveyor.

6.2.2 Workflow engine (internal and external)

In this implementation, internal and external workflow engines were running on same domain with different accounts. The engines run process instances. While executing the job (workflow), user can hold the job for reason and release hold to continue or attach any documents in attachment. Furthermore, the user or others that belong to the system can see all histories, list of jobs and information about that job. So this component was implemented well and satisfied not only expected transparency criteria but also extra transparency criterion that is other user can view the jobs but cannot edit, and checking quality by quality assurance workflow.

6.2.3 Version manager

Protected default central database is controlled by head manager. From central database, local database, supply database are child versions of central database as described in Figure 7. The local version will be authorized to manager. Auditor creates version from local version which will be source to create data
workspace in workflow system. Versions of job provision, process deed, surveying are temporally created during process execution. They will be cleaned up by manager monthly. Version manager, version auditor and version supply data are public because users need to view and edit (edit, reconcile, post). Since job versions are children of auditor version, they need to be granted privileges. However, job version is automatically generated by workflow system. So the privileges need to be given to group of users which are responsible for specific job type. Auditor version will give privileges to group of Notary and group of surveyor view all of classes but only edit feature class, group of administrator view all of classes but only edit attribute classes. Versions are created on ArcSDE and able edit and delete version, privilege rights for user, reconcile and post changes to target version of geo-database. ArcSDE provided enough functions for version manager and enhanced transparency criteria of isolation. The privileges could not work out through workflow environment so criterion security was not well implemented.

6.2.4 Control flow mediator

The mediator was able to notify the both internal and external participants about what is going on in the process and users know what s/he has to do. After Notary finishes his job, the workflow informs cadastral by notification message. Once administrator receives notification, s/he has to start process deed job. So the routing function works well in the implementation. As mentioned, Notary submits deed and provisional boundary, the notification is sent automatically. So it comes in sequence in cadastral system. Notary can see histories of all jobs, holds, and attached documents of each job. Notary behaves like other user of the system but restricted rights such as Notary can’t delete job, version or map document. Manager defines rights for Notary group in workflow environment as described in implementation. However, format function has not been implemented in this research.

6.3 Database layer

6.3.1 DBMS

In PostgreSQL, schema for user is created and password for each schema is set up. Only manager owns geo-database and workflow data. Other users such as administrator, surveyor, and auditor has own schema and password and are granted to use workflow and geo-database. So users can execute workflow with appropriate data. Geo-database is designed and objectid is the primary key throughout tables. There are four tables which are esd00_parcel, esd00_object, esd00_subject, esd00_right. One parcel can have more than one buildings (object) and one building (object) has to lie on at least one parcel (1-m). One parcel can have more than one right (1-m). One parcel can be owned by more than one person but one person can own more than one parcel (m-m). One subject can have many rights (1-m). DBMS proved that PostgreSQL has provided all functions to manage database. Transparency criteria such as clarity of roles and responsibilities and security were fulfilled.

6.3.2 Data flow mediator

PostgreSQL creates users for system with account and password and head manager who is responsible for central database management system who can track histories of every change in database. However, format convert function was not implemented in this research. The mediator was able to enhance security to database and ACID.

In conclusion, the implementation was successful on ArcGIS environment and proves that architecture can enhance transparency in land transaction. Server layer and database layer were well functioned and satisfied all criteria even satisfied more requirements such as checking quality and users can view but cannot edit jobs and job documents of others’. However, client layer and mediators were not well implemented, some functions were absent which makes the components difficult to satisfy the criteria. Also there are some limits of implementation. First is that, one subdivision case may have four job identifications because there are four workflows to complete transaction. Second is that the privileges for versioning did not work well through workflow environment. They may affect negatively to transparency in land transaction.
7 CONCLUSION

Implementation of RA with supporting the WfMS architecture suggests that RA indeed enhance transparency by incorporating structural, functional and transactional requirements in three layers structure. However, it depends very much on implementation architecture, precise workflows and chosen software. Mediators and version manager play important roles in enhancing transparency beside client interface and administration and monitoring. The mediators navigate between workflows in core engines and workflow in external engines and secure the dataflow and authorization of external users. The version manager helps transparently distributing necessary data to workflow relatively. So the users in different geographical locations can access to the data and execute workflows.

The paper recommends for organization in case implementation the reference architecture. Firstly, the senior leaders should be committed with enhancing transparency in the organization. The organization should have clear roles and responsibilities for users. It also need IT/IS experts to develop detailed architecture and support technical issues. One of important point for a successful implementation is chosen software which is able to perform well functions and fit with budget. The organization may not need to implement whole architecture but just take the most significant and appropriate components.

For further research, the negative effects of transparency should be investigated more. Next studies also can be done to overcome some technical limits of the implementation. Moreover, quantitative method should be considered in other related studies due to higher persuasiveness. In addition, further researches should take in account data model and legal affects in reference architecture.

8 REFERENCES


