Improving the Redevelopment Process of Obsolete Industrial Sites

An Application of Urban Land Readjustment and Game Theory

Submitted in partial fulfilment of the requirements for the degree of

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in

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by

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‘Herverkavelen is zij die willen ontwikkelen in positie brengen’
‘Reparcellation is positioning those who want to develop’

- Kadaster -

Preface

This master thesis is written as completion of the master track Construction Management and Urban Development (*also named Construction Management and Engineering*) at the Eindhoven University of Technology.

The last six months of the master track were dominated by exploration and intensive research towards Urban Land Readjustment, Game Theory, and the improvement of the redevelopment process of obsolete industrial sites in the Netherlands. The research is conducted in cooperation with the Kadaster (*department Ruimte & Advies Apeldoorn*), KENWIB-foundation (*collaboration between government, business and university in the province of Noord-Brabant*) and Eindhoven University of Technology.

At the beginning I was looking for a topic which possessed a relationship with the topics: stakeholder management, land management, process management, and industrial sites. In addition, the changing urban development practise and economic crisis in the Netherlands grabbed my attention, such as new players and forms of collaboration, shifted focus towards the redevelopment of existing urban areas, and improved costs awareness. With these topics and events in my mind I started searching for a suitable topic. Urban Land Readjustment crossed my path, which is currently under development to become an official land management instrument in the Netherlands, and it turned out to be the connecting link. The instrument attracted my attention due to the versatile usage and possibility to reduce unwanted stagnation during urban development.

I faced many challenges during this research, from finding a suitable topic and expertly company, to the interpretation of literature, dealing with research methods, writing outcomes, and conclusions of the thesis. Writing this thesis was not possible without the help of many people. Firstly, I would like to thank my supervisor from the Kadaster Guido Kuijer and his team (*Marc van Geene, Johan Groot Nibbelink & Sanne Holtslag-Broekhof*) from the department Ruimte & Advies in Apeldoorn. They gave me the opportunity to do my research and gave access to their knowledge and expertise in the field of Urban Land Readjustment. Secondly, I want to show my gratitude to my supervisor from the Eindhoven University of Technology Brano Glumac. He helped me with the research methods and structuring the research process. Thirdly, I want to thank Gert Regterschot for his help with statistical problems during the modelling process.

And last but not least: I would like to thank my family and friends for their help and support. But also for leisure and welcoming distraction moments together!

Enjoy reading,

Guido van Veen
Eindhoven
August, 2014

Chapter 1: Research Introduction

The purpose of this research is to improve the redevelopment process of obsolete industrial sites in the Netherlands. In this chapter the research design is explained in detail. The chapter starts with some brief background information about obsolete industrial sites in the Netherlands. In subsequent paragraphs, the problem statement and research questions are formulated. Sub-questions will be derived from the central question, which will be used for answering the main question. The chapter will end with research boundaries, limitations, a description of methodologies, and a thesis reading guide.

1.1 Obsolete Industrial Sites in the Netherlands

Industrial sites are of great importance for the Dutch economy, because they provide employment for one third of the total labour force (Ministerie van Infrastructuur en Milieu, 2011). But the spatial quality of these industrial sites is worrisome, because approximately thirty percent do currently not meet the requirements. The sites are in poor condition, obsolete, cluttered, lacking coherency due to individual sales of plots, and providing poor accessibility (Ministerie van Infrastructuur en Milieu, 2011). The obsolete industrial sites are usually not part of cities and villages and therefore situated at the outer ring. But there are also old sites of heavy industry, the so called brownfields, constructed long before 1975, located in the urban centres (Beseme & Puylaert, 2009). The primary focus of entrepreneurs lies on their production process, and fragmented ownership of property is causing low interests for maintenance (Schenau, 2011; Louw, 2004; Planbureau voor de Leefomgeving (PBL), 2009). The poor condition of these industrial sites is causing fast depreciation and affects the spatial quality. However, municipalities are still trying to offer many hectares of land for new industrial sites, despite problems with obsolete industrial sites. The Minister of Infrastructure and Environment (*VROM*) has thus stated that land is scarce in the Netherlands and thus the space is unnecessarily in danger due to the construction of Greenfields (Ministerie van Infrastructuur en Milieu, 2011). The new awareness triggered the search for new solutions for tuning the qualitative and quantitative supply and demand, whereby the focus changed from building new industrial sites towards the redevelopment of obsolete industrials sites. The main target: creating sustainable and solid industrial sites wherein private parties are willing to invest (VROM, et al., 2010; Ministerie van Infrastructuur en Milieu, 2011).

The government is determined to counteract pauperisation, and to stimulate efficient use of space and improvement of spatial quality. Therefore, as part of the policy program 'Mooi Nederland', by the Ministries of Economic Affairs (*MEZ*) and VROM in 2008, a specialised 'Taskforce Redevelopment Industrial Sites (*THB*)' was created under direction of P. Noordanus. He argued that one third of the industrial sites are obsolete, which represents 32,000 ha of land (Noordanus, 2009; Noordanus, 2010; Ministerie van Infrastructuur en Milieu, 2011). The Taskforce identified four major problems on the industrial market: (1) fast aging of industrial sites, (2) a large and inexpensive supply of Greenfield locations, (3) missing demand-driven developments by private parties and therefore many different offers by the municipalities, and (4) often poor spatial quality and landscaping of Greenfield developments (Noordanus, 2009). The Taskforce advised that new industrial sites are needed in the future, but that by the development of new industrial areas the government has to take into account the problems with existing industrial sites. This to prevent the same problems on new-

ly developed industrial sites in a few years' time. To counteract the problems the Taskforce proposed that redevelopment and maintenance needs to be 'verzakelijkt (*commercialised*)', whereby sustainable industrial sites need to be the final result (Taskforce herontwikkeling bedrijventerreinen, 2008; Noordanus, 2009).

The 'verzakelijking' resulted in an active collaboration between public parties, developers and investors. As a result, direct subsidies from the provinces to the municipalities were discontinued. Specialized development agencies (*such as the BOM, LHB*) were created to restructure and revitalise approximately 15,800 hectares of obsolete industrial sites until 2020 (Ecorys, 2013). In addition, the 'verzakelijking' is aiming at better regional coordination and redevelopment of obsolete industrial sites. Not plot by plot, but by the approach of a joint 'area development' (Noordanus, 2009; Taskforce herontwikkeling bedrijventerreinen, 2008). Unfortunately, not long after the new approaches the economic crisis occurred, which caused a major upheaval. As a reaction, public and private parties (*i.e. developers and investors*) reduced their investments and tried to reduce their financial risks. The restructuring tasks stagnated due to a lack in demand (*market, often the impetus to restore a site*), budget cuts from both parties (*financial*), and other priorities of the governments (*institutional*). This event eventually resulted in a poor rate of completion (*only 20% of the total amount of planned redevelopment activities*) (Vastgoedmarkt, 2013; Bleumink, 2013; Taskforce herontwikkeling bedrijventerreinen, 2008). The times of major redevelopment projects are over, and a growing interest of public parties is observable towards investments by private parties (*developers, investors, property owners*) in redevelopment. Entrepreneurs are currently regarded as a potentially interested group; their demand could be triggered by, for example, problems with expansion, business climate affected by vacant premises, or other problems (Vastgoedmarkt, 2013; IBIS, 2013). As a result, public parties are trying to trigger private parties (*especially entrepreneurs*) to invest by using 'uitnodigingsplanelogie (*invitation planology*)' (IBIS, 2013).

1.2 Problem Definition

The Kadaster is noticing the stagnated redevelopment process of obsolete industrial sites, but also stagnation in the whole urban development practise. It appears that the Kadaster is trying to find a positive stimulant for a joint approach, where fragmented ownership of property, unwillingness of participation, and problems with conflicting interests are not blocking initiatives for a redevelopment project between multiple (*private*) parties. The shifted focus towards the redevelopment of existing industrial sites requires a different approach than Greenfield development. The Kadaster is noticing that existing land management strategies are failing and new approaches are needed to support these (*new*) kinds of (re)development initiatives in order to reduce the number of vacant plots, improve the spatial quality, and economize. Therefore, the problem statement has been defined as follows:

> ***'The Kadaster detects stagnation and missed opportunities for the redevelopment process of obsolete industrial sites'.***

1.3 Research Questions

In this paragraph, one main research question is composed and two sub-questions have been derived. The purpose of this research is to stimulate the redevelopment process of obsolete industrial sites. The main research question is composed as follows:

How is the Kadaster, by using 'interventions', able to improve the redevelopment process of obsolete industrial sites in the Netherlands?

For the delineation of the research two possible ways have been used for providing interventions for the improvement of the redevelopment process of obsolete industrial sites in the Netherlands. These are (1) 'Urban Land Readjustment (*ULR*)' and (2) 'Predictions'. First, ULR is an experimental land management instrument which is currently under development by the Kadaster in collaboration with e.g. the Dutch government and private parties. The Kadaster is able to support the usage of ULR and thus able to provide interventions with the tool. Second, the Kadaster is interested in instruments that can predict. Prediction provides the Kadaster with a strategic advantage, as a particular scenario can be analysed before it occurs. The Eindhoven University of Technology provided the Game Theory as a tool for the analysis and prediction of complex decision-making. The following sub-questions have been formulated:

- How is the Kadaster able to improve the redevelopment process of obsolete industrial sites by interventions with 'Urban Land Readjustment'?
- How is the Kadaster able to improve the redevelopment process of obsolete industrial sites by interventions with 'predictions' during decision-making processes with the help of the Game Theory?

1.4 Research Objectives and Contributions

First of all, this research has been written with the purpose to stimulate the redevelopment process of obsolete industrial sites in the Netherlands. Second, the Netherlands is a small and densely populated country with very limited land area. Therefore this research contributes to the improvement of spatial quality, sustainable development, and the Dutch economy. Third, the research has been written for better understanding of the changing context of the urban development practise and industrial market, especially in view of the challenges faced and the changing importance of stakeholders. The fourth objective is to gain knowledge about Urban Land Readjustment and its implementation in Dutch spatial planning. Writing the thesis in English is providing other countries with the opportunity to learn from Dutch practise. Fifth, another objective was to provide the Kadaster with a tool for the improvement of analysis and prediction of decision-making scenarios with the scientific research method Game Theory. With this tool they might be able to intervene by optimizing decision-making during the redevelopment process and reduce missed opportunities. And last, there are limited applications of the Game Theory in the field of urban development. The goal is to provide a contribution towards modelling a complex decision-making scenarios.

1.5 Research Boundaries

There is a predefined time scheduled for this research and therefore it is not possible that all aspects of Urban Land Readjustment and problems during the redevelopment process of old obsolete industrial sites can be investigated and described. The research will provide a global overview of the current status of ULR as proposed in June 2014 by the '*Commissie Stedelijke Herverkaveling*' and presented to Minister Schultz van Haegen of the Dutch Ministry of Infrastructure and Environment. The tool is still under development, and aspects may change over time. It must be noted that not all redevelopment processes are the same: this is con-

text and site specific. The setting of stakeholders, their interests, and strategic behaviour are unique in each situation. As a delineation the case study of Maasbracht will be used.

1.6 Research Methodologies

The following methodologies will be used to provide answers to the research questions: literature study, case study, Game Theory, Agent Based Modelling (*ABM*) software NetLogo, Strategic Choice Modelling, and Fuzzy Delphi Method.

1.6.1 Literature Study and Case Study

The literature study will provide information about the problems on obsolete industrial sites and the experimental spatial planning tool Urban Land Readjustment. Furthermore, it provides insight into the complexity of collaboration and decision-making in the field of urban development. The literature study will thereby help to find more information about the scientific research method Game Theory and its applications.

1.6.2 Game Theory

The Game Theory is a research theory of interdependent decision-making in which the involved decision-makers hold conflicting interests (*preferences*) and the outcome of their decisions cannot be determined by one actor or group only. The Game Theory is often defined as the 'theory of conflict' due to its focus on conflicting interests. In many fields the Game Theory is an accepted research method, such as natural science, computer science, and social science. 'The increasing attention of Game Theory is due to the potential to improve our understanding of social interactions in general and interactive decision-making in particular (Samsura, et al., 2010)'. The Game Theory is not yet widely used in the field of urban development, which could be explained by the particularly context-driven environment. But there is a growing interest in the usage of Game Theory in the urban development practise (Ball, 1998; Ball , et al., 1998; Auman, 1985; Myerson, 1991; Colman, 1999; Hargreaves Heap & Varoufakis, 2004; Samsura, et al., 2010). In this research a three-player-bargaining game in extensive form will be constructed wherein a negotiation scenario will be modelled on the basis of the case study of Maasbracht. The decision-making scenario will be analysed and the outcome predicted. With the help of the Game Theory, the Kadaster is able to steer the redevelopment process of old industrial sites in advance, and thus able to intervene on the basis of predicted future developments ahead of time in order to reduce stagnation and problems in the process.

1.6.3 Agent Based Modelling (ABM)

For this research the Agent Based Modelling (*ABM*) program NetLogo will be used. ABM is a class of computational models, specifically designed for the simulation of actions and interactions of so called autonomous agents, aiming to view their effects on the total system. ABM uses elements from the field of Game Theory. NetLogo is a program which can be used for Multi Agent Models and is useful for simulation modelling in the field of construction management and urban development (Ralha, et al., 2013; Yan, et al., 2013; Ling, et al., 2013; Parsons & Wooldridge, 2000). The Game Theory model will be modelled in NetLogo for fast computation of the outcomes of the model.

1.6.4 Strategic Choice Modelling (SCM)

The Game Theory in combination with Discrete Choice is called Strategic Choice Modelling. Discrete Choice Models are models which describe, explain, and predict choices between two or more discreet alternatives, for example choosing between different transportation modes (Bas, et al., 2008). Strategic Choice Modelling is able to calculate the outcome of the extensive form game by using statistical formulas. The model will be converted to NetLogo for the calculation of the prediction of the final outcomes of the Game Theory model.

1.6.5 Fuzzy Delphi Method (FDM)

The Fuzzy Delphi Method (*FDM*) is derived from the traditional Delphi method. This tool is a communication technique to gain information in a structured way, mainly based on a weighting system obtained from a panel of experts. The method is thus based on group thinking of qualified experts that assures the validity of the collected data. Applying the Fuzzy Delphi Method to group decision may solve the 'fuzziness' of common understanding of expert opinions (Ishikawa, 1993; Noorderhaven, 1995). The Fuzzy Delphi Method will be used for gaining experts' opinions for the prediction of the outcome of the Game Theory model.

1.7 Thesis Outline

This first chapter presented the problems with obsolete industrial sites in the Netherlands and the large influence of the economic crisis. The importance of fighting aging is emphasized. In addition, the research design is explained, including the problem statement, research questions, boundaries, and methodologies.

Chapter two presents a tripartite literature review. Part A is dedicated to the experimental land management strategy Urban Land Readjustment. In this part the changing urban development practise, the origin and process of ULR, and ULR compared with existing land management strategies in the context of Dutch spatial planning will be discussed. With the knowledge of ULR and the changing context of the urban development practise, the report will continue with part B wherein we will return to obsolete industrial sites in the Netherlands. In this part a brief overview will be given about the emergence of aging on industrial sites in the Netherlands and other problems. Afterwards, ULR will be linked with the redevelopment process whereby the study will examine how the Kadaster is able to improve the redevelopment process of obsolete industrial sites by interventions with help of ULR. In part C a side step will be made towards decision-making in the urban development practise which is needed to understand how prediction can be used for interventions. We will see that collaboration and decision-making is one of the most complex parts of the redevelopment process. In addition, the negotiation process during ULR will be presented and afterwards the Game Theory will be introduced. The Game Theory will be used as research method for the analysis and prediction of a certain decision-making moment.

In chapter three the case study 'wet industrial site' in Maasbracht will be analysed. The redevelopment process of the industrial site is one of the eleven pilot projects of ULR in the Netherlands. Maasbracht is a 'wet' industrial site in the province of Limburg where ULR has been applied due to problems with the expansion of the companies on site.

The fourth chapter will go deeper into the 'prediction of interventions' by using the Game Theory to analyse and predict a specific decision-making moment in the case study of Maasbracht. The question that will be answered is: what will the optimal strategies for the involved stakeholders, both public and private parties, be during the redevelopment process of the case study in Maasbracht? By predicting this development in advance, the Kadaster is able to adjust and steer decision-making and behaviour towards an optimal result. And thus the Kadaster is able to improve the redevelopment process by interventions with 'predictions'. The aim is to create a three-player bargaining Game Theory model. First, the stakeholders of Maasbracht will be grouped and translated to players, which are more useful for the Game Theory. Second, a bargaining game about the influence level of two chosen negotiable attributes will be constructed. The interests, payoffs, and strategies of involved actors will be made visible. For the prediction the Fuzzy Delphi Method will be used to receive usable data from experts in the field of urban development. Based on the outcomes, advice will be provided about the predicted optimal influence level of both parties in order to reduce problems. Hence, the possibility to steer the process will improve the redevelopment of Maasbracht.

The fifth and final chapter consists of the most important research conclusions and summarizes the answers to the research questions. Afterwards, the recommendations for the Kadaster will be written, a discussion will be started, and further research will be suggested.

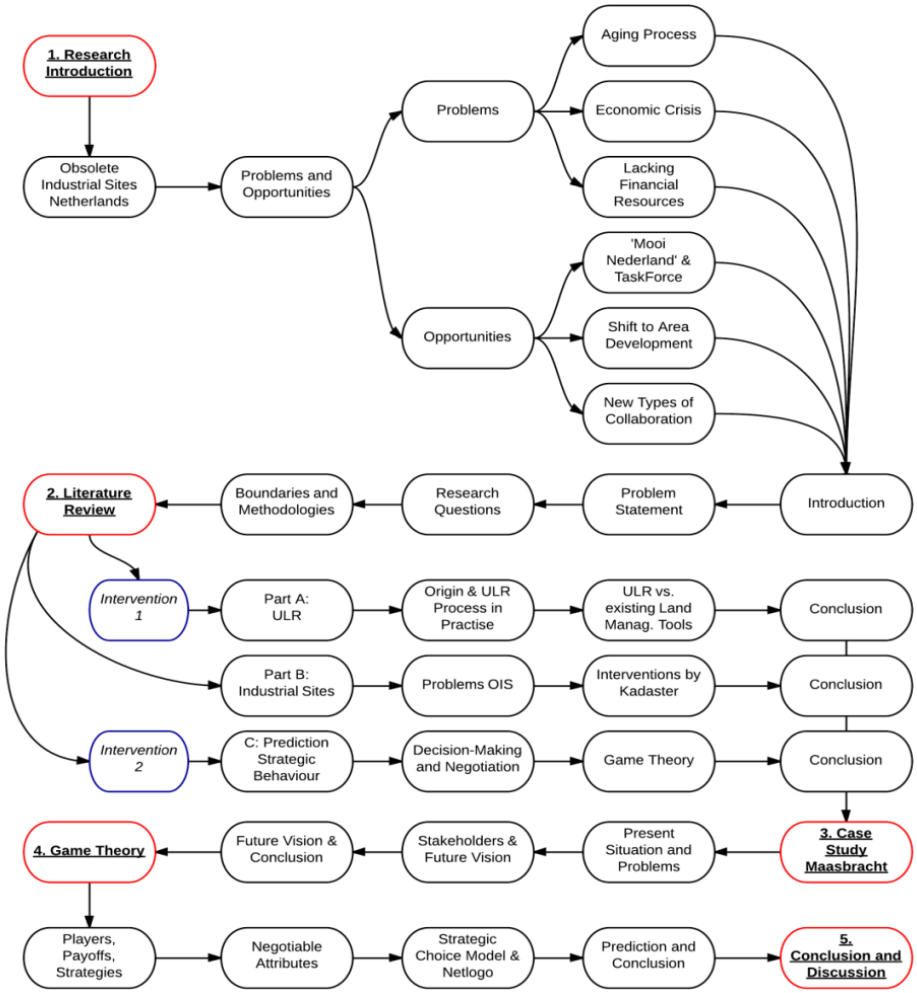

Figure 1 | Research Overview

Chapter 2: Literature Study

Part A | Changing Urban Development Practise & Urban Land Readjustment

The economics crisis is not only affecting the redevelopment process of obsolete industrial sites, but the whole urban development practise. Therefore, the first part of the literature review starts with the changing urban development practise. We will see that the changing context has caused a shift in focus towards the redevelopment of existing property for the sake of (*e.g.*) combating obsolescence, enhancing safety, promoting the expansion of premises, and meeting the changing demand (Pleijte, et al., 2006). But redevelopment of existing urban areas, including obsolete industrial sites, requires a different approach as compared to Greenfield development, mainly due to problems with fragmented ownership of property, unwillingness to participate, and conflicting interests. The Kadaster is willing to provide a positive stimulant to reduce unwanted stagnation by introducing the experimental land management strategy Urban Land Readjustment for Dutch spatial planning. The report will therefore continue with the introduction of ULR (Bonke, 2013).

2.1 Changing Urban Development Practise in the Netherlands

For many decades, especially after World War II, the urban development practise in the Netherlands was dominated by the ambition for growth and resulted in new cities, residential areas, and work locations (De Wolf, et al., 2004; Van der Krabben, 2011; PBL & ASRE, 2013). It was a time when financial resources were plentiful and many projects could be characterized as ambitious and large scaled, build for a supply-driven market, lacking flexibility due to highly detailed masterplans, top-down approach managed by the government, focussed on realizing profits on both land and real estate developments, and whereby exploitation and maintenance were immaterial (Peek, 2011; Noordanus, 2010; Praktijkleerstoel Gebiedsontwikkeling, 2013). But the tide has turned: the urban development practise is changing significantly (StrateGis Groep, 2010; Van der Krabben, 2011). Despite the ambition and enthusiasm for growth, problems appeared between ambition and reality. The land management approach, also referred as Gebiedsontwikkeling 1.0, turned out not to be future proof since the outbreak of the economic crisis in 2008. This event significantly changed the real estate sector, urban development practise, and the functioning of urban areas (Verlaat, 2008; Peek, 2011; Noordanus, 2010).

<table>
<tr><th>Exploitation</th><th>Initiative</th><th>Feasibility</th><th>Realisation</th><th>Exploitation</th></tr>
<tr><td></td><td colspan="3">Gebiedsontwikkeling 1.0</td><td></td></tr>
<tr><td colspan="4">Gebiedsontwikkeling 2.0</td><td></td></tr>
<tr><td colspan="5">Gebiedsontwikkeling 3.0</td></tr>
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Figure 2 | Comparison Gebiedsontwikkeling Models (Kadaster 7, 2013)

The crisis has caused a major drop in demand and investments have fallen substantially. It is expected that this situation will last for a long period and will even become a structural problem (De Wolff, 2013; Van der Krabben, 2012). In practise we can see e.g. high vacancy rates on the office and retail market, quantitative oversupply on the housing market, and obsolescence and deterioration in industrial areas. All of these affect the spatial quality and

local economies (Van der Krabben, 2011). Private parties, such as developers and investors, are less present on the development market and are trying to reduce their risks. Public parties have fewer resources to fulfil an active role, are primarily engaged in crisis management and reinvention, and became more aware of the high risks in pursuing an active role (*i.e. active land policy*) in urban development (PBL & ASRE, 2013; Van der Krabben, 2011). It can be stated that urban development in the Netherlands is stagnating and many parties do not know how to react to the changing context. As a result, the urban development practise, real estate sector, and public authorities are searching for adjustments and especially new approaches in the form of alternative strategies and business models (Van der Krabben, 2011; PBL & ASRE, 2013; De Zeeuw, et al., 2013; Zeeuw, 2011). Urban Land Readjustment is one of the potential alternative strategies which are currently under development by the Kadaster and other parties. They joined forces in the Commissie Stedelijke Herverkaveling to gain knowledge, set up pilot projects, and exchange advice (Commissie Stedelijke Herverkaveling, 2014).

2.2 Land Consolidation and Urban Land Readjustment

Urban Land Readjustment is an experimental instrument in the Netherlands for the rescheduling of property, such as land and real estate, with the aim of taking initiative or facilitating area (re)development (Kadaster 1, 2013). The instrument has been derived from an instrument known since almost 100 years in the Netherlands called Land Consolidation. In Dutch we call it ruilverkaveling. Land Consolidation has been a legal spatial planning instrument in the Netherlands since 1924 and is part of the WILG Act legislation (*Wet Inrichting Landelijk Gebied*) (Rijksdienst voor Cultureel Erfgoed, 2011; Bergman, 2012; De Wolff, 2013). Land Consolidation was introduced in response to an economic crisis in the Netherlands and used by the government to improve the self-sufficiency of food production. With this legal instrument it was possible to exchange land between landowners voluntarily or by enforcement (Molema & Van den Brink, 2008; Rijksdienst voor Cultureel Erfgoed, 2011; Kadaster 6, 2013). The problems with rural plots at that time were fragmented ownership of property, small and poorly accessible plots, and poor drainage (Rijksdienst voor Cultureel Erfgoed, 2011). With help of Land Consolidation, farmers were able to get fewer but larger plots closer to the location of the farm and were able to improve the economic functioning of their business (De Wolf, et al., 2004).

2.3 Urban Land Readjustment Process

ULR is an instrument which facilitates the exchange of property - forced or voluntary - within an existing urban area. There are three forms of ULR, namely (1) ULR by agreement ('*voluntary*' and seen as '*Organische Ontwikkeling'*), (2) ULR by decision ('*light*' and seen as *'Uitnodigingsplanologi*e'), and (3) ULR under direction ('*forced*')[1] (De Wolff, 2013; Kadaster 7, 2013; Commissie Stedelijke Herverkaveling, 2014). The instrument is officially a private instrument specifically designed to deal with fragmented ownership of property situations without using expropriation (De Wolff, 2013). Public parties may also be involved during the urban redevelopment process by taking the initiative and/or facilitating the process, but can also participate if they possess property, such as land and real estate. These parties all hold different kinds of interests. The process is an attempt to meet all mutual and individual in-

[1] *At this moment there is no official legislation for ULR yet, and therefore ULR by agreement can be used. Legislation might help to stimulate urban development projects and may even help in forcing property owners to participate. Legislation is expected in the year 2018* (De Wolff, 2013; Kadaster 1, 2013).

terests, which makes it a complex process (Kadaster 4, 2013; Arentze & Achten, 2007). To manage this process and to meet the wishes and interests of the involved stakeholders, a bottom-up process-oriented approach was proposed in June 2014 by the 'Commissie Stedelijke Herverkaveling' (*a collaboration between representatives from VGN, Kadaster, NEPROM, Ministeries van BZK, IenM and Experts*) and presented to Minister Schultz van Haegen of the Ministry of Infrastructure and Environment (Kadaster 2, 2013; Kadaster 1, 2013). Figure 3 provides an overview of the extensive form of the ULR process. It must be noted that the process is characterized by many negotiations. In the upcoming paragraphs the process will be explained in more detail. The basis of the process has been extracted from the Dutch rural Land Readjustment process:

2.3.1 Forming the Area Commission & Urbanisator

The process can be initiated by four different approaches, namely (1) mono-actor environment, (2) multi-actor environment, (3) government induced environment, and (4) government initiated environment. Mono-actor refers to the fact that a single private party is taking the initiative to start an urban (re)development process and asks a public party to facilitate. Multi-actor environment refers to the collaboration between multiple private parties and may ask public parties to join or facilitate the process. Government induced refers to the representation of collective (*public*) values by public parties, trying to induce private parties into self-organizing area development whereby the public party will become a partner, or will facilitate the process. Government initiated area development means that a public party will initiate, from the perspective of collective values and development, and will actively involve local parties (Kadaster 4, 2013).

First, an 'area commission' will be formed. This commission includes representatives from the area, initiators, and public parties. The commission will start the collective planning and will be supported by independent experts like the Kadaster. The area commission is seen as an 'advisory commission' which will become part of the municipality. If needed, the area commission is able to appoint a second party which will guide and guard the entire process. This party will also form a link between the involved actors in order to mitigate the risks, such as lack of progress or high costs. This party is called the 'Urbanisator', which can be an independent consultancy management bureau or a commission formed by people from inside the area commission or a government party. The municipality has a special role because it has to safeguard public interests (*e.g. infrastructure, green spaces, etc.)* and has the legal authority to finalize the master plan when it is ready for execution. The initiative of the development has now kicked off.

2.3.2 New Masterplan and General Administrative Law

Second, a new masterplan is required and will form the basis for the final land exchange. The master plan is also used for delineation of the area. All landowners put their ground into a fictitious 'Ground Pot' which removes fragmented ownerships (*the ground pot can be seen as joint Area Development Company or 'Gebiedsontwikkelingsmaatschappij' wherein the owners of land and real estate temporary transfer their rights into the company*). Before it is possible to create the new master plan, the current situation has to be described, a vision has to be made for the new situation, and input has to be gathered from all involved actors for the new situation. A document with Starting Points for the ULR (*Uitgangspunten Stedelijke Herverkaveling*) will be created which includes Taxation and Valuation of property

and a Wish Session with all involved parties. The Taxation and Valuation (*Taxatie en Waardering*) will include a List of Current Rightholders and will be prepared by the Kadaster on behalf of the area commission. The List of Rightholders (*Lijst van Rechthebbenden*) is the description of the situation of the current ownership and status of the property (*e.g. quality of the land, mortgages, restrictions, lease and tenancy relations, advice for the ULR, etc.).* The Wish session (*Wenszitting*) is an inventory of individual wishes regarding existing and future land and real estate of all involved actors.

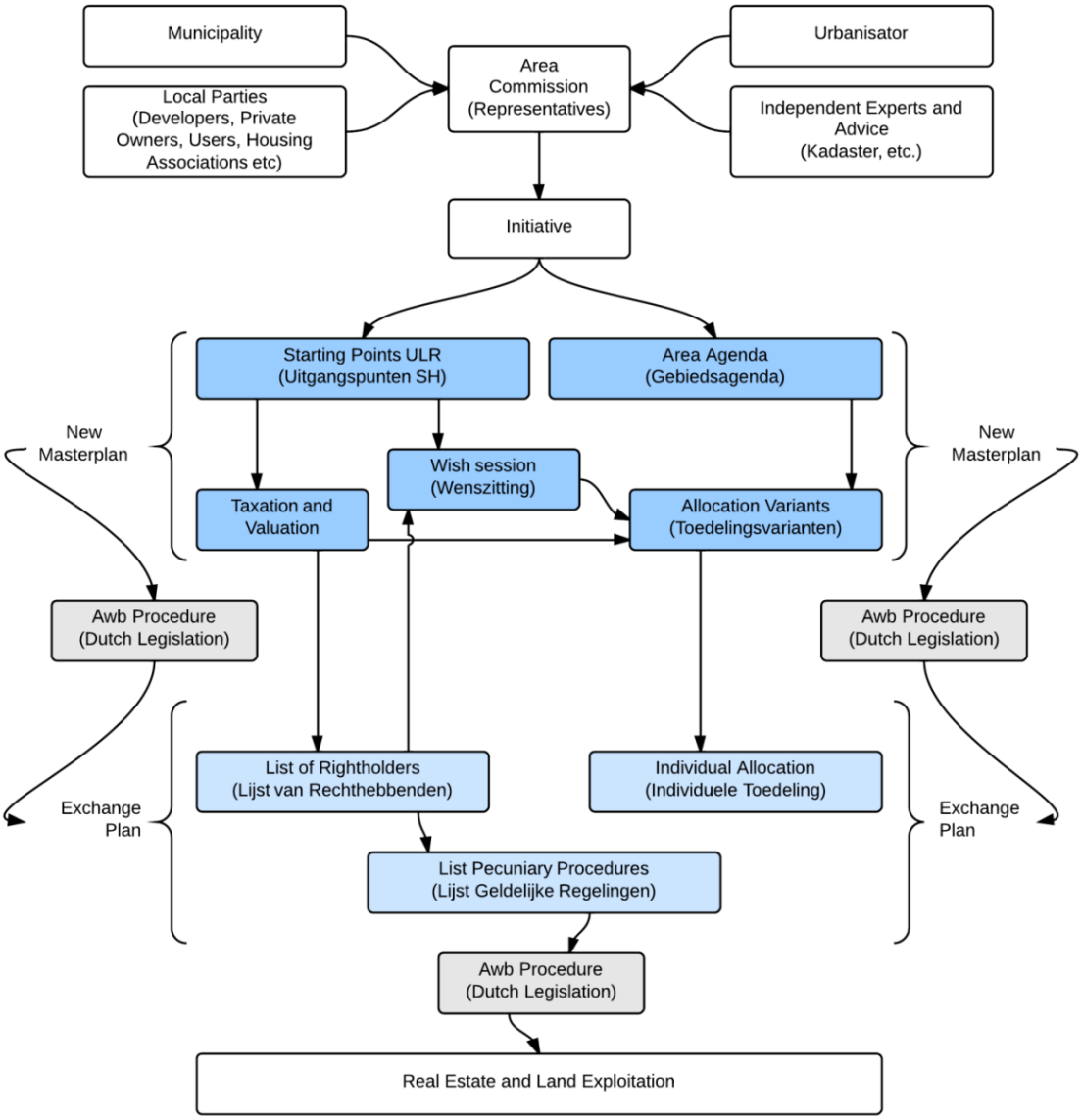

Figure 3 | Process Urban Land Readjustment (Kadaster, 2013)

The individual wishes of the involved parties are identified by the area commission and recorded directly. They have significant influence on the input for the new master plan. During the session, the area commission will ask for proposed changes in corporate rights, property or anterior agreements. They will also clarify the legal consequences if there are changes in the legal situation after a reference date which has to be determined by the area commission. Besides the Starting Points for the ULR, an Area Agenda (*Gebiedsagenda*) will be created by the area commission with a vision of the appointed area. The Taxation and Valuation,

Wish Session and Area Agenda will be used to create Allocation Variants. The Allocation Variants (*Toedelingsvarianten*) is the combination between the Area Agenda and Wish session translated into one or several new ownership situations. The area commission uses the allocation variants as instruments to establish support among the parties of the area. The area commission will choose the plan with the best fit and the one with the most support of the involved actors. The new master plan is then complete and will be used for the land exchange process. When the new master plan has been made and agreed upon by the involved parties, it will be brought into effect with help of the General Administrative Law (*Awb*). Legal changes of the new master plan can be made with the help of the General Administrative Law, which means actors and citizens are able to view the new master plan and provide feedback for changes during a specified period of time. After this period, the design will then be changed if needed. If everybody agrees, the new plan can be made legal and binding for all parties.

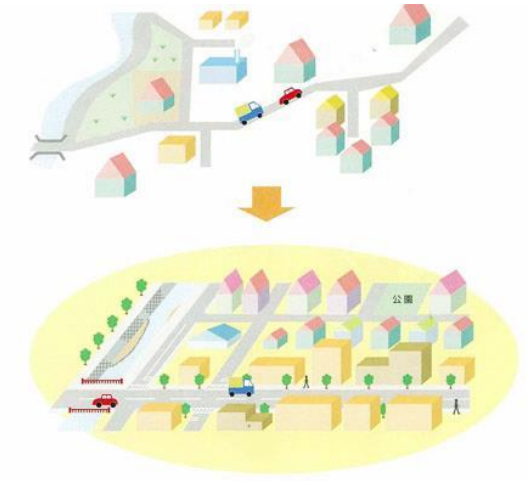

Figure 1 | Urban Land Readjustment
Before and After Situation

2.3.3 Land Exchange Process and Execution

Third, the new master plan has been finished and will be used for the land exchange process. In this phase the actual exchange of land takes place. It is seen as the transition between the existing and future state of the area. The ´exchange plan´ will be made by the area commission. The exchange plan will be the translation between the new master plan and new ownership of the involved actors. One of the Allocation Variants is chosen and will be converted into an Individual Allocation. The Individual Allocation (*Individuele Toedeling*) is the translation of the Allocation Variants into the new individual ownership situation and contains realistic calculations of the costs and benefits of new situation and the differences between the begin situation and final situation. There is also an individual consultation session wherein location, shape, financing, etc. can be discussed and changed. The outcome of the consultation may result in changes to the proposed allocation. The List Pecuniary Procedures (*Lijst Geldelijke Regeling*) is the financial settlement overview which will be used for acceptance of the new ownership situation. The differences between the old situation and new situation which arise and are expressed in different surface, value and use of property are then settled. The final plan will be brought into effect with help of the General Administrative Law (*Awb*). If everybody agrees the new plan can be made legal and binding for all parties. The execution and exploitation can start.

2.3.4 No more Expropriation and Forced Participation

The power of the instrument lies in the ability to force actors to join the (re)development process by law. As a result there is no more need for expropriation *(which may result in cost and time savings for the municipality and probability reduction of stagnation*) and freeriders will no longer benefit. But the question is how to force these parties? Despite the current absence of official legislation, the keyword is 'the majority'. If the majority is in favour, then the city council will be able to impose the usage of Urban Land Readjustment (Commissie Stedelijke Herverkaveling, 2014).

2.3.5 Cost Distribution

The costs arising from the plan preparations will be pre-financed by the government or shared between the involved parties subject to agreement. The costs of the actual execution of ULR, including preparation and execution costs, are borne by the involved owners themselves. The government is able to provide subsidies to use them as stimulant, and to lower the owners' costs to make the process more feasible. The aim of ULR is to create higher taxation values in a certain area after the redevelopment. The extra created value of the land, the difference between the new and old value, will be used for the (re)development of public spaces and maintenance. If an owner is creating extra value by himself, for example by further development of his property, then he is allowed to keep it. And thus, in the best case scenario, all parties will benefit after the ULR process (Kadaster 1, 2013; De Wolff, 2013).

2.4 Forms and Core Tasks of Urban Land Readjustment

Five approaches of Urban Land Readjustment can be distinguished, namely: (1) small scale tailored exchange of property (*kleinschalig ruilen op maat*), (2) usage land readjustment (*gebruiksverkaveling, regarding leasehold*), (3) Umlegung (*new allocation of parcels in the new situation occurs in proportion to the value*), (4) trade chain (*ruilketting*), and (5) integral planned land readjustment (*integraal planmatige ruilverkaveling, even between regions*) (Kadaster 7, 2013). The last approach can be seen as one of the most complex approaches, since there are many different stakeholders (*>30*) involved, with many different interests, and many types of buildings usage. The question is whether ULR is able to facilitate this. The Wolff (2013) identified eight core tasks of ULR:

- **Exchange of land:**
  The exchange of land refers to the adjustment of the plot boundaries and/or the exchange of plots between land owners in order to realize a project;
- **Exchange of buildings:**
  It is also possible that real estate is situated on top of the land. And thus besides the exchange of land, also the buildings on top of the plots will be exchanged between owners in order to realize a project;
- **Exchange of construction and development rights:**
  It can also be necessary to transfer the 'development and construction' rights to another place, and thus to exchange the construction and development rights in order to realize a certain project. For example when a developer wants to build new property in times of economic crisis (*and thus runs a high risk of vacancy after finishing the project*), then the development right can also be exchanged against the redevelopment of existing buildings in the same area or a complete different area;

- **Exchange of users:**
  Another possibility can be found in the exchange of users in order to realize a certain project. If a certain area needs to be (re)developed or there are areas with scattered vacancies for example, then existing users can be transferred to another building(s) from another owner(s). This can be used to fight empty properties and/or clustering of certain activities (*e.g. shops*);
- **Cede of land for public or collective facilities:**
  It is also possible that land will be ceded in order to realize collective facilities in order for a more intensive use of an area, such as parks and infrastructure. An owner can volunteer or be forced to cede land and thus after the project has been finished the owner will receive less land back;
- **Joint realization of collective or semi-collective facilities**
  If private parties want to develop a certain area, they may want to create collective or semi-collective facilities and infrastructure. Then it is possible to allow construction on the land and collective investment of the transformation of the land including risks;
- **Joint realization, redevelopment, and maintenance of real estate:**
  To realize this point it is necessary that collaborating owners are clients of the project. This point can be seen as extensive renovation and/or maintenance of real estate in a certain area. Another example is the reduction of property in shrinking areas. Then it is possible to allow construction on the land and collective investment in the transformation of the land including risks;
- **Organizing joint direction**:
  In a private-private setting the owners need to organize the process jointly. Therefore owners need to transfer rights temporarily to a central party in order to realize a certain project. In a public-private setting the municipality may take this role.

2.5 Urban Land Readjustment National Pilot Projects Netherlands

Despite that ULR is in experimental phase, more and more public and private parties are showing their interests in the new land management instrument. This has resulted in eleven pilot projects across the Netherlands, each with their own problems and focus. The pilot projects are executed with the help of many different parties and experts, lead by Commissie Stedelijke Herverkaveling (Commissie Stedelijke Herverkaveling, 2014). Good examples showing the usability of ULR are: '*reducing vacancy shopping street in Dordrecht*', '*full freedom of urban design residential area Lammenschans in Leiden*', '*redevelopment of the west side of Nijmegen station*', and '*redevelopment of the wet industrial area in Maasbracht*' (Kadaster 8, 2014). Besides the pilot projects, there are even studies whereby ULR will be used to reduce the high vacancy rate on the Dutch office market by exchanging users (Buitelaar, 2012). In chapter 3 one of the pilot projects will be discussed and analysed in more detail: the redevelopment of the wet industrial area in Maasbracht.

2.6 Urban Land Readjustment and Existing Land Management Instruments

We gained more insight into ULR as land management instrument, the question is which other land management instruments can be used for urban development, and how does ULR differ from these other land management strategies? Land development can be seen as the financial transcription of a spatial plan and consists of estimations of costs and revenues which are plotted against a certain time period (Hobma & Schutte-Postma, 2012). For land development we need land management instruments to transform land to its new state. If

we are looking at the traditional perspective of land management in the Netherlands, we see that the government has always felt a strong need to regulate land use. Or in other words: centralized spatial planning or governmentally dominated top-down approach (Tam, et al., 2009; Hobma & Schutte-Postma, 2012). The government wants to determine a specific purpose for a piece of land, such as industry, housing, offices, etc. To regulate the use of land, the government also wants to influence building plans, such as fire safety, aesthetics, structural safety, ventilation, heat regulation, etc. This traditional perspective of land management in the Netherlands is based on public interests (Hobma & Schutte-Postma, 2012). As mentioned in the introduction, urban development is changing. As a result, land management strategies are also changing from a centralized spatial planning towards decentralized spatial planning. Public private collaborations are gaining more and more interests (Tam, et al., 2009).

Initiative	Strategy/Governance	Financial Instrument	Juridical Instrument
Public Initiative	• Public Developer (Publieke Ontwikkelaar) • Regional Development Company (Regionaal Ontwikkelbedrijf) • **Traditional Model**	• Tax Increment Financing • Garantiefonds • JESSICA	• Urban Ground Lease (Stedelijke Erfpacht) • Obtaining Guarantees (Garantstellingen)
Public-Private Initiative	• **Joint Venture Light** • **Building Right Model** • Coalition Model • **Concession Model** • Neighbourhood Development Company (Wijk Ontwikkeling Maatschappij) • Chain Control (Ketenregeling)	• Revolving Fund • Incentive Zoning • Regeneration Fund • Owners Association on Neighbourhood Level (VvE op Gebiedsniveau) • Green Stocks (Groenaandelen) • Area Stocks (Gebiedsaandelen) • Scrapping Fund	• Exchangeable Development Rights (Uitruilbare Ontwikkelrechten) • Vacancy Regulation (Leegstandsverordening) • Building Envelops (Bouwenveloppen)
Private-Private Initiative	• Private Management Outdoor Area (Particulier Beheer Buitenruimte) • Collective Private Commissions (Collectief Particulier Opdrachtgeverschap)	• Innovation Fund • Investment Fund • Area Stocks • Owners Association on Neighbourhood Level	• Transferable Development Rights (Verhandelbare Ontwikkelrechten) • Transferable CO2-Development Rights (Verhandelbare CO2-ontwikkelrechten)
Existing owners or users	• **ULR (*SH*)** • Collective Private Commissions (Collectief Particulier Opdrachtgeverschap) • Organic Development Strategy (Organische Ontwikkelstrategie)	• Crowd funding • Area Stocks • BIZ (Bedrijveninvesteringszone)	• Buying Guarantees (Afnamegaranties) • Guarantees between Periods (Overbruggingsgaranties) • Sales Guarantees (Verkoopgaranties) • Temporary Rental

Table 1 | Land Management Strategies in the Netherlands (Van der Krabben, 2012)

Many (*new*) land management instruments are available to choose from in the field of urban development. The question is which other land management strategies are available in the Netherlands and what makes ULR different and unique? And of course, why and when to choose ULR? Van der Krabben made an overview of the instruments used in the Netherlands which can be found in table 1 (Van der Krabben, 2012). The table has been divided in (1) public initiative, (2) public-private initiative, (3) private-private initiative, and (4) existing owners or users. When talking about land management instruments in the Netherlands, we can distinguish between four widely used models (Van Dijk & Pekelharing, 2013; Hobma & Schutte-Postma, 2012; Samsura, et al., 2010), these are the traditional model, concession model, building claim model, and joint venture model. In this part of the report we look at the differences between these four models and compare them with ULR.

2.6.1 Traditional Model (Public Land Management Model)

In the Netherlands local authorities are not only active in spatial planning but also in the acquisition and sale of land, in contrast to many western countries where private developers take the initiative. In this 'classical model' or 'public land development model' the municipality acquires the land (*with or without help of legal instruments such as the Wet voorkeursrecht Gemeenten or expropriation*) within the plan area. The municipality creates the development plans and makes the land ready for building. Afterwards, they sell plots at full development value to interested parties *(e.g. private developers and end-users*) who are able to further develop the plots in more detail within the boundaries of the master plan. The municipality has a directing role, not only from a public point of view, but also a role as active land developer. The municipality is able to influence the land exploitation, but has to bear all risks associated with it. The net income from buying and selling is used for cost recovery (Van Dijk & Pekelharing, 2013; Van der Krabben, 2012).

2.6.2 Building Claim Model (Public Private Land Management Model)

The building claim model is a partnership agreement between private parties (*e.g. developers, private land owners*) and public parties (*e.g. a municipality*). In this model private developers sell the title of land to the public authorities in return for a 'building claim'. The municipality then prepares the lands for construction. When finished the municipality transfers several plots back to the developers, including the right for the private party to build on these plots. All risks are just like the traditional model for the public party. It is particularly suitable if a developer owns several plots of land that are scattered around the development area (Hobma & Schutte-Postma, 2012; Van Dijk & Pekelharing, 2013).

2.6.3 Concession Model (Public Private Land Management Model)

The concession model is also a partnership agreement between private and public parties (Hobma & Schutte-Postma, 2012), but it can be seen as a private land management strategy (Van Dijk & Pekelharing, 2013). A public party may choose to ask for a number of conditions in advance (*e.g. programming, infrastructure, zoning, overall quality*). The private parties will then acquire the required land by themselves (*the private parties are mainly developers for large scale urban developments*). The content of the plan will then filled in by private parties (*land exploitation, property exploitation, and also public areas*) within the constraints of the public party. In this case not the public party is faced with high financial costs and risks as in the traditional model, but they shift towards the private parties. The concession model is gaining more and more interests, because public authorities are holding fewer resources to

fulfil an active role in urban renewal, and municipalities restrain their active attitude to reduce financial risks (PBL & ASRE, 2013; Van der Krabben, 2011). Since the economic crisis in 2008, the concession model has therefore attracted more and more interests (Van Dijk & Pekelharing, 2013). However, developers and investors are hardly active in large scale urban development due to the decreasing demand.

2.6.4 Joint Venture Model (Public Private Partnership)

Another partnership agreement, but a different and much more intensive collaboration model than the building claim model, is the joint venture model. The involved parties will jointly incorporate a company, or so called legal entity, constituting the legal vehicle for (re)developing an area. This is called a Joint Land Development Company (*Gezamenlijke Grond Exploitatie Maatschappij or GEM*). The company is a joint collaboration wherein both parties hold a 50% share. The division of risk is the same as the division of shares. This model is suitable if both parties are willing to share financial contributions, risks, and opportunities in (*long-term*) land (re)development. The joint venture model is also to stimulate projects if risks are too high for one party alone. The last reason why a joint venture can be considered is because of the civil and tax law: the model offers possibilities to realise tax advantages and to limit liabilities for the involved parties (Hobma & Schutte-Postma, 2012; Van Dijk & Pekelharing, 2013).

According to Bergman (2012), the land management strategies fall under Dutch private law. Some of the strategies have a public law backup in order to deal with parties who are not willing to cooperate. In the traditional and concession model we can find expropriation as a public law backup instrument. For the building claim model there is no public law backup available yet. Therefore ULR may help as public law backup. If ULR becomes part of official legislation, then it can be used as public law backup for the building claim model (Bregman & De Wolff, 2011).

Strategy	Private Law	Public Law Backup
Traditional Model	Purchase land (*Optionally supported by Wet Voorkeursrecht Gemeenten*)	Expropriation
Building Claim Model	PPP-Collaboration and purchase of land	Unavailable (*Possibility is **Urban Land Readjustment** as backup*)
Joint Venture Model	PPP-Collaboration and purchase of land	Unavailable
Concession Model	PPP-Collaboration and purchase of land	Expropriation or Environmental Permit
Self-realisation	Anterior or Posterior agreement	Environmental Permit (*Omgevingsvergunning*)

Table 2 | Private and Public Law (Bregman & De Wolff, 2011)

2.6.5 Urban Land Readjustment (Private-Private Partnership)

In the recent years, a growing number of municipalities are choosing the possibilities of facilitating urban development (*i.e. facilitating land policy*) instead of using traditional active land management strategies (*such as the traditional land management model and building claim model*). However, the concession model has received increasing attention. The main reasons for this change are the high financial risks in times with fewer resources available (PBL & ASRE, 2013). Developers and investors are less present on the market, and there is less demand from the market, hence the change towards existing areas and especially existing owners. The question is, why is ULR getting so much attention? The simple answer is: existing tools are lacking support for the redevelopment of existing property and are primarily effective during Greenfield development. Thus ULR is reducing limitations with fragmented ownership of property, problems with the willingness to participate, and high investments for land acquisition which can be removed from the process (Nibbelink, et al., 2013). Despite public parties not being willing to bear the risks anymore, they are now able to start an area development in public interest. Depending on the public interests, they can steer the process or 'let it go on its course' as in the case of Lammenschans Leiden. They are thus able to choose their attitude, influence level, and flexibility.

It can be stated that ULR, compared to other tools, is (1) it putting the responsibility, financially and by means of a process, to those who will benefit and to those who will bear risk, (2) is able to force owners to participate (*if introduced as legislation*) without expropriation and is able to exclude freeriders, (3) acquisition costs are lower than other models, because the ground component is removed from the process, (4) the interest rates of projects are considerably lower, (5) the tool is trying to create extra value over time on land which can be used for the maintenance for the development of public spaces and maintenance (Kadaster 1, 2013), (6) ULR can be seen as tool which lowers the threshold to start an area development process and acts as a pressure blower (De Wolff, 2013; Nibbelink, et al., 2013). However, it must be noted that ULR is not steering on demand, but lowers the threshold to start a redevelopment. ULR must not be seen as the panacea or magic formula; all problems cannot be solved and therefore need other, especially financial, instruments. It is also a fact that when there is no demand, none of the strategies will work (Commissie Stedelijke Herverkaveling, 2014; Van der Krabben, 2012).

2.7 Conclusion

Redevelopment projects have three major problems: (1) fragmented ownership of property, (2) unwillingness of participation, and (3) participation of many different stakeholders with individual interests. As a result, these problems may cause serious delays and even stagnation. But redevelopment is (*e.g.*) needed to fight obsolescence, improve safety, expansion problems, and changing demand. Existing land management strategies are failing, because they cannot provide support for these problems. Except expropriation, but this is often avoided due to the time consuming and expensive nature of this municipal activity. And besides, municipalities do not have enough resources. The literature study showed that Urban Land Readjustment is a potential tool for the reduction of these problems and for the stimulation of redevelopment processes. Urban Land Readjustment has been designed for the facilitation of the exchange of property among private owners inside an urban area. If legislation in 2018 is coming, the tool is able to force owners to participate. Fragmented ownership would in this case no longer be a limiting factor causing poor or stagnating redevelop-

ment projects. It is a proven fact that one important local owner is able to stop a whole process. The process of ULR has been designed to create a balance between support (*the extent to which the parties commit themselves to the initiative*) and feasibility (*the extent to which facts indicate whether an initiative could be achieved*). By a guarded process, where every stakeholder is able to express his wishes and interests, it is attempted to reduce conflicting interests by way of negotiations. Support will be created by the creation of multiple allocation variants. The tool provides a lowered threshold to start an area development process and is seen as a pressure blower. Unfortunately, the tool is not able to steer on 'demand' and the tool often needs other tools for solving problems. Therefore: ULR must not be seen as magic formula or panacea, because without demand none of the land management strategies will work.

Part B | Obsolete Industrial Sites & Urban Land Readjustment

In part A we have seen that the urban development practise is changing. Also the redevelopment of obsolete industrial sites is becoming interesting to many different parties. This part of the report provides a deeper analysis of problems with obsolete industrial sites. Thereby the questions which interventions, by using Urban Land Readjustment, the Kadaster may provide to improve the redevelopment process of obsolete industrial sites. Before we are able to answer this question we need to identify the key problems.

2.8 Current Status of Industrial Sites in the Netherlands (Obsolescence)

The government made an agreement, the 'Convenant Bedrijventerreinen 2010-2020', in the end of 2009, with provinces and municipalities in the Netherlands for the improvement of obsolete industrial sites. But what is the current status of the industrial sites? There is many data available about the current status of industrial sites in the Netherlands. This information is maintained by the Dutch Ministry of Infrastructure and Environment, Stec Groep and Arcadis in the 'IBIS' (*Informatiesysteem Bedrijventerreinen*) (IBIS, 2013). The following information has been subtracted from the IBIS: the Netherlands is possessing 3722 industrial sites (*counted on the 1st of January 2013*). Approximately 28% is obsolete, 56% is not obsolete, and there is no data available about the remaining 16%. The ratio is almost equal to the year 2012. In figure 4 an overview can be found about the status of the industrial sites per province. Despite the high investments by both public and private parties we can see that there are still many obsolete industrial sites. Subsidies are abolished due to the crisis which was often the impetus for redevelopments. The government and IBIS are seeing a positive effect: entrepreneurs are in the spotlight for the redevelopment of their own property. But entrepreneurs are often seeing a higher property value than the reality by sales. And thus their pension is lower as expected (IBIS, 2013).

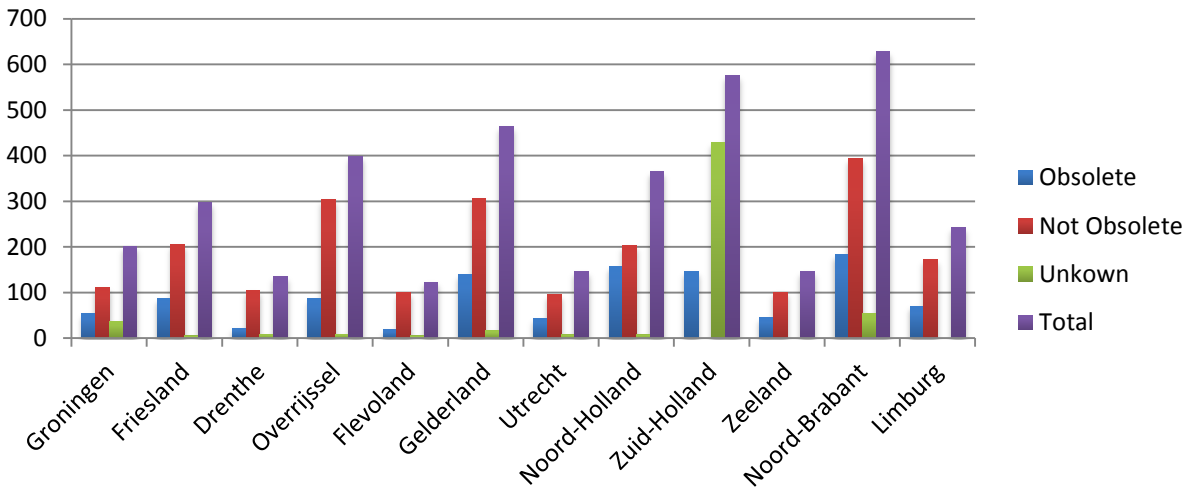

Figure 4 | Overview of the Status Industrial Market 2013 per Province (IBIS, 2013)

Redevelopment tasks is an intensive collaboration between public and private parties. Private investments are primarily needed due to the changing context caused by the crisis. Public parties are not having enough resources. As a result, public parties are stimulating private parties for investments. Public parties are primarily busy with stimulating these initiatives

(IBIS, 2013; VROM, et al., 2010; Kadaster 1, 2013). And thus 'uitnodigingsplanelogie' is needed by public parties to seduce entrepreneurs for investments and improvement of quality.

The obsolescence of industrial sites is primarily caused by (1) the changing requirements of business accommodations in time, and (2) active attitude of municipalities due to their industrial policy (Schenau, 2011; Planbureau voor de Leefomgeving (PBL), 2009; Louw, 2004): The industrial land policy that municipalities have been using for decades laid an important foundation for the acceleration of the obsolescence of industrial sites. The policy was purely dominated by the local interests of the municipalities. The approach was aimed at the expansion of new employment and using revenues of land to offer cheap land to individual parties. This eventually created the patchwork of fragmented ownership of property structure on many industrial sites. Revenues of municipalities were low due to the low plot prices.

The low amounts of revenues were used for the investments in new industrial sites which were lacking in quality. In addition, municipalities were not able to save money to be used for maintenance and exploitation of public spaces. Due to the cheap and large offer of new industrial sites, companies were able to find new and cheap locations easily if their requirements changed over time. The vacant buildings and the lack of maintenance attracted (*temporary*) lower quality businesses activities until even these activities stopped. Therefore it could be stated that municipalities contributed to the obsolescent and vacant industrial sites. But not only municipalities are guilty of the emergence of old and aging industrial sites. Companies are primarily focussed on their production process instead on their real estate and the surrounding spatial quality of the environment. And thus companies are partly responsible for the aging of industrial sites. The empty sites are causing a large problem for the income of municipalities. Municipalities are now only able to collect the taxes from ownership (*eigenarendeel, OZB*) of property and not the taxes from users (*gebruikersdeel*). And thus they will miss millions of Euro in their income (Keala, 2012).

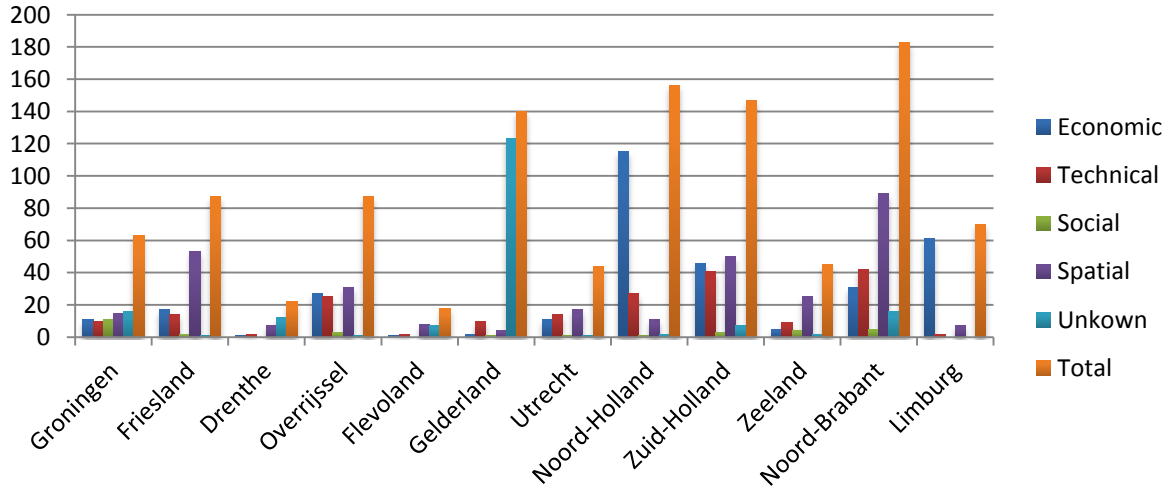

Figure 5 | Types of Obsolescence per Province (IBIS, 2013)

But aging is also caused by four different processes of obsolescence (Schuur & Arts, 2001), namely (1) economic obsolescence (*which can be seen as the changing users' needs in time*), (2) technical obsolescence (*such as poor and lacking maintenance of buildings and infrastructure*), (3) social obsolescence (*stricter and changing legislation for the environment*),

and (4) spatial obsolescence (*surrounding areas have been changed during time and changed the land use*). A mismatch between the areas as a result of spatial obsolescence may even lead to declining demand and even to vacancy. The information of the four different types of obsolescence per province can be found in figure 5. It can be observed that spatial obsolescence is ranking (*very high*) on the first place, followed by technical obsolescence, economic obsolescence, and social obsolescence (IBIS, 2013). In figure 6 the types of obsolescence divided in percentages of the total in the Netherlands. As we can see spatial and technical obsolescence are the two largest.

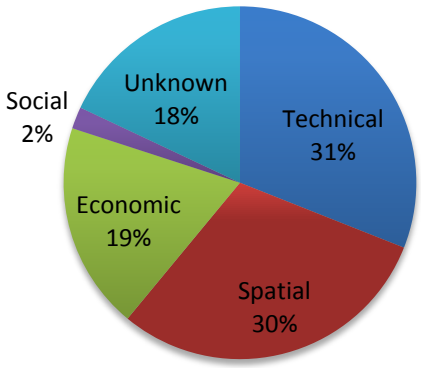

Figure 6 | Types of Obsolescence Total Overview in the Netherlands (IBIS, 2013)

The question is why entrepreneurs are reluctant to investments? The answer is simple according the IBIS (IBIS, 2013): many industrial sites have signs of obsolescence and vacancy, but they are still functioning. And thus there is no drive for investments. As a result, high costs for (*public*) parties to start a redevelopment process. And on the other hand, the economic crisis caused that many entrepreneurs are/were primarily focussed on the production to survive the crisis (Vastgoedmarkt, 2013).

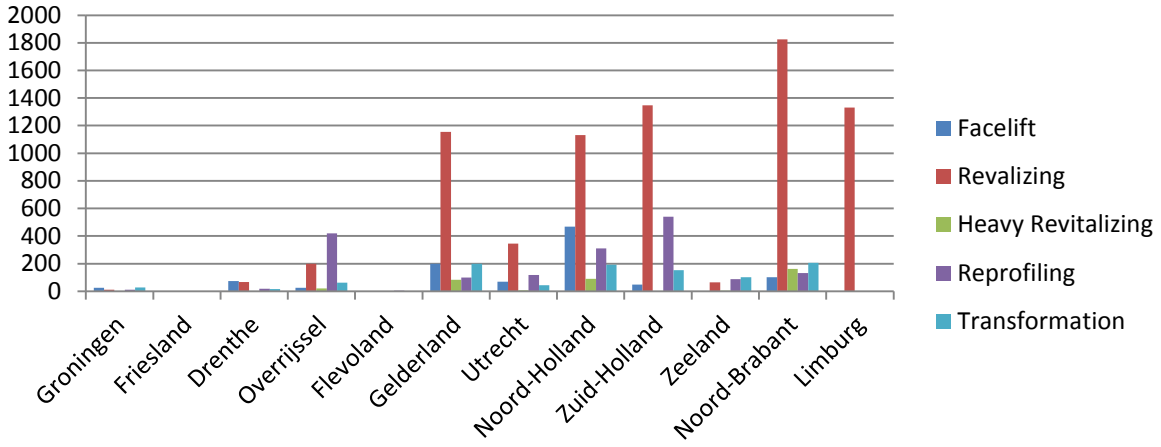

Figure 7 | Total Amount in Redevelopment in Hectares, per Phase, per Province (IBIS, 2013)

Figure 7 is providing an overview of the amounts of surface which are currently being redeveloped. The redevelopment process has been divided into five subcategories: facelift *(refurbishment*), revitalizing *(same function, but improving infrastructure, public spaces, and private space*), heavy revitalizing (*same function, but partially demolishing, new infrastruc-*

ture, remediation), reprofiling (*partially new functions of the industrial site, partially demolishing*), and transformation (*demolishing, full transformation to new function*) (IBIS, 2013). The province of Noord-Brabant, Noord-Holland, and Gelderland are possessing an high amount of revitalizing and even heavy revitalizing tasks.

2.9 Current Status of Industrial Sites in the Netherlands (Land Allocation)

We have seen so far the redevelopment tasks in the Netherlands. Beside the redevelopment tasks municipalities are still offering industrial land. In figure 8 we can see the total amount of land allocation in the Netherlands. A declining trend can be observed in the period 2007 and 2011. The economic crisis has a large influence, because of declining consumer spending's, governmental budget cuts, and European crisis. Entrepreneurs are cautious in buying new property. Except for the province of Noord-Brabant, where the municipality is offering a large amount of land compared to the other provinces (*see figure 9*).

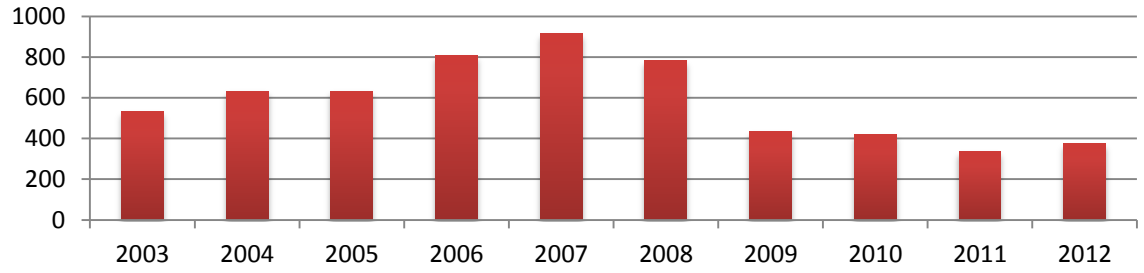

Figure 8 | Annual Industrial Land Allocation, Netherlands, in Hectares (IBIS, 2013)

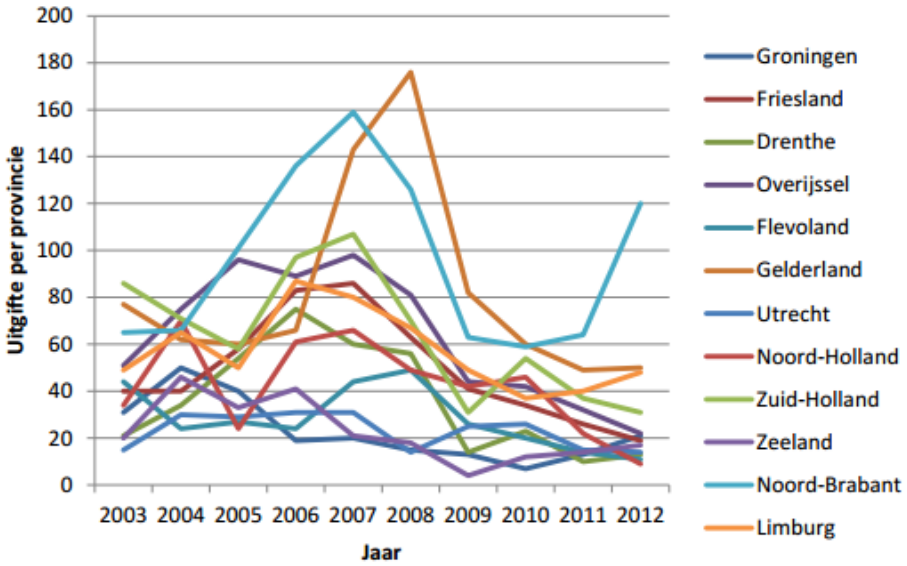

Figure 9 | Land Allocation per Province 2003-2012 (IBIS, 2013)

The drop of land allocation is, beside the crisis, also caused by the shrinkage. Both are causing over programming of the industrial site. And thus, the offer is larger than demand. Resulting in vacancy, stop of redevelopment projects, and low use of space. Therefore, many parties are seeing a solution in the creation of 'scarcity'. Scarcity will result in a higher demand, and lower offer. But at this moment it is not possible due to the high amount of land

allocation and drop in demand (Van Dijk & Pekelharing, 2013). In figure 10 the last overview of the total stock in the Netherlands (red) and annual land allocation in the Netherlands.

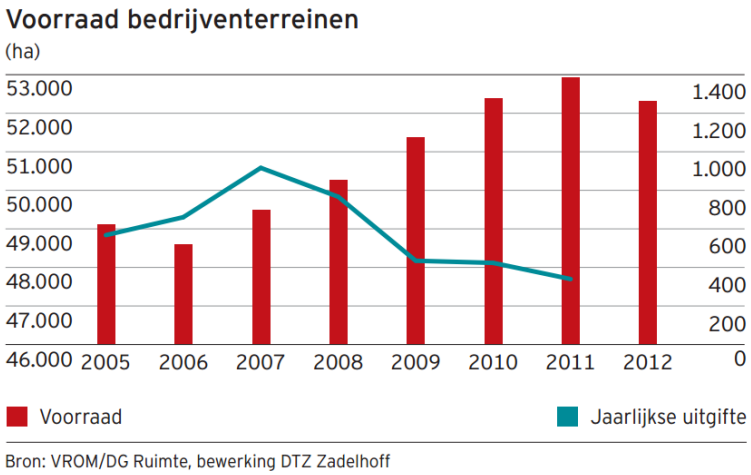

Figure 10 | Total Stock of Industrial Sites vs. Annual Land Allocation in Hectares (DTZ, 2013)

2.10 Current Status of Industrial Sites in the Netherlands (Supply vs. Demand)

And lastly, an overview of the total absorption and supply of industrial sites in the Netherlands based on the lettable area in m^2 (*figure 11*). As you can see the absorption is much lower than the industrial supply.

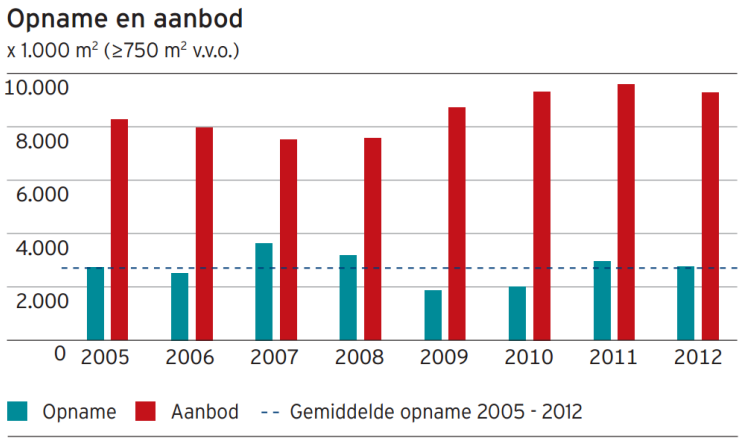

Figure 11 | Absorption and Supply of Industrial Sites (free lettable area in m^2) (DTZ, 2013)

We have seen that obsolescence is a large problem on industrial sites. But more problems can be found: e.g. planning and regional coordination, fragmented ownership of property and local initiatives, involved actors and negotiation.

2.11 Planning and Regional Coordination

A large problem can be found with the planning of industrial sites by municipalities, eventually affecting the business climate of other (*closely or regionally*) located industrial areas (VGN, 2011; VROM, et al., 2010). Due to the continued growth ambition of the municipalities and through pursuing their active land policy on new industrial sites (*i.e. to gain income by selling building ready plots*), without looking at existing properties on industrial sites and the drop in demand, they were creating plots which were not bought by market parties. The

resulting number of new industrial areas led to a lack of occupancy on existing ones, finally creating empty plots. Because of the active land policy there is a surplus of plots ready for building on industrial areas. This is mainly because municipalities offer these plots so they are able to compete with other municipalities in order to attract businesses and create employment to stimulate local economy (Van der Krabben, 2011). Another problem can be found in the regional coordination: building new industrial areas and/or expanding existing areas may fit within local plans, but there is no mutual consensus with neighbouring municipalities. New construction in one municipality may result in moving companies in the neighbouring municipalities towards the new area and thus result in surplus of real estate (VGN, 2011).

2.12 Fragmented Ownership and Local Initiatives

The shifted focus towards the (re)development of existing industrial areas is causing a new major problem, which can be found in the patchwork of land. Due to the municipalities' active land policy, the classic plot allocation on industrial sites has created fragmented ownership of property (Pen, et al., 2013; VROM, et al., 2010). The fragmented ownership of property has led to private parties not feeling the necessity for involvement in the development and exploitation of their site (VROM, et al., 2010). Fragmented ownership does not have to be an issue, but when private owners are lacking initiative for a redevelopment process, the process may stagnate and will affect the quality of the site (Pen, et al., 2013; Cabernet, 2006). The municipality is only able to redevelop public spaces, but not the privately owned plots and real estate. The municipality does not have the right to force involved landowners into the redevelopment process (*except by expropriation*), they are only able to redevelop public spaces. This will severely affect the process and thus the redevelopment and stimulation of these sites (De Wolf, et al., 2004). Municipalities desperately need local initiatives. But what to do if the current owners do not want to collaborate during a redevelopment process or remain inactive? This would result in forced measurements such as expropriation, restrictions in the master plan, and in providing permits (De Wolf, et al., 2004). That again would result in unintended effort, extra investments, lawsuits and frustration and not be an optimal final result.

2.13 Involved Actors, Negotiation, and Decision-Making

One of the largest problems faced during an industrial redevelopment process can be found in the diversity of involved professions (*i.e. multi-actor environment*) (Cabernet, 2006). 'Clearly the topic involves so many scientific and social disciplines that it is difficult not only to understand how the whole system works, but also to define the limits' (EEA, 2002; Cabernet, 2006). We can say that the multi-actor environment often causes long negotiation processes, conflicting interests, chances of (*financial*) failures, trying to transfer risks to other parties, and differences in power of stakeholders (Cabernet, 2006; EEA, 2002; Samsura, et al., 2010; StrateGis Groep, 2010). Each stakeholder has different perspectives and needs. Therefore, problem-oriented solutions will need to focus on the multi-actor environment approaches which will respect the diversity of the stakeholders' values and respect their perspectives (Cabernet, 2006). In general, redevelopment is a time consuming process in which key actors try to create new values and markets. Unfortunately, one stakeholder is often not powerful enough to manage the entire project by himself. Problems with communication and the lack of understanding between stakeholders can significantly affect the redevelopment process (Cabernet, 2006). That is why the governance industrial redevelop-

ment process has to change towards a process-oriented approach to reverse the stagnation of industrial redevelopment (Ligtenberg, et al., 2001; Cabernet, 2006). A conflicting interest can be found for example between market parties (*which can be defined as individual entrepreneurs*) which are settled in an industrial area, and often have a much shorter time frame for redevelopment than a public party such as a municipality (Alker, et al., 2000). 'It is essential to improve the decision-making process in order to make the redevelopment process of obsolete industrial sites competitive to Greenfield development', which is less complex (Cabernet, 2006).

2.14 Urban Land Readjustment and Industrial Redevelopment Process

How is ULR able to stimulate the obsolete industrial redevelopment process? The literature study tried to identify the key aspects of ULR as land management strategy and the problems that can be found during the redevelopment of old industrial sites. According to the Kadaster (2013): 'ULR is the right instrument to guide the restructuring of industrial areas'. Van der Krabben (2012) adds: 'ULR may be useful in (*small*) expansion areas and periperal urban areas. The instrument is also suitable for urban restructuring and transformations'. In this part of the report, the link between the identified problems during the redevelopment process and ULR as land management strategy will be combined:

2.14.1 Fragmented Ownership vs. Industrial Redevelopment Process

ULR is able to break the impasse if fragmented ownership situations are available during a redevelopment process of obsolete industrial sites. A positive side effect of the instrument is that is does not (*or reduces*) the use of instruments such as expropriation, purchase of property, and WvG, resulting in faster leading time of the process (TU Delft & Kring van Adviseurs, 2012; Cabernet, 2006; Kadaster 1, 2013; De Wolff, 2013).

2.14.2 Creating Support Actors vs. Industrial Redevelopment Process

The literature study brought to light that there is a shift from a hierarchical top-down approach of governance towards a bottom-up approach wherein end-users should be more involved during the (re)development of an area. They are eventually the users of the area. Support of the new plan may only succeed if there is support among the involved actors. ULR is a new way of governance which supports this idea. As we saw in the process of ULR, there is a 'democratic and amicable' process wherein the users of the area and the public party together will create a new plan of the area (*the idea of organic development*). Involvement of all actors is the key element, without it the plan may not succeed. Everyone can express his wishes and objectives, which will be translated by (*independent*) experts towards a new plan. The actors are able to negotiate if they are not supporting the plan or want to see changes. They possesses control concerning the final plan (TU Delft & Kring van Adviseurs, 2012; Tam, et al., 2009; Kadaster 1, 2013).

2.14.3 Cost Savings and Risk Reduction vs. Industrial Redevelopment Process

Another important outcome of the literature study is that municipal budgets are under severe pressure and possess less resources due to the economic crisis. Besides the lack of financing possibilities, municipalities became more aware of the risks of an active approach. As a reaction, the municipalities will restrain their active attitude (PBL & ASRE, 2013; Van der Krabben, 2011). Therefore they are looking for possibilities to change their attitude from active traditional land policy towards facilitating land policy in order to reduce financial risks.

Municipalities also want to stimulate owners towards self-realisation (i.e. private-private urban development) (De Wolff, 2013). According to van der Krabben (2013), 'Urban Land Readjustment is a new step in urban development with reduced costs and reduced amount of risks for the involved actors which can enable a potential source of value'. Acceleration, because the involved actors on a obsolete industrial site will be triggered to participate with ULR (*voluntary or forced*), expropriation can be avoided, and land acquisition may be required to a lesser extent. Cost saving, because of the reduced land acquisition costs and interest costs (Kadaster 2, 2013). And last, financial risk reduction for the municipality and other involved actors, because the costs arising from the plan preparations will be pre-financed by the government or shared between the involved parties depending on the agreement. The costs of the actual execution of ULR, which includes preparation and execution costs, are borne by the involved owners themselves (Kadaster 1, 2013; De Wolff, 2013). In this way the municipality does not have to bear the full financial risks, but it is carried by the involved owners.

2.15 Conclusion

It can be stated that obsolete industrial sites are a societal problem in the Netherlands. The government is seeing the necessity of fighting obsolescent and vacant old industrial sites. Both public and commercial parties are responsible for the aging and deterioration of the spatial quality of many industrial sites. The aging and deterioration is causing depreciation of property (*and often a reduced pension due to the higher expected valuation of property by the entrepreneur*), poor spatial quality, and reduced economic position of the region. Redevelopment projects are often not started, despite the large amount of money provided by public parties. Private parties are simply waiting, because in their opinion their site is still functioning, and thus there is no drive for investments. But the crisis caused a large drop in demand whereby entrepreneurs merely focussed on their production process in order not to go bankrupt. Times of major redevelopment projects are over and a growing interest by public parties in redevelopment initiatives by entrepreneurs can be observed. Mainly because of the many private properties caused by fragmented ownership of property. The impetus to start a redevelopment process is often caused by a growing business, poor business climate due to empty premises, or other problems. Municipalities are needing a different approach to trigger investments by using 'uitnodigingsplanelogie' instead of 'toelatingsplanelogie'. Problems arises when entrepreneurs are hindered by fragmented ownership of property. The Kadaster is able to provide an important contribution to stimulate redevelopment projects by implementing ULR.

Part C | Decision-Making and Prediction

The next part of the report focussed on collaboration and especially decision-making. Every stakeholder has individual interests and goals, and without commitment of these stakeholders, the process will stagnate or even fail. This problem is also faced during the process of ULR. Therefore more insight is needed into these stakeholders' interactions, especially due to the changing importance of stakeholders, whereby the focus lies on existing owners and end-users. The process of ULR can be seen as a process which is characterized by many conflicting interests and goals, which necessitate decision-making and negotiations. The Game Theory has been selected as methodology for the analysis and prediction of strategic behaviour of stakeholders. Prediction may be useful for interventions of the Kadaster. In chapter four, the Game Theory will be used for the analysis and prediction of a specific decision-making instance.

2.16 Decision-Making and Negotiation in Urban Development

Actors in the urban development practise, both individuals and groups, can be seen as agents, entities with individual preferences (Ross, 1997). These agents will meet in an environment of spatial decision-making where they will interact to pursue their respective interests and preferences. However, the involved agents have conflicting interests; one agent is not able to determine the overall outcome. All agents have their own vision and intensions. This environment may cause conflicts between the stakeholders. This social interaction between agents is one of the key elements in the urban development practise (Adams & May, 1991). But herein lies the enormous complexity of urban development processes: decision-making processes are dynamic, particularly complex and never identical, giving rise to uncertainties and unexpected occurrences (Ligtenberg, et al., 2001; Yousefi, et al., 2007; Wang, 2011; Roo, 2004). The complexity arises due to: (1) the involvement of many stakeholders who all pursue their own interests and needs, (2) agents responding differently based on their own rationalities, (3) changing agents' strategies due to the strong link between market processes and institutional context, and (4) complexity arising due to the fact that decisions are independent and thus the decision of one actor influences the decision of others (StrateGis Groep, 2010; Van der Krabben, 2011; Cabernet, 2006; Samsura, et al., 2010; Adams , et al., 2005; Buitelaar, 2007; Ross, 1997).

One successful way to resolve conflicting interests is by using negotiation. But despite that negotiation may resolve conflicting interests between agents, negotiation during urban development processes sometimes causes delays and even failures due to the fact that a mutual agreement cannot be reached (Yousefi, et al., 2007). Negotiation aims to explore the situation to find a solution that is acceptable for all involved actors. The definition of negotiation which will be used in this report is: 'the process of bargaining (*give and take*) between two or more involved parties (*with individual needs, aims, and viewpoints*), seeking to discover a common ground and reach an agreement to settle a matter of mutual concern or to resolve a conflict' (Businessdictionary, 2014). The agents will provide offers and counter-offers during the negotiation process, but problems arise when not all interests and objectives are exposed due to a hidden agenda or simply not expressed (Yousefi, et al., 2007). Urban development will stagnate without commitment between the actors, because the decision-making process of all actors is interlinked.

Stakeholder	Immaterial Interests	Material Interests
Public	• Employment; • Vital Urban Economy; • Spatial and Environmental Quality; • Intensive and Efficient Use of Space; • Sustainable Maintenance; • Sustainable Management; • Image; • Contacts with Companies.	• Financial Feasibility of plan/land Development; • Investments from Companies; • Higher Yields from Property Taxes; • Increase of Land Prices or Ground Rents.
Private	• Improvement of Urban Quality; • Better functioning of the company; • Sustainable Maintenance and Management for long term quality guarantees; • Continuation of Operational Management; • Image, quality, and sustainable developments.	• Higher value of real estate and land; • Cost savings through improved functioning of the company; • Cost savings through effective maintenance and management; • Returns/yields; • Building volume / profit; • Value of Real Estate, Long-term Profitable Investments.

Table 3 | Examples Stakeholders' Interests Redevelopment (Blokhuis, 2010)

2.17 Important Actors, Changing Roles, and Interests

There are many different actors present during a redevelopment process. The important actors are governmental responsible parties (*e.g. municipality, province, state, water authority*), end-users (*e.g. entrepreneurs, tenants, dwelling owners*), development parties (*e.g. project developers, investors*), and parties with other interests (*e.g. landowners, owners of infrastructure such as the NS/Prorail, energy suppliers*) (StrateGis Groep, 2010; VROM, et al., 2010). The Dutch municipalities have traditionally always had significant influence on this process. The changing roles are affecting the stakeholders' level of influence (Bryson, 2004; Heurkens, 2008; Loon & Wilms, 2006). There is a noticeable shift in governance from a top-down approach towards a bottom-up approach, or in other words: 'a shift from central urban planning towards a process management based approach' (HDRO, 2014; De Wolff, 2013; VROM, et al., 2010; Kadaster 4, 2013). Urban Land Readjustment supports this idea: property owners and end-users are becoming more and more important. We can see that in contrast to the traditional approaches, private owners and users will possess the power to express and change the outcome of the redevelopment significantly. Municipalities are more moving towards facilitating the process. An overview of the possible material and immaterial interests of both public and private stakeholders can be found in table 3. Public parties for example have interests which are based on public interests: employment, spatial quality, and economic wealth. Private parties have individual interests, such as the optimization of a production process, yield, etc.

2.18 Negotiations in Urban Land Readjustment

The complexities of collaboration and negotiation, perhaps to even a greater extent, are also faced when ULR is part of a (re)development process. ULR has been designed to manage this. But how will this be managed? ULR is a good example where negotiation plays an important role to achieve overall good results for all stakeholders. It is a process-oriented approach, with the target to create a balance between support and feasibility. Support is the extent to which the parties commit themselves to the initiative; feasibility is the extent to

which facts indicate whether an initiative could be achieved. ULR is designed as a chain of negotiation processes. The result of one process will form the basis for the next process. The process is cyclic, which means that if one part of the process cannot be finished, the involved actors will go back to the previous step inside the chain. Headlines of the negotiation process are: (1) creating the new program, (2) capturing the initial state, (3) creating a new allocation, and (4) the financial settlement (Kadaster 4, 2013). The Urbanisator, Kadaster, or another (*independent*) party guard and manage the process in order to reduce stagnation. An overview of the process can be found in figure 12.

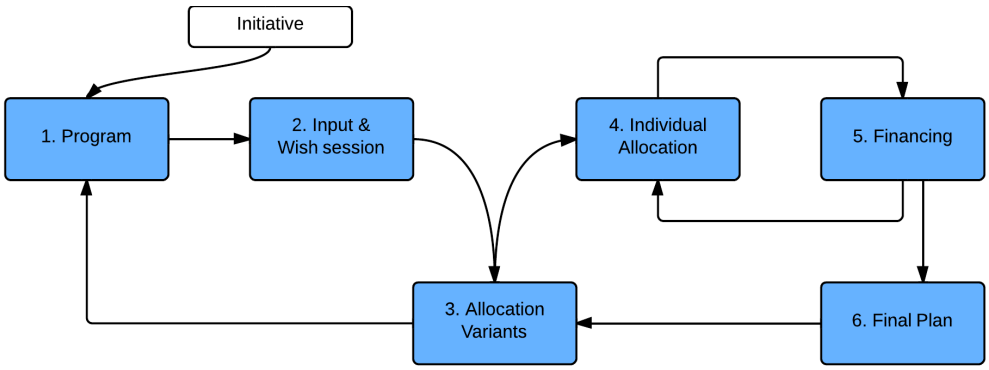

Figure 12 | Schematic Overview Negotiation Process ULR (Kadaster, 2013)

2.18.1 Program, Input and Wish Session

The initiator and other involved parties are known, as well as the appointed area. The real negotiation process will start. (1) The target is to create a joint new program with the involved actors. Decision-making and negotiation is needed: questions need to be answered and decisions have to be made between the actors, such as what is the delineation of the area, which property will be used, and of course, what is the future vision of the area? (2) Due to the democratic process, all involved actors are allowed to express their wishes about the redevelopment which will be the input for the new plan, executed by the area commission. Another important part is to capture the initial state of the area. The wishes of the involved actors and the initial state of the area will be used as input for the translation into a new area agenda. Of course the stakeholders have conflicting interests, such as the interests mentioned in table 3, depending on the stakeholder and situation. Therefore an important task lies with the area commission: to translate the wishes and interests towards an optimal plan.

2.18.2 Allocation Variants

The Taxation and Valuation, Wish Session and Area Agenda will be used to create (3) Allocation Variants. The Allocation Variants is the combination between the Area Agenda and Wish Session translated into one or several new ownership situations. The area commission uses the allocation variants as instruments to create support among the parties of the area. Again, negotiation will play an important role. Because which new ownership situation will be chosen and are the wishes interpreted in a good way? It is possible that the new plan needs to be changed after the negotiations between the parties in order to finalize the plan (*and thus taking a step back in the process*).

2.18.3 Individual Allocation Variant & Financing

When the final decision about the allocation plan has been made, the individual allocation negotiation starts. The focus of these negotiations is on the individual division of property. Individual consultations will be held wherein location, shape, financing, etc. (*i.e. the refinement of the allocation*) will be discussed with the involved actor. It is possible that an owner does not agree with the plan or would like to change some parts of it. Then negotiations are needed and new decisions have to be made to change the plan. The outcome of the consultation may result in changes in the proposed allocation. If all individual allocations have been approved, the (5) financial part needs to be approved. The financial part is the List of Pecuniary Procedures and is used for the financial settlement which will be used for acceptance of the new ownership situations. Questions arise: is it feasible for me and for the whole area, etc.? If there is no mutual agreement, then negotiations are needed to change the plan in such a way that everybody agrees. It is thus possible to step back into the process to change for example the individual allocation.

2.18.4 Final Plan

If steps 4 and 5 have been approved and the plans have been changed, the final plan is complete. It is important to check if the final plan matches the allocation variants and will match the program in the first step. If not, the process has to be repeated, or parts need to be amended to ensure the support of the stakeholders.

2.19 Analysing and Predicting Stakeholders' Behaviour with the Game Theory

We have seen that collaboration and decision-making is a difficult, but very important part of urban development, even during the well managed process of ULR. Therefore 'we want to understand social interactions in general and interactive decision-making in particular' (Samsura, et al., 2010). Analysing the strategic competition between stakeholders is possible by using the research method Game Theory (Adams & May, 1991). Besides, the Game Theory can be used for the prediction of the outcome of specified scenarios (Carmichael, 2008). The Game Theory is also called Interaction Decision Theory, which has been derived from the field of Decision Theory. But there is a difference between the Decision Theory and the Game Theory: the Decision Theory is the perspective of a single actor, whereas the Game Theory focuses on the interaction between multiple actors (Myerson, 1991). But a number of remarks need to be made. First, the application of the Game Theory in the field of urban development is limited, mainly due to the fact that spatial planning is context-driven, but the contribution is growing (Ball, 1998; Ball , et al., 1998). Second, the Game Theory, just like other research method, uses simplified models from real world scenarios (Samsura, et al., 2010). However, in many fields this simplification has been accepted to a certain extent (Berryman & Angus, 2009). And third, the Game Theory is seen as limited in modelling the interactions of involved actors, purely based on the undeniably complex and case-specific circumstances (Samsura, et al., 2010). But the Game Theory is seen as a promising methodology in the field of urban development (Ball, 1998; Ball , et al., 1998; Samsura, et al., 2010; Glumac, 2012). The Game Theory can be seen as decision support system (DSS) and used to support and improve decision making of individuals or groups. System in this context refers to computer technology (*software programs*) which is actively involved during the decision-making process (Arentze & Achten, 2007).

This research will contribute towards the research of the implementation of the Game Theory in the world of urban development. In addition, this report will examine whether the Game Theory is a methodology which can be used by the Kadaster and the field of Urban Land Readjustment. This section will briefly provide an introduction to how the Game Theory works, based on the available literature, especially the basic terms games, players, strategies, outcomes, payoffs, and solutions will be discussed (Auman, 1985; Luce & Raifa, 1957; Carmichael, 2004; Dixit & Skeath, 2004; Samsura, et al., 2010):

2.19.1 Games

A Game Theory process is divided into two separate but coherent parts. The first part is the descriptive part of the game and describes the context and assumptions; the second part is the solution which describes the outcomes of the game according to the descriptive part. A game is seen as a situation of collective decision-making whereby the focus lies on finding the optimal solution. A game can be played in three different ways: (1) coalition form, (2) strategy form, and (3) extensive form. In chapter 4 we will apply the extensive form during the collective decision-making on the case study Maasbracht. The extensive form has a higher level of detail of the decision-making process compared with the other forms. The games in extensive form are played in a sequential way, which means that when one actor makes a move, the other will react on this specific move, and so on. The extensive form is expressed by a so called decision tree.

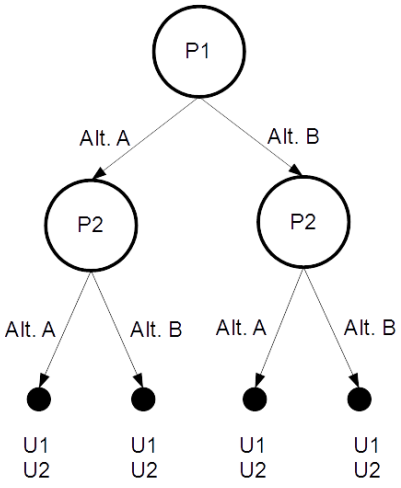

Figure 13 | Decision Tree in Extensive Form

Figure 12 provides an overview of a decision tree. The structure of the tree consists of branches and nodes. Nodes stand for a decision-making moment of a certain player (*P1 and P2*), while branches represent the moves a player may choose. The game starts with an initial node. The initial node is the root of the game and stands for the first player who will make a decision. The branches end in different decision nodes, a node where the other player can make his decision (*Alternative A or Alternative B*). The game will be played until the end of a game (*black dots*), where a certain payoff (*U1, U2*) will be received. A tree can be very extensive with many end nodes, depending on the decision possibilities and number of players. There are possibilities to change a game, which started in the extensive form, into the strategic form or the coalition form game. But this has certain consequences: loss of detail which is difficult to repair. It is also possible vice versa, a coalition form and strategy form can be changed into an extensive form. But again there will be problems with the loss of

information when the level of abstraction will be increased. Games in extensive form provide more information about the structure of the game situation. As a result, sometimes these extensive forms are too complicated to understand and thus a strategic form (*also called the normal form*) is necessary to represent a game.

2.19.2 Players

A game is played between agents, the stakeholders, called the players in the Game Theory. As set of players can be described by $N = \{1, \dots, n\}$. The players are the decision-makers and will react to changes in the game tree. A player will receive information during the game. The Game Theory has two kinds of information: perfect information and imperfect information. By perfect information a player knows his position on the game tree and knows the moves of the other players exactly. By imperfect information, the player does not exactly know where he is located on the tree. But he is able to estimate the probability that he is at a certain node on the tree. Both situations can be found in the urban development practise. For example, land owners and project developers know what decisions have been made by the municipality. However, it is possible that there are situations in which players have imperfect information, for example when information has not been expressed correctly or lack transparency.

2.19.3 Strategies

Each player uses his own strategy to pursue and maximize his interests and objectives. During the game the players will adopt a plan to achieve their payoff. A strategy can be seen as a plan of action. It is important to know that each player makes his own selection of a strategy, but the final result will depend on all choices made. The strategy may be used to compete with each other, but also to maximize the total benefits of a project. An example of a strategy in the field of urban development: a municipality may choose to use the Traditional Land Management Model, Building Claim Model, Public Private Partnership Land Model or in case of this report Urban Land Readjustment. It must be noted that the Game Theory is built on the fact that all players will choose their own strategy, but the final result depends on the choices of all players. And thus each player is only able to determine the partial outcome.

2.19.4 Payoffs

When the game has been played, the outcome is final when all players have made their decisions. The behaviour of the players, or the overall set of strategic selections, during the game will result in the outcome. The payoff is the value of the outcome for a player. In a multi-actor environment the values of the payoffs of the involved players may differ and has different preferences over the set of outcomes. One player may receive the best outcome while another player will receive the poorest outcome. The question is how to solve games when players get conflicting payoffs. It must be noted that there are three variables inside a game which can be used to steer or change the decision making process. These are the players, strategies and payoffs. The payoff is based on a utility: 'The utility refers to some ranking, on some specified scale, of the subjective welfare or change in subjective welfare that an agent derives from an object or an event. By 'welfare' we refer to some normative index of relative well-being, justified by reference to some background framework' (Ross, 2012; Ross, 1997).

2.19.5 Solutions

A game may have multiple solutions. But the question is: what is the most optimal solution? There are different concepts to find the solution, but they are subject to the kind of game. Examples are the Neumann-Morgenstein and Shapley Value. But one of the most used solutions is the concept named the Nash Equilibrium. The Nash Equilibrium is the theoretical prediction of the outcome of a certain game. The Nash Equilibrium (*NE*) is named after the founding father John Nash, who introduced this concept in the 1950s. The NE can be seen as the bundle of strategies, one selected strategy for each player during the game, whereby none of the players has the incentive to change his strategy. It is possible that a game possesses multiple Nash Equilibria. Therefore the Sub game Perfect Nash Equilibrium (*SPNE*) can be used: it represents a Nash Equilibrium of every subgame in the game. The SPNE can be found by using backward induction method in extensive form games, and thus the backward induction starts from the end nodes of the game. The best strategy for each of the n players in the game can be defined as an equilibrium which can be described as $s^* = (s^*_1, \dots, s^*_n)$. To find the equilibrium, solution concepts are suitable for defining such preferred strategies. A solution concept $F : \{S_1, \dots, S_n, U_1, \dots, U_n\} \rightarrow s^*$ can be described as a rule which defines an equilibrium based on the possible strategy profiles and the payoff functions.

2.20 Conclusion

To conclude this chapter we can state that complexity during urban (re)development projects is caused by the involvement of (*many*) different actors, each with their own interests and wishes, causing long negotiations that may even result in the stagnation or cancellation of a process. In addition, one party may be more influential than the others. Important changes in the urban development practise influenced the manageability of these processes and changed the importance of the involved actors. From a top-down managed process (*whereby the municipality had a high level of influence*) towards a bottom-up approach, whereby property owners and end-users are gaining a higher level of influence. When examining the redevelopment process of obsolete industrial sites we can state that an important cause for the stagnation of these projects can be found in lacking consensus between the involved actors, mainly due to partly shared, partly contradictory and/or individual conflicting interests. In addition, there is the fact that one single actor is simply not able to determine the overall outcome of the process and thus all parties are interdependent. A key for solving such conflicts is to create an environment wherein cooperation between actors (*e.g. government, developer, owners, end-users*) can be managed well in such a way that the different ideas, preferences, and interests of all parties can be addressed and conflicting interests can be settled. Due to its design, ULR can provide a contribution to this. ULR is a guarded cyclic process-oriented approach, characterized as a chain with multiple decision-making moments and negotiations, to create a balance between support and feasibility. The Game Theory may provide a contribution to the improvement of the obsolete industrial site redevelopment process, based on the 'analysing and prediction' possibilities. If a scenario can be analysed in advance and the outcome predicted, the Kadaster is able to intervene by steering the process of Urban Land Readjustment towards an improved decision-making process.

Chapter 3: Redevelopment Wet Industrial Area Maasbracht

Urban Land Readjustment Case Study in the Province of Limburg

The third chapter will focus on the case study of Maasbracht, which is located in the province of Limburg. This is one of the eleven pilot projects of Urban Land Readjustment in the Netherlands. This chapter is to gain insight into an interesting case study with problems relating to fragmented ownership of property, the involvement of different public and private stakeholders, conflicting interests, and changing importance of stakeholders. Afterwards, the case study will be used for the analysis and prediction of a specific and important decision-making scenario about the optimal influence level of the involved parties to reduce stagnation possibilities with the help of the Game Theory. The case study has been chosen in collaboration with the Kadaster because of the limited number of involved actors to maintain an overview of the process and, as ULR will be applied on the case study of this real life situation, in order to provide realistic information about ULR in practise.

3.1 Initiative Redevelopment Process

The municipality of Maasgouw (*comprises of the villages Maasbracht, Heel, and Thorn in the province of Limburg*), Ontwikkelingsmaatschappij Midden-Limburg BV (*OML*), and the Limburgse Herstructureringsmaatschappij voor Bedrijventerreinen BV (*LHB*) made an agreement in the beginning of the year 2013 to start with the redevelopment of their so called 'wet industrial areas'. The term wet industrial areas refers to the maritime-related business activities and locations next to the river Maas. The interests of these three stakeholders are mainly to improve the local and regional economy. The approach should lead to several specific redevelopment projects between the years 2013 and 2018 (Gemeente Maasgouw, et al., 2013). The Ontwikkelingsmaatschappij Midden-Limburg is a company which has been set up as collaboration by different municipalities from the province of Limburg, specifically for sales of plots on existing and new industrial areas, maintenance of these sites and the restructuring of existing sites, and it is point of contact between entrepreneurs and government (OML, 2014). The Limburgse Herstructureringsmaatschappij voor Bedrijventerreinen is a private company, which has been set up by the province of Limburg and private parties (*e.g. investors*). The LHB has a special fund for investments for the redevelopment of old industrial sites, used as catalyst, and will execute the redevelopment process by improving the business climate for entrepreneurs and the quality of the environment (LHB, 2014).

3.2 Koeweide-Battenweg

An overview of the industrial areas of Maasgouw can be found in figure 14. It should be noted that part of the industrial areas are suffering from vacancy and obsolescence, affecting the high quality locations and business climate. For the delineation of the research we will focus on the industrial sites named Koeweide-Battenweg, located in the city of Maasbracht (*orange circle*). Koeweide-Battenweg is a medium sized industrial site of 50 hectares in total (*35 hectares net*). Maasbracht is characterized by its strategic position along the River Maas and the Juliana Channel. As a result, the economy of the region is largely based on maritime activities, especially ship repair (both commercial and pleasure boats), ship building (*pleasure boats and production of specialized components*), and dredging services. Another im-

portant activity is related to the mineral extraction industry coming from the mines in the Southern part of Limburg. But activities are changing. The maritime activities are becoming more and more important for the region due to the closure of the mining industry and completion of a number of long-term excavations along the river Maas. Reorientation and increasing scale have provided new possibilities to support the economy: increasing scale due to the improved accessibility of the River Maas for large commercial boats, reorientation as to the shift towards pleasure boat activities due to the declining mineral extraction industry. But the increasing scale and reorientation are causing implications for the use of space in that specific area. Quays must be extended to welcome the larger ships, and entrepreneurs are having problems with expansion possibilities and current locations of properties. Fragmented ownership of property and lacking private initiatives are the largest problems to start the redevelopment process (Gemeente Maasgouw, et al., 2013; OML, 2014; LHB, 2014; OML, et al., 2013).

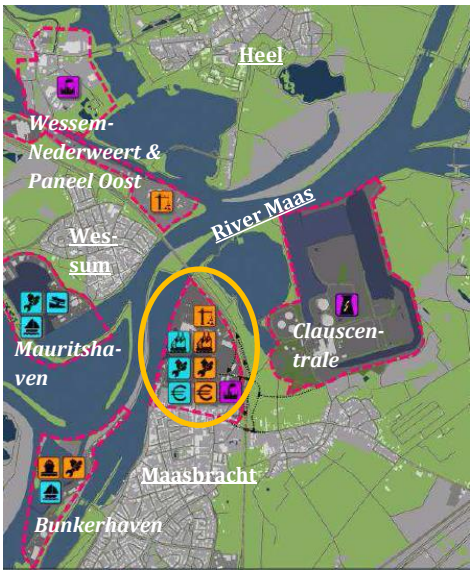

Figure 14 | Maasgouw (Maasgouw, 2013)

3.3 Current State of Koeweide-Battenweg

Many of the Dutch shipbuilding and ship-related activities are located in Maasbracht. One of the strong points is the cluster of highly reputable companies on site well known by many skippers from in and outside of the Netherlands. The aim of the site is to welcome skippers for repair and services. But the entrepreneurs have problems with the expansion of their current business activities on their existing land, and property is scattered over the industrial site. Moving towards another location is not always the best option, because they are tied to the land due to the strategic position at the Maas and the reputation of the site. Another large problem is the noise restrictions which have been imposed by the municipality and Dutch legislation. The noise restrictions are in place due to the residential area located next to the industrial site. Therefore the site is located in a ‘noise-zone’. The noise-zone protects

the legal status quo for both residents and companies. On the one hand, companies are not able to expand noise producing activities indefinitely to protect the noise-sensitive zones such as the residential area. On the other hand, the noise-zone is protecting the companies against upcoming dwellings and other noise-sensitive companies who wish to establish in close range. A noise investigation on the site has shown that the noise level exceeds the legal threshold. At this moment the exceeded noise-threshold is tolerated to keep the companies, which are important for the municipality, in Maasbracht. It can be stated that the challenge of the industrial area is to keep the important maritime companies in Maasbracht, without causing undue inconveniences for the surrounding residents (Gemeente Maasgouw, et al., 2013).

3.4 Future State - Urban Land Readjustment and Enforcement of Participation

The municipality, LHB, and OML have taken an initiative to start a redevelopment process. The entrepreneurs see the necessity to act and therefore they will voluntary join the redevelopment process. But it must be noted that entrepreneurs (*who are land owners, property owners, and users*) have been coerced by the municipality into active participation (*i.e. uitnodigingsplanelogie = invitation planology*). Because there is no official legislation in Dutch spatial planning yet, the municipality used a clever trick. The municipality regulates the industrial site by the master plan and permits. The entrepreneurs situated on the site hold, for example, permits for a specific number of boats moored at the quay. But due to space problems this numbers have been exceeded. These numbers of rows increased in time due to the expansion of business activities. Even for ship repairs they have problems to reach the boats. The municipality condoned this for many years. But it is now threatening with the enforcement of existing rules if entrepreneurs are not willing to collaborate. There is, however also an incentive for the private owners to participate in the redevelopment process, because in the current situation they do not have many possibilities to expand. The just completed enlargement of the sluices in the river Maas would enable further expansion of the business activities of the entrepreneurs. As all parties are seeing the necessity to change, we will state that all parties are participating on a voluntary basis. Despite the public and private parties pursuing their own interests, they are still depending on each other.

The municipality wants to make the industrial area future-proof, but has limited resources for an active attitude due to the crisis. Besides, the municipality does not want to bear the financial risks. Therefore the municipality and LHB looked for an instrument with which the following four aspects could be attained: (1) the ability to stimulate the redevelopment of the industrial area with limited resources, (2) the ability to encourage the private owners in order to redevelop their property so they are able to expand their business activities with their own wishes and needs (demand-driven), (3) a way to deal with fragmented ownership of property to reduce the stagnation probability without using expropriation, and (4) stimulation of private parties to invest in their own redevelopment (Gemeente Maasgouw, et al., 2013; OML, 2014; LHB, 2014; OML, et al., 2013). The LHB and Kadaster, through the national pilot program of ULR, provided a possible answer to stimulate the redevelopment process with the help of ULR. The instrument was seen as potential instrument for the redevelopment process with respect to the four aspects mentioned.

All parties including the private owners entered the process of Urban Land Readjustment. In figure 15 the present situation of the site and the future vision of the site can be found.

Starting points of the redevelopment process were: larger quays, more clustering of properties, and expansion space. An exploration of the preferences was made by means of group discussions and individual sessions. Thereby the private owners jointly created the new plan. As we can see, there is (1) focus on the exchange of ownership of property (*primarily land*), and (2) creation of a joint exchange plan to meet the interests of all parties without changing the function of the land. Plots will be exchanged between property owners, but boundaries and shapes will be maintained. The coloured blocks in figure 9 stand for the private parties who will participate in the redevelopment process. The colours show the current plot and future plot ownership. The municipality, LHB, OML, and Kadaster facilitated and supported the negotiations towards this new situation. Multiple allocation variants (*4 allocation variants, whereby 3 were removed due to high cost expectations*) were proposed, whereby figure 9 is the chosen version. The process is seen in three stages: exploration phase, planning stage, and realisation phase. At this moment the financial problems and feasibility are being explored.

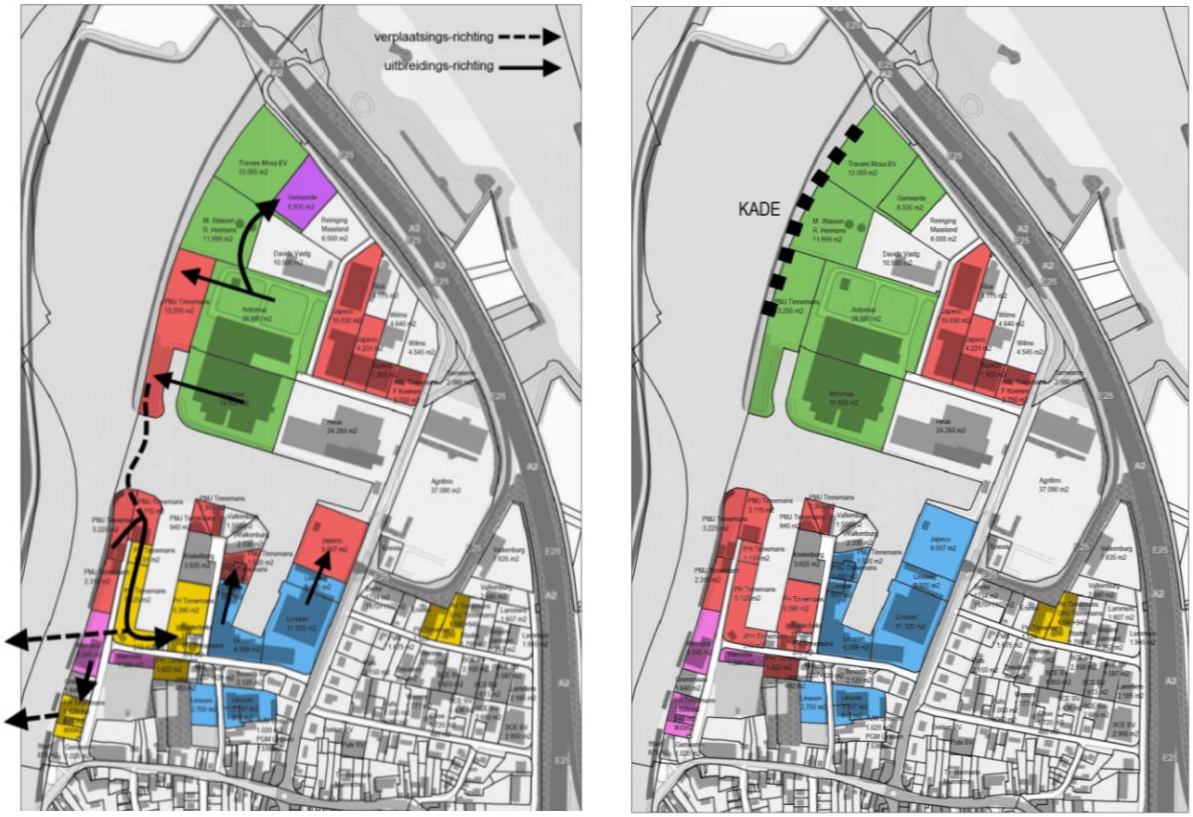

Figure 15 | Current (left) and Future (right) Ownership Situation (Kadaster, 2014)

3.5 Involved Actors Maasbracht

The Urban Land Readjustment process of Maasbracht involves five entrepreneurs. But it is important to understand which actors are involved and what their interests are. The actors are divided into two different groups, namely the Public Parties & Experts and Private parties. A brief overview of the involved stakeholders:

3.5.1 Public Stakeholders & Experts

Municipality of Maasgouw/LHB/OML/Kadaster - The municipality of Maasgouw is taking the initiative of the redevelopment of the industrial areas of Maasgouw. The municipality is re-

sponsible for the structural vision of the area. The main target of the redevelopment is to stimulate the local and regional economy (*e.g. by creating employment, upgrading its image, future proof the area, and improve its spatial quality*) and does so based on public interests. Another related target is to improve the quality of the specific areas. The municipality is making plans to create future-proof industrial sites, but is limited in financial resources for the redevelopment process. The LHB and OML will support the municipality with the execution of the project. The municipality, LHB and OML will establish a 'steering group' and a 'project group'. The operational and integral project responsibilities are vested with the LHB. The three public parties are willing to pay the plan precreation costs and costs for hiring external expertise at a total amount of €71,667 (*municipality*) + €34,167 (*LHB*) + €15,000 (*OML*) = €120,835. An additional amount of €29,167 needs to be paid by the other interested parties. The public parties need to invest in the redevelopment of their own property, and thus the public parties are shifting the financial risks towards the private owners. The municipality possesses a small piece of land in the northern part of the industrial site, but that will be sold to one of the private owners. The municipality also owns the infrastructure of the area. The municipality is prepared to change the master plan if there is enough support (Gemeente Maasgouw, et al., 2013; OML, et al., 2013).

Kadaster - The Kadaster must be seen as quasi-autonomous non-governmental organisation (*or quango*). It is a government maintained public register of registered property. Among its core activities are land management and urban development, such as the development and implementation of ULR. The Kadaster is pursuing an optimal outcome for the project and not for pursuing financial benefits. Beside an optimal outcome they will provide information, support for the process, and legal certainty for the involved actors (Kadaster 1, 2013).

3.5.2 Private Stakeholders

Cerec-Antonius (green) - On the green coloured plots the entrepreneur Cerec-Antonius is located with a company called Antonius Vesselheads BV. The company was founded in 1937 in the city of Maasbracht. The company serves customers across the globe with the production and design of high-end dishes, heads, elbows, expansion bellows and other parts for ships. Cerec-Antonius can be seen as a metal worker with more than 70 years of experience in the manufacturing of custom made products, made from different kinds of steel, from low to high alloy. The company is renowned worldwide as excellent all-round transformer of plate material. Their interest in the participation in the development process is aiming for expansion room and larger docks closer to the waterfront. The company holds land ready for sales. http://www.cerec-antonius.com/

P.M.J. Tinnemans (red) & P.H. Tinnemans (yellow) - On the red and yellow plots we find the family company Tinnemans, which consists of multiple holdings scattered over six locations in Maasbracht. The main financial holding is called P.M.J. Tinnemans Beheer BV. Subsidiaries are the Scheepswerf- en Handelsmaatschappij Tinnemans BV (*shipyard and trading company*), ASL Tinnemans VOF (*wholesaler in boating equipment*), Japeco Holding BV (*financial holding*), G.H.J. Tinnemans (*ship repair*), and P.H. Tinnemans (*metalworker, carpeting, interior construction, ship repair, shipbuilding*). They focus on large vessels and possess their own dry-dock, cranes, moorings and spaces for storage on their own land. This party is aiming for less scattered property, room for expansion and better access to the waterfront.
http://www.tinnemansscheepsbouw.nl/

Kleinstra (purple) - Located on the purple plots we can find the company called Kleinstra en Zoon BV. The company is active in different branches, namely sales of boat engines and boat related articles, transportation of minerals and materials and towaging of boats. Kleinstra has its own moorings, dry-docks, cranes and space for storage. Their location is suitable for their needs. They are only seeing problems with space on busy days and thus have to moor boots in multiple rows. Problems occur with the accessibility of these boats.
http://www.kleinstramaasbracht.nl/

Linssen (blue) - The last involved private actor is the entrepreneur Linssen with the company called Linssen Yachts. The company manufactures luxury yachts made of steel. Linssen Yachts is a byword for steel displacement yachts of superior quality and for continuous innovative product and process development. In every decade since the company was established, Linssen Yachts has been the driving force behind innovative ideas for modernising the yacht building process. On the location in Maasbracht there is a large showroom located and in-house production facilities. They also possess mooring places for their ships at the waterfront. They are aiming for expansion room, and due to lack of space the company opened a new company in the city of Echt. They would have preferred to open this new company in Maasbracht. http://www.linssenyachts.com/en

3.6 Conclusion

The case study provided insight into a pilot project whereby Urban Land Readjustment is used. We can clearly see that the municipality is restraining its active attitude and does not possess enough resources to start the redevelopment on its own. Expropriation is not an option. The public parties are trying to improve the local and regional economy and want to make the area future proof. Thus we can state that the public parties have the following interests: material -> spatial and environmental quality, employment, image, immaterial -> contacts with companies, and intensive and efficient use of space. Then we have the private parties, who will not take action on their own. Luckily, the private owners are seeing the necessity for the redevelopment of their industrial site. Their target is to gain more space to expand their business activities. Therefore their interests can be translated towards improving the function of their companies, improvement of spatial quality, employment, and financial benefits after the redevelopment. We can state here that when the necessity for private owners is high, then they will take action. Fragmented ownership in this case was the limiting factor where ULR has been used to remove the uncertainties. The government coerced the private owners to participate, but it was still on a voluntary basis as that participation cannot be enforced until the legislation is in force.

Chapter 4: Game Theory Prediction

Influence Level Stakeholders Maasbracht – Three Player Bargaining Game

The goal of the fourth chapter is to analyse and predict the outcome of an important decision-making moment for advice to the Kadaster. More specifically, to analyse the strategic behaviour of both public and private parties from the case study of Maasbracht. The question is: what will be the optimal influence level on the '*future land use'* and '*reparcellation*' for both public and private parties to ensure optimal participation?, which is an important contribution towards reducing the stagnation possibility of the redevelopment process. The prediction will be used as advice to the Kadaster. The Kadaster, which is involved as process leader, is in turn able to advise the public parties about a strategic approach. The Game Theory has been used as a research tool. The analysis with Game Theory is three-folded: (1) to gain insight into the decision-making moment and predict the optimal outcome, (2) to provide advice for the Kadaster, and (3) to contribute towards the improvement of the Game Theory in the field of urban development.

4.1 Game Theory: Influence Level

The Game Theory will be used to analyse a certain decision-making moment and strategic behaviour of stakeholders during a negotiation situation, in this case the negotiation of the influence level of future land use and reparcellation. Therefore a model will be created to analyse and predict the most preferred outcome of the influence level. It can be stated that all settings in the redevelopment of an industrial site differ. The model will therefore be generalized for the usage of analysis and prediction in different negotiation settings. Generalization will help to make further research simpler and better comparable. The basis of the Game Theory in section 2.13 will be used, thereby additional and more advanced terms will be introduced. It must be noted that there are as yet no standard procedures for the usage of Game Theory in the field of urban development. Therefore this research will be based on the eight steps which have been proposed by Glumac, et al. (2014): (1) Selecting a Game Class, (2) Selecting a Game Form, (3) Selecting a Game Solution Concept, (4) Description of Institutional-Economic Context of the Game, (5) Game Conditions and Environment, (6) Validation of Game Structure, (7) Estimating Payoffs, and (8) Analysis of the Final Outcomes.

4.2 Game Class Selection: Non-Cooperative, Conflicting Interest Games

The first step is selecting a game class. The Game Theory makes a distinction between four types of classes, which can be divided into two groups, usable for studying the interaction between players. These are (1) cooperative and non-cooperative games, and (2) conflict and common interest games (Bowles, 2004; Shoham & Leyton-Brown, 2009; Allan, 2005). The difference between cooperative and non-cooperative games is the willingness of players to cooperate. During cooperative games the involved players have agreed in advance to collaborate, allowing to jointly coordinate their actions to pursue collective payoffs. In other words: 'Cooperative Game Theory focuses on what coalitions of players can achieve, and assumes that players can meet and make binding agreements as to how to play. Even though the structure is cooperative, players are assumed to be selfish' (Peck, 2010). One example of cooperative games in the field of construction management and urban develop-

ment is forming a Public Private Partnership (*PPP*). Contrarily, non-cooperative games can be described as 'a set of players, a description of strategies available to each player, and the payoffs received by each player for each combination of strategies. The idea behind this game is that every player will chose his own feasible strategy, and that the payoffs are not related to the chosen strategy but also depend on the strategy choices of the others' (Peck, 2010). Besides, there are also conflicting and common interest games. Conflicting interest games are games wherein players have conflicting interests: they possess partly shared or contradicting interests. Common interest games are games where the players both prefer the same Nash Equilibrium outcome and thus possess 'common interests' (Bowles, 2004).

It seems obvious to choose a cooperative game for the case study of Maasbracht, mainly due to the coalition of involved players making a joint new plan of the industrial site in the setting of ULR. But for the game we choose differently: instead of a cooperative game a non-cooperative and conflicting interest game will be chosen. Every player is pursuing his own interest during the process of Urban Land Readjustment (*e.g. during the Wish Session, Allocation Variant, and Individual Allocation Variant*) and an individual player is simply not able to determine the overall outcome of the game (*e.g. Area Agenda, final exchange plan, etc.*). All players need each other, and during negotiations they are trying to use the chosen strategy to pursue their interests. Each involved actor in Maasbracht will follow his own strategy, but the outcomes also depend on the strategy choices of the other players. The municipality of Maasgouw is pursuing their interest to improve the regional and provincial economy, but also to reduce their risk by letting the private owners pay for their own part of the development. Contrarily, the entrepreneurs are pursuing (*e.g.*) their interest to get expansion room, less scattered property, and better accessibility to the waterfront. One entrepreneur gives preference to one interest more then another entrepreneur.

4.3 Game Form Selection: Extensive Form

In section 2.15 the extensive form has been discussed. But we also have another option: the normal form. We have these two options due to the fact that a non-cooperative game has been chosen, and thus offering the extensive or normal form. The normal form is also called a strategic form. A strategic game is characterized by a decision-making process whereby the players will act in a simultaneous way. In other words: the players are acting in a single time sequence, such as the well-known game rock-paper-scissors. The extensive form, in contrast, represents players who react in a sequential way (*e.g. Player A makes a certain decision, player B will react based on the reaction of player A*). For this research we assume that decision-making in the field of urban development is a time consuming process (*e.g. it is common that decision and negotiation can take months to years before a decision has been made, including the process of Urban Land Readjustment*). Therefore the extensive form will be used for the final model. It must be noted that the choice of game form will affect the solution concept which will be discussed later in the report (Peck, 2010; Samsura, et al., 2010; Stengel, 2008; McGraw-Hill, 2005).

4.4 Game Solution Concept: Sub Game Perfect Nash Equilibrium (SPNE)

For the game a solution concept needs to be defined. Due to the choice of the extensive form we will use the sub game Perfect Nash Equilibrium (*SPNE*), which can be calculated by using backward induction. A solution concept can be described as the formal rule how the game will be played. In other words: 'a solution concept is a prediction of how the game will

be played or a consistent theory of how the game might be played' (Peck, 2010). The Nash Equilibrium is named after John Nash, a mathematician and economist. He demonstrated that there is equilibrium in every non-cooperative game with mixed strategies. The sub game Perfect Nash Equilibrium can be described as an equilibrium in which every sub game (*which is a subset of the whole game*) is in Nash Equilibrium. The sub game Perfect Nash Equilibrium can be seen as a refinement of the Nash Equilibrium during dynamic games. It can be seen as a strategy profile wherein every sub game of the total finite game is in Nash Equilibrium. Every finite game possesses a SPNE. In other words, if (1) any smaller game of the larger game has been played by the players and (2) the players' behaviour is representing a Nash Equilibrium of the smaller game, then we can say that their behaviour is the SPNE of the total game (Osborn, 2004; Peck, 2010).

4.5 Institutional-Economic Context of the Game

From a multi-agent point of view we can also say that the institutional-economic context of the game is the environment wherein the game will be played. Examples are the land management strategies such as the building claim model, concession model, traditional model, and joint venture model. But as expected, the game will be played inside the environment of Urban Land Readjustment. We have to keep in mind that ULR will be applied on another environment, namely the redevelopment process of industrial sites. This study will address ULR as development model wherein private owners are stimulated by the government to participate in the redevelopment process (*i.e. uitnodigingsplanelogie*). And thus the public party is making the first move. The land management strategy ULR is versatile in use, therefore the case study of Maasbracht is limited by the exchange of property (*i.e. location*) between the private players (*i.e. private-private setting*). The municipality is in this case facilitating the process together with the LHB and OML. ULR has been used to reduce stagnation possibilities, for minimum investments for the public parties, and risk reduction for the municipality.

Beside the environment, the players of the game need to be identified. The identified actors, (*section 3.3*), are the most important players for the case study of Maasbracht. But the aim of the game is to try to generalize the model as much as possible so it can be used for other redevelopment process analyses. Therefore we need to define (*generalized*) key players with respect to ULR. As we have seen earlier, important general players are: investors, developers, entrepreneurs and governmental parties. But for this research a different and more suitable division of players will be proposed for ULR with respect to the four roles mentioned earlier. (VROM, et al., 2010; Kooijman, 2009; Samsura, et al., 2010; Van der Krabben, 2012).

Literature describes four players (*investor, developer, user/entrepreneur, municipality*) as the most important players during an industrial site redevelopment, but often seen as individual players (e.g. Adams, et al., 2001b; VROM, et al., 2010; Samsura, et al., 2010). But ULR in the case study exposed a deeper division and coherency of roles: a single player may fulfil multiple roles during a redevelopment process. One example is the private parties of Maasbracht: these players can be seen as entrepreneurs, but also own the land and the real estate. The entrepreneurs can thus be seen as property owners. By participating in the ULR process they are trying to invest in their properties, optimize their business activities in the hope for a more efficient workflow, and create even better opportunities to gain more profit. Thus, an entrepreneur can be seen as independent developer and event investor (in de Kijker, 2014;

Hieminga, 2006). Moreover, the entrepreneur is using his property for business activities and thus can be seen as end-user. The same principle can applied to e.g. the municipality, which is a land owner as well as provides the governance of the redevelopment process.

To generalize the players, we need to create certain groups with the same interests during a negotiation. Table 4 shows the translation of the involved actors of the case study towards players for the Game Theory model. It must be stated that other types of division can be made, but for this research we are using this new division.

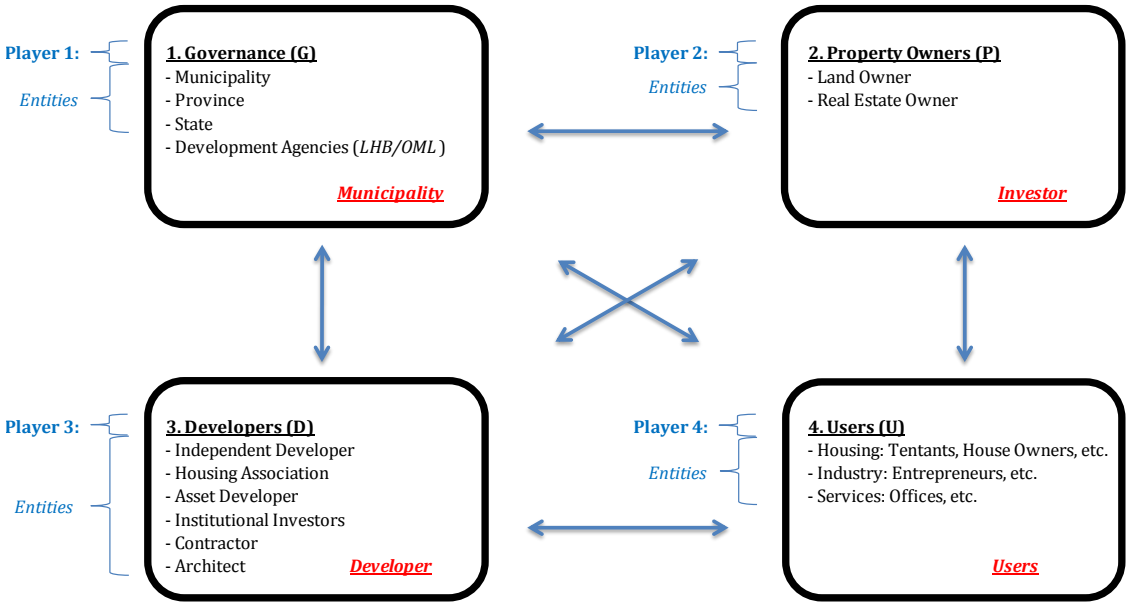

Figure 16 | New division of Players and Interactions Game Theory (Black) and Old (Red)

The chosen players have first been divided into 'Types' (*i.e. groups*), namely (1) **Governance**, (2) **Property Owners**, (3) **Developers**, and (4) **Users**. Every type has been subdivided into 'Entities' (*i.e. subgroups*), which are the players belonging to a certain group, each having corresponding characteristics and interests. Figure 16 provides the final overview of the types, entities and their possible interactions. The new proposed division of players is done with help of expertise from the Kadaster and University of Technology Eindhoven. The proposed division of players is more in line with the changing urban development practise, especially the changing roles of involved actors.

A list with possible interactions, subtracted from figure 9, can be found in appendix I. All possible interactions (*1 vs. 1*) can be seen as separate negotiations. We can divide these interactions into two sorts: (1) games (two separate players) and (2) sub games (*player is playing against the same player due to the overlapping roles*). Modelling all interactions will take a long time. Therefore the three most important interactions based on the case study of Maasbracht will be used. Therefore a three player model will be created. Normally, a game will only be constructed between two players. But in the field of urban development even three players is still sufficient.

Case Study Maasbracht	Description		Players (Game Theory)	Entities (Game Theory)
Public Parties: **- Municipality** **- Province**	Municipality and Province are the initiators. Possesses power for changing the masterplan. Target: Stimulation of local and regional economy.			

Quango/Support:
- Kadaster
- LHB
- OML
	Kadaster is supporting and guiding the ULR process together with the LHB/OML.
	Target: optimal final result.
	
	LHB is leading the process and possesses a fund for investments.
		→	**Type 1:**
			Governance
				- Municipality
				- Province
				- State
				- Development Agencies
				  - Kadaster
				  - LHB
				  - OML, etc.

Private Parties:
- Entrepreneurs:
  - **Cerec Antonius**
  - **P.M.J. Tinnemans**
  - **P.H. Tinnemans**
  - **Kleinstra**
  - **Linssen**
	Entrepreneurs are Land Owners and Real Estate Owners on the industrial site.	→	**Type 2:**
			Property Owners
				- Land Owner
				- Real Estate Owner

Public Parties: - **Municipality**	Municipality owns a plot on the industrial site and thus municipality is also land owner.			

Private Parties:
- Entrepreneurs:
  - **Cerec Antonius**
  - **P.M.J. Tinnemans**
  - **P.H. Tinnemans**
  - **Kleinstra**
  - **Linssen**
	In the setting of ULR, the aim is to redevelop property and trying to gain profit overtime. Thus, the entrepreneurs can be seen as developers/investors.	→	**Type 3:**
			Developers
				- Independent Developer
				- Housing Association
				- Asset Developer
				- Institutional Investor
				- Contractor
				- Architect

Public Parties: **Municipality/OML** **Province/LHB**	The municipality and province can be seen as some sort of investor. They are paying for the preperation costs of the project. With the investment they are hoping to make the area future-proof.			

Private Parties:
- Entrepreneurs:
  - **Cerec Antonius**
  - **P.M.J. Tinnemans**
  - **P.H. Tinnemans**
  - **Kleinstra**
	The private parties can be seen as users of their property.	→	**Type 4:**
			Users
				- Housing
				- Industry
				- Services

Table 4 | Players and Entities: From Case Study to Game Theory Translation Table

4.6 Game Condition and Environment

The descriptive part of the game is composed from a limited set of attributes. The attributes can be described as variables, and thus representing the changes during a redevelopment process. These attributes can be seen as product characteristics and possess different levels (Louviere, et al., 2000). The game condition state can be seen as delineation of the game to make it statistically valid (Glumac, 2012). During an expert meeting with the Kadaster, the case study of Maasbracht, and with the help of various literature, five attributes have been chosen which are negotiable during ULR and will be used for the Game Theory model. It is also possible to choose non-negotiable attributes, but this requires a different approach by creating scenarios with help of a full factorial experiment. It must be noted that each industrial site has a unique set of attributes in terms of environment, usage, people, etc. Contamination is not always an important factor (Cabernet, 2006).

4.6.1 Negotiable Attributes

Different literature has identified important attributes belonging to a redevelopment process. These attributes can be divided into legal, physical and financial attributes. Examples are accessibility, usage, potentiality for different land uses, and governmental incentives. During an expert meeting with the Kadaster, we identified five attributes which will be used as input for the Game Theory model. The chosen attributes have been selected based on the idea that they are '*negotiable*' during the negotiation process and also if they can be applied to the ULR land management strategy. The important chosen attributes for the Game Theory model with respect to Urban Land Readjustment are (Ganser & Williams, 2007; Thornton, et al., 2007; Glumac, 2012; Thomas, 2002; Peiser, 2007; French, 2001; Falkowski, 2012):

1. **Ownership of Property (OP):**
   The ownership of property refers to an individual or entity who possesses the title of land and real estate. The title of an 'asset' can be seen as a bundle of rights. During a redevelopment process these rights may change. One owner will negotiate with another owner to obtain certain rights for his purpose of a specific property. But it is also possible that there is negotiation between a user and property owner for e.g. a license for internal use of property or the license to modify, etc. Negotiation is thus needed to change the title of rights of ownership of property. Levels: (0) Few (between 2 owners), (1) Several (between 2 till 5 owners), (2) Many (between 5 and more owners).

2. **Reparcellation (RP):**
   The second attribute is the possibility and necessity of (re)parcellation in order to create the new plan. This attribute refers to the change of shape, location and size of plots which are located on the industrial site. Levels: (0) Low; (1) Medium; (2) High.

3. **Potential for Different Future Land uses (PL):**
   The attribute refers to the potentiality of the land for other uses (*e.g. changing function of the land*). If we look back to the process of ULR (*chapter 2.2*), it can be stated that the involved parties will temporarily clear the area of ownership, in order to be able to redevelop the site. In this way it will be possible to remove or create new functions: houses, offices, industry, etc. In Maasbracht they have to negotiate if they are willing to keep the land use or change the allocation. Levels: (0) Low, (1) Medium, (2) High.

4. **Approval Process (AP):**
   There are several moments during ULR where the actors need to approve certain outputs of the phases. The actors will bring in their wishes related to their interests and objectives during the Wish Session. Then the Area Commission tries to translate these wishes into an Area Agenda and Allocation Variants. Before the new master plan and Allocation plan can be approved, the involved actors need to accept the new plans (*i.e. does the new plan and allocation of property fit their wishes and objectives? If not, new negotiations are needed between the parties to change the plan*). If all actors agree, then the individual allocation needs to be approved which will be used for the exchange plan. And again, if some parties do not approve the new individual allocation, negotiation is needed to change and approve the individual allocation. It can take a long time to get the approval from all involved actors. Another approval process is the Awb procedure, which is mandatory under Dutch legislation. Citizens and other parties are able to provide feedback on the new plans. If they do not agree, plans may need to be readjusted. This may cause stagnation of the redevelopment process. Therefore the Area Commission needs to manage the process closely to prevent stagnation with help of the Urbanisator. Levels: (0) Few approval points, (1) Several approval points, (2) Many approval points.

5. **Governmental Incentives (GI):**
   The last attribute is the governmental incentives. This attribute is revering to provide incentives for parties in order to participate during a development. This can be done by providing for example subsidies and tax shelter. With help of these incentives projects may become feasible that would otherwise be impossible due to a lack of funds for the investment. It may also help to reduce the amount of expropriation. This attribute is negotiable, because the actors are able to apply for an incentive in order to make their project feasible and/or lower the amount of their investment. The higher the amount of money, the less they have to invest. Of course the municipality wants to provide as little incentives as possible. As a result, parties need to negotiate about the total amount of incentives to receive.

   For the case study Maasbracht we can say that the municipality and province will benefit from a better economical position after the redevelopment of the industrial site. Therefore they are able to provide governmental incentives to stimulate the private owners. The LHB and municipality are not pursuing profit, but they try to optimize the costs and revenues in a project. In this way the deficiency in a project is reduced as much as possible. The municipality and LHB are also able to provide incentives in order to keep the companies, instead of letting them move to other sites. But for the case study we can state that the companies are area bound because of the strategic position at the waterfront and the River Maas. Levels: (0) Low amount of incentives, (1) Medium amount of incentives, (2) High amount of incentives.

The amount of attributes and their associated levels can be translated into the amount of decision-making moments, or, in other words, the nodes inside a game tree.

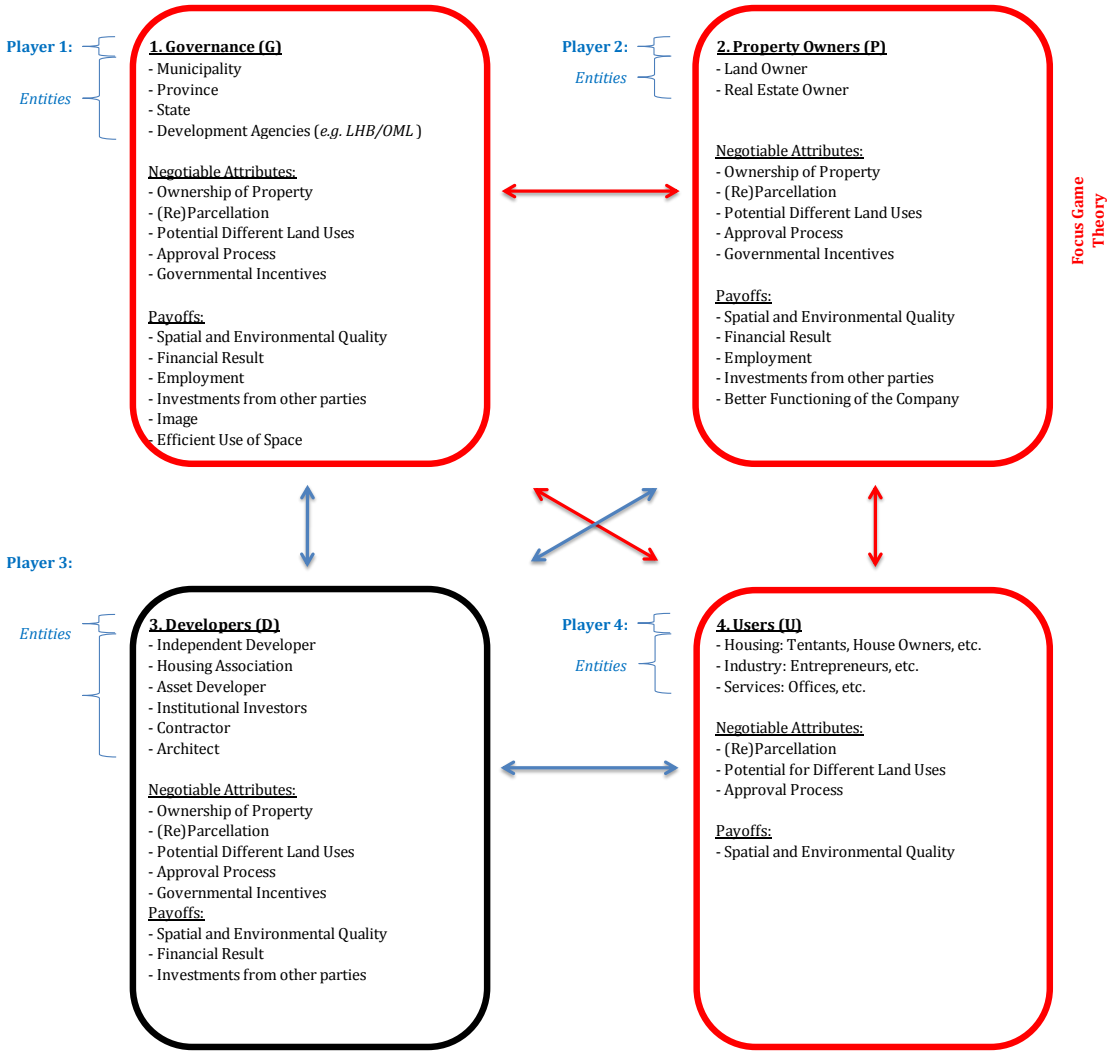

Figure 17 | Overview Types, Entities, Negotiable Attributes and Payoffs

The negotiable attributes can now be linked with the selected types and entities in figure 17. Every type has its own objectives and interests. Therefore the identified negotiable attributes may differ for each of the types and entities. The payoffs (*the amount wherein the stakeholders' interests have been reached*) of the players have been chosen based on table 4 'the interest of public and private parties' and the case study of Maasbracht. In figure 10 the total overview of the players, their negotiable attributes, and payoffs has been drawn. Subtracted from chapter 3, we can state that the property owners and the municipality, LHB/OML are the most important stakeholders in Maasbracht. Therefore the emphasis of the Game Theory will lie on the players Property Owners and Governance. Since end-users are becoming more and more important, the game will also be played with a third player: the end-user, normally seen as e.g. a tenant. But in the game we want to clarify the 'multiple roles' which a specific player can possess. In this case the entrepreneur, who can be seen as property owner and user. As an assumption we can state that the role of the property owner will have other negotiable attributes (*or priorities*) than the role of the end-user. We have to keep in mind that more and other attributes can be chosen. And other attributes may affect a decision.

4.6.2 Choosing Game Type: Ultimatum or Bargaining Game

Non-cooperative, conflict games can be played in two different ways, namely as ultimatum games or bargaining games (Rapoport, et al., 1994; Güth, et al., 1982; Güth, 1995; Bearden, 2001). An ultimatum game can be seen as a game wherein a pie needs to be split between two players. This can be seen as a 2x2 game wherein each player possesses two strategies: a proposer (P) makes one offer to a responder (R) how to split the pie, for example the division of the pie *x = {P ; R} = {75% ; 25%}*. The responder has two options: (1) accepting the proposed split by P, or (2) rejecting the proposed split of the pie. After the responder made his choice (*i.e. option 1 or 2*) the game will end. It must be noted that if the responder chooses option 2, the game will end and results in zero earnings for both players (Güth, et al., 1982). A bargaining game has the same structure as an ultimatum game, but now the players have more opportunities for mutual benefits (Nash Jr., 1950). If the responder chooses option 2, he rejects the split of the pie, and makes a counter offer to the proposer. For example the split *x = {50% ; 50%}*. The proposer is able to (1) accept the counter offer, or (2) reject the counter offer. The game will stop, or with a mutual benefit as outcome or again zero earnings for both players. A bargaining game can be extended by new counter offers from both parties. Ultimatum and bargaining games are also applicable in urban development practice, such as negotiation in choosing a building claim (*ultimatum game*) and negotiation about future land use and parcellation of land (*bargaining game*) (Samsura, et al., 2010; Glumac, et al., 2014; Glumac, 2012).

In reviewing the context of Urban Land Readjustment we can state that the negotiations can be described as bargaining and ultimatum games. If we look at the negotiable attributes (*which have been identified for ULR in section 3.6.1*) it can be stated that these are possible scenarios for ultimatum or bargaining games. For example (1) ownership of property: does a player accept or reject an offer to exchange ownership of property from another player within an ultimatum game, (2) (re)parcellation: bargaining game with offer and counteroffer about the size and shape of land, (3) potential for different land use: bargaining game with offer and counteroffer from another player of land uses, (4) approval process: if a player does not agree with the allocation or individual allocation variant then a negotiation in bargaining game form can be played wherein offer and counter offer from the player will result in adjustments in the plan, and (5) governmental incentives: ultimatum or bargaining game about the amount of money the municipality and/or development agencies (*e.g. such as the LHB*) is willing to contribute to make a plan feasible for a land owner.

4.6.3 Three Player Bargaining Game Model

We know the context of the game, players, negotiable attributes, and payoffs. Also a list has been created with all possible interactions between stakeholders. For one specific situation, with respect to ULR, a decision-making scenario will be modelled whereby negotiation will be used, allowing for counteroffers. Almost all literature describes a game with only two players. But in the urban development practise we can see that there are many more actors involved. Therefore this model will be created for three players, playing a bargaining game. With more players the model would be too complex. Figure 18 shows the three player's bargaining game interactions. Three games can be distinguished, namely (1) G vs. P, (2) G vs. U, and (3) P vs. U. But it must be noted that instead of three games, only two games will be played. If we look at the case study, we can see that the Property Owner (P) is also the User (U). Thus $Player_1$ = P = U = Entrepreneurs and $Player_2$ = G = Governance = Municipali-

ty/Province. But both roles have different negotiable attributes. If U was a tenant for example, then the third game could be played. But the interests and choices of the property owner also affect the interests and choices of the property owner and vice versa. Therefore the link between P and U has been interrupted.

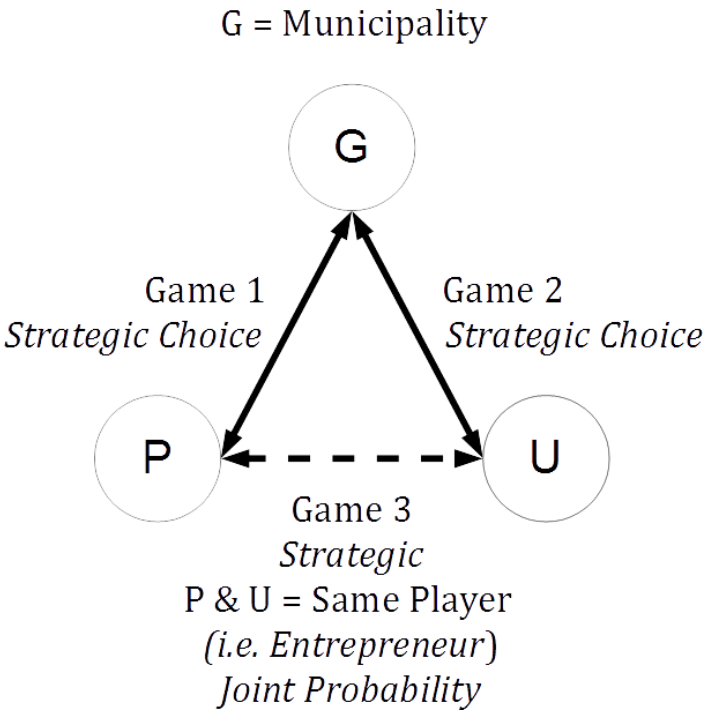

Figure 18 | Players & Games Overview

4.6.4 Extensive Form Bargaining Game

Figure 18 has been extended towards the final game with trees and resulted in the total game in figure 19. The game has been derived from a game which was originally designed by Glumac (2012; 2014). The original game could only be played between two players, but with the help of NetLogo, a three-player bargaining model was created. And again, this game addresses two specific negotiation issues with two of the identified negotiable attributes for Urban Land Readjustment (of *equal importance*), namely (1) the influence of the future land use and (2) reparcellation of the land on an industrial site in the Netherlands. These two issues are important to the negotiation process, because they may influence the payoffs such as the spatial and environmental quality, financial result, improve employment, and acquire investments from other parties to realize a certain goal.

Normally, the reparcellation and future land use is the decision by a public party such as the municipality. But a private party is able to influence it, if they do not agree then the land prepared by the municipality may be building ready but not usable by private parties. As a result it is possible that plots will not be sold (*i.e. there is no demand*). Also the shifted focus is important: private parties are less present on the development market and public parties have fewer resources to fulfil and play an active role in urban renewal. The municipal budgets are under severe pressure and there is less money available from other governmental bodies. Besides the lack of financing possibilities, municipalities became more aware of the risks of an active approach. As a reaction, municipalities will restrain their active attitude (PBL & ASRE, 2013; Van der Krabben, 2011; Hobma & Schutte-Postma, 2012).

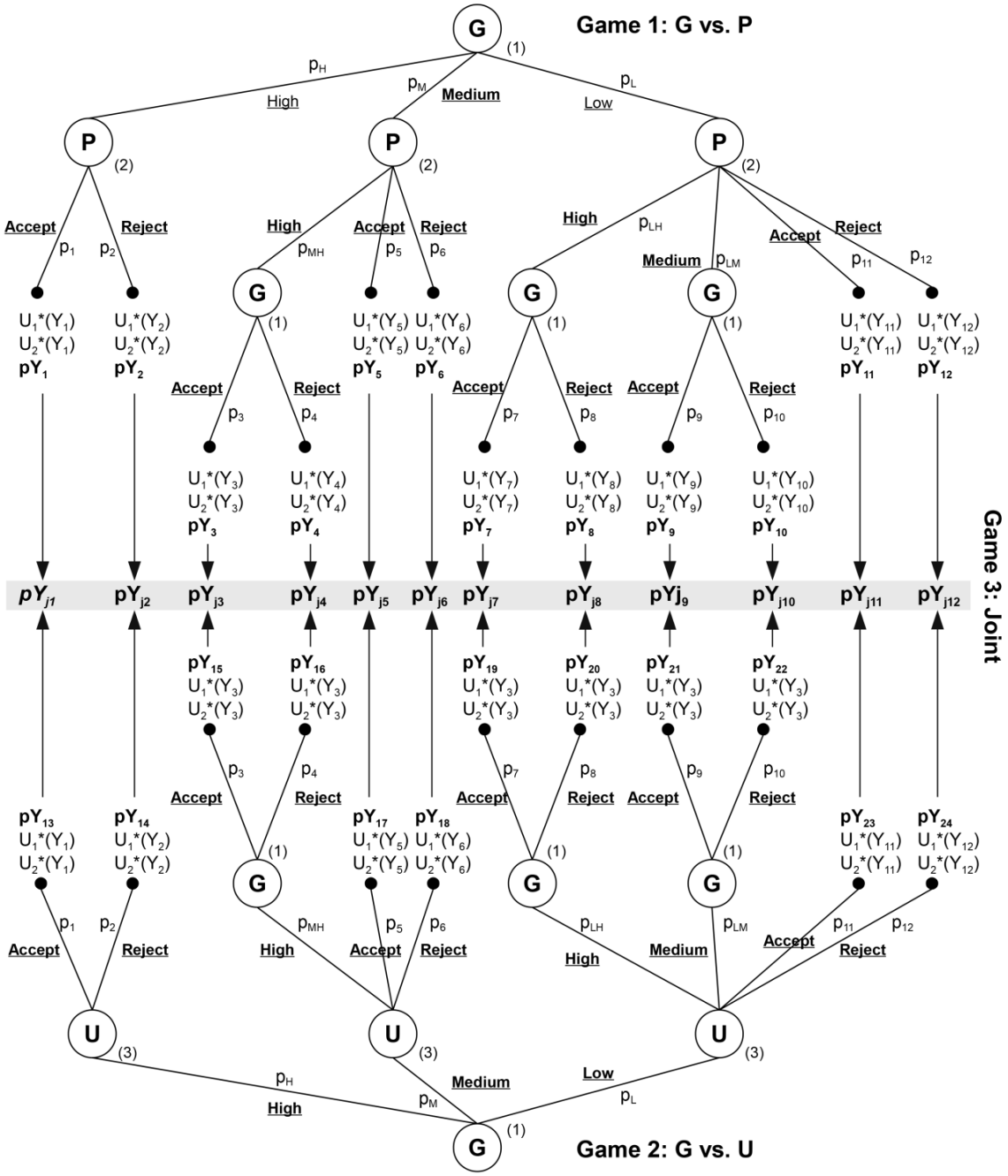

Figure 19 | Bargaining Game 1, 2 & 3 (Sequential Played)

As we can see in the case study, an active attitude from the property owners is needed (*i.e. private investments for pursuing their interests and reducing problems with ownership of property*), municipality and province are trying to trigger and facilitate the redevelopment (*i.e. less investments, minimum risk, but creating employment and economic growth*).

4.6.5 Game Theory and Discrete Choice Modelling

The question is, how to calculate the outcome probabilities? Besides the influence levels and accept/reject, figure 12 displays additional symbols. The combination between the Game Theory and Discrete Choice Modelling has resulted in a Strategic Choice Model. The strategic choice model (*DCM*) is able to help calculating the solution of the game outcomes. In the DCM the choice probabilities p_k, outcomes Y_k, and expected utilities for a certain player

$U_a(Y_k)$ can be found. Statistics will help to calculate the probabilities. The SPNE solution of the model can be calculated with help of backward induction. The input of the model is the utilities. If these utilities are known the probabilities of the decision end nodes can be calculated. For the calculation it is assumed that the players are acting rationally. To calculate the probabilities the normal distribution will be used. The normal distribution, function f(x), is a continuous probability distribution with two parameters: expected value μ and standard deviation σ. The normal distribution whereby $\mu = 0, \sigma = 1^2$ is called the normal density function (van de Craats, 2002):

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-(\frac{(x-\mu)}{2\sigma})^2}, (\mu = 0, \sigma = 1^2) \quad => \quad \emptyset(\eta_{AB}) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}x^2}$$

As for each probability density: the integral over the whole area is exactly equal to 1:

$$N_{\mu,\sigma} = \int_{-\infty}^{\infty} \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}x^2} dx = \frac{1}{\sqrt{\pi}} \int_{-\infty}^{\infty} e^{-y^2} dy = 1$$

Now the probabilities p_1, p_2, p_3, p_4, p_5, p_6, p_7, p_8, p_9, p_{10}, p_{11} & p_{12} can be calculated for both games (1) **G vs. P**, and (2) **G vs. U**. separately. For example the probability p_7 and p_8 can be calculated as follows:

$$p_7 = \int_{-\infty}^{U_1(Y_7)-U_1(Y_8)} \emptyset(\eta_{178}) d\eta_{178} \quad \& \; p_8 = 1 - p_7$$

Action probabilities where there are more than two actions in a decision node, such as p_{MH} and p_5, with the assumption that the disturbance are independent:

$$p_{MH} = \int_{-\infty}^{p_3U_2(Y_3)+p_4U_2(Y_4)-U_2(Y_5)} \emptyset(\eta_{5MH}) d\eta_{5MH} \int_{-\infty}^{p_3U_2(Y_3)+p_4U_2(Y_4)-U_2(Y_6)} \emptyset(\eta_{6MH}) d\eta_{6MH}$$

The other probabilities of the actions in the same node can be calculated by:

$$p_6 = 1 - p_5 - p_{MH}$$

The final probability outcomes can be calculated by:

$$p_{Y_8} = p_L \, p_{LH} \, p_8$$

The last steps of the calculation are the possibilities of the outcomes of p_{High}, p_{Medium} and p_{Low} these probabilities are mutually exclusive:

$$p_{High} = p_{Y_1} - p_{Y_2} - p_{Y_7}$$
$$p_{Medium} = p_{Y_5} - p_{Y_9}$$
$$p_{Low} = p_{Y_{11}}$$

The joint probabilities can be calculated in many different ways, for example by using a log-linear analysis. But this will make the model too complex to understand. Therefore Gert Regterschot, statistician at the TU/e, helped me to find a statistically valid, but simple method to

create the joint probabilities. The equation used has been derived from the field of risk management: *Risk = Probability of an event occurring * consequence of that event*, or better *Risk = Consequence * Vulnerability * Threat* (Whitfield, et al., 2011). Both probabilities in the game are dependent on each. Depending on the weight of the decision-makers, the outcome can be corrected by an index. For example player A has a higher influence level (*for example he is the property owner and seen as more important*) than a tenant (*who has no right to change the function of property*). The total formula can also be corrected by an index factor. This can be done to catch uncertainties. Therefore the following equation is used whereby an event pY_1 is the probability of an event occurring multiplied by the *consequence of that event* which is the pY_{13} which has consequences on the outcome. The index factor is in this case to correct deviations:

$$pY_{j1} = pY_1 * pY_{13} * Index$$

As assumption for the model, the index has been set to 1 on advice from the statistician. Normally the index has to be calculated based on a large population. Because this information is not yet available (*new research needed*) the index is not an important factor for this model. Appendix II provides all formulas of the Strategic Choice Model.

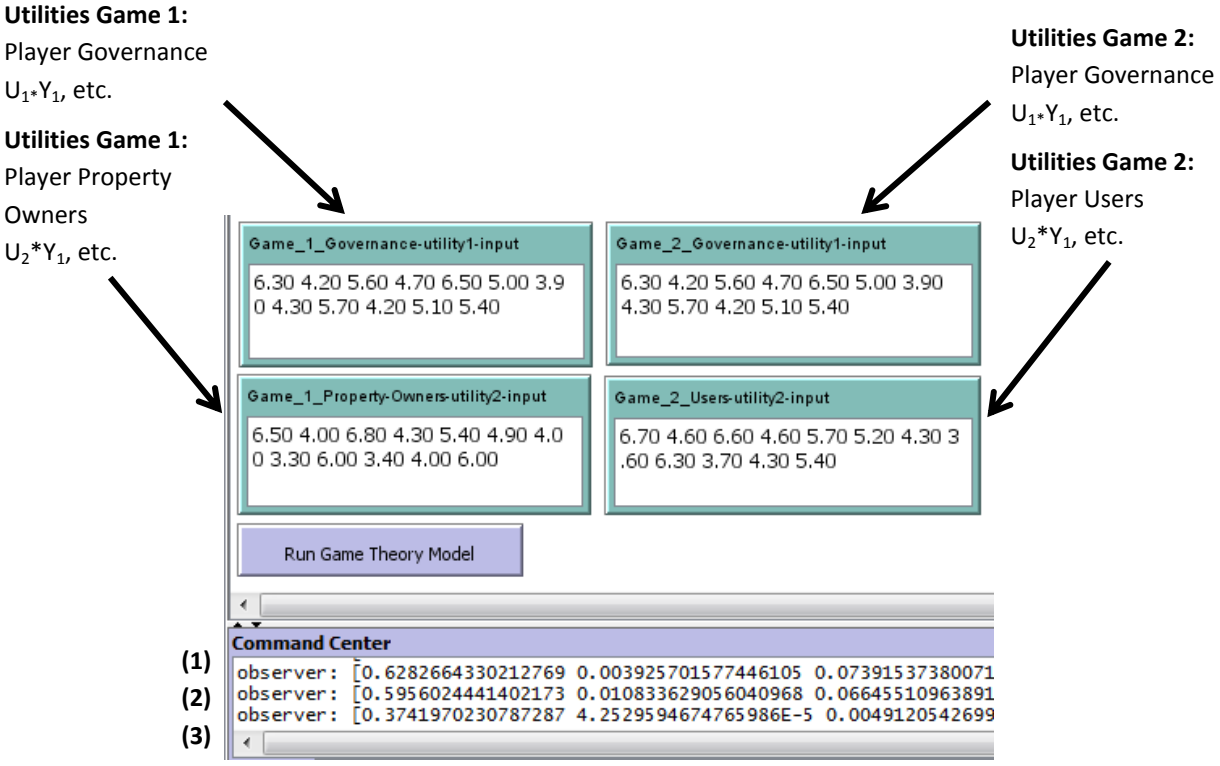

Figure 20 | NetLogo Model

Observer 1 provides the outcomes of game 1, observer 2 provides the outcomes of game 2, and observer 3 provides the outcomes of the total game. The game is thus able to provide all answers on each game separately and finally the joint probabilities. The game structure has been validated with the help of experts from the Kadaster during expert meetings.

4.7 Data Collection: Estimation Payoffs & Calculation Outcome Probabilities

There is still one step missing: 'the utilities' which allow us to calculate the probability outcomes. The question is, how to subtract the utilities from the practise? Different methods are available, but for this research the Fuzzy Delphi Methods will be used. The Fuzzy Delphi Method (*FDM*) allows us to subtract the utilities by a group understanding approach by weighting attributes for example (Glumac, et al., 2010). To gain the utilities, experts in the field of Urban Development were asked for their contribution. First, the case study of Maasbracht was explained in detail, including the decision-making moment, in a group meeting setting. They were asked to provide the '*most preferred outcome of the game*' (*weighting the outcomes of the game according to the preferences (=payoffs) of the specific players*), in contrast with the '*most probable outcome*' of the game (*by weighting the preferences without seeing the whole tree by using a questionnaire, whereby afterwards a ranking of the most probable outcome can be calculated by backward induction*). The preferences are regarded here as the payoff. To rate the outcomes the experts were asked to estimate the importance of the outcomes by two kinds of ranges, maximal and optimal, on the scale 1-10. First, the maximum range needed to be filled in response to their broadest importance base at an end branch. Afterwards, the experts filled in the optimal range in correspondence with their most specific importance. Thereby, each expert weighted each end branch for each of the three roles. Thus: per end branch every expert filled in three weightings, one for each role (*Governance, Property Owners, and Users*).

For example weighting the Governance players' end branch High_Accept (*figure 21*). Four weights have to be given in the two ranges. First the maximal range a=1 to d=5, and then the optimal range b=2 and c=3. This is resulting in four rows with the numbers {*a=1, b=2, c=3, d=5*} as weighting of the utility. In this way a better and more detailed overview can be created about the experts' opinions instead of just weighting by a single number. In the example below you can see how the Excel sheet can be filled in for the end branch *High_Accept* outcome of the game. Thus, the experts had to do this 12 outcomes*3 players = 36 utilities.

1. Weighting example Game Governance vs. Property Owners U_1*Y_1 High_Accept
Player: Governance

1	2	3	4	5	6	7	8	9	10

2. Weighting example Game Governance vs. Property Owners U_2*Y_1 High_Accept
Player: Property Owners

1	2	3	4	5	6	7	8	9	10

3. Weighting example Game Governance vs. Property Owners U_2*Y_1 High_Accept
Player: Users

1	2	3	4	5	6	7	8	9	10

Figure 21 | Example Fuzzy Delphi Weighting High_Accept End Branch

Afterwards, the data needed to be converted towards an overall fuzzy number, for each player, for each specific end branch. This was done by using the trapezoidal fuzzy number. The final weight of a single branch, weighted by a single expert, can be expressed by the equation $w_j = a_j + b_j + c_j + d_j$. For estimating the overall values of all involved experts the following equations were used, wherein n = number of experts (Klir & Yuan, 1995):

$$a_j = \min\{a_{ij}\}, \qquad b_j = \frac{1}{n}\sum_{i=1}^{n}(b_j), \qquad c_j = \frac{1}{n}\sum_{i=1}^{n}(c_j), \qquad d_j = \min\{d_{ij}\},$$

The overall outcomes of the game can be found in table 6. The last step is the defuzzification towards a single real value. Therefore the simple centre of gravity method was used (Klir & Yuan, 1995):

$$S_j = \frac{a_j + b_j + c_j + d_j}{4}$$

Table 6 provides an overview of the final fuzzy numbers {*a,b,c,d*} and defuzzied numbers S (*which represents the indication of the payoffs*). The last step is to put the utilities into the NetLogo model for the final calculation of the probabilities. In appendix III the full data overview of the experts can be found.

End Branch	Player	a	b	c	d	S	SPNE
H_a	G	1,00	2,20	3,20	4,00	2,60	
	P	1,00	2,80	3,80	5,00	3,15	
	U	2,00	3,40	4,40	6,00	3,95	
H_r	G	3,00	8,00	9,00	10,00	7,50	
	P	3,00	8,00	9,00	10,00	7,50	
	U	5,00	8,00	9,00	10,00	8,00	
M_a	G	3,00	4,80	5,80	6,00	4,90	
	P	2,00	4,00	5,20	6,00	4,30	
	U	3,00	5,80	7,00	8,00	5,95	
M_r	G	5,00	6,80	8,00	9,00	7,20	
	P	4,00	5,80	7,80	8,00	6,40	
	U	4,00	6,20	7,20	8,00	6,35	
L_a	G	6,00	8,00	9,00	10,00	8,25	X
	P	7,00	8,00	9,00	10,00	8,50	
	U	5,00	8,00	9,00	10,00	8,00	
L_r	G	1,00	2,20	3,40	5,00	2,90	
	P	1,00	2,40	3,40	5,00	2,95	
	U	1,00	2,20	3,20	4,00	2,60	
M_h_a	G	1,00	2,00	3,00	4,00	2,50	
	P	1,00	2,20	3,40	5,00	2,90	
	U	1,00	2,20	3,20	5,00	2,85	
M_h_r	G	2,00	3,80	5,00	6,00	4,20	
	P	2,00	4,00	5,20	6,00	4,30	
	U	2,00	4,00	5,00	6,00	4,25	
L_h_a	G	3,00	6,00	7,40	8,00	6,10	
	P	2,00	5,40	6,40	7,00	5,20	
	U	3,00	5,00	6,00	7,00	5,25	
L_h_r	G	3,00	5,00	6,00	7,00	5,25	
	P	2,00	5,00	6,00	8,00	5,25	
	U	2,00	5,00	6,00	7,00	5,00	
L_m_a	G	3,00	5,00	6,00	7,00	5,25	
	P	4,00	5,00	6,00	7,00	5,50	
	U	4,00	5,00	6,00	7,00	5,50	
L_m_r	G	1,00	2,80	3,80	4,00	2,90	
	P	1,00	2,80	4,00	5,00	3,20	
	U	2,00	3,00	4,00	5,00	3,50	

Figure 2 | Outcomes Utilities

4.8 Analysis of the Final Outcomes Game Theory

The last step is the analysis of the final outcomes of the model. The values of S have been filled in into the NetLogo model for the calculation of all probabilities. The final probabilities have been put in an Excel table (*table 22*) to provide an overview of the prediction of the outcome of the game. Game 1 represents the game *Governance vs. Property Owners*, Game 2 represents the game *Governance vs. Users*, and Game 3 the *joint probability* of both games.

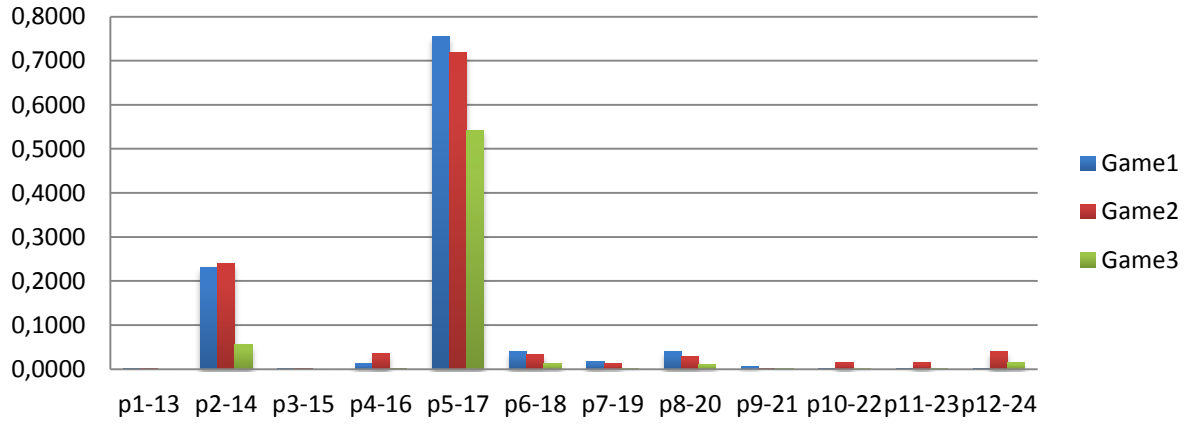

Figure 22 | Final Probabilities of the Game

As we can see, the outcome of the joint probability pY_5 has the highest probability to be chosen according to the experts. The outcome belongs to the end branch that the Governance player is offering a medium influence about the specific attributes '*Future Land Uses and Reparcellation*'. As can be observed from the graph, both the property owners and the users accept the offer. We can also see that joint probability of pY_2 also scores a high outcome. The outcome represents an aversion towards a high influence level of the Governance player. And thus we can state that the predicted outcome of the bargaining game is a medium influence level of the municipality, accepted by the property owners and users, who receive a higher influence level on the redevelopment. Thus, all involved stakeholders are receiving approximately an equal influence level.

4.9 Conclusion

The prediction has showed that a medium influence level of the public parties (*especially the municipality*) is the most preferred outcome, whereby the private owners are accepting and willing to collaborate. This can be seen as an equal level of influence on the 'future land use' and 'reparcellation' of the industrial site Maasbracht. It can be stated that a 'dominant leading' position must be avoided by the public parties. The outcome of the model supports the high probability that a high level of influence (p_2-p_{14}) of the Governance player will be rejected by the players Property Owners and Users. And besides, a low influence level by the Government, and even by the other two players, scores very low probabilities which are close to 0. The final conclusion: public parties may <u>*not*</u> start the redevelopment process of the wet industrial area on the basis of a dominant strategy. This will eventually cause aversion by the private parties and stagnation of the redevelopment process. By offering a medium influence level, the private parties will also receive a medium influence level, and the redevelopment will be accepted. Optimal collaboration is required, but in this case both parties are able to steer and maximize their payoffs. And therefore, the Kadaster is able, by prediction,

to intervene during a redevelopment process, for example by providing this advice to the public parties. And thus the process can be steered for optimal results. As for the Game Theory part, the Game Theory provides an abstraction of a real-world situation. The aim is to use the tool to create and understand behaviour of the stakeholders, but not in full detail. Furthermore, the models are simplifications and many assumptions need to be made. Some argue that modelling of behaviour in the context of urban development makes no sense due to the context-driven environment. But this research shows that the Game Theory can be useful for specific chosen scenarios. Unfortunately, creating the models is time consuming due to the amount of statistics and mathematics involved. Software is not yet available to create easy Game Theory Models of this scale. And thus: Game Theory in the used form is not advisable for the Kadaster, because a specialist would need to be hired for the creation and usage of the models, which would result in high investments for the Kadaster.

Chapter 5: Conclusions and Recommendations

This final chapter presents the findings of the research. First, the conclusions of the research and the answers to the central research questions will be provided. The report ends with the discussion and recommendations section.

5.1 Conclusions

The purpose of the research is to stimulate the redevelopment process of obsolete industrial sites in the Netherlands. This is triggered by the statement that the Kadaster is detecting stagnation and missed opportunities during the redevelopment process of obsolete industrial sites. The main question in this research is how the Kadaster is able to improve the redevelopment process of obsolete industrial sites in the Netherlands by using 'interventions'. We have seen that missed opportunities are caused by limitations with fragmented ownership of property, unwillingness to participate, and conflicting interests between stakeholders. The limitations are causing unwanted stagnation, increased risks, and unwanted and unpredictable outcomes of the process. But the redevelopment of obsolete industrial sites provides benefits for the environment, economy, and society. For this research interventions of the Kadaster via two possible ways have been explored, namely 'Urban Land Readjustment' and 'predictions'.

Obsolete Industrial Sites

It can be stated that obsolete industrial sites are a societal problem in the Netherlands. The government is seeing the necessity of fighting obsolescent and vacant old industrial sites. Both public and commercial parties are responsible for the aging and deterioration of the spatial quality of many industrial sites. The aging and deterioration is causing depreciation of property (*and often a reduced pension due to the higher expected valuation of property by the entrepreneur*), poor spatial quality, and reduced economic position of the region. Redevelopment projects are often not started, despite the large amount of money provided by public parties. Private parties are simply waiting, because in their opinion their site is still functioning, and thus there is no drive for investments. But the crisis caused a large drop in demand whereby entrepreneurs merely focussed on their production process in order not to go bankrupt. Times of major redevelopment projects are over and a growing interest by public parties in redevelopment initiatives by entrepreneurs can be observed. Mainly because of the many private properties caused by fragmented ownership of property. The impetus to start a redevelopment process is often caused by a growing business, poor business climate due to empty premises, or other problems. Municipalities are needing a different approach to trigger investments by using 'uitnodigingsplanelogie' instead of 'toelatingsplanelogie'. Problems arises when entrepreneurs are hindered by fragmented ownership of property. The Kadaster is able to provide an important contribution to stimulate redevelopment projects by implementing ULR.

Urban Land Readjustment

The literature review shows that Urban Land Readjustment is a potential land management strategy currently under development by the Kadaster, Association of Dutch Municipalities (*VNG*), NEPROM, Kadaster, Ministry of Home Affairs (*BZK*), Ministry of Infrastructure and Environment (*IenM*), local governances and experts. The tool is based on the German Um-

legung and can be used for rescheduling of property, such as land and real estate, with the aim of taking the initiative or facilitating an area development. ULR differs from existing land management strategies due to its ability to reduce problems with fragmented ownership of property situations and the possibility to force participation of owners if the vast majority is willing to take the initiative towards redevelopment. Existing land management strategies are failing due to missing support of these two mentioned problems. The only tool in Dutch spatial planning that is able to deal with fragmented ownership of property is expropriation. But this is often avoided by public parties due to the time consuming and expensive process. In addition, the well-managed process of decision-making is specifically designed for complex collaboration between stakeholders, whereby property owners and end-users have a high level of influence to express their preferences. Public parties are more providing a facilitating role in order to reduce their risks and investments, this in line with the crisis and changing attitudes.

The process has been designed as a chain of cyclic negotiation, whereby the results of one negotiation will form the basis for the next step in the process. The outlines of the process can be summarized in five phases, namely (1) initiative phase, (2) capturing the initial state, (3) creation of a new program, (4) creation of allocation variants, and (5) financial settlement. The legal protection of the individual owners is an important factor and therefore protected by an independent party, such as the Kadaster. It must be noted that ULR is not yet an official tool in the Netherlands, and therefore in the 'experimental phase'. Probably from 2018 onwards, it will be seen as an additional toolbox for public parties.

Analysation and Prediction with the Game Theory

Literature review has shown that (*lack of*) collaboration and decision-making are important causes for the stagnation of redevelopment projects, mainly due to lacking consensus between involved stakeholders. This is caused by partly shared and partly contradictory interests. Also, it is a fact that one single actor is simply not able to determine the overall outcome of the process and thus all parties depend upon each other. In short: conflicting interests are causing problems with decision-making. One key method is to create an environment wherein cooperation between stakeholders can be managed well in such a way that the different ideas, preferences, and interests of all parties can be addressed and conflicting interests can be settled. ULR provides a contribution to the design of negotiations by a coordination of preferences, in the form of 'wishes' translated in different 'allocation variants', to create support of the involved stakeholders and by which conflicting interests can be settled. Or in other words: ULR is a guarded cyclic process-oriented approach, characterized as a chain with multiple decision-making moments and negotiations, to create a balance between support and feasibility. In addition, the Kadaster has a growing interest in theories and models which are able to analyse and predict complex decision-making scenarios. Therefore the entity wants to understand social interactions in general and interactive decision-making in particular. Literature shows that analysing and predicting strategic competition between stakeholders is possible by using the Game Theory research method. By using predictions, the Kadaster is able to see problems before they occur, and may provide interventions to optimize the process.

Advice Case Study Maasbracht: 'Urban Land Readjustment' and 'Predicting and Analysing'
If we look at the case study of Maasbracht, the redevelopment process of the industrial site Koeweide-Battenweg, it has emerged that applying Urban Land Readjustment by the Kadaster improved the process by: (1) fragmented ownership of property is no longer a limiting factor, (2) all parties are able to provide their wishes and interests, (3) ULR created support for a new joint plan, and (4) the Kadaster is able to steer the process due to its position as an independent party. The Game Theory was used for the analysis and prediction of a decision-making moment. The three-player-bargaining game model has, with the input from experts, generated a prediction that the Kadaster can forward as advice to the municipality of Maasgouw: public parties (*municipality of Maasgouw, LHB, and OML*) and property owners/end-users should not hold a dominant 'leading position'. If this is the case, the redevelopment process will fail. And thus the Kadaster can use the prediction for interventions to improve the redevelopment of obsolete industrial sites.

To answer the central question of this report: 'How is the Kadaster, by using 'interventions', able to improve the redevelopment process of obsolete industrial sites?', the final conclusion of this report is that the Kadaster is able to improve the redevelopment process of obsolete industrial sites by using interventions with: (1) 'Urban Land Readjustment', for removing limitations with fragmented ownership of property situations, enforcement of participation of actors, and creating mutual agreement by using guarded negotiations during ULR, and (2) using 'predictions' with for example the Game Theory for interventions before/during decision-making scenarios. Predictions provide the Kadaster with a strategic advantage, because a particular scenario can be analysed before it happens.

5.2 Discussion and Recommendations

Creating the model was a time consuming activity, merely due to the complexity of statistics and mathematics. A discussion started during an expert meeting with the Kadaster about the usability of this kind of Game Theory models in the field of urban development, and especially during the process of Urban Land Readjustment. First of all, these models are very limited due to the large number of assumptions, simplifications of complex real-world interactions, and the usage of perfect information instead of the more realistic imperfect information. Besides, there are many uncertainties about retrieving data. Furthermore, there is no software available for the simple creation of extensive form games which automatically applies the correct formulas of the Strategic Choice. This would tremendously improve the speed of the modelling process and create more flexibility. For the Kadaster this means that a specialist would be required who is capable of creating these kinds of models. As a result, it would be a time consuming and especially a costly activity for the Kadaster. Therefore it can be stated that the form is not suitable to provide a better understanding or to predict a specific decision-making moment during the process of ULR. The Game Theory is more suitable for scientific research.

Another important outcome of the expert meeting is the fact that we concluded that the human brain is a complex but effective tool for analysing and predicting decision-making moments. Experts, due to their years of experience, are able to see the interests, strategies, payoffs, and outcomes much quicker. They are able to see connections, or filter out connections, which are relevant for the decision-making moment. But the question is: is there a way how the Game Theory may be useful during the process of Urban Land Readjustment?

To answer the question: yes, the Game Theory can be used for stimulating decision-making in practise. It may even be useful for the decision-making processes during ULR. We have seen that ULR is characterized by many decision-making moments and negotiations to solve conflicting interests. The Kadaster has experts for facilitating the process of decision-making, but property owners and end-users for example do not always have these skills. So, here lies an opportunity for stimulating and optimizing decision-making during ULR in the form of creating better awareness and involvement. The question is how? The answer could be, for example, through a brainstorming session with property owners, end-users, and municipality (*and even developers, investors, and other stakeholders*).

During these meetings complex decisions will be made by using, for example, the game tree. The game tree can be used for demonstrating and visualizing to the involved actors which decisions, strategies, payoffs, and outcomes are possible. And, of course, the effects of certain decisions. The benefit of using the Game Theory is that the construction of the game tree is required to analyse and define the assumptions very precisely. In this case no mathematics and statistics are needed. Common sense and the expertise of independent companies can be used. This will result in better understanding and improved support among the stakeholders. This report does not provide a fully detailed implementation possibility of Game Theory in the practise. Therefore, new research has to be done for the feasibility, application, and implementation form.

5.3 Further Research

This research is not able to address all information about the topics Urban Land Readjustment, Brownfield redevelopment processes, and the usage of Game Theory. During the process new insights and questions have emerged which could be translated into recommendations for further research:

- The Game Theory is still of limited use in both practise and scientific research relating to urban development practise due to the complexity and context-driven scenarios and changing settings. Further research may contribute towards an application of the Game Theory in a simple but effective form which is suitable for companies to use for example during a brainstorming session or expert meeting. Also the usability of other tools should be investigated for analysis and prediction of social behaviour, for example Agent Based Social Simulation (*ABSS*).
- Urban Land Readjustment is a fascinating subject but questions are emerging on the steering effect of municipalities. If there is not enough support for a redevelopment process of a certain area, how should the municipality facilitate the process if only the minority of entrepreneurs are seeing the necessity to participate?
- The tool must not be seen as a tool only designed to use during a crisis. What will be the effect on the usage of Urban Land Readjustment after the crisis? How will the market behave, and will the urban development practise not fall back into its old habits?

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APPENDIX I. LIST OF POSSIBLE SUB-GAMES

Negotiable Attributes:	Type:	Entities:	Different and/or Same:
Ownership of Property	P vs. P	Land Owner vs. Real Estate Owner	Different and Same
		Land Owner vs. Land Owner	Different and Same
		Real Estate Owner vs. Real Estate Owner	Different and Same
	G vs. P	Municipality vs. Land Owner	Different and Same
		Municipality vs. Real Estate Owner	Different and Same
		Province vs. Land Owner	Different and Same
		Province vs. Real Estate Owner	Different and Same
		State vs. Land Owner	Different and Same
		State vs. Real Estate Owner	Different and Same
	G vs. G	Municipality vs. Province	Different
		Municipality vs. State	Different
		Province vs. State	Different
	G vs. D	Municipality vs. Independent Developer	Different
		Municipality vs. Housing Association	Different
		Municipality vs. Asset Developer	Different
		Municipality vs. Instituational Investor	Different
		Municipality vs. Contractor	Different
		Municipality vs. Architect	Different
		Province vs. Independent Developer	Different
		Province vs. Housing Association	Different
		Province vs. Asset Developer	Different
		Province vs. Instituational Investor	Different
		Province vs. Contractor	Different
		Province vs. Architect	Different
		State vs. Independent Developer	Different
		State vs. Housing Association	Different
		State vs. Asset Developer	Different
		State vs. Institutional Developer	Different
		State vs. Contractor	Different
		State vs. Architect	Different
	P vs. D	Land Owner vs. Independent Developer	Different and Same
		Land Owner vs. Housing Association	Different and Same
		Land Owner vs. Asset Developer	Different and Same
		Land Owner vs. Institutional Investor	Different and Same
		Land Owner vs. Contractor	Different and Same
		Land Owner vs. Architect	Different and Same
		Real Estate Owner vs. Independent Devel.	Different and Same
		Real Estate Owner vs. Housing Association	Different and Same
		Real Estate Owner vs. Asset Developer	Different and Same
		Real Estate Owner vs. Institutional Devel.	Different and Same
		Real Estate Owner vs. Contractor	Different and Same
		Real Estate Owner vs. Architect	Different and Same
	D vs. D	Independent Developer vs. Independent D.	Different
		Independent Developer vs. Housing Assoc.	Different
		Independent Developer vs. Asset Developer	Different
		Independent Developer vs. Institutional Inv.	Different
		Independent Developer vs. Contractor	Different
		Independent Developer vs. Architect	Different
		Housing Association vs. Housing Association	Different
		Housing Association vs. Asset Developer	Different
		Housing Association vs. Institutational Invest.	Different
		Housing Association vs. Contractor	Different
		Housing Association vs. Architect	Different
		Asset Developer vs. Asset Developer	Different
		Asset Developer vs. Institutional Investor	Different
		Asset Developer vs. Contractor	Different
		Asset Developer vs. Contractor	Different
		Asset Developer vs. Architect	Different
		Institutional Developer vs. Institutional Devel.	Different
		Institutional Developer vs. Contractor	Different
		Institutional Developer vs. Architect	Different
		Contractor vs. Contractor	Different
		Contractor vs. Architect	Different
		Architect vs. Architect	Different

(Re)Parcellation	P vs. P	Land Owner vs. Real Estate Owner	Different and Same
		Land Owner vs. Land Owner	Different and Same
		Real Estate Owner vs. Real Estate Owner	Different and Same
	G vs. P	Municipality vs. Land Owner	Different and Same
		Municipality vs. Real Estate Owner	Different and Same
		Province vs. Land Owner	Different and Same
		Province vs. Real Estate Owner	Different and Same
		State vs. Land Owner	Different and Same
		State vs. Real Estate Owner	Different and Same
	G vs. G	Municipality vs. Province	Different
		Municipality vs. State	Different
		Province vs. State	Different
	G vs. D	Municipality vs. Independent Developer	Different
		Municipality vs. Housing Association	Different
		Municipality vs. Asset Developer	Different
		Municipality vs. Instituational Investor	Different
		Municipality vs. Contractor	Different
		Municipality vs. Architect	Different
		Province vs. Independent Developer	Different
		Province vs. Housing Association	Different
		Province vs. Asset Developer	Different
		Province vs. Instituational Investor	Different
		Province vs. Contractor	Different
		Province vs. Architect	Different
		State vs. Independent Developer	Different
		State vs. Housing Association	Different
		State vs. Asset Developer	Different
		State vs. Institutional Developer	Different
		State vs. Contractor	Different
		State vs. Architect	Different
	P vs. D	Land Owner vs. Independent Developer	Different and Same
		Land Owner vs. Housing Association	Different and Same
		Land Owner vs. Asset Developer	Different and Same
		Land Owner vs. Institutional Investor	Different and Same
		Land Owner vs. Contractor	Different and Same
		Land Owner vs. Architect	Different and Same
		Real Estate Owner vs. Independent Devel.	Different and Same
		Real Estate Owner vs. Housing Association	Different and Same
		Real Estate Owner vs. Asset Developer	Different and Same
		Real Estate Owner vs. Institutional Devel.	Different and Same
		Real Estate Owner vs. Contractor	Different and Same
		Real Estate Owner vs. Architect	Different and Same
	D vs. D	Independent Developer vs. Independent D.	Different
		Independent Developer vs. Housing Assoc.	Different
		Independent Developer vs. Asset Developer	Different
		Independent Developer vs. Institutional Inv.	Different
		Independent Developer vs. Contractor	Different
		Independent Developer vs. Architect	Different
		Housing Association vs. Housing Association	Different
		Housing Association vs. Asset Developer	Different
		Housing Association vs. Institutational Invest.	Different
		Housing Association vs. Contractor	Different
		Housing Association vs. Architect	Different
		Asset Developer vs. Asset Developer	Different
		Asset Developer vs. Institutional Investor	Different
		Asset Developer vs. Contractor	Different
		Asset Developer vs. Contractor	Different
		Asset Developer vs. Architect	Different
		Institutional Developer vs. Institutional Devel.	Different
		Institutional Developer vs. Contractor	Different
		Institutional Developer vs. Architect	Different
		Contractor vs. Contractor	Different
		Contractor vs. Architect	Different
		Architect vs. Architect	Different

Potential Different Land Uses	G vs. G	Municipality vs. Province	Different
		Municipality vs. State	Different
		Province vs. State	Different
	P vs. P	Land Owner vs. Real Estate Owner	Different and Same
		Land Owner vs. Land Owner	Different and Same
		Real Estate Owner vs. Real Estate Owner	Different and Same
	D vs. D	Independent Developer vs. Independent D.	Different
		Independent Developer vs. Housing Assoc.	Different
		Independent Developer vs. Asset Developer	Different
		Independent Developer vs. Institutional Inv.	Different
		Independent Developer vs. Contractor	Different
		Independent Developer vs. Architect	Different
		Housing Association vs. Housing Association	Different
		Housing Association vs. Asset Developer	Different
		Housing Association vs. Institutational Invest.	Different
		Housing Association vs. Contractor	Different
		Housing Association vs. Architect	Different
		Asset Developer vs. Asset Developer	Different
		Asset Developer vs. Institutional Investor	Different
		Asset Developer vs. Contractor	Different
		Asset Developer vs. Contractor	Different
		Asset Developer vs. Architect	Different
		Institutional Developer vs. Institutional Devel.	Different
		Institutional Developer vs. Contractor	Different
		Institutional Developer vs. Architect	Different
		Contractor vs. Contractor	Different
		Contractor vs. Architect	Different
		Architect vs. Architect	Different
	U vs. U	Housing vs. Housing	Different and Same
		Housing vs. Industry	Different and Same
		Housing vs. Services	Different and Same
		Industry vs. Industry	Different and Same
		Industry vs. Services	Different and Same
		Services vs. Services	Different and Same
	G vs. P	Municipality vs. Land Owner	Different and Same
		Municipality vs. Real Estate Owner	Different and Same
		Province vs. Land Owner	Different and Same
		Province vs. Real Estate Owner	Different and Same
		State vs. Land Owner	Different and Same
		State vs. Real Estate Owner	Different and Same
	G vs. D	Municipality vs. Independent Developer	Different
		Municipality vs. Housing Association	Different
		Municipality vs. Asset Developer	Different
		Municipality vs. Instituational Investor	Different
		Municipality vs. Contractor	Different
		Municipality vs. Architect	Different
		Province vs. Independent Developer	Different
		Province vs. Housing Association	Different
		Province vs. Asset Developer	Different
		Province vs. Instituational Investor	Different
		Province vs. Contractor	Different
		Province vs. Architect	Different
		State vs. Independent Developer	Different
		State vs. Housing Association	Different
		State vs. Asset Developer	Different
		State vs. Institutional Developer	Different
		State vs. Contractor	Different
		State vs. Architect	Different
	G vs. U	Municipality vs. Housing	Different
		Municipality vs. Industry	Different
		Municipality vs. Services	Different
		Province vs. Housing	Different
		Province vs. Industry	Different
		Province vs. Services	Different

		State vs. Housing	Different
		State vs. Industry	Different
		State vs. Services	Different
	P vs. D	Land Owner vs. Independent Developer	Different and Same
		Land Owner vs. Housing Association	Different and Same
		Land Owner vs. Asset Developer	Different and Same
		Land Owner vs. Institutional Investor	Different and Same
		Land Owner vs. Contractor	Different and Same
		Land Owner vs. Architect	Different and Same
		Real Estate Owner vs. Independent Devel.	Different and Same
		Real Estate Owner vs. Housing Association	Different and Same
		Real Estate Owner vs. Asset Developer	Different and Same
		Real Estate Owner vs. Institutional Devel.	Different and Same
		Real Estate Owner vs. Contractor	Different and Same
		Real Estate Owner vs. Architect	Different and Same
	D vs. U	Independent Developer vs. Housing	Different
		Independent Developer vs. Industry	Different
		Independent Developer vs. Services	Different
		Housing Association vs. Housing	Different
		Housing Association vs. Industry	Different
		Housing Association vs. Services	Different
		Asset Developer vs. Housing	Different
		Asset Developer vs. Industry	Different
		Asset Developer vs. Services	Different
		Institutional Investor vs. Housing	Different
		Institutional Investor vs. Industry	Different
		Institutional Investor vs. Services	Different
		Contractor vs. Housing	Different
		Contractor vs. Industry	Different
		Contractor vs. Services	Different
		Architect vs. Housing	Different
		Architect vs. Industry	Different
		Architect vs. Services	Different
	U vs. G	Municipality vs. Housing	Different
		Municipality vs. Industry	Different
		Municipality vs. Services	Different
		Province vs. Housing	Different
		Province vs. Industry	Different
		Province vs. Services	Different
		State vs. Housing	Different
		State vs. Industry	Different
		State vs. Services	Different
Approval Process	G vs. G	Municipality vs. Province	Different
		Municipality vs. State	Different
		Province vs. State	Different
	P vs. P	Land Owner vs. Real Estate Owner	Different and Same
		Land Owner vs. Land Owner	Different and Same
		Real Estate Owner vs. Real Estate Owner	Different and Same
	D vs. D	Independent Developer vs. Independent D.	Different
		Independent Developer vs. Housing Assoc.	Different
		Independent Developer vs. Asset Developer	Different
		Independent Developer vs. Institutional Inv.	Different
		Independent Developer vs. Contractor	Different
		Independent Developer vs. Architect	Different
		Housing Association vs. Housing Association	Different
		Housing Association vs. Asset Developer	Different
		Housing Association vs. Institutational Invest.	Different
		Housing Association vs. Contractor	Different
		Housing Association vs. Architect	Different
		Asset Developer vs. Asset Developer	Different
		Asset Developer vs. Institutional Investor	Different
		Asset Developer vs. Contractor	Different
		Asset Developer vs. Contractor	Different
		Asset Developer vs. Architect	Different

	Institutional Developer vs. Institutional Devel.	Different
	Institutional Developer vs. Contractor	Different
	Institutional Developer vs. Architect	Different
	Contractor vs. Contractor	Different
	Contractor vs. Architect	Different
	Architect vs. Architect	Different
U vs. U	Housing vs. Housing	Different and Same
	Housing vs. Industry	Different and Same
	Housing vs. Services	Different and Same
	Industry vs. Industry	Different and Same
	Industry vs. Services	Different and Same
	Services vs. Services	Different and Same
G vs. P	Municipality vs. Land Owner	Different and Same
	Municipality vs. Real Estate Owner	Different and Same
	Province vs. Land Owner	Different and Same
	Province vs. Real Estate Owner	Different and Same
	State vs. Land Owner	Different and Same
	State vs. Real Estate Owner	Different and Same
G vs. D	Municipality vs. Independent Developer	Different
	Municipality vs. Housing Association	Different
	Municipality vs. Asset Developer	Different
	Municipality vs. Instituational Investor	Different
	Municipality vs. Contractor	Different
	Municipality vs. Architect	Different
	Province vs. Independent Developer	Different
	Province vs. Housing Association	Different
	Province vs. Asset Developer	Different
	Province vs. Instituational Investor	Different
	Province vs. Contractor	Different
	Province vs. Architect	Different
	State vs. Independent Developer	Different
	State vs. Housing Association	Different
	State vs. Asset Developer	Different
	State vs. Institutional Developer	Different
	State vs. Contractor	Different
	State vs. Architect	Different
G vs. U	Municipality vs. Housing Association	Different
	Municipality vs. Industry	Different
	Municipality vs. Services	Different
	Province vs. Housing	Different
	Province vs. Industry	Different
	Province vs. Services	Different
	State vs. Housing	Different
	State vs. Industry	Different
	State vs. Services	Different
P vs. D	Land Owner vs. Independent Developer	Different and Same
	Land Owner vs. Housing Association	Different and Same
	Land Owner vs. Asset Developer	Different and Same
	Land Owner vs. Institutional Investor	Different and Same
	Land Owner vs. Contractor	Different and Same
	Land Owner vs. Architect	Different and Same
	Real Estate Owner vs. Independent Devel.	Different and Same
	Real Estate Owner vs. Housing Association	Different and Same
	Real Estate Owner vs. Asset Developer	Different and Same
	Real Estate Owner vs. Institutional Devel.	Different and Same
	Real Estate Owner vs. Contractor	Different and Same
	Real Estate Owner vs. Architect	Different and Same
D vs. U	Independent Developer vs. Housing	Different
	Independent Developer vs. Industry	Different
	Independent Developer vs. Services	Different
	Housing Association vs. Housing	Different
	Housing Association vs. Industry	Different
	Housing Association vs. Services	Different
	Asset Developer vs. Housing	Different
	Asset Developer vs. Industry	Different

		Asset Developer vs. Services	Different
		Institutional Investor vs. Housing	Different
		Institutional Investor vs. Industry	Different
		Institutional Investor vs. Services	Different
		Contractor vs. Housing	Different
		Contractor vs. Industry	Different
		Contractor vs. Services	Different
		Architect vs. Housing	Different
		Architect vs. Industry	Different
		Architect vs. Services	Different
	U vs. G	Municipality vs. Housing	Different
		Municipality vs. Industry	Different
		Municipality vs. Services	Different
		Province vs. Housing	Different
		Province vs. Industry	Different
		Province vs. Services	Different
		State vs. Housing	Different
		State vs. Industry	Different
		State vs. Services	Different
Governmental Incentives	G vs. P	Municipality vs. Land Owner	Different and Same
		Municipality vs. Real Estate Owner	Different and Same
		Province vs. Land Owner	Different and Same
		Province vs. Real Estate Owner	Different and Same
		State vs. Land Owner	Different and Same
		State vs. Real Estate Owner	Different and Same
		Development Agencies vs. Land Owner	Different
		Development Agencies vs. Real Estate Owner	Different
	G vs. D	Municipality vs. Independent Developer	Different
		Municipality vs. Housing Association	Different
		Municipality vs. Asset Developer	Different
		Municipality vs. Instituational Investor	Different
		Municipality vs. Contractor	Different
		Municipality vs. Architect	Different
		Province vs. Independent Developer	Different
		Province vs. Housing Association	Different
		Province vs. Asset Developer	Different
		Province vs. Instituational Investor	Different
		Province vs. Contractor	Different
		Province vs. Architect	Different
		State vs. Independent Developer	Different
		State vs. Housing Association	Different
		State vs. Asset Developer	Different
		State vs. Institutional Developer	Different
		State vs. Contractor	Different
		State vs. Architect	Different
		Development Agencies vs. Independent Devel.	Different
		Development Agencies vs. Housing Association	Different
		Development Agencies vs. Assest Developer	Different
		Development Agencies vs. Institutional Devel.	Different
		Development Agencies vs. Contractor	Different
		Development Agencies vs. Architect	Different

APPENDIX II. FORMULAS STRATEGIC CHOICE MODEL

The NetLogo model is using the following statistical equations to run the strategic choice model. NetLogo is able to estimate the outcome probabilities and game outcomes of the total game when the utilities Ux(Yk) are known (Glumac, 2012; van de Craats, 2002):

***Calculation of Probabilities in Game Tree with NetLogo in following order*:**

$$p_1 = \int_{-\infty}^{U_2(Y_1)-U_2(Y_2)} \emptyset(\eta_{221})d\eta_{221}$$

$$p_2 = 1 - p_1$$

$$p_3 = \int_{-\infty}^{U_1(Y_3)-U_1(Y_4)} \emptyset(\eta_{134})d\eta_{134}$$

$$p_4 = 1 - p_3$$

$$p_7 = \int_{-\infty}^{U_1(Y_7)-U_1(Y_8)} \emptyset(\eta_{178})d\eta_{178}$$

$$p_8 = 1 - p_7$$

$$p_9 = \int_{-\infty}^{U_1(Y_9)-U_1(Y_{10})} \emptyset(\eta_{1910})d\eta_{1910}$$

$$p_{10} = 1 - p_9$$

$$p_{MH} = \int_{-\infty}^{p_3U_2(Y_3)+p_4U_2(Y_4)-U_2(Y_5)} \emptyset(\eta_{5MH})d\eta_{5MH} * \int_{-\infty}^{p_3U_2(Y_3)+p_4U_2(Y_4)-U_2(Y_6)} \emptyset(\eta_{6MH})d\eta_{6MH}$$

$$p_5 = \int_{-\infty}^{U_2(Y_5)-p_3U_2(Y_3)-p_4U_2(Y_4)} \emptyset(\eta_{45})d\eta_{45} * \int_{-\infty}^{U_2(Y_5)-U_2(Y_6)} \emptyset(\eta_{65})d\eta_{65}$$

$$p_6 = 1 - p_5 - p_{MH}$$

$$p_{LH} = \int_{-\infty}^{p_7U_2(Y_7)+p_8U_2(Y_8)-p_9U_2(Y_9)-p_{10}U_2(Y_{10})} \emptyset(\eta_{5MH})d\eta_{5MH} * \int_{-\infty}^{p_7U_2(Y_7)+p_8U_2(Y_8)-U_2(Y_{11})} \emptyset(\eta_{11LH})d\eta_{11LH} * \int_{-\infty}^{p_7U_2(Y_7)+p_8U_2(Y_8)-U_2(Y_{12})} \emptyset(\eta_{12LH})d\eta_{12LH}$$

$$p_{LM} = \int_{-\infty}^{p_9U_2(Y_9)+p_{10}U_2(Y_{10})-p_7U_2(Y_7)-p_9U_2(Y_9)} \emptyset(\eta_{LHLM})d\eta_{5MH} * \int_{-\infty}^{p_9U_2(Y_9)+p_{10}U_2(Y_{10})-U_2(Y_{11})} \emptyset(\eta_{11LM})d\eta_{11LM} * \int_{-\infty}^{p_9U_2(Y_9)+p_{10}U_2(Y_{10})-U_2(Y_{12})} \emptyset(\eta_{12LM})d\eta_{12LM}$$

$$p_{11} = \int_{-\infty}^{U_2(Y_{11})+p_7U_2(Y_7)-p_8U_2(Y_8)} \emptyset(\eta_{LH11})d\eta_{LH11} * \int_{-\infty}^{U_2(Y_{11})+p_9U_2(Y_9)-p_{10}U_2(Y_{10})} \emptyset(\eta_{LM11})d\eta_{LM11} * \int_{-\infty}^{U_2(Y_{11})+U_2(Y_{12})} \emptyset(\eta_{1211})d\eta_{1211}$$

$$p_{12} = 1 - p_{11} - p_{LM} - p_{LH}$$

$$p_H = \int_{-\infty}^{p_1U_1(Y_1)+p_2U_1(Y_2)-p_{MH}p_3U_1(Y_3)-p_{MH}p_4U_1(Y_4)-p_5U_1(Y_5)-p_6U_1(Y_6)} \emptyset(\eta_{MH})d\eta_{MH} * \int_{-\infty}^{p_1U_1(Y_1)+p_2U_1(Y_2)-p_{LH}p_7U_1(Y_7)-p_{LH}p_8U_1(Y_8)-p_{LM}p_9U_1(Y_9)-p_{LM}p_{10}U_1(Y_{10})-p_{11}U_1(Y_{11})-p_{12}U_1(Y_{12})} \emptyset(\eta_{MH})d\eta_{MH}$$

$$p_m = \int_{-\infty}^{p_{MH}p_3U_1(Y_3)+p_{MH}p_4U_1(Y_4)+p_5U_1(Y_5)-p_6U_1(Y_6)-p_1U_1(Y_1)-p_2U_1(Y_2)} \emptyset(\eta_{MH})d\eta_{MH} * \int_{-\infty}^{p_{MH}p_3U_1(Y_3)+p_{MH}p_4U_1(Y_4)+p_5U_1(Y_5)+p_6U_1(Y_6)-p_{LH}p_7U_1(Y_7)-p_{LH}p_8U_1(Y_8)-p_{LM}p_9U_1(Y_9)-p_{LM}p_{10}U_1(Y_{10})} \emptyset(\eta_{LM})d\eta_{LM}$$

$p_L = 1 - p_M - p_H$

Normal Density Function:

$\emptyset(\eta_{AB}) = \frac{1}{\sigma\sqrt{2\pi}} e^{-(\frac{(x-\mu)}{2\sigma})^2}$, $(\mu = 0, \sigma = 1^2)$ **=>** $\emptyset(\eta_{AB}) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}x^2}$

$N_{\mu,\sigma} = \int_{-\infty}^{\infty} \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}x^2} dx = \frac{1}{\sqrt{\pi}} \int_{-\infty}^{\infty} e^{-y^2} dy = 1$

Calculation Probability Outcomes:

$p_{Y_1} = p_H\, p_{MH}$
$p_{Y_2} = p_H\, p_2$
$p_{Y_3} = p_M\, p_{MH}\, p_3$
$p_{Y_4} = p_M\, p_{MH}\, p_4$
$p_{Y_5} = p_M\, p_5$
$p_{Y_6} = p_M\, p_6$
$p_{Y_7} = p_L\, p_{LH}\, p_7$
$p_{Y_8} = p_L\, p_{LH}\, p_8$
$p_{Y_9} = p_L\, p_{LM}\, p_9$
$p_{Y_{10}} = p_L\, p_{LM}\, p_{10}$
$p_{Y_{11}} = p_L\, p_{11}$
$p_{Y_{12}} = p_L\, p_{12}$
$p_{High} = p_{Y_1} - p_{Y_2} - p_{Y_7}$
$p_{Medium} = p_{Y_5} + p_{Y_9}$
$p_{Low} = p_{Y_{11}}$

Joint Probabilities::

$pY_{j1} = pY_1 * pY_{13} *$ *Index*
$pY_{j2} = pY_2 * pY_{14} *$ *Index*
$pY_{j3} = pY_3 * pY_{15} *$ *Index*
$pY_{j4} = pY_4 * pY_{16} *$ *Index*
$pY_{j5} = pY_5 * pY_{17} *$ *Index*
$pY_{j6} = pY_6 * pY_{18} *$ *Index*
$pY_{j7} = pY_7 * pY_{19} *$ *Index*
$pY_{j8} = pY_8 * pY_{20} *$ *Index*
$pY_{j9} = pY_9 * pY_{21} *$ *Index*
$pY_{j10} = pY_{10} * pY_{22} *$ *Index*
$pY_{j11} = pY_{11} * pY_{23} *$ *Index*
$pY_{j12} = pY_{12} * pY_{24} *$ *Index*

APPENDIX III. FUZZY DELPHI OUTCOMES

End Branch	nr.	Player	a1	a2	a3	a4	a5	b1	b2	b3	b4	b5	c1	c2	c3	c4	c5	d1	d2	d3	d4	d5	a min	d min	c	b
H_a	1	G	1,00	1,00	1,00	2,00	1,00	2,00	2,00	2,00	3,00	2,00	3,00	3,00	3,00	4,00	3,00	4,00	4,00	4,00	5,00	4,00	1,00	4,00	3,20	2,20
	2	P	2,00	1,00	2,00	2,00	2,00	3,00	2,00	3,00	3,00	3,00	4,00	3,00	4,00	4,00	4,00	5,00	7,00	7,00	5,00	5,00	1,00	5,00	3,80	2,80
	3	U	3,00	2,00	2,00	2,00	3,00	4,00	3,00	3,00	3,00	4,00	5,00	4,00	4,00	4,00	5,00	6,00	6,00	6,00	8,00	6,00	2,00	6,00	4,40	3,40
H_r	4	G	3,00	3,00	7,00	7,00	7,00	8,00	8,00	8,00	8,00	8,00	9,00	9,00	9,00	9,00	9,00	10,00	10,00	10,00	10,00	10,00	3,00	10,00	9,00	8,00
	5	P	4,00	3,00	7,00	7,00	6,00	8,00	8,00	8,00	8,00	8,00	9,00	9,00	9,00	9,00	9,00	10,00	10,00	10,00	10,00	10,00	3,00	10,00	9,00	8,00
	6	U	4,00	5,00	7,00	7,00	6,00	8,00	8,00	8,00	8,00	8,00	9,00	9,00	9,00	9,00	9,00	10,00	10,00	10,00	10,00	10,00	4,00	10,00	9,00	8,00
M_a	7	G	4,00	3,00	4,00	4,00	3,00	5,00	4,00	5,00	5,00	5,00	6,00	5,00	6,00	6,00	6,00	7,00	6,00	7,00	7,00	8,00	3,00	6,00	5,80	4,80
	8	P	3,00	4,00	3,00	3,00	2,00	4,00	5,00	4,00	4,00	3,00	5,00	6,00	5,00	5,00	5,00	6,00	7,00	6,00	6,00	6,00	2,00	6,00	5,20	4,00
	9	U	4,00	4,00	4,00	4,00	3,00	6,00	5,00	6,00	6,00	6,00	7,00	7,00	7,00	7,00	7,00	8,00	8,00	8,00	8,00	8,00	3,00	8,00	7,00	5,80
M_r	10	G	6,00	5,00	6,00	6,00	6,00	7,00	6,00	7,00	7,00	7,00	8,00	8,00	8,00	8,00	8,00	9,00	9,00	9,00	9,00	9,00	5,00	9,00	8,00	6,80
	11	P	5,00	4,00	5,00	5,00	5,00	6,00	5,00	6,00	6,00	6,00	8,00	7,00	8,00	8,00	8,00	9,00	8,00	9,00	9,00	9,00	4,00	8,00	7,80	5,80
	12	U	4,00	4,00	4,00	4,00	5,00	6,00	7,00	6,00	6,00	6,00	7,00	8,00	7,00	7,00	7,00	8,00	9,00	8,00	8,00	8,00	4,00	8,00	7,20	6,20
L_a	13	G	7,00	6,00	7,00	7,00	7,00	8,00	8,00	8,00	8,00	8,00	9,00	9,00	9,00	9,00	9,00	10,00	10,00	10,00	10,00	10,00	6,00	10,00	9,00	8,00
	14	P	7,00	7,00	7,00	7,00	7,00	8,00	8,00	8,00	8,00	8,00	9,00	9,00	9,00	9,00	9,00	10,00	10,00	10,00	10,00	10,00	7,00	10,00	9,00	8,00
	15	U	7,00	5,00	6,00	7,00	6,00	8,00	8,00	8,00	8,00	8,00	9,00	9,00	9,00	9,00	9,00	10,00	10,00	10,00	10,00	10,00	5,00	10,00	9,00	8,00
L_r	16	G	1,00	1,00	2,00	1,00	1,00	2,00	2,00	3,00	2,00	2,00	3,00	3,00	4,00	3,00	4,00	5,00	5,00	5,00	5,00	5,00	1,00	5,00	3,40	2,20
	17	P	1,00	1,00	2,00	1,00	1,00	2,00	2,00	3,00	2,00	3,00	3,00	3,00	4,00	3,00	4,00	6,00	6,00	5,00	6,00	6,00	1,00	5,00	3,40	2,40
	18	U	1,00	1,00	2,00	1,00	1,00	2,00	2,00	3,00	2,00	2,00	3,00	3,00	4,00	3,00	3,00	5,00	5,00	7,00	5,00	4,00	1,00	4,00	3,20	2,20
M_h_a	19	G	1,00	1,00	1,00	1,00	1,00	2,00	2,00	2,00	2,00	2,00	3,00	3,00	3,00	3,00	3,00	4,00	4,00	4,00	4,00	4,00	1,00	4,00	3,00	2,00
	20	P	2,00	1,00	1,00	1,00	1,00	3,00	2,00	2,00	2,00	2,00	4,00	3,00	3,00	3,00	4,00	5,00	5,00	5,00	5,00	5,00	1,00	5,00	3,40	2,20
	21	U	2,00	1,00	1,00	1,00	2,00	3,00	2,00	2,00	2,00	2,00	4,00	3,00	3,00	3,00	3,00	5,00	5,00	5,00	5,00	8,00	1,00	5,00	3,20	2,20
M_h_r	22	G	2,00	3,00	3,00	3,00	2,00	3,00	4,00	4,00	4,00	4,00	5,00	5,00	5,00	5,00	5,00	6,00	6,00	6,00	6,00	6,00	2,00	6,00	5,00	3,80
	23	P	3,00	3,00	3,00	3,00	2,00	4,00	4,00	4,00	4,00	4,00	6,00	5,00	5,00	5,00	5,00	7,00	6,00	6,00	6,00	6,00	2,00	6,00	5,20	4,00
	24	U	3,00	3,00	3,00	3,00	2,00	4,00	4,00	4,00	4,00	4,00	5,00	5,00	5,00	5,00	5,00	6,00	6,00	6,00	6,00	7,00	2,00	6,00	5,00	4,00
L_h_a	25	G	3,00	4,00	3,00	4,00	7,00	5,00	6,00	5,00	6,00	8,00	7,00	7,00	7,00	7,00	9,00	8,00	8,00	8,00	8,00	10,00	3,00	8,00	7,40	6,00
	26	P	2,00	3,00	2,00	3,00	5,00	5,00	5,00	5,00	5,00	7,00	6,00	6,00	6,00	6,00	8,00	7,00	7,00	7,00	7,00	10,00	2,00	7,00	6,40	5,40
	27	U	3,00	3,00	3,00	3,00	4,00	5,00	5,00	5,00	5,00	5,00	6,00	6,00	6,00	6,00	6,00	8,00	7,00	8,00	7,00	8,00	3,00	7,00	6,00	5,00
L_h_r	28	G	3,00	4,00	4,00	4,00	3,00	5,00	5,00	5,00	5,00	5,00	6,00	6,00	6,00	6,00	6,00	8,00	7,00	7,00	7,00	8,00	3,00	7,00	6,00	5,00
	29	P	2,00	3,00	3,00	3,00	3,00	5,00	5,00	5,00	5,00	5,00	6,00	6,00	6,00	6,00	6,00	9,00	8,00	8,00	8,00	8,00	2,00	8,00	6,00	5,00
	30	U	2,00	2,00	2,00	2,00	3,00	5,00	5,00	5,00	5,00	5,00	6,00	6,00	6,00	6,00	6,00	7,00	8,00	8,00	8,00	8,00	2,00	7,00	6,00	5,00
L_m_a	31	G	3,00	3,00	3,00	3,00	4,00	5,00	5,00	5,00	5,00	5,00	6,00	6,00	6,00	6,00	6,00	7,00	7,00	7,00	7,00	8,00	3,00	7,00	6,00	5,00
	32	P	4,00	4,00	4,00	4,00	4,00	5,00	5,00	5,00	5,00	5,00	6,00	6,00	6,00	6,00	6,00	8,00	7,00	7,00	7,00	9,00	4,00	7,00	6,00	5,00
	33	U	4,00	4,00	4,00	4,00	4,00	5,00	5,00	5,00	5,00	5,00	6,00	6,00	6,00	6,00	6,00	8,00	7,00	7,00	7,00	8,00	4,00	7,00	6,00	5,00
L_m_r	34	G	1,00	1,00	1,00	1,00	2,00	2,00	3,00	3,00	3,00	3,00	3,00	4,00	4,00	4,00	4,00	4,00	5,00	5,00	5,00	5,00	1,00	4,00	3,80	2,80
	35	P	1,00	1,00	1,00	1,00	2,00	2,00	3,00	3,00	3,00	3,00	4,00	4,00	4,00	4,00	4,00	5,00	5,00	5,00	5,00	5,00	1,00	5,00	4,00	2,80
	36	U	2,00	2,00	2,00	2,00	2,00	3,00	3,00	3,00	3,00	3,00	4,00	4,00	4,00	4,00	4,00	5,00	5,00	5,00	5,00	5,00	2,00	5,00	4,00	3,00

ENGLISH SUMMARY

IMPROVING THE REDEVELOPMENT PROCESS OF OBSOLETE INDUSTRIAL SITES: AN APPLICATION OF URBAN LAND READJUSTMENT AND GAME THEORY

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ABSTRACT
The Dutch government has a growing interest in (1) the prevention of cluttering, (2) better efficiency and intelligent use of space and (3) improvement of spatial quality. Thus, the government created the 'Mooi Nederland' ('Beautiful Netherlands') policy, in which the redevelopment of obsolete industrial sites in collaboration with market parties is placed high on the agenda. However, the economic crisis has caused problems in the execution of this policy: a decline in demand, problems with financing issues, and restraining attitudes of both public and private parties. As a result, projects have stagnated and some were even cancelled. The days of major redevelopment projects are over, and a growing interest in redevelopment initiatives by private parties is observable. Especially in the spotlight are entrepreneurs, who are looking for (joint) customizations of their industrial sites due to a growing business, poor business climate caused by vacancy or problems with the premises, for example. Problems arise with fragmented ownership of property and the conflicting interests of involved actors who are often blocking initiatives. As a result, the Dutch land registry Kadaster is detecting stagnation and missed opportunities. The question in this report is how the Kadaster, by using 'interventions', is able to improve the redevelopment process of obsolete industrial sites in the Netherlands. For this research, two possible ways of providing interventions have been attracted, namely via 'Urban Land Readjustment (ULR)' and 'Predictions (with the help of Game Theory)'.

Keywords: Urban Land Readjustment (*ULR*), Obsolete Industrial Sites, Decision-Making, Ownership of Property, Game Theory, Dutch Spatial Planning

INTRODUCTION

The Netherlands is facing a serious social problem: the obsolescence of industrial sites. One-third of the industrial sites are worrisome, because approximately thirty percent are not meeting the requirements of the present day. The sites are in poor condition, are obsolete, are cluttered, lack coherency due to individual sales of plots and provide poor accessibility. The poor condition of these sites is leading to fast depreciation and also affects the spatial quality. But municipalities are still trying to offer many hectares of new industrial land. The Dutch government, especially the Ministry of Infrastructure and Environment, noticed that

scarce land in the Netherlands is unnecessarily in danger. The government took actions as part of the policy program named 'Mooi Nederland' ('*Beautiful Netherlands'*): the redevelopment of obsolete industrial sites by the 'Taskforce for the Redevelopment of Industrial Sites'. This taskforce identified four large problems in the industrial market: (1) fast aging of industrial sites, (2) a large and inexpensive supply of greenfield locations, (3) lack of demand-driven developments by private parties and (4) an often lacking spatial quality and poor landscaping of greenfield developments. The taskforce advised the government that new industrial sites are needed in the future, but that the government must take into account the problems with existing industrial sites, in order to prevent the same problems occurring in a few years on newly developed industrial sites.

To counteract the problems, the taskforce proposed that the redevelopment and maintenance be commercialized, whereby sustainable industrial sites must be the final result. An intensive collaboration between public and private parties was created for a large-scale redevelopment project of 15,800 hectares. Unfortunately, not long after the new approach was used, the economic crisis developed, and this brought about enormous changes. As a reaction to the financial crisis, both public and private parties reduced their investments and tried to reduce their financial risks. The redevelopment tasks stagnated due to a lack of demand, budget cuts and the development of other governmental priorities. This stagnation eventually resulted in a low completion rate of only 20% of the total amount of planned redevelopment activities. The period of major redevelopment projects is over, and a growing interest of public parties in private party investments (by *developers, investors and property owners*) for redevelopment tasks is observable. Entrepreneurs are currently seen as a potential group;, their demand is evident when they are experiencing problems with, for example, expansion possibilities, an affected business climate due to vacancy or problems with premises.

Problem Statement and Research Questions

The Kadaster is noticing the stagnated redevelopment process of obsolete industrial sites, but also stagnation in the whole urban development practise. It appears that the Kadaster is trying to find a positive stimulant for a joint approach, where fragmented ownership of property, unwillingness of participation, and problems with conflicting interests are not blocking initiatives for a redevelopment project between multiple (*private*) parties. The shifted focus towards the redevelopment of existing industrial sites requires a different approach than Greenfield development. The Kadaster is noticing that existing land management strategies are failing and new approaches are needed to support these (*new*) kinds of (re)development initiatives in order to reduce the number of vacant plots, improve the spatial quality, and economize. Therefore, the problem statement has been defined as follows:

'The Kadaster detects stagnation and missed opportunities in the redevelopment process of obsolete industrial sites'.

This thesis has been written with the purpose of stimulating the redevelopment process of obsolete industrial sites. Special attention will be paid to the above three underlined topics. The question is how the Kadaster is able to intervene to improve the redevelopment process of these sites. Therefore, the following central research question has been formulated:

How is the Kadaster, by using 'interventions', able to improve the redevelopment process of obsolete industrial sites in the Netherlands?

For the delineation of the research two possible ways have been used for providing interventions for the improvement of the redevelopment process of obsolete industrial sites in the Netherlands. These are (1) 'Urban Land Readjustment (*ULR*)' and (2) 'Predictions'. First, ULR is an experimental land management instrument which is currently under development by the Kadaster in collaboration with e.g. the Dutch government and private parties. The Kadaster is able to support the usage of ULR and thus able to provide interventions with the tool. Second, the Kadaster is interested in instruments that can predict. Prediction provides the Kadaster with a strategic advantage, as a particular scenario can be analysed before it occurs. The Eindhoven University of Technology provided the Game Theory as a tool for the analysis and prediction of complex decision-making. The following sub-questions have been formulated:

The following sub-questions have been formulated:

- How is the Kadaster able to improve the redevelopment process of obsolete industrial sites by interventions with 'Urban Land Readjustment'?
- How is the Kadaster able to improve the redevelopment process of obsolete industrial sites by interventions with 'Predictions' during decision-making processes with the aid of Game Theory?

Research Structure

This first chapter presented the problems with obsolete industrial sites in the Netherlands and the large influence of the economic crisis. The importance of fighting aging is emphasized. In addition, the research design is explained, including the problem statement, research questions, boundaries, and methodologies.

Chapter two presents a tripartite literature review. Part A is dedicated to the experimental land management strategy Urban Land Readjustment. In this part the changing urban development practise, the origin and process of ULR, and ULR compared with existing land management strategies in the context of Dutch spatial planning will be discussed. With the knowledge of ULR and the changing context of the urban development practise, the report will continue with part B wherein we will return to obsolete industrial sites in the Netherlands. In this part a brief overview will be given about the emergence of aging on industrial sites in the Netherlands and other problems. Afterwards, ULR will be linked with the redevelopment process whereby the study will examine how the Kadaster is able to improve the redevelopment process of obsolete industrial sites by interventions with help of ULR. In part C a side step will be made towards decision-making in the urban development practise which is needed to understand how prediction can be used for interventions. We will see that collaboration and decision-making is one of the most complex parts of the redevelopment process. In addition, the negotiation process during ULR will be presented and afterwards the Game Theory will be introduced. The Game Theory will be used as research method for the analysis and prediction of a certain decision-making moment.

In chapter three the case study 'wet industrial site' in Maasbracht will be analysed. The redevelopment process of the industrial site is one of the eleven pilot projects of ULR in the Netherlands. Maasbracht is a 'wet' industrial site in the province of Limburg where ULR has been applied due to problems with the expansion of the companies on site.

The fourth chapter will go deeper into the 'prediction of interventions' by using the Game Theory to analyse and predict a specific decision-making moment in the case study of Maasbracht. The question that will be answered is: what will the optimal strategies for the involved stakeholders, both public and private parties, be during the redevelopment process of the case study in Maasbracht? By predicting this development in advance, the Kadaster is able to adjust and steer decision-making and behaviour towards an optimal result. And thus the Kadaster is able to improve the redevelopment process by interventions with 'predictions'. The aim is to create a three-player bargaining Game Theory model. First, the stakeholders of Maasbracht will be grouped and translated to players, which are more useful for the Game Theory. Second, a bargaining game about the influence level of two chosen negotiable attributes will be constructed. The interests, payoffs, and strategies of involved actors will be made visible. For the prediction the Fuzzy Delphi Method will be used to receive usable data from experts in the field of urban development. Based on the outcomes, advice will be provided about the predicted optimal influence level of both parties in order to reduce problems. Hence, the possibility to steer the process will improve the redevelopment of Maasbracht.

The fifth and final chapter consists of the most important research conclusions and summarizes the answers to the research questions. Afterwards, the recommendations for the Kadaster will be written, a discussion will be started, and further research will be suggested.

LITERATURE RESEARCH

Interventions with Urban Land Readjustment

Urban Land Readjustment (ULR) is an experimental instrument used in the Netherlands for the rescheduling of property, such as land and real estate, with the aim of taking initiative or facilitating the (re)development of an area. Literature research shows that ULR is an instrument that is based on the German '*Umlegung*', where the focus lies on the reorganization of corporate rights and not specifically on collaboration, such as the France AFU. However, ULR is different compared to existing land management strategies (e.g., building claim model, traditional model, concession model and joint venture model) due to its ability to reduce limitations from fragmented ownership of property and its ability to enforce participation by the vast majority. Existing land management strategies are failing, mainly due to the lack of (legal) support but are more effective during greenfield development whereby limited ownership of property exists and fewer owners are involved. Existing tools are not sufficient, and only one tool in Dutch spatial planning is able to deal with fragmented ownership of property: expropriation. But this tool is often avoided by public parties due to the time-consuming and expensive activity involved. In addition, ULR is able to provide a well-managed process of decision-making and negotiation whereby interests and wishes of the involved stakeholders will be aligned through the use of a bottom-up approach. Property owners and end-users possess a high level of influence during the process, whereby public parties are merely facilitating (i.e., facilitating land policy) the process.

Five approaches of ULR can be distinguished, namely: (1) small scale exchange of property (in Dutch, '*kleinschalig ruilen op maat'*), (2) usage land readjustment ('*gebruiksverkaveling',* regarding leasehold), (3) Umlegung (new allocation of parcels in the new situation occurs in proportion to the value), (4) trade chain ('*ruilketting'*) and (5) integral planned land trade readjustment ('*integraal planmatige ruilverkaveling',* even between regions). The tool is able to facilitate in the exchange of land, buildings, construction and development rights, and users; the ceding of land for public or collective facilities; the joint realization of collective or semi-collective facilities and of redevelopment and maintenance of real estate; and the organisation of joint direction. The process has been designed as a chain of cyclic negotiation, whereby the results of one negotiation will form the basis for the next step in the process. The outlines of the process can be summarized in five phases, namely (1) initiative phase, (2) capturing the initial state, (3) creation of a new program, (4) creation of allocation variants and (5) financial settlement. The legal protection of the individual owners is an important factor and is therefore protected by an independent party, such as the Kadaster. It must be noted that ULR is not yet an official tool in the Netherlands, and therefore in 'experimental phase'. Probably from 2018 onwards, it will be seen as an additional tool for public parties.

Obsolete Industrial Sites in the Netherlands

It can be stated that obsolete industrial sites are a societal problem in the Netherlands. The government is seeing the necessity of fighting obsolescent and vacant old industrial sites. Both public and commercial parties are responsible for the aging and deterioration of the spatial quality of many industrial sites. The aging and deterioration is causing depreciation of property (*and often a reduced pension due to the higher expected valuation of property by the entrepreneur*), poor spatial quality, and reduced economic position of the region. Redevelopment projects are often not started, despite the large amount of money provided by public parties. Private parties are simply waiting, because in their opinion their site is still functioning, and thus there is no drive for investments. But the crisis caused a large drop in demand whereby entrepreneurs merely focussed on their production process in order not to go bankrupt. Times of major redevelopment projects are over and a growing interest by public parties in redevelopment initiatives by entrepreneurs can be observed. Mainly because of the many private properties caused by fragmented ownership of property. The impetus to start a redevelopment process is often caused by a growing business, poor business climate due to empty premises, or other problems. Municipalities are needing a different approach to trigger investments by using 'uitnodigingsplanelogie' instead of 'toelatingsplanelogie'. Problems arises when entrepreneurs are hindered by fragmented ownership of property. The Kadaster is able to provide an important contribution to stimulate redevelopment projects by implementing ULR.

CASE STUDY MAASBRACHT

For analysing the implementation of Urban Land Readjustment in practise, this research examined the case study of Maasbracht in the province of Limburg, municipality *Koeweide-Battenweg*. This is one of the eleven pilot projects of the Dutch Commission for Urban Readjustment (*Commissie Stedelijke Herverkaveling*). The municipality of Maasgouw, the Middle Limburg Development Company (*Ontwikkelingsmaatschappij Midden-Limburg B.V.*, or *OML*) and the Limburg Restructuring Company (*Herstructureringsmaatschappij voor Bedrijventerreinen B.V.*, or *LHB*) reached an agreement in early 2013 to begin redeveloping their so-called 'wet industrial sites'. The term refers to the maritime-related business activities and

location next to the Maas River. The interests of these three stakeholders are the improvement of the local and regional economies, a special focus on Maasbracht due to the highly reputable shipbuilding and repair companies and a counteraction of vacancy and pauperisation. In addition, there is a changing focus towards sales of pleasure boats and ship repair due to the closure of the mineral extraction industry. The goal is to make the industrial site future-proof. Unfortunately, the municipality does not possess enough resources for the redevelopment, and the fragmented ownership of property also produces problems. The parties, in collaboration with the Kadaster, explored the possibilities to facilitate the redevelopment of the industrial site and ULR was selected. The entrepreneurs see the necessity for action and therefore they will voluntary join the redevelopment process. But it must be noted that the entrepreneurs (who are land and property owners, as well as users) have been somewhat forced by the municipality to actively participate. Because official legislation for Dutch spatial planning does not yet exist, the municipality used a clever trick: the municipality is regulating the industrial area using the masterplan and permits. The entrepreneurs situated on the site possess, for example, permits to moor boats only one row deep at the quay. The number of rows has increased over time due to the expansion of business activities, and the municipality condoned this for many years. But the municipality is now able to threaten with enforcement of the rules.

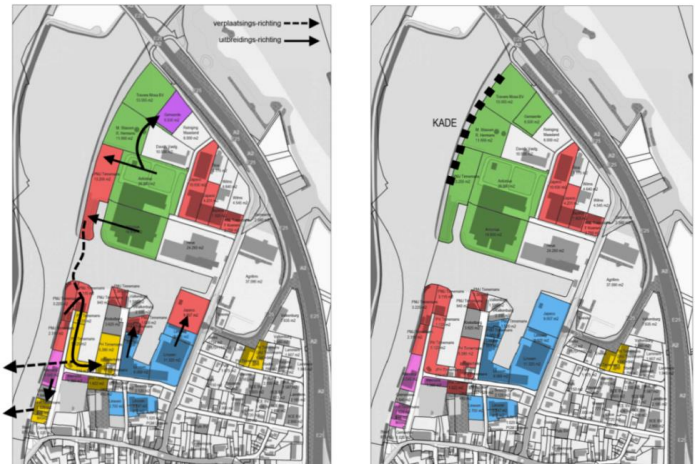

Figure 1 | Current (*left*) and future (*right*) ownership situation (Kadaster, 2014)

On the other hand, there is an incentive for the private owners to participate in the redevelopment process because they do not have many possibilities to expand in the current situation. With the just finished enlargement of the locks in the Maas River, it is now possible for the entrepreneurs to expand their business activities. Because all parties are seeing the necessity to change, this study assumes that all parties are participating on a voluntary basis. Despite the fact that public and private parties are pursuing their own interests, they are dependent upon each other. With the help of ULR, all stakeholders jointly created a new plan for the exchange of land and settled their wishes and interests. See Figure 1 for an overview of the present and future situation.

Interventions with 'Prediction' using Game Theory

The Kadaster has a growing interest in theories and models that are able to analyse and predict complex decision-making scenarios. It wants to understand social interactions and interactive decision-making. And, thus, the Kadaster may be able to intervene to improve the redevelopment process of obsolete industrial sites by 'prediction'. Prediction provides the Ka-

daster a strategic advantage, because a particular scenario can be analysed in advance. The Kadaster is able to intervene by 'steering' (e.g., advising) in the correct and most optimal direction during the redevelopment process. Literature shows that analysing and predicting strategic competition between stakeholders is possible by using the Game Theory research method. Game Theory is a research methodology of interdependent decision-making in which the involved decision-makers possess conflicting interests and the outcome of their decisions cannot be determined by only one actor or group. Game Theory is not yet widely used in the field of urban development, which may be due to the especially context-driven environment. But there is a growing interest in the use of Game Theory in the practise of urban development.

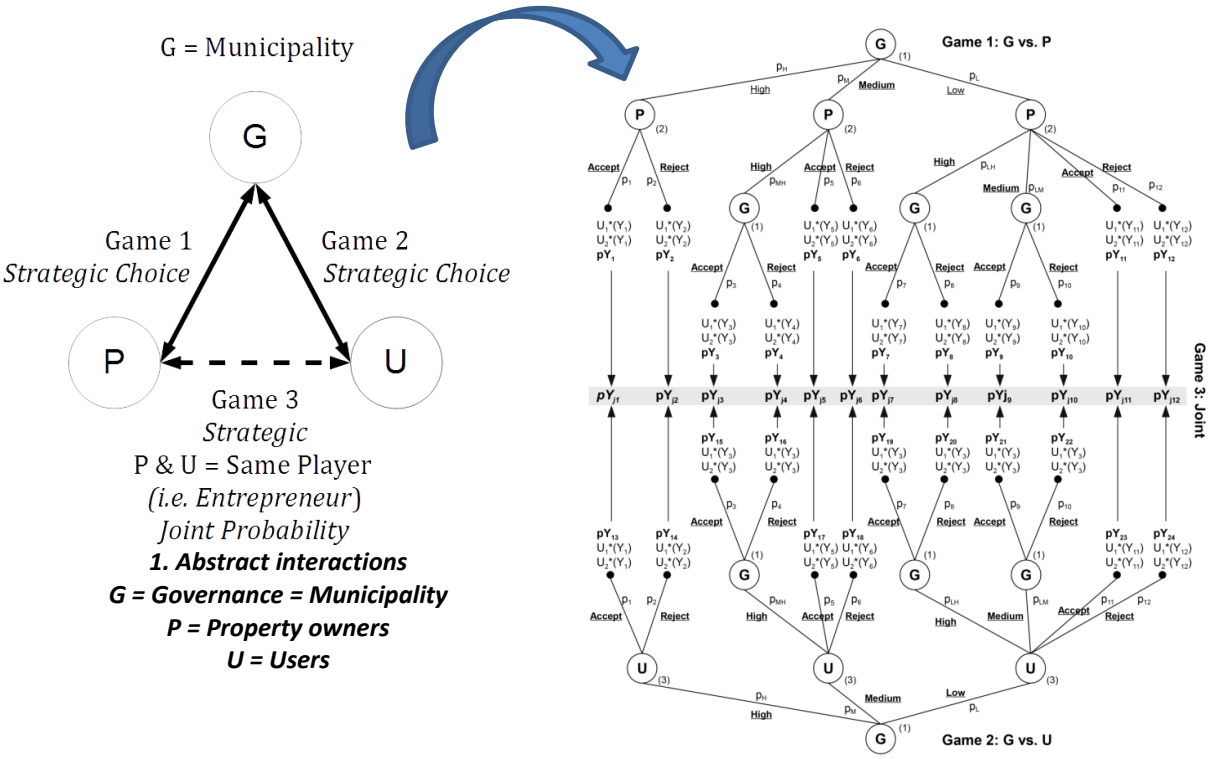

Figure 2 | Game Theory modelling overview

The Eindhoven University of Technology provided to this research study its knowledge of Game Theory. This research attempted to predict a complex decision-making scenario based on the case study of Maasbracht. The goal was to predict the optimal influence level on the 'future land uses' and 'reparcellation'. The influence level can be divided into three measurements, namely high, medium and low. High represents a maximum influence level of the two attributes and low reflects a minimum influence level. This is important for multiple reasons: (1) If a player possesses a high influence level, then he is able to maximize his payoff. But it is possible that he will bear all the financial risks, and even other problems, such as the fact that other parties are not willing to cooperate. (2) If a player possesses a low influence level, he is not able to maximize his payoff, but he has no financial risks. It is possible that he will become a free rider. And (3) a medium influence level suggests that both players may possess a certain amount of influence. And thus both parties are able to steer their payoffs. This could eventually result in an optimal collaboration. Therefore, by using the Prediction with Game Theory tool, the optimal influence level of the players in Maasbracht can be determined. The prediction can eventually be used as advice from the Kadaster towards the involved stakeholders.

To create the prediction, a Game Theory model needs to be created. The model in Figure 2 has been constructed based on an eight-step procedure:

(1) **Selection of a Game Class:**
Non-cooperative, conflicting interests game;
(2) **Selection of a Game Form:**
Extensive form;
(3) **Selection of a Game Solution Concept:**
Sub Game Perfect Nash Equilibrium;
(4) **Description of Institutional-Economic Context of the Game**:
Urban Land Readjustment and the case study of Maasbracht;
(5) **Game Conditions and Environment:**
Five different negotiable attributes have been identified whereby 'future land use' and 'reparcellation' have been chosen. Bargaining form.
(6) **Validation of Game Structure:**
By the Kadaster;
(7) **Estimation of Payoffs:**
Using the Fuzzy Delphi Method and experts' input;
(8) **Analysis of the Final Outcomes**:
With the use of NetLogo and Excel.

Fuzzy Delphi Method (*FDM*)

The model requires utilities that allow the model to calculate the probabilities of the game. 'A utility refers to some ranking, on a specified scale, of the subjective welfare or change in subjective welfare that an agent derives from an object or an event. The term 'welfare' refers to some normative index of relative well-being, justified by reference to some background framework'. To gain the utility values, the Fuzzy Delphi Method (FDM) was used. The Fuzzy Delphi Method allows the subtraction of the utilities by a group understanding approach by weighting for example attributes. Five experts in the field of urban development were asked for their contribution in an expert meeting session. First, the case study of

Maasbracht was explained in detail, including the decision-making moment (the model). The experts were asked to weight the utilities for each of the three players and for each of the end branches, based on the two attributes. The weighting was done on a scale of 1 to 10. Weighting was not based on one single number, but on four different weights by using two specific ranges: the maximal range {1 and 5} and the optimal range {2 and 3}, which lies within the maximal range. These weights were stored in an Excel sheet for each expert consisting of four rows with, for example, the numbers {a=4, b=7, c=8, d=9} as a weighting overview of one utility of a single player. In this way, a better and more detailed overview of the experts' opinions can be created instead of simply weighting by a single number. Thus, the experts had to provide their weighting figures 36 times: *12 outcomes * 3 players = 36 utilities*. Afterwards, the data was converted into an overall fuzzy number for each specific end branch and players. The fuzzy numbers were 'defuzzicated' for the last step by using the simple centre of gravity method.

Analysis of the Final Outcome

The last step is the analysis of the final outcomes of the model. The values of S have been entered into the NetLogo model for the calculation of all the probabilities. The final probabilities have been put in an Excel table (*Table 1*) to provide an overview of the prediction of the outcome of the game. Game 1 represents the game *Governance vs. Property Owners*, Game 2 represents the game *Governance vs. Users* and Game 3 reflects the *joint probability* of both games.

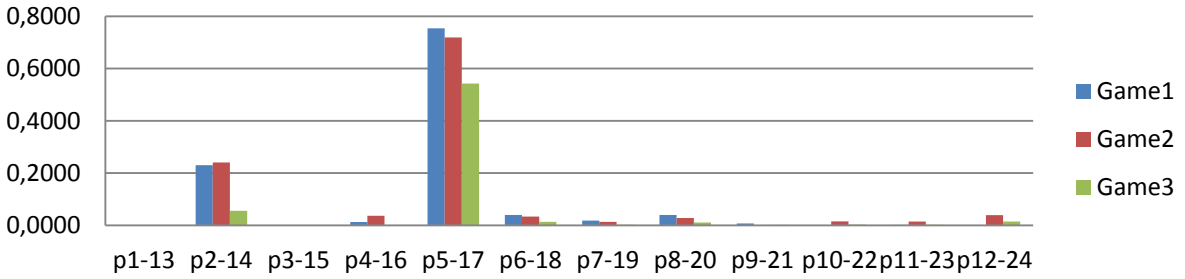

Table 1 | Final probabilities from NetLogo to Excel.

The prediction has showed that a medium influence level of the public parties (*especially the municipality*) is the most preferred outcome, whereby the private owners are accepting and willing to collaborate. This can be seen as an equal level of influence on the 'future land use' and 'reparcellation' of the industrial site Maasbracht. It can be stated that a 'dominant leading' position must be avoided by the public parties. The outcome of the model supports the high probability that a high level of influence (p_2-p_{14}) of the Governance player will be rejected by the players Property Owners and Users. And besides, a low influence level by the Government, and even by the other two players, scores very low probabilities which are close to 0. The final conclusion: public parties may <u>*not*</u> start the redevelopment process of the wet industrial area on the basis of a dominant strategy. This will eventually cause aversion by the private parties and stagnation of the redevelopment process. By offering a medium influence level, the private parties will also receive a medium influence level, and the redevelopment will be accepted.

Optimal collaboration is required, but in this case both parties are able to steer and maximize their payoffs. And therefore, the Kadaster is able, by prediction, to intervene during a re-

development process, for example by providing this advice to the public parties. And thus the process can be steered for optimal results. As for the Game Theory part, the Game Theory provides an abstraction of a real-world situation. The aim is to use the tool to create and understand behaviour of the stakeholders, but not in full detail. Furthermore, the models are simplifications and many assumptions need to be made. Some argue that modelling of behaviour in the context of urban development makes no sense due to the context-driven environment. But this research shows that the Game Theory can be useful for specific chosen scenarios. Unfortunately, creating the models is time consuming due to the amount of statistics and mathematics involved. Software is not yet available to create easy Game Theory Models of this scale. And thus: Game Theory in the used form is not advisable for the Kadaster, because a specialist would need to be hired for the creation and usage of the models, which would result in high investments for the Kadaster.

CONCLUSION

To answer the central question of this report, *How is the Kadaster, by using 'interventions', able to improve the redevelopment process of obsolete industrial sites*, the final conclusion of this report is to be followed. The Kadaster is able to improve the redevelopment process of obsolete industrial sites by using interventions with: (1) 'Urban Land Readjustment', for removing limitations in situations with fragmented ownership of property, for enforcement of player participation and for creating mutual agreement by using guarded negotiations during ULR and (2) 'Prediction' using, for example, Game Theory for interventions before/during decision-making scenarios. Prediction provides the Kadaster with a strategic advantage, because it allows a particular scenario to be analysed in advance. The Kadaster is then able to intervene to steer in the correct and most optimal direction. Advice: In the case study of Maasbracht, the Kadaster may offer an issue to the initiator, the municipality of Maasgouw, that a dominant 'leading' position in this case is a 'no go'.

G. (Guido) van Veen

In front of you lies the result of my final project of the master program Construction Management and Urban Development at the Eindhoven University of Technology. The last six months of the master track were dominated by intensive research towards the application of the experimental land management instrument Urban Land Readjustment and its application on industrial sites in the Netherlands. Writing this thesis was not possible without the help of many people. Therefore I would like to thank everyone who helped me.

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NEDERLANDSE SAMENVATTING

HET VERBETEREN VAN HET HERSTRUCTURERINGSPROCES VAN VEROUDERDE BEDRIJVENTERREINEN: EEN TOEPASSING VAN STEDELIJKE HERVERKAVLING EN GAME THEORY

Nederland zit met een groot maatschappelijk probleem: de veroudering van bedrijventerreinen. Uit onderzoek is gebleken dat ongeveer een derde van alle bedrijventerreinen een slechte conditie heeft, zijn verouderd en rommelig, missen samenhang door de uitgifte van individuele kavels, bezitten leegstand, en zijn slecht bereikbaar. De Nederlandse overheid grijpt in met haar beleid 'Mooi Nederland' waarin verpaupering, efficiënt land gebruik en ruimtelijke kwaliteit het uitgangspunt vormt. Voor bedrijventerreinen, onderdeel van het Mooi Nederland beleid, is er een 'Taskforce Herstructurering Bedrijventerreinen (THB)' opgezet onder leiding van P. Noordanus. Zijn commissie stelt dat er vier grote problemen zijn op de bedrijventerreinen markt: (1) snelle veroudering van deze gebieden, (2) grote en goedkoop aanbod van nieuwe bedrijventerreinen, (3) missende private vraag waardoor gemeenten te veel variantie aanbiedt, en (4) vaak lage kwaliteit van nieuwe bedrijventerreinen. Vandaar dat de 'verzakelijking' in het leven is geroepen. Een beleid dat er een actievere samenwerking ontstaat tussen publieke en private partijen om veroudering tegen te gaan. Directe subsidies van provincies naar gemeenten zijn afgeschaft, daarvoor in de plaatst zijn herstructureringsbedrijven gekomen, zoals de BOM, die als katalysator dienen te werken. Daarbij staat 'gebiedsontwikkeling', 'regionale afstemming', en verminderen van nieuwe terreinen centraal. Hoofddoel: het samen creëren van duurzame bedrijventerreinen. Daarvoor moet 15.800 hectaren worden geherstructureerd. Door het intreden van de crisis is de vraag gedaald en zijn de publieke en private investeringen teruggelopen. Met als gevolg: stagnatie van de herstructureringsopgave. Nieuwe initiatieven blijven uit, vandaar dat de focus is verandert naar de private eigenaren op bedrijventerreinen. De grote aanpak van herstructureringen zijn afgelopen, maar deze partijen zien vaak door gebrek aan ruimte of leegstand dat er 'iets' moet veranderen.

PROBLEEMDEFINITIE EN HOOFDVRAAG

Onder andere de economische crisis heeft er toe geleid dat herstructureringen zijn gestagneerd. Vandaar dat de focus is verschoven naar ondernemers die behoeften hebben tot verandering als gevolg van gebrek aan uitbreidingen, leegstand, of verbeteren van veiligheid etc. Ze willen initiatief nemen om het probleem aan te pakken, maar het Kadaster ziet dat er veel van deze initiatieven problemen ondervinden met versnipperd eigendom, niet willen meewerken van partijen, en conflicterende belangen. En dus gemiste kansen. De probleemstelling is als volgt: het Kadaster ziet stagnatie en gemiste kansen tijdens de herstructureringsproces van verouderde bedrijventerreinen. De hoofdvraag in dit rapport is: *hoe het Kadaster doormiddel van 'interventies' het herstructureringsprocess kan verbeteren?* Twee mogelijke manieren zijn aangetrokken, namelijk het gebruik van 'Stedelijke Herverkaveling' en 'Voorspellingen'.

LITERATUURSTUDIE

Stedelijke Herverkaveling - Stedelijke Herverkaveling (*SH*) is op een slimme manier omgaan met eigendommen om op deze manier gebiedsontwikkeling mogelijk te maken. De gebruikers en eigenaren worden hier actief bij betrokken door hun wensen over het gebied en eigendom kenbaar te maken. Vervolgens zullen de betrokkenen samen een nieuw gebiedsplan opstellen waarbij geen enkel partij slechter uit het proces kan worden. De financiële risico's

en kosten liggen bij die gene die profijt van de ontwikkeling zullen hebben. Onafhankelijke partijen, zoals het Kadaster, zijn hierbij nauw betrokken om de rechtszekerheid te kunnen garanderen. SH wordt gekenmerkt door cyclische onderhandelingsprocessen waarbij de uitkomst uit één stap, de input vormt voor volgende nieuwe stap. Wanneer een stap niet naar wens is verlopen wordt teruggegaan naar de vorige. Het proces bestaat uit: (1) initiatief fase, (2) analyseren huidige staat, (3) nieuw programma creëren, (4) toewijzingsvarianten creëren, (5) financiële waarborging. Grote voordelen van SH zijn: kosten en risico's zijn voor diegene die baat hebben, geen onteigening nodig, afdwingen participatie, en lagere kosten doordat de grond uit de kosten kan worden gehaald. Met SH kan bijvoorbeeld leegstand van kantoren en detailhandel worden aangepakt, het uitruilen van gebruikers, maar heeft ook potentie om problemen aan te pakken die spelen tijdens herstructureringsprojecten op bedrijventerreinen. De grootste kracht van Stedelijke Herverkaveling is, vergeleken met bestaande land beheermodellen, het afdwingen van participatie zonder onteigening. En dus is versnipperd eigendom niet meer de grootste zorg waarbij herstructureringen en ontwikkelingen spaak lopen. En biedt het op die manier zekerheid. Dit is alleen mogelijk als daadwerkelijk wetgeving wordt geïmplementeerd. Vanaf 2018 waarschijnlijk een officiële wetgeving.

Verouderde Bedrijventerreinen in Nederland - De vraag is waar de veroudering van bedrijventerreinen vandaan komt. Bedrijventerreinen worden vaak gezien als lelijk, relatief gezien goedkoop, en terreinen die snel verouderen. Daarbij komt dat gemeenten gebrand zijn op de verkoop van nieuwe bedrijventerreinen. Hierdoor is er een afkeer ontstaan op nieuwe bedrijventerreinen. Er zijn vier verschillende verouderingsprocessen te onderscheiden: (1) economische veroudering (*veranderende behoeften*), (2) technische veroudering (slecht onderhoud), (3) sociale veroudering (*veranderende wetgeving*), en (4) ruimtelijke veroudering (*omliggende gebieden zijn door de tijd verandert*). De grootste oorzaak van veroudering op Nederlandse bedrijventerreinen is veroorzaakt door het goedkope aanbod van kavels door beleid van gemeenten. Door de lage prijzen, en dus lage inkomsten, hebben gemeenten vooral lage kwaliteit bedrijventerreinen aangelegd, die per kavels werden gekocht. Wanneer een bedrijf noodzaak voelt om zijn productie proces aan te passen is het voor hen goedkoper om te verhuizen naar een nieuwere en goedkope locatie. Want daar kan het bedrijf aangepast worden aan de nieuwe 'behoeften'. Tevens, door de lage prijzen van grond, hebben gemeenten nooit kunnen sparen voor onderhoud en exploitatie. Hierdoor is vooral de openbare ruimte verouderd. Maar, ondernemers zijn mede schuldig aan de veroudering. Vanwege het feit dat ondernemers zich eerder bezig houden met het optimaliseren van bedrijfsvoeringen, dan te investeren in hun eigendommen en omgeving. Door het verhuizen van bedrijven, is er leegstand ontstaan. Die werd tijdelijk opgevuld met bedrijven met lagere kwaliteit bedrijfsvoeringen. Opgeven moment zijn die ook vertrokken en leegstand en veroudering werd een feit. Literatuur heeft laten zien dat grote problemen, en weggegooide kansen, op bedrijventerreinen worden veroorzaakt versnipperd eigendom, geen lokale initiatieven, slechte regionale afstemming, en conflicterende belangen.

Casestudy: natte bedrijventerrein Maasbracht - Een interessante case studie is geanalyseerd in dit onderzoek. Geen enkel bedrijventerreinen is het zelfde: verschillende belanghebbenden en verschillende problemen. Daarom is er gekeken naar de case studie 'Koeweide-Battenweg' in Maasbracht, Provincie Limburg. De gemeente Maasbracht, OML en LHB zijn een samenwerking aangegaan om de scheepvaart gerelateerde bedrijventerreinen toekomstig bestendig te maken door hoogwaardige en duurzame vestigingsplaatsen te ontwik-

kelen. De private partijen worden nadrukkelijk betrokken in dit proces waar SH wordt gebruikt. De unieke industrie die daar gevestigd is, is grotendeels gebaseerd op de scheepvaart en mineraal verwerking. Door het sluiten van de mijnen in het zuiden van Limburg is er een verschuiving naar nieuwe markten, zoals de bouw van plezierjachten en reparaties. Om deze unieke plek die bij veel schippers bekend is te versterken en om op de veranderende behoeften van de ondernemers in te spelen, is er overgegaan tot herstructurering. Nadeel van het plan: de gemeente heeft weinig financiële middelen en versnipperd eigendom speelt een grote rol voor de eigenaren. Zij kunnen niet uitbreiden doordat ze elkaar letterlijk in de weg zitten. Het afdwingen van participatie is nog niet mogelijk met SH, maar de gemeente had een stok achter de deur: het nastreven van vergunningen, die in de meeste gevallen niet werden nageleefd (*soort van uitnodigingsplanelogie*). De vijf eigenaren zien de noodzaak in en gaan verder vrijwillig actief mee het proces en creëerde een gezamenlijk niet plan.

Interventie door voorspelling met Game Theory - Van praktijk naar wetenschappelijk onderzoek. Naast de grootste problemen met versnipperd eigendom en onbereidheid van participatie, wordt samenwerking en besluitvormingen gewaardeerd als het meest complexe aspect in stedelijke ontwikkeling waar het vaak misloopt. Stagnatie of stoppen van projecten is daarbij mogelijk, als gevolg hoge financiële risico's en onvoorspelbare uitkomsten. Elk belanghebbende, individueel of als groep, kunnen worden gezien als entiteiten met elk hun eigen belangen, en ontmoeten elkaar in een ruimte van ruimtelijke besluitvorming, waarin ze hun eigen belangen zoveel mogelijk willen nastreven. Soms ten koste van andere waardoor conflicterende belangen ontstaan. De complexiteit komt door: (1) veel verschillende partijen met eigen belangen, (2) ze reageren verschillend op basis van hun eigen rationaliteit, (3) veranderende strategieën als reactie op marktwerkingen en veranderende institutionele contexten, en (4) besluitvormingen zijn afhankelijk van elkaar en één enkel persoon is niet instaat om de uitkomst te bepalen. Daarom is onderhandeling effectief ter bemiddeling, maar leiden vaak tot lange en vertragende processen doordat er geen overeenkomst gevonden kan worden. Vandaar dat dit soort processen goed gemanaged moeten worden, zoals het geval bij SH.

Om inzicht te krijgen in (*strategisch*) gedrag van mensen kan Game Theory gebruikt worden. Een methodiek die een besluitvormingsscenario analyseert en kan voorspellen. Vandaar dat er in dit onderzoek is gekozen om een beslissingsmoment, aangaande de invloed veranderingen van de belanghebbenden, te analyseren, modelleren, en te voorspellen. Dit met in de gedachten hoe het Kadaster, doormiddel van Game Theory, een interventie kan plegen. Met als doel het herstructureringsproces van oude bedrijventerreinen te verbeteren. Voordeel hiervan is dat op voorhand een complexe besluitvorming kan worden geanalyseerd, waarbij de uitkomsten en afwegingen gebruikt kunnen worden om tot een goede besluitvorming te komen. Onzekerheden en risico's kunnen bij voorbaat worden gereduceerd. Met behulp van Game Theory een 'driespeler onderhandelingsmodel' is gecreëerd gebaseerd op de setting van de case studie. De meeste indelingen van belangrijke belanghebbend tijdens de herstructurering van een bedrijventerreinen zijn: gemeenten, ontwikkelaars, investeerders, en gebruikers. Dit onderzoek heeft een nieuwe indeling voorgesteld, waarbij SH en de veranderende context de input was, waarbij de speler zijn verandert naar 'typen' spelers: (*publieke*) bestuurders, eigenaren, gebruikers, en ontwikkelaars. En elk type speler is onderverdeeld in 'entiteiten': bestuurders (*gemeente, provincie, rijk, ontwikkelingsmaatschappijen, Kadaster, etc.*), eigenaren (land- en vastgoedeigenaar), gebruikers (*huis, kantoor, industriële gebrui-*

kers). En voor iedere type zijn specifieke payoffs en onderhandelbare attributen geïdentificeerd gebaseerd op de case studie. Waarbij een opmerking geplaatst dient te worden: in de context van bijvoorbeeld SH en herstructurering kunnen deze rollen overlap veroorzaken. Want immers de eigenaar, de ondernemer, is vaak tevens tot op zekere hoogte de *gebruiker*, maar nu ook *ontwikkelaar* en *investeerder*.

Met deze nieuwe indeling en gedachten is een overzicht gemaakt van alle mogelijke interacties tussen deze type spelers waaruit de meest voor de hand liggende interacties: (1) publieke bestuurders vs. eigenaren & (2) bestuurders vs. gebruikers & (3) gebruikers vs. eigenaren. Deze interacties zijn gemodelleerd in een extensive form Game Theory beslisboom, waarbij uit vijf geïdentificeerde onderhandelbare attributen er twee gekozen zijn voor het spel: toekomstig land gebruik en herverkaveling. Deze twee attributen zijn onderverdeeld in ieder drie invloed niveaus: hoog, medium, laag. En dus de vraag: wat zal, gezien de case studie, de optimale strategie en uitkomst zijn? Waarbij hoog veel zeggenschap betekent, en laag geen zeggenschap over deze attributen. Er wordt verder geen verschil gemaakt tussen de belangrijkheid. Doormiddel van de Fuzzy Delphi methode is aan experts gevraagd wat is de 'meest geprefereerde uitkomst van het spel'. Dit doormiddel van wegingen (*schaal 1-10*), voor elke speler, voor elke eind node van het model. Deze getallen zijn van fuzzy (vage) numbers omgezet naar gedefuzziede nummers en ingevoerd in het gescripte ABM programma NetLogo (*berekenbaar door Strategic Choice Modelling*) voor de berekening van de uitkomsten.

Het model laat zien de uitkomsten, die door het model afhankelijk van elkaar zijn gemodelleerd, dat de uitkomst wordt voorspeld op de uitkomst dat als de gemeente in Maasbracht een medium invloed zal bieden, de eigenaren EN gebruikers hierbij akkoord zullen gaan. Tevens is te zien aan de uitkomsten dat als een hoge invloed wordt aangeboden dit wordt afgeslagen. Dit heeft invloed op de payoffs van alle partijen. Bij een hoge invloed zal een partij in staat zijn om de meeste invloed uit te oefen op zijn eigen payoffs, maar kan daar ook de meeste risico's bij dragen. Voorbeeld is een actief grond beleid, resulterend in problemen met eigenaarschappen en onbereidheid. Een medium level zou betekenen dat er een optimale samenwerking mogelijk is waardoor problemen met eigenaarschap wordt verkleind en dwingen zelfs niet perse noodzakelijk is. En bij een lage invloed, dan kan de tegenpartij zijn eigen payoffs maximaliseren. Als de uitkomsten worden gereflecteerd aan de praktijk kan worden geconcludeerd dat het resultaat overeenkomt met de werkelijkheid. Dus het Kadaster kan een advies geven op basis van de voorspelling aan de gemeente van Maasbracht: neem geen dominante 'leading' positie in. Anders wordt verwacht dat het project vastloopt.

CONCLUSIES EN DISCUSSIE

In het rapport hebben we gezien dat het Kadaster interventies ter beïnvloeding van het herstructureringsproces, op positieve wijze, doormiddel van 'Stedelijke Herverkaveling' en 'Voorspelling' kan uitvoeren. Stedelijke Herverkaveling: verwijderen van versnipperd eigendom, afdwingen van participatie, en conflicterende belangen zoveel mogelijk op elkaar af stemmen. Voorspellen, met behulp van Game Theory, heeft laten zien dat het Kadaster interventies kan plegen tijdens besluitvormingen. Hierdoor zal op voorhand gekeken worden wat de beste uitkomsten zullen zijn. En kunnen daardoor tijdens het proces sturing geven. Toch is SH geen magische formule of panacee, want het stuurt niet op de vraag. En Game Theory: is complex, tijdrovend, en gebaseerd op veel aannamen voor gebruik in het proces van SH. Nieuw onderzoek nodig voor implementatie van Game Theory in het proces van SH.