

The weighing in mixed housing stock – what to do with it?

Development of a decision support model

Author:

Thomas Borger

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“For time and the world do not stand still. Change is the law of life. And those who look only to the past or the present are certain to miss the future.”

-John F. Kennedy-

Guidance committee:

Schaefer, W. (Wim)

Glumac, B. (Brano)

Weenen, B. van (Bart)

Presented on:

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1 INTRODUCTION

1.1 General introduction

The housing market is like many other markets, very dynamic and dependant on different actors. Markets respond to different triggers from outside like: monetary and fiscal policies, economic parameters and trends in the housing market itself. The market does not function on its own; it needs input from everywhere to keep functioning.

In the last few years, the input in the housing market was quite negative with the financial crisis. This had its effect on the different house owners and housing providers, like housing corporations. Especially housing corporations have a tough time now. They represent a large part of the total housing market and therefor influence the workings of the market quite a bit (about 1/3 of the total housing stock is part of the housing corporations).

To illustrate the impact of this change, there are some numbers available to show this. There was a dramatic decrease in the amount of jobs at housing corporations. Seven out of ten housing corporations will fire 15% of their full-time people. Translating this to real numbers, means that of the 28.000 full-time jobs in the social sector roughly 4.200 jobs will vanish. This decrease in job all has to do with the fact that the housing corporations in general are suffering from the financial crisis; an external factor influencing the housing market drastically.

Furthermore, the removal of jobs was not enough. Housing corporations also sold quite a lot of households in the recent years. This averages on 167 social rental households per year, over 381 housing corporations. When asking housing corporations, they think they can sell more households in the future (42%), while others think they will be selling less (27%) (Vastgoedmarkt, 2014).

In this research there will be focussed on a specific part of the housing corporation portfolio. A part that came into being thanks to the actions housing corporations took in the past. These are the apartment complexes with different owner structures. So these complexes are still partly owned by housing corporations and the other part is owned by individual private owners. In these mixed ownership complexes there will be looked for possibilities to make them more competitive in the current housing market. This is done by seeing if it is possible to make a sustainable change in the housing complex.

The research is done as a part of my graduation program of the master program Construction Management and Engineering at the Technical University of Eindhoven. Since there was no company willing to support this research, a lot of information was gathered from literature and previous conducted interviews at all kinds of companies that are related



to the topic of mixed ownership. I would like to thank all the different companies that took their time to help me by offering some time. Sadly, I cannot add the different interviews to this research, since the questions asked there were meant for a different study. But in general the different interviewed people gave a good description about the topic between the questions.

Lastly I would like to mention that the research was performed as a part of the Kenwib project. In the Kenwib project the goal is to find the answers to achieving a more sustainable built environment.

1.2 Structure

The research will be divided into four main parts: the research field, literature research, the modelling and the results. First there will be a more specific outline of the research itself in the next chapter. This will be done by addressing the problem that is being researched and the actual research question(s) that will be answered in the end of the research.

After the outlines of the research, literature will be used to determine different factors that are needed to understand the problem. From the literature these factors will be determined, along with other information that is needed in the course of the research.

By using the different parts of literature, the models will be developed. These will be decision tables and system dynamics. By using these models, the different cases can be evaluated and the models can be validated.

Finally, the different conclusions of the research will be presented in the end of the research. There will be concluded what the impact is of the different models and how they can affect the situation the housing corporations are in now, in relation to mixed ownership complexes.



2 FIELD OF RESEARCH

In the Netherlands there is a unique organization to support the lower incomes in their housing needs. This organization is the housing corporation. In the beginning of time, the housing corporations were in a close collaboration with the government. They could receive financial support and were able to financially survive without any trouble. In 1988 this changed and the corporations no longer got governmental support and had to attract it from the capital market. This change made that most housing corporations disconnected from the government completely. Due to these developments, the housing corporations were forced to change their occupation in the market. Their core existence was to support the lower incomes in a proper rental apartment. However, these houses all consisted of a financial gap. This gap was prior to the changes in 1988 filled by the government. Now the gap had to be filled with other financial means.

To fill this financial gap, the corporations extended their portfolio to other types of households and housing types. They became more diverse and tried to get finance through it. Regardless, this still left them with all the rental houses for the lower incomes. This money pit was also a problem on itself, especially when the financial crisis occurred in 2008. This resulted in a complete shut-down of the housing market, limiting the financial income of the housing corporations.

The only option left was to try and sell the cheaper rental houses, from the sixties and seventies, in their portfolio to limit the financial burden. In the end this resulted in the sales of smaller parts of housing complexes to private owners. Which in turn, introduced the mixed housing complex (or HoA-complex) (KWH, 2011).

Now-a-days housing corporations are stuck with these kinds of mixed complexes. There is no real vision on what to do with them and they are largely used as individual sales objects in a larger building entity. All kinds of support from the housing corporation are reduced to an absolute minimum and the hopes are that the complaints stay out. This way the housing corporation is hindered in the lowest amount. By taking this approach, the remaining rental households in the mixed complex stay in possession of the housing corporation. Quirijns, 2011, looked into this problem before and sought to find limitations that housing corporations experience when it comes to these kinds of mixed ownership complexes. She made the distinction between several aspects (legal, financial and technical). Where this provided a good base to tackle mixed ownership complexes, there is no real investigation made on how the housing corporation should act. There is no denying that these aspects play a role in the decision making, but it cannot be that there are no other aspects that are also involved. A good example would be the new owners in the complex and how the housing corporation sees them in the project and process.



The new owners of the dwellings are often seen as a liability for the housing corporation to achieve its goals and standards, even if the corporation made this situation the way it is. Housing corporations have no real field of expertise when it comes to private owners. On the contrary, they are used to tenants. Tenants (especially those in the social class of society) are largely depending on the housing corporation to offer them proper housing. This is in contrast to private owners, who have no binding to a housing corporation in any way. This makes that there is a rather complicated work field is developed by the different key-players in the process. On the one hand the housing corporation with its tenants, who wants to pay as little as possible and maintain the continuity and on the other hand the private owners who have no company interests and only look at the situation from their own understanding. These two different fields of interests and desires lead to a stagnation in the goals of the housing corporation to achieve a more sustainable portfolio in the upcoming years.

In the end, something has to be done with these mixed housing complexes (McKay, S.; Khare, A., 2004; Matos, S.; Silvestre, B.S., 2013). It may be clear that the housing corporation is the key-player in this situation. They have a huge responsibility to both the tenants and to themselves. The question is, what should they do?

2.1 Problem definition

The subject will focus on the mixed housing complexes that were first completely owned by housing corporations and later became partly sold to individual owners (CBS, 2012). This was done thanks to the housing corporation's plan to tackle their financial continuity. It is important to note that these complexes are multi-layered. Multi-layered mixed complexes offer a great deal of opportunities. But this is not the complete problem. If there was mixed ownership, this would mean little to the housing corporation. They contact an external manager to maintain the housing association for them and continue their daily activities. However, now there is a second part of the problem. Housing corporations agreed to make their portfolio more sustainable in the year 2020 (average of label B). This means upgrading their outdated housing stock, which also includes the mixed complexes. This problem can be explained as:

"The problem housing corporations are facing is the fact that they have mixed ownership in their portfolio and this is hampering them in becoming more sustainable"

This problem is affecting the complete portfolio of the housing corporation. However, in this research the focus will be on a single type of households that are in the portfolio of the housing corporation. This is because else it would become too complicated.

2.1.1 Point of view

The research will be conducted from the viewpoint of the housing corporation. They are the player that is mostly troubled by these dwellings and also made them come into being in the first place. The results will also be focussing on the actions that can be taken by the housing corporation and not so much by the inhabitants of the complex. this does not take away that the housing corporation has to face the inhabitants.

2.1.2 Inhabitants

Housing corporations offer housing to all kinds of people in the society. In relation towards the topic, not all the inhabitants are equally relevant when it comes to achieving a more sustainable portfolio. In general housing corporations should have 90% of their tenants in the social rent sector. This implies an annual income of less than €34.789 and a monthly rent lower than €699,48 (Aedes, Inkomens- en huurgrens: regels per 2014 , 2013; Rijksoverheid, parameters-huurtoeslag-inkomensgrenzen-staatssteun-verkoopregels-en-inkomensafhankelijk, 2013). Currently only 69% of the tenants is in this group.

When inspecting multi-layered mixed housing complexes, there are two main groups that live in these complexes: the singles (69,3%) and the couples (30,7%) (Woononderzoek 2012, 2013).

The age of the inhabitants varies in a big way. This is because of the life-cycle of humans in relation to buildings. The expectation would be that in the midst of the person's life the complex dwellings become less attractive. However, research has shown that this is the case but only marginal (see also figure 1) (Aedes, wie-zijn-de-bewoners-van-een-corporatiewoning, 2013). This is mainly because more people stay single longer or have children on a later age.

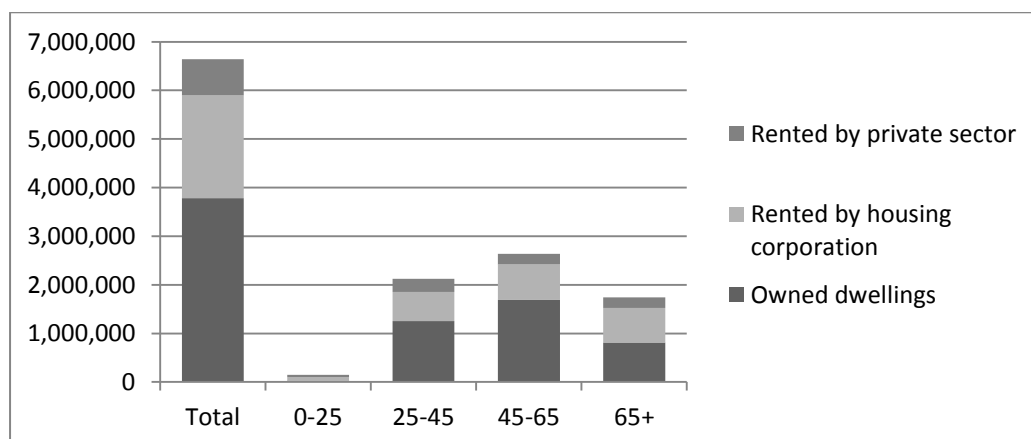
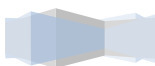


Figure 1: overview of the age of inhabitants, based on house ownership (Aedes, wie-zijn-de-bewoners-van-een-corporatiewoning, 2013)



2.2 Position of the problem

Over the years, the housing corporations sold houses to maintain their financial cash flow. These houses were either sold to the current tenants or sold to new inhabitants. This meant the tenant left and the house was sold on the public market (Aedes, Housing corporations partner in living, 2012). Even though there is no clear distinction between the amount of houses sold as ground-dwellings and tiered dwellings, a vision can be made about this. Since a housing corporation's portfolio owns roughly 40% (Aedes, wie-zijn-de-bewoners-van-een-corporatiewoning, 2013) in tiered dwellings, it can be that there is a part of the sold households situated in housing complexes.

An earlier talk with Mitros (Housing Corporation in Utrecht) confirmed this vision. They are actively promoting people to buy their own household if they have the financial means to do so. This is in relation to what the general policies of housing corporations are. Housing corporations have roughly 30 – 40% of their portfolio flagged as “potential sell object in near future” (Compaen, 2013; Domus, 2012; WoonInc, 2014; Woonwenz, 2012).

In the last years the sales in households started growing again (see also figure 2). Up until the financial crisis in 2008 the sales were declining. When the financial crisis started, the sales grew. The predictions are that the sales will keep growing in the future. This mainly has to do with the fact that housing corporations offer large discounts to tenants to buy their rental apartment. This triggered some tenants to buy their dwelling relatively cheap compared to the market value of the dwelling.

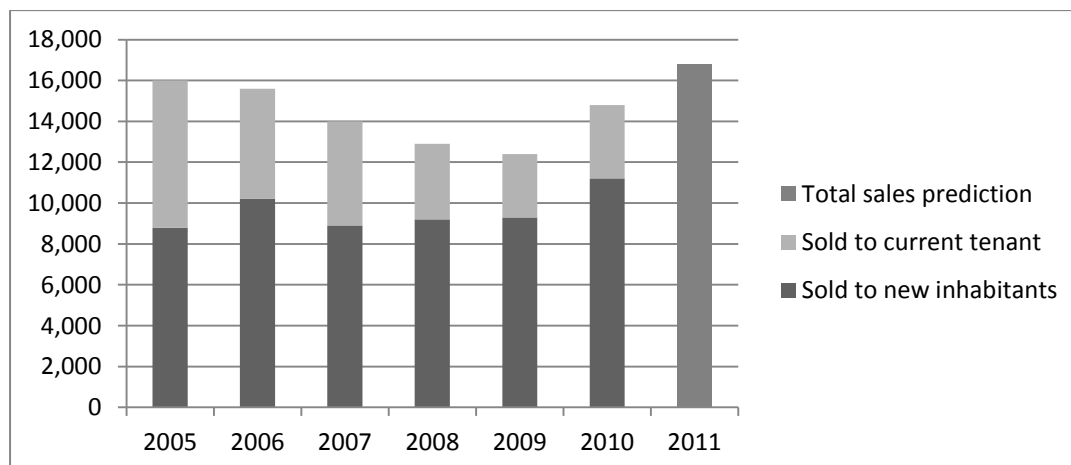


Figure 2: total housing corporation sales in the portfolio (new construction excluded) (Aedes, Housing corporations partner in living, 2012)

3 RESEARCH DESIGN

3.1 Aim of the research

The aim of this research will be twofold. In the first place there will be looked for a decision model that will include different factors (financial, technical, social and legal) that are important for a housing corporation. This way an advice can be generated towards the housing corporation. Secondly, there is the aim to try and create some awareness towards housing corporations. In most cases, these mixed ownership complexes are abandoned in terms of making a sustainable change. This in spite of the fact that these mixed ownership complexes offer a great deal of opportunities.

3.2 Research questions

To look into this problem, a research question is formulated. Along with this question several sub-questions are also defined. The main question can be defined as follows:

“What would be the best approach for a housing corporation to tackle mixed housing complexes in relation to becoming more sustainable?”

To answer this question several sub-questions are defined:

1. What external factors influence the possible actions for energy upgrading in mixed ownership housing stock?
 - a. How do policies (national, provincial, local) influence the action chosen?
 - b. How is future supply and demand influencing the action chosen?
2. What internal factors influence the possible actions for energy upgrading in mixed ownership housing stock?
3. What is the list of possible actions; given the external and internal factors?
 - a. What are the advantages and disadvantages of the different actions?
 - b. How can the different actions be measured?
4. How to support decision makers in housing corporations?

3.3 Research steps

To find the answer to the different research questions, different steps will be undertaken. In the beginning, the research will start off with a literature research. In this literature research the different relevant factors will be sought that influence the housing corporation in decision making (questions 1 and 2). Additionally, the literature will provide the different actions that a housing corporation can take in relation towards a mixed ownership complex. The fact that the housing complex is consisting of multiple inhabitants, makes that there are more options available compared to ground bound dwellings (question 3). By answering the different parts of the third sub-question, the steps can be made towards the fourth sub-question.



The fourth sub-question involves more than just literature. With the aid of the information found in the previous questions the base for the fourth question is established. But to really make a tool that helps decision makers of housing corporations in the process, some additional steps are needed.

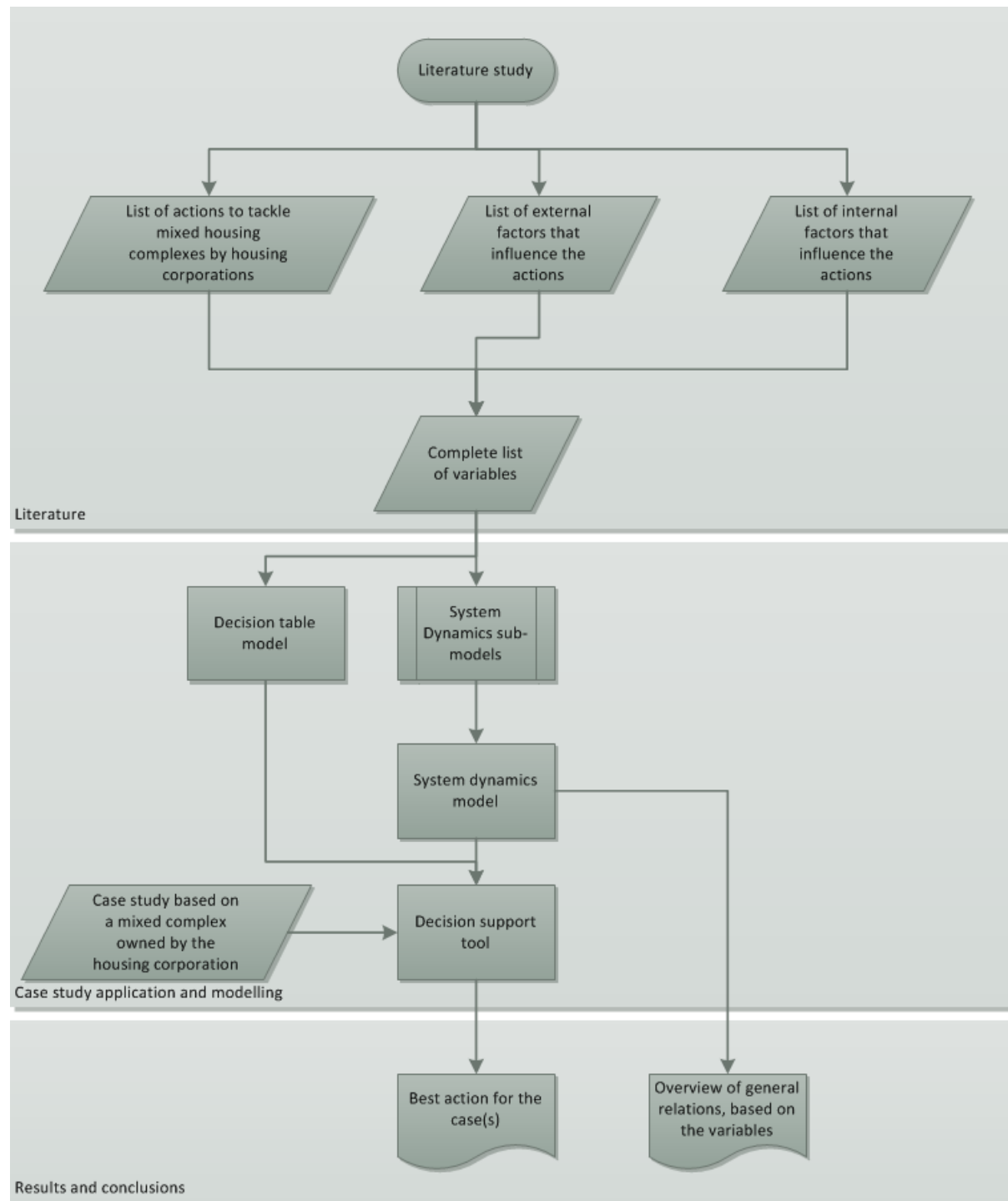


Figure 3: research steps

To look further into the fourth research question, several methods will be used to determine if a housing complex is suitable for upgrading. These methods will consist of both decision tables and system dynamics. The combination of the two methods will lead to the answer of the fourth sub-question of this research.

To make sure that the different models are working properly, two case studies will be applied. These case studies represent different situations and therefor offer a better test for the models to see how they interact and behave. Based on the cases and the working of the two models, an advice will be given to the housing corporations in the end of the research (see also figure 3).

3.4 Methodology

As mentioned in the previous paragraph, there will be two research methods that will be used to help find the answer to the research questions. For this research, the two methods are interlinked and use the same group of variables that are determined in the first three research questions to generate the results.

Decision tables

The decision table is used to visualize precise and yet compact knowledge into a model. What this is that the model generates a clear overview of different variables (which in this research are extracted from literature) and combines those with possible reactions (which in this research are found in literature and are based on taking the mindset of the decision making team of a housing corporation).

Printer troubleshooter									
		Rules							
Conditions	Printer does not print	Y	Y	Y	Y	N	N	N	N
	A red light is flashing	Y	Y	N	N	Y	Y	N	N
	Printer is unrecognized	Y	N	Y	N	Y	N	Y	N
Actions	Check the power cable		X						
	Check the printer-computer cable	X	X						
	Ensure printer software is installed	X	X	X	X				
	Check/replace ink	X	X		X	X			
	Check for paper jam	X	X						

Figure 4: example of a decision table

In the common world, everyone has had an experience with these tables. But very few know they actually did. A good example would be when a person decides to buy a house. The real estate agent will ask certain questions to you to determine what kind of house you look for. Basically, (s)he applies the method of a decision table. (S)he tries to eliminate the houses



that are on the market that you would never want anyway and picks a few houses that you probably are interested in.

In this research the decision table will visualize the different variables that are found in the literature and connect them towards the advised actions that should be taken. This leaves the housing corporation with a model where they only have to fill in the variables and get an instant advice.

System dynamics

System dynamics offers the possibility to model complicated real-world situation in a simplified visual world. This is exactly what is needed to make a rough estimation of one of the variables.

To start a system dynamics model, there is first a pre-model or causal loop diagram. The causal loop diagram outlines the different relations between the core variables and links them with arrows. Each arrow is then marked with either a positive or negative sign, which indicates the relation between the two variables. A positive relation means that if the first variable increases, the second variable also increases. A negative relation means that the second variable does the opposite of the first; so if the first variable increases the second variable decreases.

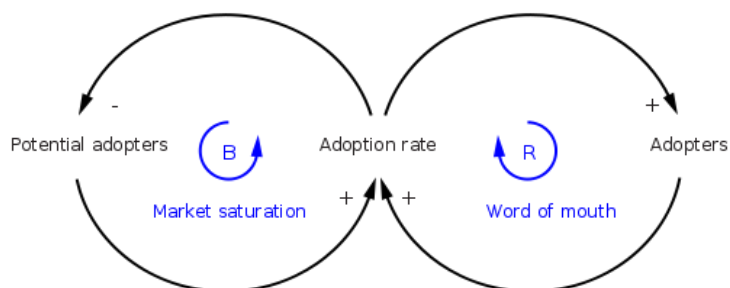


Figure 5: example of a causal loop diagram

The causal loop diagram will then be modified to a real system dynamics model, which is the stock and flow model. The stock and flow model takes the causal loop diagram as a base and from there more variables are added that influence the working of the model. What the model will do is use the different variables to determine what the stocks and flows will do. The stocks are units in the model that have a memory and mostly represent important aspects like money, people or goods. The flows make changes to the stock. They either

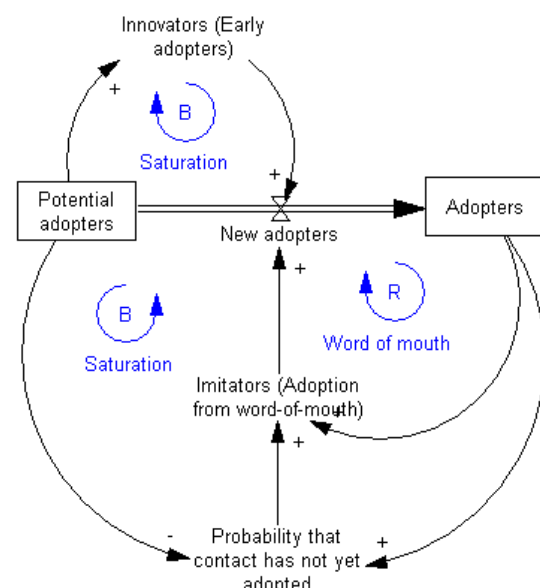


Figure 6: example of a stock and flow model

make the stock diminish or increase. Over the course of time the results of the simulation of the stock and flow model can be extracted. By changing the different variables in terms of what they provide to the system, different situations can be modelled.

The system dynamics will be used to estimate a variable that is needed in the decision table. To do this, the other variables that are in the decision table will be used as input of the system dynamics model. The reason behind this is that the housing corporation can estimate all the different variables before the process starts, except for one variable.

Case study

The third method used will be the case study; this implies using a real-world situation and uses it in the models to either: test the models or predict how this particular case should be handled. In this research the case study will be used to examine the models and see if they function as expected. In total, two cases will be used to test the models. This is because the two cases both have a different approach towards the problem that is not handled by the models themselves.

3.5 Expected results

Based on the research some results can be expected. Firstly, there is the literature. Based on the literature there is expected to find some variables that are important to housing corporation when it comes to decision making and especially decision making in terms of sustainability in mixed ownership complexes. These variables on themselves provide a base to determine the way housing corporations work.

Then the models will provide some kind of advice towards the housing corporation. This advice will target the specific mixed ownership complex and give advice specific to that complex. Based on the advice, the housing corporation can then make a decision on what to do with the complex.

3.5.1 Limitations

Like all the researches, there are limitations that make that this research will never be able to relate to the real world in all the cases. These limitations should be acknowledged. One important aspect is that the models are targeting the housing corporation. There is very little done to the situation of the inhabitants. This is quite in contrast to expectations, since the housing corporation is relying on the inhabitants to cooperate. However, adding the complete part of the inhabitants would lead to a new research on its own. There for was chosen to not go into depth about the inhabitants.

Secondly, there is the point of the decision table. The different variables from literature are translated into levels for the decision table. However, not every housing corporation has a similar portfolio. Corporations in large cities have more layered stock, compared to smaller



housing corporations in small cities. Identifying all the different types of housing corporations would lead to a very extensive decision table, since every variable then should consist of a vast amount of levels. Adding more levels to the variables would lead to a very large decision table, which becomes very confusing and in the end it will even be unreadable for the user. There for was chosen to keep the levels of the variables to a minimum, but in such a way that the most important levels are still used in the decision table.

3.5.2 Relevance

Housing corporation

This research is mostly relevant towards the problem owner: the housing corporation. They get a tool that can help them make quick decisions about mixed ownership complexes in relation to their sustainability goals. They can quickly go through all their mixed ownership complexes and see which ones are suitable and which ones are not. But this is not the only group that can claim it is relevant to them.

Inhabitants

The results are also relevant for the inhabitants of the mixed ownership complex. People want to know what they are involved in and what is going to happen. By using the tool the inhabitants, like the housing corporation, get a quick view on what should be done. In the meeting with the house owners or tenants the tool can provide a visual aid to inform the inhabitants about the choice and make them better understand why the choice was made to begin with.

Governments

Another group of people that could be interested in the results are the governments. The reason behind this is that the housing corporations have an agreement with the government to achieve a more sustainable portfolio in the future. This tool could also give governments the point-of-view of the housing corporation. Especially when the deadline of the 2020-agreement is approaching and some housing corporations still did not make it to the desired level.

University

Lastly, universities could profit from this research and its results. There is still very little known about these types of dwellings and how they could be placed in a sustainable perspective. By this research the first steps were made to open up the part of the portfolio that mostly is used to just generate money and nothing else.

4 LITERATURE RESEARCH

In this chapter the different factors to make a choice will be investigated. To do this, a literature review will be applied and the results will be elaborated in this chapter. This chapter will handle two aspects from literature. The first of the aspects are the different internal and external factors that play a role in making the decision as a housing corporation. And secondly, there will be the different actions a housing corporation can take in terms of tackling the goal of making a mixed ownership complex more sustainable.

4.1 Internal and external factors

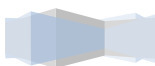
Important to note is that there are certain factors that can contribute to the neglecting of this particular type of housing stock in the portfolio. In this research there will be seven main factors that play a role. These are the process management innovation, relations with other players, user's behavior, preference for smaller projects, investment costs, age of the portfolio and the selling process. Each of these factors will be more closely elaborated in the next pages.

4.1.1 Process management innovation

In the construction world, there is very little innovation when it comes to the building process. This is mainly because a large amount of innovations simply fails. Innovations are risky and no one wants to take the risks, especially since the most of the benefits of the risks will not be at the innovator, but at the customer (tenant and private owner in this case). The housing corporations, since they work with tighter budgets, have even less reasons to try and be innovative. This results in a more passive attitude towards innovation and low investments. The main belief is that the new methods are still rather unreliable for housing corporations to be used. Especially since housing corporations cover a large group of tenants (mostly between 10.000 and 50.000 tenants), there is no room for them to try and test these new methods. If they would do so, and they fail to achieve success, this can lead to a negative image and could harm their continuity (Mondol, J.D., Koumpetsos, N., 2013; Ecorys, 2008). This result in housing corporations to pick a proven concept that gave them good results in the past. This proven concept will then be applied in the portfolio and no further research will be done to other possible solutions.

4.1.2 Relations with other players

The housing corporation is limited in its activities by other players. Housing corporations are restricted by the rules and regulations of the Dutch governmental levels. These governments put rules and regulations in place, by which the housing corporation has to comply. The governments on their turn are influenced by the rules and regulations that are made in the European Union. Besides the rules and regulations from the different governmental organs, the housing corporation has a different group of people that are



interesting: the inhabitants. Since the inhabitants are both tenants and private owners the difference between the two groups is important to acknowledge.

European Union

The European Union set rules on competition (C(2009)9963) in 2009. This set of rules was placed to make room for fair competition in the market. Housing corporations were increasingly active in markets other than social housing. By doing so, they threaten the competition on the other markets since the housing corporations receive financial support from the State. Furthermore, they construct houses that are meant to be sold, which puts the housing corporations even further away from their core activities (Europa-Nu, 2014).

To counter these activities, the European Commission set new rules to strengthen the competition on the Dutch market. The housing corporations should split their activities between no-support activities (non-DAEB) and support activities (DAEB). By doing so, the different activities are clearer and the governmental support can be evaluated. Furthermore, the DAEB activities should contain 90% of the housing corporation's activities. The remaining 10% can be non-DAEB (Europa-Nu, 2014; Novum, 2014).

National government

Due to the increasing awareness of sustainability, the national government made an agreement with other players named the Energy-agreement (Aedes, Energieakkoord duurzame groei, 2013). In this agreement the government promises to adjust some rules in the national regulations to make sustainable renovations more applicable. Currently, there are rules like the ownerships rights (no one is allowed to trespass other people's property or rented property with permanent material items like cables) which prevent proper appliance of sustainable upgrades in complexes (Aedes, Energieakkoord duurzame groei, 2013).

Not all the households have an energy label currently. The rules are that when a household is offered on the market, an energy label is needed. However, in situations with housing corporations, there are plenty of households that still house the same users since this rule became into being. To tackle this, all the houses that have no energy label will be receiving an indicative label. By applying this measure, the users become more aware of the energy situation of their households (Vassileva, L., Wallin, F., Dahlquist, E., 2012; Aedes, Energieakkoord duurzame groei, 2013). This way the housing corporations can assess their complete portfolio. This will be needed since the social housing sector also faces the *Convenant Energiebesparing Huursector* (CEH), besides the Energy-agreement. The CEH conducted goals for housing corporations to achieve in the near future. In the CEH is noted that the average energy label of every housing corporation should be label B in 2020. To support this, the government is supplying €400 million (Aedes, Energieakkoord duurzame groei, 2013).

Local government

The Netherlands have a hierarchy structure of the political system. This means that national rules are carried on towards the more local instances of the government. The Energy-agreement lead to a more detailed for of plans in the local governments, but the general idea is still the same. The local governments will support sustainable energy developments by supplying subsidies and advise on how to save energy (Eindhoven, 2013; Venlo, 2012). What the local government is doing, is tapping into the larger supply of national subsidies to help the local incentives.

In the policies are also similar goals towards the national government. The municipality of Eindhoven wants to be energy neutral in the year 2045, which is quite similar to the national goal of building energy neutral in the year 2050 (Eindhoven, 2013). The difference is that the local governments are more detailed in how they want to support the different incentives of sustainable energy.

Tenants

The tenants are bound to the housing corporation with the rental agreement. This agreement sets the rent and rules for both players alike. When there is decided that a sustainable upgrade will be placed, this will change the agreements in the rental agreement. The housing corporation will try and recoup the investment of the system on the people that are actually using it; the tenants. By doing this, there is a need for a change in the rental agreement and the rent. To accomplish this; a voting is needed amongst the tenants. In this voting, 70% has to agree with the proposed changes (Woonwenz, 2012; Woonbond, 2009).

Private owners

The private owners are united in the house owner association (HoA). In this group, the housing corporation takes the place and voice of all the tenants combined. The HoA leaves the housing corporation with a different kind of situation. They need a 66% agreement in the voting of the HoA to pass any form of sustainable upgrade to the complex. However, the private owners are a lose group of individuals. They can have no direct relation with the housing corporation other than that they are in a similar complex with tenants. Convincing this group of individuals is difficult, since they are also paying for a part of the sustainable upgrade (Turcu, 2012).

4.1.3 User's behavior

Housing corporations have control over a lot of aspects when it comes to making a more sustainable portfolio. However, there is one aspect that is uncontrollable: the human behavior (Kyrö, R., Heinonen, J., Junnila, S., 2012). Studies have been done that imply that negative human behavior can make sustainable developments useless (Vassileva, L., Wallin,



F., Dahlquist, E., 2012; Jaing, P., Tovey, K., 2010). After making the sustainable upgrade, the tenants tend to become more unaware of the situation, which in the end will result in them being more ignorant when it comes to saving energy properly. In other words: they will leave appliances active longer or leave windows open (Palma, I.C., Mengual, E.S., Solà, J.O., Montero, J.I., Caballero, C.P., Reiradevall, J., 2013).

When comparing the different projects a housing corporation can realize, it is easier to change the behavior of people when there is a limited amount of people that need to be informed (Vassileva, L., Wallin, F., Dahlquist, E., 2012). This results in a smaller margin for error, and thus a more reliable result in combination with the sustainable upgrade.

4.1.4 Preference for smaller projects

Housing corporations tend to prefer multiple smaller projects over a single large project. This way the teams of the housing corporation can all tackle a situation where they face only a few owners that they need to convince, compared to a large project where the people can influence each other in a negative way more easily (Kaygusuz, A., Keles, C., Alagoz, B.B., Karabiber, A., 2013).

A second reason to prefer the smaller projects is that there are existing plans and procedures that a housing corporation can use, with only minor adjustments. By doing so, they have a shorter process (in both preparation and renovation time). The construction method is already predefined and when multiple small projects are possible, the housing corporation can still purchase the materials that are needed cheaper (Kaygusuz, A., Keles, C., Alagoz, B.B., Karabiber, A., 2013; Vassileva, L., Wallin, F., Dahlquist, E., 2012).

4.1.5 Investment costs

The costs for upgrading a complex are higher than upgrading a part of the portfolio which contains terraced houses, or similar ground-dwellings. Since the terraced houses are in a lesser manner connected than households in a complex, they can be split into smaller investment group and be spread over a few years of time. In a complex, the investment should be made for the entire building at once. This makes that there is need for a rather substantial investment in a single moment in time (Mondol, J.D., Koumpetsos, N., 2013; Osmani, M., O'Reilly, A., 2009; Hester, N., Li, K., Schramski, J.R., Crittendem, J., 2012).

The other part of the investment is to get the money back by using the applied system. Currently there is a financial recoup system in place called the “*woonlastenwaarborg*” (English: housing costs guarantee or HCG). The HCG is an agreement between tenants and lessor about the increase in rent, based as a percentage on the projected savings of the sustainable system (Woonbond, 2009). This means that if, for example, a system saves annually €300,- on the energy bill, the annual rent can be increased by €210,- (or €17,50 each month). This way there is a profit for both the lessor (they get more rent) and for the

tenant (they save money on the combined bill of energy and rent). The problem is that when the ECG is applied, the financial means of the housing corporation are fixed in that particular project, until break-even moment of the system. The private owners will recoup their investment by use of the energy savings.

Differently, there is the system of fund gathering by the house owner association. In this case, the sustainable upgrades are planned in the meetings of the house owners and each owner will contribute a small amount monthly to be able to afford the upgrade in the end. If this is the case, the private owners and the housing corporation will be doing the investment and if there is an increase in rent is up to the housing corporation (See also appendix 1).

4.1.6 Large number of '60 – '70 complexes in the portfolio

Housing corporations mainly build a lot of new houses just after the Second World War. In the current time, these households are still being used. Since these households are so old, they face all kinds of unwanted problems when it comes to making a more sustainable portfolio. The biggest issue is that these households are relatively small compared to later build houses. This is in contrast to the fact that current demand for more living space is growing (Mondol, J.D., Koumpetsos, N., 2013).

A different problem with these complexes is that they lack a form of quality. They were developed quickly to offer a lot of people housing just after the world war. Most of these households lack decent glazing and insulation (Compaen, 2013; Domus, 2012). This problem is currently tackled by most housing corporation in the form of offering large maintenance to apply the insulation and change the glass.

4.1.7 Ongoing selling process

Since housing corporations serve the social class of society, they are facing a situation where the rent of the buildings is not enough to generate a positive financial cash flow. Due to this, the housing corporations flagged roughly 30% of their entire portfolio as *“future sale object”* (Compaen, 2013; Domus, 2012; Woonwenz, 2012). If there is a tenant currently living in a house that is flagged to be sold, they can buy the house with a discount of 10% compared to the market value of the household (Compaen, 2013). The discount to current tenants is not a set value. In most cases the tenant discount is far greater than the 10% offered by Compaen. There have been rental apartments that have been sold with a discount of up to 65% of the market value. This resulted in sales in the past, which then made that the housing corporation was no longer responsible for any maintenance or upgrade of the sold households.

As soon as the households are flagged to be sold, and this is announced, the housing corporation withdraws its investments and only does the planned maintenance and will



respond to complains that are emerging from the tenants in the household (Domus, 2012). This is the downside of the sale. The fresh owner of the apartment now has to arrange his own maintenance and other upgrades that are needed now and in the near future.

4.2 Different actions to tackle mixed ownership housing stock

There are all kinds of actions a housing corporation can undertake while looking at the sustainable goals of making an average of label B in the year 2020. In these actions, the use of a mixed ownership housing complex to make quick steps in their sustainability goals could be a suitable solution. The main thing then is, role should the mixed ownership complex play in reaching the goals set for 2020.

Answering this leads to different kinds of actions and different kinds of payoffs. In this research there will be assumed that there is a desire to investigate the possibility of adding the mixed ownership complex in the sustainable plans, instead of what is happening currently. Since now these complexes are mostly used to generate financial means for the housing corporation.

4.2.1 Main actions for the complex

If the housing corporation decides that the particular complex is suitable for sustainable upgrading, there three actions the housing corporation has. Based on the situation the housing corporation is in, which the financial problems on the one hand and the sustainable goals of 2020 on the other hand, the different actions are limited to the most fundamental actions: keep the situation as it is (in terms of inhabitants), continue selling or reacquire the sold households. The successive choice is the actual action the housing corporation is going to undertake with the particular mixed ownership complex. These actions will then contribute towards the goals of making a more sustainable portfolio.

Keep the current situation with tenants and private owners

The first action is also the easiest action (Turcu, 2012). In this action the situation is accepted as it is and the sustainable upgrade is made with the current users of the mixed ownership housing complex (Kyrö, R., Heinonen, J., Junnila, S., 2012). This situation can occur in two ways: the housing corporation takes an active role in the redevelopment of the complex and starts the project by informing all the users. Or the housing corporation waits for a voice to occur from the users that they want the sustainable upgrade. This way the housing corporation does not have to win the user's trust.

Either way, there should be a voting amongst the tenants for the plans. This is because the plans will hold changes in their rent (Woonwenz, 2012). After 70% of the tenants agree, there is a second voting in the HoA with all the private owners. If they agree with a majority of 65% the project can start. The voting will always occur when there are still people inhabiting the apartment complex (see also appendix 2 for more information).

Because there are still private owners in the complex, the housing corporation has a lower risk when executing the plans. Since the private owners are no part of the portfolio, but are in the same complex, it is reasonable to assume that the private owners will have to invest for their own part of the sustainable upgrade. The housing corporation will invest on behalf of the tenants that live in the complex (Compaen, 2013; WoonInc, 2014).

(Re) acquire the private owned households

The second action is mainly focused on the (re)acquiring of the previously sold households to private owners. The private owners will be asked to sell their household back to the housing corporation in exchange for either removal expenses and the monetary value of the household or by offering a different household from the housing corporation's portfolio. Along this offer is the clause that it will only apply when all private owners agree. Else this will be a useless action to take and a different action has to be chosen.

From a housing corporation perspective, this action is interesting to execute. There are no consequences for the tenants, besides some hinder. And the complex becomes in a state it was previously in already. Now the housing corporation can work in their field of expertise and plan the sustainable upgrade. After the upgrade the housing corporation can put the new building in the market, with still some available households (Compaen, 2013; Domus, 2012).

Try and sell the remaining rental households in the complex

Since housing corporations have a rather broad portfolio, it is possible that there already are some plans to make sustainable upgrades somewhere. However, this is a financially struggling process. A good way to make the portfolio more sustainable would be to see if there are any mixed ownership complexes that can be sold to the tenants to get more room to make sustainable investments elsewhere. By offering a purchase discount to tenants the likelihood of them buying the household grows. Some housing corporations even offered a discount of 50% of the household market value (Tiwos, 2013), even though this is very rare. In most cases the discount is around 10-20% of the market value.

This action works twofold for the housing corporation. Firstly, they can get rid of a though complex that they would have to make sustainable in the future. Since their long-term goal is to be energy-neutral. And secondly, by selling households they get a financial benefit. This benefit is by having fewer households they have to maintain and they get the revenue of the sales. This revenue can then be used to make other projects for sustainable upgrades feasible, since this was the whole idea behind selling more households in the sustainable plan.



4.2.2 Sub-actions for the complex

Besides the main actions for making a more sustainable portfolio, there are also actions that follow from the choice of the main action. In this paragraph these action will be further elaborated.

The HC can take all kinds of perspectives in relation towards a sustainable upgrade in the mixed ownership complex. All these perspectives lead to sub-actions. If there is chosen to keep the current situation, the second action would be to determine if the HC will take a leading role in making a sustainable upgrade. If this is the case, the standard actions are needed to see how the development will progress. These are actions like informing the inhabitants, staying active over the time of the project as HC and doing feasibility studies (financial, social, environmental and social). If they choose not to take a leading role, the whole project shifts into a different position. Now there is apparently some reason which makes the complex less suitable for upgrade. This can result in no upgrade at all. Therefore it is important in this situation that the inhabitants come with an incentive. The only way this can be done, is when the HC informs the inhabitants that they think their complex is not suitable (SEV, Evaluatie gemengde complexen, 2010; Westveld, Presentatie Surinamelaan, Amersfoort, 2010).

The second action, (re)acquire the sold households, puts the HC in a more financial stressing situation. They have to buy-out all the private owners and then make the sustainable upgrade with just the tenants. This offers a trade-off between financial costs in the beginning and an easier process later on. Besides the actions that are also in place when keeping the situation, the most important thing is to identify the private owners. This offers valuable information for the HC when trying to sell households in the future (or when they plan on selling the empty households in the complex after upgrading) (Thorbrugger, 2013).

When the third action is chosen, the HC goes all-out on selling the remaining households. If this action takes place, there are some feasibility studies done already and they should conclude that the complex offers a low perspective in relation to a sustainable upgrade. This action should be taken when all other actions are not feasible (See also table 1).



Table 1: actions the housing corporation can take (based on annual reports)

	Different actions to take:	Second action to take:	Third action to take:	Process actions to take:
Involved in the sustainable plan		Take the incentive to sustainable upgrade the complex (active attitude)		Inform inhabitants, active involvement, feasibility studies
	Keep current situation with tenants and private owners	Wait for incentive from the users (passive attitude)	Look for different possible actions	Inform inhabitants, feasibility studies
	(Re)acquire the private owned households	Offering removal expenses and monetary value of the apartment to private owners	Buyout private owners	Inform inhabitants, active involvement, feasibility studies, identify the buyer
	Try and sell remaining rental households in the complex	Flag the complex as sale object	Steps to sell the households begin; purchase discounts for tenants	Inform inhabitants, active involvement, feasibility studies, identify the buyer

4.2.3 Pay-off of the different actions

Each of the different actions holds different results. These results are expressed in pay-offs for the different people that inhabit the mixed ownership complex and the responsible housing corporation. From the different actions, there are a few actions that are interesting in terms of sustainable upgrading, and others are less appealing.

The actions that represent an active involvement when keeping the current situation and the (re)acquiring of the households bode the best pay-offs for players in terms of sustainability. When keeping the situation, the different owners can use each other to minimize risk and create an information platform. This enables the housing corporation (HC) to get information easily. Also they gain knowledge about working with a group of people that is not directly depending on the HC to have a proper household. This knowledge they can later apply in other projects and developments (also in the field of new developments for the open market). By applying the upgrades, the complex becomes more lettable. The private owners have to invest themselves, but become a partner of the housing corporation. This way the private owners have a more secure investment and the value of their property will increase (SEV, Samen onder een dak - VvE's renoveren duurzaam, 2012; Nul20, 2009; MBA, 2010).

In the situation where the HC (re)acquires the sold households, the pay-offs are quite similar. The only difference is that there is no shared risk between players (HC does all the investments) and that they have to buy-out all the private owners. This can prove to be a very risky situation, but if it succeeds the HC has a better perspective of making sustainable upgrades (MBA, 2010).



Table 2: pay-offs for the different players, based on the main actions (SEV, Samen onder een dak - VvE's renoveren duurzaam, 2012; Nul20, 2009; MBA, 2010; SEV, Evaluatie gemengde complexen, 2010)

	Different actions:	Housing corporation:	Private owner:	Tenant:
Pay-offs for the different players	Keep current situation with tenants and private owners (active)	Working in the given situation, shared risks with private owners, knowledge development, image improvement, increasing marketability and lettability of the complex	Have to agree in the HoA (65%), invest themselves, gain partly ownership of the system, recoup through savings, close collaboration with HC	Have to agree (70%), rent changes
	Keep current situation with tenants and private owners (passive)	passive attitude, which can lead to no changes	Have to take the incentive	Have to take the incentive
	(Re)acquire the private owned households	Working with only tenants (corporation's field of knowledge), long preparations to buy all households, increasing marketability and lettability of the complex, complete ownership	Get financial compensation for their household, possibly can get a different house at the housing corporation	No changes in their situation in the beginning, later on involved in the sustainable process, rent changes
	Try and sell remaining rental households in the complex	Generate finance to make room for investments elsewhere in the portfolio	No changes in their situation	No continuation of the rental agreement, can purchase their dwelling for a discount

Other actions (passive situation and sell the households) lead to no direct sustainable upgrades of the complex. The passive attitude leads to a delay, where no one is certain of the future. The idea is that there is a reversed situation, compared to the active involvement. By being passive, the HC waits for the inhabitants to make a suggestion and therefor receiving the trust of making the change. If there is an ambition to be more sustainable in the near future, this is not a suitable way of making this happen. Neither is the selling of the rental apartments. Arguably this gives the housing corporation a more sustainable portfolio, but for the wrong reasons. By selling low quality households, they increase their average portfolio label. The best would be to take the investments and make the sustainable upgrade elsewhere in the portfolio. However, this still leaves the market with a low-quality housing object. Thus this would only shift the problem to a different owner (Nul20, 2009; MBA, 2010).

4.3 Conclusions regarding literature

In this chapter the different aspects that influence the choice of a housing corporation were sought. Based on the literature, the following research questions can be answered.

Sub question 1:

What external factors influence the possible actions for energy upgrading in mixed ownership housing stock?

Part 1:

How do policies (national, provincial, local) influence the action chosen?

What was observed is that the housing corporation is tightly regulated by both the European and national governments. The European party fears unfair competition if the housing corporations get too much support from the national government. This made that there came rule on when national support was to be given. It is only possible now to give support when the money is used for the social class of the portfolio. Also, the social class part of the portfolio should contain 90% of the complete portfolio.

On a national level, there is the set rule to achieve a more sustainable portfolio. This can be done with the financial support of the government, but only if the new rent is not higher than the social rent limit.

Part 2:

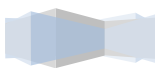
How is future supply and demand influencing the action chosen?

Most of the housing corporations have a rather outdated portfolio of houses. These houses and apartments will be the topic of debate in the near future. Tenant demands are shifting, similar to the fact that private owners' demands also change over-time. So these older apartments in the portfolio will be soon in the category of demolishment, since it cannot keep up the required demands of the present day. Housing corporations know this fact and look for ways to either sell the apartments or do minimal changes to keep the apartments rentable.

Sub question 2:

What internal factors influence the possible actions for energy upgrading in mixed ownership housing stock?

Internally, the housing corporation has a few factors that also play a role on their choice. The housing corporation is responsible to supply proper housing for the social class, which also means that they have to keep their portfolio up-to-date. However, the process of housing corporations and upgrading houses is still very limited. Housing corporations focus on the known facts and techniques that also worked in the past. This makes that the housing corporations are rather controversial, which also translates through into some



other factors; like preference for smaller projects and the selling process. Housing corporations tend to work on smaller projects first. In these situations they face lower numbers in terms of inhabitants, which places the housing corporation in a better position for negotiations. Lastly, was the fact housing corporation has chosen to sell a lot of their portfolio in the near future. The reasoning behind this is simple, but effective for the housing corporation. By selling the households, the households is removed from the portfolio and no further investments have to be done as the housing corporation (see also figure 7). This figure represents the different factors that play a role towards the problem that is addressed in this research. There is no sustainable upgrade in the mixed ownership complexes and presented are seven main causes that play a role in the decision not to make a sustainable upgrade.

Sub question 3:

What is the list of possible actions; given the external and internal factors?

Part 1:

What are the advantages and disadvantages of the different actions?

In this research there are three main actions that will be used: keep the situation as it is, sell the remaining households and buy the apartments back. If is chosen to keep the situation as it is, the process can be rather quick and plans can be made to make an upgrade in the complex. This situation offers the housing corporation to gain knowledge of a different field of possible interest (field of private owners). Also the investment costs and risks are shared with the private owners. This is because the private owners are partly owning the complex, and there for are not part of the responsibility of the housing corporation.

If is chosen to sell the remaining apartments, the housing corporation keeps the current strategy they have with most of these complexes. The main goal would then be generate financial means to keep the continuity of the housing corporation safe. A different option would be to invest the sales revenue in a different complex that is suitable for upgrade.

Finally there is the option of buying back the apartments. This is the most risky and costly option, which is most likely only applied in a very rare situation. But it does have the advantage that the housing corporation has no other owners left and can work in their field of knowledge (tenants). However, they have to buy out the private owners. This can prove to be tricky since the private owners cannot be forced in any way, since there no obligations between private owners and the housing corporation.

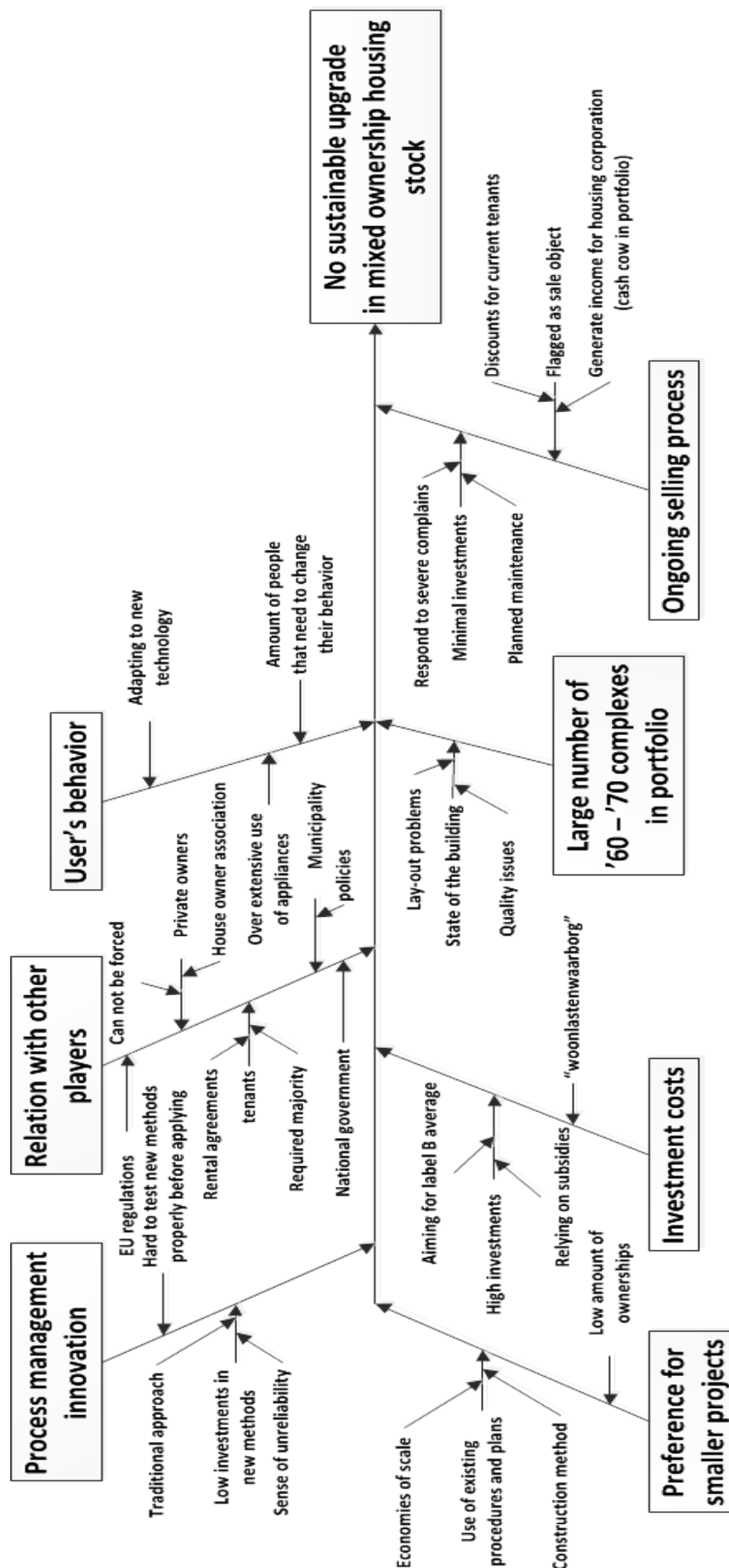
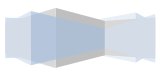


Figure 7: relations of all the different causes (Aedes, 2013; Turcu, 2012; Palma, I.C., Mengual, E.S., Solà, J.O., Montero, J.I., Caballero, C.P., Reiradevall, J., 2013; Vassileva, L., Wallin, F., Dahlquist, E., 2012; Kaygusuz, A., Keles, C., Alagoz, B.B., Karabiber, A., 2013; Mondol, J.D., Koumpetso, N., 2013; Osmani, M., O'Reilly, A., 2009; Hester, N., Li, K., Schramski, J.R., Crittenden, J., 2012)



5 METHODOLOGY

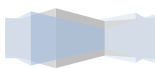
To further look into the decision making problem for housing corporations, two different methods will be applied. In the first method decision tables (DT) will be created. The decision table will consist of several parts like: preconditions, conditions, sub-conditions, actions and rules. By applying the different parts of the decision table, every possible situation is captured into the decision table. Based on the decision table, the housing corporation can provide the conditions and a proposed action will be given. To supplement the decision tables, a system dynamics (SD) model will be made. The SD model will be used to estimate a required condition of the DT. This way a better insight is created towards the inhabitants when their situation changes.

5.1 Decision tables

Decision tables are used to structure complex decisions that are made in the decision-making process (Arentze, F. and Borghers, A., 2003; Witlox, 1998). By following the decision table, the decision maker can translate the premise (or conditions) into a conclusion on what to do (or an action). By applying all the conditions in a decision table, a compact overview of the situation is created to better comprehend the choice problem that is presented. Since the actions are directly linked to the clearly represented conditions, the DT is a rather consistent and correct method to make a decision (Arentze, F. and Borghers, A., 2003; Arentze, 2003). This makes that the method is very suitable for making complex decisions.

Before making a DT, there should be certain criteria that have to be true for the DT to perform properly. These criteria are called preconditions. The preconditions mark the field in which the choice will be made and makes sure that the DT is suitable for only those kinds of situations that occur under the entire defined precondition (Witlox, 1998). The DT itself consists out of four main quadrants: conditions (C_i), condition alternatives (CD_i), actions (A_j) and action entries (AD_j). The conditions are certain attributes that are relevant to the choice that is being made (C_i where i is the number of the condition). This can be all kinds of factors that are present the DT with inputs, premises or causes. These conditions are translated towards the different alternatives the condition can take (CD_i). The CD_i can take an infinite amount of options, with a minimum of two options. By going from the top condition, down to the lower conditions, a single line will emerge which contains the best action to take. If a condition has no effect on the actions, mainly because previous conditions make the condition obsolete, a “_” will be used. This signals that the condition is irrelevant towards the action (Arentze, F. and Borghers, A., 2003; Batchelder, 1991).

The actions (A_j) of the DT are a succession of the conditions and how these conditions present them in the current situation. Based on the conditions, the actions provide the best possible conclusions and consequences. The actions translate towards action entries (AD_j).



The action entries are based on the conditions and have in general three different action states. A “X” is used when an action should be used, a “-” when the action should not be taken and a “.” is used when the action state is undefined (Arentze, F. and Borgers, A., 2003). These general used symbols are not mandatory for a DT and will not always be applied. In these cases the symbol is interchanged with a word that explains the action. In general, the actions, like conditions are infinite, but adding a substantial amount makes for a complex DT. To prevent this from happening, action- or condition-subtables are used (Arentze, F. and Borgers, A., 2003).

To make the DT complete an additional part is added, called the rule. The rule states which conditions are needed for an action to occur (Witlox, 1998). In other words, each action has its own rule. Based on the rules, the different conditions lead to a specific action. The combination of these will give the pay-off of the choice (Qian, Y, Liang, J., Dang, C.).

When applying this to the research, the main decision table can be formed. As mentioned the DT consists of different aspects like the conditions, actions and rules. The different aspects of the decision table will be elaborated further in the following paragraphs.

Table 3: decision table for the housing corporation

C1. Ownership condition	Positive								Negative				
C2. Portfolio transformation	Need					No Need			Need				No Need
C3. Investment costs	Low		Med		High	Low	Med	High	Low	Med	High	—	
C4. Process time	S	L	S	L	—	—	—	—	—	S	L	—	—
A1. Portfolio action	K	K	K	K	K	K	K	S	B	B	S	S	S
A2. Inform inhabitants	X	X	X	X				X	X	X	X	X	X
A3. Offer removal expenses									X	X			
A4. Look for better techniques	X	X	X										
A5. Buyer identification						X	X	X	X	X	X	X	X
A6. Partnership with other HC		X	X	X									
A7. Look for other projects					X	X	X	X			X	X	X
A8. Sustainable upgrade	X	X	X	X					X	X			
	01	02	03	04	05	06	07	08	09	10	11	12	13

5.1.1 Preconditions for the decision table

As explained before, are the preconditions the area where the DT makes choice possible. In the area of mixed ownership redevelopment, this is no difference. Most of the time the preconditions are formed after the DT is made, but for understanding the table, the preconditions are crucial to be discussed first.

Based on the found literature, there are a few preconditions that can be applied towards the decision table. To properly make a valid decision, there will be assumed that there are no weird changes in the proceedings of how the housing corporation and the inhabitants act before and after the sustainable upgrade. They will thrive for a mutual goal to reach a more sustainable building which will benefit all the players (housing corporation and inhabitants alike) (see also table 4).

Table 4: list of preconditions (Based on literature)

Precondition	Description
User's Behavior	The way users use their appliances in their household will not change after the sustainable upgrade. They will act with their best intentions to keep the projected results.
Upgrade process	The housing corporation, in principle, will apply the sustainable upgrades as how they have done previously in other projects.
Regulations	The aim is to contribute towards the regulations that state housing corporations should become more sustainable in the future.
Sustainable plan	The complex that is targeted with the DT is aimed to be sustainable upgraded by using the DT.

Based on these preconditions, the DT will work. If there are changes in the preconditions in relation to the real-world developments, the DT could prove to be unreliable (Arentze, 2003).

5.1.2 Conditions and sub-conditions

The DT will function by using the different conditions to make a choice. In this DT there will be a total of four conditions. The different conditions are: ownership condition, portfolio position, investment costs and process time. The ownership condition checks the relation with the inhabitants. This means that whether-or-not the inhabitants agree or disagree with the proposed plans. It is legally required that the votes pass to make the change. The portfolio position determines if there is a real need to make a change in the complex. Based on previous sales and the amount of mixed complexes in the portfolio will be determined if there is an actual need to intervene. As a third condition there is the investment costs. The investment costs are based on what the change will be and how much it will costs to achieve this. Lastly the process time is the time it takes to complete the entire project. This



means from the start, where the first decision is made up until the moment that the project is completely done. The process time is more than just the moment there is decided to make an upgrade, the whole process is also included.

These four conditions will have sub-conditions that make the condition comprehensible. Since the conditions are in rather vague terms that offer room for discussion on what it should mean, the sub-conditions are in place. These conditions are more concrete and therefore offer a more explicit view on what the conditions mean (Kahavi, 1995; Witlox, 1998; Qian, Y., Liang, J., Wang, F., Ma, N., 2010; Batchelder, 1991) (see also table 5).

Table 5: conditions and their description (based on previous literature)

Condition:	Condition alternatives:	Description:
Ownership condition	Positive / Negative / Very negative	If the population of the complex is positive towards a sustainable upgrade, based on sub-conditions
Portfolio position	No need / Need	How the portfolio is effected by the mixed ownership complex, based on sub-conditions
Investment costs	High / Medium / Low	The total costs and return on investment, based on sub-conditions
Process time	Very long / Long / Short	The time the total project will take, based on sub-conditions

Sub-condition: ownership condition

Because there are tenants and private owners in the complex, the ownership situation changes for the HC. Meaning there are more steps before a sustainable upgrade actually can take place. In a normal situation, there would be a voting amongst the tenants. This voting takes place when substantial changes are proposed that have an impact on the building and its inhabitants. In this context, a sustainable upgrade would be regarded as a substantial change. For the tenants, 70% has to agree with the proposed changes (Quirijns, 2011; Rijn, 2011). Now there are also private owners that have to agree. They own a part of the building, thus they have an invoice towards any proposed changes. After the tenants have voted to agree, the HC can vote for them in the HoA meeting. In this meeting the HC takes the vote amount of all the tenants together (meaning that if there are 50% rental households, the HC has a combined vote weighing for 50% of the total votes, the other 50% belongs to the individual private owners). In this part of the voting, 65% of the combined votes have to agree (VvE beheer, 2013). After both votes have passed, the HC is free to make the proposed changes (table 6). The situations will be divided into three main groups, as stated in Table 5. If the situation is “very negative”, there will be assumed that the

inhabitants offer so much resistance towards the proposed plans, that it is not feasible to continue. There for, the “very negative” ownership condition is left out the decision table.

Table 6: sub-table for the sub-conditions of the ownership condition (VVE-site, 2013; VVE-belang, 2013; VvE beheer, 2013)

Sub-table for ownership condition				
C. Tenants	< 70%		≥ 70%	
C. Private owners	< 65%	≥ 65%	< 65%	≥ 65%
C1. Ownership condition	Very negative	Negative	Negative	Positive
	1	2	3	4

Sub-condition: portfolio transformation

The second sub-table checks the portfolio of the housing corporation. It is checked on two different aspects: the amount of mixed ownership complexes in the total portfolio and the recent sales in the complex. The portfolio position is at its best when there are no recent sales in the complex. This means there have not been changes in the setup of the inhabitants and therefor it is more likely that the complex is not in demand by the public. For the amount of mixed ownership complexes in the total portfolio more is better. This means that these complexes need to be dealt with by the HC to reach the set sustainable goals. If there is only a very small amount of mixed ownership complexes, there is less reason to look into these complexes and they probably will be neglected (table 7).

Table 7: sub-table for the sub-conditions of the portfolio position (EKTIV, 2013)

Sub-table for portfolio transformation						
C. Amount of mixed ownership complexes	< 20%			≥ 20%		
C. Recent sales in the complex	< 6 months	[6 and 12 months]	> 12 months	< 6 months	[6 and 12 months]	> 12 months
C2. Portfolio transformation	No need	No need	Need	No need	Need	Need
	1	2	3	4	5	6

Sub-condition: investment costs

The third sub-table is developed for the investment costs. For a housing corporation, the costs of a project are important. This determines if they are prepared to actually undertake the project. It represents itself as a weighing of different factors that increase and decrease the continuity of the organization. In this perspective, three sub-conditions are taken. First is the size of the project. This determines if there should be a substantial investment or a more controlled investment (since housing corporations favor smaller projects). The second sub-condition is targeting at the actual investment. Here an average price for sustainable upgrading is used and then the project is compared to the average price. Higher prices mean higher risks and not necessarily to better results. Finally there is the label level what will be achieved. Based on the label there can be said if the upgrade is purely making an energy savings upgrade (label B or lower) or also an energy producing upgrade (label A or higher).



Because of better results in the label, and thus applying more techniques, this can push the experienced investment costs down in a lower category. For example, if there is a small amount of households that requires a large investment and then gets label A or better, the pay-off for the housing corporation will become better (in terms of lettability and rent) since the households offer more desired quality (table 8).

Table 8: sub-table for the sub-conditions of the investment costs (SEV, Samen onder een dak - VvE's renoveren duurzaam, 2012; Den Bosch, 2012)

Sub-table for investment costs								
C. Amount of households	≤ 50				> 50			
C. Investments per apartment	≤ €20.000		> €20.000		≤ €20.000		> €20.000	
C. New energy label	Label B or lower	Label A or higher	Label B or lower	Label A or higher	Label B or lower	Label A or higher	Label B or lower	Label A or higher
C3. Investment costs	Low	Low	High	Med	Med	Low	High	High
	1	2	3	4	5	6	7	8

Sub-condition: process time

The process time is determined by different time factors that are in place when a project is starting. First there is the preparation time (process time) and then there is the actual project (instalment time). These times can vary quite a bit, but in general, these times should be as short as possible, while still maintaining quality. For the process time the ranges are a bit wider. There is still nothing concrete done to the complex. But in most cases the process time is below two years (or 24 months). The actual renovation time is more pressing and aims to be done in three months. The longer and more complicated upgrades are mostly planned over a single year, but here the winter is excluded; thus making nine months. If the process time is expressed as “very long”, the project is considered not to be feasible and is left out of the decision table (table 9).

Table 9: sub-table for the sub-conditions of the process time

Sub-table for process time							
C. Preparation time (process)	≤ 12 months			(12 and 24 months)			≥ 24 months
C. Renovation time (instalment)	< 3 months	[3 and 9 months]	> 9 months	< 3 months	[3 and 9 months]	> 9 months	–
C4. Process time	Short	Short	Long	Short	Long	Long	Very long
	1	2	3	4	5	6	7

5.1.3 Actions

With the use of the determined pre-conditions and conditions, the different actions can be determined for every combination of these conditions. In total there are 13 possible outcomes from the conditions. Each of these requires an action with it. In total there are 8 actions defined (6 sub-actions and 2 main-actions). First there is the action of the portfolio. This is the choice between the three different actions found in literature: keep the situation, sell the households or buy back the households. Based on this action, there are some additional actions that can take place. In most cases the inhabitants will be informed about the change. Since the housing corporation needs the agreement of the inhabitants it is relevant to keep the inhabitants informed. Additionally there are some smaller actions that are important for the housing corporation. When is decided to buy back the apartments, the housing corporation has to offer removal expenses to the private owners. This can be used to persuade private owners to leave. Either way there should be investigated who the buyer is. Knowledge is key to success in these situations and knowing a lot about the tenants is common for the housing corporation. However knowing a lot about the private owners is far less common.

In some situations it can happen that the situation allows for looking into better techniques. This is a rare action, since housing corporations generally do not want to take the risk. To compensate this, the housing corporation can always look for a partnership with other housing corporation(s). This way the risks can be divided more and the housing corporations can learn from each other.

In the end the most important action is taken. This is the choice if the complex is actually part of the sustainable upgrade plans or not. Each different column has the final action of either look for other projects or to make the sustainable upgrade (table 10).

If the complex is not suitable there will be advised to look for other projects that are better suitable. These complexes can still be flagged to keep the situation as it is. This is then to revise the situation in the future, since there are ample opportunities that could make the complex suitable.

Based on these actions, the different situations that occur from the conditions are handled. To define the different actions, the perspective of a housing corporation's board is taken. From their point-of-view they should decide which complexes are suitable under which conditions.



Table 10: different actions of the DT (MBA, 2010; Quirijns, 2011; Rijn, 2011)

Actions:	Description:
Portfolio action	The main actions that can be taken; keep situation, sell households or (re)acquire households
Inform inhabitants	Provide information and feedback to the inhabitants; happens in almost every situation
Offer removal expenses	Provide a financial compensation for either tenants and / or private owners when they have to move
Look for better techniques for sustainable upgrade	New techniques enter the market regularly, these can prove to be better than the currently offered techniques
Buyer identification	Look for general information about the (recent) buyers of the complex; what are their wishes and demands?
Partnership with other HC	Other HC can provide information and support when there is a situation that is unfamiliar with the HC itself
Look for other projects	If a complex is not suitable, there should be looked for a different part of the portfolio to make sustainable
Sustainable upgrade	Performing the proposed sustainable upgrade

5.1.4 Rule map

To combine the DT, the different conditions and actions have to be linked together. This is defined by the rules of the DT. Rules can be defined in various ways. The mostly used method is either defining each rule independently (so each unique set of conditions is formatted in a different rule) or each action is translated back into the situations it can occur (Bazan, 2000). Either method of making the rules is good, but for this research the second option was used. What basically happens is that each different combination of conditions is linked to the different actions. This means that the housing corporation provides the conditions, and based on that the path is determined. This path is defined as the straight line below the final condition. To do make the different rules, a perspective of the decision board of a housing corporation is applied. This is in combination with the previous assumed situation where the housing corporation wants to achieve the goal of reaching average label B in 2020. The rule map of the decision table can be found in appendix 3.

5.1.5 Pay-offs

The pay-offs depend on which of the different set of conditions is present and how there will be responded towards these conditions. Based on the previous mentioned actions the pay-offs are determined. There will be a first distinction between the different situation that prove to have a viable pay-off and the situations where the complex offers no pay-off in terms of sustainable upgrading (knowing this is also a form of pay-off for the HC).

The main goal of the DT would be to determine the suitability of the complex. If it is not suitable, there is no reason to try and make the sustainable upgrade in the first place. However, if it is suitable, there are positive pay-offs that can arise. The most important one, for housing corporations, would be the increasing possibilities of renting or selling the households after the upgrade. This way they can recoup the investment, but more importantly they have less vacancy. Indirectly, this will improve their portfolio to become more sustainable. In this situation there can be said that housing corporations will not make sustainable improvements for the sake of being sustainable. They treat this as a side-effect while increasing their marketability of their portfolio.

Some additional pay-offs that can be interesting are also considered, based on the chosen conditions and actions. Especially when working with the group of private owners, an extra field of interest is touched by the project. This way the HC can accumulate the thinking of the private owners and use this to generate a field of knowledge on how to work with these people in the future. Also by applying a more sustainable approach, the image of the HC will improve. This provides marketing possibilities towards people that want to save on their electrical bills (see also figure 8 and appendix 4).

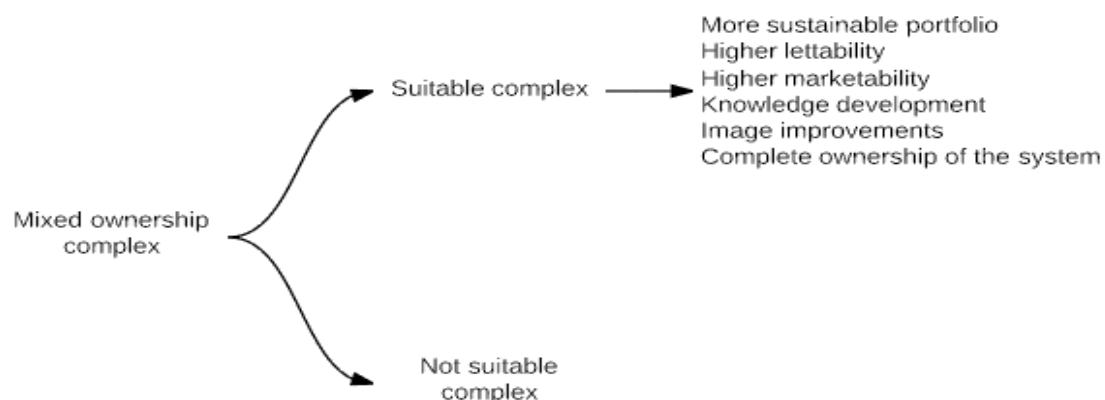


Figure 8: general overview of the pay-offs (MBA, 2010)

5.1.6 Validation

DT's have a twofold way of checking if they are complete. This is often referred to as exhaustiveness and exclusiveness (Arentze, F. and Borgers, A., 2003). Exhaustiveness is easy to test and states that every condition should stretch a field of $-\infty$ to ∞ . In other words, every possible situation should be able to be handled by the conditions. Exclusiveness means that each different combination of conditions is unique and is implemented in the DT by using rules and actions. When checking the decision table, these rules hold true.



5.2 System dynamics

In contrast to decision tables, the system dynamics approach is a more dynamic system. System dynamics is used to understand behaviour of complex systems over a specified period of time. General models consist of feedback loops and delays that influence the way the system is working. System Dynamics is mostly applied in the field of social sciences like companies, societies, families, cities and organisations. In this field the model makes social-society or social-economic phenomena visible.

There are three main parts of a system dynamics model: the causal loop diagram (CLD), the stock and flow model (SFM) and the equations that are used in the SFM. The CLD is a stand-alone model that merely displays the relations between the most important parts of the model. Less important relations and parts of the model are not displayed in a CLD. The CLD is then used to develop the SFM and its belonging relations. All these relations are then defined by using equations and feedback systems.

5.2.1 Causal loop diagram

In this CLD are a few loops that make for the model boundaries and architecture. The point of the CLD is to provide a form of feedback to the domain. They are nothing more than maps that show links between causes and effects. Relations between the causes and effects can either be positive or negative (Sterman, 2000). CLD's are marked by the use of feedback circles. In the figure are three feedback circles, which can be either balancing (keep the situation stable), or reinforcing (increasing or decreasing the situation).

The CLD diagram represents different relevant choices and outcomes after the upgrade. The housing corporation will initialize a technical improvement and estimate what this will do in terms of changes in the rent. If there is a change in the rent the tenants have to cast their vote. When the tenants decide to vote against the plans the housing corporation cannot continue. On the other hand are the private owners that will see if the upgrade actually is an improvement to their own situation. Owners will have to pay themselves and set this against the fact if the results are worth the investment. These different loops will be modelled in the SFM (see also figure 9).

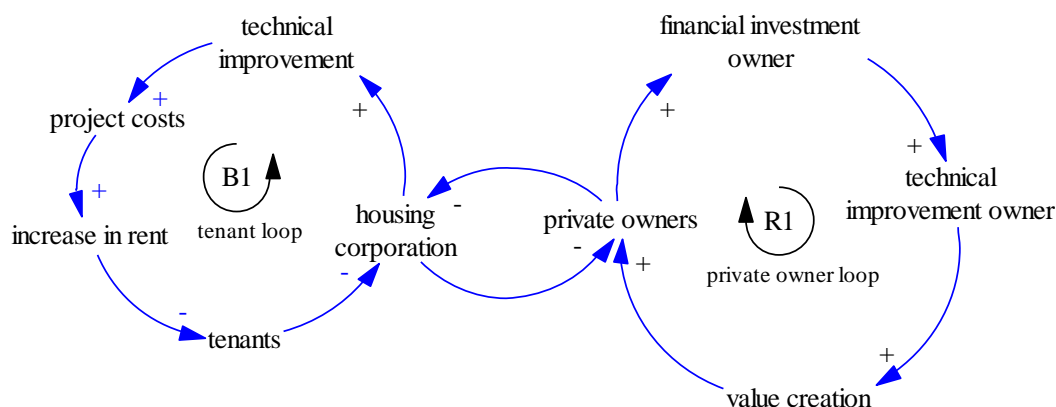


Figure 9: Causal loop diagram

5.2.2 Modifying the variables

In an ideal situation the variables of the previous model would be used in this model also. However, there are certain variables that offer no value to the inhabitants or they interpret them differently. There for, the variables as they are now are useless to use when trying to generate the pay-offs of the inhabitants.

To change this, the variables are interpreted to a level of the inhabitants. When looking at the tenants, there is very little interest in the time aspect of the project as a whole. The only question they will ask themselves is: how long am I bothered by the building crew making the upgrade? The process time is mostly irrelevant, since the tenants are not directly involved in the making of the plans (unless the housing corporation decides otherwise). In terms of investment costs, the tenants again are rather biased. They do not invest, they pay rent and the housing corporation is responsible for making the investment for the upgrade. The tenants will compare the rent change and the savings they get on the rent. The reason behind this is that the tenants believe that the housing corporation already is profiting since the upgrade increases the market value. Lastly, the energy label is just an aim for the housing corporation in the year 2020. Tenants will translate this label to an increase in comfort (see also table 11).

Table 11: interpret of the tenants

Housing corporation	Tenant
Time	→ Will only be bothered by the instalment, will not take much part in the negotiations (mostly stays informed)
Investment costs	→ They do not invest; they are biased about the investment. They only care about their rent change and the difference between the total energy savings and the amount their rent increases due to the upgrade
Energy label	→ They care about comfort, not an energy label

Similar to the tenants, the private owners will also interpret the different conditions. The time of the upgrade greatly depends on the private owner themselves. Some owners will be more interested and will be bothered with a quick process and instalment, while others take a more passive attitude and will be less bothered by the process time and take a similar view as the tenants towards the problem. The housing corporation looks into the investment costs, the private owners look further than just the investment. The investment is only a part of the complete financing track. Owners will evaluate the investment based on the outcome of the system in terms of energy savings per month and the time it takes to recoup the total investment. The energy label is, by owners, linked to the value of the apartment. If the energy label is increased, this will result in the fact that the apartment increases in market value. So if the owner decides to move, they can sell their apartment for more and the chance to sell it bigger (see also table 12).



Table 12: interpret of the private owners

Housing corporation	Private owner
Time	→ Is not professionally occupied with the upgrade, some owners will be more involved than others
Investment costs	→ Major part for upgrading or not, but only in relation with the savings the system generates
Energy label	→ A higher label would mean a higher market value

Other variables like the *amount of mixed ownership in the portfolio* and *recent sales* are irrelevant to the inhabitants and will not be modelled.

5.2.3 Stock and flow model

The SFM will consist of different parts, called sub-models. These sub-models will tackle different parts of the problem and combined will lead towards input values for the decision table. In total there are two sub-models present. These are: estimated tenant agreement and the estimated private owner agreement.

To make a proper estimation of the agreeing tenants and private owners, there is a formula used called the utility function. This function describes the relation between different variables and how people experience this variable as an important feature of a choice. For the two inhabitant groups the formula can be formulated as:

$$\hat{U}_{tenant} = \beta_{label}X_{label}\alpha_{label} + \beta_{inv}X_{inv}\alpha_{inv} + \beta_{time}X_{time}\alpha_{time} + \varepsilon$$

Where:

\hat{U}_{tenant} = The estimated utility

β = The importance value of the single variable

X = The condition of the variable

α = normalisation factor

ε = The error term

The same function can be designed for the owners, this because they have different values to the different conditions of the variables. To add this utility function in system dynamics the IF THEN ELSE function will be used. However, the utility needs to be translated into a probability first. To do this, the standard formula for the probability is used:

$$p = \frac{\exp U}{\sum \exp U}$$

If we want to fill in all the different values of the β for the utility, there would be a need for nine β 's for both the tenants and private owners. Unfortunately, there is no research that supports all these β -values in a single research. Therefore the different β 's will be transformed from a single β . In total two β -values, from different researches will be used to estimate the other β -values. To transform the β to the other values, the importance rating table will be used (Menassa, C.C., Baer, B., 2013), this table includes all the different normalisation factors or α 's. By applying the different weights, the amount of required β 's is reduced to three. Namely one for when the condition statement is true, one for when it is false and a third for the third level of the instalment delay (since it is described as less than three months, between three and nine months and more than nine months). However, this division is based on the factors of the housing corporation. Inhabitants have a main interest in the fact that the upgrade is done as soon as possible. Therefore the only distinction made will be between less than three months and more than three months (SSW, 2013; IntermarisHoeksteen, 2013).

Menassa and Baer (2013) defined the weight between different factors of tenants and owners and the relation between the two groups. For this research only five of these variables will be used. These five factors are:

1. avoid of opposition
2. regulatory requirements
3. project capital costs
4. comfort (only for tenants)
5. property value (only for owners)

The process time can be caught in the variable of *avoid of opposition* (Tenant-value: 2.8 and Owner-value: 2.0). Since there are agreements on when the project should be done, the *regulatory requirements* (Tenant-value: 3.7 and Owner-value: 4.2) will be used for the instalment time. The investment costs will be caught in the factor of *project capital costs* (Tenant-value: 2.7 and Owner-value: 4.2). Lastly, the energy label will be taken from two different values. This is done because the tenants and owners both have a different interpretation of the effects of the energy label. The tenants will check for the *comfort* (Tenant-value: 4.0), while the owners will check the increase in the *property value* (Owner-value: 2.3). The complete overview with the weights of tenants and owners can be found in appendix 5.

The reason that only five factors are used is because of consistency between the two different models. If additional variables would be added, the housing corporation would need to find more data and that is not the goal of this model. The goal is to estimate the ownership condition based on the same variables as in the decision table.



In the system dynamics model this will translate to four IF THEN ELSE equations; one for every condition out of the decision table that is relevant for the inhabitants (process time, instalment time, investment costs and energy label). This function will look like:

IF THEN ELSE (X_1, p_{1a}, p_{1b})

Where:

X_1 = The condition statement

p_{1a} = The probability when the condition is true

p_{1b} = The probability when the condition is false

Tenant agreement sub-model

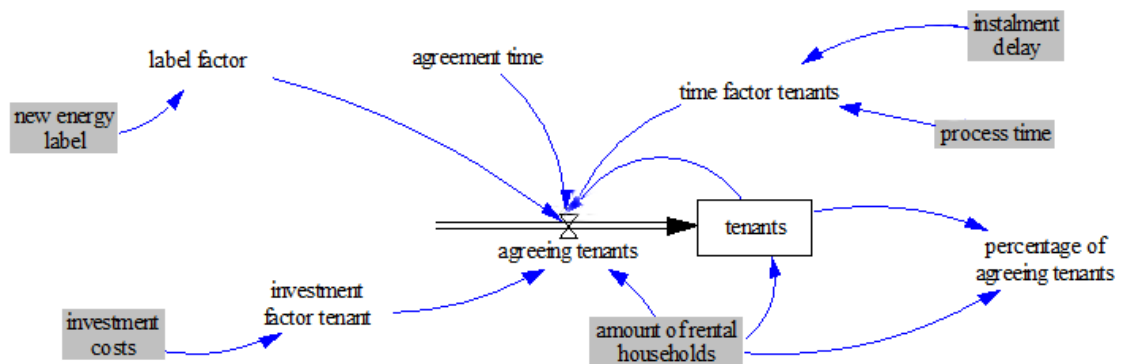


Figure 10: tenant agreement model

Figure 10 shows the system dynamics model of the tenant agreement. The sub-model is represented by a single stock and a single inflow. The stock accumulates the amount of tenants that agree over a period of time. The stock is modelled in such a way that it can never exceed the maximum amount of rental households. The stock is regulated by the inflow, which in turn is relying on the different *IF THEN ELSE* functions in the conditions. These conditions (label factor, investment factor and time factor) all generate a part of the inflow of the flow. These conditions will see if the estimated value is higher or lower than the ranges used in the decision table. Based on this, the different factors will contribute a growth value into the flow and the acceptance of tenants will grow over-time. Together these *IF THEN ELSE* functions represent the probability of the function, over a given time frame. All the tenants that accepted the plans are removed from the flow. This way they cannot vote twice and influence the stock by being counted double.

In the end the goal is to see when this sub-model reaches the 70% agreement boundary, which is set by regulations as the minimum amount of accepting tenants to continue.

The way the model acts will represent a form of policy check, instead of a process check. This is because a process check would mean that all the different moments that the people are together would form a higher platform of mutual agreement. This would be near impossible to model and there for the policy is modelled instead. To model this, the previously mentioned β and weights will be applied. With the use of a β from literature, the other β values are determined. In table 13 are the different values of the alphas and betas of the tenants.

To achieve the different values, the standard β value was used from the research of Reuvekamp (2013) and Islam (2014). Since the housing corporations are a relatively Dutch subject and mixed ownership is hardly researched in terms of the different variables that play a role in the sustainability process, there is no single research that can provide both the needed β values. There for the only option is to use two researches and combine and modify them with the use of the table of Menassa and Baer (2013).

Table 13: alpha and beta values of the different variables for tenants (Islam, 2014; Menassa, C.C., Baer, B., 2013; Reuvekamp, 2013)

Variable	X	α	$\beta 1$ (if X is true)	α	$\beta 2$ (if X is false)
Energy label*	≥ 7	4.0	0.444	4.0	0.140
Investment costs	$\leq \text{€}20.000$	2.7	0.300	2.7	0.095
Instalment delay	≤ 3 months	3.7	0.411	3.7	0.130
Process time	≤ 12 months	2.8	0.311	2.8	0.098

*energy label is expressed in a number: G = 1, F = 2, E = 3, D = 4, C = 5, B = 6, A = 7, A+ = 8, A++ = 9, but the check is made between label B and lower and A and higher. This because label A and higher includes sustainable energy production.

Since the different β values are static numbers, they do not perform properly under dynamic conditions. Therefor the different β values need to be changed to accommodate this. To do this, the probability will be estimated by using: $p = \exp U / (\sum \exp U)$.

Table 14: probability of acceptance for tenants

Variable	X	P (if X is true)	P (if X is false)
Energy label*	≥ 7	0.038	0.028
Investment costs	$\leq \text{€}20.000$	0.033	0.027
Instalment delay	≤ 3 months	0.037	0.028
Process time	≤ 12 months	0.033	0.027



Private owner agreement sub-model

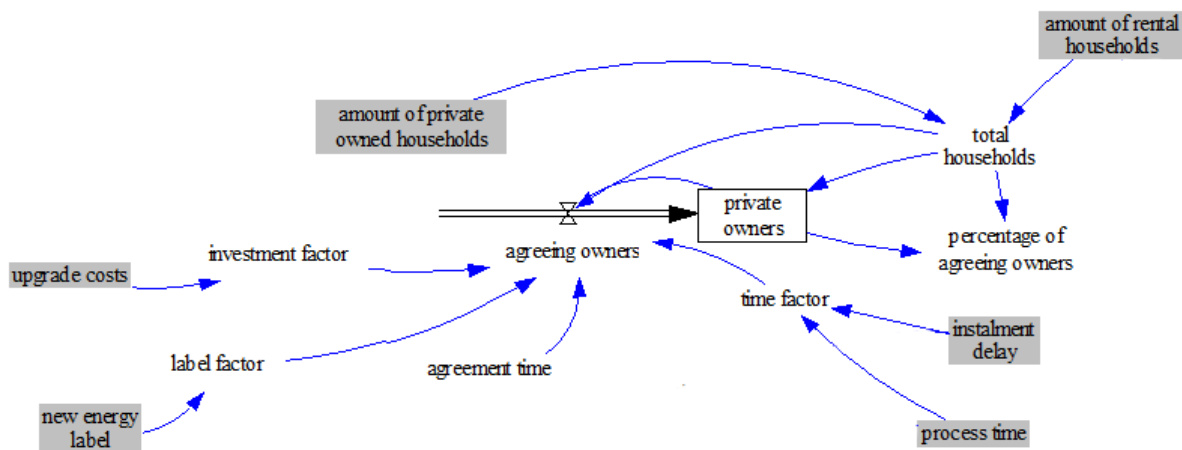


Figure 11: private owner agreement model

For the owners a similar sub-model is developed (figure 11). Here also a single stock and a single flow are used to estimate the amount of owners that will agree on the proposed ideas. In this case the goal is not to reach the 70% threshold, but a lower threshold of 65% agreeing owners. In this model, the housing corporation represents a voice equal to the amount of tenants that live in the complex. In other words, there is already an amount of owners agreeing based on the number of tenants. Since the tenants vote first before housing corporation can express its voice in the house owner meeting. If the tenants do not agree (in a reasonable time) the stock of the owners will start empty, but this can only happen if the housing corporation has less than 35% ownership. Else the required 65% cannot be reached anyway.

Besides the change in the way the voting starts, the owner model estimates the agreement in a similar way as the tenant model. Here also there are three factors that influence the choice of the owners (label factor, investment factor and time factor). These factors again will contribute a part of the acceptance, based on the input provided. Together the different conditions will provide the owner's utility of the proposed plans. Again, the output of the model can be reflected against the time it needs to achieve the required threshold of agreeing people (65%). To get the complete picture, the time it takes to get enough tenants and the time it takes to get enough owners should be counted together. This is because the tenants have to vote before the housing corporation can cast his vote in the house owner meeting. The difference is that the owners have different preferences and therefor also need to be treated as a different group in the system. In the system the same input will be used as in the other system, since the tenants and owners vote about the same project.

This sub-model will also check the policy instead of the process. In essence there will be goal seeking behaviour towards the total number of households in the complex. Since every agreeing owner is removed, the remaining group becomes smaller and the flow of agreeing

people will diminish. To estimate the acceptance of the private owners, the similar setup will be used as with the private owners. Some β -values will be extracted from literature and then be modified to supplement the other conditions in the model. Table 15 shows the values of the betas of the private owners. Based on the preferences of the owners the betas are somewhat different from the tenants (all formulas of the complete SD model can be found in appendix 6).

The second sub-model will also work with its own set of provided β values. These are also generated from the diagram of Menassa and Baer (2013). Similar to the tenant β values, the owner values are diminished by the fact that the β values will influence the policy over a time period instead of a static decision moment.

Table 15: alpha and beta values of the different variables for owners (Islam, 2014; Menassa, C.C., Baer, B., 2013)

Variable	X	α	$\beta 1$ (if X is true)	α	$\beta 2$ (if X is false)
Energy label*	≥ 7	2.3	0.256	2.3	0.080
Investment costs	$\leq \text{€}20.000$	4.2	0.467	4.2	0.146
Instalment delay	≤ 3 months	4.2	0.467	4.2	0.146
Process time	≤ 12 months	2.0	0.222	2.0	0.070

*energy label is expressed in a number: G = 1, F = 2, E = 3, D = 4, C = 5, B = 6, A = 7, A+ = 8, A++ = 9, but the check is made between label B and lower and A and higher. This because label A and higher includes sustainable energy production.

Similar to the tenants, the owners will also have a probability generated from the different utilities. Again, the formula for the probability will be used: $p = \exp U / (\sum \exp U)$.

Table 16: probability of acceptance for owners

Variable	X	P (if X is true)	P (if X is false)
Energy label*	≥ 7	0.032	0.027
Investment costs	$\leq \text{€}20.000$	0.039	0.028
Instalment delay	≤ 3 months	0.039	0.028
Process time	≤ 12 months	0.028	0.026

5.2.4 Validation options

The system dynamics model is not a stand-alone model. It works to feed information that is estimated based on the input, so the inhabitants can make a better choice. In this relationship it is tricky to validate the workings of the model. It could either be validated by



using expert feedback or by applying cases to see if the model predicts outcomes that are in line with the information that is provided.

In this research the second way of validation is chosen. This form of validation is more practical and direct related towards the problem. There will be checked if the model generates similar results as what is observed in the case study. If this is the case, then there can be said that the models perform under the practical circumstances.

5.3 Conclusions regarding methodology

With the different models the second part of the third research question can be answered.

Sub question 3:

What is the list of possible actions; given the external and internal factors?

Part 2:

How can the different actions be measured?

By applying a decision table, the actions can be placed into a specific characteristic. By looking at the internal and external factors, which are placed in the conditions of the table there can be determined which action is suitable. The actions themselves are not directly measured but are related to the set of conditions that are presented in the decision table. This also relieves the housing corporation, since there is no need for exact numbers in terms of input for the conditions. The conditions are measured in terms of different levels that affect the choice.



6 CASE STUDY AND RESULTS

To test the different models that were established in the previous chapter, two case studies will be used. These case studies will be highlighted in this chapter, which will result in the results of the research in terms of what the different models generate as an advice. This advice will then be aimed at the particular project.

6.1 Case study

The different cases will be addressed in this part of the research. In total two cases will be used to test the models (Surinamelaan, Amersfoort and an apartment complex in Venlo). The reason for these cases is that they both used a different way of approaching the problem. In the Surinamelaan case, all the aspects of the decision table are applied, while the apartment complex in Venlo does not address all the aspects. The difference between the two cases will be explained also in this part of the research.

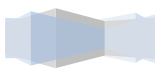
6.1.1 Surinamelaan, Amersfoort

In the south part of Amersfoort lay the five apartment complexes that together form the project Surinamelaan. The complexes are situated outside the city limits. This offers a larger green area around the complex which was appealing for the buyers in the complex. Along with the good public transport connections and the short travel time to the centre of Amersfoort made that a large part of the apartments was sold quickly to private owners.



Figure 12: location of the Surinamelaan in Amersfoort (Google, 2014)

In Amersfoort are two main housing corporations active: *De Alliantie* and *Portaal*. Of these two, *De Alliantie* has the majority of households in their possession, including the complexes at the Surinamelaan. About ten years ago, the housing corporation decided that they will sell the apartments in the complexes. By making this decision, the housing corporation stopped all forms of investments in the complexes and limited its activities to planned



maintenance. This made that the housing corporation was not interested in sustainable improvements of the complexes. Three years after the announcement that the housing corporation would sell the apartments in the complexes, a covenant was made between all the inhabitants to make work of more sustainable complexes. At this moment in time, the housing corporation change its point of view and decided to think along.

The Surinamelaan holds a total of 122 apartments, split over five complexes. The housing corporation *De Alliantie* started selling rental apartments in 2005. When the first private owners inhabited the new houses, they noticed a rather high electrical bill. This in combination with the personal assessment about the environment started the discussion about sustainable renovation. Initially, there was only one person who was interested in this sustainable renovation. He organized study days with inhabitants, AgentschapNL, the province of Utrecht and the councilman of environment of the city of Amersfoort. Later on, they would also form the Community of Practise, to further inform the inhabitants.



Figure 13: Surinamelaan, Amersfoort (Google, 2014)

In 2008 the corporation sold so many rental apartments, that they cannot fulfil their goals to reduce CO₂. This in the end led to several new meetings between the corporation and its tenants. The most important demands were the raise of the housing costs and the lowering of the energy costs. The data used in the case study can be found in appendix 7.

6.1.2 Apartment complex, Venlo

In the city of Venlo lies a different apartment complex. This complex has also made a sustainable improvement, but in a different way than the previous case. Where the previous used the tenants to recoup the investment, this case does not.

The private owners and housing corporation set up an agenda for some major upgrade to the complex, in the form of replacing the glass with HR++ glass. This was set on the agenda for the year 2020, and the plan was to save the money by using the monthly payments required to the house owner association. However, a few years back, the owners decided that the glass should be replaced in the year 2014. This meant that the monthly fee towards the house owner association was increased in the past few years and when the glass was replaced they had enough funds available to completely pay for the upgrade. The data used in the case study can be found in appendix 8. There is no visual description available about the complex. The house owner association manager did not want to provide the (street)name of the complex for privacy reasons.

6.1.3 Static input values

Even though the cases provide some of the input values, there are input values that are indifferent regardless of the case. These values will influence each case study in a similar way. These are values like the inflation, interest rate (even though it can slightly vary between different housing corporations) and the value that is developed based on the energy label. These static input values can be found in exogenous variable overview table in the appendix 6.

6.2 Results of the case studies

Based on the different cases the results of the research are presented. Both cases will be used to check the previously developed models and if they represent a proper value with is in line with the outcome of the actual case. In this paragraph the results of the different models are presented. As mentioned before, the system dynamics will be used to determine a value of the decision table. At first the conditions of the decision table are used to determine the input of the system dynamics, which will return the estimated value of the final condition that is needed to fill in the decision table. Based on the complete decision table the proper action for the particular case can be determined.

6.2.1 Results case 1 – Surinamelaan, Amersfoort

In this particular case, the complete package of upgrades is used. This package includes the applying of insulation, glass and replacing the boiler systems. To achieve this, there was an agreement with the Rabobank to lend the money for the project. With the use of the loan, the project was realised.

The decision table conditions for the Surinamelaan

Based on the different values the sub-tables produce the different conditions of the complex. Since this is a rather large complex, most of the conditions fall into the higher categories of the variables. Almost every condition is at its highest alternative, except for the energy label. There is one side note of the investment costs. The sustainable upgrade was planned simultaneously with the regular large maintenance of the housing corporation. This means that there is an additional €8.000 as investment for the housing corporation in this case. For this research the additional costs for maintenance are excluded. This is because the maintenance fees are fixed in the house owner association budgets. This means that the investment for the maintenance also had to be made, even if there is no sustainable upgrade. Based on the data provided by the case, there is no telling about the ownership condition. This condition will be estimated. Table 17 shows the input of the sub-tables of the decision table.



Table 17: conditions of the Surinamelaan case (based on various literatures)

Sub-conditions	Sub-condition alternative	Condition state
Tenants	?	C1. Ownership condition: ?
Private owners	?	
Amount of mixed ownership	> 20%	C2. Portfolio transformation: Need
Recent sales	(6 and 12 months)	
Amount of households	> 50	C3. Investment costs: Med
Investment per household	< €20.000	
New energy label	Label B or lower	C4. Process time: Long
Preparation time	(12 and 24 months)	
Renovation time	> 3 months	

The agreement model

With the previous determined information (table 17), there can be estimated what the agreeing percentage will be. In the case of the tenants, there will be looked at a percentage of 70%. From the figure below, the estimated agreement time can be determined. For this case this is eleven months.

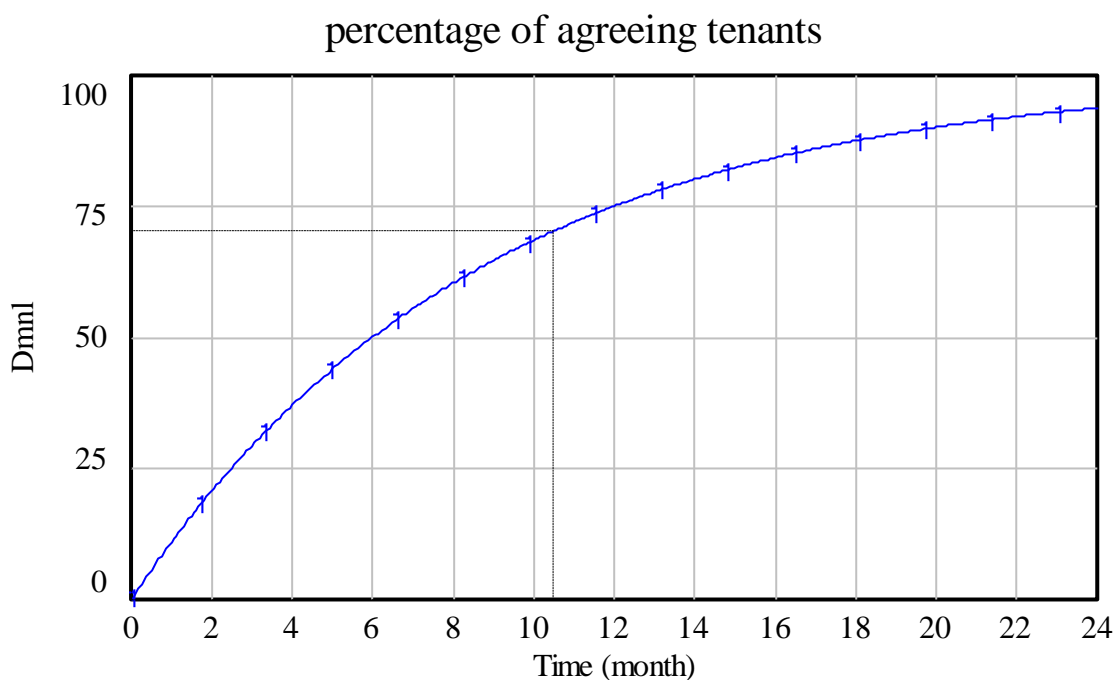


Figure 14: percentage of agreeing tenants

Secondly, there needs to be determined how long it will take to reach the 65% acceptance amongst the private owners. This is a rather quick process. The reason for this is simple: the ratio between tenant apartments and private owned apartments is 55:67. So the start value, after the tenants agreed is already 45%. An additional 24 private owners agreeing would be sufficient. These additional 24 private owners would be reached after roughly four months.

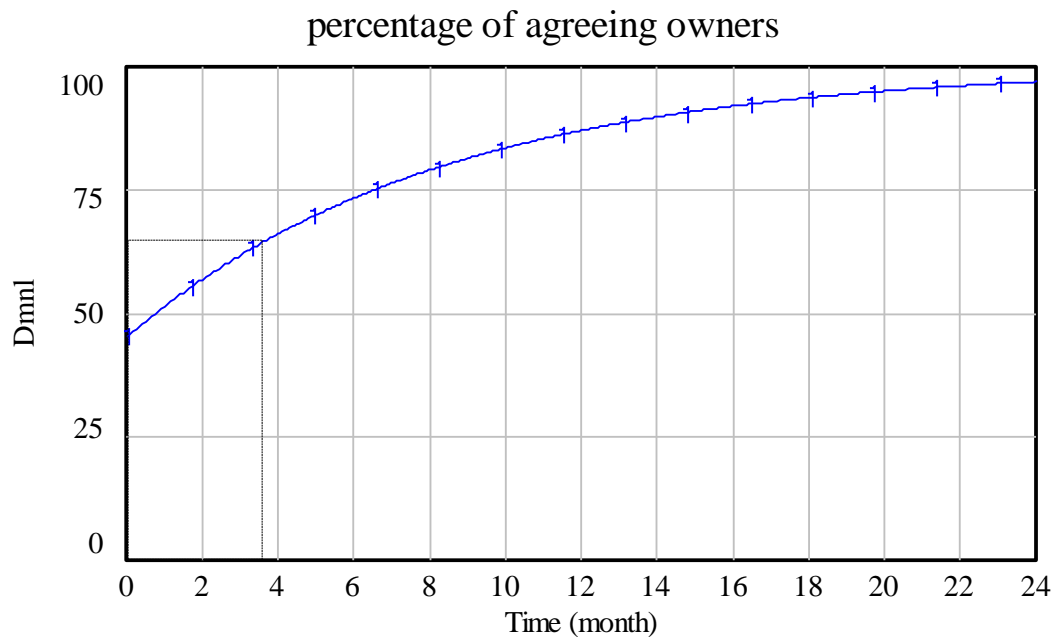


Figure 15: percentage of agreeing owners

The situation has a timespan of eleven months for the tenants to reach the required 70% acceptance level. After this, the owners can cast their vote, which is done in four months. So in about fifteen months there will be an agreement between all the inhabitants. This result is in line with the preparation time of roughly two years in total before the sustainable upgrade started.

The decision table for the Surinamelaan

The different interpretations of the investment costs will lead to a different result in terms of advised actions. In this case, filling in the decision table leads to the advice of making the sustainable upgrade.

If these results are placed this back in the decision table, the result would be rule #4 for the situation. By applying this rule different actions occur. The foremost action is to not continue the selling process and maintain the current situation with tenants and owners. The complex will be upgraded as is. Secondly, with the aid of some enthusiastic inhabitants in the complex, the different inhabitants were informed. In this case the housing corporation was still a bit reluctant, since there was no real practical example they could use as a source of experience. This was also the reason no other housing corporations were asked to join in, since they simply also did not know how to deal with this situation themselves (see also table 18).



Table 18: decision table of the Surinamelaan case

C1. Ownership condition					Positive				Negative				
C2. Portfolio transformation	Need					No Need			Need			No Need	
C3. Investment costs	Low		Med		High	Low	Med	High	Low	Med		High	–
C4. Process time	S	L	S	L	–	–	–	–	–	S	L	–	–
A1. Portfolio action	K	K	K	K	K	K	K	S	B	B	S	S	S
A2. Inform inhabitants	X	X	X	X				X	X	X	X	X	X
A3. Offer removal expenses									X	X			
A4. Look for better techniques	X	X	X										
A5. Buyer identification						X	X	X	X	X	X	X	X
A6. Partnership with other HC		X	X	X									
A7. Look for other projects					X	X	X	X			X	X	X
A8. Sustainable upgrade	X	X	X	X					X	X			
	01	02	03	04	05	06	07	08	09	10	11	12	13

6.2.2 Results case 2 - Apartment complex, Venlo

The second case holds a simpler example of a sustainable upgrade. The reason that this second case is highlighted is because of the different approach towards the sustainability of the complex. At the Surinamelaan project they used a bank loan system to get the financial means of the project, while this case evades all kinds of external finance. In this case the most time was used for the preparations of the funds. So there was enough money on the bank account of the house owner association to finance the investment.

This directly means that there is no increase in rent for the tenants. Since the housing corporation contributes towards the fund of the house owner association monthly anyway. Also the sustainable intervention already was on the agenda, but was brought forward so it was achieved earlier.

The decision table conditions for the complex in Venlo

With the use of data provided by Spectrum HoA management, this case can be applied into the decision table. However, there is need for a change in the data that was provided. The preparation time (> 24 months) is now so long that there is no use for the decision table and the project should be discarded. The reason this is so long, is that they also used the preparation time to gather the required funds to make the sustainable upgrade. The actual preparation time without the saving part (starting with a loan) would be less than one year. Since the agreement was made in less than 12 months, this time will be used as the preparation time.

Also, there is no percentage of mixed ownership available due to the fact that no names were given. This means the housing corporation cannot be tracked and there for no value of this can be placed. This leads to no further issues with the model, since the recent sales are less than six months, which in either possibility of the percentage of mixed ownership leads to the same outcome in the sub-table.

The upgrade in this case is limited to replacing the windows with HR++ glass. This instantly affects the investment costs of the situation. The investment per household is roughly €3.500, which is far below the €20.000 limit. The complex itself houses 100 households. Of the 100 households, there are 20 rental apartment and 80 private owned apartments. In terms of investing, the housing corporation only has to invest for the 20 rental apartments, and not for the 80 previously sold private owned apartments. At this moment in time this saves them investment costs.

Table 19: conditions of the Venlo case (based on data from Spectrum HoA management)

Sub-conditions	Sub-condition alternative	Condition state
Tenants	?	C1. Ownership condition: ?
Private owners	?	
Amount of mixed ownership	n/a	C2. Portfolio transformation: No need
Recent sales	< 6 months	
Amount of households	< 50	C3. Investment costs: Low
Investment per household	< €20.000	
New energy label	Label B or lower	
Preparation time	< 12 months	C4. Process time: Short
Renovation time	< 3 months	

The agreement model

Since there is no increase in rent, there is no need for the tenants to vote. This means that their agreement model is also irrelevant. For the agreement model of the owners there will be assumed that the housing corporation was already in favour of the ideas. They started



the actual process to speed up the sustainable upgrade. So it is only logical that they would agree with the plans.

But could there be a decent estimation of the agreement of the owners, without too much trouble? What we see is that there is an agreeing percentage of 65% somewhere in the sixth month. This is well in line with the preparation time (without the fund gathering) of less than one year. Especially since in this case, there were not enough people turning-up in the first meeting to be able to vote. In a new meeting there still were not enough people turned-up to make a voting possible, but since this was the second meeting, the voting was allowed and passed by 100% of the people that cast their vote. Figure 16 shows the policy of the agreement.

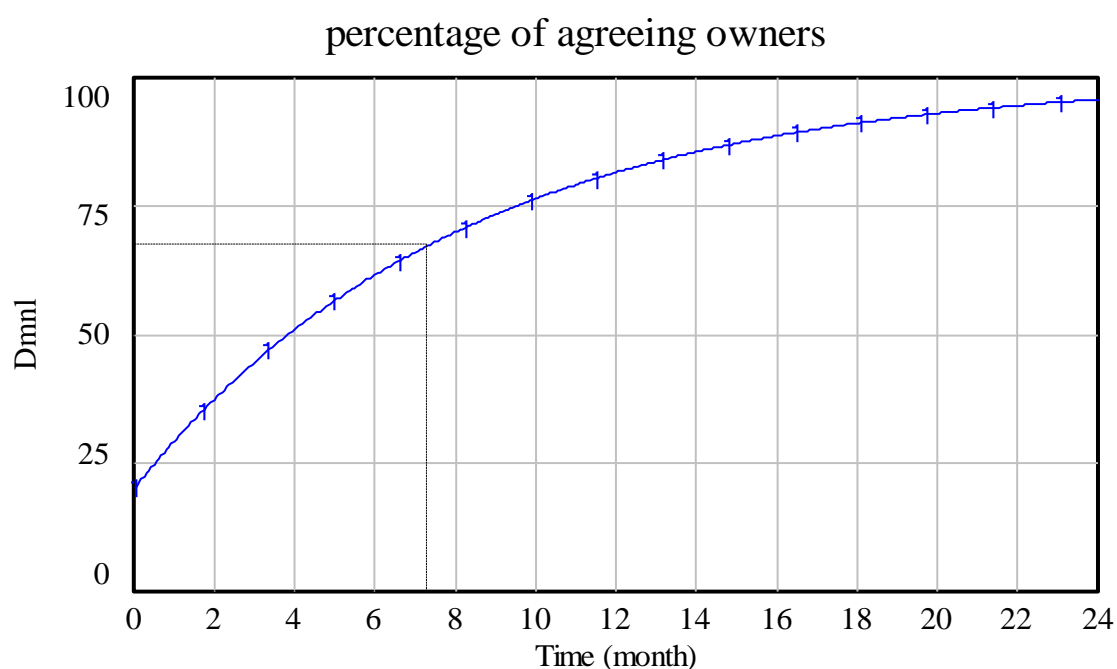


Figure 16: percentage of agreeing owners

The decision table for the complex in Venlo

The four conditions can be fed into the main decision table, which will give the advised action to the housing corporation on what to do with this mixed ownership complex.

Based on the decision table, there should be no sustainable upgrade in this particular complex. The situation should be kept the way it is and there should be a proper identification of the buyers. This is what happened in this case: the buyer were identified and based on that action there was chosen to speed up the changing of the glass in the complex, which already was on the agenda for 2020. So in essence there was no unforeseen sustainable upgrade in this complex. The actions before the final action (A7 or A8) made that a situation change happened in such a way that the glass was changed earlier (see also table 20).

Table 20: decision table for the Venlo case

C1. Ownership condition	Positive								Negative				
C2. Portfolio transformation	Need						No Need		Need			No Need	
C3. Investment costs	Low		Med		High	Low	Med	High	Low	Med		High	—
C4. Process time	S	L	S	L	—	—	—	—	—	S	L	—	—
A1. Portfolio action	K	K	K	K	K	K	K	S	B	B	S	S	S
A2. Inform inhabitants	X	X	X	X				X	X	X	X	X	X
A3. Offer removal expenses									X	X			
A4. Look for better techniques	X	X	X										
A5. Buyer identification						X	X	X	X	X	X	X	X
A6. Partnership with other HC		X	X	X									
A7. Look for other projects					X	X	X	X			X	X	X
A8. Sustainable upgrade	X	X	X	X					X	X			
	01	02	03	04	05	06	07	08	09	10	11	12	13

6.3 Conclusions regarding the results

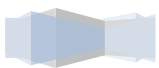
With the different results the final sub-question of the research can be answered.

Sub question 4:

How to support decision makers in housing corporations?

As was seen in the different cases, the two models work together with the same input variables to give estimations on what to do. Based on the cases the workings and interaction between the two models was tested and analysed. The decision table makes use of conditions that can be easily acquired by housing corporations (portfolio transformation, investment costs and process time). The last condition (ownership condition) is harder to estimate before starting the process. Therefore this condition is estimated with the other conditions (investment costs and process time) in a second model. This way an early estimation can be made if the sustainable upgrade will be feasible for the housing corporation.





7 CONCLUSIONS AND RECOMMENDATIONS

In this chapter the final conclusions of the research are presented. Based on the conclusions, several recommendations will be made towards the housing corporation and the inhabitants. There will be acknowledged that there are flaws in the research and these will be elaborated in the discussion. Some of these flaws can be solved in the future, but this will require some further research on this topic.

7.1 Conclusions

In this research we set out to find the answer to the following research question:

“What would be the best approach for a housing corporation to tackle mixed housing complexes in relation to becoming more sustainable?”

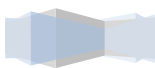
To come back to the research question: there is no best approach to tackle the situation. This is depending on the situation and on how the portfolio of the housing corporation is made up. Since every situation is different, the different models were used to determine if a complex is suitable. The decision table (see also chapter 5) will provide an advice on what to do, based on the conditions that are present.

Different aspects play a role in the choice of a housing corporation to make a sustainable upgrade were investigated in literature. Based on the literature, there was found out that these mixed ownership housing complexes are mainly used as cash cows for the housing corporation (see also paragraph 4.1.7). The hopes are that these complexes slowly vanish out of the portfolio by sales in the complex. Important here is that there is a dilemma in the housing corporation thanks to the 2020 agreement. Only four sales on average in these complexes happen each year. Therefore the following problem was defined:

“The problem housing corporations are facing is the fact that they have mixed ownership in their portfolio and this is hampering them in becoming more sustainable”

This means there is a future need to make these complexes more sustainable. To help tackle the mixed ownership problem, the decision table was introduced, based on the found conditions in literature (See also chapter 4).

The decision table can provide two results in terms of reaching a more sustainable portfolio. The first result is that the complex should be improved. This directly leads to a more sustainable portfolio. Obviously this result is the most positive result. However the second option is that the complex is removed from the sustainable list and that there will be no upgrade. This would mean the housing corporation needs to find its sustainable projects elsewhere in their portfolio to reach their goals. This option can also lead to, in the end,



expelling the complex from the portfolio by sales. Even though this is not the desired result in terms of sustainability, it will give the housing corporation some more room to breathe. Since the sales remove the apartments with a bad label from the portfolio slowly. This would mean that even the bad complexes are in some way useable by the housing corporation to reach their sustainability goals while not endangering their organisation.

Lastly, there can be concluded from the different cases (see also chapter 6) that were applied that there can always be unforeseen interactions and variables that make the situation easier to handle (or more difficult). This has become clear in both cases. In the first case the inhabitants grouped together and urged the housing corporation to do something. In the other case, there was the fact that there was chosen for a different way of financing, so that the tenants do not need to vote. This speeds up the process and also the changes of success in the end. Just keep in mind that there is no perfect situation.

7.2 Recommendations

Based on the research there are several recommendations that can be made towards the different groups of players that are involved (housing corporation and inhabitants).

Housing corporation

The advice to the housing corporation would be to be more interested in the complete portfolio in relation to the set goals in 2020. Also the mixed ownership complexes are part of the portfolio and will be playing a role in the future to determine if the goals that are set will be made. The housing corporations now should get more involved into these projects and start looking for feasible projects in the mixed ownership complexes.

Inhabitants

Inhabitants can play a major part in the goals of the housing corporation and their own living situation. There was observed in the case of the Surinamelaan that active involvement of the inhabitants can lead to the fact that the housing corporation will undertake action, even if the complex was discarded in the first place. The advice for the inhabitants would be to see if there are options open at the housing corporation to implement sustainable changes. If there are, this will only lead to positive results in terms of value creation, and comfort.

7.3 Discussion

The models as presented in this thesis are merely a support tool. In the end it is up to the housing corporation to determine if they want to actually make the sustainable changes in the portfolio and reach the goals set for the year 2020. There is no way of checking if they fill in the conditions in a honest manner and if they judge the outcome as a mere advice to help them make a choice.

Also, the model uses some conditions that are based on literature. These values of these conditions are, of course, subject to change depending on the housing corporation. This totally depends if the housing corporation is more active in larger cities, with more complexes or is more active in a sub-urban area with fewer complexes. In this research it is near impossible to adapt the model to each possible situation. There for the model acts with average values that can (and should) be changed when evaluating the housing corporations situation and goals.

The system dynamics model offers the housing corporation some insights in how the agreement of the inhabitants (tenants and private owners alike) will be. However, there was no time left to properly examine the β values of every different variable, let alone the different probabilities. This means that the model can provide wrong feedback in certain situations. Additional, the housing corporations are a very Dutch phenomenon. This has had its effect on the research and on the system dynamics model. Since most researches published are done in an international setting, there is no word of the housing corporations. This makes that estimating the β values is tricky and therefor can contain mistakes.

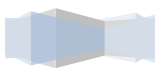
Lastly, since there was no company directly related to the research topic, there was a limitation on behalf of the researcher. A company could have greatly contributed towards certain aspects of the literature (like the choice factors), the making of the decision table or the supplying of the values of the system dynamics model.

7.4 Further research

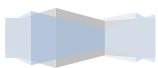
In this thesis the goal was to find a decision support tool for the housing corporation when it comes to making mixed ownership housing stock more sustainable. The perspective of this research therefor was aimed at the housing corporation, leaving the inhabitants (tenants and private owners) somewhat out of the picture. A good next step would be to determine how the inhabitants are looking at these plans and if there are more grounded rules that define their way of acting.

Secondly, the decision model advises about these complexes based on conditions. There is no further elaboration on what to do with complexes that are judged to be unsuitable for sustainable upgrading. In a further research this step could be made, so that also the mixed ownership complexes that has, based on the conditions, no spot in the sustainability plans are dealt with in a proper manner.

Thirdly, there is so far no grounded research done to determine the β values that are used in this research. A new research could be done to see if these values hold any truth or that there are other (additional) factors that play a role in the agreement process.



Finally, it would be interesting to see if there is a solid business case possible for these kinds of households. Here there is just a tool to help the housing corporation decide per case individually, but it leaves for debate if there is a possibility to make a larger scale business that focusses on these types of mixed ownership complexes.



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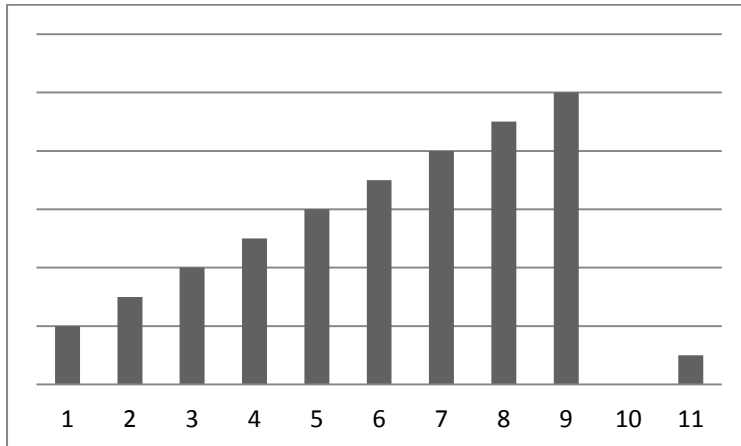


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APPENDICES

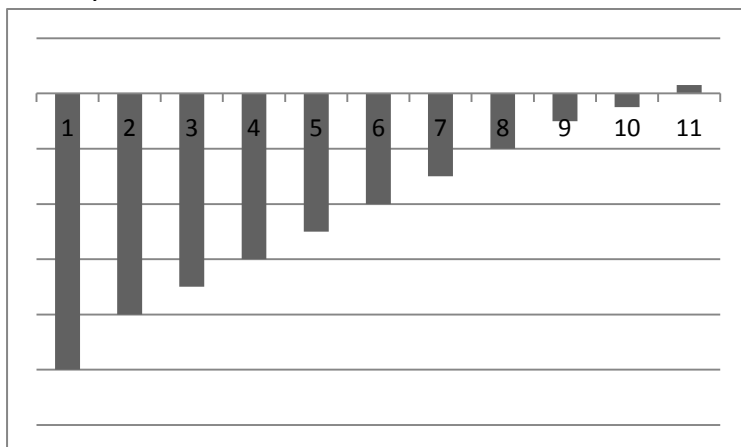
Appendix 1: different investment methods

Fund gathering:



When fund gathering is applied, the housing corporation and the individual private owners will save a monthly amount to make upgrades in the future. These changes are proposed on the HoA meeting and a 66% majority has to agree with these plans, because this will ask a larger contribution of the individuals in the upcoming years.

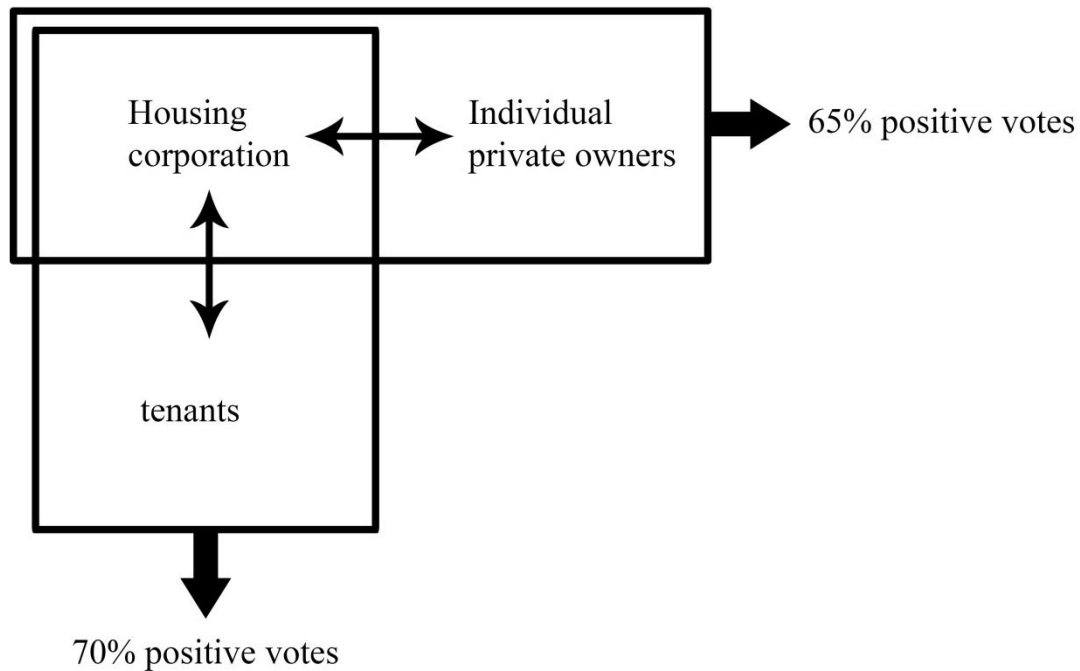
Loan system:



In the loan system, the owners will ask for a loan to make the upgrade instantaneously. This means that the sustainable upgrade is achieved quicker than when there is decided for the fund gathering. In general, this method also makes for larger costs, since there is interest that has to be paid for the loan. The loan is paid back with the savings on the energy. This means that in the first years when the system is active, there is no change in the total monthly costs. The energy costs will be lower and the difference between the old and new situation is used to pay back the loan.



Appendix 2: voting process



The voting process contains of two main activities that are in sequence of each other. First there is the (possible) voting of the tenants. In this voting, 70% of the present tenants have to agree with the proposed changes to the rent, based on the changes the housing corporation is making to the complex. This voting will only occur if there is a proposed change in the rent when the sustainable upgrade is placed. If there is no change in the rent, there is no need to let the tenants vote. Secondly, there is the voting of the house owner association. In this voting process, the housing corporation represents the voice of all the tenants in the voting process. This means that a representative of the housing corporation has a very strong voice (for example, if the housing corporation has 20 rental apartments, their vote is 20 times stronger than the other votes). After the owners have voted in the meeting, the plans can continue if there is a 65% majority in favour of the proposed plans.

Appendix 3: Decision table rule map

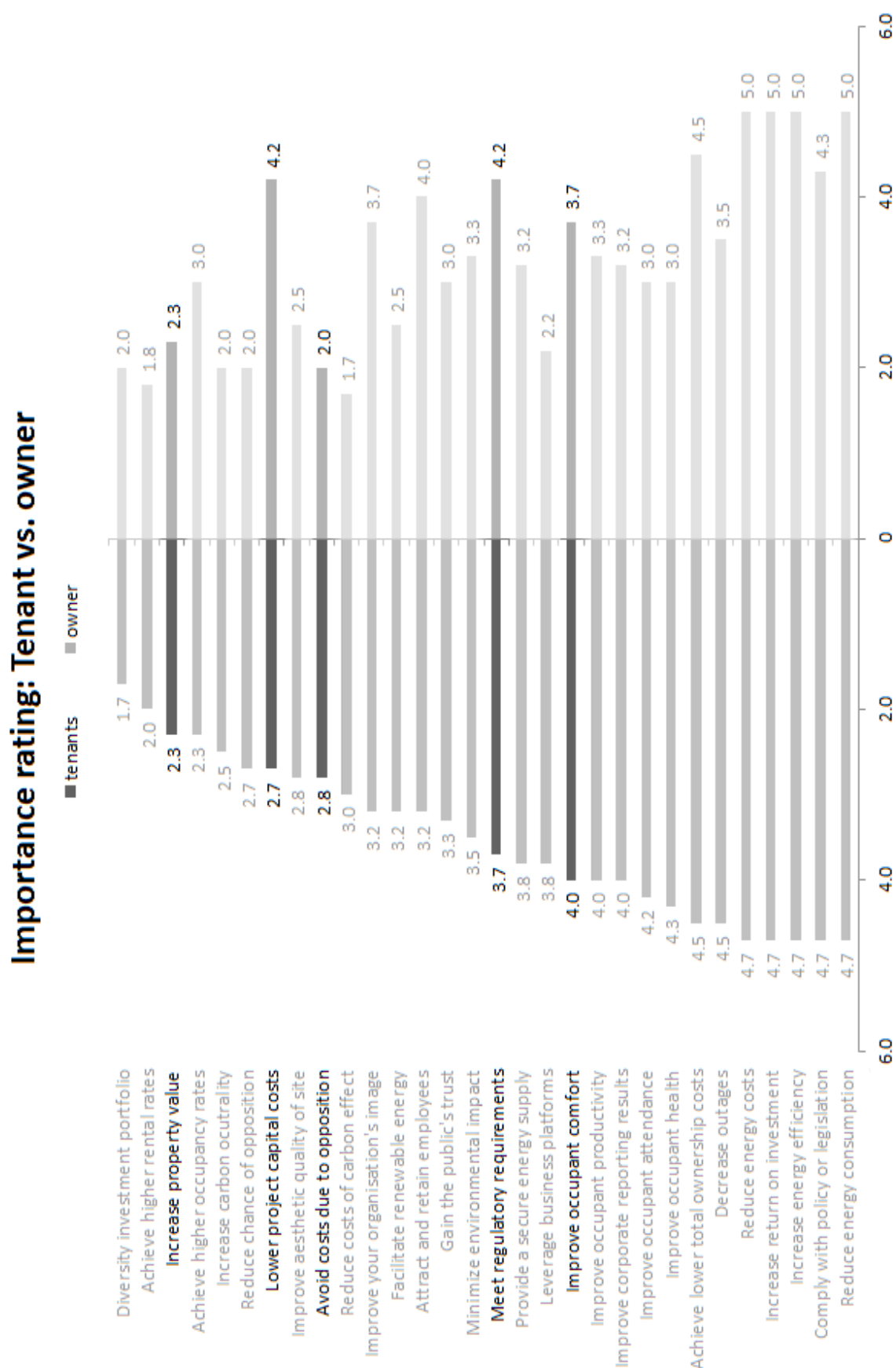
IF	<i>Ownership condition = positive AND Portfolio transformation = need OR Ownership condition = positive AND Portfolio transformation = no need AND investment costs ≠ high OR Ownership condition = negative AND Portfolio transformation = need AND investment costs = high OR Ownership condition = negative AND Portfolio transformation = need AND investment costs = medium</i>	THEN	<i>Portfolio action = keep situation</i>
IF	<i>Ownership condition = negative AND Portfolio transformation = no need OR Ownership condition = positive AND Portfolio transformation = no need AND investment costs = high OR Ownership condition = negative AND Portfolio transformation = need AND investment costs = high</i>	THEN	<i>Portfolio action = sell households</i>
IF	<i>Ownership condition = negative AND Portfolio transformation = need AND investment costs = low</i>	THEN	<i>Portfolio action = buy back households</i>
IF	<i>Ownership condition = positive AND Portfolio transformation = need AND investment costs ≠ high OR Ownership condition = negative OR Ownership condition = positive AND Portfolio transformation = no need AND investment costs = high</i>	THEN	<i>Inform inhabitants</i>
IF	<i>Ownership condition = negative AND Portfolio transformation = need AND investment costs = low</i>	THEN	<i>Offer removal expenses</i>
IF	<i>Ownership condition = positive AND Portfolio transformation = need AND investment costs = low OR Ownership condition = positive AND Portfolio transformation = need AND investment costs = medium AND process time = short</i>	THEN	<i>Look for better techniques</i>
IF	<i>Ownership condition = negative AND Portfolio transformation = need AND investment costs = medium</i>	THEN	<i>Convince inhabitants</i>
IF	<i>Ownership condition = negative OR Ownership condition = positive AND Portfolio transformation = no need</i>	THEN	<i>Buyer identification</i>
IF	<i>Ownership condition = positive AND Portfolio transformation = need AND investment costs = low AND process time = long OR Ownership condition = positive AND Portfolio transformation = need AND investment costs = medium</i>	THEN	<i>Partnership with other HC</i>
IF	<i>Portfolio transformation ≠ need OR Portfolio transformation = need AND investment costs = high</i>	THEN	<i>Look for other projects</i>
IF	<i>Ownership condition = positive AND Portfolio transformation = need AND investment costs ≠ high OR Ownership condition = negative AND Portfolio transformation = need AND investment costs ≠ high</i>	THEN	<i>Sustainable upgrade</i>



Appendix 4: Pay-off table for the different actions

Pay-off table													
C1. Ownership condition	Positive								Negative				
C2. Portfolio transformation	Need				No Need				Need			No Need	
C3. Investment costs	Low		Med		High	<u>Low</u>	<u>Med</u>	<u>High</u>	Low	Med		High	–
C4. Process time*	S	L	S	L	–	–	–	–	–	S	L	–	–
P1. More sustainable portfolio	X	X	X	X					X	X	X		
P2. Increased lettability									X	X			
P3. Increased marketability	X	X	X	X									
P4. Knowledge development		X	X	X		X	X	X	X	X	X	X	X
P5. Image improvement	X	X	X	X					X	X			
P6. Complete ownership of system									X				
P7. Complex is not suitable					X	X	X	X				X	X
	01	02	03	04	05	06	07	08	09	10	11	12	13

Appendix 5: Weights on the different variables (Menassa, C.C., Baer, B., 2013)



Appendix 6: System dynamics overview table

Stocks:

Name	Function	Unit	Description
Private owners	IF THEN ELSE (private owners < total households, agreeing owners, 0) (initial value: amount of rental households)	Households	Amount of private owners that are agreeing; stock cannot contain more than the total amount of households
tenants	IF THEN ELSE (tenants < amount of rental households, agreeing tenants, 0) (initial value: 0)	Households	Amount of tenants that are agreeing; stock cannot contain more than the total amount of tenant households

Flows:

Name	Function	Unit	Description
Agreeing owners	(total households - private owners) * (investment factor + label factor + time factor) / agreement time	Households /month	Agreeing owners per month (owners that agree are excluded)
Agreeing tenants	(amount of rental households - tenants) * (label factor tenants + investment factor tenant + time factor tenants) / agreement time	Households /month	Agreeing tenants per month (tenants that agree are excluded)

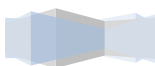
Exogenous variables:

Name	Function	Unit	Description
Amount of private owned households		Households	Numerical value for the number of private owner apartments
Instalment delay		Month	The time it takes to install the upgrade, from the moment the project is started
Process time		Month	Time it takes to start the project
Upgrade costs		Euro	Costs to make the sustainable investment for private owners
New energy label		Dmnl	The energy label after the upgrade
Investment costs		Euro	Costs to make the sustainable investment the rental apartments
Amount of rental households		Households	Numerical value for the number of rental apartments
Agreement time	1	Months	Value to manipulate the factors to provide reasonable results since they act dynamic

Functions are subject to change, based on the case study. All empty variables are based on the case study.

Variables:

Name	Function	Unit	Description
Investment factor	IF THEN ELSE (upgrade costs >= 20000, 0.028, 0.039)	Dmnl	Relation of the investment and the willingness to support the project
Label factor	IF THEN ELSE (new energy label >= 7, 0.032, 0.027)	Dmnl	Relation of the energy label and the willingness to support the project
Time factor	IF THEN ELSE (instalment delay <= 3, 0.039, 0.028) + IF THEN ELSE (process time <= 12, 0.028, 0.026)	Dmnl	Relation of the project time and the willingness to support the project
Percentage of agreeing owners	private owners/ total households * 100	Dmnl	Amount of a agreeing owners based on the total group
Total households	amount of private owned households + amount of rental households	Households	Total amount of households present in the complex
Investment factor tenants	IF THEN ELSE (investment costs >= 20000, 0.027, 0.033)	Dmnl	Relation of the investment and the willingness to support the project
Label factor tenants	IF THEN ELSE (new energy label >= 7, 0.038, 0.028)	Dmnl	Relation of the energy label and the willingness to support the project
Time factor tenants	IF THEN ELSE (instalment delay <= 3, 0.037, 0.028) + IF THEN ELSE (process time <= 12, 0.033, 0.027)	Dmnl	Relation of the project time and the willingness to support the project
Percentage of agreeing tenants	tenants / amount of rental households * 100	Dmnl	Amount of a agreeing tenants based on the total group



Appendix 7: Variables for Surinamelaan case

Name	Function	Description
Instalment delay	12	The time it takes to install the upgrade, from the moment the project is started
Upgrade costs	€14.000	Costs to make the sustainable investment for private owners
Investment costs	€14.000	Costs to make the sustainable investment the rental apartments
Subsidies PO	€0	Governmental support towards private owners
Funds PO	€0	Available funds per owner
Amount of private owned households	67	Numerical value for the number of private owner apartments
Amount of rental households	55	Numerical value for the number of rental apartments
Process time	24	Time it takes to start the project
Old energy label	F	The energy label before the upgrade
New energy label	B	The energy label after the upgrade
Agreeing tenants	>70%	Percentage of tenants that agree with the plans
Agreeing PO's	>65%	Percentage of private owners that agree with the plans
Mixed ownership portfolio stock	53%	Percentage of total portfolio that is part of mixed ownership complexes
Recent sales	< 12 months	If there are apartments sold recently (less than 6 months, less than 12 months or over 12 months)

(Westveld, VvE's Surinamelaan: samenwerking tussen eigenaren, huurders en verhuurder, 2009; SEV, Samen onder een dak - VvE's renoveren duurzaam, 2012; De Alliantie, 2014; Doodeman, Banken steken geld in VvE-complexen, 2013; Doodeman, Vijf flats effenen weg voor VvE-financiering, 2013; Hal, 2013)

Appendix 8: Variables for Venlo case

Name	Function	Description
Instalment delay	2	The time it takes to install the upgrade, from the moment the project is started
Upgrade costs	€3.500	Costs to make the sustainable investment for private owners
Investment costs	€3.500	Costs to make the sustainable investment the rental apartments
Subsidies PO	€240	Governmental support towards private owners
Funds PO	€5.000	Available funds per owner
Amount of private owned households	80	Numerical value for the number of private owner apartments
Amount of rental households	20	Numerical value for the number of rental apartments
Process time	12	Time it takes to start the project
Old energy label	D	The energy label before the upgrade
New energy label	B	The energy label after the upgrade
Agreeing tenants	>70%**	Percentage of tenants that agree with the plans
Agreeing PO's	>65%	Percentage of private owners that agree with the plans
Mixed ownership portfolio stock	n/a*	Percentage of total portfolio that is part of mixed ownership complexes
Recent sales	< 6 months** *	If there are apartments sold recently (less than 6 months, less than 12 months or over 12 months)

**for privacy reasons, the location and specific housing corporation were not mentioned by the case provider*

***there was no tenant voting needed since the HoA funds paid the upgrade*

****there were roughly 4 sales last year, mostly around June, when people get their holiday payments*



Appendix 9: English summary

The weighing in mixed housing stock – what to do with it?

Development of a decision support model

Author(s): Borger, T.M.W. (Thomas)

Graduation program:

Construction Management and Urban Development 2013-2014

Graduation committee:

Prof. dr. ir. W.F.Schaefer (TU/e)

Dr. ir. B. Glumac (TU/e)

Ir. B. van Weenen (TU/e)

Date of graduation:

21 August 2014

ABSTRACT

After the Second World War the goal was to produce a lot of dwellings for the people. In this moment in time the quantity was important. Now the visions are changing and the (sustainable) quality of the houses that are built becomes more important. This leads to problems for housing corporations, when they on the one hand have to provide housing for lower incomes and on the other hand have to invest to meet the sustainable desires.

In this research there was looked at the different conditions that play a role during the decision moment if a post- Second World War housing complex is suitable or not for sustainable upgrading. This leads to the introduction of a decision table to advise the housing corporation make the choice.

Keywords: Housing corporations, mixed ownership complex, decision tables, system dynamics, sustainable upgrading

INTRODUCTION

The Netherlands has a unique organisation to support the lower incomes in the society in terms of offering housing. This is the housing corporation. Up until 1988 the government supported the housing corporation financially to make sure the housing corporation's continuity was not in danger and they could continue to carry out their main objective of offering housing. However, this all changed in 1988. At this moment in time the housing corporations had to get the financial means to survive from the private market. This results in a more diverse portfolio, since the housing for the lower incomes is not feasible.

For a long time this was sufficient for the housing corporations to survive. But with the financial crisis in 2008 the housing market collapsed and their tools to get enough financial means were diminishing. This resulted in even trying to sell part of the lower income housing (mostly '60 and '70 buildings) towards either the current inhabitant or to a new person after the tenant left. By selling households to maintain the financial situation of the housing corporation decent, the housing corporations created a new type of complex: a complex with both tenants and private owners (KWH, 2011).

Now we are six years after the crisis and the effects are still around. The housing market is still recovering and at the same time there are new plans brewing by the different governments and housing corporations. So was decided to have the entire portfolio of the housing corporations on an average energy label B at the end of 2020.

Problem definition

Housing corporations made the decision to achieve a more sustainable portfolio by the year 2020. The goal in the 2020 agreement is to reach an average of label B in the complete portfolio of the housing corporation. This means that all the different parts of the portfolio should contribute somewhat so the goal can be reach on time. Achieving this goal is in a large part of the portfolio simple, but in some parts problems arise. Especially in the area of the mixed ownership complexes. These complexes have both regular tenants and private owners living in the same apartment complex. This leaves the housing corporation with a particular complex there they do not have complete control. Therefor the following problem is defined:

“The problem housing corporations are facing is the fact that they have mixed ownership in their portfolio and this is hampering them in becoming more sustainable”

Research structure

In this research we will look into the possibilities of these post-World War Two housing complexes that now house both tenants and private owners alike. This is such a unique combination (along with having a housing corporation as a part-owner) that there is very little research done in the field of these kinds of buildings.

The housing corporation is placed in a dilemma which they feel is (given the current time) not necessary to be addressed at this moment in time. This only makes the situation escalate more when not every part of the complex becomes sold in 2020. Therefor there is a need to address some of these mixed ownership complexes.

To look into the problem, the following research question will be used to guide the research, along with several sub-questions.



“What would be the best approach for a housing corporation to tackle mixed housing complexes in relation to becoming more sustainable?”

To answer this question several sub-questions are defined:

1. What external factors influence the possible actions for energy upgrading in mixed ownership housing stock?
 - a. How do policies (national, provincial, local) influence the action chosen?
 - b. How is future supply and demand influencing the action chosen?
2. What internal factors influence the possible actions for energy upgrading in mixed ownership housing stock?
3. What is the list of possible actions; given the external and internal factors?
 - a. What are the advantages and disadvantages of the different actions?
 - b. How can the different actions be measured?
4. How to support decision makers in housing corporations?

LITERATURE

In the literature review there are two aspects that play a role in finding the solution to the problem of upgrading mixed ownership housing stock. These are the factors that play a role during the choice and the different possible actions.

Factors that play a role in the choice

To investigate the different factors that make up for the choice of a housing corporation to upgrade a mixed ownership complex, literature was used. In total there are seven factors that influence the choice of a housing corporation:

1. Process management innovation
2. Relations with other players
3. User's behaviour
4. Preference for smaller projects
5. Investment costs
6. Ongoing selling process
7. Large amount of '60 – '70 complexes in the portfolio

Housing corporations are, like the construction sector, rather passive in terms of new methods and applying new techniques. Since the housing corporations have the goals to offer housing to people of the social class, this is extra stressing. There is no one to recoup the extra investments of the innovative solutions since the social class has little to spend. This means that the housing corporation would want to achieve a lot with very little investments in the portfolio. To further minimize the risk, the projects are kept to a small

size to prevent massive losses if things go wrong (Turcu, 2012; Palma, I.C., Mengual, E.S., Solà, J.O., Montero, J.I., Caballero, C.P., Reiradevall, J., 2013; Mondol, J.D., Koumpetsos, N., 2013).

There is a part of the portfolio that requires extra attention, and this is the part with the mixed ownership complexes. Currently they are used as *cash cows* for the housing corporation. These complexes are relatively old and therefore cost a lot to make them up-to-date to the current demands in the market. This makes that the housing corporations decided that it would be better to sell these apartments in the complex to either tenants or other people who are willing to buy it. This way the housing corporation generates some income from the complex, while they minimize the maintenance to only planned maintenance and direct complains from inhabitants (Vassileva, L., Wallin, F., Dahlquist, E., 2012; Kaygusuz, A., Keles, C., Alagoz, B.B., Karabiber, A., 2013; Osmani, M., O'Reilly, A., 2009; Hester, N., Li, K., Schramski, J.R., Crittendem, J., 2012).

Different actions to undertake

There are all kinds of actions a housing corporation can undertake with the mixed ownership housing complex. In this research there will be three main actions defined (Turcu, 2012; Abdul-Aziz, A.R., Jahn Kassim, P.S., 2011). In the first action state there will be no change in the household situation. So the tenants and private owners that live in the complex all keep on living there (Kyrö, R., Heinonen, J., Junnila, S., 2012; Energiesprong, 2012). If there is chosen to keep the situation as it is, there are two things that can happen. Either there will be a sustainable upgrade in the complex or there will be no sustainable upgrade.

A second option would be for the housing corporation to buy back the private owned households and make the complex completely inhabited by tenants again. This action would require a very unique situation to occur, since this is the riskiest action that can be undertaken.

The third action is what is happening currently in the market. The housing corporation labels the complex as a *cash cow* project and only tries to extract money from it by doing as least as possible. In this situation all the apartments are up on the market to be sold. Sometimes there are even large discounts for the current tenants to buy the apartment (Tiwoos, 2013).

METHOD

To see if a mixed ownership complex is suitable for upgrade the decision table will be used. This method offers the housing corporation a way to easily determine the different conditions and an advice is formed by the table (Arentze, F. and Borgers, A., 2003; Batchelder, 1991).



Table 1: complete decision table

C1. Ownership condition	Positive							Negative					
C2. Portfolio transformation	Need					No Need			Need			No Need	
C3. Investment costs	Low		Med		High	Low	Med	High	Low	Med	High	—	
C4. Process time	S	L	S	L	—	—	—	—	—	S	L	—	—
A1. Portfolio action	K	K	K	K	K	K	K	S	B	B	S	S	S
A2. Inform inhabitants	X	X	X	X				X	X	X	X	X	X
A3. Offer removal expenses									X	X			
A4. Look for better techniques	X	X	X										
A5. Buyer identification						X	X	X	X	X	X	X	X
A6. Partnership with other HC		X	X	X									
A7. Look for other projects					X	X	X	X			X	X	X
A8. Sustainable upgrade	X	X	X	X					X	X			
	01	02	03	04	05	06	07	08	09	10	11	12	13

Preconditions

The model will only perform under certain preconditions. These are the different rules that make a specific choice possible. When the different preconditions are not met, then the table should not be applied.

Table 2: preconditions of the decision table

Precondition	Description
User's Behavior	The way users use their appliances in their household will not change after the sustainable upgrade. They will act with their best intentions to keep the projected results.
Upgrade process	The housing corporation, in principle, will apply the sustainable upgrades as how they have done previously in other projects.
Regulations	The aim is to contribute towards the regulations that state housing corporations should become more sustainable in the future.
Sustainable plan	The complex that is targeted with the DT is aimed to be sustainable upgraded by using the DT.

Conditions

With the found attributes in literature the different conditions can be determined (table 3).

Table 3: conditions and their description (based on literature)

Condition:	Condition alternatives:	Description:
Ownership condition	Positive / Negative / Very negative	If the population of the complex is positive towards a sustainable upgrade, based on sub-conditions
Portfolio position	No need / Need	How the portfolio is effected by the mixed ownership complex, based on sub-conditions
Investment costs	High / Medium / Low	The total costs and return on investment, based on sub-conditions
Process time	Very long / Long / Short	The time the total project will take, based on sub-conditions

Now are the condition alternatives of these conditions still very vague. To address this problem, the sub-tables are used. In the different sub-tables the conditions are further split up into sub-conditions that are more practical.

Table 4: sub-table for the sub-conditions of the ownership condition

Sub-table for <i>ownership condition</i>				
C. Tenants	< 70%		≥ 70%	
C. Private owners	< 65%	≥ 65%	< 65%	≥ 65%
C1. Ownership condition	Very negative	Negative	Negative	Positive
	1	2	3	4

Table 5: sub-table for the sub-conditions of the portfolio position

Sub-table for <i>portfolio transformation</i>						
C. Amount of mixed ownership complexes	< 20%			≥ 20%		
C. Recent sales in the complex	< 6 months	[6 and 12 months]	> 12 months	< 6 months	[6 and 12 months]	> 12 months
C2. Portfolio transformation	No need	No need	Need	No need	Need	Need
	1	2	3	4	5	6



Table 6: sub-table for the sub-conditions of the investment costs

Sub-table for investment costs								
C. Amount of households	≤ 50				> 50			
C. Investments per apartment	≤ €20.000		> €20.000		≤ €20.000		> €20.000	
C. New energy label	Label B or lower	Label A or higher	Label B or lower	Label A or higher	Label B or lower	Label A or higher	Label B or lower	Label A or higher
C3. Investment costs	Low	Low	High	Med	Med	Low	High	High
	1	2	3	4	5	6	7	8

Table 7: sub-table for the sub-conditions of the process time

Sub-table for process time							
C. Preparation time (process)	≤ 1 year			(1 and 2 years)			≥ 2 years
C. Renovation time (instalment)	< 3 months	[3 and 9 months]	> 9 months	< 3 months	[3 and 9 months]	> 9 months	–
C4. Process time	Short	Short	Long	Short	Long	Long	Very long
	1	2	3	4	5	6	7

With these different sub-tables the actions can be determined and the complete decision table can be formed.

Actions and decision table

In literature the different main action were already found: keep the situation as it is (in terms of inhabitants), buy back the sold apartment or sell the remaining rental apartments. Of course do these actions on itself not that much for a housing corporation. To give more guidance there are some more actions defined that are related to the different main-actions and conditions.

These sub-actions, as they can be called, are simple proceedings that will help guide the project or process. This are actions like informing the inhabitants, offer removal expenses, look for better techniques for sustainable upgrade, buyer identification and partnership with other housing corporations. In the end the decision table will lead to the two different resulting actions, or the actions that are the most important. This is the distinction between either making a sustainable upgrade or look for other projects that are better suitable for sustainable upgrade.

System dynamics: ownership condition estimation

From all the different conditions that are presented in the sub-tables, there is one factor that is tricky to estimate by the housing corporation: *the ownership condition*. To address this, a small system dynamics model will be used by applying the formula of the utility:

$$\hat{U}_{tenant} = \beta_{label}X_{label}\alpha + \beta_{inv}X_{inv}\alpha + \beta_{time}X_{time}\alpha + \varepsilon$$

Where:

\hat{U}_{tenant} = The estimated utility

β = The importance value of the single variable

X = The condition of the variable

α = normalisation factor

ε = The error term

The different utilities will then be modified in a probability so the system dynamics model can calculate the ownership condition.

$$p = \frac{\exp U}{\sum \exp U}$$

This model will use the same conditions as presented in the decision table. Only there interpretation of some terms will be different for the tenants and private owners. The tenants and private owner will have no relation to the energy label and will translate it to something else. Tenants will translate the higher label to an increase in comfort, while owners will translate it to a higher market value of their apartment when they decide they want to sell it.

RESULTS

By using two case studies, the different models were tested and applied. In the different cases the models worked by simply filling in the conditions and reading out the different actions that were advised. What was most interesting to observe was that there can be subtle changes in the process which lead to a completely different advice. This, for example, was the case in the case of the Surinamelaan. Here inhabitants (tenants and private owners) formed a group against the housing corporation to convince the housing corporation to act. In the end the decision table does what it should do, it weighs the risks, based on the conditions and gives an advice.

CONCLUSIONS AND FURTHER RESEARCH

In this research the goal was to see what housing corporations should do with mixed ownership in their portfolio in relation to becoming more sustainable. What was experienced is that there is no single solution for this problem; every complex should be



evaluated individually and based on the conditions a choice should be made. This research merely formed an advice in the form of a decision table, if the housing corporation sticks to the advice is up to them. All that is certain is that there is no ideal situation. There will always be factors that are either unforeseen or unpredictable. The models merely attempt to capture some factors to make an educated guess on what should be done in that particular situation. What is known is that there is still more research needed to investigate this problem completely.

When looking back at the situation, given the 2020 goal of reaching an average of label B in the portfolio in that specific year, the housing corporations are running out of time soon. They should quickly determine which of these mixed ownership complexes are feasible for upgrade and which are not. 2020 is approaching soon and the time it takes to actually make the upgrade is often overlooked or underestimated.

We mainly took the perspective of a housing corporation in the research. This is in contrast to the real world situation where the needs and wishes of the tenants and private owners also play a more direct role on the activities a housing corporation can do. The inhabitants were not the target of this research and require a further investigation.

To finish the research about these mixed ownership complexes; there is the fact if it provides a solid business case. By researching if it is possible to have a solid business case these projects could be seen in a totally different perspective.

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After a false start on a different topic, there was decided to leave that topic and start all over with a fresh start. This was for all the best, in the end. The research, even though, without a direct company, gave a ton of information and experience in the field thanks to roughly ten different company visits for all kinds of information.

Together with the support of fellow students and family, this lead to the results of this research as of how they are presented in this report.

Februari 2012 – September 2014	Master construction management and engineering
Oktober 2013 – june 2014	Facilities and financial manager – CME conference
September 2012 – September 2013	Certificate technology entrepreneurship
September 2012 – September 2013	Board of CoUrsE!
September 2008 – Februari 2012	Bachelor architecture, building and planning



Appendix 10: Dutch summary

INTRODUCTIE

In Nederland is een organisatie ontstaan voor het huisvesten van de lagere inkomens in de samenleving; de woningcorporatie. Door de taken van de woningcorporatie kregen deze subsidies vanuit de overheid om te kunnen blijven bestaan. In 1988 veranderde dit en de woningcorporaties moesten hun middelen van de kapitaalmarkt halen. Het resultaat was dat het portfolio van de woningcorporatie veelzijdiger werd, omdat het huisvesten van de lage inkomens niet haalbaar was anders. Tot 2008 ging dit goed, maar de crisis veranderde dit. Om toch te kunnen blijven bestaan, werden woningen verkocht. Dit leidde ook tot de verkoop van woningen in de verscheidene wooncomplexen die in het bezit waren van de woningcorporatie. Doordat niet iedereen de woning wou overkopen van de woningcorporatie ontstond een nieuw type wooncomplex, namelijk het gemengde wooncomplex (of VvE-complex).

Zes jaar na het begin van de crisis zijn de effecten nog merkbaar. De woningmarkt is nog herstellende en tevens zijn er nieuwe afspraken in de maak tussen overheden en de woningcorporaties. Een van deze nieuwe afspraken was om ervoor te zorgen dat de portefeuille van de woningcorporatie een gemiddeld energielabel heeft van B in het jaar 2020.

Probleem definitie

De afspraak om in 2020 een label B te hebben plaatst de woningcorporatie in een lastige positie. Grote delen van het portfolio zijn reguliere woningen en hierbij zijn er weinig problemen als het aankomt op verduurzamen. Desondanks ontstaan er wel problemen in de complexen waar eerder woningen zijn verkocht. Deze complexen bevatten huurders en kopers en daardoor weet de woningcorporatie niet goed wat er moet gebeuren met deze complexen in relatie tot het verduurzamen van het portfolio.

Onderzoek structuur

In dit onderzoek wordt onderzocht wat de verschillende mogelijkheden zijn voor deze wooncomplexen met huurders en kopers. Door de unieke situatie van zowel huurder als kopers en de samengang met de woningcorporatie, is er weinig onderzoek gedaan naar dit type problemen.

De woningcorporaties hebben veelal geen lange termijn visie op dit type problemen. De meeste corporaties verwachten dat een deel van het probleem zich nog zal oplossen middels de al eerder ingezette verkoop van woningen. Echter, dit is geen garantie dat de gestelde doelen van 2020 gehaald zullen worden. Daarom zal er ook gekeken moeten

worden naar de mogelijkheden van deze gemengde wooncomplexen voor het verduurzamen van het portfolio van de woningcorporatie.

Om dit te onderzoeken is de volgende onderzoeksvraag geformuleerd:

“Wat is de beste aanpak voor woningcorporaties om gemengd eigendom te verduurzamen?”

LITERATUUR

In de literatuur worden verschillende factoren die van belang zijn onderzocht. Allereerst zijn er de factoren welke een invloed hebben op de keuze van de woningcorporatie. De corporatie maakt niet de keuze uit zichzelf, maar gebruikt verschillende factoren om een afweging te maken om een complex al dan niet te verduurzamen. Vanuit de literatuur zijn er zeven factoren gevonden welke een rol spelen bij het maken van de keuze:

1. Proces innovatie
2. Relaties met andere belanghebbenden
3. Gedrag van de eindgebruiker
4. Voorkeur voor kleinere projecten
5. Investeringskosten
6. Het al in de verkoop zijnde van een groot deel van het portfolio
7. Het grote aantal verouderde complexen in het portfolio

Gebaseerd op deze keuzefactoren kunnen verschillende acties gekozen worden. Voor dit onderzoek zijn in totaal drie hoofdacties gekozen. Deze drie acties zijn: het behouden van de situatie zoals deze is; het verkopen van de huurwoningen en het terugkopen van de koopwoningen.

De combinatie van de keuzefactoren en de hoofdactie resulteert in een reeks van kleinere acties en uiteindelijk tot de belangrijkste keuze. Dit is de keuze of een gemengd complex vatbaar is voor verduurzaming of dat er gezocht moet worden naar een ander project.

METHODIEK

Om de verschillende factoren en acties te ordenen, wordt gebruik gemaakt van een zogenaamde *decision table* of keuzetabel. Hierin worden de verschillende keuzefactoren uitgezet als condities waarnaar het invullen van deze condities leidt tot een verticale kolom met daarin alle acties die geadviseerd worden.



Tabel 1: complete keuzetabel (Engels)

C1. Ownership condition	Positive								Negative				
C2. Portfolio transformation	Need				No Need				Need			No Need	
C3. Investment costs	Low		Med		High	Low	Med	High	Low	Med		High	–
C4. Process time	S	L	S	L	–	–	–	–	–	S	L	–	–
A1. Portfolio action	K	K	K	K	K	K	K	S	B	B	S	S	S
A2. Inform inhabitants	X	X	X	X				X	X	X	X	X	X
A3. Offer removal expenses									X	X			
A4. Look for better techniques	X	X	X										
A5. Buyer identification						X	X	X	X	X	X	X	X
A6. Partnership with other HC		X	X	X									
A7. Look for other projects					X	X	X	X			X	X	X
A8. Sustainable upgrade	X	X	X	X					X	X			
	01	02	03	04	05	06	07	08	09	10	11	12	13

Van alle condities is er één die niet goed af te schatten is voordat het proces begint; de *ownership condition*. Om deze toch te kunnen schatten is een System Dynamics model gebruikt. Dit SD model maakt gebruik van de andere condities om zodoende de schatting te maken van de acceptatie van de huurders en kopers.

RESULTATEN

In dit onderzoek zijn twee case studies toegepast op de verschillende modellen. Het voornaamste was om te testen of de modellen een goede weergave geven van de werkelijkheid en niet te veel afwijken van de cases. Dit is gedaan door de verschillende condities in te vullen in de keuzetabel en het SD model. Aan de hand van de ingevulde waarden ontstond een advies, welke overeen kwam met de uitwerking van de case in de werkelijkheid.

CONCLUSIES EN VERDER ONDERZOEK

In dit onderzoek werd onderzocht wat een woningcorporatie zou moeten doen met een gemengd wooncomplex als ze zouden willen verduurzamen voor 2020. Wat gebleken is, is dat er voor elk complex een andere oplossing kan bestaan. De keuzetabel geeft geen eenduidige oplossing voor de wooncomplexen, maar weegt de verschillende keuzefactoren van de woningcorporatie af en baseert daarop een gepaste actie. Dit betekent dan ook dat als een complex andere waarden heeft voor de keuzefactoren, dat er een ander advies ontstaat. Dit betekent ook dat de woningcorporaties nog een belangrijke taak voor zich hebben liggen; namelijk alle gemengde complexen individueel evalueren en kijken welke bij kunnen dragen aan het bereiken van de duurzaamheidsdoelstelling in 2020.

Wat wel met zekerheid gezegd kan worden is dat de tijd tot 2020 kort is. Om e tijd optimaal te kunnen benutten is het noodzakelijk om zo snel mogelijk de inventaris op te maken en te beginnen met kijken waar duurzame resultaten geboekt kunnen worden.

Natuurlijk is dit onderzoek maar een klein deel van een groter probleem. In dit onderzoek is bijvoorbeeld het beeld van een woningcorporatie genomen als uitgangspunt. Echter werkt een woning corporatie nooit alleen, er zijn altijd bewoners betrokken. De bewoners zijn in dit onderzoek niet volledig onderzocht en vereisen nog verdere uitwerking om een beter beeld te vormen van de situatie die zich voordoet.

Verder zou het interessant zijn voor woningcorporaties om te weten wat de gevolgen zullen zijn voor het bedrijf. Een business case over dit soort complexen zou een grote bijdrage kunnen leveren aan de motivatie om te handelen.

