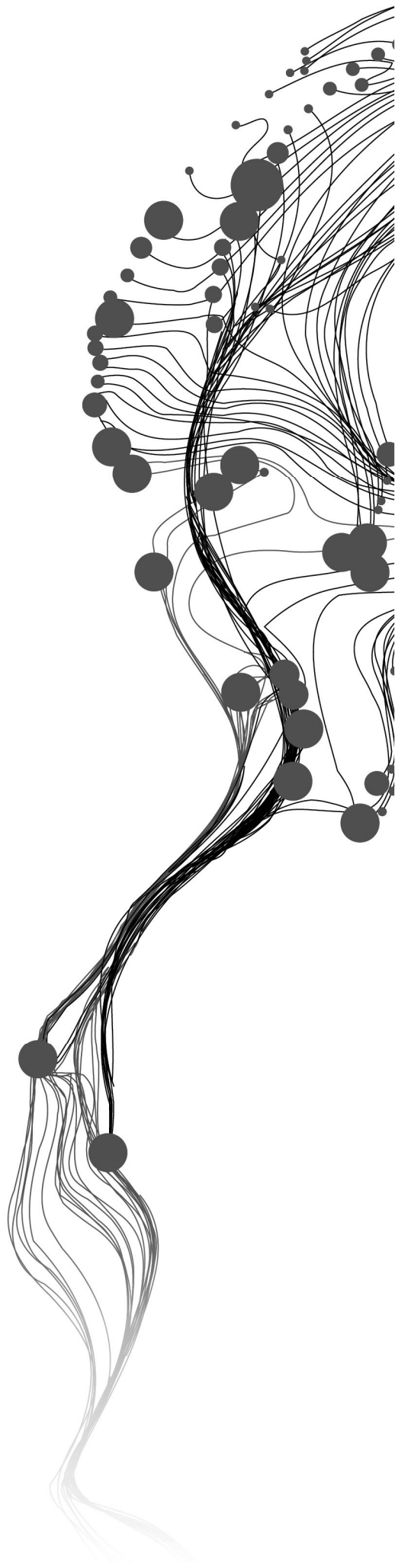


Implementing information security in workflow management system

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February, 2012

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DISCLAIMER

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ABSTRACT

The information security is important for many organizations and no exceptions for land administration organisations. The aim of this research is to develop information security requirements in GIS based Workflow Management System (WfMS). This research follows three steps as research approach namely determination of requirements, designing and prototyping Workflow Management System (WfMS).

The requirements of information security are determined by reviewing theoretical literature and the literature on experiences found in four countries (British Columbia in Canada, England, China, and the Netherlands).

Based on the issue of information security, and the interviewing of Dutch Kadaster, the design criteria are then developed. Confidentiality is about the grouping of the people. Different group have different privilege to access the data. Integrity means during the work is transferred, it cannot be modified. Therefore it is important to find who has modified the data illegally. Availability means the data has to be processed correctly before transferring to the other actors. So the processing quality should be concerned. Authenticity means that the data is trust worthy as always, when the surveyors or notaries want to see the boundaries, the buyer/seller has to show on the spot. No-repudiation means once the data is processed correctly and legally, no one can deny the editing.

In this research the workflow of a generic land subdivision case is developed on the basis of design criteria. The criteria rely on the roles of actors, the responsibilities of each actor, the communication among actors and the organization of the job types. The versioning concept is used to realise these criteria. The notaries and the buyer or the seller can only check the data, therefore under the default database, only a query layer is given to let them check the parcel information. Surveyors, the administrators and the quality control managers have their own working versions under the default database. Administrator can edit both spatial data (for the provisional boundaries only) and non-spatial data (for ownership and person data). Surveyors can only edit spatial data (for the actual boundaries after field surveys). The quality control manager can view the data, but cannot edit any data.

The workflow is prototyped and implemented in the ArcGIS Workflow Management System. The workflow is designed for a subdivision case and is divided into four steps, they are preparation, provisional registration, field surveying and office work, and the last step is finalizing and archiving.

The results in running the workflow indicate that the workflow can realize the confidentiality, availability and the authenticity quite well. But the integrity cannot be realized totally, because the archiving of data is not within this research scope and it important to archive versions for the historical data.

The non-repudiation is difficult to realize, because when the information is sent by E-mails, for the job notification, it is not secured enough. Also when the notaries want to attach a deed in the system, the only way to add attachments in workflow manager is to a shared hard disk. Non-repudiation is the element that can hardly be realized in ArcGIS Workflow Management System.

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After this six month efforts, finally this research is finally done. I have been given a lot of emotion feelings from the progress of doing this research and frustration when cannot find related documents and happiness when the software is finally working well. I also gain a lot of knowledge when doing this research. For me, as a twenty four years old student, I find it is a nice experience of how to do a MSC research.

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1. CHAPTER 1: INTRODUCTION

1.1. Background

Information security means protecting information and information systems from unauthorized access, use, disclosure, disruption, modification, perusal, inspection, or recording. Generally, at the beginning of the information system development, the designers of a system paid little attention to its security aspects, after that the proper level of functionality has been achieved, some approaches are used that take into consideration information security (Siponen & Baskerville, 2001). Robert & Courtney (1999) has listed many possibilities of losing grip on information security, such as errors and omissions, dishonest or disgruntled employees, disasters and strangers.

Security issues are important, because in securities trading process, there are usually some errors or problems that may cause transaction risks and failures. Such problems not only increase processing costs but also damage service reputations (Guerra, 2002).

Wang and Xu (2005) developed a multi-agent system to detect and track transaction errors. Each agent has definitions and rules, with the rules, architecture of the agents could be formed. The securities monitoring system is to track and identify errors in securities transactions. This article focuses on those rules to control monitoring and diagnosing activities, to track and identify errors in securities transactions. The confidentiality and the availability could be realized in this case of designing multi-agent system.

Park (2004) proposed a new model that decreases conflicts between user transactions by classifying data objects in a database system according to the users' interest. The goal is achieved by newly interpreted and then applied to transaction processing in multilevel secure database systems. In that case, the integrity as well as the availability could be protected.

Jacques Wainera (2007) discussed that delegation supporting (Çagdas & Stubkjær, 2011) the workflow manage system is important. The delegation system could be introduced into a role-based system to fulfil the needs of data security as well as promoting its flexible and thus to promote efficiency. The workflow is introduced by extending the role-based access control (RBAC) model. Different user may have different right accessing the data, therefore, the confidentiality of the information system could be realized.

Ramaswamy (1999) has defined the interest of the data security system in which the data flow is described in several diagrams. Each individual diagram is divided into the several layers. Such diagrams clearly illustrate the workflows among organizations. The Open System Interconnection reference model is introduced. A model with seven layers of data security is presented and each of the layers has the different versions with the different regulations. These seven layers in an information system are designed to realize the integrity of organization.

However, while dealing with land information, it has its own risk losing security, especially a manual paper-based system enables the users to promote frauds in land administration organization. Even in

digital environment, agencies can edit and delete without evidences if appropriate privileges on security are not provided. Therefore, digital database would be in danger with false data. Following global trend, in many countries, there are revolutions of digitizing data and developing Land Information System (LIS). Such LIS always helps promoting the organizations' income. With the LIS, there would be competitive products produced by the government or the private companies. These products could promote the high accurate data, bring revolutions of surveyors, and benefit of social life especially in the economy aspects (de Vries, 2004; Hallett et al., 2003; Jacobs, 1989).

Land Information System also brings some benefits in speeding up the process of land transaction, land mortgage and so on. It brings some new problems of losing security on the data, and the difficulties in work to be done by the notaries, land surveyors, and cadastral office (in some countries, municipalities). These difficulties cause delay in land transaction and unreliable database system (Arcieri, Cammino, Nardelli, Talamo, & Venza, 1999).

1.2. Research problems

It is evidence those elements of information security such as confidentiality, integrity, availability, authentication and non-repudiation on land information has been addressed in isolation. Literature indicates that these elements have not been implemented in combination of the user requirements in a LIS as a whole. The design of Workflow Management System so far concentrates mainly on improving the efficiency in land transaction.

Therefore, the main goal of this research is to address land information security aspects in land transaction process using WfMS in inter-organizational environment.

1.3. Research objectives

1.3.1. Main objective

To develop land information security requirements in GIS based Workflow Management Systems.

Sub-objectives

There are three sub-objectives to achieve the main objective.

- a) To identify land information security requirements for a land transaction process
- b) To implement the security requirements in a prototype
- c) To validate them using GIS based WfMS

1.4. Research questions

1.4.1. Main question:

How can the land information security aspects be implemented in a land transaction process?

1.4.2. Sub questions for each sub objectives:

- a) To identify land information security requirements for the land transaction process
 - How the concept of information security could affect land administration and land information system?
 - Why these elements are needed for information security?
- b) To implement the security requirements in a prototype.

- What are the roles of citizens, notaries or lawyers, and cadastral officers involved in land administration especially in land transaction?
- Which kinds of versions are needed among different actors in the process of land transaction?
- c) To validate the prototype in LIS based system
 - How to validate integrity elements of land information security in WfMS?

1.5. Conceptual framework

The following figure 1.1 shows the conceptual framework for this research. There are many aspects on deciding the information security. In this research, information security aspects include confidentiality, integrity, availability, authenticity, and non-repudiation in Land Transaction process of land administration.

Those aspects might have different weights or requirements among the citizens and actors. In another words, different regulations can be applied to the citizens and actors of external users and internal users.

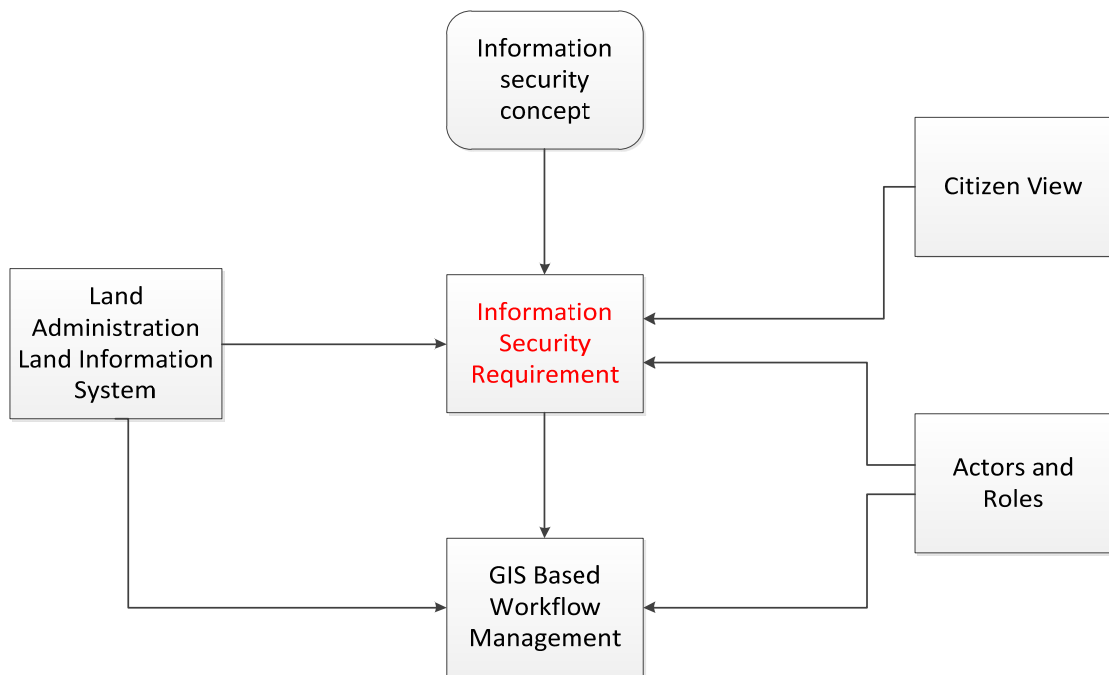


Figure 1-1 Conceptual framework

Therefore, versions are needed among different users who might access land information data with different privileges. Those versions might be tested in a GIS based workflow manage system to find out the outcome whether those versions fit for the WfMS, and whether those versions could help promote information security in land information system.

For the Workflow management system, this research needs to understand the programme of workflow management system, and the relationship of postGIS and the workflow management administrator and the workflow manager. Therefore a prototype can be executed by the workflow manager.

1.6. Research Methodology

This research consists of three main steps consisting of a) requirement determination using desk research supported by interviewing experts of Dutch Kadaster office, Notary and Municipality on the concept of information security for land transaction, b) designing a Workflow Management System incorporating information security aspects, and c) prototyping WfMS in GIS environment.

Step 1 – Requirements of information Security

Finding requirements of information security in Land Information System is a first step in this research. There are several parts which could affect on the secured access to the land information or data. These parts include citizen view, the role of actors on Land Information System itself. In this step, it is necessary to understand the requirements by literature review, especially for the citizen part. Then visiting the Dutch Kadaster to interview with experts or officers could largely help understanding the requirements on actors and LIS parts.

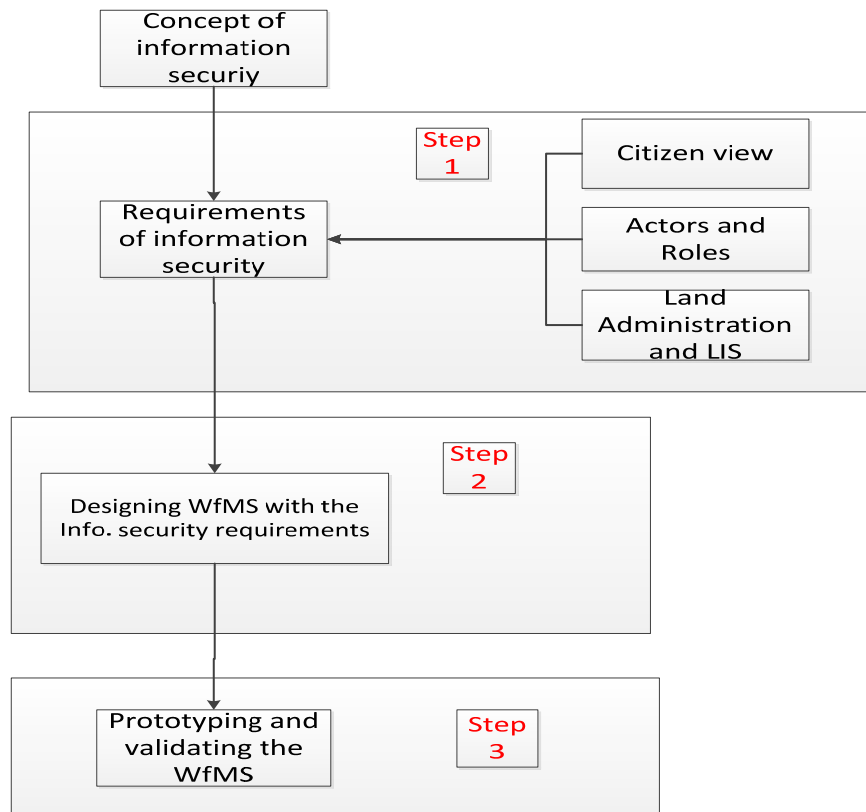


Figure 1-2: Research methodology

Step 2 – Designing WfMS with the information Security

By understanding the key elements of different parts in step 1, design of a WfMS for generic case in land subdivision is performed. Versioning concept is utilised to allocate security requirements among the surveyors, the notaries or lawyers, and so on. These versions are based on the key elements of requirements of land information security. The key issue of this research is to prototype versions in workflow management system. By using Unified Modelling Language (UML) diagrams such as use case diagram, activity diagram and class diagram are designed. With this, the workflow is designed.

Step 3 – Prototyping and validating the WfMS for Land Transaction

Workflow Management System is developed, tested and validated to know whether it helps promoting information security. This step 3 is executed and tested under the environment of postGIS/PostgreSQL and ArcGIS workflow manager system.

1.7. Thesis structure

The structure of this research is organised in the following chapters.

Chapter 1 – Introduction

The chapter includes general information security concept in the land information, research problem on protecting the information security including the research objectives.

Chapter 2 - Addressing Information Security in Land Administration

This chapter discusses the specific concepts of land information security and the experiences of four countries (British Columbia, England, China and Netherlands) on promoting land information security.

Chapter 3 - Workflow management system in Netherlands

This chapter presents the workflows of the land transaction and subdivision case in the Netherlands, and the outcomes as results of interviewing the notaries, experts from land registry, and municipality based on the issue of information security.

Chapter 4 - Designing workflow for implementing information security in the case of land subdivision

This chapter illustrates the designing of the workflow in a general case of land subdivision.

Chapter 5 - Prototyping and Validation

This chapter shows a prototype and validation of the workflow in ESRI ArcGIS software

Chapter 6 – Conclusion and recommendations

This chapter describes the conclusions derived from this research and shows further recommendations.

2. ADDRESSING INFORMATION SECURITY IN LAND ADMINISTRATION

2.1. Introduction

Nowadays, in many countries, land information for administration of land is still being processed from the paper-based to the computer-based system. McLaughlin and Nichols (1994) mentioned that “computers have changed how and by whom information is assembled, stored, delivered, and used... Yet despite the technical change the free flow and use of the information is still in its infancy. The potential user must first know that data exists and then find a route through various databases, system configurations, interchange formats, and communication linkages. Consequently, the trip is limited to priority users and experienced travellers...” (McLaughlin & Nichols, 1994).

Land Information System can be defined as the “structures and services to make availability, accessibility and use of geographic information as efficiently as possible, i.e. available, accessible and affordable” (Groot, 1990). Like other infrastructures such as transport, communication, etc. it can also be described “as a set of institutional, technical and economical arrangements to support the availability of relevant, up to date, and integrated geo information, timely and at affordable cost; to support decision making processes related to country’s sustainable development ” (Paresi & Radwan, 1995).

This chapter offers concepts on information security and some experiences on the cadastral organizations in four countries in promoting the land information security aspects.

2.2. Information security concept

“Information security means protecting information and information systems from the unauthorized access, use, disclosure, disruption, modification, perusal, inspection, recording or destruction” (Wikipedia, 2011). Apart from the physical protection of data and information, we need a mechanism that secures on access to data and information in Land Information System by the unauthorized users, and this is important while using computer based Land Information Systems.

2.2.1. General concept

There are five basic aspects needed for judging whether an information system is secure or not. These aspects/elements are confidentiality, integrity, availability, authenticity and non-repudiation (Wikipedia, 2011).

- a) **Confidentiality:** It is the term used to prevent the disclosure of information to unauthorized individuals or systems.
- b) **Integrity:** In information security, integrity means that data cannot be modified undetectably.
- c) **Availability:** For any information system to serve its purpose, the information must be available when it is needed. This means that the computing systems used to store and

process the information, the security controls used to protect it, and the communication channels used to access it must be functioning correctly.

- d) **Authenticity:** In computing, e-Business and information security it is necessary to ensure that the data, transactions, communications or documents (electronic or physical) are genuine.
- e) **Non-repudiation:** It implies that one party of a transaction cannot deny having received a transaction nor can the other party deny having sent a transaction.

2.2.2. Concepts applied in land administration

Modern information technology permits capturing data, management, retrieval and use of the geo information in computer and communication environment. Notwithstanding the development of information technologies, the users of geo information still should know the location of datasets, availability of data, the method to access, the structure of data, etc (Groot, 1997).

The private and public organizations, who are acquiring data, normally do not know the place where related data are residing; even though they know, it is difficult to access, share, and use data because of the lack of legal regimes and standards (exchange format and data structure), and different system configurations. Thus, when we consider the availability, accessibility, and use of cadastral data in a government perspective, this context causes much duplication, which waste time and money.

Therefore, a national land information system would be assumed as a mean to facilitate access, sharing, and integration. In order to realize these, it requires the development of a platform to formulate, enforce and coordinated information policies and legislation for ensuring improved physical availability and legitimate accessibility and use of high quality geographic data and technology and reasonable costs.

There are several purposes for developing a secured information workflow. In general, the primary purpose is to provide land information more effectively better quality of service to the individuals, and private and public organizations. Specifically, it aims to save time, efforts, and money during data access and use as avoiding unnecessary duplication in the harmonization and standardization of required data sets and promoting the sharing of available data (Groot, 1997), which could be addressed with the element of availability.

Technological progress in the last few years has removed many of the barriers, which inhibited the development of geographic information systems (GIS). There is general agreement that the potential of this technology to store, manipulate and present spatial data is considerable. However, if full advantage and effective utilization of GIS would be expected in these opportunities, it is necessary to overcome a number of human, intuitional and organizational constraints (Cambell, 1990).

Many institutional issues like political support, data availability, regulations and legislative activities related to data sharing between organizations, access right, copyright, privacy, organizational changes, etc, which on one hand could promote information security. But on the other hand, it may create barriers to implementation of an integrated information flow among organizations; the information security is then affected in a negative way.

In Dutch system, the Land Administration concepts of information security have been addressed differently between external and internal actors. The internal actors means the information used to communicate among surveyors, local office, and centre office must be always reliable. In the internal aspects, the actors could always access the information at any time. Once the information is legally modified by another internal actor, other parts could get noticed immediately. If the information has been modified illegally, other parts would realize it immediately or the computer system would deny those processes. The internal actors mainly focus on the security elements about integrity and authenticity (Stolk & Lemmen, 2003).

However, from the external points of view, the information security is more concentrated on the checking the information such as cadastral information. The information should be modified in time and history data of each parcel also needs to be available on line. Specifically, the notary plays an important role in land transfer. Notary as a middleman needs to check personal information about buyers and sellers. Notary is also sending the deeds to Dutch Kadaster. Therefore the deed should be written accurately and needs less mistakes. The external actors focus on the elements about confidentiality, availability, and non-repudiation.

There are also issues (as discussed below) that affect the concept of information security (Young, 2007).

Data availability

Availability of cadastral map is important in the early stage of land information system. It would affect the availability and authenticity from the information security aspect. After processing the data, the database should be updated on time. It is necessary to advertise what data are available to the public to the actors involved as well as for the specified purposes.

Communications

When some information is being processed, the time issue should be considered. Reviewing the current situation, there can be some gaps in time between central and local offices and between government and private sectors. There are no mechanisms to solve them like public consultation, user liaison groups, marketing and sales. These may be causing several to set up a 'consultative committee' to inform both information providers and potential users of the progress of implanting land information system and to care about their requirements.

Technical issues

Information technology can have computers and the management of the data processing, data processing automatically instrument or others are developing at an increasing speed, many barriers need to be resolved to ensure optimal utilization of the advanced technologies.

Standards

Standards can be defined such as "standards are documented agreements containing technical specifications or other precise criteria to be used consistently as rules, guidelines, or definitions of characteristics, to ensure that materials, products, processes and services are fit for their purpose"

2.3. Practices in provision of land information security in land administration

In order to investigate how information security issues are considered in land administration, this section takes four countries as cases (namely, British Columbia, England, P. R. China, and Netherlands). These countries as cases are chosen because there are literatures available concerning land administration on these countries, and these available literatures from these cases are related to these issues about data availability, communications, technical issues and standards.

2.3.1. British Columbia (Canada)

Land title in British Columbia operates under a system which is based on the principles of the 'Torrens' registry system. Only a person registered as owner who has, under the Torrens system, a legal title to land, can only do transaction by the act of registration on a public register with the issuance of a new certificate of indefeasible title. A title that is indefeasible cannot be defeated, revoked or made void. The person who has legal title to land has a right, good against the world, to the land, right to transfer or otherwise deal with their legal title to land. Registered title also allows for simple, quick and inexpensive land transfers (BC land title and survey organization, 2011).

As with any area of commerce, there may be people who mis-represent ownership of land. Identity theft is a concern these days and people should always ask for identification when dealing with any individual with regard to land title to ensure that they are dealing with the true owner of the land. In British Columbia, the system could prevent frauds and information theft. Lawyers and notaries check their clients' identities before submitting the documents to the Land Title and Survey Authority (LTSA). FINTRAC rules require real estate brokers and agents to verify their clients' identities following specific guidelines, and to keep client information record for every purchase or sale of real estate. If some parties in a real estate transaction are not represented by a real estate broker, the broker/agent will need to verify those parties' identities. Financial institutions are also required to verify their clients' identities for certain transactions following specific FINTRAC guidelines.

Land ownership fraud is rare, and there is very little evidence to suggest that it is a problem in British Columbia. British Columbia's land title system includes numerous checks and balances to identify and prevent fraud. The Land Title and Survey Authority are responsible for operating the land title and survey systems in a manner which assures secure and marketable titles.

In BC, the ownership of land is referred to as land title and is documented by registration through the LTSA. Once registered, the LTSA issues a Certificate of Title which represents that the named owner has legal title to the land. A registered title is conclusive evidence of the ownership of that land and provides legal certainty of ownership. Only a person registered as owner has the right to transfer or otherwise deal with their legal title to land.

A property owner's legal title to land is legally protected in BC under the Land Title Act. The LTSA is responsible for managing the land title system in a manner that protects and maintains the security of land ownership records and documents.

The land title system of registration provides certainty of ownership. Along with other professionals involved in creating documents and dealing with title, the LTSA examines documents for accuracy every time land is sold. Other interests include things such as leases and statutory rights of way.

The responsibilities of the LTSA include:

- examining and registering
- applications for transfer of legal title to land;
- examining and registering
- applications for charges on title, such as mortgages, and releases of such charges;
- examining and depositing

The communication with other parties

Since British Columbia's land title system includes numerous checks and balances to identify and prevent frauds, they constantly monitor the land title system to make sure it meets current needs. They work closely with the Law Society of British Columbia, Society of Notaries Public of British Columbia, the Association of British Columbia Land Surveyors, lenders, and real estate professionals to ensure that the system remains secure, fair and cost-effective for users.

Professionals such as lawyers, notaries, real estate agents and land surveyors contribute to having a high quality land title system in BC by representing the interests of individual citizens in transactions related to legal title to land. They prepare legal ownership documents and survey plans for registration and filing with the LTSA for registration. Standards are established by professional organizations governing the practices of lawyers, notaries, real estate agents and land surveyors. Professionals in these fields are expected to be vigilant in their practices to help identify and prevent fraud.

In any situation where these professionals are found to be negligent, claims may be made against them through their professional organization. They may also be subject to disciplinary actions by their professional organization.

2.3.2. England

Process of transactions and registrations

The sale is negotiated by the estate agent 'subject to contract'. Previously a deposit would have been paid as assign of good faith on behalf of the purchaser; now it is more common to conduct a more modern check on the financial standing of the prospective purchaser. The lawyers are then called in. The seller's solicitor prepares a draft contract of the property, which are generally described by reference to a title. The purchaser's solicitor ought to check that the description remains valid. Secondly, there are special conditions relating to the purchase- there normally include details such as the purchase price, the date for completion of the transaction, the capacity in which the vendor is selling, the root of title offered, whether possession is vacant or subject to tenancy, the details of any restrictive covenants and any defects in the title. Thirdly, there are general conditions which are standard to most transactions (Burdon, 1998; Hirst & Barry, 2007).

At the same time, the solicitor makes 'preliminary enquiries as regards for example ownership of boundaries, the provision of unities etc ,and conducts local searches as regards to the local land changes- usually in standard form.

The title is deduced and investigated. This involves examination of an 'abstract of title' which is delivered by the vendor's solicitor to the purchaser's solicitor who checks it against the prior deeds or who may simply rely on the fact that previous abstracts will have been checked by previous solicitors. Where the title is registered there is no requirement for an abstract of title, it is enough to provide the purchaser's solicitor will make 'requisitions on title'- i.e. ask questions designed to clear up any outstanding point. Searches are made against the vendor to ensure that he or she is not bankrupt etc. Older text books state that the investigation of title occurs after the exchange of contracts, but modern practice is for it to occur prior to exchange to permit completion relatively soon after the exchange.

When the contract is exchanged two copies are made and each party signs. At this point both parties are committed to the transaction.

Where the land is unregistered there is no mandatory form of conveyance but, in practice, where a conveyance is used it will follow a more or less standard pattern. Firstly the document identifies itself as a conveyance, mortgage etc. after which the parties are identified by name and address. The 'recitals' specify the purpose of the deed, may narrate the title of the vendor to hold onto the purchaser in fee simple. A person dealing with unregistered land which will, following disposal, be the subject of an application for first registration is also entitled to use the form of transfer applicable to register the land provided a suitable property description is used in place of a reference to a title number.

Processes of checking land information in England

In England, the HMLR have introduced two means of obtaining information from the land registry. These means are by direct access and via a telephone call.

Under computerized direct access, an authorised customer is able to view the computerised register on screen and print information. By this means the customer can identify the owner of property and identify any charges affecting a title. The customer can also view details of any pending transactions or searches with priority affecting the title. If one does not have the title number the search can be conducted by postal address. He or she may also order copies of the register, the title plan and documents referred to on the register (except lease and mortgages). Official searches with priority and official searches of the Index Map may also be ordered via direct access. More service are planned, including on-line access to title plans once the titles map base is stored in digital form.

The telephone call centre may be used to order official search of index map, official copies of the register, title plan or copies of documents referred to in the register(except lease and mortgages) and to obtain immediate official searches with priority.

2.3.3. China

China has just started making Land Information System during the recent year. Therefore, a lot of human and financial resources have been devoted in construction of Land Information System. In the old days, the manual system has draw backs on its efficiency, lack of accuracy, and time consuming. These weaknesses affect information security of land information system.

Yan and Wang (2003)has discussed about the designing of land information system in China. They referred some criteria that the designing of the land information system should follow. The principles are including:

- building block design
- principles of delamination
- data integrity

In order to realize the principles, Shen and Tan (1997) implemented followings,

- Practicability operated authorization: different actors have different privileges to access the system. These authorizations could only be determined and supplied by the manager. It is important that one system has only one manager.
- Login password: once the passwords are delivered to the actors, they could change it. The passwords for the actors are always secret. Even the manager does not know the passwords.

- Operation data: operation data is always recorded every time when any actor works on the data. The operation data is recorded with date, actor name and the steps of the actors.
- Protections of the system when leaving the system: when the actors leave the screen up to ten minutes the system is closed. When the actor accesses the system again, he/she has to retype the password code again.
- Data encryption: using encryption to avoid the data being formulated illegally.
- Historical data: the historical database cannot be modified.

Yuhua (2010) has listed the following system components of the Cadastral Information System based on the information security

a) Username and code system:

The username and code system could identify the user. In that way it could protect the information from being misused or deleted by others. In order to make full use of that, the code should be changed quite frequently. And the code should be long enough.

b) Control of the authorization:

The authorization control is defined by different layers, therefore, different users can access to different resources and functions. For example, the upper layer can read and get resources that from lower layer. But on the other hand, the lower level cannot get resources from upper level. The system is designed in a practice way, in some situation, the upper layer user cannot edit the data that lower layer user has accessed.

c) Fire-wall technique:

The content management system is using fire wall. The fire wall is firstly to determine what kind of order is allowed to pass through the fire wall, and which kind is not allowed. By using the fire wall, the information from outside environment could be checking thus to promote the system information security.

d) Backup of the database:

Using the backup, the database could avoid the data from illegally delete or modify. There is possibility that the system could lose its security when virus infects it. With the backup system, the data would be more secure.

2.3.4. Netherlands

The Netherlands case indicates a very secure case of the way of communication from the notaries and the land registry. Notaries use electronic signature to send deeds. The regulations of each actor in the communication are well described (Wakker, Molen, & Lemmen, 2003).

An electronic signature is attached or logically related to an electronic document. This kind of signature is more sophisticated than a scan of document with normal signature. An electronic signature is related in unique way to the person who signed the document. It allows for the identification of the person who signed the document created with tools that can be controlled by the person who signed the document. It creates to the data concerned in such way that each modification afterwards in those data can be identified and based on the qualified certificate generated by a secure tool for electronic signatures.

Those conditions make that an electronic signature has same legal status as a normal signature. The technique on which the electronic signature is based on two keys which are related and which cannot be disconnected between a public and private key. These keys are unique for one person. The key is related to which person is registered by a trusted third party and is documented in a digital certificate. The longer the key is, the better the system is.

Sending documents such as deeds are organized as follows:

Notary sends an electronic deed with his or her private key. The receiver of this document is the Kadaster, can verify with the related public key (which includes the certificate attached with the document) if this document is unchanged and if it has been sent by the holder of the private key. This complex procedure is done by the software, so it is convenient for the user who uses the public key system.

Certification Service Provider (CSP) is an independent and reliable third party that generates electronic keys and publishes electronic certificates in which it is declared that an electronic key is related to a person. Of course the holder of the key is obligated to identify him or her to the CSP. Everybody can check the certificate with the original CSP. For this reason the CSP has to maintain which keys are still valid and which keys have been revoked: the issue of the key has a certificate revocation list. One CSP in the Netherlands is Diginotar.

The integrity and completeness of the document is checked by a hash value, a number of(digit) which is unique for related document(deed).

Every notary has to sign individually each deed he is sending to the Kadaster. For that reason, his computer is equipped with a smart card reader. He can enter his smart card to digitally sign the deed. All these digital deed are sent to a central point of the Kadaster. The Kadaster is also sending signed messages: proofs of receipt, proofs of registration etc. it should be quite clear that the register isn't signing every individual message with smart card. Instead of this, Kadaster is using crypto-server. That is some special hardware that signs every message. This hardware is temper-free, so when someone tries to open it to retrieve the private key kept in the crypto-server it flushes its own content.

2.4. Findings on provision of land information security

In the British Columbia case, the standards that roles of actors involved in the land transaction process are indicated. It also indicates that many checks are applied and identities are recorded when the land registry communicates with the other departments. This could fulfil the security issues especially communication issue.

In the England case, the checking and registering follow a standard process before the work can be transferred to others. Therefore the standards are important. It also shows that with the use of computer system, the system provides enough information to the people for registering on line.

In the case of China, it shows that China has just started the Land Information System, and it reveals a lot of techniques for securing information is used, for examples, username and code system, control of the authorization, fire-wall technique and backup of the database.

In the Netherlands case, the public/private key trusted by a third party is used in transferring deeds with the electronic signature. In this system, actors such as notaries must follow standards. This case also shows that issues of communications, data availability, technique issues and the standards are most prominent.

Land Information System plays an important role in promoting its efficiency of handling massive cadastral data. On the other hand, the new computer based system could raise new challenges in the information security aspects. The Chinese case and also other cases indicate that the management aspect, strict regulations are given and the responsibilities are clearly stated. The land registration has to follow a certain process. A lot of checking process is followed to promote its information security using technologies such as the electronic signature, the fire wall and user passwords.

Since these four cases were used to investigate the general nature of information security, further in depth study and analysis are necessary in term of detail workflows to find out how information can securely be handled during land transaction phases. For this purpose, the further detail study in the Netherlands is presented in the next chapter 3.

2.5. Technology used for provision of land information security

Single access point and check point patterns are often used together to protect the system from misuse or damage. The single access point defines a clear entry point to the system that can be assessed implementing the desired security policy. The check point pattern builds an easy access control mechanism on top of the single access point that is able to distinguish between authorized and unauthorized attempts to access the system.(Belanger & Hiller, 2002)

Another one of the most commonly used security pattern to control access of information is Role-Based Access Control (RBAC). It controls access to information by associating the users to roles that allowed to access to specific information. Most of organizations have a variety of job functions that require a different set of skills and responsibilities. Most of the time the employees and the employers are classified according to their functions or tasks; common tasks require similar sets of rights. The RBAC pattern helps organizations to define precise access rights for its members according to the “need to know” policy (Jacques Wainera, 2007).

Although it was a theoretical pattern, it can be easily applied in practice using an implementation model. Users (or employees) are assigned to detailed roles and roles are given rights according to their functionalities (Leong, Yu, & Lee, 2003).The association class called ‘Right’ defines the access type that the user, with his role, has regarding to the protected object. The user may be able to read the protected information, modify or delete it. Each user may have one or more roles, depending on how many tasks he or she performs. Each role may have the rights to use one or more protected objects depending on their functionality.

Currently available research results in the area of access control are dominated by models of role-based access control (RBAC). RBAC shows good potential to be successfully employed in a workflow system. The information security principle of separation of duties (SoD) is important in the modelling of integrity in a workflow environment. A physical and logical separation of tasks can improve the prevention of fraudulent activities (Ou & Ou, 2009).

2.6. Workflow Management System

ESRI ArcGIS Workflow Manager is an enterprise workflow management application that could allow an integration framework for ArcGIS multiuser geo-database environments. It can have lots of job management and tracking and streamlines the workflow. It could save the time and easily the processing. It gives tools for allowing the resources and tracking the status and progress of jobs. A detailed history of

job actions is automatically recorded for each job to give managers a complete report on how the job was completed. This information can be supplemented with comments and notes to provide even richer job documentation. Workflow Manager handles complex geo database tasks behind the scenes by assisting the user in the creation and management of versions. An integration of the Workflow Manager and ArcGIS geo database tools provides a way of tracking feature edits made through Workflow Manager does jobs using the geo database archiving tools.

This software has the tracking tools available. Workflow Manager allows the designers to identify the who, what, when, and how of activities on all jobs within their organization. Workflow Manager also provides people with step-by-step information on these jobs.

“With the Workflow Manager application, designers can define their business process using the workflow tools available. The job types usually have a workflow associated with geo database. These workflows consist of steps that execute applications or perform some automated tasks. The steps that are available in the Workflow Manager library allow people to open a predefined ArcMap document, executable, geo processing tools, URL addresses, or custom applications that are business specific.”(ArcGIS workflow help)

The workflow manager can imitate the true process of land transaction. It has standard steps defined in the software, therefore the work can be organized from this software with each step has a certain regulation.

The software can integrated with the ArcMap and the GIS data base can be created as different versions. Each version to the different users can have different privileges to access, and therefore information is secured.

2.7. Concluding remarks

This chapter firstly indicates there are four general issues that concern with information security. They are data availability, communication, technology for efficient processing data, and standards. These four issues are investigated by using literature review on the experiences of four countries (British Columbia, England, China and Netherlands). These cases reveal that these four general issues are enough at the system level. But in order to investigate the design criteria for information security aspects (as mentioned in section 2.2.1) in the Workflow Management System, a further in-depth study is needed. The next chapter 3 explains in detail about the Workflow Management System for a case of land transaction process in Netherland Kadaster.

3. WORKFLOW MANAGEMENT SYSTEM IN THE NETHERLANDS

3.1. Introduction

The previous chapter presented the concepts and general issues of information security supported by the cases in four countries. This chapter investigates actual workflow management system in detail for the case of land transaction (subdivision and full land transfer) in the Dutch Kadaster. It consists of the results derived by visiting and interviewing with the Dutch Kadaster experts at the central and regional offices, land experts of Enschede municipality and the notary. From these results, the information flows for land transaction among the different actors/users are described using UML diagrams.

3.2. Netherlands Kadaster organizaion

The Dutch Land Registry Office (or Kadaster) collects information about registered properties in the Netherlands, records them in public registers and in cadastral maps, and makes these information available to the members of the public, companies and other interested parties in society (Kadaster Organization, 2011).

Registered goods include not only the immovable properties such as the land ownership parcels, the houses and apartments, but also moveable properties such as the ships and the aircrafts.

Registering, informing and maintaining land records including land use planning have been the tasks of Kadaster since 1832. To enable Kadaster to better perform all of these tasks, it became what is known as a 'Self-Administering State Body' in 1994. This means that Kadaster is a legal entity under public law which performs its tasks as an independent organization.

During five years, the Dutch Kadaster has changed a lot. In the old time, there were 15 local offices in 15 regions and one head quarter. At present, there are only 6 local offices located in Eindhoven, Arnhem, Rotterdam, Amsterdam, Groningen, Zwolle, and one headquarter located in Apeldoorn. In order to reduce the cost in the future, Dutch Kadaster plans to reduce the amount of offices again. It will be only one local office and one head quarter. It could be realized firstly because of the highly developed work distributed system they are now using, all the jobs are given via E-mail, and land surveyors could get jobs even at home. Secondly, every land surveyor has his own package of jobs. He does everything of his job and he has his own boss in local office called manager.

Jobs are divided into the local jobs and central jobs. The responsibilities of the central office are to distribute jobs to the surveyors all over the whole country. Once there is a job that needs surveyor involvement, the central office would be involved. In central office, there are planners in planning department which helps to distribute jobs to the surveyors. In case, the workload of the surveyor is too much then the planner can request another surveyor from private company to do surveying jobs, but not legal guide or editing spatial data. The planner and surveyor use SAP – Workflow Management System

developed by German company. Though both parties use SAP but they have different authorization to access to the software. The planner can view and edit all workflows of surveyors but a surveyor can only see and edit his own.

Normally, the central office will not change data in SAP Workflow Management System. It happens only when there is a mistake coming from a surveyor; the central office could change the steps in workflow. By SAP Workflow Management System, the planner at central office could easily access how much work a surveyor has in hand and how much work he could finish. There are other important information that the central office could also access, such as for each individual survey work, who is the surveyor, who the manager is and so on.

Cadastral registers are kept in the system AKR (Automated Cadastral Registers), the maps in LKI (survey and mapping information system): two separated systems with interface connection in order to appropriately coordinate the ongoing updating of the cadastral registers and maps.

3.3. Workflows in Kadaster Office

Land transaction includes transfer and mortgage. But this case study just focuses only on land transfer without mortgage. There are two types of land transfer namely full land transfer of ownership and land subdivision.

3.3.1. Workflows in central office

Figure 3.1.shows the activities normally conducted at the central office. The job starts with customer service request. Customer service tells the price, and if customer agrees, the work comes to the central office. And the planner in central office distributes the job to most appropriate surveyor. Every morning the jobs come to the screen with the location of job, job type, and job's unique code. Figure 3.2 shows the jobs on the screen with their types.

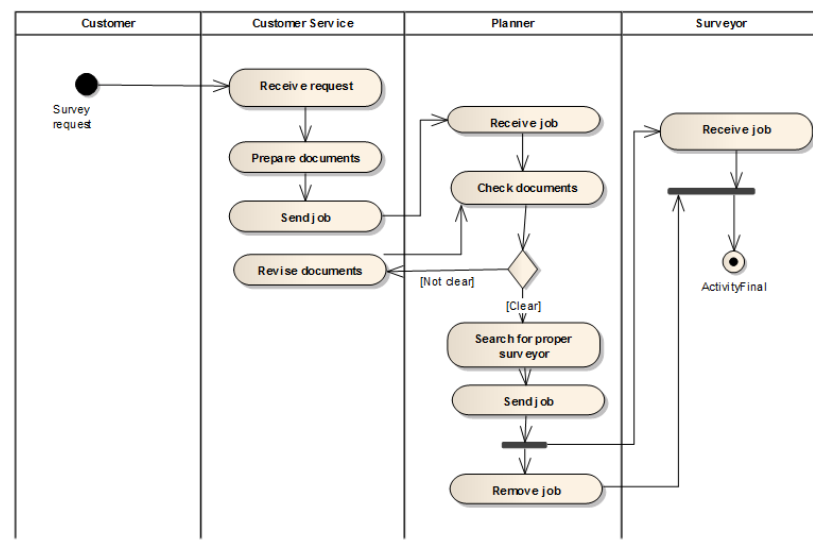


Figure 3-1: Workflow at central office

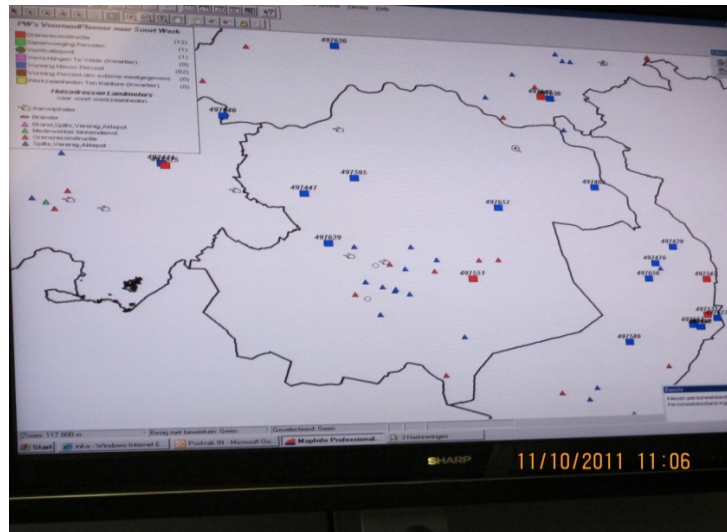


Figure 3-2: Jobs on the screen

The jobs are classified into the four kinds, the different types of job has different shapes and colour. The blue square ones, is a parcel the customers want to subdivide it ; it is the job of surveyors who go field to measure the land. For the red square ones, it is the job of surveyors who go fields to tell the owners where the boundary is. It is a very difficult job; sometimes only one surveyor could not do that. For the green triangle ones, it is an easy job, it means the two parcels merge together; the surveyors only do computer work. For the finger one, it needs surveyors to talk to the local people to know where the boundary is and the measurement work could leave to the private company.

Job type	Describe of the job type
Blue Square	For one parcel the customers want to explicit it out, it is the job of surveyors go field to measure the land
Red Square Ones	It is the job of surveyors go fields to tell the owners where the boundary is
Green Triangle	It means the two parcels merge together; the surveyors only do computer work.
Finger One	It needs surveyors talk to the local people to know where the boundary is and the measurement work could leave to private company.

Table 3-1: List of job type

On the screen, location of the surveyors' residence is also shown. Each blue triangle stands for a surveyor who could only do the work marked with Blue Square. Red triangle stands for a surveyor who could only do the work marked with red square.

The central office would first get E-mail from the customer service, if the documents are clear and enough, it will be marked with blue and sent it to a proper surveyor later. If some work could leave to the private companies, it would be marked with red.

Every day in the morning, there would be probably 80 survey requests from the whole country appearing on the screen. The planner would distribute work by the location of the work, the work type, and the

location of the surveyors as well as the statues of surveyors. When there is a job in one area, planner won't focus on former border, but which surveyor is nearer and available. Once the job has been sent to the surveyors, the planner will remove the job from the mail box, and planner also send the information to the ASP workflow management system.

Each surveyor has his own maximum amount of workload. The planner won't give jobs more than that amount. Also, the when one surveyor is sick, he will be marked with "Z" and no more jobs will be given to him. Special situation happens when one surveyor is very sick and he cannot go to field for two weeks or more. The planner has to redistribute his jobs which have already in his workflow list to other surveyors who are available.

In most of the Dutch islands, there are no surveyors living in, when they have 2-3 jobs there surveyors would go by boat

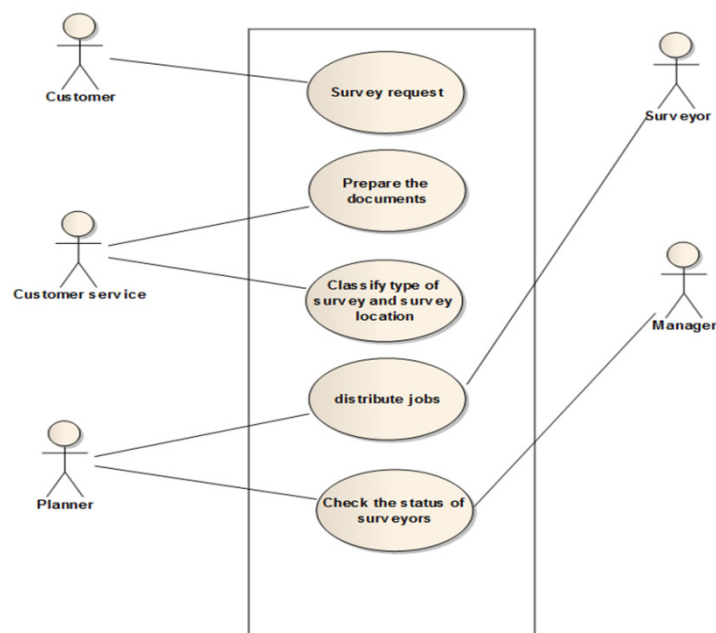


Figure 3-3: Use cases and actors at central office

3.3.2. Workflows in local office

In case of full transfer ownership, the process needs involvements of notary, registrar, surveyor and administrator. The customers go straight to the notary office and make a deed. Then the deed will come to the registration office. However, when the notary makes the deed, notary has to do some research about the customers. He can ask registrar if he needs some information from the Kadaster. In the office, all of registrars receive same emails from notaries about deeds. But when one clicks to choose one specific email/request, others cannot access or open that email. Besides, the registrar checks the legal issues in the deed when they receive the deed from the notary. Registrar and notary have an agreement that if the registrar recognizes the mistakes in the deed, then he informs the notary. Within 3 days, if the notary fixes it, he does not have to pay. There are two cases in transfer full land parcel. One simple case is buyer buys a

parcel or an apartment. This case just needs notary to make a deed and send directly to Registration Department (RD) and the registrar processes the deed and edits administrative data.

Another case is buyer buys his neighbour parcel to merger his land. This case needs a surveyor to process spatial data. The notary still sends the deed to the R.D. At the same time, notary requests customer service to process this parcel, surveyor will receive the jobs from the head department in Apeldoorn. Then after the boundary between two parcels is deleted, surveyor does not assign a new parcel number as the software automatically gives unique number for new parcel. The registrar will then change the owner's name and other information. During the procedure, the notary will take care of fees for Kadaster office, Customer Service, Tax Office. Last but not less, the administrator will check all the editing information whether something is wrong or not. If some information or editing is wrong, he will track the responsibilities belong to whom. If the mistake from the registrar or surveyor, he asks them to fix it. If the mistake from customer or notary, he may have to pay. The final step is confirmation letter (in case changing boundary, map also is included) from the Kadaster office to the notary, and the notary then gives to the customer.

In the diagram, the survey request goes to the surveyor through customer service and planner.

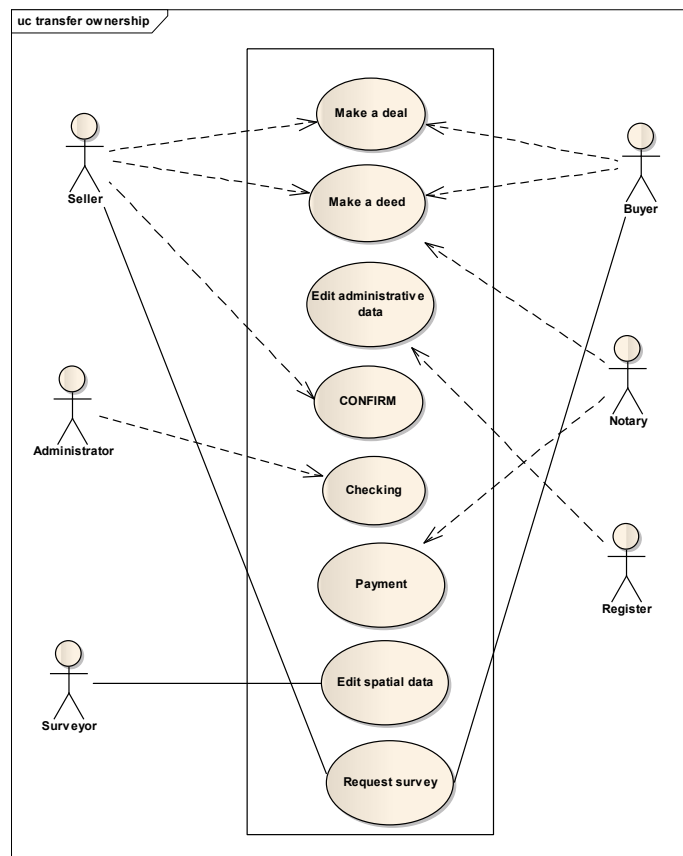


Figure 3-4: Use case diagram of transfer ownership

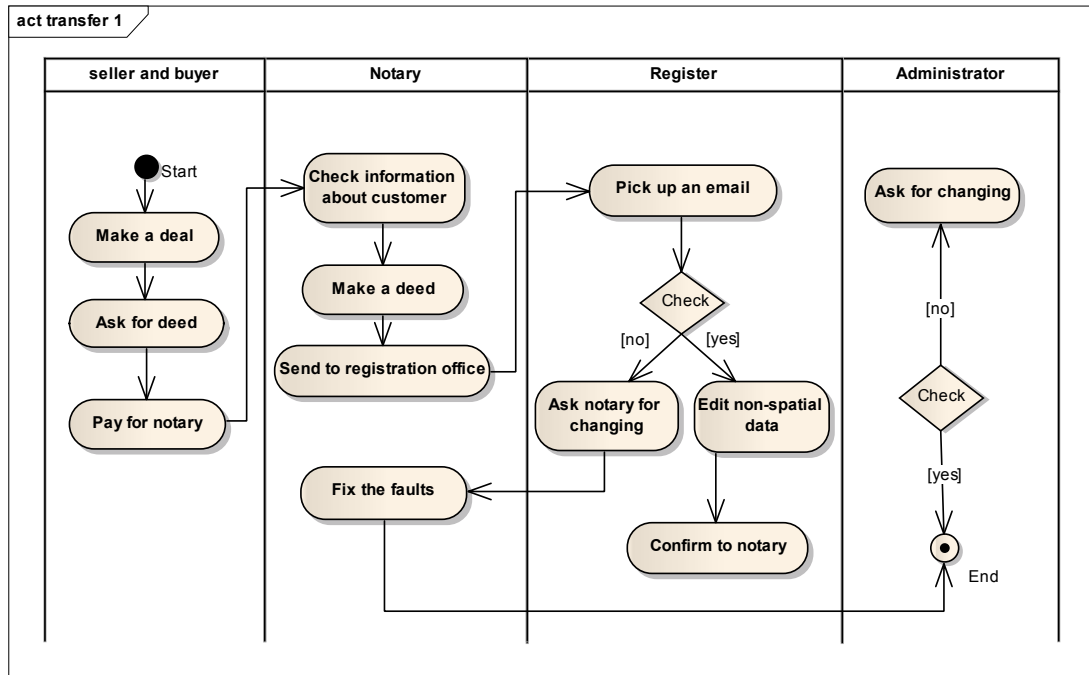


Figure 3-5: Transfer full ownership type 1

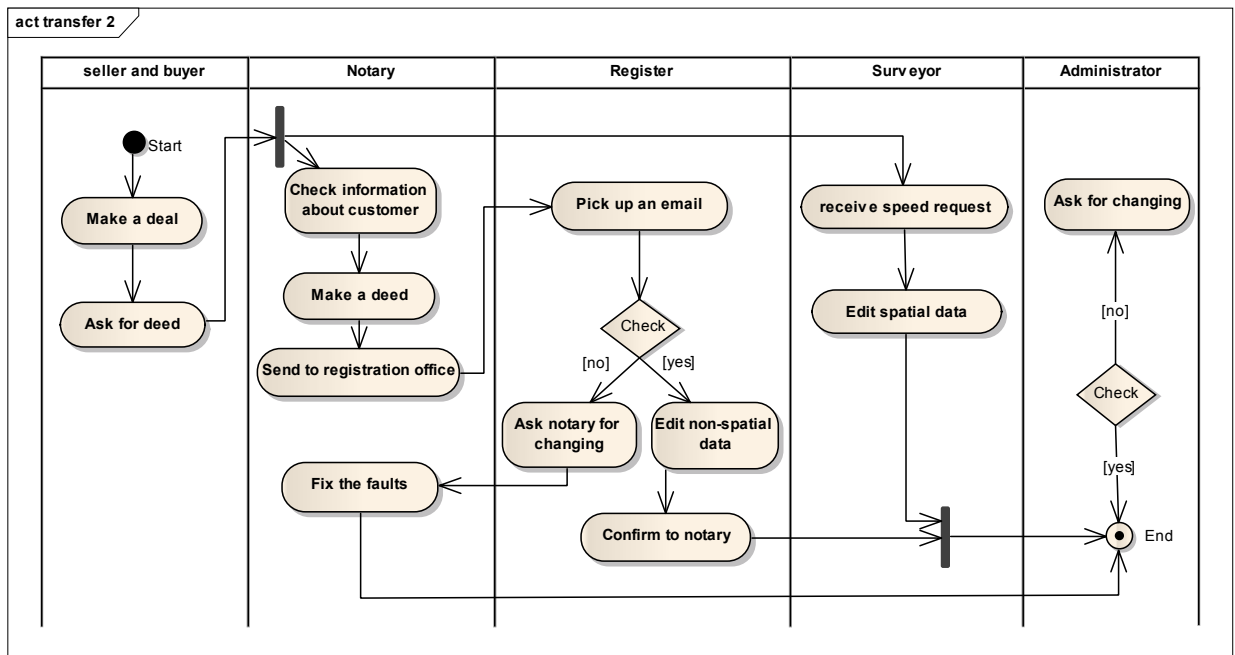


Figure 3-6: Transfer full ownership type 2

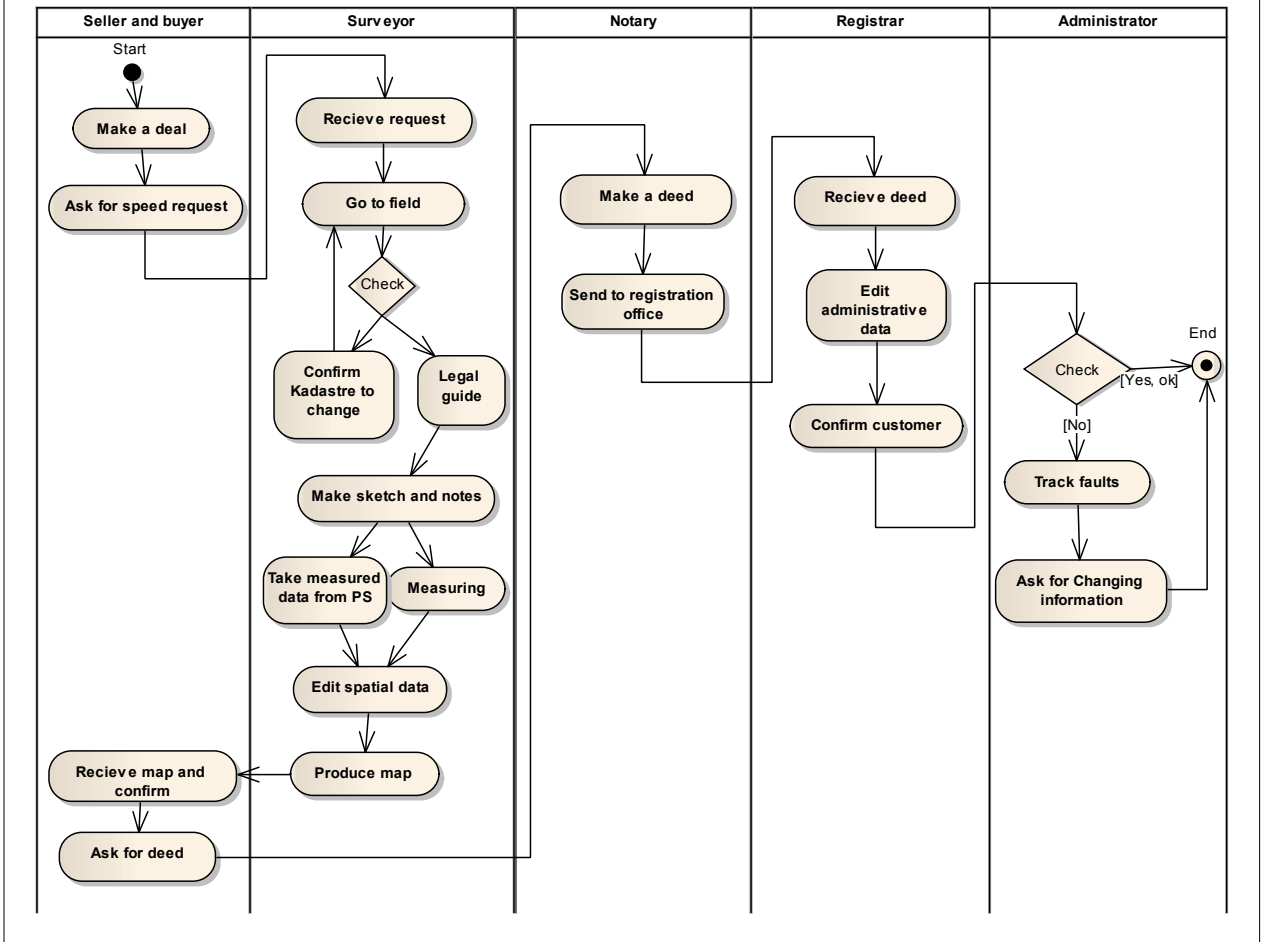
3.3.3 Subdivision

In case of subdivision a parcel, the seller and the buyer agree with each other about how much the buyer wants to buy (subdivision) or how much each area is before go to notary or requesting for surveying.

The process contains the steps in term of the surveyor's work. Subdivision is different from the transferring full parcel because its initial step starts with survey request. There are two kinds of survey requests.

First one is called "speed request" that customer wants to know exactly how much land he is buying/selling. Each area is evaluated against money. Or even the seller and buyer want to know where the boundary is after subdivision. That is why they ask for "speed request" before going to a notary for deed preparation. So after request for surveying, the surveyor comes to do his jobs. "Speed request" needs to be finished within 20 days since the day speed request is made. In case, one of parties goes to holiday and the surveyor cannot finish within 20 days, he will ask for extra time. And everything including extra deadline and reason are recorded in the system. The customer receives a map and confirmation letter from Kadaster office. Then customer then goes to the notary to prepare a deed.

Another way is that both seller and buyer go to a notary to make a deed. Then the notary sends survey request to the customer service. At the same time he sends the deed to notary. When surveyor receives tasks to do, he will ask an appointment to the seller and buyer. The surveyor goes to the field with all parties and carries all documents such as request, deed, form for sketch, coordinates, etc. He will check the information in the request or in the deed. If anything is wrong, he will ask the notary or registrar fix it. While talking to the seller and the buyer where the boundary is or whether he wants exactly 300m², so on, the surveyor makes a sketch and makes a note of everything and signature of both sides. If the measuring is easy and does not take long time he will do. But if it takes long time, he can ask a private surveyor to do. After fieldwork, he goes back office with sketch, notes, measuring data or collects from private surveyor. He puts the data in software called MapInfo Professional and edit new boundary, make new parcel number but the surveyor will not edit the owner's data and still keeps the old parcel number but marks in different colour. After all, customer and notary still have to make a deed and send to the registrar. Then the registrar edits non-spatial data, puts new owner to subdivided parcel and so on. Finally, the manager checks the whole process again.



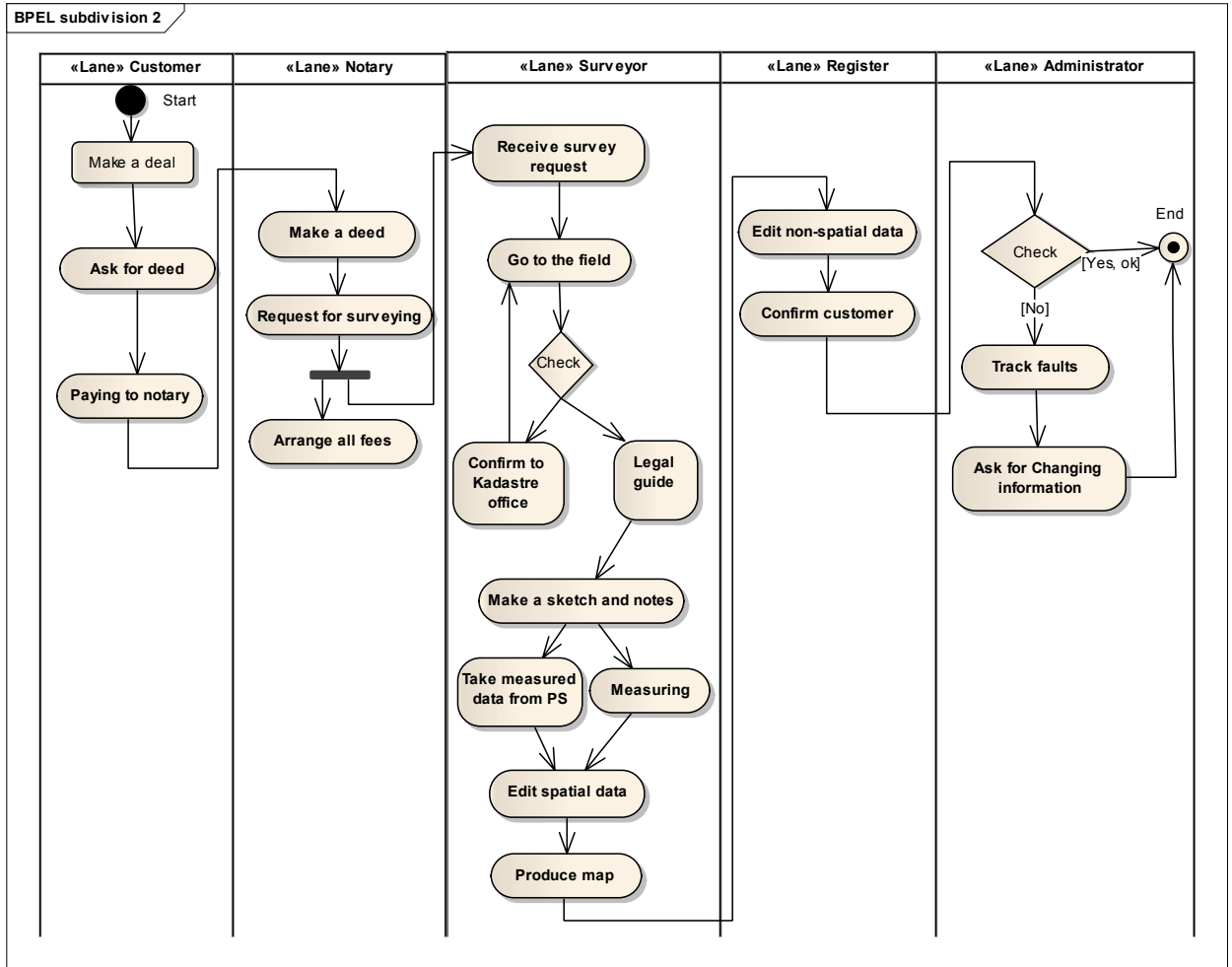


Figure 3-7: Subdivision type 1

3.4. Land Information Security in workflows

Based on the interview, an onion model of information flow among different stakeholders is generated. This graph has illustrated that both Dutch Kadaster and municipality has formulated the land information system. Kadaster and municipality have different databases, which together makes the whole product and service. The information provided by the Kadaster and municipality is free access to the public. Different thing is Kadaster provides different account to the notaries and real estate agent and searching information in Dutch Kadaster needs money. Municipality and Kadaster would communicate with each other to achieve updating their unique databases.

Notaries play an important role in the process of land transaction and subdivision in the Netherlands system. To finish a case of land transaction or subdivision, notaries need to check information about the parcel on the website from Dutch Kadaster. Both buyer and seller's personal information is needed; in that case, notaries need to communicate with the municipality. After processing all the information, notaries send digital deed to Dutch Kadaster.

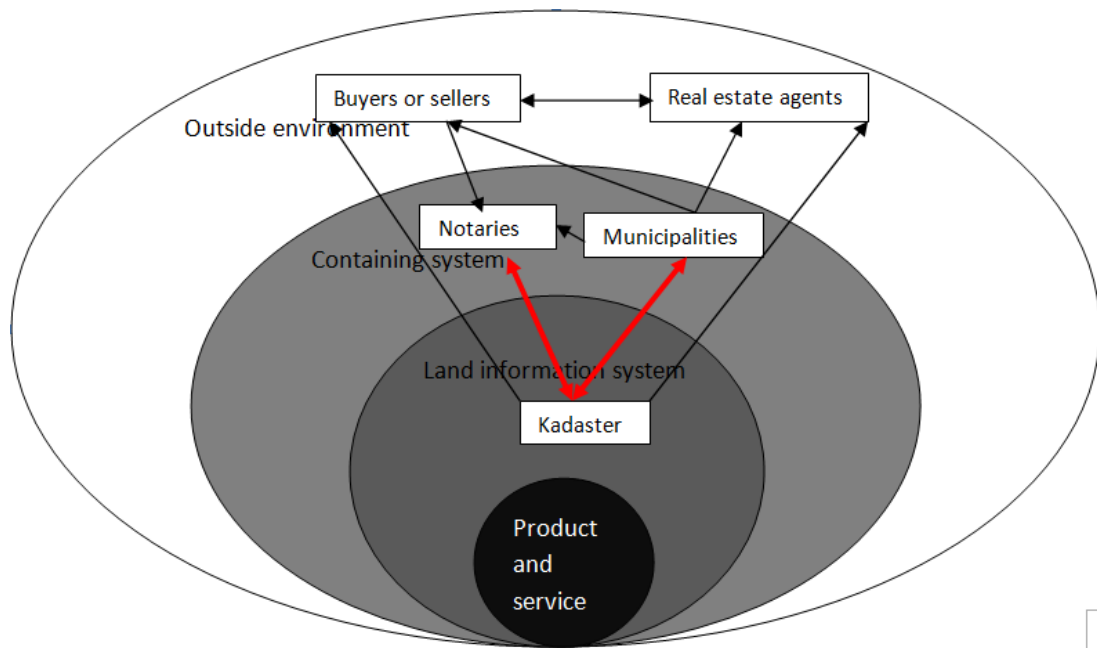


Figure 3-8: Onion model of information flow

Real estate agent would gain the house selling information from the seller and provide it through internet.

3.4.1. Dutch Kadaster as an internal actor

In the land transaction process, if mistakes are made then the system will detect it as soon as possible. People could make mistakes, but actually the software sees through all the processes. That process flow in administrative point of view effects AKR system.

For administrative purpose, Dutch Kadaster does not have specific workflow. All the information is available online to the manager and surveyor involved. One person starts dealing with it also a stock of deed which should be handle today. And Kadaster has 5 or 6 registrars, and they are monitoring, supervising all the legal administrative activities, but in local office Kadaster has administrator who deals with the deeds.

It is one of criteria that every deed has to be processed in one day. Every deed has to be registered in sequence. If there are two deeds coming in, one about transfer a parcel, one is about mortgage, and the administrator has to deal with them at the same time. The administrator cannot change the sequence. There is also certain freedom in the administrator's work as long as every deed is processed within one day.

Every notary knows that his deed is processed. So sequence is not a problem. Sequence of entry is not always kept but normally there are no requests from the customer and notary. So administrator does it in sequence. It is not an issue unless there is some dependence between the deeds, and then it is necessary process in sequence. For example, if the sale is after the sale and then sequence is important. Also for the system because if the transfer completed and there is transfer after that. We have to know that one day,

the parcel was one-hour owned by one person. Administrator cannot do that if mix them. This is hardcore procedure in AKR. For example, you pick the second deed and you try to process it and you find the seller is not the owner.

Transfer of whole parcel is easy one. It has only administrative work, no LKI activities, and no survey activities. There is a small fee, directly notary pays it. Usually, once per month notary is going to pay all fees to Kadaster. Second workflow, deed of part of parcel, part of parcel is sold, surveyor goes to the field. The seller and buyer have to show where the boundary is in the field. This survey costs a lot of money. But it is paid together with the deed at the same time. Deed entitled with bill is going out. People paid for survey before work done in future.

The notary has to check, authenticate and authorize person if he is owner. He has obligation to do that. If it not correct, he is not allowed to process. That is not the task of Kadaster.

In the point of security, because there are separate flows (seller/buyer, notary, Kadaster), actual security in process takes place during transaction between persons and organization who have their own responsibilities. Notary checks the real owner by unique number/ person identifies in AKR, Kadaster people checks if notary did correct or not. And if not he has to rectify it. That is formal security. And when the surveyor asks the seller and the buyer to show the boundary in the field, the seller and the buyer can authorize to third party to be on behalf of them. And you have to show the paper to do so. Surveyor checks again information. For Kadaster, the legal security is mission.

Flexibility is addressed differently into organizations. In some company, they try to give all activities in lower level workflows. One mistake might lead to the whole system stopped, so it is necessary to give limited flexibility to actors.

Administrators cannot play with the parcel number before parcel is created. They cannot also create new parcel until the new boundary is processed in the system. That is logical sequence. They first enter boundary data, they generate parcel number, and create new parcel. That is their flexibility in work. But at the end of that whole show, there are fix procedure on checking it.. It is cartographic or administrative jobs.

Planners can change status in the higher level, assign one job to a surveyor and change status who is surveying. But Kadaster is not going to see whether it is that correct person or not. That is choice.

3.4.2. External actors

A. Notaries

Notaries play an important role in the process of land transaction and subdivision in the Netherland system. They obey the principle of “equal exchange”, buyer first give money to notary, if transfer is finished, notary give money to the seller. Every payment is through the bank. Notary will give the interest of money to the customer.

To finish a case of land transaction or subdivision, notaries need to check information about the parcel on the website from Dutch Kadaster. Both buyer and seller’s personal information is needed; in that case, notaries need to communicate with the municipality. Before the land transfer, notary needs to know the

market price of one house; this price information is given by WOZ. Price of the house is first checked from WOZ, if the transaction price is much lower than the market price, the notary would deny that transaction. After processing all the information, notaries send digital deed to Dutch Kadaster.

For the notaries, everything is digital online. Notaries can check information from Kadaster online. Each question costs 1 euro. Notaries have their own account. Notaries can make queries according to postcode, address, nature person or company.

Notaries' system is integrated from the GBA system in municipality, if someone wants to transfer a house, his name is taken out from the municipality database. Mistakes of wrong spelling hardly ever happened. When notaries send deed to the Kadaster, the Kadaster would also automatically generate a confirm letter to the notaries. In case, if one notary's E-mail code is been stolen by other person, this E-mail could also send deed to Kadaster. If that happens, notary would know that by the confirmed letter, the deed will be cancelled.

B. Municipality

Municipality as an external actor can claim information from Dutch Kadaster. The Municipality has its own databases. They have the data about land information on rights, mortgage, value and personal information. Due to the budget, the land information is only updated monthly, and the land information database in municipality has limited attributes. Any municipalities are obligated to have their own information in their office. Information about owner, deed, the price of last transaction is offered.

As an external actor, municipality is also the information producer. Municipality is the agent for address to be generated. This kind of information is delivered to the Dutch Kadaster. Municipality has to pay money to Kadaster. Since 25 years most of information processing is done in digital. Nowadays, data from both municipality and Kadaster is via internet. Municipality only gets the changes of cadastral data but not the whole database.

Municipality provides data free of cost to the public.

Producing road names and house numbers

In any municipality, address is one kind of the important information. Address is combination of many components and link with object and status of building. This is relation between building and addresses and to the map and parcel. And person/ company both have relation with address. Address is link between person to building parcel and map.

Municipality puts the cadastral data and the address data together, making the links. Once the municipality provided something in addresses, they would also make the information digitalize in Auto-CAD. They are going to fill the information like street names and house numbers in cadastral data. If everything is completed, it will go to Kadaster.

For most of the cases, the local commissions of the streets decide the names. And the house numbers is produced by the staffs of municipality following a certain rule. Till now they are still busy controlling double addresses. Commission is only decide the street name. The municipality would do queries to check if there is a duplicated house number in a same street.

In the case of subdividing a parcel, then municipality has to give a house number. House number is an attribute with the building. If there is only a parcel without a building, it doesn't have a house number. If someone wants to build up a building, he/she has to first ask permission. When someone has a building, he/she will get the a house number from municipality.

Special case happens, when it was an old house citizens having permission to build new house and it temporally duplicated house number. But in basic administration, that two addresses have two unique identify numbers. It can be building without address because no one lives there: shed, house for keep animals in farm.

Check information.

From internet, the data from municipality is free. The information about basic cadastre is open to the public. What's more, the municipality also provides information about limitations of selling or buying a house. If someone is going to buy a big house, he/she needs to see the property of its limitation, like monument cannot be sold. This kind of information can also be checked from real estate agent, but people have to pay it.

The notaries need to check whether a person sell or buy the land is validated. Municipality also has database about personal data, which Dutch kadaster doesn't have. Notaries have to check whether the address is validated or not. In that way, they have to contract municipality.

Limitations of selling a house and Plan

Municipality can set limitations about buying and selling a house. If the municipality wants to put the limitation like a monument that means the owners cannot rebuilt one house until they get permission from municipality. Government would decide which building is monument and this message would be sent to the municipality and updated into municipality's database and then goes to kadaster.

A certain area could have some limitations. Netherlands has land use planning, and in this land use plan, it has exactly stated what is allowed in a certain area. Based on normally cadastral map or topographic map, people can get information about exactly land use plans in different areas. It could be one single land use plan or could be mixed land use. The plan is open to the public. Not everything but quite a lot. You can see it on graph and links to the text.

If the municipality wants to build a plot, they can use data about land use planning and all the information. They want find all information in several area. In order to avoid the speculation on the ground, they are putting the limitation in the area where we are interested. If someone wants to sell his property the notary he would check whether the house has limitation for a period of time or not.

Set regulations to the citizens

Before the process of subdividing a parcel, if people want to explicit the house and change the address number they have to ask permission from the municipality. In that way it could control what going on to reduce the bad effect to their neighborhood. A settlement area cannot suddenly change to the area where only students live.

If owner wants to build a wall to divide the house, he/she has to ask permissions. The subdivided house could fit for the minimum standard. If there the process to subdivide a house or even to tear the building down, people has to ask the permission.

Update data to Kadaster and process

Kadaster doesn't need house number. If the parcel has no building then there is no address, so kadaster use their unique parcel number. But people still can see who the owner of the address is, and where he lives. Parcel number from Kadaster is most basic; municipality is trying to link with parcel administration and address administration. There is a link between photography and administration.

Deed goes to municipality once a month and that is parcel data from Dutch Kadaster. For the administration data they get two files: one file about subjects, another file about the person changes both the files with parcel administration. They have special software that can import from Kadaster. Municipality has special software. The geometry information is digitalize in AutoCAD and can be read in this software.

The data should be correct. If the information we send to Kadaster is right or wrong municipality would get message back.

Municipality send the address information will go automatically. Municipality change information here but send to kadaster. They have back up of the data. It is different from data we get from Kadaster.

Municipality has licenses to distribute cadastral information. The meaning of that is the number they have distributed; all the actors involved have to use the same address. They do it here and send it to kadaster and Kadaster send it to the actors who are concerned.

Information security--integrity

It is important nobody can edit everything. Certain people can change only information about address, building. Only 8 people have been given authorities to change data like registration of people. In this case, integrity is more important. It is also important that the information is always correct. If somebody wants to change it they should have knowledge to do it. In order to change something, municipality has to make official documents. The historical document has saved to prevent illegal thing happens. If somebody adds building the application building permission and request is approved then it become official document. Once per month they check everything is going correctly or not.

3.5. Concluding remarks

The discussion shows that within the internal users the information flow is always timely and accurate. Information security aspects are well addressed. For example, in Dutch Kadaster, it is good that nobody could edit all kind of cadastral information: Surveyors process spatial data while administrators process non-spatial data. This easily promotes the confidentiality. However, there are some gaps in data flow with the external users.

- For the external environment, the difficulty is that there is no consistent between the databases of Kadaster and Municipality. Updating data is delayed for a month and makes the information online not actual. The element of availability is not addressed.
- The notaries as mediators are involved with many other actors. Thus the process of the notary is complex, and leads to many problems on providing correct information. That can affect its integrity.

4. DESIGNING WORKFLOW FOR IMPLEMENTING INFORMATION SECURITY IN THE CASE OF LAND SUBDIVISION

4.1. Introduction

The previous chapters have discussed about the concepts of information security and the techniques used for promoting information security in Workflow Management System within and between the organizations. Based on the experience of Dutch Kadaster, this chapter discusses design aspects for implementing information security in the Workflow Management System by following the concept of versioning. This chapter mainly focuses on a generic case of land subdivision.

4.2. Design criteria for Workflow management System

As discussed in the previous chapters, the elements of information security (Confidentiality, integrity, availability, authenticity, and non-repudiation) are important to consider in land transaction processes. Following the previous chapter 3 critically, this research reveals that the following design criteria are essential for each element of information security in a WfMS for land transaction process.

Security elements	Criteria
Confidentiality	<ul style="list-style-type: none">- Grouping the actors in land subdivision- Access to information- Roles of groups
Integrity	<ul style="list-style-type: none">- Data is not modified during the job transfer- Transfer all necessary data- Makes sure transfer and receive the same job- Sequence of the jobs
Availability	<ul style="list-style-type: none">- View the data at any time- The data should be processed properly for each steps- When transferred job, data is still readable for other actors
Authenticity	<ul style="list-style-type: none">- In the workflow, recording the response of the questions to make sure the steps are confirmed- Examples, signing an agreement, surveying in the field
Non-repudiation	<ul style="list-style-type: none">- Once the information is sent, no one can deny it.

Table 4-1: Designing criteria of workflow management system

Confidentiality means that the information should not be processed or viewed by the users who are not relevant to a certain job, for example, notaries should not process administrative data in land registry, and administrator in land registry should not sign a deed. Therefore, grouping of the users is important. The groups are divided depending on their roles of the land subdivision process. Different groups have the privileges to access different information. In the implementation aspect, how to organizing the group should be considered well.

Integrity reflects that during transaction process the information is delivered among the actors, and it is very important to make sure that the information is not modified. Therefore each actors need to have user name and password to login system. Historical data is important as well, so that every process of editing data could be reviewed. The person who have edited or modified data is recorded in the system. The job needs a certain ID, so that, if one step is finished and is delivered to another step, and this way it is clear to find the sequence. In the real life, each user may have a lot of job in hand at the same time, so it is necessary to know which the job is parent one.

Availability implies that the geo data could be viewed at any time by the users concerned. What is more important, the geo data is processed properly, so that when it is delivered to other users, they can continue processing without any problems. For example, notaries have to sign a deed following a certain rule, so that the land registry knows in which way to divide a certain parcel. The administrative data should be processed properly so that when the work is delivered to the surveyor, everything is clear for the later job.

Authenticity is the issue that in order to finish the process of land subdivision, buyer/seller and notary, buyer/seller and surveyor have to be together to make sure the new boundaries are well defined. The subdivision plan needs to be stated clearly.

Non-repudiation includes that the deed and the provisional subdivision plan sent by the notaries have to be sent in a certain way so that once it is delivered to the registry organization; it is undeniable already. Also the non-repudiation reflects that the communication with the land registry organization should be trusted and efficient.

4.2.1. Roles of actors and responsibility towards information security

In the subdivision case, there are five groups of people involved, they are, buyer/seller, notary, administrator, surveyor and quality control manager.

The process begins with buyer/seller, they check the parcel information and they would go to a notary for subdivision work. The information on parcel could be correct and up to date; therefore, this part is focusing on the availability and authenticity.

For the group of notaries, they need to check both parcel information in the Land Information System and the personal information. If the information provided by the buy/seller is correct, the notary could make a subdivide plan and sign a deed to the land registry. For the information security issue, the deed of the spelling should be correct, and the information sent by notaries, as an external user, has to be trusted and reliable.

For the groups of administrators, their jobs are for editing non-spatial data. But for the subdivision case, they would first edit spatial data, putting provisional boundaries to get new parcel numbers. After that, they could be able to make a land transfer on the non-spatial data. From the groups of administrators, a

land subdivision job in the non-spatial job is fixed, but in the spatial job is not finished yet. Therefore the job will be delivered to the group of surveyors.

Once the surveyors get the job, they will check whether the information is enough or not, if the information is not enough, they will ask the administrator for more editing. If the information is correct, they would go to the field, and meet the buyer/seller and sometimes their neighbours at the same time to make sure the boundaries. After that, they will do the surveying job and store the data in the computer and after that to process it in the land registry. The surveyors can only edit spatial data in the registry in order to protect the non-spatial data.

After the editing from the surveyors, the quality control would get notice and get the job from the surveyors, they check the data again and archive the data for the historical data and post the data to the database.

4.2.2. Communication between actors

The communication between the actors is important, because information security does not only lie in one single actor processing information, but also lies in the communication between actors.

There are two challenges in the communication aspect, and the first one is to prevent the disclosure of information to unauthorized individuals or systems. And that could affect the land information data confidentiality. The other challenge is the once the actor receives information from the other actors, he cannot deny the information. And the job's sequence is important, because there are many jobs

The way of communication between the buyer/seller and the notary is always face to face, because the buyer/seller need to prepare the document and the deed and send to the notary, and the notary need to prepare the subdivide plan and the deed, both documents need to be signed. Therefore, from the implementing aspect, there are fewer problems in the communication between the buyer/seller and the notary.

The problem exists in the communication between the notaries and the administrators, because notary, as an external actor, needs to communicate with both sides of the land registry and the customers (buyer/seller). Hence, the way of notaries sending message is much more important, and it plays an important role of deciding whether the information is secured or not.

The measure of the secured land information flow, in this chapter, to protect the information from the disclosure the using electronic signature could promote the information non-repudiation.

4.2.3. Organizing jobs and steps

A way of sending alerts to members of staff takes place automatically when certain event occurs in the Workflow Management System, for example, when a certain task needs attention or a major element of the job changed. Consequently, the users can confidently work on the important jobs without worrying about missing new job assignments or failing to meet certain job.

Workflow Manager provides e-mail notifications for the job events. A user who has subscribed to a particular notification type will receive an e-mail once the event has occurred. For instance, when a quality assurance technician is subscribed to certain step, and the surveyor finishes subdivision, it reassigns the job to the quality assurance technician for further processing. Since the QA technician is a subscriber to that step, the user will receive an e-mail notifying him or her of the assignment.

To implement the land information security elements, it is important to make clear each actor's privileges. The privileges should be given as much as what he should do in the process of land subdivision, or land transfer.

For example, in the case of land subdivision, the information actually divided into two parts, one is the spatial information, and the other is the non-spatial information. The experience from Dutch Kadaster shows that the subdivision case is actually transferring two times. Different actors transfer different data in the same parcel. The Dutch Kadaster could do that because they have different software, AKR and LKI. With the two kinds of different software, the job could be separated for the different actors.

In the subdivision case, the actors like administrator needs to firstly create provisional boundaries in order to get two parcels and then the actual role of the administrator is just to edit the non-spatial data. From the regulation points of view, it is also possible to first edit spatial data and then edit non-spatial data. But then the buyer/seller will have to wait for a long time the subdivision result as well as the deed. That really affects the information security in the data availability aspect.

This aspect can really affect the efficiency of the data processing, because once the non-spatial data is processed in the database, it could be able to reflect enough information to make a deed, and it is legally evidence of the land transfer or the subdivision case. But on the other hand, if firstly make a surveying version and a fixed boundary, it could be able to promote the roles and the regulations in one way. But in another way it will affect the efficiency of the land transfer of land subdivision, because the land surveying needs surveyors go to the field, and that costs more time than the computer work of processing the non-spatial data.

Therefore the roles could be flexible. In order to promote the data availability, it is possible to grant administrator making a provisional boundary privileges. These boundaries will then be finalised by the surveyors and then double checked by the quality control manager.

4.3. Designing of workflows

Considering design criteria mentioned above for a long transaction like subdivision case, it is realised that versioning with appropriate privileges for various actors on access to databases is a way to promote information security in land transaction process. In following sections, we discuss versioning concept including structure. Based on this concept, workflows for land transaction are presented using UML activity diagram.

4.3.1. Versioning concept

Versioning is a mechanism that enables concurrent multiuser geo-database editing. It uses an optimistic concurrency data-locking model, which means no locks are applied to the affected features and rows during long transactions.

A version references a specific state of the geo database. It contains all the datasets in the database and evolves over time. Users access data in an enterprise database through a version. Behind the scenes, simple queries in the underlying DBMS are used to view and work with the referenced state for a particular point in time or to see an individual user's current edits.

Versioning simplifies the process of land transfer and the land subdivides by protecting from the unauthorized users. The roles and regulations with privileges are assigned very clear to the version users. If the process is defined very clear and the workflow is designed logically for each version, there would be very fast and convenient for the actors involved to finish the processing. Grouping the people could be realized by versioning. Certain groups could process certain data on their own versions. Also, if the all versions are archived, the history data will be stored and retrieved in any moments by administration

manager. Versions can restrict actor roles as well. Therefore using the versioning could promote the information security.

4.3.2. Database version structure

Different versions are created for the default databases focusing on the roles of actors for different process. Figure 4.1 shows the database version structure.

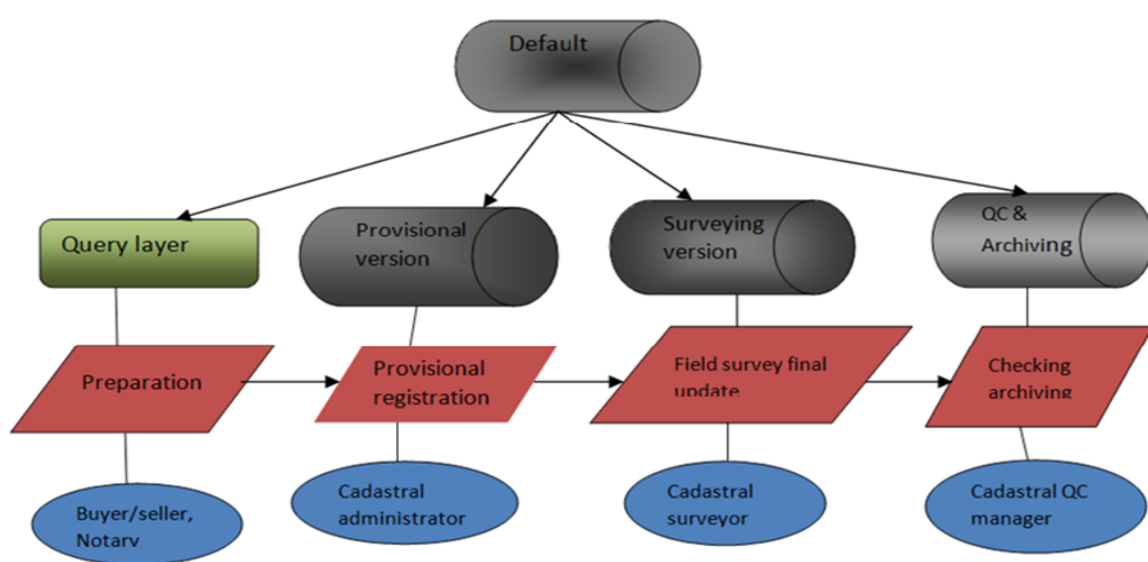


Figure 4-1: Database version structure

There are three versions and one query layer in this database structure. The query layer is for the customers (buyer/seller) and the notaries, followed with the workflow of preparation. Under the default version, there are three versions. They are provisional version, surveying version, and quality control and archiving version. The parent version of them is the default version. Provisional version, surveying version and quality control and archiving version could post to the default version. The whole work process is designed as followed:

- a) The buyer/seller and notary finish the process of preparation and send the deed and subdivide plan to the registry. If they want to check the information of the parcel, they could get the information just by querying the default database. In this step there is no version given to the notaries and the buyers/sellers. Therefore the external users cannot directly access the database, if they want to check some information, they can check by going to the query layer. The information is thus secured to the externals.
- b) The cadastral administrator receives the document and makes a provisional boundary in the provisional version database in that way, the administrator could get two parcel numbers from a subdivided parcel. The administrator transfers one of the parcel ownership to the buyer, and sends the job notice to the surveyor. At the same time, the provisional version is posted to the default version. The provisional registration version is accessible to the administrators; therefore they can edit spatial data to divide a parcel into number of child parcels. The provisional version provides privileges to the administrators for both editing spatial data and the non-spatial data.

Although the editing spatial data do not belong to the job of the administrators, the editing spatial data privilege is granted to the administrators because only after this step, the administrator can make the land ownership transfer.

It is possible that first giving the job to the surveyors and then deliver to the administrators, but if so, it will make the subdivision very slow, because the subdivision is legal only after the updating the non-spatial data.

- c) The surveyor gets the notice, and does field work follows the information given by the administrator. Finally, the surveyors edit the spatial data in the surveying version, and posts to the quality control version.

The surveying version has the privileges in editing the spatial data only to the surveyors. Therefore the non-spatial data is secured.

- d) The quality control manager would check whether the information is correct or not, if some information was not correct, he will send it to the part concerned, to ask that group of users to fix it. If the information was correct, he will archive the versions for the historical data, and post to the default version.

The quality control version is given to the quality managers; this version has a privilege to view by the Quality Control Manager only. He cannot edit any data, the spatial data and non-spatial data are thus secured.

4.3.3. Workflows of land parcel subdivision

The workflow for land parcel subdivision is divided into four steps. (see Figure 4.2) :

- a) Step 1 - Preparation
- b) Step 2 - Provisional registration
- c) Step 3 - Field surveying and office work
- d) Step 4 - Finalising and archiving

The land parcel subdivision starts with the buyer/seller, they made a request for subdividing the parcel. The notaries receive the request and ask for the document, the document include, the old deed of the parcel, the personal information from both buyer and seller.

If there is mortgage in that parcel, the buyer also needs to prepare. The notaries check the document from the land registry and the municipality. This step needs to be taken care, because the whether the deed is fake or not is very important, and this kind of step affects the authenticity of the land information. From the land registry, notaries would find the information about the parcel owner, the price of the parcel since the last time transfer, and the mortgage information. Notaries also need to check the personal information from the database of the municipality. After checking the information notaries make a decision. If some information is not correct, notary would end this process. If all the information provided by the buyer and seller is correct, then notaries make a subdivision plan. The plan will be checked by both buyer and seller. Both sides of the actors need to be satisfied with the subdivide plan. In this step, the subdivision authenticity is realized, the workflow is designed like if buyer/seller feel not satisfied with the subdivision

plan written by the notaries, notaries would revise the plan until both sides satisfied. The step has regulated the notary cannot sign a deed until both sides of the buyer and seller are satisfied with the subdivide plan. Then notaries would make an agreement for both sides, and send the subdivide plan to the land registry.

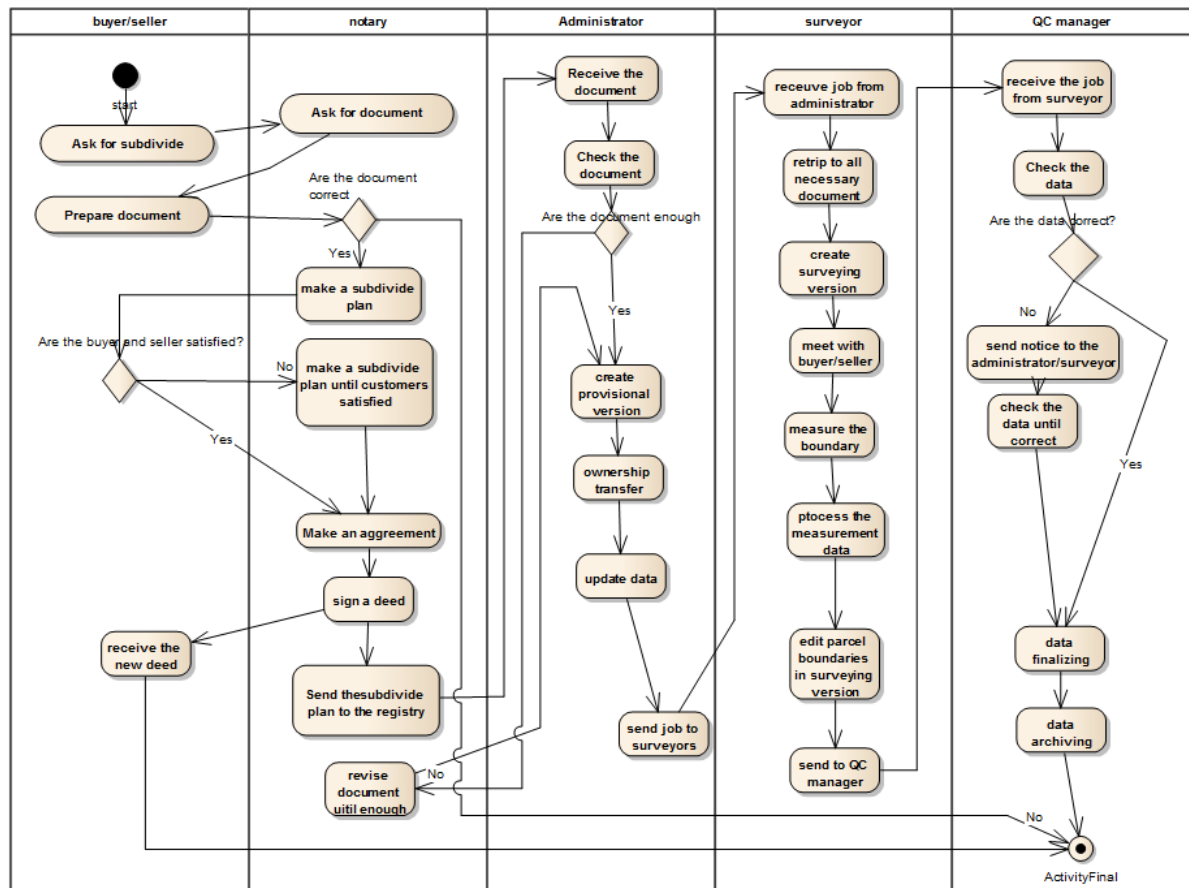


Figure 4-2: Workflow of land parcel subdivision

The land registry received parcel subdivision plan, and creates the job. Once the job is delivered to the land registry, the administrator will send confirm messages to the notary, to make sure the job request is now in progress. This step has reflects the integrity of the land information issue.

The administrator would check the document sent from the notaries. If the document is not clear, then administrator will request the notaries revise it until it is clear and correct. If every document sent from notaries is correct. The administrator would create the provisional version. The administrators make provisional boundaries in the provisional version. And update the data, and deliver the job to the surveyor. The information from the deed is important, because administrator can only edit the data with everything on the deed is correct. Therefore the checking of the document is important and if deed is correct, that means the information sent from the notary is available.

The administrators can make provisional boundaries in that version, but actually, making provisional version is just in order to create new parcel numbers, with the new parcel number, administrators can process non-spatial data, edit the ownership transfer. The provisional may not be correct, so that the subdivision still needs surveyors to do the field work.

The job of the non-spatial part is now finished and the boundaries need to be fixed by the surveyor. The surveyors receive the jobs from the administrator. The job delivered by the administrator has to have a certain job name to distinguish jobs. This step has to be considered well so that the delivering job is qualified. The confidentiality is realized because surveyors cannot edit other boundaries, if surveyors do so, there might be some problems happen on processing the different job.

When the surveyors get the job, firstly they will collect all the necessary documents to go to the field measuring the land. And then, create a surveying version under the default version. Before going for surveying, surveyors need to make an appointment with the buyer/seller and the neighbours around the parcel, because the surveyors need the people who own the parcel and the people who have the land near the parcel to point out where the boundaries are. The buyer/seller and the neighbours have to be showed up when surveyors come, if one of them is busy and might not able to come, he/ she has to write a letter and ask one instead of him/her. If that happened, surveyors have to ask him/ her to showing the ID and record this into the surveying document. This is very important, because the boundaries can only be measured after the pointing out from both sides. Therefore there is a very heavy authenticity issue on that. After measuring the land, surveyors have to process the data, store the measurement data in the hardware and edit the spatial data in the surveying version. After that, surveyors will send job to the quality control manager.

The quality control manager will view all necessary documents and view the edited parcel and check whether there is a mistake happens, if mistakes happen, the manager will send the information to the administrator or the surveyor to make sure the data and the document is correct. If there is no mistake, the quality will finalize the data and archive the data, to keep the history editing data. The historical data is important; the versioning system could be able to archiving the different version. If some actor did something illegally, it will be found from the historical data. This step needs to be taken care because it affects the information integrity. The whole process is then finished.

4.4. Concluding remarks

This chapter presents the designing of workflow for the case of land subdivision based on the criteria of the information security. It is also argued that designing workflows based on versioning could promote information security. By giving each version for a workflow, design criteria are imposed and the roles of actors are defined clearly to execute workflows. The next chapter concentrates on prototyping WfMS in ESRI ArcGIS Environment using ArcGIS Workflow Manager and validates design criteria.

5. PROTOTYPING AND VALIDATION

5.1. Introduction

The previous chapter 4 provides the design of workflow in UML activity diagram for a generic land subdivision case based on design criteria using versioning concept. This chapter presents firstly prototyping of workflow in ESRI ArcGIS workflow manager, and secondly provides validation of design criteria with discussion based on the prototype results.

5.2. Prototyping workflows and outputs

The whole process for land subdivision is defined into five user groups as shown in the table 5. Different group does different job types and has different access privilege. Workflow is divided into four steps namely step 1 for preparation, step 2 for provisional registration, step 3 for field surveying and office work, and step 4 for finalizing and archiving. Colour indicates which users are involved in a particular step.

Group	color	job type	Privileges on version
Buyer/seller	Green	Check the parcel information Create job	Read
Notary	Red	Check the parcel information Create job	Read
Administrator	Orange	Create provisional version. Create job Edit spatial data Edit non-spatial data. Assign jobs Views subdivide plan from notaries.	Read and write
Surveyor	Yellow	Create surveying version Create job Edit spatial data View non-spatial data View deed and sketch map from notaries	Read and write
QA/QC manager	Blue	View spatial data Create job View non-spatial data View deed and sketch map from notaries. Delete version Manage Holds Archive the document	Read

Table 5-1 : Privileges of actors

All the actors involved could check the information from the query layer. The administrator makes provisional boundaries using parcel subdivision plan, these boundaries are not accurate, but they are provisional only for registering new owners. But the buyer/seller and the notary can also check data by making query to databases.

Step 1: Preparation

This workflow involved two groups of actors, both of them are the external actors. They cannot edit data, but they are able to view the data. The colour assigned with green is for the group of buyer and seller. The red colour is for group of the notary. Both groups could access the default data from the query layer. There is no versioned given in this workflow, this workflow starts with the buyer/seller, and the whole process is then triggered by the notaries.

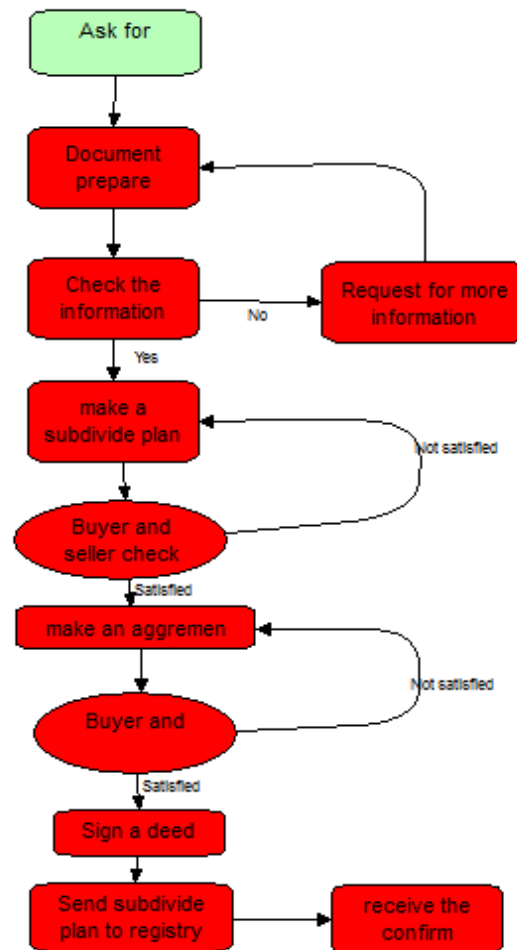


Figure 5-1 : Preparation

Group: buyer/seller and notary

Buyer/seller could assign jobs to the notary, but notary, as external actor, may not assign job, so once the job is assigned to the notaries, they have to follow the workflow, they have to obey the structure, and

notaries will make subdivide plan under the communication with the buyer/seller. The subdivision plan may not be sent to the land registry until both sides of buyer and seller are satisfied. This is the first block in the subdivision case. External actors could only view from this database.

Step

1. Ask for subdivide

This step is assigned to the buyer/seller, if buyer and seller want to subdivide the parcel, they will ask for notary for the transfer of the land.

2. Customer prepare

This step is assigned to the notary. The notary will ask for document, include deed, mortgage information, and personal information of both sides.

3. Check the information

The notary will check the parcel information from the land registry, and the personal information from the municipality. Notary needs to check whether the document provided by the buyer and seller is enough, if not enough, notary will ask for more documents. And notary will check the deed, to see whether it meets the data from the land registry. If the parcel information is different from the deed, notary can end the process.

4. Make a subdivide plan

Notary will listen to the buyer and seller, understand the subdivide proposal they came with, and make a subdivide plan. This plan will be viewed by the buyer and seller.

5. Buyer and seller check

This step is assigned to the notary, but that needs buyer and seller to check. If satisfied from both sides, the subdivide plan will be signed by both sides.

6. Make an agreement

Notary will sign a deed and again to the buyer and seller.

7. Buyer and seller check

The buyer and seller double check the agreement from the notary. If they are not satisfied, they still could ask notary to revise or rewrite the agreement, until satisfied.

8. Send subdivide plan to registry

The notary with the signed agreement, use public key and electronic signature to keep the document is real and cannot be denied, and send that subdivide plan to the land registry wait for the new parcel numbers.

Step 2: Provisional registration

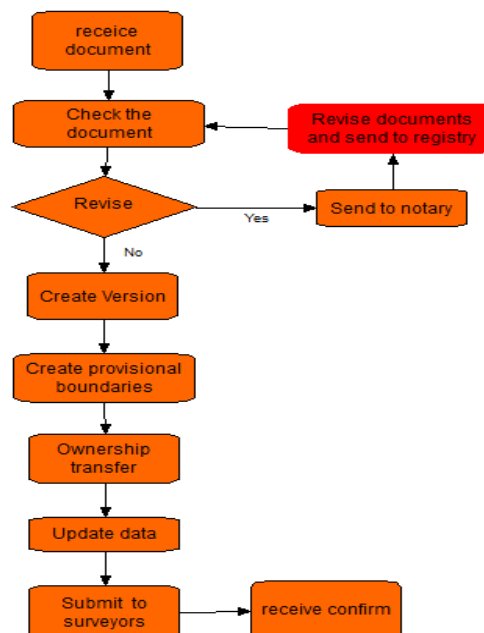


Figure 5-2: Provisional registration

Group: Administrator, notary

This step is assigned to the administrator and the notary; the administrator will work on the provisional registration work space. Administrator could create version under the provisional registration version. The version allowed people to edit both spatial and non spatial data.

Steps

1. Receive document

The administrator receive the document of the subdivide plan from the notary, the administrator will confirm that he has received the document to the notary.

2. Check the document

The administrator will check whether there is mistakes happened in the document, for example, wrong spelling or wrong parcel number. If there is something wrong, the administrator will send that again to the notary to revise it. The step could not be skipped until no mistake found.

The check list include,

- Check the sending time.
- Check whether the information is enough or not.
- Check the electronic signature.
- Check the completeness of the deed

3. Send to notary

If mistakes found, the administrator will send the job to notary.

4. Revise document and send to land registry

The notary will revise document and make up the mistakes and send the document again to the land registry.

5. Create provisional version

Administrator creates the version under the parent version of provisional version. This version has granted the user editing both spatial and non-spatial data. The database reflects in the Arc Map, Privilege for view AS-IT. And for edit is AS-IT.

6. Create provisional boundaries

Administrator creates provisional boundaries in the provisional version. And this boundary may not be accuracy enough to illustrate the subdivide plan. All the satisfied boundaries need to be edited by the surveyor.

7. Ownership transfer

With the new boundaries, the new parcel number is generated, and the administrator could be able to transfer the ownership in the new boundaries. The version will not be deleted, and will be waiting for archiving.

8. Send new parcel ID to notary

The administrator could be able to send the new parcel ID to the notaries, by the land registry E-mail. So the notary would make sure it is the administrator who made this parcel ID.

9. Submit to surveyors

The administrator will finish all the process and send that job to the surveyors by E-mail. The surveyors could be able to process new boundaries. There once the headquarter gets the surveying request, the staffs of headquarter would check whether the document is enough. If document is enough, then the work will be delivered to the surveyor concerned.

Step 3: Field surveying and office work

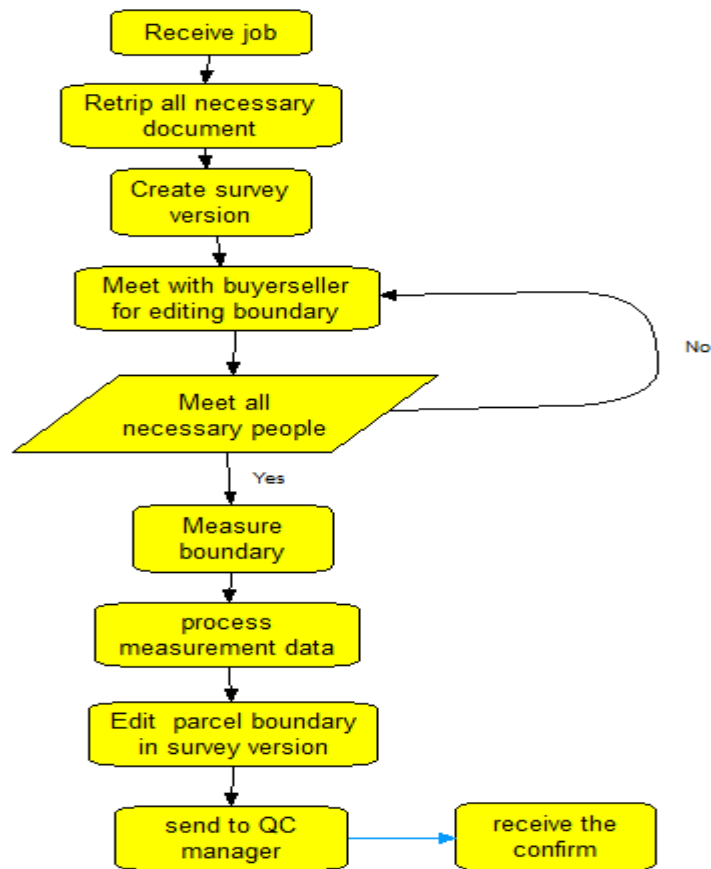


Figure 5-3: Field surveying and office work

Group: Surveyor

This workflow is assigned to the group of surveyors, the surveyors only edit spatial data, but the non-spatial data they are able to view. Surveyors work on the surveying and office work version, and can create version under the surveying version.

Steps

1. Receive job

The surveyor receives job from the administrator from the E-mail of job notice. With the parcel number, the subdivide plan.

2. Create surveying version

The surveyor creates the surveying version. The version has granted the privileges for editing spatial data and views the non-spatial data.

3. Retrip all necessary document

The surveyor will collect all necessary documents in order to make an appointment with the buyer/seller to specific the boundaries.

4. Meet with buyer/seller for editing boundary

The surveyor needs the buyer/seller and even the neighbours of the parcel to specific the boundary. The boundaries will not be fixed until the buyer/seller could point out where the boundaries are. Buyer/seller has to be on the spot when survey comes to identify the boundary.

If one of them cannot come, he/she has to find another person on behalf of him, to show the boundary. Surveyor needs to collect the information of person who on behalf of the buyer/ seller.

5. Measure boundary
Surveyors measure the boundary after getting to know the exact boundary in the real land.
6. Process measurement data
Surveyors will first make a sketch map and record all the data in the computer, or the hard disk. To make sure the data is stored and finish the field work.
7. Edit parcel boundary in survey version
Surveyors will fix the new boundaries in the surveying version. The version will not be deleted, and will be waiting for archiving.
8. Send to the QC manager
Surveyors finish all the job and send all the jobs to the quality control manager. The job notice will be sent by E-mail.

Step 4: Finalizing and archiving

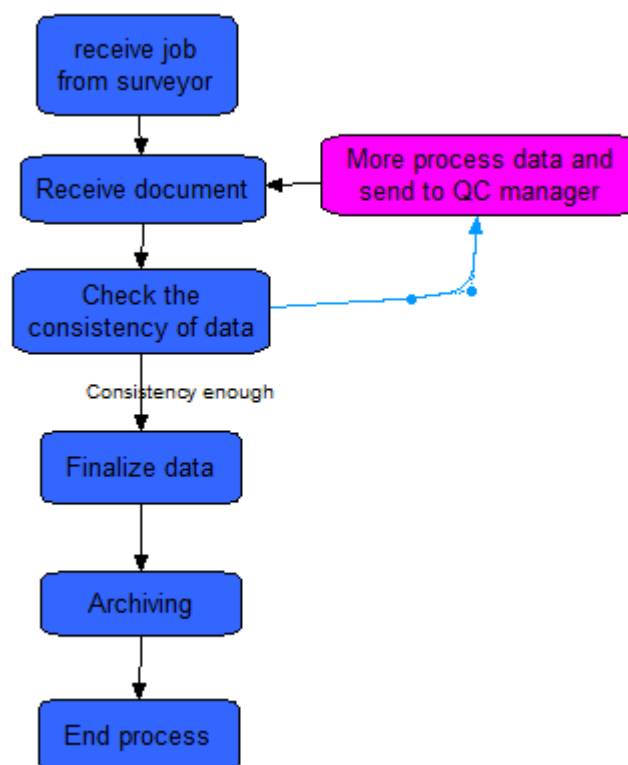


Figure 5-4: Finalizing and Archiving

Group: QC manager

QC manager needs to check spatial data information and non spatial data information. Check the deed and the notary sent time. Check the time of sending deed, registration and edit.

Steps

1. Receive job from surveyor
The quality control manager receives the data from the surveyor. And start checking in the workspace of quality control and archiving. Quality control manager check data in the QC version.
2. Receive document
The quality control manager receive all the document, collect all the necessary data from the
3. Check the consistency of data
4. More process data and send to QC manager
5. Finalize data
6. Archiving

7. End process

5.3. Results

Step 1: Preparation

The Figure shows that the job has created in the workflow manager, with the job ID and the job type. The job creation time is showed. From information security aspect, this information is important. Because of the job ID and the creation time, the job sequence could be found. When this job is delivered to other actors, there is apparent job option, with this, the jobs between actors can be connected.

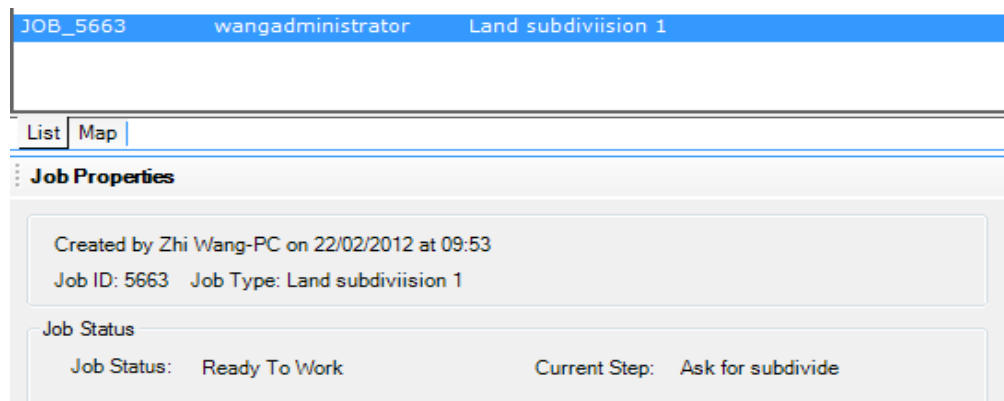


Figure 5-5: Job creation

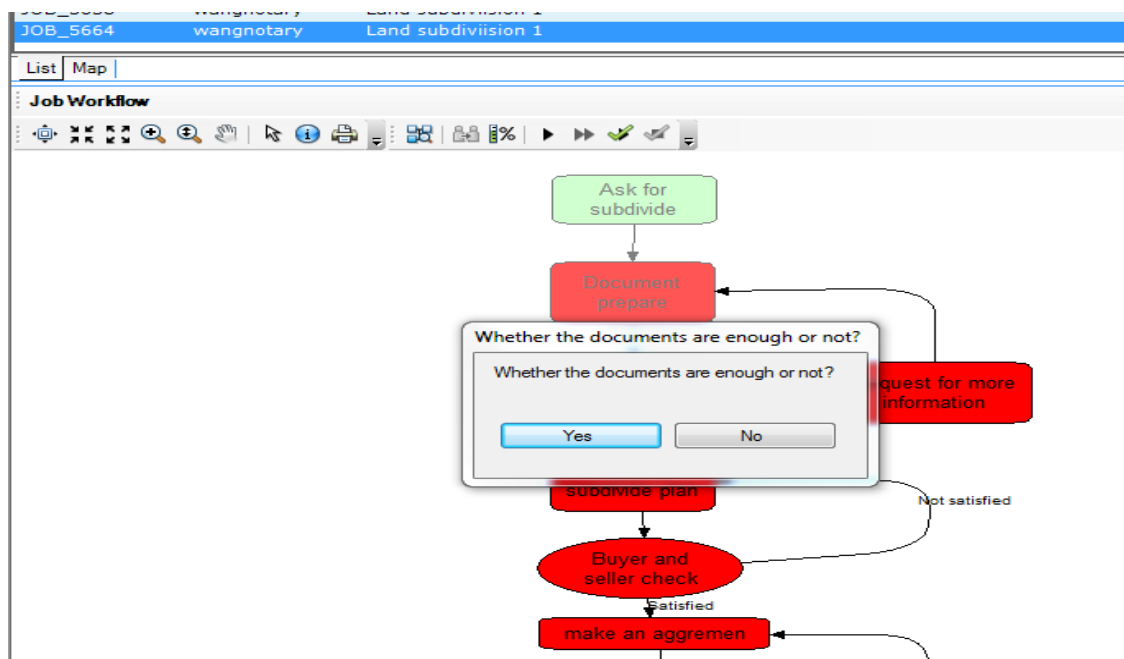
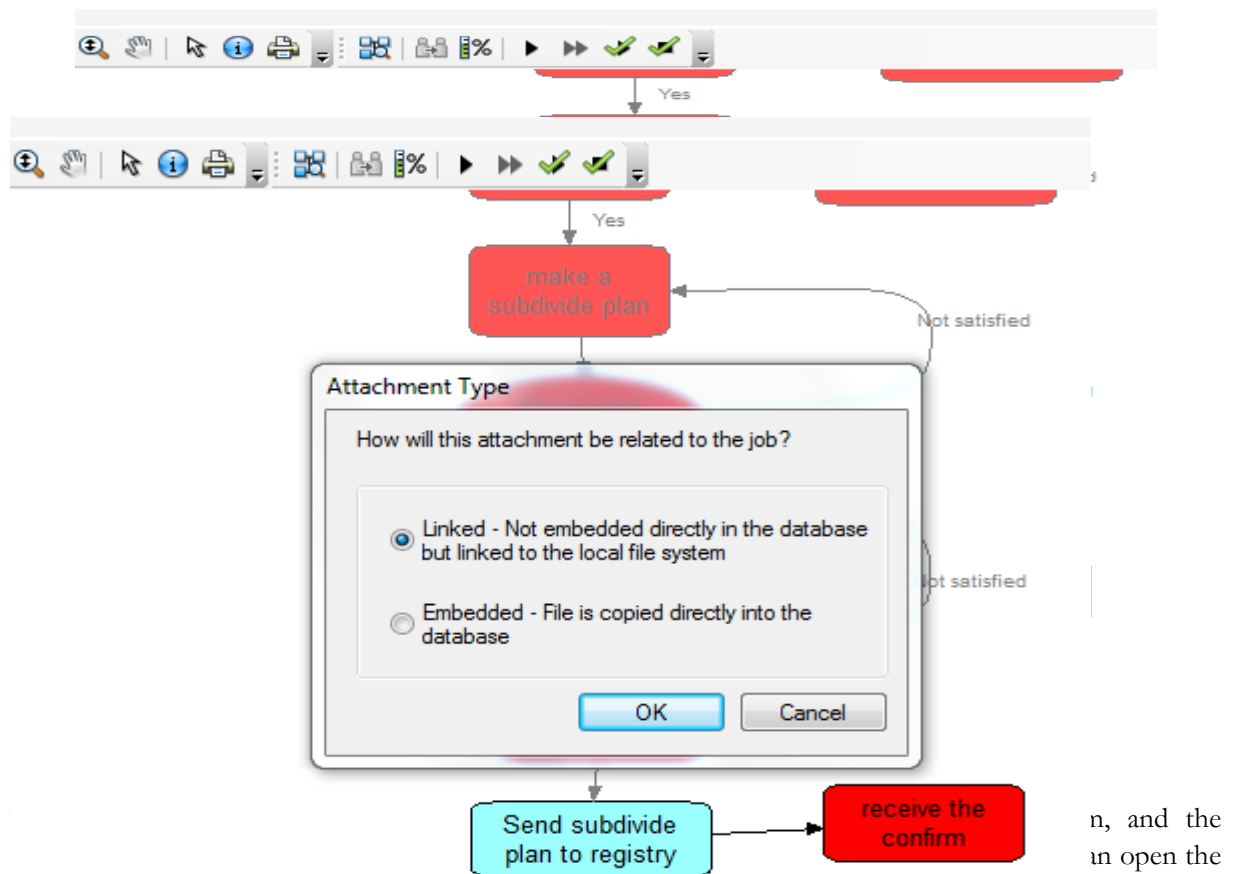


Figure 5-6:Ask questions

When a job is executed to the step check document, the workflow manager will ask questions to the notary, choosing Yes or no will lead to different steps; the choice of the notaries made will be recorded in the historical data in workflow manager.



Step 2: Provisional registration

Job Assigned

JTX Emailer [wang28158@itc.nl]

发送时间: 2012年2月23日 2:54

收件人: Zhi Wang

Job 6466 assigned to wangadministrator by wang

Figure 5-8: Add attachment

Once the job is assigned from the notaries to the land registry, the administrator will receive the message about a job ID and the assigned time from his own E-mail box. Figure 5.9 shows that the job is assigned to the administrator. The job ID is 6466.

Job Type: Land subdivision 2

Job Properties

Assignment

☐ Group

☐ User

☒ Unassigned

Start Date: ☒ 22/02/2012

Due Date: ☒ 22/02/2012

Data Workspace: provisional registration

Parent Version: wang.provisional registration

Priority: Low

Parent Job: 5664

Figure 5-9: Job dependences

From the E-mail information, the administrators could create job from the parent job. From the parent job options, administrators can find a job with ID 5664, and create job with that parent job.

JOB_5665 wangadministrator Land subdivision 2

List Map

Job Properties

Ownership Dates Data Workspace Description

Job Ownership

Job Owner: Zhi Wang-PC

Job Name: JOB_5665

Priority: Low

Parent Job: JOB_5664

Figure 5-10: Job properties

From the user wangadministrator, the job properties are showed from Figure 5.10. Therefore the sequence of the work is realized. Because the job_5665 and the job_5664 is linked, it is easy to find that for this job, the notary and the administrator are processing the same work.

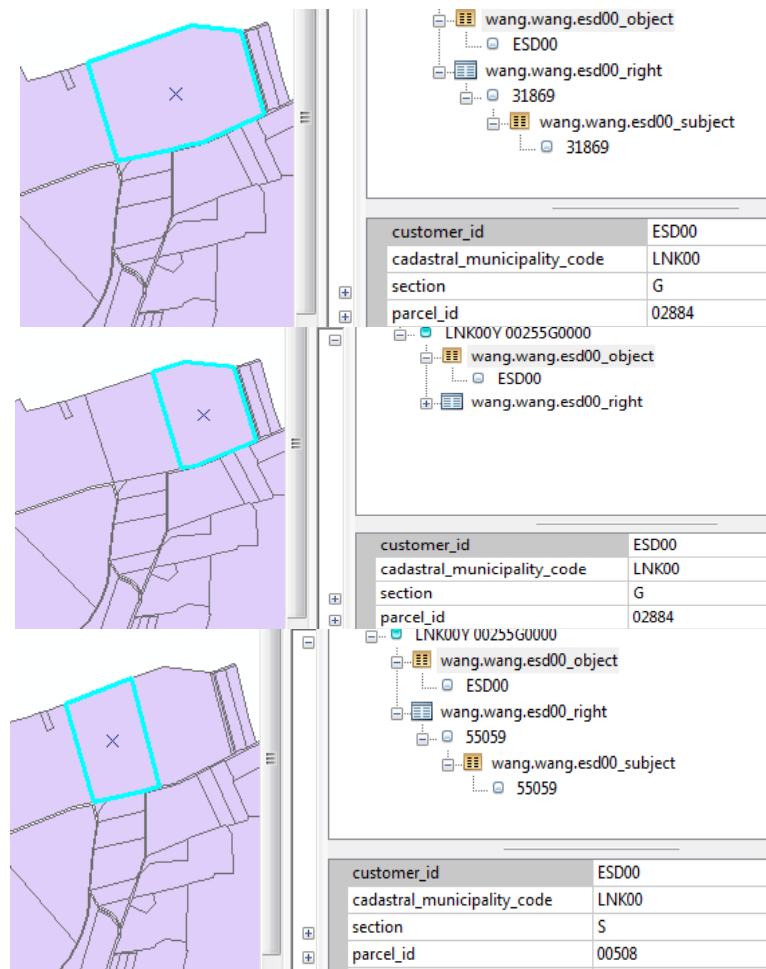


Figure 5-11: Subdividing parcel and get new parcel ID

This figure shows the administrator receives the deed from the notary and firstly process the spatial data in order to get new parcel ID. Once a polygon is divided in the ArcMap, the new parcel ID is generated. And with this, the administrator can process the administrative data, for transferring the ownership.

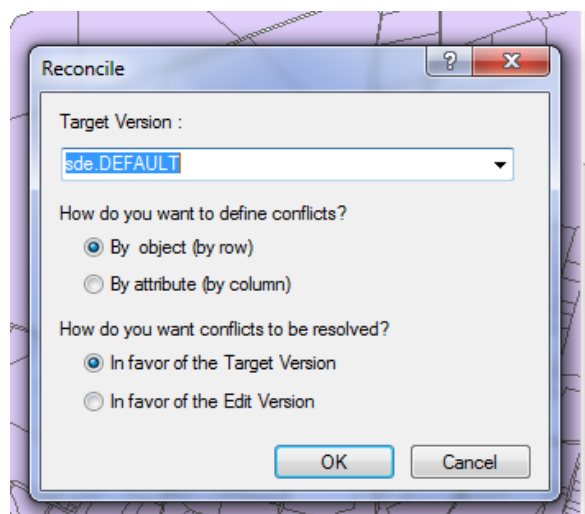


Figure 5-12: Reconcile and post

The administrator version is created from the provisional version, it just a temporary version, to be archived, once after processing, it needs to be reconciled and post to both the provisional version and the default version. Figure 5.11 shows the reconcile step in ArcMap.

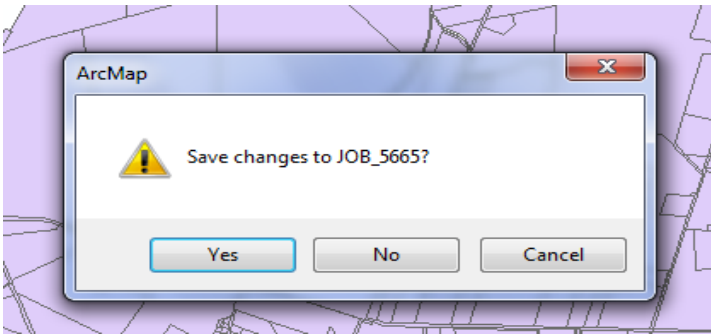


Figure 5-13: Save the changes

The job finished, before the administrator can close the ArcMap program, the system will ask questions for save changes to JOB_5665. Click yes, the progress will be saved to the Job, and the information of processing job will be recorded in the workflow manager.

Job History				
Enter Comment:		Add		
Date/Time	User	Type	Message	
22/02/2012 10:31:15	wangadministrator	StartStepExec	Step Revise the document (6214) executed by wangadministrator.	
22/02/2012 10:31:44	wangadministrator	Comment	Question Response: No	
22/02/2012 10:31:53	wangadministrator	StopStepExec	Step Revise the document (6214) execution stopped by wangadministrator. Successfully executed	
22/02/2012 10:32:19	wangadministrator	StepCompleted	Step Revise the document (6214) marked as done by wangadministrator.	
22/02/2012 10:32:50	wangadministrator	StartStepExec	Step Create Version (6212) executed by wangadministrator.	
22/02/2012 10:33:02	wangadministrator	CreateVersion	Version wangadministrator.JOB_5665 created by wangadministrator.	
22/02/2012 10:33:08	wangadministrator	StopStepExec	Step Create Version (6212) execution stopped by wangadministrator. Successfully executed with	
22/02/2012 10:33:19	wangadministrator	StepCompleted	Step Create Version (6212) marked as done by wangadministrator.	
22/02/2012 10:33:43	wangadministrator	StartStepExec	Step Create provisional boundaries (6220) executed by wangadministrator.	
22/02/2012 10:45:51	wangadministrator	StopStepExec	Step Create provisional boundaries (6220) execution stopped by wangadministrator. Successfull	
22/02/2012 10:46:12	wangadministrator	StepCompleted	Step Create provisional boundaries (6220) marked as done by wangadministrator.	
22/02/2012 10:46:43	wangadministrator	StartStepExec	Step Ownership transfer (6216) executed by wangadministrator.	
22/02/2012 10:47:29	wangadministrator	StopStepExec	Step Ownership transfer (6216) execution stopped by wangadministrator. Successfully executed	
22/02/2012 10:50:55	wangadministrator	StepCompleted	Step Ownership transfer (6216) marked as done by wangadministrator.	
22/02/2012 10:51:19	wangadministrator	StartStepExec	Step Update data (6221) executed by wangadministrator.	
22/02/2012 10:52:05	wangadministrator	StopStepExec	Step Update data (6221) execution stopped by wangadministrator. Successfully executed with re	
22/02/2012 10:52:22	wangadministrator	StepCompleted	Step Update data (6221) marked as done by wangadministrator.	
22/02/2012 10:52:53	wangadministrator	StartStepExec	Step Submit to surveyors (6217) executed by wangadministrator.	
22/02/2012 10:53:14	wangadministrator	StopStepExec	Step Submit to surveyors (6217) execution stopped by wangadministrator. Successfully execut	

Figure 5-14: Job history

The history of processing the data can be viewed from the workflow manager. Figure 5.12 shows the job history, in that list, the modify date, time, the process name and if one step has question, the question response is also recorded.

Step 3: Field Surveying and Office work

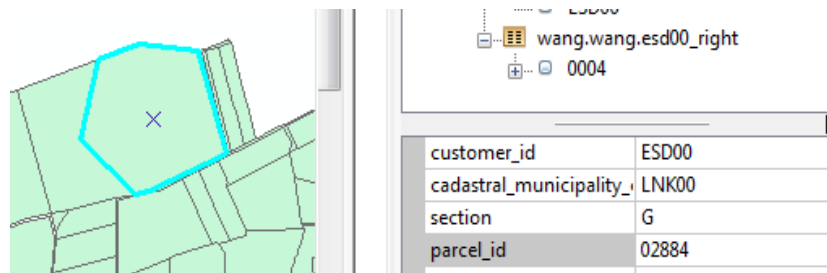


Figure 5-15: Edit boundaries

After processing the workflow of the administrator, the job will be delivered to the surveyor; the surveyor will create new versions for processing the spatial data. The provisional boundaries edited for the administrators is not of high accuracy enough, therefore after the measuring the land parcel boundaries in the field, the surveyor will again process the spatial data. During processing, ArcMap keeps maintaining topological structure of spatial data. And again, reconcile to the provisional registration version and the default version.

Step 4: Finalizing and archiving

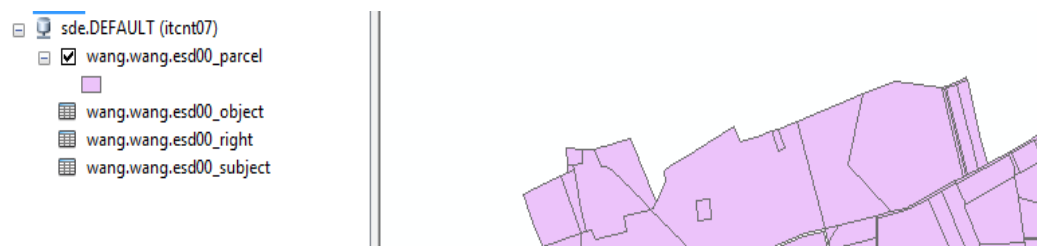


Figure 5-16: Checking the data

After processing the data by the surveyor, the job will be delivered to the quality control manager. The manager will open the default version to see the changes of the data, since the job before the quality control manager the last modified the data is the surveyor; the surveyor has posted changes to the default. Quality control manager can also change versions to the job version of administrator's. That job version is still the provisional boundary, but not changed to the final boundary. With the comparison of the data, quality manager can see the consistency of the jobs. After the final check by the quality control manager, the manager will archive the data, and close the job.

5.4. Validation and discussion

Validation of this prototype is done by executing workflows many times. This process of validation provides some interesting experiences that can be used for discussion/issues related to the design criteria of information security. The following paragraphs provide results on the validation of workflows of each step.

- a) **Step 1 Preparation** – this step is designed for the groups of notaries and buyer/sellers. As only a query layer is given to them, they cannot access the database. Experience indicates that there are problems in the attachment function in the notification. The software provides users two ways of adding an attachment (such as a deed). One way is directly to add in the workflow database, the other is to add in a local file system. This research has used the latter one, because the job is divided into four steps. When a job is transferred to another workflow, the attachment cannot be transferred. In this case the only way is to add an attachment in a local file system, and it may not

be so secured adding in a local system. The confidentiality and integrity may be questionable. It is also possible that the notaries can just send separated E-mail to the land registry with attachment rather than using the attachment system in workflow manager.

- b) **Step 2 Provisional registrations** – this step is implemented for the administrators. The sequence of the job can easily be realized from the creation of the jobs and connect it to parent job using a parent job menu of the job properties. Therefore, using the parent job, job step can be transferred properly. When implementing this part of workflow, it is difficult to launch ArcMap from the workflow manager; the solution is to change the base map in the workflow administrator.
- c) **Step 3 Field Surveying and office work** – in this step, there is a record that can store all the response of the questions, for example, there is a step that when a surveyors going to the field, surveyors have to ask questions on whether the buyer and seller are on the spot to show the boundaries, if the response is yes the step can be proceed, otherwise the step can only stay in that step.
- d) **Step 4 Finalizing and archiving** – this step of workflow is meant for the quality control managers. Their jobs are mainly to check the consistency of the versions and archiving the versions. The consistency of each job can be realized, because the quality control manager will go through different versions to find the differences of each version. They can find whether the same job but editing a different area on the map. The archiving part is not implemented yet, it needs further research.

In the workflow, each step is defined in details, so that each step ensures that the editor can edit the data in a correct way. When the job is transferred, viewing is still available by the other actors, and thus the actors can view the data at anytime by going through the versions. This research also shows that when data model is implemented in the polygon-based database, the software worked well.

5.5. Concluding remarks

This chapter has discussed the prototyping and validation of Workflow Management System for Land Subdivision process. The whole workflow is divided into four steps. Each step has its workflow involved different actors to accessing and processing the spatial data and other workflow data. The results indicate that all the design criteria of information security are included in the prototyping.

During validation process, the result also shows that the criteria of confidentiality can well be implemented by grouping the actors. The workflow can be accessed by the different users of the group. Therefore certain group of users can access different data, this criteria has implemented well. In the criteria of integrity, the workflow prototype can define each step of jobs, and for each group of users, the steps are defined well. But for proper consistency, it is also necessary to have historical data and its management needs further investigation.

The availability is implemented well. In case of the internal use, the internal users can view any data. But the external users such as notaries, buyers and sellers can check the data by the query layer. Authenticity can be implemented by the steps with questions. In the job history, there is the record of the response of the questions, and therefore this step can be implemented well. Prototype shows that the non-repudiation cannot be implemented in the workflow management system, because the attachments in the job database cannot be transferred to another job. Alternative approach needs to be found.

6. CONCLUSION AND RECOMMENDATIONS

Based on the previous chapters this chapter presents conclusions as per each sub-objective of the research defined in the section 1.3.1 of the chapter one. Then it provides recommendations as further research needed.

6.1. Conclusion

There are three sub objectives in this research. The following sub-sections provide conclusions.

6.1.1. To identify land information security requirements for the land transaction process

The concept of information security affects functioning of Land Information Systems both from the management as well as the technical perspectives. In the previous chapters the literature indicates five elements of the information security namely confidentiality, integrity, availability, authenticity and non-repudiation. Additionally if the land information is secured or not, four case studies show that it is basically relying on four aspects from the management: data availability, communications, techniques, and standards. If proper attention to these aspects is lacking, information security is consequently compromised.

In-depth study on Workflow Management System of land transaction in the Netherlands indicates that number of design criteria is required to incorporate elements of information security. These criteria are :

- a) Confidentiality - Grouping the actors in land subdivision, access to information and roles of groups
- b) Integrity - Data is not modified during the job transfer, Transfer all necessary data and Makes sure transfer and receive the same job, and sequence of the jobs
- c) Availability - Viewing the data at any time; the data should be processed properly for each steps; when transferred job, data is still readable for other actors
- d) Authenticity - In the workflow, recording the response of the questions to make sure the steps are confirmed; signing an agreement, surveying in the field
- e) Non-repudiation - Once the information is sent, no one can deny it

6.1.2. To implement the security requirements in a prototype

To implement the information security criteria into the workflow, the version structures are designed. Under the default version, the provisional version, surveying version, and the quality control and archiving version is created. Each version has a specific group of actors. The job is delivered by grouping the actors; a certain group of actor only do a part of job in a certain version. The workflow of land subdivision in a general case is illustrated, this workflow can be divided into four sub-workflows for the next step—implementation. Based on this workflow, the roles the responsibilities of actors are discussed as followed,

The role of citizens is defined as the buyer/seller in the process of land transaction or land subdivision. They request for subdivision plans, and check the parcel information from land registry office. The notaries play an important role in the land transaction and land subdivision. Notaries and the buyer/sellers as the external actor of the land transaction, both groups cannot edit any data in the land registry. All they

could do is just for viewing data and ask transaction and subdivision request in the land registry. However, notaries have to send a deed to the land registry office. Therefore the notaries need to send certificate to the land registry office together with submission. The certificate must be trusted. Therefore the information security within this communication needs to be secured very well.

In the designing part, there are no versions given to the external actors to protect the information from any fraud. If they want to check some information from the database of land registry, they can check from the query layer.

In the land registry office, there are three groups of experts as internal actors, involved during the process of land subdivision. They are surveyor, administrator, and the quality control (QC) manager.

The administrator's job is to edit administrative data, but for the subdivide request, in the ArcMap system, in order to get two new parcel numbers, people need to firstly cut the polygons. Therefore, the privilege of administrator is to edit provisional spatial data and the non-spatial data. The version is created and gives privilege to administrator to edit and view both spatial data and the non-spatial data.

The surveyors can only edit spatial data, the version given view all data and edit spatial data. Quality control managers cannot edit any data, because editing is the job of administrators and the surveyor. If quality control manager can edit data, the information are not secured. The quality control manager, who is responsible for the checking of the data and management of the historical data, can only view all the data and archiving the different versions.

Therefore, it is important that in the designing aspect, different actors who play different roles in the land transaction will be granted with the different privileges. .

6.1.3. To validate the prototype in GIS based WfMS

The workflow is validated in postGIS/PostgreSQL and ArcGIS workflow manager system, because it can integrate the workflow with the geo information. In the geo information, the spatial data and the non spatial data can be linked with the relationships. This research starts with this programme also because it is easily access.

The confidentiality is realized by grouping the actors of the users. To validate the confidentiality, there are five user accounts created. They are wangadministrator, wangnotary, wangqaqc, wangsurveyor and wangbuyerseller. Each belongs to the groups of administrator, notary, quality control manager, surveyor and buyer/seller. The groups have different privileges to access the data. Groups of the buyer/seller can only view the data; groups of the notary can view the data and upload the attachment, which can be deed, to the system. And the groups of administrator, quality control manager and the surveyor as the internal user, can edit the data. In this research, the accounts of the user have been created, and each user in the computer has a unique password to login the database.

The integrity is realized when the job of one actor part is finished and is transferred to the other actors. When job is created, the job ID is automatically generated by the workflow manager system. Once the job is delivered to the other user, there is a notice with the job ID. The job sequence can be found by the workflow manager system, because one delivered job can be traced from the parent job information.

However, the historical data is also rely on the archiving the versions, which has processed the data, in this versions.

The availability implies that the geo data could be viewed at any time by the user concerned. What is more important, the geo data is processed properly, so that when it is delivered to other users, they can continue processing without any problems. Except for the step 3, each workflow includes the checking data implies the data can only be processed when everything is checked. That is the workflow makes the data correct.

Authenticity can be realized from the questions. For example, the step of making a subdivide plan in the notary can only be executed to next step until buyer/seller satisfied with the subdivide plan. Steps cannot be skipped. Once the response of the step is “Yes”, it can be proceed.

Non-repudiation includes that the deed and the provisional subdivision plan sent by the notaries have to be sent in a certain way so that once it is delivered to the registry organization, it is undeniable already. Also the non-repudiation reflects that the communication with the land registry organization should be trusted, and efficient. From the literature, the communication between the external and internal users relies on the techniques of public key and the electronic signature. This part reflected the communication between the external and the internal part. But it is difficult to realized in the workflow manager, therefore this part is theoretical research, but not implemented. In the workflow management system, notaries can add attachments such as deeds to the job; it can be transferred to the internal system if the shared disk is secured enough.

6.2. Recommendation

This research has made four separately workflows in order to make the process running. The job is delivered from one workflow to another. Further research is recommended for making a complete workflow as one and compares its performance with this research in term of integrity.

This research is based on an information flow onion model, which has discussed on the chapter 3.4. For further research, it is necessary to discuss based on the method of data modelling. Data modelling can contribute to this research because data modelling is a process that can analyze the data requirements needed to support the information processes within organizations.

There are three versions created for the groups of administrator, surveyor and the QC manager. If the archiving is done then the way of processing data would be viewed clearly. Further recommendation is need to study how archiving can be done efficiently.

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