

## Complexity vs. Security in the Austrian Land Register

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### 1 LAND REGISTER AND LAND PROPERTY

The design of processes is a difficult task. Inappropriate design can increase processing time dramatically in computer programs and non-computerized administration as shown by Hammer and Champy (Hammer and Champy 1995). Public processes like spatial planning are examples for complex processes. Spatial planning must consider various requests. Errors in the planning processes may result in unsatisfying spatial situations and correcting these situations produces additional costs. The result of the process shall thus be correct, i.e. the risk of producing a faulty result shall be minimized. On the other hand, a process should be as simple as possible since simple processes are faster and cheaper.

It is a general assumption that the reduction of risk increases the complexity of a process which we will substantiate in this paper. As an example we use the transfer of land property in Austria. We use this example because the goal is clear and the number of actors is limited. We will start with the simplest situation where persons are involved who completely trust each other. Then we will gradually remove risks and show how the process becomes more complex.

Like spatial planning land registration is a public process. The process of land registration contains a number of tests to make sure the process is correct. The complexity of the tests varies in different countries but still they have a result which can be verified (Bittner and Frank 2002). The transfer of rights on land is an example for such a process:

In case of registration of title like in Austria transferring rights on land is quite complex (Navratil 1998). The transfer must be registered and requires a document that is checked in different ways. For example, the right must be in accordance with the Austrian laws and the person transferring a right must hold that right and must have the right to share it. No disputes may arise since all checks have been performed.

In case of registration of deeds like in the US the process is much simpler (Onsrud 1989). Documents are checked only if there are different opinions about the current legal status. This simplifies the process of transfer dramatically. In case of dispute, however, the process becomes more complex, since all documents registered for the piece of land are require checking.

The example shows that systems designed for the same purpose (securing rights on land, especially property) may have different design. Bogaerts and Zevenbergen separated seven aspects where the designer can select from different alternatives (Bogaerts and Zevenbergen 2001). Some of these aspects only influence the organization (centralized or decentralized, land registration with separated or integrated cadastre) or the financial system (by government or self-supporting). Other aspects influence the data provided by the system and the risk for the user if he uses this data. Comparing the design of systems in the cadastral domain is difficult as shown in (Frank 2004).

### 2 COMPLEXITY OF SYSTEMS

Different aspects of processes provide a measure for the complexity of the process. One of these aspects is the number of participants. Processes with a small number of participants are simpler than processes with a large number of participants. The number of steps in the process is another measure. Additional steps complicate the process. This section introduces some definitions on complexity, security and complex systems. We then clarify our definition of the term complex system and its implication on the Austrian land registration system.

Complex systems are lately used as a synonym for *system theory*. System theory has been founded by scientists like Ludwig von Bertalanffy (biologist) or William Ross Ashby (psychiatrist) in the last century (REFERENCES!!!). Its focus is the study of systems. A *system* can be defined as a composition of *components* that interact with each other in order to facilitate the flow of information, matter or energy ([http://en.wikipedia.org/wiki/Systems\\_theory](http://en.wikipedia.org/wiki/Systems_theory)). Research in system theory is interdisciplinary ranging from biology, mathematics, physics, computer science to philosophy, sociology and economics.

System theory studies the interaction between parts. A pile of sand is an example for a complex system. The interactions between the grains of sand cause the special shape of the pile. The interactions can be represented in terms of a formal or mathematical model.

Procedural complexity is defined in computer science. The O –notation can be used to determine the costs of an algorithm. It allows to classify algorithms according to their costs in terms of time and resources (Knuth 1973)

Abbreviation	Complexity = Costs	Intuition: 1000 x input
O(c)	constant	... same work
O(log n)	logarithmic	... 10 x work
...	...	...
O(2 <sup>n</sup> )	exponential	... hopeless

Table 1: Measuring the complexity of an algorithm using the O-notation

Several definitions of system complexity have been given in literature. Some authors are very critical about measuring the complexity of a system: Silvert claims that complexity is a property of models and not of systems. The model being an abstract simplification of the world or a snapshot of the world at a certain point of time. Complex things are sometimes described with simple models. The “complexity of an object is in the eye of the observer” and therefore measures for system complexity are either invalid or of very limited applicability unless they take the role of the observer into account (Klir 1993; Silvert 1996).

It is our belief that complexity comes from the interaction of simple parts. Complex systems are defined as a hierarchy of linked subsystems. The communication between components is of vital importance for the success of a complex system. Many software projects failed because the communication between the components has been ignored when integrating them to a complex system (Brooks 1991).

In order to design a complex system subsystems have to be identified and designed. The present model is in the domain of land registration and therefore relates to geoinformation. A critical review for component based GIS has been given by Timm and Riedemann (Timm, Riedemann et al. 1998). Geoinformation science proposed several mechanisms to reduce complexity. Hierarchies in terms of classification, aggregation and generalisation have been investigated (Timpf 1999). Frank proposes a multi-tiered ontology to separate the physical world from observations, cognitive models and agent theory (Frank 2001).

In systems like the Austrian land register, as well as in other economic systems agents have a high priority for protection against risk. Agents will therefore aim for security. We mean security in the sense of the state of being free from danger or injury. Wordnet gives still six other definitions of security (Fellbaum 1998).

In the next section an agent based model of a system for the Austrian Land Register will be introduced. The complexity of the system will be defined by an increase of agents involved in order to prevent risk. Additional measures of complexity are the time taken for a certain transaction in the system and the costs connected to it. Security are all actions taken to prevent risk. Risk being the possibility of economic loss.

### 3 TRANSFER OF OWNERSHIP – THE SIMPLEST CASE

The Austrian land register is a register of title. Thus the data provided by the land register is assumed error free and up-to-date. Problems may occur, however, if rights need not or cannot be registered. The land register is intended for private rights only (property, right of use, right to draw water). Restrictions emerging from public law are not registered. On the other hand transfers cannot be registered if it is not evident that there is a transfer. In law creates the transfer based on a fact (acquisition of property by using the land more than 30 years in the belief that it is one's property, inheritance) then the register may be out of date. Another problem is the up-to-date-ness, which depends on the cycle of database-updates. The updates of the Austrian land registration database are done each day at midnight. Thus there may be a registered document that cannot be seen in the land register.

One of the major principles of the land register is the principle of priority (Krejci 1995, p.179; Twaroch 1998). The principle of priority states that the document registered earlier is more important than the document registered later. The position in the list of documents is called rank. Conflicts can be solved easily: The document registered later is invalid.

The transfer of land in Austria consists of two steps. The first step is the creation of a contract documenting the transfer of property. The second step is the registration of this document in the land register. This contract must contain

an identification of the piece of land affected by the contract,

the right transferred (in our case the right of ownership),

the price,

the person transferring the right,

the person receiving the right,

the signatures of all involved persons, and

the date of signature.

The simplest case of property transfer is the following: A person (the seller) wants to sell land to another person (the buyer) for a specified price and the following conditions are met:

The buyer has the necessary money.

The persons trust each other.

Buyer and seller set up a contract containing all necessary information and sign it. They set up an irrevocable declaration that the transfer can be registered, the 'Aufsandungserklärung', which is comparable to the quitclaim deed. The quitclaim shall remind the seller that he gives away a right. It is usually a small paragraph which is part of the sale contract. The signatures are done in front of a notary. The notary certifies that the seller signed out of his free will. The seller then receives the payment and the buyer receives the documents, especially the quitclaim. The buyer finally uses the documents to register the transfer at the land register.

This process involves four agents: Buyer, seller, the notary, and the land register. The process consists of the following steps (see also table 1):

Setting up the contract.

Signing in front of the notary.

Exchanging quitclaim, payment.

Registering the transfer at the land register.

The process can be completed in less than one day. Setting up the contract is easy following a model contract. The meeting with the notary can be arranged so that the buyer can register the transfer the same day the documents are signed. Costs arise at two places: The notary receives payment for the certificate and the land register receives payment for the inscription. In addition taxes have to be paid.

Step	Agents	Result
setting up contract for property transfer	buyer, seller	document of sale, which can be registered at the land register to complete the property transfer
signing of the contract and other necessary documents	buyer, seller, notary	signed documents (document of sale, quitclaim), certification of the notary stating that the signatures were done voluntarily
exchange of documents and payment	buyer, seller	seller receives payment, buyer receives documents necessary for registration
registration of property transfer	buyer, land registry	buyer registers the transfer and completes the process of property transfer

Table 2: Steps of the simplest form of property transfer

#### 4 ELIMINATION OF RISK

The simplest case presented in the last section contains two risks:

The seller may not be owner of the land.

The owner may sell the parcel twice.

##### 4.1 Buying from the right Person

A problem for the buyer will occur if the seller is not owner of the land. The risk for the buyer is that he pays receives no right of ownership. The right of property can only be transferred from one person to the other. The process demands that the person transferring property is owner of the land. Thus the buyer has a claim for repayment, which he must enforce.

The land register provides evidence for land property. The easiest solution to solve the problem of the buyer is thus to demand an up-to-date copy of the land register. This copy at least proves that the seller was the owner at the date the copy was created. The copy complicates the process in two ways: It adds a step to the process (the seller has to obtain it) and adds costs.

Step	Agents	Result
obtaining copy of the land register	seller, land register (ev. notary)	proof that the person selling the land owned the land at the time the copy was obtained, reduces risk to buy from wrong person
setting up contract for property transfer	buyer, seller	document of sale, which can be registered at the land register to complete the property transfer
signing of the contract and other necessary documents	buyer, seller, notary	signed documents (document of sale, quitclaim), certification of the notary stating that the signatures were done voluntarily
exchange of documents and payment	buyer, seller	seller receives payment, buyer receives documents necessary for registration
registration of property transfer	buyer, land registry	buyer registers the transfer and completes the process of property transfer

Table 3: Steps for property transfer with protection against purchase from the wrong person

##### 4.2 Precaution against selling twice

###### 4.2.1 Problem description

The remaining risk is that the seller already sold the land and the copy of the land register was obtained prior to that sale. This risk can be reduced by accessing the land register online. The notary, for example, has access to the land register via Internet. This again increases the costs for the notary but still leaves risk because the database of the land register is updated every 24 hours (during the night). Thus the data is a few hours old and it is not possible to get more recent data. A solution for this problem would be that the notary and the land register are in the same office. However, this would restrict the right on free choice of notary.

In the current situation the data is not completely up-to-date. Even if inspecting the database online it may happen that the seller tries to sell the land to two persons. If he does this at the same day nobody will be able to notice it since registered documents will only be visible the next day.

Selling twice results in two different outcomes:

The buyer who registers the transfer first receives ownership. He is now the registered owner of the land.

The buyer who tries to register later receives no ownership. The problem of this buyer is that the quitclaim is signed by a person who is not owner of the land. Only the current owner can transfer ownership and therefore the transfer cannot be registered. He does not lose anything but he will have to enforce his claim of repayment.

The problem for the buyers is that only one of them will become owner of the land. The other person will have to sue the seller to get his money back. The decision, which of the buyers will become owner is simple: The person registering his documents earlier is the

new owner. The other person would try to register documents signed by a person that is not the owner any more and thus the documents must be rejected. The problem is to eliminate this risk for the buyer.

4.2.2 Austrian solution

The Austrian solution for this problem is the ‚Anmerkung der Rangordnung‘. The ‚Anmerkung der Rangordnung‘ acts as a placeholder in the series of documents. The property owner can apply for a rank certificate (the ‚Rangordnung‘), which is proof of priority. The rank certificate has the time stamp of the application and grants a certain position in the list of documents. The rank certificate is only valid for one year and there is only one copy of it. It is also visible in a copy of the land register.

The registration of a document together with the rank certificate causes the document to have the same position in the list of documents (the same priority) as if it has been registered at the time the owner applied for the rank certificate. Since the rank certificate is visible in the copy of the land register the buyer can demand receiving the rank certificate. The registration of the property transfer will then have the rank of the rank certificate. The transfer will be valid even if the land was sold twice and the other transfer was registered earlier. Since this has been done after the application for the rank certificate the buyer who has the rank certificate can remove all transfers registered after the rank certificate.

Figure 1 shows the principle of the rank certificate. Situation a has one valid transfer registered which thus has rank 1. The owner then applies for a rank certificate (situation b). Then the two transfers B and C are registered (situations c and d). Both transfers have a lower priority than the rank certificate. Transfer B is registered together with the rank certificate and thus receives the rank of the certificate itself. It now has priority over Transfer C (situation e). If the transfers are property transfers then the transfer B becomes invalid and can therefore be deleted (situation f).

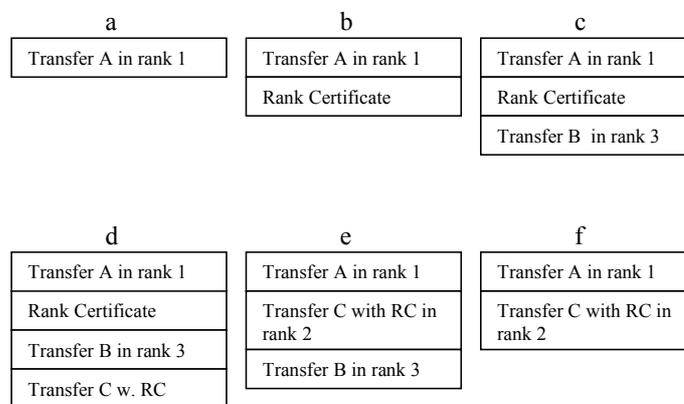


Figure 1: Principle of a rank certificate

The rank certificate adds another step to the process. The seller must apply for the rank certificate. This can only be done directly at the land register and the seller must pay fees.

Step	Agents	Result
applying for proof of priority	seller, land register	document granting a specified rank
obtaining copy of the land register	seller, land register	proof that the person selling the land owned the land at the time the copy was obtained, reduces risk to buy from wrong person
setting up contract for property transfer	buyer, seller	document of sale, which can be registered at the land register to complete the property transfer
signing of the contract and other necessary documents	buyer, seller, notary	signed documents (document of sale, quitclaim), certification of the notary stating that the signatures were done voluntarily
exchange of documents and payment	buyer, seller	seller receives payment, buyer receives documents necessary for registration including rank certificate
registration of property transfer	buyer, land registry	buyer registers the transfer (including rank certificate) and completes the process of property transfer

Table 4: Steps for property transfer with protection against purchase from the wrong person and double sale

5 BUYER BUYS WITH MONEY BORROWED

There are two possibilities how credit institutes can be connected to the property transfer. The credit institute may provide the money for the purchase or the land is encumbered by a mortgage. Mortgages are a guarantee for credits. Mortgages allow the beneficiary to demand foreclosure sale of the land connected to it. The proceeds of the auction will then be used to repay the credit and the former owner of the land receives the remaining money.

### 5.1 Credit Institute Providing the Money

The credit institute may provide the money necessary if the buyer has not enough money. The credit institute takes a risk if granting a credit. The credit institute loses the money if the borrower cannot pay the money back. Credit institutes developed several strategies to reduce this risk. We only look at mortgages as guarantee for the credit and disregard all other possibilities like insurance or distaining upon the salary. The reason for this restriction is that only mortgages influence the process of property transfer.

The problem is that the credit institute would require the mortgage at the same moment the borrower receives the money to restrict the risk of fraud for the credit institute. At that time, however, in case of property transfer the borrower is not yet owner of the land and cannot grant the mortgage. Each of the three agents provides and receives something:

The credit institute provides money and receives the approval to register a mortgage.

The seller provides the documents necessary for the property transfer and receives the money.

The buyer provides the approval to register the mortgage and receives the documents for the property transfer.

### 5.2 Credit Institute as Beneficiary of a mortgage

A credit institute may also be involved in the property transfer if there is already a mortgage connected to the land. In this case the buyer will want to get rid of this mortgage. This is easy if the credit has been repaid. The credit institute (the beneficiary of the mortgage) will then permit the deletion of the mortgage and the owner of the land can apply for deletion. The credit institute will ask for the money if the credit has not yet been paid back. This situation is similar to the situation in 5.2. Again each of the agents provides and receives something:

The credit institute receives the money and provides the approval to remove the mortgage.

The seller receives the remaining money and provides the documents necessary for the property transfer.

The buyer provides the money and receives the documents to register the transfer and remove the mortgage.

### 5.3 Combined Situation and Solution

Figure 2 shows how a combination of these two aspects leads to a situation with circular dependencies. The buyer requires the documents of property transfer (document of sale, rank certificate, and quitclaim) and the permit to delete the existing mortgage. In exchange he offers the money, part of which the seller hands over to the credit institute, which is the beneficiary of the existing mortgage. Since the buyer must borrow the money he asks a credit institute for it and offers a mortgage as guarantee for the credit. Unfortunately he must be owner of the land to permit the registration of the mortgage. Since he needs the money to become owner and must be owner to get the money the situation results in a circular dependency.

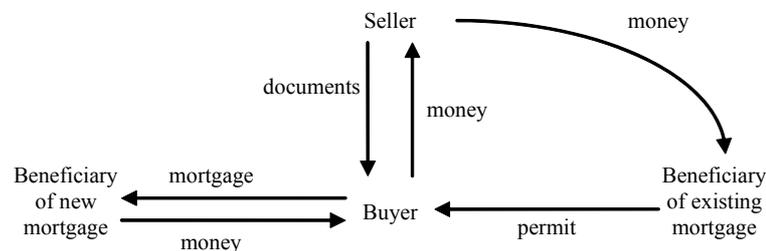


Figure 2: Exchanges for the property transfer

This situation contains risk for each of the agents. One of the actors must provide his part without receiving immediate return. Let's assume that the beneficiary of the new mortgage provides the money without receiving the mortgage immediately. There is the risk that the 'buyer' does not buy the land and permits the inscription of the mortgage. In this case the credit institute will have to perform legal steps to get the money back, which will be expensive in terms of time and money. If, on the other hand, the seller and the beneficiary of the existing mortgage agree to provide their documents it may happen that they do not receive their money. In this case they would have to perform legal steps. The situation thus requires a solution which reduces the risk for all involved actors.

The solution is the introduction of a trusted person. This person collects the money (or the promise to provide the money), the signed sale documents, and the permit to remove the existing mortgage. The person then provides each actor with what he needs:

The buyer receives the documents necessary to register the sale and delete the existing mortgage,

the beneficiary of the existing mortgage receives the outstanding money,

the seller receives the remaining money, and

the beneficiary of the new mortgage receives the document necessary to register the mortgage.

The trusted person is usually the notary since he is already involved in the process and he is a person of public trust. The notary then organizes the whole process and usually does not only collect and distribute money and documents but also registers the changes at the land register. Of course this service is not free of charge.

Step	Agents	Result
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applying for proof of priority	seller, land register	document granting a specified rank
obtaining copy of the land register	seller, land register	proof that the person selling the land owned the land at the time the copy was obtained, reduces risk to buy from wrong person
asking for credit	buyer, new credit institute	promise for credit
ask for deletion of mortgage	seller, old credit institute	permission to delete existing mortgage if credit repaid
setting up contract for property transfer	buyer, seller	document of sale, which can be registered at the land register to complete the property transfer
signing of the contract and other necessary documents	buyer, seller, notary	signed documents (document of sale, quitclaim), certification of the notary stating that the signatures were done voluntarily
exchange of documents and payment	buyer, seller, notary, both credit institutes	seller receives payment, buyer receives documents necessary for registration including rank certificate
registration of property transfer	notary, land registry	buyer registers the transfer (including rank certificate) and completes the process of property transfer

Table 5: Additional steps in order to achieve a model including credit institutes

## 6 CONCLUSIONS

The example of property transfer showed the connection between risk and complexity of a process. In our approach the only way to deal with complexity is to study a concrete case. We start out with a simple solution for our task, this provides a simple process but leaves risk for all agents. We then study scenarios with different risks, which lead to an increase in the number of process steps, agents, time, and money.

The simplest case contained risks for both, the buyer and the seller. Elimination of the risks complicated the process of property transfer by requiring more steps to be done or more persons involved. Each additional step usually also costs money. Notaries, for example, have fees for specific types on tasks. Also the land register must collect taxes for the registration of specific rights like mortgages and fees for providing information.

We assume that a similar connection between risk and complexity can be seen in other processes. Work performed by Grum and Frank (Grum and Frank 2005) also assumes that the risk of getting lost on a trip increases with the complexity of the route. We will investigate other examples in the future to check our assumption that there is in general a connection between risk and complexity of processes.

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