pursue their own interests rationally and what outcomes will result if they do. Because the focus lies on situations in which parties have conflicting and supplementary interests, and interdependence in behavior, game theory is well-suited to describe and analyze development and real estate decision making situations in which two or more actors or decision makers are involved (Samsura et al. 2010).

Basic assumptions that underlie the theory are that decision makers pursue well-defined, exogenous objectives (they are rational and try to maximize their own utility), they have an infinite game horizon (perfect recall), and they take their knowledge or expectations of other decision makers’ behavior into account (they reason strategically). Game theoretical models are representations of real-life situations, which allow them to be used to study a wide range of phenomena. They consist of at least three basic elements in order to predict interaction outcomes: players, strategies, and payoffs.

The players in a game are the decision-makers. A player is assumed to be a solitary actor who makes decisions and bears the consequences. A strategy $s_i$ is a complete plan of possible actions $A_i = \{a_i\}$, defining what player $i$ might do in any given situation during the game, aiming for utility maximization. The total set of strategies available to player $i$ is denoted as the strategy set or strategy space $S_i = \{s_i\}$. All players make their own choices by selecting strategies, but the result for each player is partly dependent on the choice of the other players. This resulting set of strategies for each of the $n$ players in the game is denoted as a strategy combination $s = (s_1, \ldots, s_n)$. The third element in the game theory is payoff. Player $i$'s payoff is denoted as $\pi_i(s_1, \ldots, s_n)$, and this can be defined as a number associated with each possible outcome resulting from a complete set of strategic selections by all the players in a game. Generally, higher payoff numbers attach to outcomes that are better in the player's rating system.

The conjunction of chosen strategies and related payoffs is defined as the outcome of the game. A clear distinction has to be made between the concepts of outcome and payoff; an outcome is the decision, if any, arrived at by the players collectively, while the definitive payoff of an outcome for a player is the value of that outcome for the player. Because players will have different valuation systems over the set of possible outcomes, and hence have different preferences over the outcomes, this is where conflicts can arise. In order to predict the outcome of a game, focus of game theoretic modelers is on possible strategies they consider a Brownfield that is $s_i$ — any land of selecting one or more strategy combinations as reflecting the most rational behavior by the players. A strategy combination that consists of the best strategy for each of the $n$ players in the game is referred to as a Nash equilibrium $(s_1, \ldots, s_n)$. Players choose equilibrium strategies in trying to maximize their individual payoffs. In order to find equilibriums, the players’ most preferred strategies should be defined. Solution concepts are suitable for defining such preferred strategies; a solution concept $F = \{s_1, \ldots, s_n\}$ is a rule that defines an equilibrium based on the possible strategy combinations and the payoff functions.

Application

Game theory can be classified into cooperative and non-cooperative game theory. Both matching narrowly with real estate development decision making processes. Cooperative game theory deals with situations in which groups of players already agreed to cooperate. There are incentives for coordinating their actions, which increases the likelihood of joint profits. Because these joint profits often exceed the sum of the individual profits, cooperative game theory deals with the question how to divide these joint profits. This might be applicable to situations in which public and private parties negotiate over the division of risks, expenses, and profits in a public-private partnership contract. Non-cooperative game theory primarily deals with the analysis of conflict situations. A conflict can occur when the interests of several decision makers are opposed or only partly coincide. Each decision maker will usually choose an option in his own interest, which need not be in the interest of the others. These individual decisions can result in worse outcomes for all players compared to a coordinated decision. In this section, we will present an example of a non-cooperative game theoretic model, applied on Brownfield Redevelopment.

Environment of the game

To set up the game, we defined the institutional-economic environment. Therefore, we used the present land development models in the Netherlands (Samsura et al. 2010). All models (Table 1) are characterized by initial situation on the market of ownership, defined parties that acquire the land, the one that service and repackage the land, and the parties that acquire the building plots. Within these models, the role of the municipality can be active or passive. Specifically, we addressed an active approach from the government, and within that group of models a PPP (Public Private Partnership) model. This choice was based upon the fact that active approach is mostly common in the Netherlands and PPPs are common practice.

A common type of PPP is a Joint Venture Company (JVC). In the game we are analyzing a specific decision to form the JVC or not. The municipality invites a developer to form a JVC for the initiative phase of a Brownfield Redevelopment project. In order to simplify the game, we assumed that the land has been already acquired by the municipality. That is an exception of a PPP model since the acquisition is usually conducted by a JVC (see Table 1). When formed, the JVC will service the land and deliver a detailed land use plan and parcelization. Therefore, the final product of the JVC is the urban land with immediate possibility to sell the building plots.

Besides setting the game in a specific institutional-economic environment, the involved parties based their decision to form the JVC or not on several other specific contextual conditions. At first, they consider a Brownfield that is $s_i$ any land of selecting one or more strategy combinations as reflecting the most rational behavior by the players. A strategy combination that consists of the best strategy for each of the $n$ players in the game is referred to as a Nash equilibrium $(s_1, \ldots, s_n)$. Players choose equilibrium strategies in trying to
Brownfield Redevelopment on the urban district scale. Thirdly, the size of a Brownfield is in the range of one to ten hectares. Finally, we assumed that different decisions would be more or less present depending on the region of the research (this research focuses on the Netherlands).

Game type

We restricted ourselves to analysis in the extensive form or a game tree analysis where the players act sequentially. The extensive form of the game compared to the strategic form brings more realistic representation of the reality. As mentioned before the game is non-cooperative.

Players of the game

We focus on two groups of actors in whole Brownfield Redevelopment process. These are the Municipality (M) and Developer (D) that would potentially form a JVC.

Strategy

At first, we will determine the negotiation issues that are treated as strategies in the game. In this game we address two issues: the availability of a building claim and developer’s influence on the future land use and parcelisation. The building claim is one of the crucial characteristics for any land development model (Samsura et al., 2010). Potential to influence future land use emerged as the most important attribute in our survey (Glimaus et al., 2010a).

Parcelisation together with servicing (land clean-up and infrastructure developing) is a stage characteristic for every land development model (Samsura et al., 2010). Additionally, the selection upon the negotiation issues is reduced to land use mix and density of development (parcelisation) at a local neighborhood scale to describe the development typology. Similarly, both the land use and parcelisation are used to compose development types.

By assigning the levels to these negotiation issues we defined the possible actions $A_m$ and $A_d$ of the strategies $s_m$ and $s_d$ for player $M$ and $D$ consecutively. The first negotiation issue, building claim has two levels: available (BC) or not available (NBC). These levels are straightforward and we did not provide any additional elaboration. Contrary, the influence on future land-use and parcelisation can be perceived arbitrary therefore a further elaboration is necessary. We determined three levels for this issue: High (H), Medium (M), and Low (L) influence. High influence means that developer can carry out any land use regulated by mix-use zoning plan and completely determine the size and the shape of any parcel in the land that will be redeveloped. To underline, changing a zoning plan is not an option, but the levels of developer’s influence ($M$, $L$) express the potential to adjust the land use ratio within the mix-use zoning. Logically, medium influence grant a developer less and low influence minimal possibilities.

Solution concepts

This game can be solved by backward induction that indicates Sub-Perfect Nash Equilibrium (SPNE). In order to improve the outcomes the interventions derived from the game theory are possible. These interventions in general consist of three elements: a) Changing the information for the involved players; b) Changing the pay-offs; c) Changing the playing rules. Based on the outcomes of the analyses, and making use of the principles of game theory in order to improve game outcomes, various previous interventions can be designed to reduce the number of conflict occurrences and accelerating the real-world realization of the Brownfield Redevelopment projects.
Perspectives of Game Theory

As decision processes in real estate development projects become more complex, we have to find theories that can support the governance of such processes through interventions. Game theory can be applied to real estate development project environments, resulting in a very basic understanding of players’ choice behavior and expected decision outcomes, together with recommendations concerning the application of intervention strategies in conflict situations. However, one should realize that game theory presents an abstraction from reality: not all intricacies of real-life interaction processes in real estate development projects are covered, and deliberately so. The aim is to use the abstract representation of the interaction structure as a tool to understand the behavior of the involved parties a bit better, not to mimic real-life to every detail. Furthermore, a major critic of the classical game theory is the assumption of perfectly rational players with complete information. To partly overcome the problems related to the assumptions of game theory, the concept of bounded rationality can be introduced. This can be achieved by combining game theory with methods that enable the possibility of having a ‘vector’ or ‘multi-valued’ utility function. This is a main subject in the research of the authors, of which the first results can be found in Glumac (2010b) and Blokhuis (2010).

References


Emerging urban futures and opportune repertoires of individual adaptation

This paper summarizes the goals and scope of a new large scale research project, funded by the EEC. The ultimate goal of this research project is to develop the first comprehensive model of dynamic activity-travel patterns in the world, expanding and integrating concepts and partial approaches that have been suggested over the last few years. Dynamics pertain to different time horizons. Long-term decisions such as demographic change, changing job or house may also prompt or force people to adapt their activity-travel patterns.

Exogenously triggered change involves change in the urban and/or transportation environment and/or the larger socio-economic institutional contexts. It may be unplanned or planned (policies). The integrated multi-agent model will simulate the primary, secondary and higher order effects of such emerging urban futures on dynamic repertoires of activity-travel patterns. A multi-agent model will be built to capture these dynamics. In addition to the multi-agent model, the PhD/postdoc projects will result in improved understanding of the effects of various policies, based on a variety of statistical analyses, and in guidelines about the most effective (set of) policies in contributing to integrated urban sustainability, and in elaborated theory about spatial dynamic choice behaviour.

“Activity-based models should be considered as alternatives to spatial interaction models.”

Introduction

An understanding of complex activity patterns (time-space behaviour) of actors is essential for improving the effectiveness of various kinds of policies and for assessing the market potential of new real estate projects. An activity-based framework constitutes an integrated framework as it (i) combines economic, social and other activities, (ii) is based on a highly detailed, comprehensive spatial and temporal representations (minutes and geocodes/small postal zones), (iii) combines different methods to simulate behaviour, (iv) focuses on the complex interdependencies between activities, household members, time periods, locations, etc., and (v) constitutes the basis for deriving measures of economic, social and environmental impact and feasibility. For these reasons, the activity-based perspective has rapidly gained momentum, especially