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

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Enschede, the Netherlands,
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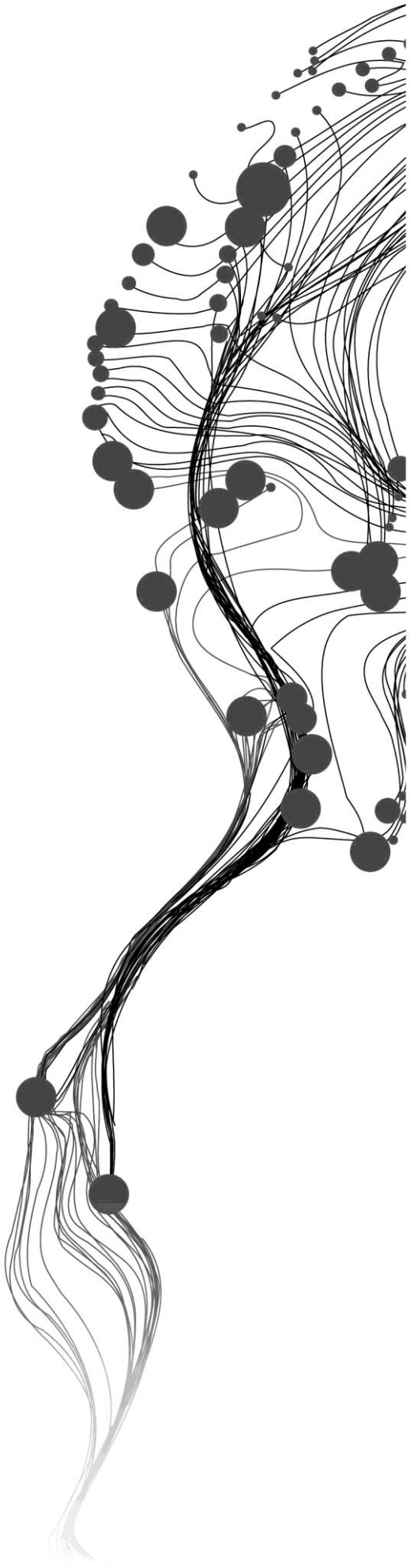

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Thesis submitted to the Faculty of Geo-Information Science and Earth Observation of University of Twente in partial fulfilment of the requirements for the degree of Master of Science in Geo-Information Science and Earth observation.
Specialization: Land Administration

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ABSTRACT

Transparency in the field of land administration is growing of interest and has increased attention at national and international levels especially in delivery of services (such as land transaction) for the citizens. The literature study suggests that GI Science including Workflow Management Systems (WfMS) contributes a lot for the efficient and transparent land transaction system. The transaction concept of atomicity, consistency, isolation and durability (ACID) are very well known within the database theory and also in practice, but the transparency issues such as structural and functional aspects are remained to be studied for implementation within a WfMS. The literature also indicates that there are already some research studies on reference architecture (RA) for WfMS purely from technical perspectives, but there is no explicit indication that directly deals transparency issues in land transaction. The main aim of this research is to develop reference architecture for land transaction WfMS that incorporates transparency characteristics.

In this research, there are four main steps as research method combining literature study, case study, design and implementation. First step is to derive transparency requirements using the literature studies on transparency concepts and land transaction. Second step consists of the theoretical studies on reference architecture to see how these requirements are incorporated. In order to learn and experience how these requirements are in practice, detail studies on the actual workflows of land transaction (as a case study) in Netherland Cadastre are conducted by interviewing the senior experts of Central and Local Cadastral Offices, and other offices of Notary, Real estate and Municipality. Then, on the basis of the results of case study, reference architecture for land transaction is designed and supporting architecture is also developed for implementation. Last step is to verify RA by implementing WfMS using ArcGIS Workflow Manager, ArcSDE and PostgreSQL.

The initial result shows that there are three main aspects namely structural, functional and transactional properties requirements in land transaction. The study indicates ACID properties alone are not sufficient for the concurrent long transaction process. While studying WfMS in practice, case study indicates both structural and functional aspects are important requirements for organizing workflows to avoid any conflicts. GI Science provides new approach (i.e. versioning database for different actors/users) in implementing a WfMS. Several design elements were introduced in RA for land transaction to embrace these transparency requirements in three layers of architecture a) client layer, b) workflow sever including version manager, and c) database layer. Supporting implementation architecture is developed showing business processes (work engines) and actors in addition of other elements specified in RA. Workflows are then designed for generic land transaction and implemented in the client server environment. The experience on executing WfMS shows components such as administration and monitoring, and workflow engine were very well executed and can enhance transparency in delivery and monitoring of land transaction services provided, while customization is required for good interaction with the clients. In conclusion, RA enhances transparency in land transaction, but it depends on the implementation architecture and its environment.

Key Words: land transaction, reference architecture, architecture, workflow management system, transparency

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Cam on tat ca da den voi toi nhu mot ky niem dep trong doi.
Tran Hai Phuong

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ABBREVIATIONS AND ACCRONYMS

ACID : Atomicity, Consistency, Isolation, Durability
AKR : Automated Kadaster Register
AOI : Area of Interest
BAL : Basic Access Layer
CI : Communication Interface
CPI : Corruptions Perceptions Index
CWA : Cross-organizational Workflow Architecture
DBMS : Database Management System
ERCIS : European Resource Centre Information System
ESRI : Environmental System Research Institute
FIG : International Federation of Surveyors
GBA : Personal data of municipality
GBA-V : Standard for updating GBA
GIS : Geographical Information System
GPS : Global Positioning System
IMF : International Monetary Fund
IT : Information Technology
jBPM : Flexible Business Process Management
LIS : Land Information System
LKI : Land Kadaster Information
LTP : Land Transaction Process
MCP : Municipality
ODP : Open Distributed Processing
PKI : Public Key Infrastructure
PS : Private Surveyor
RA : Reference Architecture
REA : Real Estate Agency
REO : Real Estate Office
RM-ODP: Reference Model of Open Distribute Process
SQL : Structure Query Language
TIO : Transparency International Organization
TOGAF : The Open Group Architecture Framework
UIS : User Interface System
URL : Universal Resource Locator
WAPI : Workflow Application Program Interface
WfMS : Workflow Management System
WIDE : Workflow on Intelligent Distributed Database Environment
WMX : ArcGIS Workflow Manager

1. INTRODUCTION

1.1. Background

Transparency is an important factor in real estate market as well as in land transaction processes (Lisec *et al.*, 2008). In both public and private sectors, a high transparent system can prevent corruption and gain satisfaction bringing trust from customer or citizens (Park & Blenkinsopp, 2011). There are two levels of transparency required in land administration namely structural and functional. Structural transparency is about organizational settings, tiers decision making and making visible on the roles and mandates to customers or citizens. Functional transparency is to make clarity what steps are taking, who is responsible and how much cost and time are required for a certain process (Tuladhar, 2010).

For information perspectives, any kind of transactions (land or business) have four characteristics which are atomic, consistent, isolated and durable (Bernstein & Newcomer, 2009) abbreviated as ACID. Atomicity means the results of transaction's execution are either all committed or all rolled back. A completed transaction transforms a shared resource from one valid state to another valid state and this is known as consistency. Isolation can be defined as serializability. Changes to resources, that a transaction effects, do not become visible outside the transaction until the transaction commits. Durability is about the changes that result from transaction commitment survive subsequent system or media failures. Since land transaction takes place among several separate agencies under public management, it is interesting to see how these transaction characteristics are realized in a workflow management system.

There are many ways for improving transparency in land administration such as laws and policies, institutional reform and technologies. Among them, the most common one is technologies. Several technologies have been mentioned as solution to increase transparency in land transactions process such as modelling, database management, workflow management, etc. Modelling procedure is introduced in land transaction in Slovenia (Lisec*, et al.*, 2008), Greece (Arvanitis & Hamilou, 2004) and other researchers. However, modelling is just a part of improvement process. Executing process and monitoring the system are also needed. On the other hand, Database Management System (DBMS) is a core of any transaction processing such as federal DBMS (Kamel & Kamel, 1992), spatio-temporal database which provides present, history, procedure tracing database (Nan *et al.*, 2006), object-oriented DBMS to enhance concurrency without allowing isolation schedule (Kim *et al.*, 1994).

Recently, Workflow Management System (WfMS) is widely applied for all kind of work processes such as banking, insurance, retail, government, internet, etc. (Bernstein & Newcomer, 2009). However, WfMS still has some limitations. Some of them are cooperative workflows, integrating applications into workflows, workflow in mobile environments, failure handling (Kamath & Ramamritham, 1996). These limitations including poor WfMS architecture can create environment for frauds and corruptions.

Therefore, some of previous researches had been studying about reference architecture for WfMS in order to address limitations. Wang (1997) proposed the system architecture based on Workflow Management Coalition with specific purpose to improve land transaction management in Beijing cadastre. Her objective was to control work flows in a distributed system so that it supports a lot for transaction process but does not mention about transparency issue and the current workflow management software (Visual dBase) does not provide efficient tools to model and implement workflow process. Many functions of workflow was failed to implement.

Further, a global reference architecture (RA) for WfMS had been designed by Grefen and de Vries (1998). This reference architecture used an "ideal" WfMS, and goes more detailed than existing architectures. Its

aim is to comply with broad set of aspects such as heterogeneous environments, extensible functionality and mobile workflow clients. However, there are no specific requirements for transaction workflow or for spatial data management.

Bass *et al.* (2003) clarified that reference architecture maps functionalities onto system decomposition (i.e. software elements) and data flows between them. In Workflow Management System, reference architecture is a framework to separate various functions of workflow environment and identify interfaces which can make different products integrating and inter working among various work steps (David, 1995).

Different views of architecture are indicated by TOGAF (The open group, 2009) which are business architecture domain, data architecture domain, application architecture domain, technology architecture domain. The business perspective focuses on the needs of users, planners, and business management. Data perspective addresses the needs of database designers, database administrators, and system engineers. Application architecture domain concentrates on needs of software and system engineers. Technical architecture domain addresses the needs of operators, administrators and managers. These views may influences transparency in land transaction, but not sufficient, as it has to address both views on structural and functional aspects of a land transaction.

In conclusion, this research focuses on the discussion whether reference architecture can or cannot enhance transparency in land transaction process and discusses how viewpoints of structural and functional aspects are incorporated in high level of detailed architecture.

1.2. Research problem

Corruption exists everywhere in land administration system all over the world (van der Molen & Tuladhar, 2007) which has high level of transparency. With corruptions, benefits for the organization could be lost and at the same time, satisfaction and trust from citizen will no longer be entrusted in the organization. So there is the need for transparency in the system. Among tools for improving transparency, technical one is mentioned as good solution to achieve transparency. Nowadays, WfMS has been used in business transaction (Vonk & Grefen, 2003) and also in land transaction (Osch & Lemmen, 2004). Nevertheless, the world of technologies always goes forward with more advanced technologies. Reference architecture concept was born in 20th century and has been widely introduced for WfMS in transaction.

There are many papers which talk about transparency in land administration and about reference architecture for WFMS (transaction) as separate disciplines. However, there are none or very few studies in enhancing transparency using reference architecture in Workflow management system. So the study aims to testify this possibility of incorporating transparency in reference architecture for WfMS.

To develop reference architecture enhancing transparency, transparency requirements need to be defined. Land transaction has four properties which are atomicity, consistency, isolation and durability. The importance of transactional properties in transparency has been realized at database level. However, there is not much about importance at workflow level. On the other hand, there are functional and structural transparency requirements in land administration. So the study needs to determine which requirements need to be imposed in reference architecture to enhance transparency in land transaction process. The viewpoints on architecture are defined to develop higher level of detail architecture for WfMS.

1.3. Hypothesis

This research proposes a hypothesis: "The design reference architecture for WfMS in land transaction enhances transparency."

1.4. Research objectives

According to research problem, main objective and sub-objectives are defined to solve the problem.

1.4.1. Main objective

To develop reference architecture for WfMS of land transaction that incorporates transparency characteristics.

1.4.2. Sub objectives

- To define transparency requirements for land transaction
- To develop Reference Architecture (RA) based on those requirements
- To verify these requirements using recent GIS-based WFMS

1.5. Research questions

Based on objectives, research questions are also carried out to achieve each objective.

1.5.1. Main question

Does RA based on functional requirements (atomicity, consistency, isolation and durability) enhance transparency in land transaction process?

1.5.2. Sub-objectives and questions

- ***Sub-objective 1:*** *to define transparency requirements for land trasaction*
- What are general concepts of transparency land transaction?
- What are transparency requirements should be considered in land transaction?
- ***Sub-Objective 2:*** *to develop RA with requirements*
- What are the RA WfMS components?
- How do transparency requirements help to enhance transparency in RA WfMS?
- ***Sub-objective 3:*** *to verify these functional requirements using recent GIS-based WFMS*
- What software is suitable for verifying the RA WfMS for land transaction?
- Does the RA (WfMS) enhance transparency according transparency requirements?

1.6. Conceptual framework

Conceptually, transparency requirements are imposed into RA (WFMS) to develop the unique reference architecture for WfMS for land transaction process as described in Figure 1.1. From the reference architecture, a WfMS architecture is derived for implementation and verification the hypothesis.

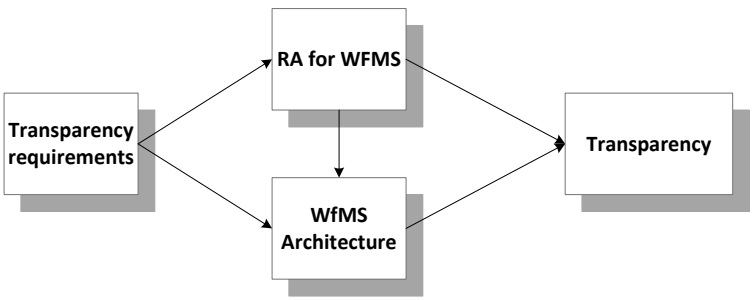

Figure 1.1: Conceptual framework.

1.7. Research methodology

The research methodology is carried out through each step of process as shown in Figure 1.2.

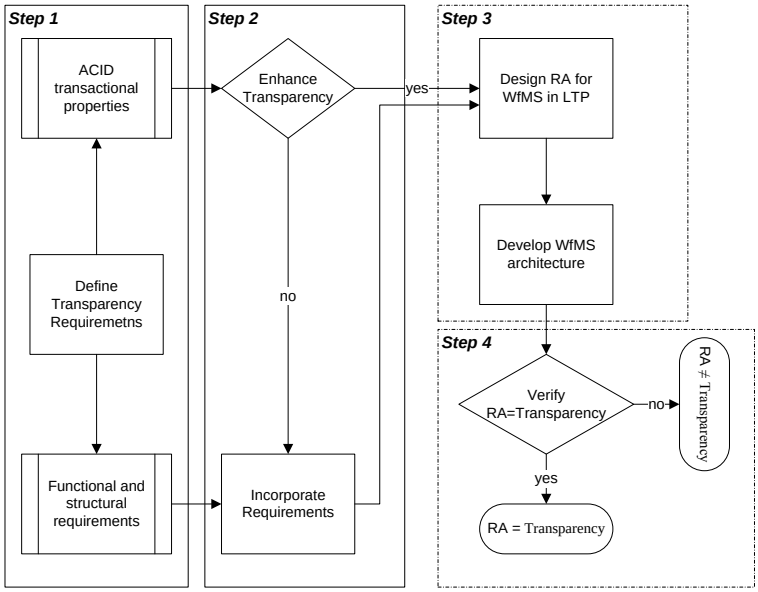

Figure 1.2: Research flowchart.

Step 1: To convince transactional properties are the elements to bring transparency in land transaction process at database level and workflow level, literature review carried out with relevant papers which are about transactional properties – atomicity, consistency, isolation and durability. Reviewing papers focused on how they explain about these elements and how they help in transparency. Besides, literature review also focused on functional and structural transparency requirements and transparency concept as well as land transaction.

Step 2: To find out which transparency requirements are needed to impose into reference architecture

Literature review paid attention on relevant works on WfMS for LTP and RA for WfMS. Besides, a fieldwork was carried out with a case of Netherlands to identify the key actors in land transaction process (LTP), their responsibilities. The visits were taken places in Dutch Cadastral Office and other actors' office such as Notary, Municipality, and Real estate. This step figured out whether ACID is enough for developing RA or it has to be incorporated with other requirements. Both theoretical and practical lessons helped to derives specific designing elements for reference architecture which embrace transparency requirements in step 1.

Step 3: Developing WfMS reference architecture for land transaction process

Based on those elements, reference architecture for WfMS in LTP was designed. Further, the study developed implementation WfMS architecture with higher level of detail than RA for next step.

Step 4: To implement and verify the RA and WfMS

This step is the main step in whole process. There are three tasks in this step. One is to implement the WfMS architecture in step 2. Second is to verify RA through WfMS architecture with transparency requirements can enhance transparency or not to answer the main question and prove the hypothesis. Verification used qualitative approach. To implement the designs, software environment should be able to support all functions and tools. Land transaction differs from other types of transaction because of "land". To ensure implementation will perform all of functions of the workflow architecture, a software package needs to be identified. It is environment not only to create and manage WfMS but also to perform spatial data like "land".

1.8. Thesis structure

Chapter 1: Introduction

This chapter will give a general view of the research with background of topic, problem statement, objectives and questions, conceptual frame work and methodology for processing the idea.

Chapter 2: Transparency concept and land transaction

This chapter gives appropriate definition of transparency and aspects of transparency and requirements for land administration. Further chapter discusses about land transaction's definition and process. From the understanding of transparency and land transaction, chapter then discusses about functional requirements which are foundation for designing architecture.

Chapter 3: Workflow Management System and Experience in Netherlands Cadastre

This chapter gives a general vision of how WfMS and reference architecture for WfMS should look like and how prior research design reference architecture based on requirements. Moreover, the chapter gives details of WfMS in land transaction in a real case – Netherlands Cadastre. The outcome of this chapter is ideas about developing workflow system to enhancing transparency or called designing elements.

Chapter 4: Reference Architecture for WfMS

This chapter discusses what components are needed in Reference Architecture for WfMS to enhance transparency based on ACID. Further, WfMS architecture is derived from the RA for implementation.

Chapter 5: Implementation and Discussion

This chapter discusses about alternative choices of software package and pick one to implement carry out process of implementation the WfMS architecture. From implementing and verifying in GIS environment, this chapter discusses the results.

Chapter 6: Conclusion and recommendation

This chapter gives remarks conclusion of the whole research and recommendations for further works.

2. TRANSPARANCY CONCEPT AND LAND TRANSACTION

2.1. Introduction

This chapter focuses on transparency concept and requirements for land transaction process to answer first three research questions as defined in section 1.4.2. The sub-chapter 2.1 gives appropriate definition of transparency, need of transparency and elements of transparency in land administration.

The next section 2.2 describes the functions of land administration and among them land transaction is one of the function. In addition, this part will explain how LIS support for land transaction in terms of database management and process management. Last point of this part is to define land transaction.
The last section 2.3 will carry out transparency requirements for land transaction process according to two main elements of transparency and transactional properties ACID.

2.2. Transparency concept

First of all, transparency is mentioned in many walks of life so in land administration it must have its own definition. Structural and functional levels of transparency are also discussed as aspects of transparency. Finally, the need of transparency element in land administration system and what land administration requires from transparency will be carried out.

2.2.1. Definition

Transparency is the main issue of this research so it is necessary to define what transparency exactly mean. In Figure 2.1, there is a map of corruptions perceptions index (CPI) of 2010 of countries all over the world. There are 178 countries in the index with score below five (scale from 10: highly clean-yellow to 0: highly corrupt-red). Even the Netherlands is one of the top countries having high level of transparency in public sector (8.8 score), corruptions still exist in land administration (van der Molen & Tuladhar, 2007). Enhancing transparency means preventing corruptions and improving trust and satisfaction from customers or citizens (Park & Blenkinsopp, 2011). Therefore, transparency is considered as important element in management system not only in public sector but also private sector.

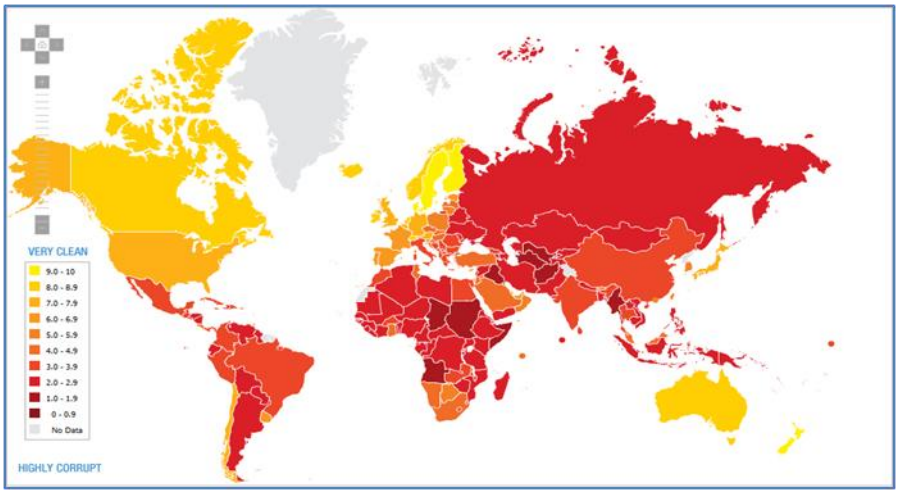

Figure 2.1: Map of the world forum. (TIO, 20/10/11)

Terminology of the word "Transparent" is routed by *trans* and *parent*. *Trans* means movement and *parent* means visible (Oliver, 2004, p. 3)so *transparent* is that every movement should be visible. According to the Oxford English Dictionary, the early English use of the word *transparent* meant "*having the property of transmitting light, so as to render bodies lying beyond completely visible*".

Transparency International defines transparency as "a principle that allows those affected by administrative decisions, business transactions or charitable work to know not only the basic facts and figures but also the mechanisms and processes. It is the duty of civil servants, managers and trustees to act visibly, predictably and understandably." And the elements "*visibly, predictably, understandingly*" are mentioned repeatedly by Henriques (2007), (Oliver, 2004), (Custovic, 2010) and Tuladhar (2010).

Nowadays, transparency has new concept - "*openness*" in terms of information (Bagdai *et al.*, 2009; Oliver, 2004; Pasquier & Villeneuve, 2007). However, in land administration, not only information but also all government rules, regulations, decisions and procedures should be available to the general public (Bagdai, *et al.*, 2009).

Finally, in land administration in general, land transaction in specific, all information about rules, regulations, decisions, procedures and *movements* of object "parcel" should be visible, predictable, and understandable for all of parties. Though transparency brings many benefits for organization, there are cautions for its negative aspects such as violation of privacy, direct cost of disclosure and revelation of sensitive information (de Jong & de Vries, 2007; Hood & Heald, 2006, p. 91).

2.2.2. Why is transparency needed in land administration?

Transparency is the key to bring better governance in land administration. Transparency is one of the principles for good governance in land administration (Zakout *et al.*, 2009). The benefits for the society once having a good governance in land transaction has been listed by (Bell, 2007) and are shortly presented here:

- Pro-poor support: rule of law is equal to all and citizen has protected rights
- Public confidence: greater public confidence
- Economic growth: security of the land tenure and regulated transaction cost and taxation
- Stewardship of the environment: responsible and accountable government
- Protection of state assets: legitimate use of state land for social and economic concessions
- Overall more effective and efficient public administration of land: former market and reliable system, more revenue sharing for public services
- Conflict prevention and resolution: equity, justice, and social stability

In another hand, week governance in land administration will lead to the following consequences (Zakout, *et al.*, 2009):

- Insecurity of tenure: lose possession and ownership rights
- High transaction costs: informal payments
- Informal land transactions/informal property market: increase informality and insecurity
- Reduced private sector investment: private sector avoids because of insecurity, high transaction cost
- Land grabbing: government officials transfer state land to political elites or for their own benefit.
- Limited local revenues: less private investor, high transaction costs but less money go to revenue
- Land conflicts: conflicts between individuals and state and among individuals.
- Landlessness and inequitable land distribution: people can't afford for buying land, even having land, insecurity and land grabbing always threaten them from landless.
- Social instability, social exclusion and political instability: land conflicts, land poorness and landlessness
- Erosion of ethics and standards of behavior: proper titles, building permits, zoning regulations, paying tax are no longer trusted.
- Unsustainable natural resources management: illegal transfers of property in forests, biosphere reserve, national parks, catchment areas of water reservoirs, etc

Another consequence of lacking transparency in land administration is encouraging corruption and reducing trustworthiness from the citizens. Corruption can be seen under three types: bribery, frauds, favoritism (van der Molen & Tuladhar, 2007). Corruption is a part of consequence of week governance. Therefore, transparency is critical component of functioning land administration (UN/Habitat. & ITC, 2006).

2.2.3. Aspects of transparency

Transparency has three main aspects: legal, structural and functional. Policy, laws, regulations, charters, codes and rules should be publicly available (Danilo R. A., 2010). Concerning about legal aspect, laws and regulations always come first to guide citizen or users go into right track. Therefore if they are hidden or unclear, people can miss-do and misunderstand. Therefore, laws and regulation play a role in enhancing transparency. "As with many other tools that support access to information, modern and effective legislation can considerably enhance accountability of public officials and build an informed society. It contributes to building trust between public agencies and the stakeholders, enhancing transparency and improving governance as a whole." (UN/Habitat and TI, 2004, p. 61)

Structural transparency is about organizational set-ups, institutional arrangements, and tiers of decision making process which should be clear and predictable. Depending on countries but in general, land administration is not only one organization. It is a connection of organizations and institutions such as national, federal, local level, tax office, municipalities and etc. Structure of how they work and communicate with each other should be clear and connected. Though, structure of individual organization is important as they have their own responsibilities, consistency among them in working to ensure the flow of work is necessary.

Functional transparency is about information on: who does what? Who is responsible for what? Who processes applications? Who makes decisions? Information is one of the public priorities and thus who or which department is processing customer's work or what they are doing with it should be disseminated transparently. Functional transparency is important because people need to know not only who own this parcel, how parcel looks like but also what is going on with their parcel.

Due to technical part, this research focuses on structural and functional transparency. Though UN/Habitat and TI (2004) said that organization structure may improve transparency, researcher (Custovic, 2010) proved that institutional reform is not enough for real transparency and proposed for further research with functional aspects. So the combination of functional and structural aspects can enhance transparency in land transaction.

Transparency can be seen like glass window of a car. It is transparent for the people sitting in the car but not for the people outside. This kind of transparency is not good for land administration. For land administration, transparency is emphasized toward not only customers/citizens but also users such as administrator, surveyor, tax agency, real estate agency, manager, municipality and private company. So transparency in land transaction should be focused on all aspects from customers to organizations.

In conclusion, there are many way to look into the transparency issue. However, the most important thing is to know what we are looking for. Transparency in land transaction mainly focuses on structural and functional aspects and it should be transparent to all of stakeholders involving into process.

2.3. Land administration and land transaction

This part will discuss about land transaction - land administration's function and how transparency is realized in land transaction through Land Information System (LIS).

2.3.1. Functions of land administration

Land administration includes four main components which are juridical, regulatory, and fiscal and information management (Dale & McLaughlin, 2000). The juridical component is about holding and registration of land rights. It contains a series of processes with rights on land and allocation of land, such as mortgage and transfer. The most important process is land registration which provides the means of recognizing formalized property rights and for regulating the character and transfer of these rights. Other processes are to demarcate the boundaries on the ground, to describe these boundaries graphically and numerically. The regulatory component is concerned with the development of the land. It includes land development and use restrictions imposed through zoning mechanisms and the designation of areas of special interest, ranging from historic districts to fragile ecosystems. The fiscal component focuses on economic utility of the land. The processes support increased revenue collection and production and may act as incentives to consolidate or redistribute land or use land for particular purposes. Information management is integral to all three components above: juridical, regulatory and fiscal. Those three components share common information requirements (LIS). While the function of a land administration system is to support the management of real property, including the physical earth (La Salle) and all things attached to it, the function of land information system is to underpin this process. Land administration system tenure processes common to most nations (Williamson *et al.*, 2010):

- Formally titling land
- Transferring land by agreements (buying, selling, mortgaging, leasing)
- Transferring land by social events (death, birth, marriage, divorce, exclusion and inclusion among managing group)
- Forming new interests in the cadastre , generally new land parcels or properties (subdivision and consolidation)
- Determining boundaries

2.3.2. Transparency situation in land administration

As mentioned above in the first part of transparency concept, corruption in land administration still exists everywhere in the world. And it makes the system lack of transparency. Following are the cases of some typical countries where corruptions happened according to a internet survey from March to April 2006 by Van de Molen and Tuladhar (2006).

- India: 79% respondents confessed that there are corruptions in the department, 36% had paid money to officials. Works bribe paid are property registration, mutation, land survey, obtaining property documents.
- Vietnam: land management is top of corruptions. The most popular corruption crimes are taking advantages of state land projects, land leasing, resettlement, asking money for land allocation, leasing, land rights transfer, land use certificate granting, etc.
- Netherlands: an administrator in land registration discharged mortgages in the land book against payment by land owner. It is also found in fieldwork interview with Dutch officials.
- Ghana: chief takes advantages of customary law to benefit him and relatives.

From Europe to Africa, from south Asia to north Asia, corruptions exist in land administration system and cause serious problems for society such as uneven in using land, bureaucratic and losing trustiness.

2.3.3. LIS – supporting transparency in land transaction

In land administration, a new system that has to be mentioned is LIS. This is the most power tool and updated technology in land sector. FIG defines LIS as "... a tool for legal, administrative and economic decision-making and an aid for planning and development. A land information system consists, on the one hand, of a database containing spatially referenced land-related data for a defined area and, on the other,

of procedures and techniques for the systematic collection, updating, processing and distribution of the data. The base of a land information system is a uniform spatial referencing system, which also simplifies the linking of data within the system with other land-related data." (FAO, 2003). It is believed to bring good governance in land administration and especially for transparent land administration system. With LIS, the land administration system can run in digitalized way which can connect all users such as lawyer, administrator, surveyor, real estate agency, citizens in one system. Digitalized land relating data is linked together by unique parcel reference number. It makes consistency and avoids duplication of parcel numbers. So it supports for curb frauds and corruptions. LIS helps citizens participate in process of decision-making and other processes through internet application (World Wide Web).

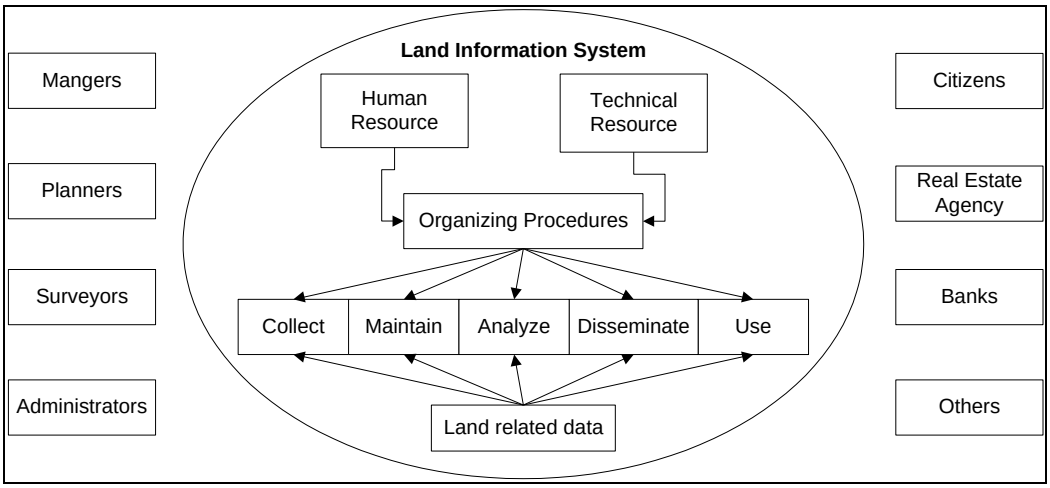

Figure 2.2: LIS components and users (Tuladhar, 2011)

In Figure 2.2, LIS is a system comprised of human resource and technical resource. They are combined to support organizing procedures and with land related data in supporting management activities such as collection, management, analysis, dissemination, use information (Dale & McLaughlin, 1988). So procedures and data are main cores of the system which use the resources to elaborate.

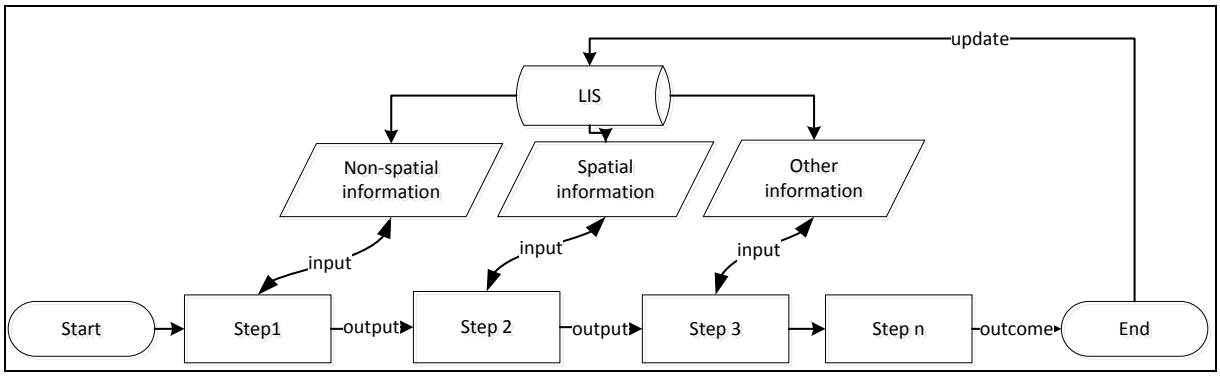

Figure 2.3: Relationship between data and process

In Figure 2.3, LIS includes non-spatial and spatial information and other information such as human resource and application (Tuladhar, 2011). A process contains a series of steps. Each step is taken with input of a specific data then produce output for next step. Next steps happen same till the process gets outcome and it update to database (DB) of LIS.

Land transaction is one of the main processes in land administration system. LIS supports for land transaction process transparently. Workflow and database management system (DBMS) take place within LIS components. Nowadays, when technologies are so fast developing, workflow management system (WfMS) is one of most popular technology for business process such as land transaction.

2.3.4. Definition of land transaction

Transaction is about exchange of something such as information, goods, services or money by an agreement carried out between two or more parties. There are many kind of transaction. Land transaction is exchange land or land use rights by agreement like deed or title. Transaction can be considered as business transaction which is an interaction in the real world where something is exchanged (Bernstein & Newcomer, 2009). Transaction processing systems have to efficiently handle high volume of data, concurrent operation, producing partial results, avoid downtime, and back up results.

So what is land transaction? "Transaction" is discussed above and what about "land"? Sometimes land transaction is called real estate transaction or real property transaction. So real property is land and anything growing on, attached to land (Zevenbergen *et al.*, 2007). Real property transaction is the procedure that is necessary for owners to show legitimacy of their ownership (property rights) and a new owner to buy them. Other parties besides the seller and buyer involved can be lawyers, notaries, real estate agencies, valuators, surveyors. Detail procedure can be dependent on whether urban or rural land is conveyed (Zevenbergen*, et al.*, 2007).

A real estate transaction is the process which rights on property is transferred between two or more parties in case of conveyance seller(s) and buyer(s). It can be complicated due to the complexity of the property rights being transferred, the amount of money being exchanged, and government regulations. However, terminology about real estate, rights or ownership depends on national law and national language. In each country one term use differently, no correspondence (Zevenbergen*, et al.*, 2007).

In term of duration of executing a transaction, two classes are called short-life and long-life transactions, respectively. Short one is short execution, response times and accesses to small portion of the database. Long one takes longer to execute (response time being measured in minutes, hours, or even days) and access a larger portion of the database. Along this dimension, one can also define a conversational transaction, which is executed by interacting with the user suing it. And land transaction is a kind of long transaction (Tamer Özsu & Patrick, 1999, p. 350). By the side, there are flat and nested transactions. Flat one has single starting and termination points and nested one contains embedded sub transactions (Marinescu, 2002).

In regards of parcel, there are many types of transactions such as pure sale and sale combined with subdivision, mortgage, etc. However, in this research, only ownership transfer partly or fully is focused on. This type of transaction is most common and happens frequently in the land market. Furthermore, the research wants to experience with transaction which involves much in maintaining spatial data.

2.3.5. Land transaction processes

Land transaction has many types which are divided according to rights on land. According to definition of transaction in previous section, the goods are rights on land and the owner which own land or own rights on land has willing to exchange the goods for money. Each of countries has different land rights. For examples, in Vietnam, the ownership is presented by land use rights, people do not own land but own land use rights. In Vietnam there are nine land use rights. They are exchange, transfer, lease, sublease, inheritance, donation; mortgage, guarantee or capital contribution. However, the most common rights about land transaction among countries are transfer full ownership or land use rights, subdivision and mortgage.

a) *The transfer full ownership*: The procedure of transfer full ownership usually starts with a person who has willing to sell his land or apartment. S(h)e advertises land or house or through to the real estate agency. When a buyer come and agrees with all things such as condition of house, area of land, price, etc. both of them can go to notary to make deed in which countries have deed conveying system or go to registration office to register a new title in which countries have title system. After register, the new owner will have a confirmation letter or new title of this parcel.
b) *The subdivision*: The process is same as full transfer but usually involves with surveying jobs. Surveyor will do measurements to identify new boundaries and new parcel number. Update spatial land

information is important in this case. Other cases, subdivision can start with provision before submitting deed to cadastre.

c) *The Mortgage:* Instead of selling ownership to other person, mortgage is a loan to purchase a property. A mortgage loan uses the property to guarantee repayment of the loan. The borrower gives the lender right against the property and the lender can exclude on the property if the borrower does not repay the loan per the agreed terms. The owner wants to mortgage his land. So he has to prove legal ownership of his land to bank. And the bank will investigate the condition of land and of legal documents then the bank will decide how much for the mortgage. After all, the owner has to register to cadastre that his land is on mortgage.

2.4. Transparency requirements for land transaction

In section 2.1, aspects of transparency were discusses. They are laws and regulation, function and structure. After discussion about transparency in land transaction process, function, structure and transaction properties are discussed below.

2.4.1. Structural requirements

Firstly, here are requirements for structural aspect:

- Clarity of roles and responsibilities is mentioned as guidelines of International Monetary Fund (IMF) (Oliver, 2004, p. 5). Within organization or among stakeholders, who do what and what are responsibilities of each actor should be clearly defined. Therefore, people will be aware that if they do some things wrong, only they are people who are responsible for their mistakes. There will not have frauds and cheats anymore.
- The role of senior leadership in organization is important in leading the organization to commit to openness and transparency (Oliver, 2004, p. 31). The leader or head manager administrate, monitor and control the whole system. If they aware of need of transparency and try to develop organization in transparent policies, the organization will be definitely transparent.
- Integrity (Kötter *et al.*, 2010; UN/Habitat and TI, 2004): clarifying what is expected from professionals and including monitoring mechanisms to ensure they adhere to their commitments and are sanctioned if they break public trust (the level of systems integration with other customer computer systems (Lonski & Parsons, 2002)). Between cadastre and other organizations, there should be integrity of information, processes and system so homogeneous character will be ensured.
- 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 maintain 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: simplification of administrative either procedures or structural innovations to promote participation and accountability (UN/Habitat and TI, 2004, p. 27).

2.4.2. Functional requirements

Secondly, here are requirements for functional aspect:

- Public availability of information: the openness of information about object, project, organization structure, functions, laws and regulation, etc .is mentioned as new concept of transparency (Oliver, 2004).
- Programs and processes provide functions 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: public should have easy and simple interface to access available information. It improves 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 scales of corruption and the degree of transparency in local governance should be assessed to measure transparency. It is also valuable for increasing public awareness and mobilizing a community committed to tackling corruption.
- Procedural checks and controls: for example, in Germany public notary checks the identity of both parties in a property transaction process (Kötter*, et al.*, 2010). Quality control is one of functions helping to detect fraud, errors and prevent them harming the system. However, this function should not be implemented too much because it will cause bureaucratic and against transparency.
- Accessibility restrictions: verification of applicants and limits to anonymous users, or grant limited rights to user are significant for security. If anyone can access to database or change anything, there will no clue who did what. That will create environment for corruptions.
- Technological security measures: access control, encrypted communication, electronic signatures, monitoring system. Technology has been developed so fast that it should be taken advantages for improving security.

2.4.3. Transactional property requirements

In all kinds of transaction, there are several properties needed to remain in DBMS in order to maintain the integrity of the data over the database. Database has ACID properties which are implemented by means of transactions (Gupta, 1999, p. 158)

- Atomicity: a transaction needs to be atomic. If transaction completes, it's committed. If it doesn't complete or just complete a part, it should be abort. Atomicity will require the system to recover or undo the transaction (Tamer Özsu & Patrick, 1999, pp. 348-349). It is important that there are *no possibilities of uncompleted transaction are executed* because it ensures no frauds can exist.
- Consistency: *only valid data will be written to the database*. When transaction stage is committed or rolled back, database should be consistent with real world. Transparency is lying in this property. In case, a parcel is written in deed-sold but in database, the object parcel still is on status-using of old owner. That situation will make criminals having chances to sell the parcel to others and unclear to public when they see the information.
- Isolation: isolation ensures *transaction executing in sequence and doesn't allow other transactions interfere*. For example, one parcel is subdivided into parcel 1 and parcel 2. The owner of parcel 2 wants to sell to another person. In order to execute the second transaction, the first transaction should be executed and updated in database.
- Durability: ensures that any transaction committed to the database will not be lost. Durability needs backup system to *restore database in case of corrupted, failures, or damages*. If the database is lost, there will no data to execute transaction or the organization has to build database from beginning. If database is partial damaged, transaction cannot ensure consistency of data (Tamer Özsu & Patrick, 1999).

Above discussion is about ACID at the database level. However, ACID can be seen at workflow level (ERCIS):

- Atomic: a transaction has all or nothing, 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.

So ACID in both database and workflow levels is part of functional transparency which can support transparency in land transaction process. Therefore, ACID is required in designing reference architecture for land transaction process.

Relationship among four elements ACID:

In long (global) transaction, ACID is required strictly to follow while in short (local) transaction, the system requires relaxed properties. Strictness focuses on isolation and atomicity which are usually conflict in long duration of transaction (Grefen *et al.*, 1999). Locking mechanism which ensures serializable character of transactions includes read lock and write lock (Bernstein & Newcomer, 2009). Before reading data, a transaction sets a read lock. Before writing (update) data, transaction sets a write lock. With the massive transactions happening concurrently, locking mechanism will delay durability of committed transaction and effect correctness. So a long transaction will take weeks or months and the data can't be locked for such a long time. To handle long transaction and conflicts, solutions should be pointed out. Version management in database was introduced (Batty, 2011) as a one of the solutions. In workflow level, long transaction like land transaction has hidden isolation because many customers request transaction at the same time and the workflow system may have to process many transactions at once.

2.5. Concluding remarks

In conclusion, this chapter was carried out to answer the research questions about transparency concept, transparency requirements and transaction properties helping in transparency. Making information about rules, regulations, decisions, procedures and movements of object "parcel" visible, predictable, and understandable for all of parties is transparency in land transaction. Land administration in general, land transaction in particular, is still facing to corruptions all over world and giving consequences such as insecure tenure, high transaction cost, land grabbing, inequity in using land. So improving transparency in land transaction is really a need.

Land transaction is the process of exchange the land use rights or properties on land from the legal owner to buyer. It is not only business process but also a function of land administration. The most common types of land transaction are land transfer full ownership, subdivision and mortgage. On the other hand, Land Information System (LIS) has been introduced in land administration using human and technical resources to elaborate functionalities of land administration so land transaction is also a part from LIS. LIS supports land transaction transparently by incorporating with workflow technology. Therefore, workflow management system is believed to be a good technology for implementing land transaction and acquiring transparency.

Based on focused aspect of transparency, the requirements were carried out following functional and structural. Besides, transaction properties are also required for transparent land transaction. In next chapter, there is more detailed explanation for WfMS supporting transparent land transaction process.

3. WORKFLOW MANAGEMENT SYSTEM AND EXPERIENCE IN DUTCH CADASTRAL SYSTEM

3.1. Introduction

Transparency concept and requirements for land transaction were discussed in previous chapter. Workflow management system was also mentioned as effective technology for land transaction to enhance transparency. In this chapter, workflow management system is discussed theoretically and practically.

The second section 3.2 consists of three main issues. First one is to bring more detailed explanation about workflow management system regarding transaction business process. Second is to clarify the glossary terminology and definition of WfMS. Third is to introduce priory works which are related to WfMS Reference Architecture and discuss which of the elements are useful and how they help in enhancing transparency according to transparency requirements.

In section 3.3, workflow management system of land transaction is discussed specifically for the case of Netherlands. Differentiating from section 3.2 with purely literature review, the practical part uses both secondary and primary data sources. The aims of this part are to learn land transfer processes in the Netherlands and how WfMS and transparency requirements including ACID are realized there.

3.2. Workflow management system: In theory

This section explains terminology of workflow environment and related works in reference architecture of workflow management system. The main methodology used is literature review.

3.2.1. Business process

A business process consists of series of logical tasks which will be carried out by resources. Resources can be human, material, data and application. However, each task needs to be assigned for specific person who will be responsible for that task (Aalst & Hee, 2002). Or it can be defined as a set of one or more linked procedures or activities which collectively realize business objectives or policy goals, normally within the context of an organizational structure defining functional roles and relationships (David, 1995; Morales, 1998).

According to definition of business process, land transaction is considered to be a business process with several activities related to land. Several actors are involved in land transaction and each actor has responsibilities to carry out specific activity. Seller and buyer need to request for registration of the transaction and for this they should provide sufficient documents for registration. At the same time, they need to request for surveying. Then registrar processes the request and edits administrative data. Surveyor will go to the field and survey and edit spatial data when the case requires. Finally, the buyer and seller receive the confirmation that transaction is finished. So land transaction is also a business process because it consists of series of steps and activities and involvements of actors.

3.2.2. Workflow management system

Currently, technology world has changed to digital age and has also changed business process in the same way. *Workflow* is referred as automation or computerized facilitation of business process, in whole or part, where documents, information or tasks are passed between participants, according to a set of rules to achieve business goals. Workflow technology enables the organization to capture both the information

and tasks of process. It not only provides functionality to match resources and tasks in a process, but also provides important information to support process management (M. Mostafa *et al.*, 2001, p. 82)

However, workflow only cannot make advantages of this new technology. *Workflow management* is the automated coordination, control and communication of work as is required to satisfy workflow process (Sheth *et al.*, 1996). *Workflow management system* 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 the workflow logic." (David, 1995). WfMS manages business process in sequence of work activities and appropriate human resources associated with the various activity steps. Each of business process have a life cycle ranging from minutes to days or months, depend on complexity and the duration of various constitute activities. Such systems may be implemented in a various ways, use various IT and communications infrastructure and operate in an environment ranging from small local workgroup to inter-enterprise. Figure 3.1 following describes relationships between basic term used in workflow environment (WfMC, 1999).

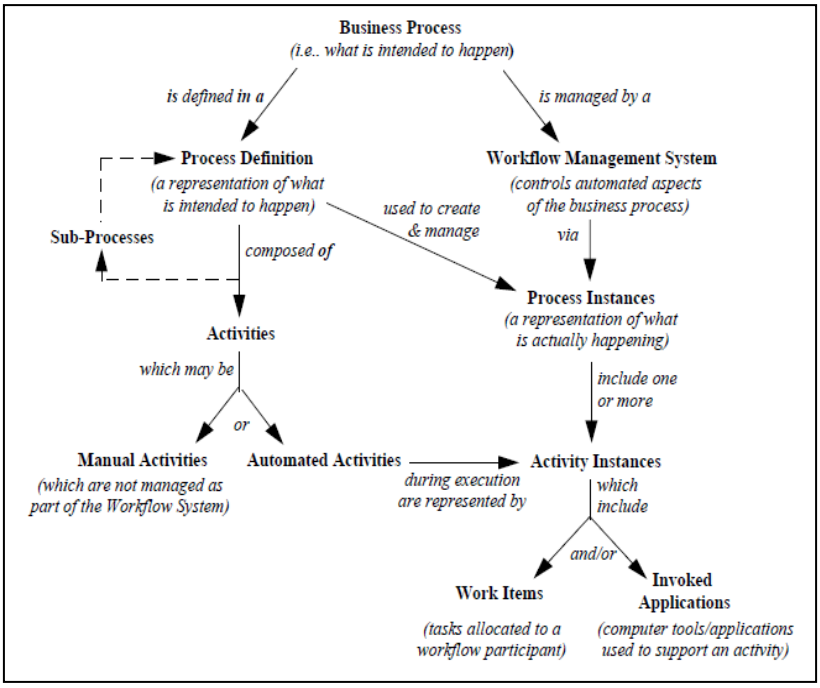

Figure 3.1: Relationships between terminology(WfMC, 1999)

There are three terminologies which are cores of workflow management system as presented in Figure 3.2. *Process definition* is presentation of business process in form which supports automated manipulation by workflow management system. It consist of bunch of activities and their relationships, references of sub-processes. Activity is description of a piece of work that forms one logical step within a process. It can be manual or automated. To carry out an activity, resources such as human or data, need to be located. *Process instance* is presentation of single enactment of a process. It is created, managed and terminated by workflow management system. *Work list* takes place in work handler which is for distributing jobs and giving to workflow engines which run process instances.

Workflow Management Coalition (WfMC) is a grouping of companies who have joined together to develop WfMC reference model. The Architectural Reference Model for WfMS identifies characteristics, terminology and components, enabling the individual specifications to be developed within the context of an overall model for workflow systems (David, 1995).This is the standard for all later research about workflow management system such as Workflow on Intelligent Distributed Database Environment (WIDE), CrossFlow, Reference Architecture for WfMS of Grefen. The reference model in Figure 3.3 describes essential components for architecture of a WfMS.

- *Workflow enactment service* consist one or more workflow engines in order to create, manage and execute workflow instances. It ensures the right activities are carried out in right order and by the right people.
- *Process definition tools* produce process definitions and resource classifications which are frequently offer facilities for analysis techniques such as simulation.

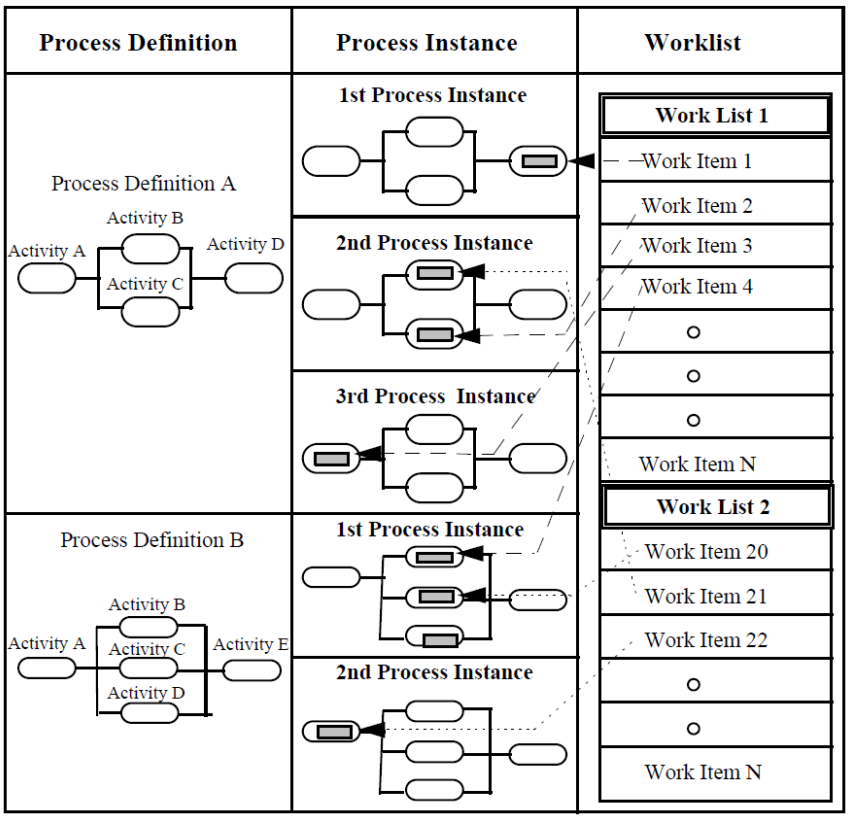

Figure 3.2: Relationship among process definition, process instances and work list (WfMC, 1999)

- *Workflow client application* indicates work list to employees. By selecting a work item, a person can begin performing a specific task for a specific case.
- Performing a task may need running in application which starts from *invoked applications*.
- *Administration and monitoring tools* are about workflow tracking, control, and staff management.
- Interface 1 is *workflow definition interchange* which has functions: open and close a connection, production of case and work item state summaries, generation of new cases, and the beginning, interruption and completion of activities.
- Interface 2 is *workflow client application interface* that communicates between work list handler and enactment service. Functions are opening and closing of a connection, production of case and work item state summaries, generation of new cases, and the beginning, interruption and completion of activities.
- Interface 3 is *invoked application interface*. Normally, application is opened directly from the workflow enactment service. However, there are cases it is opened from the work list handler.
- Interface 4 is *WAPI (workflow application program interface) interoperability* functions that facilitate the exchange of work between autonomous workflow systems.
- *Interface 5* connects between administration and monitoring tools and workflow enactment service. It includes workflow system management functions and workflow tracking functions.

3.2.3. WfMS reference architecture

Workflow Management Coalition is the start and foundation of further researches on reference architecture for WfMS because it is primitive version of reference architecture. The following discusses about more cases of reference architecture for WfMS and derives important elements for designing.

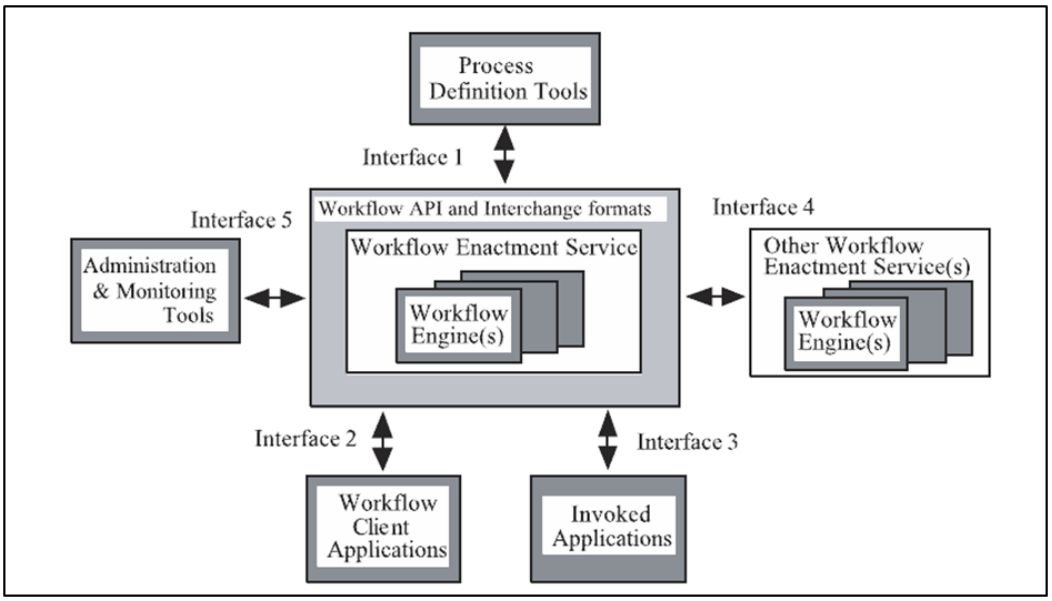

Figure 3.3: Reference model WfMS (Aalst & Hee, 2002)

A system not only consists of components but also is supported by the interactions between its components. The combination of components of a system is called structure. The roles of components of a system are presented by the functionality. The combination of the system structure and its functionality is called system architecture (Morales, 1998). "Architecture is a plan of something to be constructed. It includes the elements that comprise the thing, the relationship among those elements, the constraints that affect those relationships."(Putman, 2000). So reference architecture provides a reference for developers working with mapping functionalities onto system decomposition (i.e. software elements) and data flows between them (Bass*, et al.*, 2003). In Workflow Management System, *reference architecture* is a framework to separate various functions of workflow environment and identify interfaces which can make different products integrating and interworking among various work steps (David, 1995). Reference architecture in Open Distributed Processing (OPD) has high level system specification that defines its overall target structure in systematic and consistent manner. Reference architecture is slightly different from architecture. An architecture is more fully specified instance of a reference architecture (Putman, 2000).

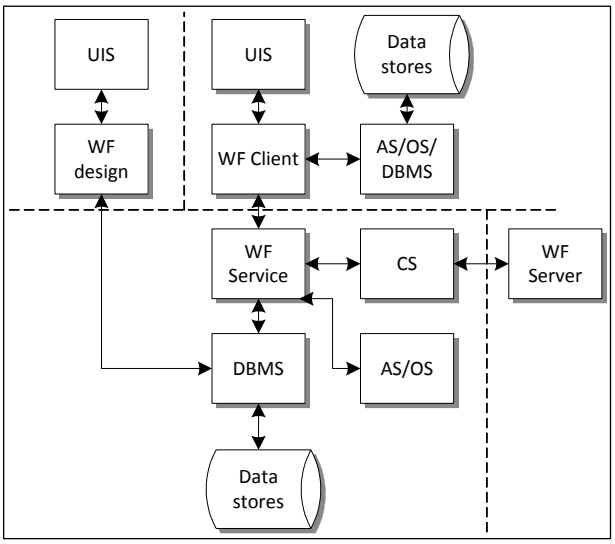

Figure 3.4: Global WfMS architecture(Grefen & de Vries, 1998)

The first work which inspires this research is "A reference architecture for workflow management system" of Grefen and de Vries (1998). This design has "high degree of modularity and flexibility both with respects to functional and technical requirements". However, the design is high level of abstraction and for general WfMS. The design in Figure 3.4 has three main components which are workflow design, workflow clients, and workflow server. Workflow design module provides services for the design of workflow application. Workflow server module provides all central services for workflow enactment. Workflow clients module provides decentral end user services

for workflow enactment and management. Three modules run in different platforms. This design is more detailed than Workflow management coalition shortly WfMC (David, 1995). Workflow service is compared to workflow engine in WfMC and interfaces of WfMC can be found in this design such as interface 1 is between WF Design and DBMS, interface 2 and 5 is between WF clients and WF Service, interface 3 is between EF Server and AS/OS, interface 4 is between WF Server and CS. The design has no specification for land transaction but it can be general architecture to modify according requirements of transparent land transaction process.

On the other hand, WIDE architecture in Figure 3.5 is paid attention for extended transaction support and active rule support sub-architectures (Ceri, *et al.*, 1997). The active rules model is divided into four classes: data events, external events, workflow events, and time events. This model supports reactive behaviour in workflow management application (in WfMC). All of workflow engine, transaction and active rule support use Basic Access Layer (BAL) to access database. The BAL provides an object-oriented database access interface to its clients and maps this to the relational interface of the DBMS to obtain data persistence. This design integrates database technology with workflow management system, supporting exception handling and transaction management.

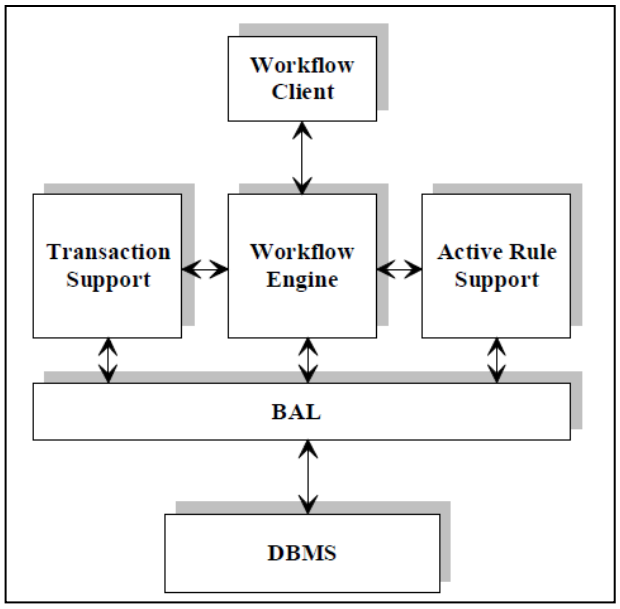

Figure 3.5: Global WIDE architecture(Ceri *et al.*, 1997)

Schulz & Orlowska (2004) discuss about Cross-organizational Workflow Architecture (CWA). The architecture is about connecting two WfMSs by mediator. Each of components has own gateway and security manager. Gateway is interface of company to the outside world which can provide confidentiality and access protection, transparency and routing, format conversation, tracking and error prevention and handling. This entity is believed to be a part that brings transparency for architecture. Since land transaction process involves many institutional levels and organizations, the workflow architecture of land transaction must consider cross-organizational mediator.

Transparency in a distributed management system is discussed with reference architecture for transparent access to the resources (Haring, *et al.*, 1998). It is said that communication interface between user and system is important issue which can bring transparency. Characters are defined to bring transparent access to system resources. They are providing simple and transparent access to network resources, increasing flexibility and efficiency in the usage, ensuring security in access to resources. The architecture has three macro layers in Figure 3.7 user level (access to the system), broker level (to match the user requests to available system), and resources (physical entities of the system: processing, communication, and storage). In the Figure 3.6, the architecture has two level of broker. One level is to except the request for executing applications from the users through Communication Interface (CI). Another is a set of brokers called managers which have responsibilities for each cluster of resources and communicate with other broker through CI. The idea that each manager has his/her own access and responsible for specific resource or workflow, can bring transparency for the system.

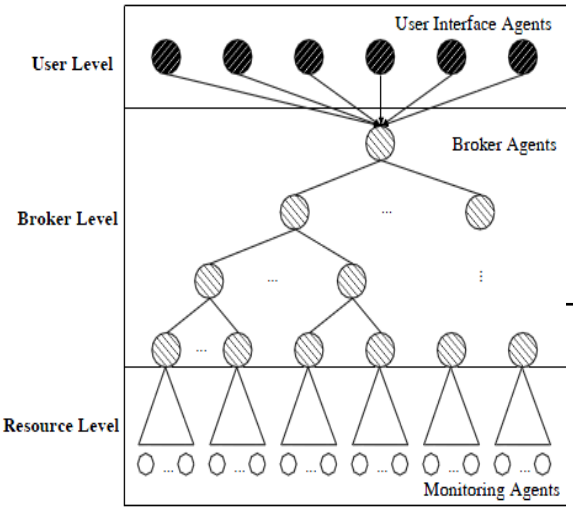

Figure 3.7: Three layers architecture (Haring, *et al.*, 1998)

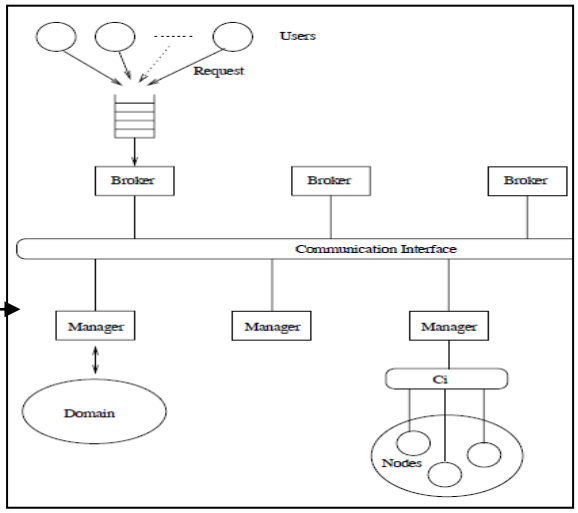

Figure 3.6: Two layers of broker (Haring *et al.*, 1998)

Gudes and Tubman (2002) designed WfMS which focuses on security at database level. Its implications are static role based specifications and dynamic individual rules. Alter-egos element in cyberspace is object which relevant details of an individual person is kept and can execute actions on behalf of the individual. One user can participate in many workflows at the same time but they can access their unique instance in cyberspace through alter-egos and access to different workflows. Each database requires unique task and only one and access to it. So it can assure the security of database. Moreover, the Workflow access layers divides into three layers. Each person can have access to her/his host, communicate through Alter-ego and the message goes to each cluster of workflow where specific agents are responsible. Basic idea of three layers architecture is same as Haring architecture (Haring, *et al.*, 1998).

3.2.4. Findings

The common of all those architectures is having three layers: client, server and database. Database has two types which are for object (land parcel) data and for workflow data. According to Grefen and Haring architecture, there should have user interface (UIS, Communication interface/broker, Alter-ego) which to help communicate with core workflow engine and access to application. The user interface is important in public information and participation of citizens. If the customers or citizens can easily access to the system, participate in the process or workflow, brings transparency for land transaction process. Between the workflow engine and resources, there should have components for scheduling the tasks and work list such as active rule support of WIDE architecture. Especially, time manager ensures the process completes in allowed duration. And scheduler helps distributing in appropriate way work list to users which can avoid waste time and human resource. Another point which is derived from these works is mediator component of CWA. As discussed previous chapter, land transaction has involvements of many actors from variety organization so the cooperation among them plays important role in maintaining consistency of information during the process and ensuring the process either completed or abort (atomicity). Workflow includes several stages of process and each stage need to be allocated different resource and rules. If many users want to access same data or resource at the same time then locking mechanism will take place and make the atomicity and isolation properties of transaction difficult to perform.

3.3. Workflow management system: In practice

In this part, a real case of workflow management system is taking place in Netherlands. The reasons of choosing Netherlands are:

- Netherlands has high score of level of transparency in land sector. So from the study of the Netherlands case, we can have idea about how develop WfMS in transparent way, what should we take into account to achieve transparency.
- Netherlands Kadaster had introduced WfMS concept in early age of workflow (Osch & Lemmen, 2004). Compare to other countries, Dutch Kadaster has a long time developing a well functions cadastre system. So learning workflow from Dutch Kadaster will bring ideas of designing workflow architecture.

Therefore Netherlands is ideal place to have designing criteria in terms of transparency in land transaction process.

3.3.1. Methodology of data collection

Varieties of data were collected in the fieldwork from two main sources: primary and secondary.

a. Secondary data

Before visiting offices, who are involved in land transfer and what the main steps of the processes were studied by literature review from documents and website of cadastre and municipality.

b. Primary data

After determining stakeholders and theoretical process, a plan for visits and methods were made as described in Table 3.1. The table presents the visited offices, interviewed stakeholders and methods used for each of them.

Table 3.1: Methodology for primary data

No.	Office	Stakeholder	Function	Methods	Aims	Note
1	Local Cadastre Office in Arnhem	Administrator Surveyor	Dealing with registration and surveying jobs	Observation and unstructured interview	Learning how they process transfer land	During interview and observation of all stakeholders there are extra questions to make clarify and dig more deep about transparency and designing criteria.
2	Central Cadastre Office in Apeldoorn	Planners Adviser Tactisch	Dealing with monitoring and checking works in local office	Observation and unstructured interview	Learning how they monitor the main workflow	
3	Enschede Municipality	Team Real Estate Information	Dealing with registration building, giving address	Structured and unstructured interview, observation	Learning how their system integrates with Kadaster	
4	Ten Hag office	Real Estate Agency	Mediating deal with seller and buyer	Structured interview	Learning how they access to information and procedure dealing with customer from the beginning to the end	
5	Hofsteenge& Wesseling office	Notary	Preparing deed and mediating payments to stakeholders	Structured interview and observation	Learning how they access and check information of customer and process with deed	

3.3.2. Results

Historical background

In 1811, fiscal cadastre was introduced in Netherlands by Napoleon. Since then, Dutch Kadaster had been completing the system and made it one of the best cadastral systems ever. From 1838, all the works such as surveying land and listing owner of parcels were done. Updating the system with registration for deeds of mortgage and transfer has continued doing. The legal land registers and the cadastre was joined within the national tax department, the Ministry of Finance.

The land registers and cadastre serve a multipurpose aim. First of all, the Civil Code prescribes 4 requirements for a legal transfer of rights 'in rem', which are right of disposal of seller, agreement between buyer and seller, required title, and recording in the public register hold by the Land Registry and Mapping Agency. The combination of Latin Notariat and land registers and cadastre provide de facto title security (van der Molen, 2006).

Procedure

A normal procedure of a land transfer is as follows. If a buyer and seller agree on a sale (most guided by a real estate agent, a non-compulsory party in the land market), a notary public (compulsory) draws up a notarial deed of transfer, after verifying the right to dispose by the seller and the like. After the signing of the deed by both parties and the notary, the notary public signs a copy as a true copy which is submitted to the administrator. The administrator checks some formal requirements, and records the deed and provides relevant evidences for this to the notary public. As the notary public is also the intermediate for the financial arrangements, the purchase prices are kept by the notary public until the evidences of recording is received, only then the purchase price is paid to the seller. A similar procedure pertains to mortgages, which secure loans on land and buildings. In case of the transfer of a subdivided land parcel, the land surveyors surveys the new boundaries, and assign new parcel identifiers (Wakker, 2003). Land Kadaster Information (LKI) is spatial data, authorized for surveyors. AKR is Automated Kadaster Register which is attribute data, authorized for administrators.

3.3.3. General Workflow

Land transfer in Netherlands has two types which are full transfer and subdivision. In case of full transfer, there is exception that the buyer wants to buy neighbor's parcel to merge with his land. This part shows the high level abstraction of the process. Then the following parts describes more detailed of each sub-process.

Figure 3.8 presents the flow work of the process. First of all, the buyer purchases the property of the owner after agrees with the deal. The purchase can be only between buyer and seller or helped by real estate agency. Then buyer and seller come to Notary to prepare deed. Dependent on the case which is full transfer or subdivision or merging, the Notary submits only the deed or do one more thing that is ask for surveying. In case of surveying jobs, request is distributed to surveyor and the job is processed while the deed is processed by administrator. After all, administrator and surveyor send confirmation to Notary and Notary informs the result to customer. Last stage is customer pay Notary. Figure 3.9 describes the process and the involved actors in higher level of detail. The diagram shows the different roles of actors. The process starts from both seller and buyer. Without one of them, transaction cannot happen. Seller has to request Real

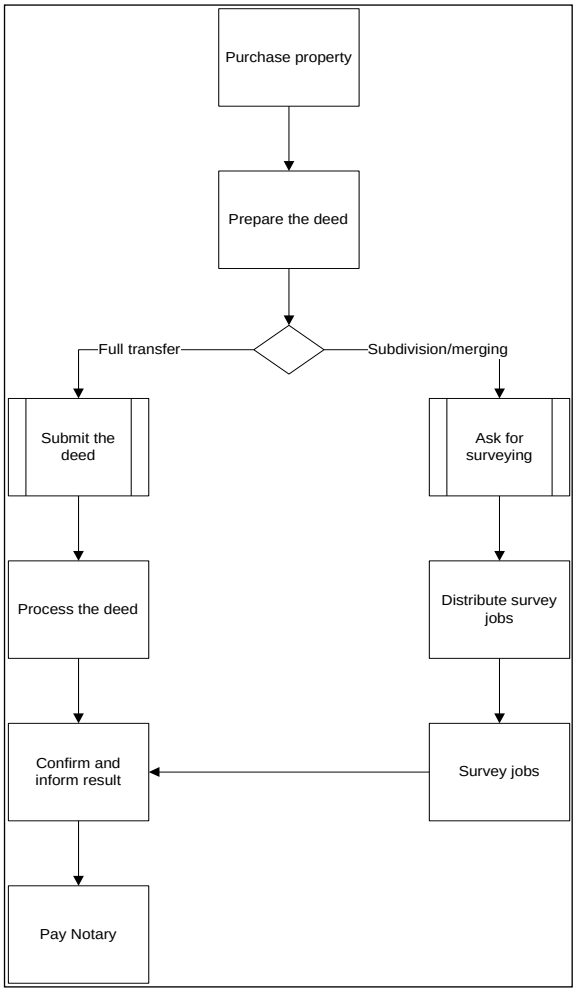

Figure 3.8: Flowchart of transfer (full transfer and subdivision)

Estate Agency (REA) to advertise the land or properties. The buyer asks to buy that land or properties because he has interest in it. After the agreement of seller and buyer is made, both of them have to *pay to REA*. This activity is same like others activities such as *request for deed, sign in the deed, pay Notary*. They take place between lanes of seller and buyer as in Figure 3.9 because both of parties need to do same activities at the same time and cannot happen in one side only. REA has roles of advertising properties, negotiating the price, and taking them to Notary. Notary has roles of preparing deed, request cadastre for transfer activities, confirming seller and buyer. Administrator in cadastre needs to update administrative data. Planner collects surveying requests and distributes geographically jobs. Surveyor needs to go to field and legal guide seller and buyer about boundary, survey and update spatial data. Details about each stage are described in next sections.

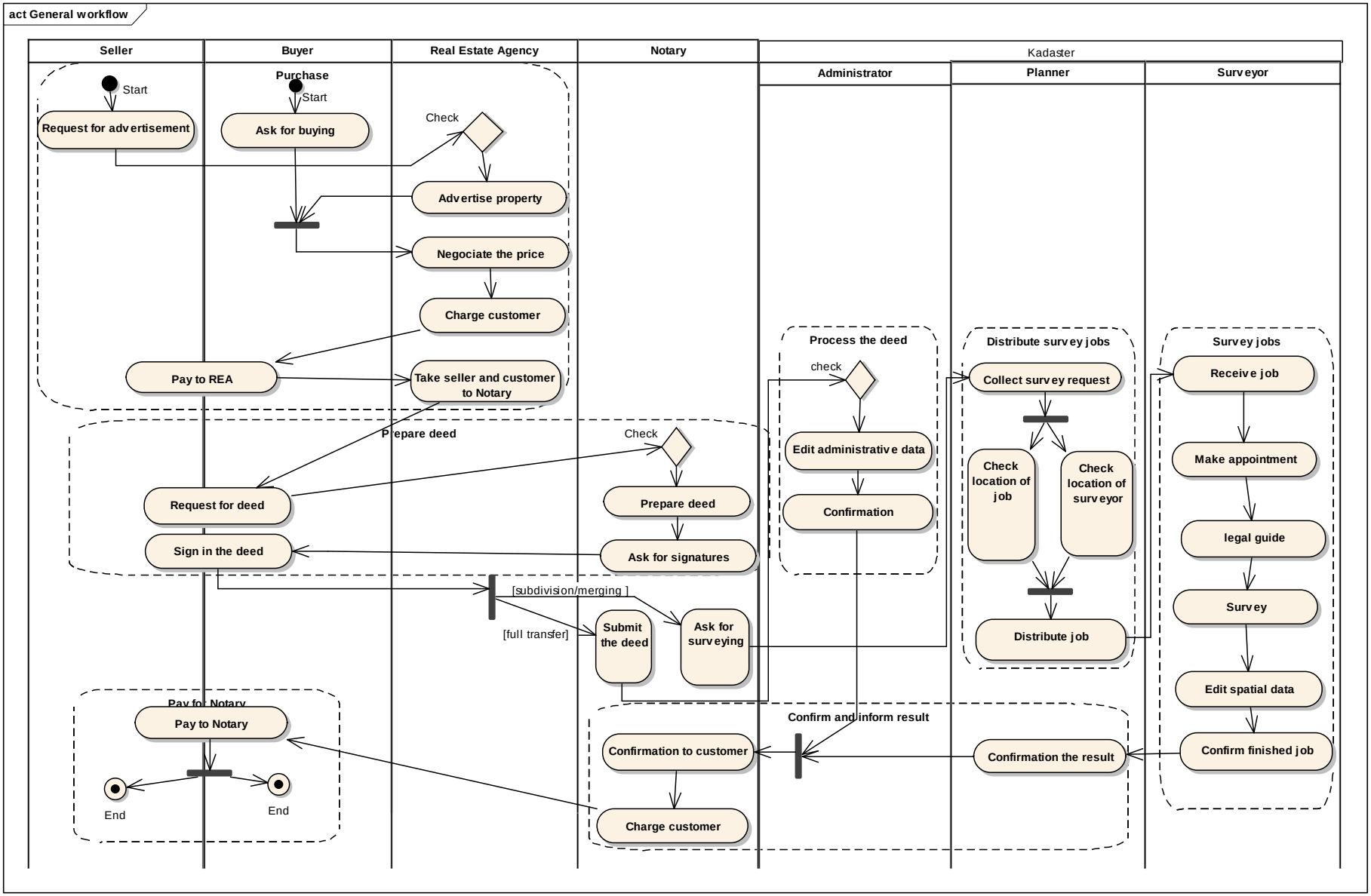

Figure 3.9: Activity Diagram for Land Transfer

3.3.4. Purchase real estate property stage

Real Estate Agency (REA) is not compulsory involved to the land transaction process but usually seller and buyer look for REA's help. Figure 3.10 is described how a transaction start and what REA's tasks are in this process. The chain starts with the people who have interest to sell the property. In the real estate market, there are people who want to sell so there must have people want to buy. The seller and buyer have equal position in the market so the process starts from two people but may be different time.

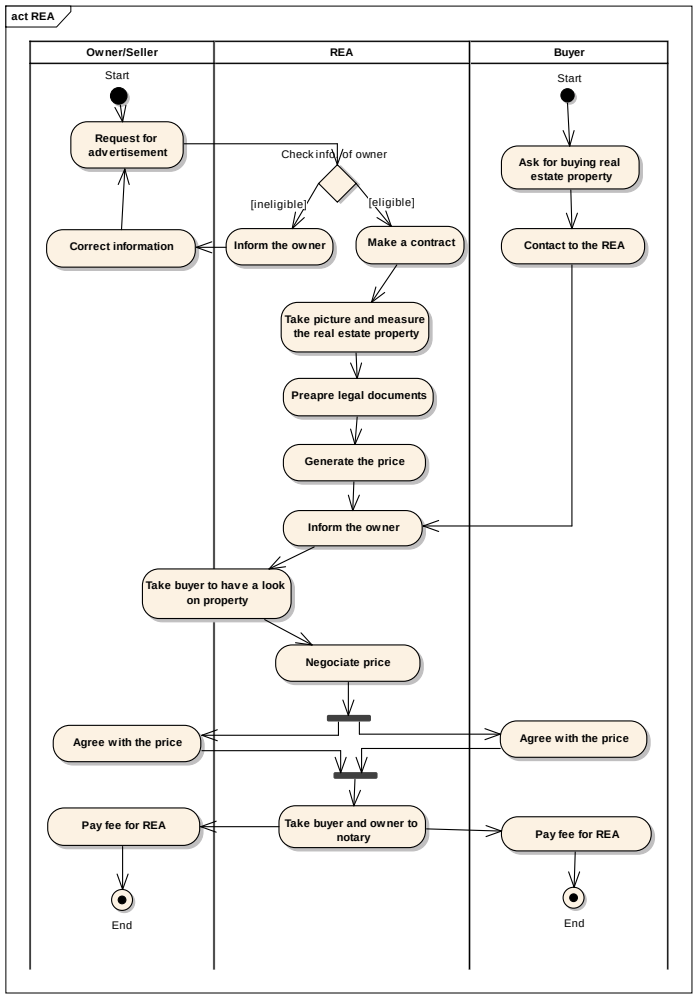

Figure 3.10: Activity Diagram for Purchase Stage

When the owner wants to sell his property, he comes to the Real Estate Office (REO) to advertise the property. Before advertising it, REA has to investigate a little about the owner and the property he wants to sell. Because the database Kadaster provides for REO is more detailed than citizen's, REO has to pay monthly for Kadaster. By accessing into Kadaster database, REA can do simple queries such as name or address then he can check whether the owner is real owner of the property. If not, there are may be some mistakes of information the seller provides. When REA is sure about the owner, they make a contract of advertising property and some regulations or terms. To have further information, REA goes to the property with owner to take pictures and do some basic measurements. Then legal documents are prepared to sell the property. The most important of advertisement a real estate property is price. And REA again looks into Kadaster database and other online sources to generate the price. Even REA does not do as professional like valuer, he just can look for similar property, search for price of that property and adjust the price which is reasonable and interesting for buyer.

The buyer is person who has interest in the property. He comes and asks about it. REA informs the owner that there are someone interested in your house. REA and owner *take buyer to have a look on the properties* in Figure 3.10, this activity takes place between seller and REA) and all of them negotiate the price base on what buyer feels. When both buyer and owner agree with the price, REA takes them to Notary to make a deed. After all, buyer and seller have to pay fees for REA because REA helped them to find their interest.

In whole process, REA plays main role with many tasks. However, it can be seen that access to information is mainly things bringing transparency. It makes the REA is sure about the owner and generates appropriate price for the property.

3.3.5. Prepare deed stage and confirmation stage

In Dutch system, Notaries play very important role in land transaction. Notary is not only the person who handling legal issue of transaction but also mediating all payments. The diagram in Figure 3.11 shows the process in Notary side.

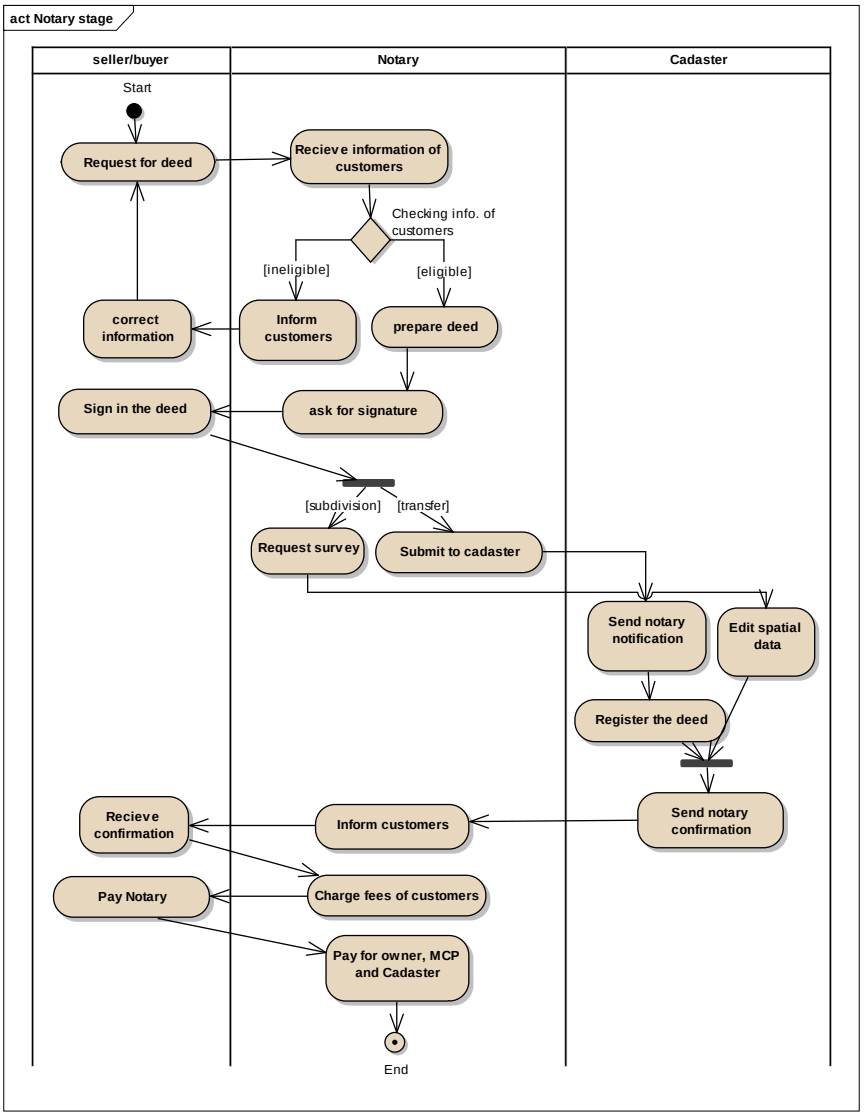

Figure 3.11: Activity Diagram of Deed Preparation Stage

Continuing with previous diagram, when buyer and seller agree with the price, they go to Notary. In this process, the roles of buyer and seller are equal so they are considered as one actor. Notary receives the case of transaction but he still has to do an investigating of the owner and property. The seller and buyer have to show only ID. Different from REA, Notary has professional access to both cadastre and municipality database (GBA-V). Notary can see history of the property, who owns it and all detailed personal information of owner even bankrupt status. In Dutch law, husband and wife share the ownership of property. So when selling the property, it is needed signatures of both parties. Also Notary needs to check the price of the property whether it is reasonable or not because it effect to taxes of municipality.

For the special database, Notary has to pay 20 Euro cent/view in GBA-V and various fees for information in cadastral database. Normally, if there are some things wrong with the owner/buyer's information, Notary asks him for detail and correct it. But most of the cases, the customer is eligible. Notary goes forward with preparing deed and asks seller and buyer and their husband/wife sign in the deed. Notary prepares deed by special software which is developed by Kadaster and it connects to municipality database. So the deed has unique ID and the information in the deed is extracted from GBA.

In case of transfer full ownership without merging parcels, Notary submits deed through email with private key and he gets notification PKI that he sent this deed to cadastre. Because of this notification, if someone steals Notary's account and send illegal deed, Notary knows it and inform to cadastre to stop the transaction.

In case of subdivision, Notary asks for surveying. When cadastral office finishes registration and editing spatial data, they send confirmation to Notary. After registration, the ownership belongs to buyer and

seller receives money from Notary. And Notary pays fees for cadastre and tax for municipality. For payment, Notary has special client account which is civil notary's purpose. It is not belong to Notary but customer pay into that account and Notary use that account to pay for other actors.

In conclusion, because of the importance of legal issue in the deed, the Notary has special software to make a deed, special account to check information. However, all the database and application are connected in order to remain consistency information. Another remark is the communication between Notary and municipality, Notary and Kadaster. They are very fast and updated. So it ensures that if there are any frauds or mistakes, they can quickly detect and handle.

3.3.6. Cadastral stages

a. Current Background

During five year, Dutch Kadaster has major change in term of organizational structure. There were 15 local offices in 15 regions and 1 head quarter. Now there are 6 local offices and 1 head quarter. Six regions of 6 local offices are Eindhoven, Arnhem, Rotterdam, Amsterdam, Groningen, and Zwolle.

In the local office, main employees are administrator, surveyor and manager. Surveyors have main tasks which are editing spatial data, legal guide the parties in the field and surveying. Registrars do registration, editing administrative data and dealing with notaries. Manager manages general things in the office, checks the changes in the system, and detects the illegal transaction or wrong information in the system.

In the central office, there are planning department which receives and distribute surveying jobs of whole country. In the past, the workload was too much but there were so many surveyors instead. However, jobs were not finished in time. Some surveyor had too much work, some had too less. So effectiveness was not achieved. Now planning department helps to distribute equally to surveyors by workflow management system SAP and GIS support.

b. Distribute surveying jobs at the central office

The central office relates to the local office mainly in distributing surveying jobs. There are 6-7 people called planner who do collect and distribute surveying jobs. They use workflow management system – SAP which was developed by a private German company and Mapinfo to present geographically jobs and surveyors.

Figure 3.12 shows how the workflow runs in the central office. There are customers, customer service, planner and surveyor. Customers can be citizens or Notary. They can request for surveying through either internet or customer service. Customers have to pay fee according to the fix price customer service charge. After all, all requests are collected by customer service and here they are digitized and categorized to send to Planning

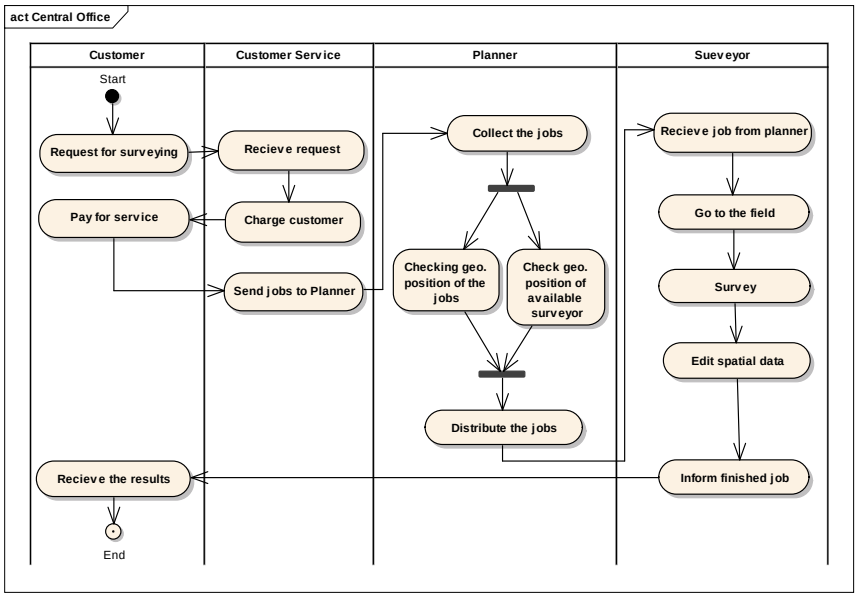

Figure 3.12: Activity Diagram of Distributing Surveying Jobs Stage

Department. At night, all of requests are on the list of Planning Department. In the morning, planners start processing them. Normally there are 80 jobs come per day. Planners try to finish it by day. Because the request's deadline is 20 days and job will be processed by next day, so when request comes to surveyor, it is already 19 days left.

Firstly, the planner looks the geographical position of the job and geographical position of surveyor. However, type of job should be same with type of surveyor. Following Table 3.2 explains detail about types of job types and work list of surveyor.

Table 3.2: Table of types of surveyor (left) and table of types of job (right).

Worklist	Description
	Boundary reconstruction
	Merging parcels
	Postal verification
	Operation in field
	Formation a new parcel
	Formation a parcel by external data/ measurement form private surveyor
	Work at the office

Type of surveyor	Description
Point figure	Identification collector
Ship	Brand
	Brand, split, merge, post
	Employee within department
	Boundary reconstruction
	Split, merge, post

There are two criteria to give the right job to appropriate surveyor:

- Type of job should suitable to type of surveyor.
- That surveyor should be available to do the job. Because each of surveyor has his own capacity of working which is informed to planner from early. If he informed he can do 10 jobs, he already received 9 jobs, so he can only receive 1 more job.

After distributing jobs to surveyor, planner can check in workflow system that how many jobs are processing, how many jobs are going to out of deadline and who are in charge of that jobs.

Surveyor has his own account for workflow management system SAP. He also can check the status of his jobs but cannot check other surveyor like planner does. Surveyor receives job then he makes appointment with seller and buyer to the field, then surveys and edits spatial data. In workflow system, there are numbers to present work status:

- *20: to tell seller and buyer where the boarders is and cross check document*
- *30: to measure parcel*
- *40:to edit spatial data/ administrative job*

After surveyor finishes his job, the workflow automatically uploads status of the job. And results are sent to customers.

c. Process the deed and process survey job at the local office

In the local office, there are administrator, surveyor, and manager. Administrators are people who process deeds and edit administrative data. They make sure all the deeds are processed in one day. Surveyors are people who receive jobs from jobs of headquarter. Their main jobs are legal guide in the field, show boundary, surveying and editing spatial data. Manager plays a role of management the work process in the local office. Besides, manager checks all of works done in month. If the work had done wrong, manager tracks whose responsibilities to ask correct the faults.

In the beginning of the fieldwork, two types of transfer are determined which are full transfer and subdivision. However, the more detailed fieldwork took, the more sub-types were found. In case of subdivision, there are two sub-types. One is buy a full parcel and one is buy full parcel to merge with own parcel. In case of subdivision, one is speed survey request which is request from customer and another is survey request from notary.

Full Transfer:

As described in Figure 3.13, the start of this process is Notary because this diagram presents the look from cadastre side. Notary submits the deed to registration office through email. Administrators can choose any deed coming to his inbox but normally they follow the sequence. After receiving the deed, administrator checks information about Notary. Because sometimes, Notary's license is out of date and he doesn't allow making deed. Administrator also checks information of the deed such as owner's name, address, parcels ID, etc. If the deed is ineligible, it is returned to the Notary to rectify it. Normally, the deed is eligible, and then it is processed and edited in administrative data. In case of normal full transfer, after administrator finishes job, the notification and confirmation is sent to Notary. But in case of merging parcel, after administrator finishes editing administrative data, surveyor receives jobs for surveying from the central office. Surveyor makes appointment with seller and buyer to legal guide them according to the deed, show them the boundary and go back to office to edit spatial data. After surveyor finishes his jobs, Notary also receives confirmation from surveyor. Actually, when Notary receives confirmation is the end of process (in cadastre side).

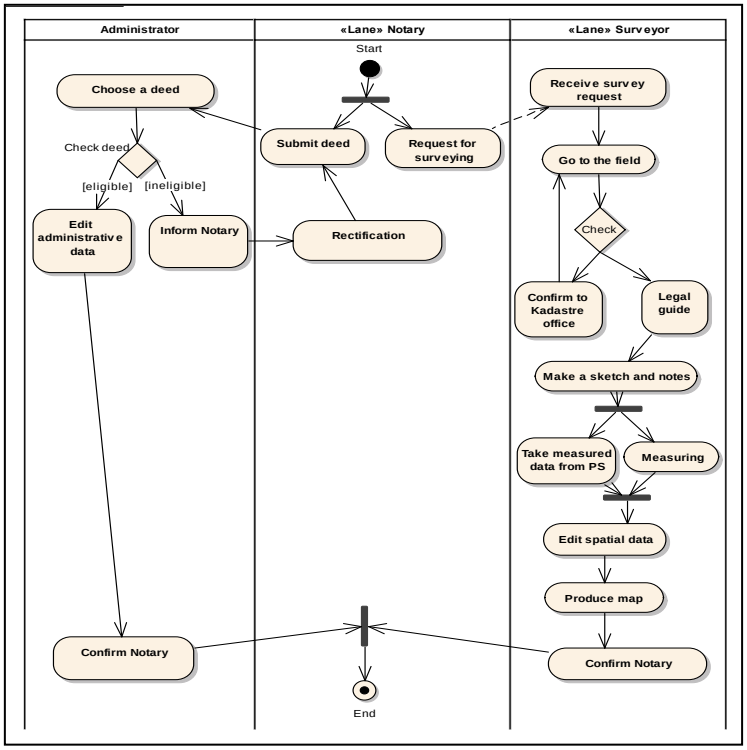

Figure 3.13: Activity Diagram for Deed Processing and Surveying Stage (full transfer)

Subdivision:

Case 1: Request survey from Notary

As can be seen in Figure 3.13, Notary submits the deed and requests for surveying at the same time. The deed is processed same as normal full transfer case. However, the part of surveyor is quite more complicated than merging parcel case above. As described in Figure 3.14, after receiving jobs from the central office, surveyor makes appointment with seller and buyer then check information in the deed with them. According how much land seller wants to sell, surveyor discusses with them the choices of cutting a parcel. After seller and buyer agree with the solution, surveyor makes a sketch and note about subdivision. Surveyor can survey himself or leave that part to private surveyor (PS). Finally, he goes back to office and uses his surveying data or collects from private surveyor to subdivide the parcel. Confirmation of administrative and surveying jobs are sent to Notary.

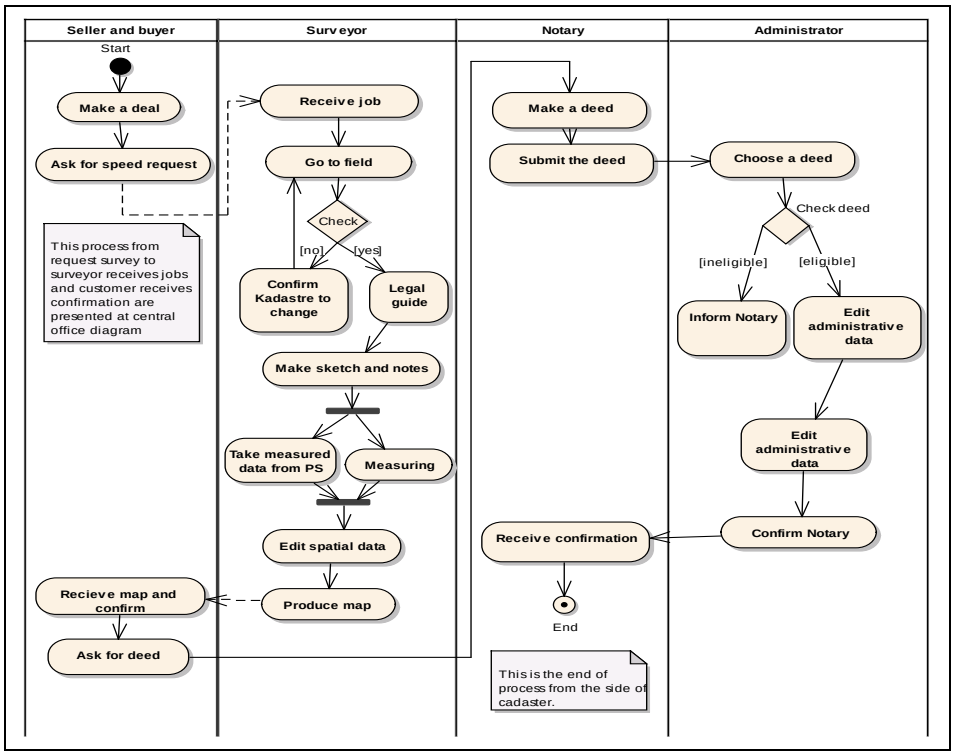

Figure 3.14 : Activity Diagram for Deed Processing and Surveying Stage (subdivision)

d. Address of building and exchange updates with Kadaster at Municipality office

In land transaction process, municipality (MCP) is not involved so much. Kadaster registers updates and manages parcel databases. MCP registers updates and manages building database. Every month, MCP and Kadaster update for each other database by exchanging the changes of data within a month. Each of them has right to receive updates but no rights to change other database. When MCP sends updates to Kadaster, they receive notification that changes are right or wrong. If the update is wrong, MCP checks it whether correct or not.

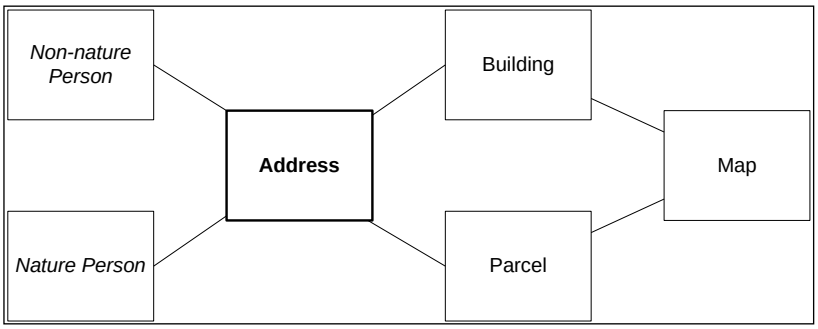

Figure 3.15: Key register model.

If someone wants to build anything on the land, he needs to ask permission from municipality. Municipality looks into land use plan. Because there are some limitations for building or rebuilding a building/a house, municipality is always careful with historical buildings such as monument, museum, etc. When a house is registered, it has address. However, land parcel without buildings does not have address. Some constructions like farm house for food or animals are not required to register. Sometimes address can be duplicated in the system in case the old house has permission for rebuilding. Municipality uses key register concept in Figure 3.15.

3.3.7. Findings

This section was carried out the case land transfer in Netherlands with primary and secondary data. There are several interesting findings about workflow and transparency in each stage which is described in Table 3.3.

Table 3.3 : Key findings in practice

	Stage	Findings
Internal	*Process the deed*	- Assessment (checking) before processing the deed - Authorization to ARK - Can access to LKI to view spatial data (cross checking) and GBA of municipality - Workflow of administrator and surveyor is quite separated - Notification and confirmation are sent automated to Notary - **I** : has to finish deed in one day make themselves have to process in sequence (flexibility in work)
	Process survey jobs	- **A:** surveyor checks deed information in the field but he only ask for correct information, do not stop the transaction. - Only surveyor can do legal guide and show boundary. Surveying jobs can leave for private surveyor. - **I**: Once surveyor is editing 1 area, others cannot view or edit that area till he finishes - Well communication through SAP WfMS with planner - Surveyor has access to AKR to check information if need
	Distribute survey jobs	- Front office to collect all request - Jobs are collected at the night. - Distribute jobs according to ability of surveyor - **I:** deadline for jobs (time manager) force surveyor to do job in sequence. - SAP cannot connect to GIS - Planner can see WF of surveyors but surveyor can not - **C:** status job between WF of planner and surveyor are consistent.
External	*Purchase property*	- Access to database of Kadaster and Municipality to check information of customer and generate the price of property - **C**: when the owner advertises his property, DB should present this status of object.
	Prepare deed	- **C**: Private software which is connected to Kadaster and Municipality. - More access to information to ensure legality and checking price which involves to taxes of municipality - Automated Notification from Kadaster (PKI) - **A**: whenever, Notary figure out something wrong, the whole process to stop. No more further steps.
	Address of building and exchange updates with Kadaster	- **C**: Municipality and Kadaster exchange updates of DB but not immediately. - **C:** parcel without building has no *address* - Whenever sending or receiving anything, there are always notification and confirmation

- The ACID is realized in Dutch land transfer process. The *consistency* and *isolation* are most important elements that bring transparency for the process. Consistency is showed in data level, workflow level. Databases between Municipality and Kadaster keep consistent so it makes easy for customers who access and check information. Yet the database doesn't update the stage of object immediately such as at stage of purchasing, no-one knows that parcel is being sold to other person.
- Beside ACID, there are some requirements for WfMS architecture.
- The process is divided to sub-processes (stage) and each of them has specific person who take responsibilities (work list). Therefore, if anything wrong, only that person is responsible for mistakes. Because the works are separated and no dependency, when transaction is abort, other people don't have to wait to continue jobs. (sub processes)
- When surveyor edits spatial data then that piece of spatial data is locked. If other surveyors need to edit the parcel in that area, they have to wait (isolation). When the surveyor finishes his job and check out that piece of spatial data, others can access.
- At every stage, information always is checked. If exception happens, they can pass it to special department which deal with these issue. It happened once in Kadaster when Notary's license was expired but he still made deed for transfer. When administrator realized it, he gave to other department and continued dealing with other deeds.
- Actually in subdivision case, the spatial data is edited after administrative is edited. This is problem of consistency in database. When in non-spatial database, there are new row of new owner and new parcel ID, in spatial database, the parcel has not split yet. So the Dutch Kadaster is testing provisional boundary which allow buyer and seller draw provision boundary right before submitting deed to Kadaster. It may increase the transparency issue in terms of publicity.
- The workflow management system was applied to stage "distribute survey jobs". SAP has scheduler for surveyor, time manager for managing durability of survey job and history jobs manager. SAP is connected to private survey companies. Kadaster gives jobs for them, when they finish, they send the results to Kadaster. On the side of Notary, though Notary has special software to connect with Kadaster, there is no WfMS for Notary.
- Dutch Kadaster has excellent client interface by website which provides all information and online-services. Beside customers who have land, other clients such as Notary, Real Estate Agency, etc. have special account for the same website but more services and information which support for their jobs related to Kadaster.

3.4. Design elements for reference architecture

From theory and practice, here in Table 3.4 are summaries of lessons that can be applied in workflow reference architecture to enhance transparency issue. These are considered as design elements.

Table 3.4: Designing Elements for Reference Architecture

Elements	Theory	Practice
Three layers architecture	√	√
Two set of databases (object and workflow)	√	√ (DB for WF is temporal)
Client interface	√	√
Client scheduler (match client's request and workflow)	X	√ (semi-automated)
Tracking historical activities	√	√ (temporally)
Workflow scheduler (match work list and resources or data)	√	√
Mediator for other WF engine	√	√
Exchange updates of DB to other actors	X	√

Concurrent users access to DB or transactions happen same time	X	√
Locking mechanism solution	X	X
WF connect to GIS	Not mention	X

3.5. Concluding remarks

First of all, chapter 3 proved that to enhance transparency in land transaction there should have more requirements than ACID properties. Among these four elements, isolation and consistency are more important in enhancing transparency at data and workflow levels. The practice of land transfer case in the Netherlands shows that there are other requirements for transparent reference architecture for WfMS in land transaction process such as front office to public information to citizens, professional gateway for Notary or Municipality to access to the database and process internal works, distribute geographically surveying jobs according. Also the case proves that if long running process like land transaction, it is better to divide it into sub-processes (stages); atomicity of the transaction will be easily ensured.

Secondly, by exploring theoretically prior works and experiencing Dutch land transfer, several elements were derived to design reference architecture such as client interface as front office, two set of database, tracking historical activities, mediator, locking mechanism, etc. Versioning approach was also discussed as solution for high isolation without interfere consistency element.

So next chapter proposes reference architecture and describe in detail of each component and how it enhance transparency in land transaction.

4. REFERENCE ARCHITECTURE FOR WFMS

4.1. Introduction

In previous chapter, design elements for reference architecture were derived from lesson of theory and practice. The reference architecture should be mapped into three layers which are client, server and database. Client layer supports for open interoperation interface between citizens and internal organization. Workflow server is the main part of workflow architecture which processes requests from citizens. Database is essential part which provides data to execute workflow. Several elements of reference architecture are client interface, client scheduler, workflow scheduler (version), tracking history, mediators, exchange database, two set of data. All these elements should be embraced in reference architecture for WfMS so it can enhance transparency in land transaction process.

This chapter uses those elements to develop reference architecture for WfMS in section 4.2. Each of components is discussed in detail what functionalities are, how it enhances transparent land transaction incorporating with transparency requirements in chapter 2. To prepare for implementation chapter and test the reference architecture enhancing transparency, higher level of detail architecture for WfMS is derived from the reference architecture within specific viewpoints. The section 4.3 describes not only the architecture but also how to develop the architecture with transparent viewpoints. Last part concludes the main works that have been done in this chapter.

4.2. Reference architecture for WfMS

Reference architecture provides a reference for developers to work with mapping functionalities onto system decomposition and data flows. Main functions of the reference architecture which are storing, maintaining database, running workflow, and interacting with users mapped in three layers: clients, server, and database management. However, these three layers have to interact consistently and each layer needs to provide several significant functions through components.

The client layer includes client interface and client scheduler. Client interface is introduced as element to enhance transparency. It provides interface for citizens' access to the system and acquiring services and information. Client scheduler connects to client interface because it collects requests and queries from client interface, analyzes them and distributes them to appropriate workflow and returns results to citizens.

The workflow server layer includes administration and monitoring, internal workflow engine, version manager, control flow mediator and external workflow engines. Administrator and monitoring component defines process definition, manages workflow engines and database. Workflow engines run process instances which are main processes of transaction. It associates with external workflow engines through control flow mediator which is a secured gateway for proactive communication. Workflow scheduler is replaced by version manager because this component has responsibilities to distribute version of database to appropriate workflow.

The database layer contains internal DBMS, external DBMS and data flow mediator. Internal DBMS has functions of storing and maintain database. The database includes database of workflow and database of parcels. Data flow mediator is secured gateway to exchange database updates between internal and external DBMS.

Reference architecture for WfMS in land transaction is illustrated in Figure 4.1:

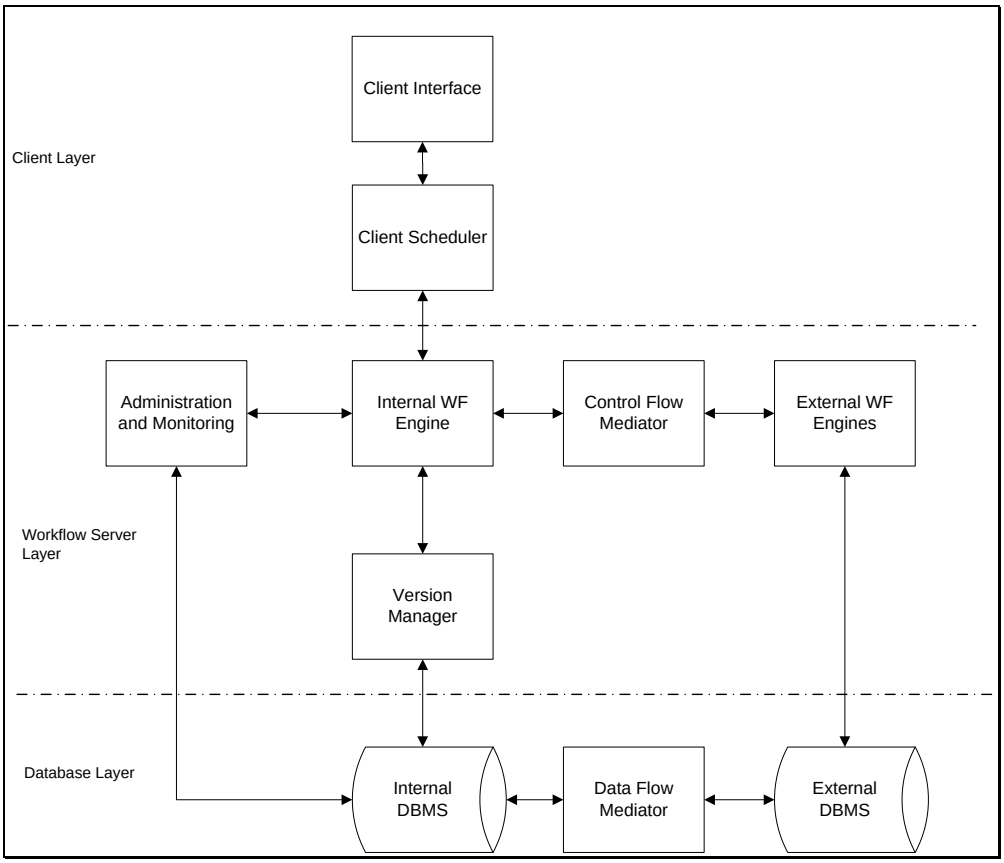

Figure 4.1: Reference Architecture for WfMS in land transaction

4.2.1. Client layer

a. Client interface

Client interface provides customers facilities for accessing to cadastral services and information. The interface is a website or open source which is easy to use. On this interface, citizens are not only able to know about parcel and owner information but also know about updated information of their land transaction. That is one of the most important criteria of transparency.

For example, Dutch Kadaster has developed successful online interface. Kadaster online has been support a lot in enhancing transparency in land administration of the Netherlands. In the interview with experts and citizens, they all agree that Kadaster is very open in public information. Citizens can query simply who own what and get the results with small payment. For citizens, the provided information is limited at basic level. For professionals and experts, the interface provides special account with more details information related to specific purposes.

b. Client scheduler

Client scheduler collects request list and matches the request from customers with the process definition in workflow engine. Event analyzer and time manager are included in this component to ensure the jobs are matched with the right process and done in time.

4.2.2. Server layer

a. Administration and monitoring

Administration and monitoring component is common interface which enables several workflow engines to share a range of common administration and system monitoring functions. Workflow engines may

work in different level of administrative (local) but all of them are managed and monitored by homogeneous central system. It controls human resource and process definition creation, and supervises process instances. Administrator and monitoring tools have following functions:

- Create and modify process definition for each workflow (stage): Land transaction process is recommended in chapter 3 to divide into stages (workflow) to enhance atomic character. By designing process definition of sub-processes, time is less consumed and atomicity of transaction will be increased to higher level.
- Create and manage users and privileges for users: it helps to clarify the roles and responsibilities of users. So this component makes sure each user or group of users has specific roles in execution process definition. Such as surveyor has roles of checking spatial character of parcel, edit spatial data, and update spatial data; manager checks updates and monitors, etc. Besides, grating rights to users to do their jobs is essential but there should be limitation according to their roles in transaction process. It is a part of security in management transaction but still it plays important role in enhancing transparency.
- Manage historical activities: it was mentioned in fieldwork about transparency that "failures and corruptions cannot totally prevent or eliminate from public administration system but there can have scenarios and predicated solutions which can handle failures and corruptions when it happens". All activities and transaction will be stored even it committed or aborts. Therefore, function of historical management will help tracking historical activities if there are mistakes or wrong execution, etc. Failures and corruptions can be detected and trace for responsibilities.

b. Internal workflow engine

Workflow engine component is essential part of workflow reference architecture which controls execution of workflow instances. Internal workflow engines have following functions:

- Create suspend, termination, etc. of process instances: workflow engine considers states transition when activities instances change to next step. These basic states will ensure the transaction atomic:

  Initiated: a process instance has been created but process has not yet fulfilled conditions.

  Running: the process instance starts executing activities instance.

  Suspended: the transaction has some problems such as information is incorrect or failures of system, process instance will return to running state.

  Completed: process instance fulfilled conditions

  Terminated: execution of the process instance has been stopped before its normal completion.
- Navigation between process instances: a transaction process contains several process instances. So integrated working environment should be implemented among process instances. Following is the *scenarios* of how different processes integrate: connected discrete, hierarchy, connected indiscrete, parallel synchronize. The processes are not only associated to each other within cadastral organization but also to other workflow engines belong to other organizations.
- Log on/off relevant data, version, or application to present the work: one of unique character of land transaction is that spatial data/information plays important role in tenure security and citizen trustiness. During execution process, the activities instances should be able to access to appropriate version of geo-database which is managed by component Version Manager or essential applications.

c. External Workflow engines

Land transaction involves to external organizations such as municipality, notary, and private survey companies. Even each of them just participate a part of transaction, they have their own business process,

business rules and data flow. So they have their own workflow engines. Their business processes are not only connected to cadastral processes but also among each other. Some works assumed that these engines are working same workflow domain. However, it is not necessary. Workflow logistic are connected discrete, hierarchy, connected indiscrete, parallel synchronize, workflow engines, as mentioned in internal workflow engine.

Before innovate the business process, Kadaster has to give authorization for private company if they want to give jobs for private company. They can access to cadastral system for executing some steps of process. However, it makes the process running slowly, atomicity was not easy to maintain and security of cadastral system was in dangerous and corruptions could take advantages of a insecure system. After each actor (private survey company, Municipality and notary) runs its own workflow, the transaction has been executed faster and more atomic. However, to communicate between cadastral core engines and external workflow engines (business to business), there is control flow mediator which will be discussed below.

d. Control flow mediator

Control flow mediator is the component which mediates between cadastral workflow management system and other workflow environment. The mediator is located between cadastral workflow engine and external workflow engines. The mediator plays important roles in enhancing transparency in land transaction as well as business to business process by the following functions:

- Communicate between cadastral workflow domain and external workflow domain: proactive communication among actors' organizations makes sure that the partners know what is going on transaction and what they have to do. If there are frauds or failures during transaction happens, with mediated communication, partners/actors can update those information and react immediately to prevent failures and corruptions.
- Navigate workflow instances without knowing details about an organization: this function helps transition from workflow instance of cadastre domain to workflow instances of external domains in correct way.
- Authorized access: technical security is learnt from theoretical transparency and practice (from Netherlands case) that authorization for privileges is important. This function provides a firewall for cadastre to prevent wrong land transaction to takes place.
- Convert format: because external organization has different format of message, the function can convert it to internal (cadastre) format.
- Store and tracking history: tracking function is also used in administrator and monitoring component. In this mediator, tracking function is used for both external and internal tracking historical activities and jobs which were exchanged among them.
- Message queue: It stores messages for communication partners. Message can be considered as notification. For example, before jobs are given or after jobs are completed, there should be a message to notify partner. In case of losing authorization or someone steal account and send an illegal transaction, message with unique key will help the user who lost account know that there are frauds. This function is applied in Dutch case and was discussed in chapter 3.

e. Version manager

Workflow scheduler aims to match data to workflow but if transactions happen concurrently with locking mechanism, it is difficult to maintain isolation and atomicity. Versioning approach as mentioned is good solution for conflict between isolation and atomicity when concurrent transactions take place. Therefore, workflow scheduler is replaced by version manager to elaborate version concept and manage versions.

This component has function of create, delete, store and manage all versions of database. It ensures after transaction commit, updates have to be posted back to database.

Version is associated with DBMS and workflow engine. Versions are created from default database. Version is used as a temporal database to edit, can be a part or whole of database. After editing, changes in version will be posted on parent database. In workflow engine, process instances are operated with specific version. For example, surveying stage needs version to edit spatial data. Even for external users who want to edit data for the process, they can have their own version which is granted by cadastral system.

4.2.3. Database layer

a. DBMS

DBMS is the essential component of any business process. DBMS has functions of storage, maintain, and update data. DB includes resource, operations, histories, and object data. Resource data is about information of staff, organization, institutions and their relationship. Operation data stores all workflow data. Historical data stores historical activities instances. Object data contains geo-database with object to parcel. In DBMS, roles of users should be define clearly, who can do what to what extends of data and restricted to users by privileges. Besides, data itself has to keep consistency by primary key and secondary key.

b. Data flow mediator

Data flow mediator is between DBMS of cadastre and external DBMS. The mediator has following functions:

- Exchange updates of database: access to information and consistency in database are significant in enhancing transparency which were mentioned in chapter 2. This mediator has main function is to create safe gateway for external and internal exchange update information. As can be seen in practice case, how Kadaster, Municipality and Notary keep updating their database and it has been helping them to avoid inconsistency.
- Format convert: because external organization has different format of data and data organization, the function can convert it to internal (cadastre) format.
- Authorized access: same to control flow mediator.

c. External DBMS

External DBMS is under control of external organizations. Each of external organization has its own DB and its own way of managing it. So in order to exchange the updates large amount of data, data flow mediator as discussed above helps external organization convert and exchange in safe way.

4.3. Implementation WfMS architecture

In order to verify the designed reference architecture, workflow architecture for land transaction is carried out in this section. The implementation WfMS architecture is higher level of detail if compare to the reference architecture. Developing architecture needs several viewpoints.

As mentioned in chapter 1, TOGAF (2009) has been developing viewpoints on architecture: business, data, application and technology. TOGAF also concludes that depending on what purpose of architecture, some or all viewpoints can be applied for developing architecture. Even new viewpoints can be created to address some specific purpose.

At the same time, Putman (2000) suggests developing architecture from five viewpoints which are enterprise, information, computational, engineering, and technology. Enterprise viewpoint defines business perspective of the system: purpose, scope, roles, policy which is similar with business viewpoint from TOGAF. Information viewpoint is about information of the system and the processing of the system which relates to data viewpoint of TOGAF. Technology viewpoint is same with TOGAF. And engineering viewpoint defines system's distribution which is similar with application in TOGAF. Computational viewpoint defines the system functionality and partitioning into components.

Transparency in land transaction was categorized into three aspects which are function, structure and transactional properties (database properties) in chapter 2. The viewpoints should be chosen in appropriate way and satisfied the transparency requirements. Enterpriser/business viewpoint can fulfill structural requirements of transparency. Computational and engineering viewpoint can fulfill functional requirements. And data/information viewpoint can fulfill database properties requirements. However, all of these viewpoints should be consistent and integrated.

Enterpriser/business viewpoint incorporates structural transparency requirements with presents of roles of user in the system especially roles of manager, hierarchy of administrative offices. Computational and engineering viewpoint incorporates functional transparency requirements in the architecture such as open access to information, assessment and monitoring, security issues. Data/information viewpoint incorporates transactional property requirements in the architecture. Versioning concept should be taken care by this viewpoint and elaborated with ACID elements. The principles are followed but the reference architecture is not layered as the RM-ODP.

The architecture for WfMS as Figure 4.2 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 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 monitoring 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 in Figure 4.2, 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 of components of the architecture should be satisfied the following transparency criteria in table 4. If the architecture can fulfill all of these criteria, it will enhance transparency.

Table 4.1: Architecture components and expected transparency criteria.

S.No.	Component	Transparency criteria
1	Customer Service	- Public availability of information - Access to information - Promote participation and accountability - Consistency
2	Scheduler	- Clarity of roles and responsibilities - Integrity
3	Administration and monitoring	- Clarity of roles and responsibilities - Accessibility restrictions - Tracking histories
4	Workflow engine	- Atomicity, consistency and isolation
5	Other workflow engine	- Integrity
6	Mediators	- Integrity - Means of proactive communication to the organization's important stakeholders - Tracking histories
7	DBMS	- Security - Clarity of roles and responsibilities - ACID
8	Version Manager	- Promote participation and accountability - ACID - Technological security - Tracking histories

4.3.1. Client Layer

a. Customer service

Customer service component includes access facilities online portal, phone and mail. It ensures citizens get open gate to *access to information*. The users who access to customer service are categorized into two types. One is general user. One is professionals and experts. General user can access free to customer service for general information such as owner, parcel, map of them or their neighbour. The provided information needs to be *consistent* with what happen in real world such as the parcel is on stage of process deed so parcel status should be present it for citizen. *The information is available for citizens* but limited at basic level because it is unnecessary for general users and also it makes sure people can use detail information to do illegal things, ensures privacy of citizens. Professionals and experts such as planners, notaries, etc. have special authorization to access to information because their needs are much more detail information for checking and processing legal processes (full transfer, mortgage, etc.). In case transaction, seller and buyer will have special account to see how the transaction workflow is going on. So this component promotes the *participation of citizens* into process and increase *accountability* of the system. Customer service will collect request from users and transfer it to next component – Scheduler.

b. Scheduler

Scheduler collects requests and matches the job request from customer service with the process instances in workflow engine. It helps to improve the level of *integrity* and consistency between client layer and server layer. Such as when citizen asks for information of his neighbor's parcel, the scheduler collects the request, analyzes and categorizes it. Then it matches the job with process instance "supply data" and

available user. After the workflow commits, scheduler returns the results as well. Each of type of jobs has fixed time to finish so time manager taks care of that. If it's going to due time but the workflow has not finished it yet, time manager will ring an alarm for who is in charge of that job will be aware of. So the scheduler plays a role in *clarity and specific responsibilities* of user.

4.3.2. Server Layer

a. Administration and monitoring component

Administration and monitoring includes process definition tools, tracking history, user manager, and authorization. Head manager in head office will take over this component. Process definition tools component is to define, create, and modify process definitions for supply data, full transfer ownership, subdivision and mortgage which will run instance in workflow engine. Each of process definition needs to attach documents or descriptions clearly about laws, policies or regulation related and assigned to specific group of users. To handle well human resources and bring *clarity of roles and responsibilities* of each user/stakeholder in the system, user manager will allocate user to appropriate activities or process and granting them *specific privileges* for the each user or group of users. All the data about process definition, user and privileges are stored in workflow data which is a part of database. It is easy for (head) managers *tracking historical activities/jobs* in workflow system.

b. Workflow engine

Workflow engine component in Figure 4.2 contains several processes. Each process as defined in administrator and monitoring component has *user* involved and specific version of database. Workflow engine component is belongs to local office. There sub-processes are supply data, full transfer ownership, subdivision and mortgage. In each of components, there are several instances for stages such as process deed, surveying, and check quality. Each stage runs and committed. After the previous one committed, the next stage can be executed because of workflow logic (connected discrete, nested, parallel, and indiscrete). So the workflows run *in sequence and atomic*. The user in workflow server layer is people who involve and have rights to execute workflow. It is different from the user in client layer which only request for cadastral services.

c. External workflow engines

Transaction has involvements of external organization such as notary (legal representative of seller and buyer), municipality and private survey companies. Each of these stakeholders has their own workflow engines which run whole process (stage) or a part of process (step/activity) but still *integrate* with cadastral engines. For example, Notary witness the agreement between seller and buyer, help them present provisional boundary on map and prepare deed. So Notary's engine has whole process of deed preparation and connects nested to cadastral engine process deed, etc. How to sure the communication and security between external and internal organizations will be described in mediators.

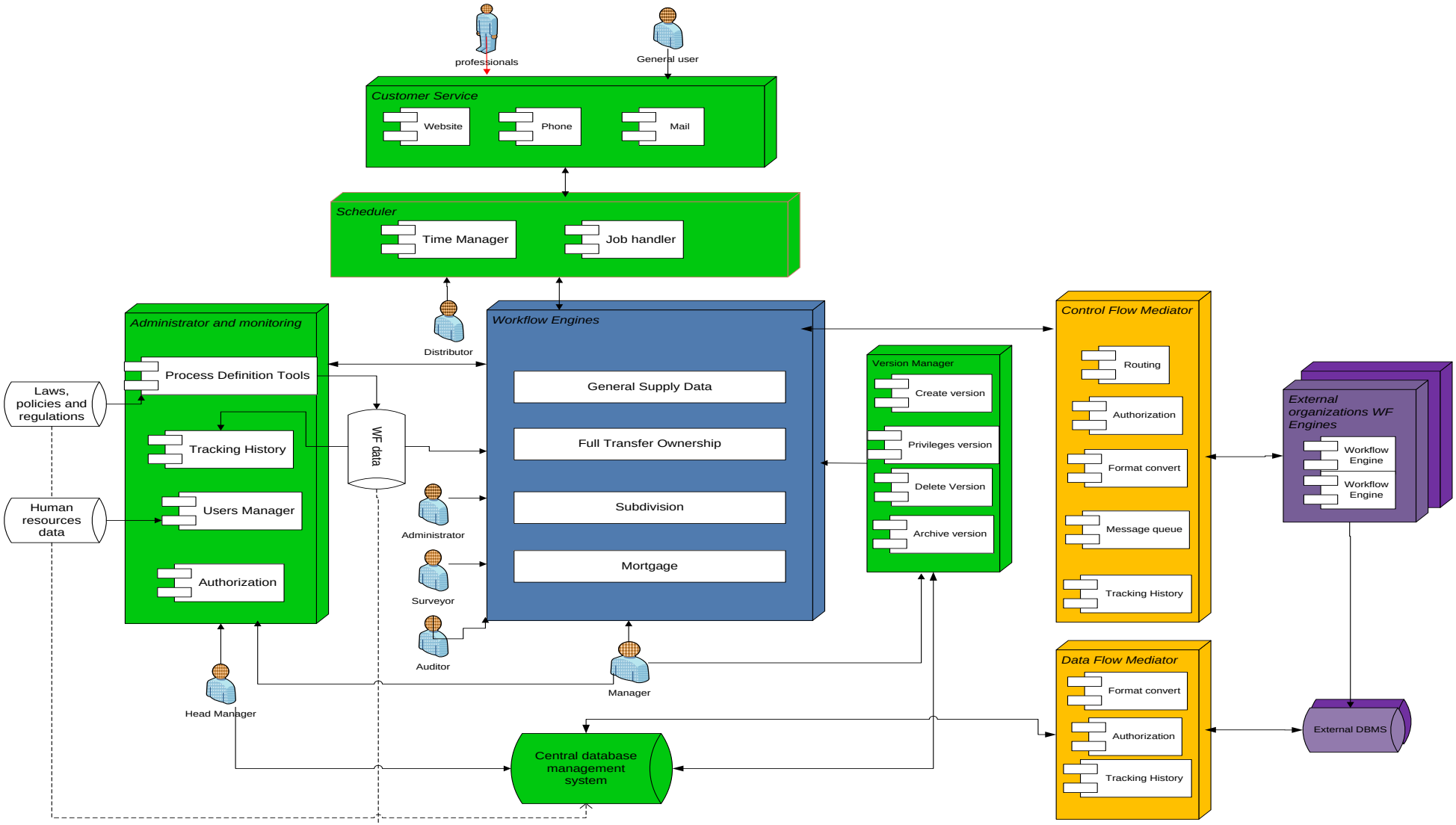

Figure 4.2: Implementation WfMS architecture for land transaction.

d. Control flow mediator

Mediators are important component to provide a safe gateway for *communication between external and internal stakeholders*. There are routing, authorization, format convert, message queue and tracking history in this mediator. The special character of gateway is ensuring the workflow logistic. As described above about external workflow engines, other's engines may connect discrete or indiscrete with cadastral engines. So routing component maintains the logistic of workflows well. Authorization is *security* function of mediator. The lesson learnt from Dutch Kadaster proves that the external integration rights with internal workflow should be given but still *limits rights to access* to the system. Outside world will have different format with cadastre so format convert is needed to interoperate workflows. Message queue makes sure that the jobs are coming in sequence. It means a lot to isolation character of transaction. As well as *tracking history* in administrator and monitoring is important for transparency, tracking history in mediator is needed.

e. Version manager

Workflow manager is interface between DBMS and workflow engines. It can create version when activities instances acquire data to work on then let the user uses and edit their own version. However, user needs to be *granted privileges* to use version according to purposes. Workflow manager allows users to reconcile and archive edits on parent version (local/central version). Land transaction is categorized in long duration and concurrent execution. So version allows the user's engines with different geographical location using and editing essential data (solves conflict of *isolation and atomicity*). Even it is national level or global level, version manager ensures that users have data without copying and locks. So it encourages *participation and accountability* of user. Moreover, version manager helps to update edits to central database in safe and *consistent* way between real world and database transaction. It also has function of *tracking history* of updates data through archiving system.

4.3.3. Database Layer

a. DBMS

Database management system (DBMS) is located in head office and managed by head manager. Human resource data and workflow data, which support for administrator and monitoring functions, are stored in nation database. Workflow data is created when administrator and monitoring component define process definition and when workflow engines run (activities and process instances). In order to privilege version to user in version manager, there should be exist *database user account* consistent with user of version such as manager, administrator, surveyor, etc. So it more embraces the *security* of database and avoids situation of database crash. The central database has *consistent and logical constraints with primary key*. Especially, parcel database has strong topology rules because the *correctness in geometry* of parcel plays very important role in cadastral transparency. At database level, ACID properties need to be maintained.

b. Data flow mediator

Data flow mediator helps the exchanging updates in database secured and able to track histories. The action of exchanging updates aims to have consistency at database between internal database and external database. When any of stakeholders wants to query from database, they receive same result.

4.4. Concluding remarks

In conclusion, this chapter developed reference architecture and higher level of detail architecture for WfMS in land transaction based on the lessons from theory and practice. Transparency criteria were incorporated with components of architecture for WfMS in land transaction. All the elements from previous chapter were imposed in this reference architecture. The RA was divided into three layers: client, workflow sever, database. Client interface and client scheduler are located in the client layer. The workflow sever layer contains administration and monitoring, internal workflow engine, control flow

mediator and version manager. Internal DBMS, data flow mediator and external DBMS take place in database layer.

Derived from the RA, implementation WfMS architecture is more detailed than RA and embraced four viewpoints which are enterprise, computational, engineering, data/information. These viewpoints are expected to incorporate structural, functional transparency and transactional property requirements. Each component was listed several expected transparency requirements. As expectation, client interface, administration and monitoring, version manager and mediators are most important components to enhance transparency.

Next chapter used the implementation WfMS architecture for implementation and verification. It shows in reality the architecture can or cannot enhance transparency.

5. IMPLEMENTATION AND DISCUSSION

5.1. Introduction

Reference architecture and architecture of WfMS were described in chapter 4. The architecture is designed with specific viewpoints which more emphasis on transparency. Each of components was described in detail about functions and which transparency criteria were embraced within. Therefore this chapter carries out the implementation and verification of the design.

This chapter answers the last two research questions: which software package is able to implement the design and whether the design enhances transparency in land transaction process. The first section 5.2 answers the question about the use appropriate software package. It discusses about alternative choices and compares functions of each component in the design with functions in the software package. So the research can bounded the implementation which is described in section 5.3. The section 5.4 is verification the implementation with transparency criteria defined in previous chapter. The last section 5.5 discusses about the results.

5.2. Choosing appropriate software for implementing the workflow architecture

In order to implement all functions of architecture, a software package should be identified. If the choice is good, implementation stage will have good result and finally can prove the architecture transparent. So first of all, number of choices is named and discussed in section 5.1.1. The next part will explain detail about the chosen software and some terminology which is different from the one in WfMC. Finally, the last part will compare components in the architecture and software component so can know in advance how far implementation can be.

5.2.1. Alternative choices of WfMS software

Avoiding the situation of previous work mentioned in chapter 1, Wang was unable to implement enough functions for her workflow model. Since workflow technology was introduced in 20th century, there are many products of workflow management system software such as jBPM, Bonita and ESRI.

jBPM (flexible Business Process Management) provides open source business process execution and management. jBPM Suite has runtime engine, Eclipse plug-in, web-based designer, management console, miscellaneous. Eclipse plug-in supports modeling business process graphically, testing and simulating the design. Runtime engine executes the processes and stores automatically history. Web based interface allows users access to business process, define and modify easily. Even business process (process instances, human task list, etc.) can be controlled through web console. jBPM strongly support user interface and service oriented system.

Bonita is another open source and service oriented workflow management system. Bonita can connect to variety commercial management software such as SAP, DB2, Oracle, PostgreSQL, etc. It also has component to design and manage business process, manage files and multi versions and especially authorize the users within organization.

ESRI originally is specialized in GIS technologies. ESRI has developed series of extensions to support managing GIS. One of newest extension of ESRI is ArcGIS Workflow Manager (WMX). Besides common functions such as runtime engine, eclipse graphic tools, connect human resource, etc. it provides automatic execution related to geo-information and tools for connecting to spatial data and processing data. Especially, WMX is advertising that can connect to ArcSDE to manage versions of geo-database. And it can join to commercial database management system such as Oracle, PostgreSQL, etc.

There is a number of software that has been developing to support workflow management system. However, these software above are powerful ones and have been applied widely. These three choices have strength and weakness but choice should be made by purpose and functions of the architecture. The first priority element software should have is ability of managing spatial data and business process. Bonita and jBPM are strong at open interface to users but lack of connection to geo-information management while ESRI (ArcGIS Resource Centre) is good at managing geo-information and handling workflow management.

5.2.2. Why is ArcGIS chosen?

ESRI or ArcGIS provides tools for managing spatial data, workflows and versions of database by ArcMap, ArcGIS Workflow Manager and ArcSDE respectively. It also has plug-in with PostgreSQL to manage database.

ArcSDE has a character which is very important to elaborate the design –versioning approach. This extension of ArcGIS can create version of database but still maintain the character of database. Moreover, ArcSDE controls and manages versions. Each of versions is able to be granted to specific user different rights of view, edit, update or delete. After the user, who is in charge of specific version, edits or deletes spatial or non-spatial data, he reconciles and posts the updates to parent version or target version. So the changes will be permanent kept in default database. As mentioned in the last part of chapter 3, versioning approach was discussed as solution for multiuser access to database and concurrent long transaction happen. It ensures the character isolation and serizability of transaction. So versioning in ArcSDE can make this theory come to reality.

ArcGIS Workflow Manager (WMX) has all functions of a workflow management system should have. Several tools are create and assign work to multi user, track job activities which allow to identify who, what, when and how of activities on all jobs within organization, report with real time view of the job in WMX repository. WMX in ArcGIS has more advanced function which integrate very much with GIS such as distribute work geographically, integrate with ArcMap, geo-processing tools, URL address, customer applications. Especially, Workflow Manager Administrator can share identical configuration across multiple servers and synchronize the contents to keep track of GIS work being done at various locations. Actually, WMX is able to not only attach the version to the work but also provides tools for associating and managing versions (ArcGIS Resource Centre, 2011).

5.2.3. Taxonomy of workflow in ArcGIS environment

Basically, the terminology used in ArcGIS is similar to terminology in workflow management coalition. However, there still exist the differences between theory and practice. Following are some significant terms and words in ArcGIS Workflow Manager:

- Job: is basically a single unit of work that is carried out within an organization.
- Job type: provides a way to categorize your work and processes. Although all jobs differ in some ways, there are usually commonalities that can be extracted and standardized. Job types allow to group similar types of work together. The user provides templates for each unit of work.
- Workflow: create process definition by a sequence of activities. In ArcGIS environment, workflow is collection of steps that user execute while working on a job.
- Step type: step here is equal to activity in WfMC. Step types are building blocks of workflow. Each step can be assigned user and document, URL, etc.
- Job history: contains a log of everything that has happened throughout the life of the job. Each of the items in the log is time stamped with the time of entry and stamped with the current user at that time. A message is also stored along with the record, explaining what happened at that point in time.

- Data workspace: contains the data that users will work with while executing their jobs. Users can switch between data workspaces, allowing them to work on data stored in multiple locations during the same job.
- Area of interest (AOI): is the geographic extent of a job. It helps managers and users track where edits are in progress to avoid conflicts and prioritize and coordinate activities among many users and user groups. The AOIs for all jobs are stored in a special feature class in the database maintained by ArcGIS Workflow Manager.

There are many terms which are very technical in ArcGIS Workflow Manager but this part just introduces the most important terms which can easy to confuse the reader.

5.3. Implementation

The chosen process is subdivision of land parcel case. The process starts from the prepare deed stage because the stage of advertisement and negotiation not relevant for transparency by interoperation workflow between cadastre and real estate agency. Another reason is that stage is not compulsory for buyer and seller. Buyer still can know, meet and negotiate seller without real estate agency. So the role of REA is not excluded in this research.

There are 4 stages for subdivision case: provisional boundary and deed preparation stage, process deed stage, surveying stage and quality assurance stage. Each *stage* will be created by one *workflow* and each workflow will be assigned to one *job type* and one *group owner*. Following parts are described each of job type.

5.3.1. Provisional Boundary and Deed Preparation

a. Description

Provisional boundary has been proposed because of the following reasons:

- The cadastre needs new parcel id and boundary for subdivision before updates attribute data.
- The consistency in database will be maintained.
- Once the provisional boundary is updated in cadastral database, other people such as neighbor of this parcel can see that parcel is selling to others.

So provisional boundary is recommended to enhance the participation of buyer and seller into transaction and maintain consistency character in database. 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 provisional boundary. So this job type is assigned to notary group but with indirect involvements of buyer and seller.

b. Workflow

The first step of Notary workflow is defining the case parcel (AOI-area of interest) and checking information of owner and parcel in cadastral database. If it correct as the seller/owner provided, Notary continue with next step of design sketch boundary with seller and buyer. If it is not qualified, Notary will hold the workflow and notify to Cadastre the situation. After correction, Notary release hold and continue the process. Step design provisional boundary is taken by buyer, seller and Notary. When buyer and seller agree about how much land will be divided, how much for each m2, they will sketch the subdivision on paper according to their knowledge. Notary will guide them and supervise the process. After getting all necessary information and sketch boundary of subdivision, Notary goes to portal database of cadastre to check the information of seller and buyer by an attribute query. If the information is not consistent with database, Notary will suspend workflow and inform to cadastre till everything is corrected, Notary will release hold and continue workflow.

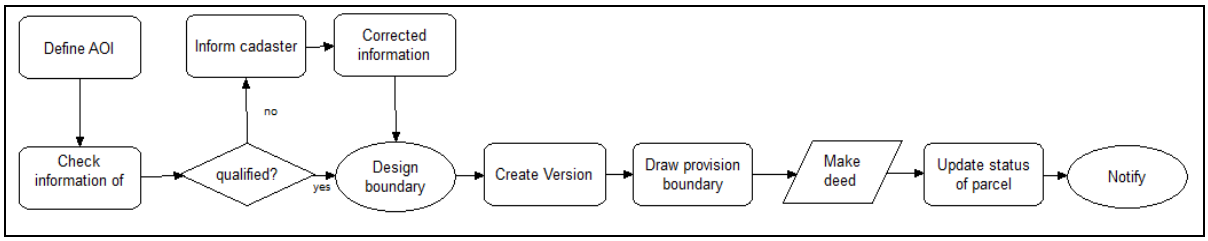

Figure 5.1: Provision and Deed Preparation Workflow

To be able draw provisional boundary and post to cadastral database, Notary needs a temporal version from cadastral database. However, Notary is not the person who is allowed to create version because that may cause insecurity for database system. So it threatens security of workflow database and also conflicts with defined roles of user that manager has responsibilities to manage the versioning (create, delete, modify). Therefore, manage responsible for creating version. After Notary receives email notification that the version is created then Notary draws the provisional boundary according to the sketch with the witness of buyer and seller. Notary will make a deed with the product map of provisional boundary with new parcel id and attach in the workflow. Next step is auditor updates provisional boundary to supply data version so citizens can see status of parcel. Notary will send a notification to cadastre that documents (deed, map) were attached and the job finishes.

c. Specifications

Notary's workflow is a part of cadastre workflow domain. Notary group includes all notaries with name and email address. Following is privileges for Notary group:

- Can add attaches for held jobs
- Can add comments for held jobs
- Can change the job owner
- Close job
- Create job
- Individual job assign
- Individual step assign
- Manage AOI
- Manage Attachments
- Manage Holds

Job type names "provision" is created with state "active", workflow "provision and deed preparation". The map to present jobs and AOI is defined same source. Default properties are assigned group "Notary", start date is creation day, job duration is 1 days, data workspace is "tran.version1/1" (version of auditor), and priority is medium.

Step setup:

- Define AOI: step owner is Notary group; step launches AOI map and notary can define AOI (target parcel) by attribute query or coordinate (GPS), step cannot skip.
- Check information of buyer and seller: step owner is Notary group; step launches base map by JTX.launchArcMap, step cannot skip.
- Qualified: step owner is Notary group, step cannot skip. Code 1 is for yes path, 2 for no path.
- Inform Cadastre: step owner is Notary group, step cannot skip. Step sends notification to cadastre that workflow is hold. Specific attached documents should be added. And the hold "missing data" should be added.
- Corrected information: step owner is Notary group, step cannot skip. Step sends notification that hold is released when fault is corrected.
- Design boundary: step owner is Notary group; step is procedural and cannot skip. Step requires attachment of sketch.
- Create version: step owner is manager; step launches JTXcreateversion so the step is automated create a version from version 1/1 of auditor and has a name of JOB_ID. Step cannot skip.

- Draw Provisional Boundary: step owner is Notary group; step launches job map with the granted version, allows Notary draws boundary and reconcile, post to version of auditor.
- Make deed: step owner is Notary group; steps automated creates pdf file of provisional map and attach with written deed.
- Update status of parcel: steps owner is auditor (version 1/1). Step launches ArcMap to post the updates from the job version to version of supply data (version 1/2).
- Notify: step owner is Auditor group; step notifies administrator workflow is committed.

5.3.2. Process Deed

a. Description

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.

b. Workflow

The first step is collect deed and provisional boundary map as significant legal documents for changes in database. After defining AOI which are two new parcels written in the deed, next step is assigned to manager.

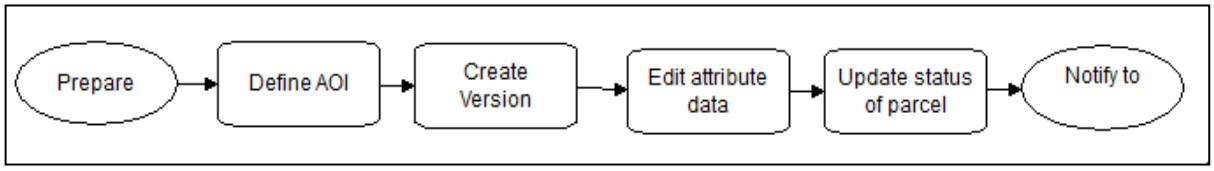

Figure 5.2: Process Deed Workflow

Manager will run step create version and privileges for administrator editing attribute data. The administrator updates information about building, rights, ownership then reconcile to auditor version. Auditor receive new task to reconcile to supply data version. So the citizens can have updated information about those parcels. At the end, administrator notifies surveyor that process deed workflow is committed.

c. Specifications

Administrator group has the following privileges:

- Close job
- Create job
- Individual job assign
- Individual step assign
- Manage AOI
- Manage attachments
- Manage holds
- Manage version
- Manage workflow
- Update properties
- Can change the job owner

Job type names "process deed" is created with state "active", workflow "process deed". The map to present jobs and AOI is defined same source. Default properties are assigned group "clerks", start date is creation day, job duration is 1 days, data workspace is "tran.version1/1" (version of auditor), and priority is high.

Step setup:

- Prepare: step owner is administrator. This step is procedural and cannot skip.
- Define AOI: step owner is administrator and cannot skip. The step launches AOI map to define two new parcels.

- Create version: step owner is manager and cannot skip. This step automated create new job version from version of data workspace.
- Edit attribute data: step owner is administrator and cannot skip. This step launches ArcMap for administrator edit attribute data. After editing, administrator has to reconcile and post to target version.
- Updates status of parcel: step owner is auditor and cannot skip. Auditor post updates to supply data version.
- Notify to surveyor: step owner is administrator and cannot skip. This step notifies surveyor that process deed workflow is committed.

5.3.3. Execute Surveying Job

a. Description

Execute 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 legal guide and measure boundary in the field. Then surveyor goes to office and edits the formal boundary.

b. Workflow

The first step is to prepare and collect to necessary documents such as deed, provisional boundary. Next step is defining AOI so the surveyor can have a vision of how parcels look like before he goes to the field.

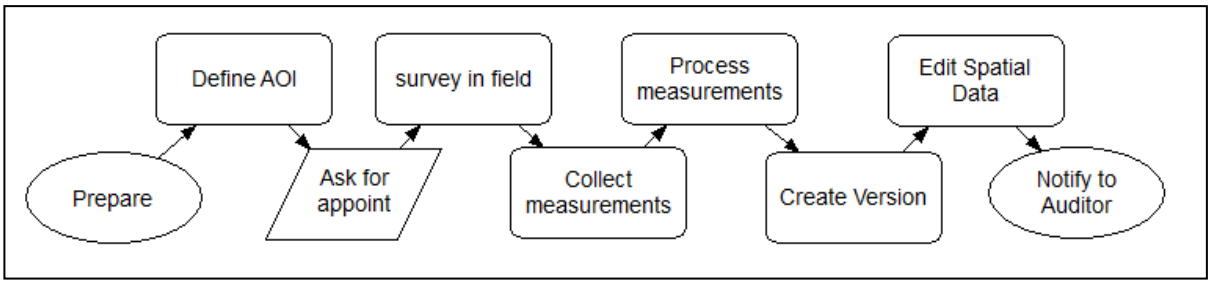

Figure 5.3: Execute Survey Job Workflow

After getting appointment with buyer and seller, he goes to the field and survey by GPS or total station, etc. Surveyor will input those measurements to specific software and process them to have formal boundary. Manager creates for surveyor a job version so he can edit provisional boundary. After editing, surveyor reconciles and posts changes to auditor version and notify auditor that job is finished.

c. Specifications

Surveyor workflow is running on cadastral WfMS domain. Surveyor group has the following privileges:

- Close job
- Create job
- Individual job assign
- Individual step assign
- Manage AOI
- Manage attachments
- Manage linked properties
- Manage holds
- Manage version
- Manage workflow
- Update properties
- Can change the job owner

Job type names “survey stage” is created with state “active”, workflow “survey stage”. The map to present jobs and AOI is defined same source. Default properties are assigned group “surveyors”, start date is creation day, job duration is 20 days, data workspace is “tran.version1/1” (version of auditor), and priority is high.

Step setup:

- Prepare: step owner is surveyor. This step is procedural and cannot skip.
- Define AOI: step owner is surveyor and cannot skip. The step launches AOI map to define two new parcels.
- Ask for appointment: step owner is surveyor and cannot skip. Surveyor can email or call buyer and seller for appointment.
- Survey in field: step owner is surveyor and cannot skip. Surveyor goes to field with equipments.
- Collect measurements: step owner is surveyor and cannot skip. Surveyor collects measurement from machine.
- Process measurements: step owner is surveyor and cannot skip. He inputs measurements and runs specific software to process those data.
- Create version: step owner is manager and cannot skip. This step automated create new job version from version of data workspace.
- Edit spatial data: step owner is surveyor and cannot skip. This step launches ArcMap for administrator edit provisional boundary. After editing, surveyor has to reconcile and post to target version.
- Notify to auditor: step owner is surveyor and cannot skip. This step notifies auditor that process deed workflow is committed.

5.3.4. Quality Assurance

a. Description

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.

b. Workflow

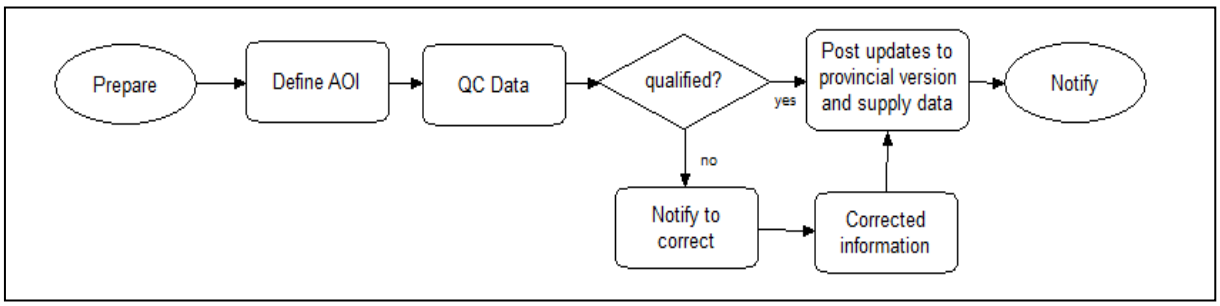

Figure 5.4: Quality Assurance Workflow

As previous workflow, auditor collects necessary documents and defines AOI. After that, auditor will run ArcMap to visualize all updates, check topology and consistent information. If the changes are not qualified, auditor will hold the process and request the one who is responsible for fault fix it. If they are qualified, auditor posts to default and supply data version.

c. Specifications

Auditor's workflow is a part of cadastre workflow domain. Auditor belongs to Quality Assurance (QA/QC) group. Following is privileges for auditor group:

- Can add attaches for held jobs
- Can add comments for held jobs
- Close job
- Create job
- Individual job assign
- Individual step assign
- Group job assign
- Manage AOI
- Manage Attachments
- Manage Holds
- Manage data workspace
- Manage version
- Manage workflow
- Can change the job owner

- Group step assign

Job type names "QA" is created with state "active", workflow "quality assurance". The map to present jobs and AOI is defined same source. Default properties are assigned group "QA/QC", start date is creation day, job duration is 1 days, data workspace is "tran.version1/1" (version of auditor), and priority is medium.

Step setup:

- Prepare: step owner is auditor. This step is procedural and cannot skip.
- Define AOI: step owner is auditor group; step launches AOI map and notary can define AOI (target parcel) by attribute query or coordinate (GPS), step cannot skip.
- QC data: step owner is auditor group and cannot skip. Step launches ArcMap to check consistent information and topology. Auditor can use data reviewer – extension tool of ArcGIS which allow comparing versions and checking topology, duplicate geometry, table check, etc.
- Qualified: step owner is auditor group, step cannot skip. Code 1 is for yes path, 2 for no path.
- Notify to correct: step owner is auditor group, step cannot skip. Step sends notification to the one who is responsible for. Workflow is hold. Specific attached documents should be added.
- Corrected information: step owner is auditor group, step cannot skip. Step sends notification that hold is released when fault is corrected.
- Post updates to default and data supply version: step owner is auditor group, step cannot skip. Step launches ArcMap to reconcile and post.
- Notify: step owner is Notary group; step notifies cadastre workflow is committed.

- ***Manager group privileges:***

- Assign any job
- Assign any step
- Can add attaches for held jobs
- Can add comments for held jobs
- Close job
- Create job
- Delete job
- Can change job owner
- Can set database login
- Can set step
- Can update properties for held job
- Create version
- Delete version
- Manage extend properties
- Individual job assign
- Individual step assign
- Group job assign
- Group step assign
- Manage AOI
- Manage Attachments
- Manage Holds
- Manage data workspace
- Manage version
- Manage workflow
- Manage query
- Manage replication
- Update properties
- Manage linked properties

5.3.5. Database Management System

In PostgreSQL, schema for user is created and set up password for each schema as described in Annex 1. 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 as in Annex 2 and object-id 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).

5.3.6. Versioning management

Central database-default which is protected is controlled by head manager. From central database, local database, supply database are child versions of central database as described in Figure 5.5. 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). Due to 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 give to groups of user 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.

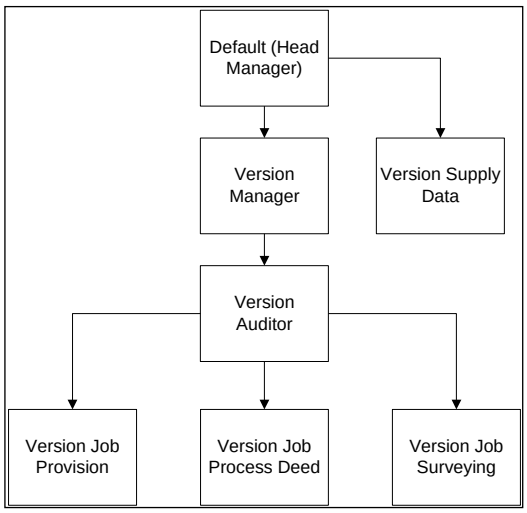

Figure 5.5: Versioning Model

5.4. Verification

After implementation architecture within ArcGIS software package, section 5.3 verifies functionality of each component and how transparent the architecture provides in case of subdivision.

5.4.1. Client Layer

a. Customer service

Customer service is supposed to be an open online source so citizens can easily access for information. However, this function is limited in ArcGIS. Alternatively, each user may set up ArcGIS system in their own computer and is granted rights for access to the system. It is limited and not so easy because the software is quite heavy program and special for GIS professionals. So the function was not able to be implemented well. However, citizens can request though email. Citizens can send email with basic information such as parcel id, object id, address as Figure 5.6.

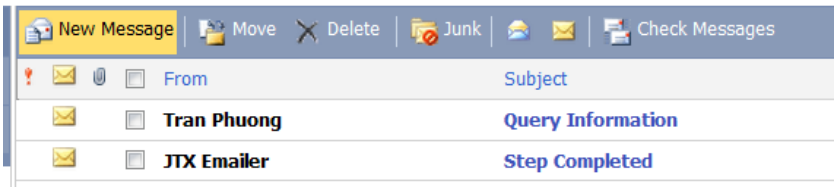

Figure 5.6 : The email request

And the citizen can receive result like Figure 5.7. Customer services supported not only provide 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 that parcel is on which stage of subdivision.

In conclusion, customer service was partially implemented and enhanced transparency criteria which are providing consistent information to public. The component has not provided appropriate interface for public so criteria access to information and promoting participation and accountability were unable to execute.

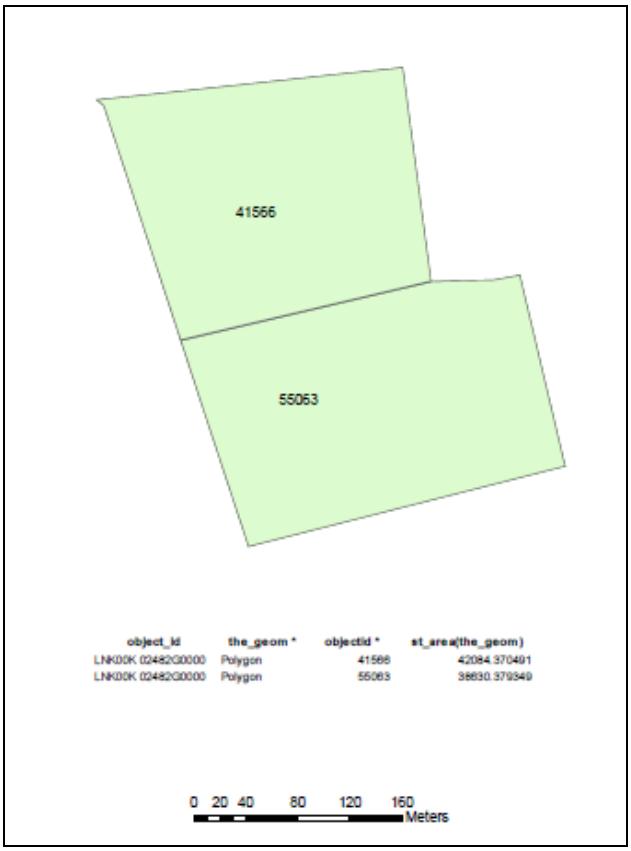

Figure 5.7: Result of request

b. Scheduler

Scheduler includes time manager, event analyzer and job handler. Job handler and event analyzer are not supported automatically by ArcGIS because the customer service is not complete. However, job handler can be done manually as Figure 5.8. 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.

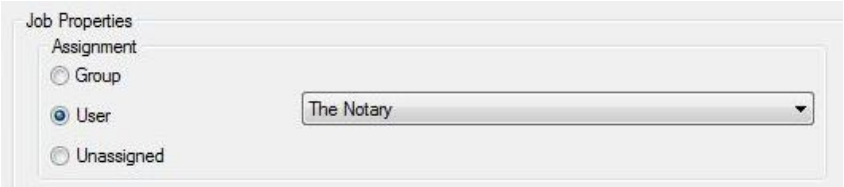

Figure 5.8: Distribute job by assigning user

Even when responsible group starts job, they can still assign to specific person in that group as Figure 5.8 (right). It is accessibility restricted but also enhances responsibilities of user. In order to distribute geographically, distributor can check job query window as Figure 5.9. Each job was defined by AOI-area of interest. 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 warning job for due data and event analyzer was absent. Therefore criteria integrity and consistent are not well perform.

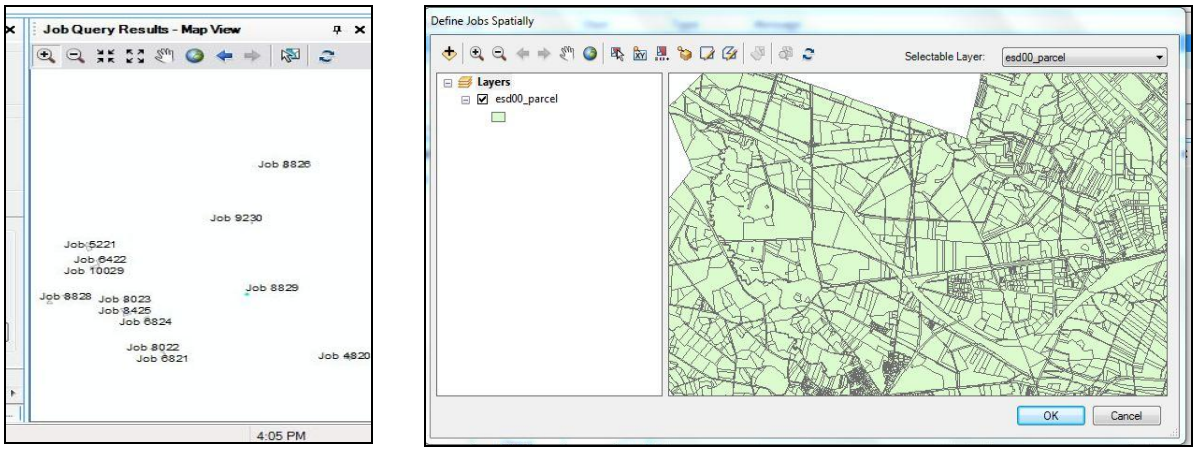

Figure 5.9: Geographical jobs (left) and Define AOI by query, point, import coordinates (right)

5.4.2. Workflow server Layer

a. Administration and monitoring component

This component is successful implemented. Workflow Manager Administrator provides simply interface to design process definition such as workflow on Figure 5.1, Figure 5.2, Figure 5.3, and Figure 5.4. Manager defines which type of execution for each step (executable, custom, launch file/URL, procedural or question). Each step is not only defined execution mechanism Figure 5.10 (left) but also has description what to do or URL link to support executing as Figure 5.10 (right).

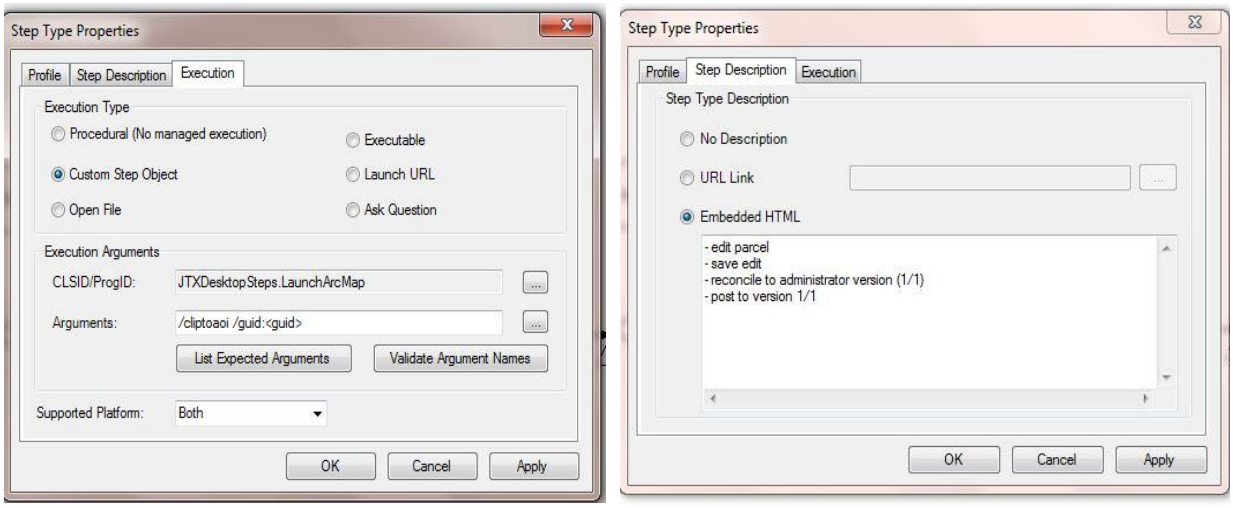

Figure 5.10: Customize step (left) and Describe tasks for step (right)

Workflow Manager Administrator provides tools to create user of workflow system and privileges as Figure 5.10 to them as named in implementation. Tracking histories in this component is located in Workflow Manager as Figure 5.12. The software allows tracing when, who and what.

In conclusion, the component was successful implemented. All of functions are performed well so it helps a lot in enhancing transparency. It handles very well human resources by creating user of workflow with name, email, address and phone. The roles and responsibilities of each user were clear and restricted with privileges. Tracking histories is detail and supporting a lot in trace back who did what and responsible for what step.

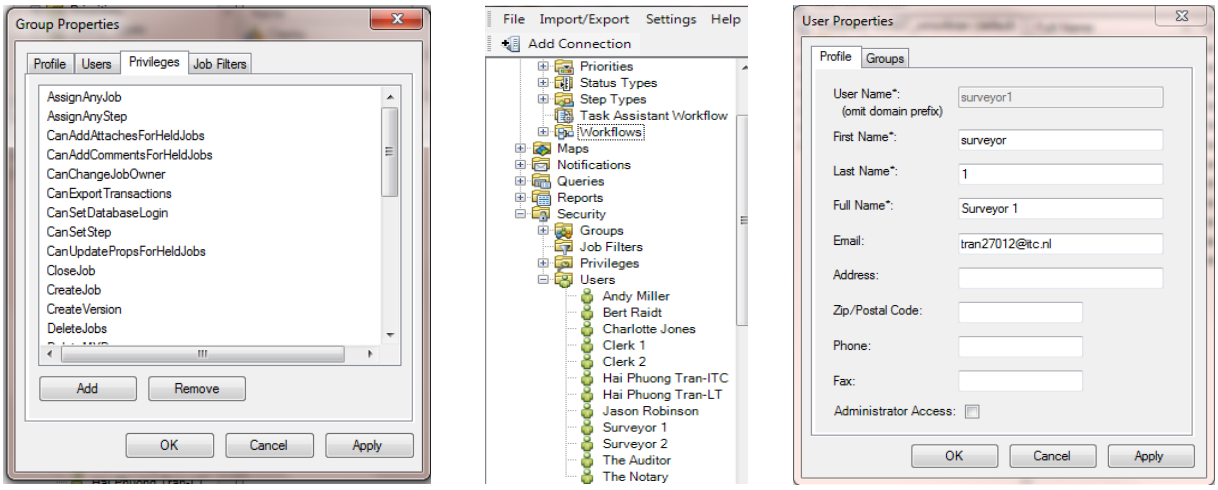

Figure 5.11: Privileges of group (left), Create user (centre) and Detail of user (right)

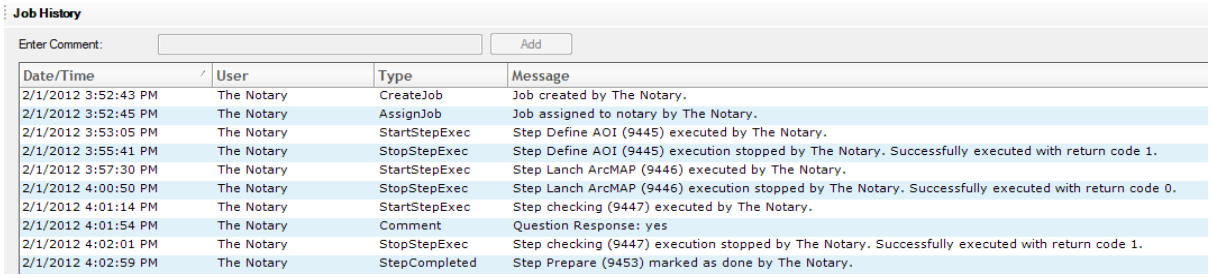

Figure 5.12: Historical activities

b. Workflow engine

ArcGIS Workflow Manager executes workflow and supervises process instances. On this interface, user can see the list of all jobs assigned to him or even others. The user can see which documents are attached in previous jobs, why the job was held. While executing job, user can see the progress of workflow, spatial data, and description of step, job as Figure 5.13. Workflow engine component is realized in Workflow Manager.

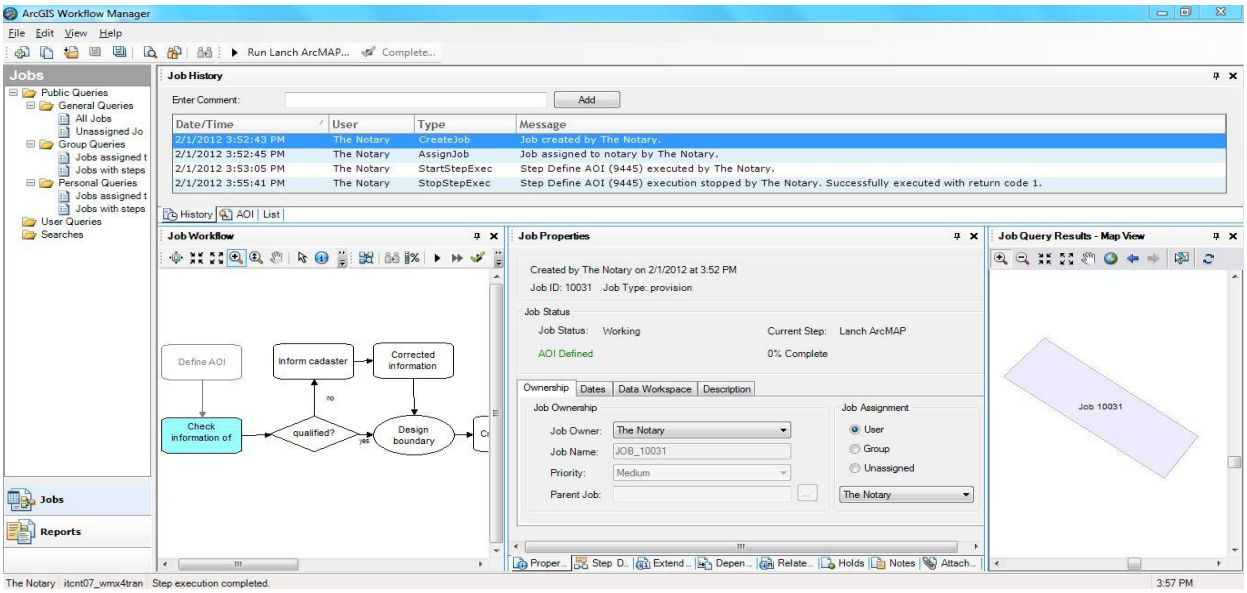

Figure 5.13: Workflow engine interface

In conclusion, workflow engines were successful implemented. It enhances all of defined criteria and extra criteria: subdivision workflow is divided into four stages that increase atomicity of process; job has

identification and durability that force user executing job in sequence. An extra criterion for this component is that different user can see others' job but can't edit except manager even they can load document which others' job had attached. Another criterion is checking and control quality which is implemented in steps of updating changes to auditor and auditor checking updated information before post to central database.

c. Control flow mediator

The mediator was not well implemented in this research because it was unable to create multi workflow environments. However, some functions still can be carried out. After Notary finishes his job, the workflow informs cadastre by notification message. Once administrator receives notification, 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 as Figure 5.14. So it comes in sequence in cadastral system.

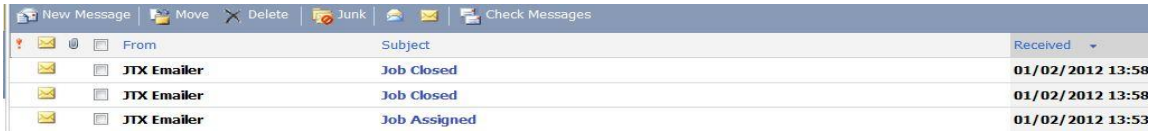

Figure 5.14: Job notification

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.

d. External workflow engines

Because external workflow engines work on cadastral workflow domain so it has same functions with cadastral workflow engines and enhance same criteria with component above.

e. Version Manager

Versions are created on ArcSDE and able edit and delete version, privilege rights for user as Figure 5.15, reconcile and post changes to target version of geo-database. ArcSDE provided enough functions for version manager and enhanced transparency criteria of isolation, security, and promoting participation and accountability. The privileges of versions could not work through workflow environment.

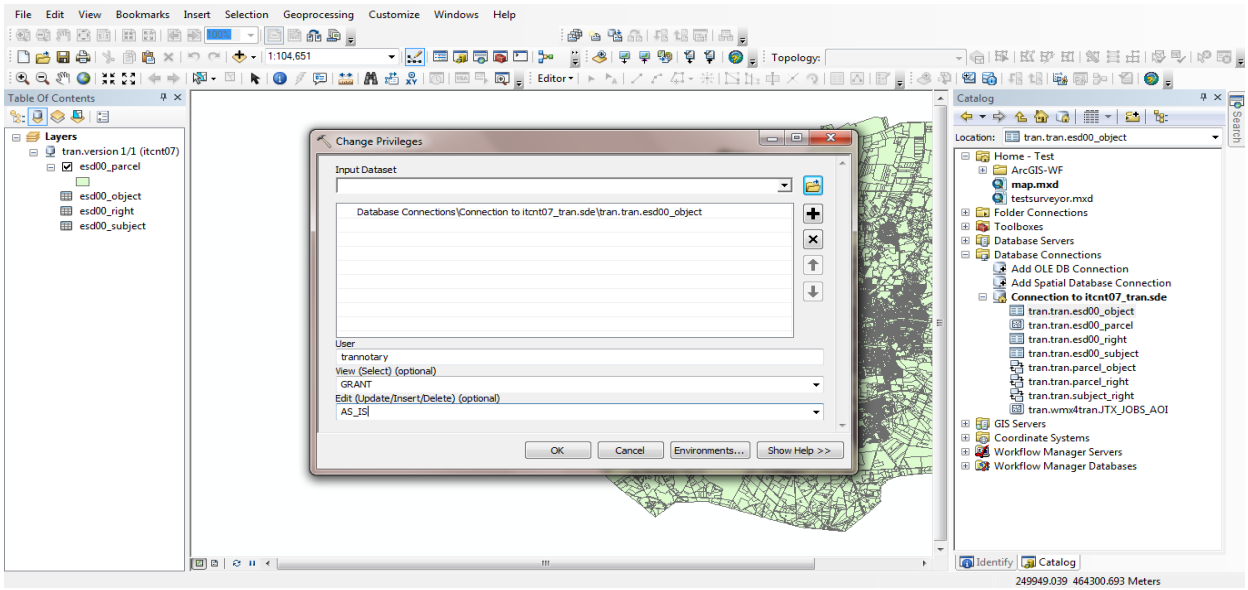

Figure 5.15: Privileges version for user

5.4.3. Database Layer

a. DBMS

DBMS was describes in implementation and proved that PostgreSQL has provided all functions to manage database. Transparency criteria such as clarity of roles and responsibilities and security were fulfilled.

b. Data flow mediator

PostgreSQL creates users for system with account and password and head manager who is responsible for central database management system can track histories of every change in database as Figure 5.16. However, format convert function was not implemented in this research. The mediator was able to enhance security to database and ACID.

	object_id character var	objectid integer	gdb_from_da timestamp w	gdb_to_date timestamp w	gdb_archive_ integer	the_geom geometry
3	LNK00H 03455G	26836	2012-02-02 11:	9999-12-31 23:	26943	0103000020407
4	LNK00H 04906G	26837	2012-02-02 11:	9999-12-31 23:	26944	0103000020407
5	LNK00H 03689G	26838	2012-02-02 11:	9999-12-31 23:	26945	0103000020407
6	LNK00P 00483G	26839	2012-02-02 11:	9999-12-31 23:	26946	0103000020407
7	LNK00H 03688G	26840	2012-02-02 11:	9999-12-31 23:	26947	0103000020407
8	LNK00H 03316G	26841	2012-02-02 11:	9999-12-31 23:	26948	0103000020407
9	LNK00H 03584G	26842	2012-02-02 11:	9999-12-31 23:	26949	0103000020407
10	LNK00H 04635G	26843	2012-02-02 11:	9999-12-31 23:	26950	0103000020407
11	LNK00H 03572G	26844	2012-02-02 11:	9999-12-31 23:	26951	0103000020407

Figure 5.16: Histories of database

5.5. Discussion

Verification shows that ESRI doesn't provide enough function for the architecture especially at client layer and mediators. However, server layer was strongly supported and database level also was successful implemented in ArcGIS and PostgreSQL. About transparency criteria, the components which are able to implement mostly meet the criteria defined in chapter 4, some even enhance more transparency due to support of software such as checking and quality control, viewing other's jobs even external or internal users.

There are some limits of implementation besides lacking of function as following:

Jobs: the subdivision process was divided into four stages (workflows). When each workflow is executed, one job is created by user. Therefore one subdivision case has four jobs executed. If someone wants to trace back the subdivision process, they need to know identification of all jobs. That may not a limitation but inconvenient in case of tracking history.

Privileges: there are privilege mechanism in database level, versioning and workflow level. While all of software components are connected and have effects on each other, having privileges at too many levels makes the system runs complicated. One of example is that when the job version is created by manager, it is supposed receiving privileges. Actually, it doesn't work out because job version depends on version of data workspace. Another example is that when privileges user in workflow administrator, it requires database log in.

Relationship between tables in database: when administrator edits attribute data, administrator can't directly use "Editor" tools but edit manually in attribute table. Surveyor and Notary, who are allowed to edit spatial data not edit attribute data, can't save editing because of relationship of among table as described in figure 5.5. If one polygon is divided into two parts, ArcGIS automatically generates new object id. That means there should be one more new row in database/tables. However, due to restricted privileges, Notary or surveyor cannot edit attribute data. Consequently, there are conflicts in database.

These limitations come from bottlenecks of selected software package. They not only make functionality weaker and less transparency.

5.6. Concluding remarks

This chapter brought a discussion about appropriate software to implement the design architecture in previous chapter. ESRI with ArcGIS is chosen because it provides effective GIS tools, extensions for version manager (ArcSDE) and workflow (ArcGIS Workflow Manager) and plug-in with DBMS (PostgreSQL). The implementation was carried out and be verified possibility of RA to enhance transparency in land transaction. However, software package still have limitations which might affect transparency negatively. So technologies can provide more advances functions to enhance transparency but in another side it also create some problems for transparency as well.

6. CONCLUSION AND RECOMMENDATION

6.1. Introduction

This chapter provides the conclusion and recommendation based on the research findings as described in each of the previous chapters. The following section 6.2 presents conclusions on the basis of research question for each research objective. The section 6.3 then presents the recommendation needed both for implementing organization and the further research.

6.2. Conclusion

1. What are general concepts of transparency in land transaction?

The concept of transparency in land transaction emphasizes that all information of rules, regulations, decisions, procedures and movements of object "parcel" should be visible, predictable, and understandable for all parties. This brings transparency in land transaction from good governance perspective. It also concludes that transparency in land transaction concerns with three main elements namely structural, functional and transactional properties. Reference architecture (RA) requires these properties to be incorporated to enhance transparency in a land transaction WfMS. However, an extreme care is required that WfMS does not violate privacy by exposing sensitive information. So security aspect is to be considered as a part of transparency.

2. What are transparency requirements to be considered in land transaction?

Theoretical studies conclude that there are a) seven structural requirements, b) seven functional requirements, and c) four transactional property requirements. They are described briefly below:

Structural transparency: These requirements are related to clarity roles and responsibilities of stakeholders, senior leader roles, integrity, proactive communication, training counter fraud staff, national and international cooperation, and institutional reform.

Functional transparency: There are several requirements such as public availability information, open program and process, access to information, assessment and monitoring, procedural check and control, accessibility restriction and technological security.

Transactional property requirements: Atomicity, consistency, isolation and durability shortened as ACID help enhancing transparency in land transaction at database level and workflow level. However, when transactions are allowed to be concurrent with long durability, isolation and atomicity are in conflict. Long transaction takes long time to commit while concurrent transaction faces difficult to fulfil isolation character. This problem is solved by introducing version concept.

3. How do transparency requirements help to enhance transparency in RA WfMS?

Literature review and case study in Dutch Cadastre reveals that realising ACID elements should be incorporated with functional and structural requirements. This research introduces three layers structure in the design of RA for workflow to bring transparency in land transaction. The layer structure consists of Client layer, Workflow server layer and Database layer.

Client layer: This layer associates between public user and the system. It provides an open interface for public access to cadastral services and information. It also interacts with workflow server layer to distribute requests of public to specific workflow.

Workflow server layer: This layer is the core of workflow management system. It not only defines business processes but also provides tools for making workflow runs by managing human and version resources. Besides, server layer ensures a secured and integrity environment for external organizations

participation. Especially, it makes clarity on the roles and responsibilities of each user and tracking histories of activities.

Database layer: This layer not only maintains four transactional properties but also provides integrity and safety gateway for exchange data between cadastre and external organizations.

4. What are the RA WfMS components?

The theory and practice of WfMS RA shows several important elements of designing reference architecture for land transaction. Since the design of RA consists of three layers, findings are given below:

The client layer includes client interface and client scheduler. Client interface provides gateway for public access to information and client scheduler handles request distribution and returning results of requests.

The workflow server layer includes administration and monitoring, internal workflow engine, control flow mediator, external workflow engines and version manager. Administrator and monitoring component defines process definition, manages human resources, and history activities. Workflow engines run process instances which are defined by administrator and monitoring and jobs from client scheduler. Control flow mediator is secured gateway between main workflow engines domain and external workflow engines. External workflow engines can be run as separate process with main workflow engines domain or partially. Version manager creates, modifies, deletes, privileges version of database and connects to workflow engines.

Database layer includes DBMS, data flow mediator and external DBMS. DBMS stores and maintains database, defines roles and privileges of users. Data flow mediator is secured gateway to exchange and update database between internal and external DBMS. External DBMS is under control of external organization.

To verify RA supporting architecture is developed for implementation. This study shows that supporting architecture requires additional views of enterprise, computational, engineering and data viewpoints. The WfMS architecture itself shows clearly component's transparency criteria. Customer service needs to fulfil public availability of information, access to information, and consistency. Scheduler has clarity of roles and responsibilities and integrity. Administrator and monitoring has clarity of roles and responsibilities, accessibility restriction, and tracking histories. Workflow engines have atomicity, consistency and isolation. External workflow engines have integrity. Mediators have means of proactive communication, integrity and tracking histories. DBMS has clarity of roles and responsibilities, security and ACID. Version manager has ACI, technology security and tracking history. Based on these expected transparency criteria, client interface, administration and monitoring, version manager and mediators are the most important components in enhancing transparency.

5. What kind of software is suitable for verifying the RA WfMS for land transaction?

Choosing an appropriate software environment for successful implementation is crucial. ESRI with ArcGIS was chosen because it can perform spatial data with professional tools, extension for versioning and workflow management. The implementation was successful performed with workflow architecture especially at server and database layers. However, the client layer was not implemented well because ArcGIS does not provide open source and online interface. Mediator of control flow was also not fully implemented because multi-environments of workflows are not created in this research. Besides, there are some limitations of implementation such as data operation and privileges of version. Those limitations may affect negatively to transparency in WfMS of land transaction.

6. Does the RA (WfMS) enhance transparency according transparency requirements?

Implementation of RA with supporting architecture suggests that RA indeed enhances transparency by incorporating structural and functional requirements in a three layer structure. However, it very much depends on supporting architecture, precise design of workflows and software environment. Mediators and version manager place important roles in bringing transparency. 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 in efficient and effective manners.

6.3. Recommendation

From this research, the following recommendations are given for both organization and for further research.

a) To implement this reference architecture to enhance transparency, it is recommended the organization should have the following conditions:

- The senior leaders of the organization are dedicated to develop the organization in transparent way.
- The organization should have descriptions about the role and the responsibilities of each department (group of user). Policies, rules and regulations are also needed to clarify.
- The organization should have experts in developing system especially in designing architecture and workflow management system.
- The organization should choose the appropriate software to implement workflow architecture that can provide sufficient functions and not exceed budget.
- The experts should help the organization to realize which components need to implement in the system.

b) The research recommends for further research below:

- Even though the research simplified as much as possible when designing each workflow, the research just focuses on reference architecture for WfMS but not emphasises on workflow process. However, the trend of transparency in the world now is moving to citizen's side, cadastre is no longer taking control of editing data but citizens and society will have responsibilities for the correct information. For further research, institutional reform should incorporate with process design to improve transparency. For example, workflow of provisional boundary and deed preparation consists of participation of seller, buyer and Notary. Notary can edit both spatial and non-spatial data. Cadastre just has responsibilities for checking quality of edits and post to database.
- Transparency issues are interesting topic to be discussed in further research. What are negative effects of transparency? Security not only supports for transparency but also restricts transparency.
- Historical maps and version for each job should be kept or not. If it is kept then it makes database too heavy and difficult to manage. If it is not kept, to trace back editing will be complicated. It request further investigation.
- Further research can be conducted with more advanced technologies or programming with Python (extensions of ESRI) to overcome limitations of implementation such as customization for client interface.
- Due to limited time, some functions of ESRI such as multi workflow domains and privileges for version were not able to execute. Recommendation for further studies is to conduct the components which were not well implemented in this research.

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ANNEXES

Annex 1: Schema and User Account in Postgre SQL

User	schema	Password
Manager (tran)	tran	trn
Auditor	tranauditor	trndtr
Surveyor	transurveyor1 transurveyor2	trnsrvr1 trnsrvr2
Administrator	tranclerk1 tranclerk2	trnclrk1 trnclrk2
Notary	trannotary	trnntr
Manager (tran)	wmx4tran	trn

Annex 2: Data Model