A negotiation decision model for public-private partnerships in brownfield redevelopment

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Abstract

Urban development cannot proceed without the commitment of multiple actors, because decision-making processes have become more and more interdependent. This article supports better decision-making in brownfield redevelopment projects in cases where the project realization depends on a public–private partnership between a municipality and a developer. In a broader sense, in this research, we investigate how the negotiation process in brownfield redevelopment projects can be improved by providing an understanding of the characteristics of a brownfield area and the interaction between the parties involved. In order to improve the process, a negotiation decision model is proposed. This is a hybrid model consisting of five phases. Its novelty lies in the combination of a latent class model and a strategic choice model that can be formulated as a prescriptive-interactive approach in decision theory. The hybrid negotiation model is applied to a reconstructed case study in order to present its possibilities. Accordingly, three applications of the model are introduced, and in each application the beneficiary is a municipality. Although using decision models for brownfield redevelopment projects has already been thoroughly studied, there is little evidence concerning the prescriptive-interactive component built into existing models.

Keywords

Negotiation, brownfield redevelopment, public–private partnership, hybrid negotiation model, latent class model, strategic choice model

Introduction

Brownfield redevelopment (BR) projects usually entail a greater risk than greenfield projects (De Sousa, 2002). However, redeveloping a brownfield site—especially one with location

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advantages—can create more value for involved actors (Liang et al., 2008). The necessity to deal with often complex environmental, economic, legal, and social aspects of the built environment may explain why BR processes can face delays (e.g. Glumac et al., 2011; Nijkamp et al., 2002), because each aspect could influence the decision making by relevant actors. On the other hand, decision making concerning urban development projects has generally undergone a number of important changes over recent decades. This transition represents a shift from governmentally dominated, top-down spatial planning, to bottom-up, public–private engagement in urban development (Tam and Thomas, 2011; Tam et al., 2009). The new policy implies pluricentric network steering—in which several public and private actors play a role—instead of traditional hierarchical top-down governmental steering.

Urban development cannot proceed without the commitment of multiple actors, because the decision processes are interdependent. Therefore, this research refers to collaboration and negotiation within a multi-actor environment. Specifically, this article reflects the possibilities to formally capture the negotiation process in BR projects. This formality is required in order to provide adequate advice.

Different theories and methods have been used to represent the interaction in decision-making or modeling of negotiations in urban development practice (Arentze and Timmermans, 2003; Cassiman, 2000; Hamalainen et al., 2001; Mayer and de Jong, 2004; Tam and Thomas, 2011). Further, contributions have also been made in the field of BR (Alberini et al., 2005; Chen et al., 2009; Mayer et al., 2005; Pfrang and Witting, 2008; Shan and Xu, 1996; Sounderpandian et al., 2005; Thomas, 2002; Walker et al., 2008; Wang et al., 2007, 2008, 2009, 2011, 2013; Wey and Wu, 2008; Yousefi et al., 2007; Zeng and Zhou, 2001).

Although there is abundant relevant literature, there remains a need to further develop functional tools. This article proposes a hybrid negotiation decision model for BR (Figure 1), comprising mainly a choice model and a theoretical game model. The development of the model is explained through five procedural phases. In essence, the negotiation model captures both actors' individual utilities and their interaction effect in negotiations. Because of this feature, this negotiation model has an advantage concerning the choice forecast in BR projects in comparison with existing choice, and theoretical game and negotiation models. The proposed model can therefore be formulated as a prescriptive-interactive decision-making approach (Raiffa, 2002). To illustrate the possibilities of this negotiation hybrid model, a reconstructed case study is used. The selection criteria for this case study were carefully chosen in order to fit the context and operational capabilities of the proposed model. The model will assist actors—a municipality in this example—to overcome the challenges of conventional negotiation in three different decision problems.

Little work has been done previously to develop models that systematically relate the characteristics of brownfield areas to the behavior of actors, thereby providing an insight into the most important points of interest and possible sources of conflict between two actors. In this article, we emphasize the possibility of using a negotiation decision model to generate and analyze different scenarios in order to create better public–private partnerships (PPPs) in BR projects. Because forming a PPP assumes a multitude of actors, this study can be perceived as a branch of negotiation modeling. Specifically, the introduced negotiation model for BR is a model type oriented with an optimization system. This specific taxonomy (Alter, 1980) addresses the guidelines for actions by generating the optimal solutions.

Figure 1. Hybrid negotiation model.

Public-private partnership negotiations for brownfield redevelopment

The first concession, or exclusive partnership, was granted to Perrier for water distribution in France in 1782 (Monod, 1982). Since then, there have been numerous examples of PPPs in urban development practice (e.g. Grimsey and Lewis, 2002; Sagalyn, 2007; Weihe, 2005). Although a uniform definition is still lacking (Weihe, 2005), PPP is a concept frequently used in urban development practice. In most cases, a BR requires a form of partnership. This is particularly the case when circumstances are not favorable for an independent development initiative by private sector actors (e.g. Grimsey and Lewis, 2002). In addition, another important factor for forming partnerships is the limited amount of public funds,

which has led governments to invite the private sector into various long-term arrangements for capital-intensive projects.

Although unrelated to the involvement of public or private actors, literature concerning BR reviews a broad range of different definitions (Alker et al., 2000; CABERNET, 2002; Yount, 2003), classifications (Adams et al., 2001; CABERNET, 2002; Chen et al., 2009), and the composition of (re)development process phases (Hieminga, 2006; Miles et al., 2007; Nozeman et al., 2008; Nutt, 2004; Peiser and Frej, 2003; Roulac et al., 2006; Zhu and Hipel, 2007). In this article, we refer to the following definition: “A brownfield site is any land or premise which has previously been used or developed and is not currently fully in use, although it may be partially occupied or utilized. It may also be vacant, derelict or contaminated” (Alker et al., 2000). In addition, the adopted classification (CABERNET, 2002) offers three categories based on two characteristics: Market land and property value after the redevelopment, and redevelopment costs. These categories are termed A, B, and C and reflect the cost–benefit ratio, starting with the most favorable option and ending with the least favorable one. It is important to note that this article focuses on category B projects. These projects are on the borderline of profitability, and therefore tend to be funded through PPP. Lastly, any BR project consists of several successive phases (Hieminga, 2006), each characterized by a list of deliverable products and the presence of different actors (Hieminga, 2006). In this article, special attention is paid to the initiative and land acquisition phase, or more specifically to two factors: Program in brief and location analysis.

The presence of different actors frequently coincides with asymmetric information (e.g. Coffin, 2003; Thomas, 2003) and conflicting interests (e.g. Blokhuis et al., 2012; Yousefi et al., 2007), which might lead to a lack of consensus among key actors and consequently cause the stagnation of BR (Glumac et al., 2013). These issues compose a negotiation process. Formally, within decision-making theory, PPP negotiations are classified as an interactive normative or a collaborative prescriptive approach (Raiffa, 2002). The former approach is dominated by the concepts of game theory and the latter by negotiation analysis. Applying game theory fosters how decisions should be made regarding various issues, for example, in a BR project (e.g. Samsura et al., 2010; Wang et al., 2007). By comparison, applying negotiation analysis facilitates the study of how to reconcile differences and reach a consensus in a BR process (e.g. Pfrang and Witting, 2008). The concept of merging these two approaches has also been investigated (Yousefi et al., 2007).

Many methods can offer planners a powerful set of spatial analytical tools (Hayek et al., 2010). However, a BR negotiation also comprises attributes that are descriptive in nature and at the same time offers an approach that can prescribe the best outcome for negotiating parties while incorporating their interaction.

Research questions

In a broad sense, in this research, we investigate how the negotiation process in BR projects can be improved by providing a comprehensive understanding of the brownfield characteristics and the interaction between involved actors at the same time. Both brownfield characteristics and interaction in negotiations can be regarded as a set of redevelopment project characteristics or attributes available to participants in a (re)development negotiation. As stated, this set is two-fold. Brownfield characteristics are a given and cannot be negotiated, therefore they are labeled as a non-negotiable subset of attributes. Similarly, the second subset of attributes is the negotiation actions between

actors, therefore labeled as negotiable brownfield attributes. In the following text, the labels are used consistently to help a reader to easily understand the methods with which these two subsets are treated.

In response to broad research interest, several questions need to be answered: (1) how to capture all the relevant redevelopment project characteristics, or attributes and actors; (2) how to measure preferences of the attributes that are preferred, driven by the shared concerns and conflicting interests of different actors in the BR process; (3) how to represent and model the interaction between these actors; (4) how to assess the probability of a negotiable set of attributes based on key actors' preferences; and (5) how to steer the outcomes of the negotiation in order to avoid a lack of consensus amongst defined key actors.

Research methods and approach

Each research question is addressed sequentially in one of the five research phases. These five phases also define the hybrid negotiation model (Figure 1), described briefly below.

Phase 1. Selected literature is used to identify important attributes and the main actors. This initial list is then reduced to the most important attributes by applying the fuzzy Delphi method (FDM) with the similarity aggregation method (SAM). In this article, we adopt a set of attributes addressing BR that are already established (Glumac et al., 2011) derived by FDM with SAM.

Phase 2. With the established set of attributes, a latent class model (LCM) (McCutcheon, 1987) reveals the utilities of the municipality and developer concerning BR choice. The utilities of these actors have also already been estimated (Glumac et al., 2015a) and are adapted in this article.

Phase 3. This procedural phase investigates interactive behavior between two actors (the municipality and the developer) in BR negotiations where the set of attributes has been previously determined in Phase 1 and is the same in Phase 2. However, in this phase there is a strong differentiation between negotiable and non-negotiable attributes. This procedural phase relies on the game theory experiment (e.g. Camerer, 2003) that is used to reveal the structure of BR negotiation. Similar to the previous two phases, this phase has already been reported (Glumac et al., 2015b) and is adopted in this article.

Phase 4. This phase provides insights into the probabilities of earlier established negotiable attributes, more precisely their levels. These probabilities are estimated by a strategic choice model (SCM) (Signorino, 2003) that is composed of the established negotiation structure from Phase 2 and payoffs based on the utilities of both actors (municipality and developer) estimated by a binominal probit model with data collected through a choice experiment.

Phase 5. The most probable negotiable attribute levels derived from the SCM are used together with LCM utilities in order to combine the interactive component of SCM with a prescriptive component of LCM.

Because of its interactive and a prescriptive component, this negotiation hybrid model can be formally regarded as interactive-prescriptive approach in decision theory.

Phase 1: Fuzzy Delphi method

There are numerous possible techniques to identify attributes, ranging from qualitative in-depth interviews to near-theoretical approaches (Timmermans et al., 1982). The hybrid

negotiation model introduced here uses FDM to obtain the most important attributes. FDM is derived from combining the traditional Delphi method with fuzzy set theory. Various researchers have contributed to the origin of this approach (Hsu and Chen, 1996; Ishikawa et al., 1993; Murray et al., 1985; Noorderhaven, 1995). The traditional Delphi questionnaire has the tendency to provide both questions and answers that are indistinct. In addition, it is a notable problem to solve the fuzziness in expert consensus in group decision making. These two key issues resulted in the proposed SAM (Hsu and Chen, 1996), which uses a trapezoidal fuzzy number to estimate group consensus. This method consists of several consecutive steps (Hsu and Chen, 1996), where the last step is screening for the most important attributes.

After the screening, it is possible to distinguish the most important attributes for each actor group, therefore comparing their choices and the degree of agreement among all actors. These attributes can be split into negotiable attributes—building claim, future land use, and future parcellation—and non-negotiable attributes—location, infrastructure change, administrative support, and synergy with surrounding users. Further, one attribute is considered as a precondition: Ownership. As mentioned earlier, this phase of the introduced negotiation hybrid model has already been elaborated and its findings published (Glumac et al., 2011).

Phase 2: Latent class model (LCM)

Choice modeling is a statistical technique that examines the choices individuals make between alternative products or services (a redevelopment project as well) that can be described as a bundle of product characteristics or attributes (Lancaster, 1966). One of the choice models, a LCM, predicts unobserved (latent) and discrete (class) behavior from a series of multivariate discrete variables (McCutcheon, 1987). A class is based on conditional probabilities that determine the likelihood of an individual being classified into it.

Based on the previously determined negotiable and non-negotiable attributes, the utilities of two generic types of developers (private traditional and private proactive), indicating the willingness to participate in a BR project, are estimated by LCM. The full descriptions of the attributes and their levels as well as the findings of the LCM are available in a previous study referred to above (Glumac et al., 2015a).

Phase 3: Game experiment

The emergence of game experiments can be traced back to a need for empirical information about the principles of strategic behavior and the ability of experiments to provide such information (Crawford, 2002). The predictions of classical game theory are very sensitive to the structure of the game. Relying only on the existing (data) input of a particular research context often leads to an unobserved or uncontrolled structure for the game. Although experiments frequently share some of these problems, the control and observation provided by modern experimental techniques assure a notable advantage in identifying the relationships between strategic behavior and the environment (Crawford, 2002). Nevertheless, theory and experiment may have strongly complementary roles. Whereas theory provides a framework to collect empirical data and interpret the respondent's behavior, experiments indicate which parts of the theory are most useful in predicting and identifying the behavioral parameters that have not been reliably determined by theory (Crawford, 2002).

Particularly in this study, the construction of a game experiment starts with setting up the negotiation decision moment through a factorial fraction design. This experimental design uses the aforementioned four non-negotiable attributes and their levels. On the other hand, the negotiable attributes are used in a game tree as edges (Crawford, 2002). Further, the game experiment consists of three main steps (Glumac et al., 2015b): (a) validation, examining the assumed game structure, (b) measuring the preference of two actors (municipality and developer), and (c) observing the game choice of both actors. For the first step (a), each node and edge were textually described and a simple multiple answer questionnaire was provided to respondents to validate every node and edge. The preferences (b) and game choice (c) of the games were estimated by FDM with SAM (Hsu and Chen, 1996). Comparison shows that the game outcomes estimated by preferences (b) and choice (c) are a match. Therefore, it is proven that the actors are rational and it is possible to use a backward induction as an estimation of a sub game perfect Nash equilibrium (SPNE) and thus use SCM. Similar to the previous two phases, this phase of the negotiation hybrid model is described in detail in an existing study (Glumac et al., 2015b).

Phase 4: Strategic choice model (SCM)

A choice model reflects only the choices made by a single actor. Therefore, these models do not capture the influence on a particular choice that results from interaction with other actors. The combination of choice models and game theory is a relatively new approach in the context of urban development, but it has been thoroughly adapted in other fields (Anderson et al., 2001; Bas et al., 2008; Arcidiacono et al., 2016; Chen et al., 1997; Choi and Desarbo, 1993; Clarke and Signorino, 2010; Hensher et al., 2007; Le Cadre et al., 2009; Luo et al., 2007; Signorino, 2003; Signorino and Yilmaz, 2003; Soetevent and Kooreman, 2007; Toivanen and Waterson, 2000).

The SCM suggests that individual n payoff for strategy j consists of three components (equation (1)): (a) a choice alternative-specific component termed $U_j^{exogenous}$, (b) an interaction component or $U_j^{endogenous}$, and (c) an idiosyncratic error term ε , treated as an individual and alternative specific random variable, the distribution of which is common knowledge among all individuals, but the exact value of which is only known to the individual n . The above can be expressed as (Han, 2006):

$$U_{nj} = U_j^{exogenous} + U_j^{endogenous} + \varepsilon_{nj} \quad (1)$$

$U_j^{exogenous}$ represents the traditional attributes of the alternative choices that affect payoffs. Here, the preference accounts for the variation in utility defined by the four non-negotiable attributes mentioned, and reflects the preference to redevelop a brownfield. In experimental terms, this component is defined as a condition. This term is formulated in equation (2), where X_k stands for all attributes from collection A that appear in all utility functions, and β_k represents a k level specific parameter vector, estimated by respondent n .

$$U_j^{exogenous} = U_{ni} = \sum_{k \in A} \beta_k X_k + \varepsilon_{ni} \quad (2)$$

$U_j^{endogenous}$ captures the attractiveness of an alternative choice as a function of the behavior of other individuals (Han, 2006). Therefore, choice probabilities are based on the choices players are expected to make in equilibrium. The endogenous component

consists of different games. Therefore, the endogenous component (equation (3)) can be regarded as the sum of utilities related to the equilibrium of all games Γ , where game $G=(1,\dots,\Gamma)$. Now, let y be the set of strategy profiles where $U_m^*(Y_g)$ is a true game equilibrium outcome utility given the set of all game outcomes g for set of attributes A of player m , where each respondent $n \in m$. Two different games—an ultimatum game and a bargaining game—are used here to represent the three aforementioned negotiable attributes.

$$U_j^{endogenous} = U_{mg} = \sum_{G=1}^{\Gamma} U_m^*(Y_g) \quad (3)$$

In phase 3, we show that the players are rational, therefore the SPNE can be expressed by backward induction. The SPNE for *building claim game* based on an ultimatum game follows (equation (4)). A similar equation is used to estimate the probability for the other two negotiable attributes. For the two players, municipality and developer, the nomenclature is 1 and 2, respectively. As mentioned, the utility of player 2 for the outcome (Y_4) would be expressed as $U_2^*(Y_4)$. The outcome of this SCM is to predict the most probable outcome or particular level of negotiable attributes.

$$y = \begin{cases} Y_1 \rightarrow U_2^*(Y_1) > U_2^*(Y_2) \wedge U_2^*(Y_3) > U_2^*(Y_4) \wedge U_1^*(Y_1) > U_1^*(Y_3) \vee \\ \quad U_2^*(Y_1) > U_2^*(Y_2) \wedge U_2^*(Y_4) > U_2^*(Y_3) \wedge U_1^*(Y_1) > U_1^*(Y_4) \\ Y_2 \rightarrow U_2^*(Y_2) > U_2^*(Y_1) \wedge U_2^*(Y_3) > U_2^*(Y_4) \wedge U_1^*(Y_2) > U_1^*(Y_3) \vee \\ \quad U_2^*(Y_2) > U_2^*(Y_1) \wedge U_2^*(Y_4) > U_2^*(Y_3) \wedge U_1^*(Y_2) > U_1^*(Y_4) \\ Y_3 \rightarrow U_2^*(Y_3) > U_2^*(Y_4) \wedge U_2^*(Y_1) > U_2^*(Y_2) \wedge U_1^*(Y_3) > U_1^*(Y_1) \vee \\ \quad U_2^*(Y_3) > U_2^*(Y_4) \wedge U_2^*(Y_2) > U_2^*(Y_1) \wedge U_1^*(Y_3) > U_1^*(Y_2) \\ Y_4 \rightarrow U_2^*(Y_4) > U_2^*(Y_3) \wedge U_2^*(Y_3) > U_2^*(Y_4) \wedge U_1^*(Y_1) > U_1^*(Y_3) \vee \\ \quad U_2^*(Y_1) > U_2^*(Y_2) \wedge U_2^*(Y_4) > U_2^*(Y_3) \wedge U_1^*(Y_1) > U_1^*(Y_4) \end{cases} \quad (4)$$

$\phi(\eta_{234})$ is a normal density function $\left(p_4 = \int_{-\infty}^{U_2(Y_4)-U_2(Y_3)} \phi(\eta_{234}) d\eta_{234} p_{Y_1} = p_{BCP1} p_{Y_2} = p_{BCP2} p_{Y_3} = p_{NBCP3} p_{Y_4} = p_{NBCP4}\right)$.

Phase 5: Combining SCM and LCM

In this phase, it is important to note the practicality of combining LCM and SCM. In principle, this is relatively elementary, although it requires predesigned compatibility. This is achieved by equating each attribute level in LCM to an action in the structure of the SCM. For example, the negotiable attribute in LCM “*building claim*” has two levels: Granted and not granted. This is represented in SCM as two edges or actions from one node, for example, a_{BC} and a_{NBC} . The non-negotiable attributes’ levels in LCM represent a set of different scenarios for SCM with a fractional factorial design, as explained.

By combining these two models, it is possible to have different applications for the two actors. To illustrate the applicability, the beneficiary is set as a municipality that deals with the decision-making problems of choosing: (1) an optimal deal for a known developer and a known brownfield site (the described case study); (2) an optimal developer for a known brownfield site; and (3) an optimal developer for an optimal brownfield site. There is still ongoing research regarding the impact of model-driven tools on reducing the occurrence of biased decision behavior. However, there is evidence that

elicitation of subjective probabilities and values provides normatively better results (Power and Sharda, 2007).

Results

Negotiation set up

To illustrate the possibilities of the proposed negotiation model a case study was selected: Strijp-S, Eindhoven, an area close to the city center and previously used as Philips industrial complex. The selection criteria for the case study needed to fit into the context of the research, with information concerning all respondents in all five phases matching each of the experimental designs. Therefore, the case study was selected based on the following criteria: (a) fit with the adopted brownfield definition (Alker et al., 2000); (b) B category of brownfields (CABERNET, 2002); (c) a project in its initial stage (Hieminga, 2006); (d) PPP already formed; (e) based in the Netherlands, because preferences can vary among different socio-institutional environments; (f) mixed future land use (285,000 m² for housing, 90,000 m² for office use, 30,000 m² for retail and cultural use); (g) size of the site should fit the scale of one neighborhood (27 ha); and (h) two actors had to be involved in BR, the municipality (Eindhoven) and developer (VolkerWessels, which created a PPP called Park Strijp Beheer).

Respondents' background

Each model requires data that were collected through two experimental designs in one survey. Therefore, a brief overview of the respondents is provided. Public and private actors could consist of several subgroups varying in their degree of formality, autonomy, and power (Bryson, 2004; Edwards, 2004). However, in the public sector, only municipal and regional development agencies are relevant for this negotiation set-up, because they are the most influential at a BR project scale. On the other hand, the private actors can be differentiated based on their goals and objectives (Hieminga, 2006): Independent project developer, contractor, asset investors, social housing associations, financial institutions, and architects. In this article, the last three categories actors are not used. The social housing association is specific to the Dutch market, and financial institutions and architects are active to a much smaller degree in BR projects. Some authors (Sounderpandian et al., 2005; Wang et al., 2011) have proposed the municipality (M) and developer (D) as the key actors. Therefore, different types of public and private actors are reported, but they are all presented as municipality (M) and developer (D) for each experimental design. The frequencies of respondents used to estimate the negation hybrid model are presented in Table 1.

Table 1. Distribution of respondents.

Type of respondent	Actor	Freq.	%
(1) Independent developers	D	25	22.5
(2) Contractors	D	29	26.1
(3) Asset developers	D	16	14.4
(4) Development agencies	M	15	13.5
(5) Municipalities	M	26	23.4
total		111	100.0

Municipality as a beneficiary of the negotiation hybrid model in three decision problems

In order to use the proposed negotiation hybrid model, an input is required from a beneficiary, here a municipality. The municipality provides the levels of non-negotiable attributes (location, infrastructure change, administrative support, and synergy with surrounding users). Each of the non-negotiable attributes can be set, based on the case study described. Location is set as “*decent*,” because its proximity to central business district is around 2 km, the location has no access to the city ring road, and there is no operating public transport. Infrastructure change is set as “*medium*,” because the majority of the buildings could be used with moderate reconstruction and similar applies to the existing infrastructure. Administrative support is regarded as “*excellent*,” because the project would be developed together with the municipality, which has a major administrative role. Finally, synergy with the surrounding users is regarded as “*excellent*,” because the redevelopment project provides a mix of land use for housing, offices, recreation, and services. This combination of land use is a better match with the surrounding dominant housing than the previous industrial use. This input of non-negotiable attributes is used in two out of three decision problems (Figures 2 and 3). The negotiable attributes should be regarded as a policy tool, and they differ for each of the three decision problems.

An optimal deal for a known developer and a known brownfield. In this application, a municipality is facing a decision choice for an optimal deal regarding a known brownfield and known developer. As mentioned, the non-negotiable set of attributes’ levels is based on the Strijp-S case study and they are shown on the lower left-hand side in Figure 2. The upper left-hand part of the figure consists of three negotiable attributes, and their levels are

Figure 2. Dashboard A.

Figure 3. Dashboard B.

estimated by SCM. On the right-hand side, the figure shows the probability prediction (0 to 1) estimated by LCM that the developer—VolkerWessels—would accept or reject this deal. The outcome indicates that there is almost a 70% (0.697) chance a developer would accept the proposed deal.

Contrary to the relatively high predicted likelihood of reaching an agreement with VolkerWessels, Eindhoven municipality accepted a less favorable deal. The municipality granted building claims for all building plots to subsidiary companies of VolkerWessels, and accepted a flexible zoning plan resulting in high developer influence on future land use (*high*) and parcellation (*high*). In addition, the municipality covered the total purchasing cost of 140m in respect of the initial land owner, Philips. This mismatch between optimal projected and actual conditions brings into question the decision of the municipality. Therefore, a municipality could use this tool to better understand its negotiation position in forming a PPP, thereby resulting in more favorable conditions regarding either negotiable attributes or initial purchasing costs.

An optimal developer for a known brownfield. In the second decision problem, a municipality has a choice between two types of developers to form the optimal partnership for a known brownfield. The tool provides the acceptance probability of the generated alternative (e.g. the case of Strijp-S) of two types of developers: A private traditional developer and a private proactive developer. Their major difference underlines the impact of the location attribute and the negotiable set of attributes (Glumac et al., 2015a). The assumption here is that the developer with a higher probability of choosing a proposed deal is more attracted to develop that site. Therefore, this developer would be a better partner, because a municipality could reach more favorable conditions regarding either negotiable attributes or initial purchasing costs.

Figure 3 presents the described application. Starting from left to right, this figure shows the levels of the set of negotiable and non-negotiable attributes, the probability prediction for accepting a deal (0 to 1) for the two types of developer, and the part-worth utility function of these two developer types for a specific set of attributes' levels. In this case, there are no major differences. What makes the utilities of both developers equal is the fact that the location attribute is set to “*decent*,” and that the negotiable set of attributes (building claim, future land use, and future parcellation) are set to the lowest and least favorable level. On the one hand, the utility of the traditional developer is mostly influenced by the location attribute. Because it is not on the “*excellent*” level, this significantly reduces the preference for choosing to participate in such a BR project (Glumac et al., 2015a). On the other hand, the proactive private developer is influenced mostly by the negotiable set of attributes (Glumac et al., 2015a). This combination of attribute levels finally results in the utilities of both developer types being equal for this specific case study.

An optimal developer for an optimal brownfield. A municipality can be in the position of choosing between two or more brownfield areas and developers at the same time, in order to find the optimal partnership. Figure 4 provides an example of two possible scenarios in which each type of developer can choose to join the BR project.

From left to right, Figure 4 shows: Two scenarios (upper blue and lower red) that are defined with the set for attributes specified with certain levels; the probability prediction (0 to 1) for accepting a deal for two types of developer for *brownfield 1* and for *brownfield 2* (upper blue and lower red); the probability prediction (0 to 1) for accepting a deal for two types of developer for the choice between two brownfields (upper); and the part-

Figure 4. Dashboard C.

worth utility function of the two developer types for each brownfield. Two effects are important to stress when using this application. First, even when both private developer types have a high probability of accepting each of the two scenarios separately (middle upper and lower), the probability of choosing one over the other scenario might change dramatically for each type of developer when a municipality offers them two scenarios at the same time (right upper). In the case of these two scenarios, evidently a private traditional developer would be much more likely to choose *brownfield 1* over *brownfield 2* and the opposite applies to a proactive developer. Second, even if there is a higher probability that a private traditional developer will choose to join the *brownfield 1* project (0.846) than that a private proactive developer would join the *brownfield 2* project (0.808), this does not imply that the optimal deal for a municipality is a partnership with a private traditional developer on the *brownfield 1* project. The utility (lower right) of a private traditional developer for *brownfield 1* (3.851) is lower than that of a proactive developer for *brownfield 2* (4.143). Therefore, for a municipality the latter utility might secure a better negotiation position in forming a PPP, thereby resulting in more favorable conditions regarding initial purchasing costs.

Conclusions

Mostly, urban planning assumes a leading role for governmental institutions that are responsible for urban development (Brail, 2008). However, the changing planning process has introduced a multitude of actors, which has major implications for urban development processes. Therefore, a better understanding of the development process is required. To cope with this trend, many decision models have been suggested in the context of BR.

The proposed model aims to enrich the existing body of research by introducing a prescriptive-interactive component in negotiation modeling. This is accomplished through its hybrid design of different techniques and methods, which are linked together and described in five procedural phases. In brief, these phases consist of: (1) FDM, used to select the most important attributes and actors; (2) LCM, used to assess the preferences and to differentiate between two major groups of developers that participate in BR projects; (3) a game theoretical experiment, used to validate a structure for the BR negotiation process and prove that actors are rational in the set context; (4) SCM, to predict the outcomes of each

of the negotiable attributes (building claim, future land use, and future parcellation) through their levels; and lastly (5) SCM and LCM together, in order to combine the interactive component of SCM with the prescriptive component of LCM. Therefore, this hybrid negotiation model can be classified as a prescriptive-interactive approach in decision theory.

In addition, this article suggests practical applications that can help a municipality as a decision maker to reach optimal deals in forming PPPs for BR projects. A municipality as a beneficiary can use this negotiation hybrid model for three decision problems: (1) an optimal deal for known developer and brownfield; (2) an optimal partner (choice of developer for a known brownfield); and (3) an optimal developer for an optimal brownfield. The applicability of this negotiation model is illustrated here by a selected case study. For first two applications, by comparing the difference between the actual reconstructed case study and the deal(s) suggested by the hybrid negotiation model, it is shown that a municipality could use this model as a tool to better understand its negotiation position and preference for different developers, thereby resulting in more favorable conditions regarding either negotiable attributes or initial purchasing costs. As an addition, the third application shows that even more complex decisions, which are overlooked in the reconstructed case study, might be elaborated and taken into account.

It is important to mention that the applications require input data for the non-negotiable attributes (location, infrastructure change, administrative support, and synergy) together with their descriptive levels, which need to be assessed by experts prior to the input. As a future development, in order to avoid the assessment of experts prior to the utilization of this negotiation model, the attributes' levels could be ratio or integer data, therefore linking with existing geographic information system databases.

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