Mauro Berta, Marta Bottero, Valentina Ferretti

A mixed methods approach for the integration of urban design and economic evaluation: industrial heritage and urban regeneration in China

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A Mixed Methods Approach for the Integration of Urban Design and Economic Evaluation: Industrial Heritage and Urban Regeneration in China

1. Introduction and overview

The evaluation of urban transformations has been introduced only recently in the Chinese practice and until now, it has rarely enjoyed the favor of a large part of the establishment, the stakeholders and the planners/designers (Sun and Zhou, 2003). Despite its persistent condition of rapid economic growth, and – subsequently – of fast modification of its cities, the Chinese debate about urban transformations seems still lacking a comprehensive cultural approach on the integration between urban design and economic evaluation, supporting the decision-making process.

Contemporary China - since the reforms about the “Four Modernizations” (agriculture, industry, technology and defense) were introduced by Deng Xiaoping in the late 1970’s - is facing a deep and quick metamorphose of its economic structures, of its production systems and of its society, having in the background a momentous transition process, from a mainly rural society to an essentially urban one. In only thirty years, between 1980 and 2010, the percentage of urban population in China increased from 19% to 49% and, in 2011, the amount of people living in the Chinese cities definitely exceeded the number of rural inhabitants (The World Bank, 2015).

This overall process has been almost everywhere materialized in a radical transformation of the urban space itself, affecting in particular the industrial settlements. The evolution of the production systems, together with the growing importance of the service industry and the economic influence of the new socialist market economy, are provoking a diffused relocation of many industrial activities, which are moving always more frequently outwards from the inner parts of the cities, freeing inside the urban fabrics a number of wide areas meant to become the locations of the new real estate major investments.

This urbanization of post-reform China has been identified with three different stages (Yeh et al, 2011): an urbanization driven by rural industrialization (1978 to 1987), by land reform (1988 to 2000), and – finally - by the service industry (2001 to present). The relocation process of polluting industries in the suburbs, which started in the 1980's, at the very beginning was essentially a limited top-down initiative, conducted exclusively by the government and not supported by any real market dynamic. A major evolution in the transition from a passive "government-led" to an active "market-oriented" industrial relocation (Jian et al, 2008) appeared effectively only after the land reform of 1987, whose influence in the differentiation of the land value became the premise for a new trend of urban transformations, involving not only the truly polluting industries but also a wider range of productive activities (Fulong et al, 2006), while the market dynamics began to encourage a fast and diffused removal of the most part of the disused industrial estate, triggering in the latest years – for the first time in Asian culture – a more and more influent debate about the identity of the recent industrial past and about the problem of the suppression of its memory.

China, namely, is facing a wide transformation of its cities that could be compared – to a certain extent – to that "modification" (Secchi, 1984) which occurred in Europe starting from the 1980's, when the deindustrialization process became worldwide visible through the large abandoned industrial relics, survived within the fabrics of cities, which gave birth, in the European culture, to a long season of studies about the conservation, the refurbishment, the reuse and the requalification of industrial heritage.

But, at the same time, it is important to avoid the trivializing temptation of reading China's recent "urban transition" (Friedmann, 2005) as a kind of an accelerated and over boosted new edition of the western urban dynamics that transformed the European cities in the late 20^{th} century. The background is actually completely different, and somehow even opposite. Europe was experiencing, in the last part of the 20^{th} century, a dawning crisis of its productive structures, as the industries were rapidly losing their primacy against service economy's and SME's rising importance; whereas China is now trying to match the new development of the service industry within the market economy, and the improvement of the domestic consumption, with a rationalization of the heavy industry, in the general framework of a still fast-growing economy. What is much interesting for our purposes is that the present condition of China is not only a potential term of comparison between two different models of economies and societies, like the European and Chinese ones, but most of all a promising testing ground to experiment new methodologies for the design and the evaluation of complex urban regeneration processes, which involve networks of actors and stakeholders bearing a variety of values and requirements often mutually contrasting or simply incommensurable, like for instance: financial returns, social improvement, environmental sustainability etc. (Blackwood et al., 2014).The reason why we decided to use the Chinese reality – and specifically a brownfield regeneration process in a complex urban environment – as a field test for an experimentation about mixed methods applied to urban transformations is therefore related to the peculiar emerging conditions of that context, from the cultural, political and economic points of view. Many recent studies showed that Chinese cities – and most of all Beijing, which is rapidly reorganizing its traditional monocentric urban structure into a multipolar metropolitan framework – are witnessing the combination of a huge economic potential, which is speeding up the transformations, and a substantial lack of cultural and methodological instruments to manage a so fast modification (Bonino and De Pieri, 2015). In this framework a mixed methods research approach – allowing to take a large set of both qualitative and quantitative values into account, in the framework of a multi-level decision aiding process – seems to be a promising strategy to support strategic planning and design.

After the introduction, the rest of the paper is organized as follows: section 2 illustrates the Mixed Methods approach in the context of urban design processes; section 3 clarifies the methodological background of the present research, illustrating the theory of the Stakeholders Analysis, the Multicriteria Analysis and the Discounted Cash Flow Analysis; section 4 presents the development of the Mixed Methods approach for supporting the re-development of the area of Shougang/Er-Tong in Beijing, highlighting the application of the evaluation models and the obtained results and, finally, section 5 summarizes the main conclusions that can be drawn from the study.

2. The mixed methods approach

2.1 Methodological background

In social sciences, three research approaches are normally employed: a) qualitative, b) quantitative and c) mixed methods (Creswelll, 2003; Tashakkori and Teddlie, 1998).

Generally speaking, qualitative research is an approach for exploring and understanding the meaning that individuals or groups ascribe to social or human problems. Emerging questions and procedures are entailed in the research process, data are collected in the participant's settings and data analysis is inductively developed from particular to general themes.

The quantitative research approach aims to test objective theories by examining the relationship among variables. It is important to highlight that under this approach the theories are built deductively. In particular, variables can be measured and the data can be analyzed through mathematical and statistical procedures.

The combination of the aforementioned approaches refers to mixed methods research, that is an approach based on the collection of both qualitative and quantitative data, integrating the two forms of information and using distinct designs for the broad purposes of breadth and depth of understanding and corroboration (Johnson et al., 2007).

These three research approaches are based on different philosophical worldview assumptions. In particular, the main paradigms can be described as follows (Creswell, 2003).

- Post-positivist paradigm: these assumptions have represented the traditional form of research and they are based on quantitative research. This paradigm is also called the "scientific method" (Phillps and Burbules, 2000).

- Constructivist paradigm: this paradigm is typically seen as an approach to qualitative research. Constructivists believe that individuals seek understanding of the world in which they live and they develop subjective visions of their experiences. Under this paradigm, researchers have to look for the complexity of these visions rather that narrowing meanings into few categories of ideas (Crotty, 1998).
- Transformative paradigm: this approach arose in the 80's and 90's from individuals who felt that post-positivists assumptions imposed laws and theories that were not able to fully explain real-world problems; in fact, these theories did not fit marginalized people in the society, issues of power, social justice, discrimination and oppression. In studying these groups the research focuses on inequities, linking political and social actions to these inequities.
- Pragmatisms: it is an approach where researchers focus more on the research problem rather than on methods and they use pluralistic approaches able to understand a problem. In particular, pragmatism applies mixed method research. Under this approach researchers have freedom of choice and they do not see the world as an absolute unit but they take inspiration from many approaches for collecting and analyzing data (Cherryholmes, 1992). .

Table 1 summarizes the different research approaches available, highlighting the philosophical paradigm they refer to, the research design they apply and the research methods they use.

Table 1 Main research approaches (source: elaboration from Creswell, 2003; Tashakkori and Teddlie, 1998)

	Qualitative research	Quantitative research	Mixed methods research

Philosophical paradigm	Constructivist/transformative	Post-positivist	Pragmatics
Research design	Narrative research Phenomenology Grounded theory Case study	Experimental designs Surveys	Convergent Explanatory sequential Exploratory sequential Transformative, embedded, multiphase
Research methods	Emerging methods Open-ended questions interviews, observation data, audiovisual data text and image analysis interpretation	Pre-determined Methods Instruments based questions Performance data Statistical analysis Mathematical interpretation	Both pre-determined and emerging methods Both open-ended and closed-ended questions Multiple forms of data Statistical and text analyses Across databases interpretation

From the analysis of Table 1 it is possible to stress that mixed methods research is based on the pragmatism paradigm, it makes use of both pre-determined and emerging methods, it concerns both closed-ended and open-ended questioning and it focuses on non-numeric and numeric data analysis. Moreover, considering the research design, four possible schemes are available in mixed methods research, that can be described as follows (Creswell, 2003):

- convergent parallel mixed methods is a form of design in which the researcher converges or merges quantitative and qualitative data in order to provide a comprehensive analysis of the research problem;
- explanatory sequential mixed methods is one in which the researcher first conducts quantitative research, analyzes the results and then builds on the results to explain them in more detail with qualitative research;
- exploratory sequential mixed methods entails first a qualitative phase that can be useful for constructing evaluation instruments or for specifying variables that need to go into a follow-up quantitative study;
- more advanced mixed methods implies innovative design such as transformative, embedded and multi-phase mixed methods. In particular, transformative mixed methods is a design that uses the theoretical perspective of social justice and power as basis for the research. In embedded mixed methods design quantitative or qualitative data is embedded within a larger experiment. Multiphase design is common in the field of evaluation and program interventions and concurrent or sequential strategies are used in tandem over time in order to understand long term consequences.

From the point of view of the applications, it is possible to state the mixed methods research has been extensively used in health science and education research to develop new methodologies and to improve the quality and scientific power of data. In particular, in the aforementioned contexts, the diversity of mixed methods research approaches reflects the nature of problems faced by public health and education, such as disparity among population, age, cultures, behavioural factors, etc.

2.2 Mixed methods research applied to the evaluation of urban design

It is well known that urban design can be regarded as a multifaceted concept which includes socio-economic, ecological, technical, political and ethical perspectives. Moreover, urban design can be also understood as a process, referring to a method, procedure or series of actions or events that led to the accomplishment of some results (Boyko et al, 2005). Following these assumptions, decision problems in the domain of urban design represent "weak" or unstructured problems since they are characterized by multiple actors, many and often conflicting values and views, a wealth of possible outcomes and high uncertainty (Prigogine, 1997; Simon, 1960). Under these circumstances, the evaluation of alternative scenarios is therefore a complex decision problem where different aspects need to be considered simultaneously, taking into account both technical elements, which are based on empirical observations, and non technical elements, which are based on social visions, preferences and feelings.

In this research we tried to set up, and to experiment in the field, a mixed methods approach (Bazeley, 2009) to urban design and project evaluation, based on a multidisciplinary work.

The present study aims at investigating the role of mixed-method approaches for supporting decision-making processes in the context of urban design. In particular, the work that has been developed in the research takes into consideration the following elements (Creswell et al, 2011):

- focus on a research question that calls for multi-dimensional systems, multi-level perspectives and multi-actors evaluation;
- employment of both qualitative driven approaches for exploring the general problem and quantitative driven approaches for better investigating alternative options and performances;
- use of multiple methods in order to benefit of synergic effects.

Moreover, among the different possibilities for designing mixed methods research, the multi-phase one has been chosen (Creswell et al., 2011). This design seems to be particularly appropriate in the context of urban design, because it allows to follow the subsequent phases of project formulation and it gives the possibility of having a dataset built on the results from the previous one. As it will be presented in the rest of the paper, the sequential design permits to begin in clarifying the problem and in defining the goal and the objectives/values to be reached by a qualitative investigation, that is followed by a quantitative analysis for better defining the project and for validating the final proposed solution.

As observed by Myllyviita et al. (2014), although there is a wide scholarly discussion on mixing methods, successful real examples in environmental decision and policy making are still scarce. Moreover, so far the assumed benefits of using mixed methods have not been systematically tested. There is thus an evident need to pursue and to better communicate the benefits of mixing. Very few applications of mixed methods can be found in the domain of urban and territorial planning (e.g. Bottero 2015, Cerreta et al., 2014; Ferretti, 2016). Most studies concern the combination between SWOT analysis and multicriteria analysis for structuring the preliminary phases of the decision process (Ferretti et al., 2014a; Kajanus et al, 2012; Yavuz and Baycan, 2013; Zavadskas et al., 2011; Kurttilla et al., 2000) and the integration of MCA and economic-financial evaluation models for addressing the design projects (Azimi *et al.*, 2013; Jimenez and Pascal, 2008; Mikucioniene *et al*., 2014). Mention should be made to the fact that the approach proposed in the present paper has an innovative character because it considers the integration of different methods for supporting the overall process and their early application starting from the very beginning of the design process, from the definition of objectives and values to be reached with the intervention to the final definition of the morphological form of the project. To the knowledge of the authors of the paper, this study represents the first experimentation of the combination of a specific technique of Multicriteria Analysis (i.e. the Multi Attribute Value Theory) with stakeholders' analysis and Cash Flow Analysis.

3. The mixed methods components in a nutshell

3.1. Process scaffolding

A distinguishing feature of the methodology followed in the present study is the combined use of different tools for designing complex urban regeneration processes, in the framework of a multi-level decision aiding process able to support strategic planning and design, with specific reference to regeneration processes for abandoned industrial sites in urban areas.

In particular, phase I of the proposed process consists in the development of a stakeholder analysis (Dente, 2014) aiming at identifying the actors involved in the problem, as well as their values and objectives. Phase I informs phase II of the process as the system of identified objectives is used in the development of a Multicriteria Analysis (MCA) (Figueira et al, 2005) aiming at the selection of the best alternative project for the regeneration of the abandoned site under investigation (see section 4.1 for a context description of the analyzed case-study). Finally, phase III of the process develops a Discounted Cash Flow Analysis (DCFA, French and Gabrielli, 2004) in order to assess the economic feasibility of the project that has been selected through the MCA procedure.

Figure 1 shows the mixed-methods decision process that has been followed as well as the different approaches that have been integrated in order to develop a sound decision-making process and a comprehensive assessment of the consequences associate to each alternative under analysis.

The proposed mixed method approach has been tested on 5 different portions of the area under analysis, by testing the different combinations of approaches shown in Table 2.

As it is possible to see from Table 2, as far as Stakeholders' analysis is concerned, three different methodologies have been considered in the study. The Stakeholder Circle methodology developed by Bourne and Walke (2008) provides a means for the project team to identify and prioritise a project's key stakeholders and is based on the development of the Stakeholder Circle diagram which allows to analyse and map the characteristics of each stakeholder. The stakeholders mapping approach is based on the construction of the power/interest matrix which is represented by a grid where the power and the interest are the relevant elements, allowing the comprehension of crucial issues, such as the level of interest of each stakeholder group to impress its expectations on the project decisions and the powerful of each group of affecting the project decisions (Olander and Landin, 2005). Differently from the previous methods, Social Network Theory is an interdisciplinary endeavour and the information used in this method focuses on the relationships between pairs of stakeholders in a network (Dente, 2015).

With reference to Multicriteria Analysis, among the available approaches and methods, the present research has focused on the methods of Analytic Network Process (ANP) and Multi-Attribute Value Theory (MAVT). In particular, the ANP (Saaty, 2005) represents a theory of relative measurement on absolute scales of both tangible and intangible criteria based on both the judgement of experts and on existing measurements and statistics needed to make a decision. By including dependences and feedback, the ANP is able to capture what happens in the real world, thus providing effective support for the kind of decisions needed to cope with the future. There are different possible ways for structuring the decision problem in ANP: in the present study we considered the simple network, the complex Benefits-Opportunities-Costs-Risks (BOCR) network and the Benefits-Costs (BC) network. Also MAVT can be used to address problems that involve a finite and discrete set of alternative options that have to be evaluated on the basis of conflicting objectives. For any given objective, one or more different attributes, which typically have different measurement scales, have to be identified in order to measure the performance in relation to that objective (Keeney and Raiffa, 1976). By being able to handle quantitative as well as qualitative data, MAVT plays a vital role in the field of environmental decision-making where many aspects are often intangible.

Methods	**Masterplan A**	**Masterplan B**	**Masterplan C**	**Masterplan D**	**Masterplan E**
Stakeholder analysis					
Stakeholders circle		■		■	
Social Network Analysis			■		■
Power interest matrix	■				
Multicriteria Analysis					

Simple Analytic Network Process(ANP)	■				
ANP (Benefits and Costs networks)				■	
Complex ANP network			■		
Multi Attribute Value Theory (MAVT)		■			■
Cash Flow Analysis		■			■

Table 2. The mixed methods combinations experimented by the authors

The remainder of the paper will develop more in detail the combination that, according to the authors, has more potential for urban and regional planning applications (i.e. the combination used under the column “Masterplan E”). In particular, Social Network Analysis (SNA) (see section 3.2) has the advantage of representing very interdisciplinary endeavours, based on sociology and anthropology, thus attracting attention towards the use of behavioural social analysis. In contrast with other stakeholders’ analysis methodologies, SNA focuses on the relationships between pairs of stakeholders in a network. This approach seems particularly appropriate for studying urban and territorial decision processes, where the different actors are associated in very dynamics contexts (Yang, 2014). The second component of the mixed approach selected for this paper was the Multi Attribute Value Theory (MAVT) approach (see section 3.3). MAVT presents several advantages for dealing with complex decision making problems in the territorial planning domain. Firstly, MAVT helps in structuring the decision by classifying the problem in various objectives, criteria to measure the objectives and alternative options to solve the problem. Secondly, MAVT allows both qualitative and quantitative information to be taken into account in the evaluation. Thirdly, MAVT enhances the understanding of the policy problem by forcing the Decision Makers to build a value function that represents their preferences. Fourtly, MAVT offers the possibility of reasoning about the problem by clarifying the strengths and weaknesses of the different alternative policies. Furthermore, MAVT strongly supports the decision-making process because it permits to clearly visualize and communicate the intermediate and final results. Finally, MAVT has demonstrated to be able to support a transparent decision-making procedure and to efficiently handle decisions with large sets of alternatives and attributes (Schuwirth et al. 2012). For these reasons, MAVT has been applied to many real-world decisions, in both the private and public sectors (Munda 2005).

Further insights will be provided in the conclusion section about the advantages and drawbacks compared to the other combinations illustrated in Table 2.

3.2. Stakeholder Analysis

As shown in Figure 1 and in Table 1, the first method proposed in the process refers to stakeholder analysis.

In public policy making the actors and their behaviors represent the core of any possible theoretical model (Dente, 2014; Boerboom and Ferretti, 2014). The actors are those individuals or organizations that make the actions able to influence the decisional outcomes and that do it because they pursue goals regarding the problem and its possible solution, or regarding their relations with other actors (Dente, 2014). The first, essential, step of a decision process to support public policies formulation thus consists in the identification of the actors and of their objectives.

Stakeholders are a specific subset of the actors, defined as those who can affect the realization of organizational goals or that can be affected by the realization of organizational goals (Liu and Du, 2014). Following this reason, it should be noticed that a distinction exists between the terms "actor" and "stakeholder". In fact, actors are those who make important decisions, while stakeholders are the people interested in the process, who can behave after the decision has been taken in such way as to cause consequences for the actors.

Stakeholder analysis plays a very important role in strategic planning and sustainability assessment procedures since it allows to identify conflicting interests at an early stage of the process (Gill et al., 2013).

From a practical point of view, stakeholder analysis is based on the identification and classification of stakeholder groups. Indeed, stakeholders have access to and can mobilize different types of resources (i.e. political, economic, legal and cognitive resources), they can be grouped into different categories (i.e. political actors, bureaucratic actors, special interests, general interests and experts) and they can have different roles (i.e. promoters, directors, opposers, allies, mediators, gatekeepers and filters) (Dente, 2014).

In decision-making processes, stakeholder analysis is thus a continuous and iterative procedure which involves the following subsequent steps:

1. Identification of all the relevant stakeholders
2. Documentation of actors needs
3. Analysis and assessment of actors influence/interest
4. Management of actors expectations
5. Design of actions
6. Revision of the status and repetition of the procedure

The final aim of the analysis is to develop a strategic view of the human and institutional landscape, the relationships between the different actors and the issues they care about most.

Different techniques are available to analyze stakeholders and actors but, in the field of urban development projects, it is of particular importance to highlight the solution dynamics of collective problems. This is the main focus of the so-called Social Network Analysis (Marin and Mayntz, 1991; Rhodes, 1997) that became popular at the end of the past century and that generated sophisticated methodologies for the study of a decisional network. One of the most popular ways to represent the morphology or form of a network of actors is to represent actors as dots and their connections as arrows, as shown in Figure 2 (Dente, 2014). This will allow to understand the dynamics and calculate complexity, density and centrality of the network, which are important elements sometimes able to explain the results.

Generating knowledge about the actors involved in the process and their associated objectives will allow to better structure the decision making process aiming at identifying the best performing solution for the area under analysis.

3.3. Multicriteria Analysis

The second method proposed in Figure 1 consists thus in the application of a specific Multicriteria Analysis technique. . Multicriteria Analysis (MCA, Roy and Bouyssou 1993; Figueira et al. 2005) is a valuable and increasingly widely-used tool to aid decision-making where there is a choice to be made between competing options. It is particularly useful as a tool for sustainability assessment and urban and territorial planning, where a complex and inter-connected range of environmental, social and economic issues must be taken into consideration and where objectives are often competing, making trade-offs unavoidable (Huang et al. 2011). In fact, MCA has been regarded as a suitable set of methods to perform sustainability evaluation as a result of its flexibility and the possibility of facilitating the dialogue between stakeholders, analysts and scientists (Cinelli et al. 2014; Antunes et al 2012; Rowley et al., 2012).

MCA consists of a group of approaches which allow to account explicitly for multiple criteria, in order to support individuals or groups to rank, select and/or compare different alternatives (e.g. products, technologies, policies). Different theories exist within the context of MCA methods, that can be described as follows:

a) Utility function theory: the utility-based theory includes methods synthesizing the information in a unique parameter (also called performance aggregation based approaches) and it was introduced during the 1970s by Keeney and Raiffa (1976);

b) Outranking relation: the outranking relation theory involves methods based on comparisons between pairs of options to verify whether "alternative a is at least as good as alternative b" (also called preference aggregation based approaches) (Roy and Bouyssou 1993);

c) Sets of decision rules: the decision rule theory originates from the artificial intelligence domain and it allows deriving a preference model through the use of classification or comparison of decision examples (Greco et al. 2001).

Many applications of MCA exist in the field of sustainability assessment and a broad overview can be found in Munda (2005), Huang. et al. (2011), Cinelli et al. (2014).

As shown in Table 3, different techniques have been tested in the present research but the following section will present more in details the Multi Attribute Value Theory (Keeney and Raiffa, 1976) which seems a particularly promising line of research in the field of strategic planning and environmental decision-making (Ferretti et al., 2014b; Ferretti and Comino, 2014).

From the methodological point of view, the process to be followed to build a MAVT model can be described as follows:

1. Defining and structuring the fundamental objectives and related attributes.
2. Identifying and creating alternative options.
3. Assessing the scores for each alternative in terms of each attribute.
4. Modelling preferences and value trade-offs.
5. Ranking of the alternatives.

It is important to underline that different strategies are available for the development of a MAVT model. The holistic scaling and the decomposed scaling strategies are the most used in practice and the reader is referred to Beinat (1997) for a detailed discussion of the two approaches.

The final result of the MAVT procedure is thus a ranking of alternative options.

3.4. Discounted Cash Flow Analysis

At this point of the process, further analysis are worthy in order to verify the financial feasibility of the best performing option (Manganelli, 2015). To this end, Discounted Cash Flow Analysis has been proposed and applied for all the 5 areas considered in our study. The method is based on the identification of the full range of costs and incomes of the project in order to allow the investor to understand if minimum objectives will be achievable.

In particular, this technique is used to derive economic and financial performance criteria for investment projects (French and Gabrielli, 2004) in the form of synthetic and easy to interpret indicators that allow the Decision Maker to understand if the project should be accepted or rejected. The most used project performance criteria are the Net Present Value (NPV, as shown in equation 1) and the Internal Rate of Return (IRR, as shown in equation 2).

$$NPV = \sum_{t \to 0}^{T} \frac{B_t - C_t}{(1+r)^t} \tag{1}$$

$$\sum_{t \to 0}^{T} \frac{B_t - C_t}{(1+r)^t} = 0 \Rightarrow r = IRR \tag{2}$$

In equation 1 and 2, B_t are the benefits, C_t are the costs, T is the life time of the project and r is the discount rate. Moreover, with reference to equation 1, it is important to highlight that, if the NPV = 0 (i.e. the discounted benefits are equal to the discounted costs), we should be indifferent in the decision whether to accept or reject the project; if instead the NPV > 0 (i.e. the discounted benefits are larger than the discounted costs), we should accept the project; finally, if the NPV < 0 (i.e. the discounted benefits are smaller than the discounted costs), we should reject the project. With reference to equation 2, it is important to highlight that the project is admissible if IRR > r (i.e. the rate of return exceeds the opportunity cost).

The final step in the proposed process consists in a sensitivity analysis of the results obtained both from the Multicriteria Analysis procedure and from the Discounted Cash Flow Analysis. Developing a sensitivity analysis allows to test the stability of the obtained results and the robustness of the model in order to provide to the Decision Makers robust recommendations and guidelines.

4. Case study

4.1. Context description

The area chosen for the experimentation is the former mechanical factory of Shougang/Er-Tong, located in the western outskirts of Beijing, in the Shijingshan district, at about 15 km from the city centre and at about 2 km from the huge former steel factory of Shougang, part of the same industrial group. The factory site is situated outward to the 4th ring road and about 2 km southward to Chang'an Avenue, the main east-west infrastructure of the city.

The Overall Urban Plan of the city (2004-2020) determines that the neighborhood of Shijingshan, which will be linked to the city centre with the underground in the next years, is meant to become in a near future a "Central Recreation District" (CRD), with facilities for service industry and leisure. In this framework Er-Tong site (whose factories occupy an area of about 84 ha) has been identified as the core of a pilot operation of urban regeneration.

Er-Tong plant was originally the second mechanical factory of Beijing, founded in 1958; after only 20 years it was renamed as Beijing Heavy-Duty Mechanical Factory and, after a bankruptcy, it was taken over in 1992 by Shougang group, which maintained this plant working until the first decade of the 21st century.

The whole site is characterized by a sizeable number of productive relics (buildings, chimneys, machines and conveyor belts etc.), whose dimensions are in some cases monumental, and by an abundant presence of infrastructures, representing a physical trace of the original functioning of the factory. These features make it suitable, therefore, for a design experimentation whose ambition is to reflect on the valorization of the historic memory and its rapport with the conservation of the physical objects, as well as on the processes of selection and reinterpretation of the industrial heritage.

In the last years an overall project for the entire area has been proposed, with core functions related to the construction of a "China Animation and Gaming City", a huge district dedicated to ICT gaming business. This project is already defined in physical terms, with a matrix of scattered towers surrounding the central area, where the main industrial relics are included. Recently two other hypothesis of masterplan have been defined; the first one is focused on the creation of a business park (not so dissimilar from the original concept, in terms of functions, but completely different in morphological terms); the second one is meant to develop a more mixed urban fabric, with Service Industry facilities, commercial parts and residential zones. The following paragraphs will explain the design, evaluation and selection of the best requalification option for the area under analysis.

4.2. Results of the Stakeholder Analysis

In order to support the design process in the formulation of the strategies for the transformation of the Er-Tong area, the stakeholders' analysis has been applied. In particular, the aims of the stakeholders' analysis were:

1. to identity and group the stakeholders with an interest and/or an influence on the system;
2. to understand the stakeholders' capacity development for the management of the transformation;
3. to establish a set of values representing the stakeholders objectives and points of views with respect to the project under investigation.

According to the methodological framework described in section 3, groups of organized stakeholders have been identified that can have an interest in the transformation of the Shougang area under examination. Table 3 surveys the most relevant stakeholders of the problem, with specific reference to the level, the type of actions and the nature of the resources at stake.

No.	Stakeholder	Level	Type of actor	Reources
1	National government	National	Political	Political
2	National Health and Family Planning (NHFP)	National	General interest	Legal
3	Bejing city	Local	Political/bureaucratic	Political/legal
4	Fengtai district	Local	Bureaucratic	Legal
5	Shougang company	National	Special interest	Economic
6	Environmental associations	Local	General interest	Cognitive
7	Bureau of Commerce	Local	General interest	Cognitive/economic
8	Bureau of Culture	Local	General interest	Cognitive/economic
9	Developers	International/national/local	Special interest	Economic
10	Citizens	Local	Special interest	Cognitive/economic
11	Economic activities	Local	Special interest	Economic
12	Tourists/visitors	Local	Special interest	Cognitive/economic
13	Architects and planners	International/national/local	Experts	Cognitive

Table 3. Most relevant stakeholders for the transformation of Er-Tong

Another crucial aspect in the analysis of the stakeholders of the process is to move from the exam of the single actor to the groups of actors involved in the problem, with particular attention to the interactions existing among them. This allows to understand if any feature exists which can contribute to highlight solution dynamics of the decision process (Dente, 2014). In order to develop such analysis, the methodology of the social network analysis has been applied in the present study.

According to this methodology, it is necessary to examine the size and the form of the decision network under investigation and to calculate specific indexes that allow the comprehension of the dynamics that regulate the network. Figure 3 represents the decision network for the present application. As it is possible to see, the nodes represent the stakeholders previously identified (Table 2) while the arrows represent the connections among them, based on the resources they exchange.

In order to measure the complexity of the decision network it is possible to create a matrix that places the actors in different cells, according to the typology of the actors and the dimension of the interest (Table 4).

Dimension/type of actors	Political	Bureaucratic	Experts	Special interest	General intereset
International			13	9	
National	1		13	5, 9	2
Local	3	3, 4	13	9, 10, 11, 12	6, 7, 8

Table 4. Matrix for the measurement of the network complexity

Following this measure, if all the actors are of the same type and at the same level, the level of complexity is minimum, while the complexity increases as they have different and opposite goals; the complexity is at the maximum level when all the lines (at least one actor for each territorial level) and all the columns (one actor of each type) are filled in. A complexity index can be defined by multiplying the number of lines filled in by the number of columns. For the present application the result of the calculation is 3 lines filled in x 5 columns filled in = 15, leading thus to the maximum level of complexity.

A further characteristic of the network is the density, meaning the intensity of the relations between the actors of a decision-making process. The density can be measured trough the calculation of a specific index as represented in equation (2):

$$D = \frac{\sum K_i}{(n^2 - n)} \quad (3)$$

where D is the density index varying between 0 and 1, n is the number of actors and k_i is the number of relations in each group. In the present study, the application of formula (1) provides a quite low density index, i.e. 0.19. It is possible to state that in this case the high complexity of the network is weakened by the low density of the system, contracting both the benefits and the obstacles of the process.

Finally, it is possible to take into consideration the centrality of the different actors, namely the fact that one or a few actor monopolize relations with participants. The centrality index of the network can be measures as in equation (4)

$$C = \frac{k_i}{\sum K_i} \quad (4)$$

where C is the centrality index that varies between 0 and 1 and k_i is the number of relations of each actor. According to the numerical results provided by the application of formula (2) to the decision network under examination, it is possible to state that the most central actors of the process are the Bejing city (centrality index equals to 0.42) and the developers (centrality index equals to 0.39) meaning that they are the process directors; on the contrary, other actors such as the Bureau of Commerce and the Bureau of Culture show a low capacity of directing the process (centrality index equals to 0.03).

In conclusion, the analysis of the stakeholders of the decision-making process highlighted that the decision network under investigation is characterized by an high level of complexity, with several stratekeholders groups acting at different levels and with conflicting objectives. In this sense, the use of a formal Decision Support System for assisting the decision-making processes seems to be very helpful.

4.3. Masterplan selection based on MAVT

As introduced in section 3, the first step of the Multicriteria model consisted in structuring the decision problem as alternatives to be evaluated and objectives to be achieved. Figures 4-5-6 illustrate the alternatives that have been evaluated for the requalification of Er-Tong while Figure 7 presents the set of measurable attributes that has then been identified for the evaluation of the options and that has been organized according to the value tree approach (Keeney, 1992).

Taking into account the full range of aspects relevant to the decision problem enhances the quality of the final decision, allowing the totality of the effects of the transformation project to be considered and the negative externalities and the intergenerational effects to be minimized.

It is necessary to highlight that the criteria considered in the present application arise from the Stakeholders Analysis that has been previously described. In particular, following Munda (2004) and Gamboa and Munda (2007), the evaluation criteria are the *technical translation* operated by the research team of the actors' objectives and needs, resulting from the institutional analysis. In this sense, the evaluation criteria of Figure 7 are the representation of the interests and concerns of the stakeholders' groups identified in Table 3.

The model considers the full range of possible impacts related to the project under investigation that are organized in a hierarchical structure considering evaluation criteria that have been further decomposed into specific attributes. More precisely, the evaluation considers the following criteria: 1) environmental aspects, that concern the effects of the transformation in terms of pollution, natural resources consumption and green areas; 2) social aspects, that refer to the multi-faceted consequences of the intervention on the population, considering services for the inhabitants, public safety and social inclusion; 3) economic aspects, that represent the possible interconnection points of the operation with the economic system, such as job creation or synergies with local activities; considering also the feasibility of the investment in terms of development cost and profitability; 4) urban planning aspects, that take into account both cultural heritage and urban landscape valorisation and accessibility and mobility elements. The aforementioned criteria have been used for the evaluation of the alternative scenarios for the transformation of the site.

In particular, in the first scenario (fig. 4) the existing masterplan of the Gaming City has been assumed as the basic alternative. This project is mostly based on research and development activities, located in high-rise tower and mid-rise linear buildings, often grounded on horizontal slabs. The result is a homogeneous and mostly monofunctional urban fabric.

In the second proposal (fig. 5) the same functions have been maintained, but the road pattern has been radically changed, with the introduction of criss-cross local streets and pedestrian paths; the height of the building has been changed as well, although keeping an equivalent Gross Floor Area (G.F.A.), thanks to local variations in the density, which allow to create a more variable urban environment.

The third proposal (fig. 6), starting from the second scenario, increases the complexity, introducing new functions (different residential typologies, neighbourhood commercial activities, cultural spaces etc.).

In order to be able to combine the attributes identified in Figure 7 and obtain an overall ranking of alternatives, the next step of the MAVT approach requires to build a value function for each attribute in order to translate the original performances of the alternatives on each attribute into dimensionless values usually ranging between 0 (worst performance and low objective achievement) and 1 (best performance and high objective achievement). In order to provide an example, Figure 8 shows the value function that has been built for the attribute “green areas” by interviewing specific experts in the field of urban planning.

As it is possible to see from Figure 8, green areas’ extensions smaller than 20% of the whole area covered by the project are not fulfilling the objective of regenerating the site (0 value on the y axis) while green areas' extensions bigger than 50% of the whole area covered by the project are totally fulfilling the objective (value 1 on the y axis). For the intermediate percentages of green areas, the linear function signifies that the bigger the extension, the better it is.

Following the MAVT methodology, each attribute has been described by a value function which scaled the attributes between 0 and 1 in order to compare non-commensurable items.

Once the alternatives have been evaluated, it is necessary to define the importance of the different attributes of the decision problem. In this case the Swing method has been used which explicitly incorporates the attribute ranges in the elicitation question.

In particular, the method asks to value each improvement from the lowest to the highest level of each attribute (Montibeller and Franco, 2007) by using a reference state in which all attributes are at their worst level and asking the interviewee to assign points (e.g. in the range 0-100) to states in which one attribute at a time moves to the best state. The weights are then proportional to these values.

In this study the evaluation has been performed by a multi-disciplinary panel of experts with expertise in the field of environmental engineering, sociology, urban planning and economic evaluation. In particular, the disciplinary experts were chosen in the light of their specific knowledge in the domain of Chinese architecture and urban planning. For the evaluation of the attributes, each expert had to answer a detailed questionnaire related to the specific field of expertise while for the evaluation of the criteria, the questionnaire was solved by all the experts together.

As an example, Appendix A shows the questionnaire that the expert in sociology had to answer with reference to the "social aspects" attributes.

The overall set of weights resulting from the elicitation procedure is shown in Table 4. The single attribute value functions have then been aggregated using the obtained set of weights and additive assumptions to calculate the total value of the specific alternatives. In particular, the global weight has been calculated for each attribute through the following equation: global weight = normalized weight of attribute i * the normalized weight of criterion j. The calculation developed in the case under investigation provides the final priorities represented in Table 5.

	Attributes	Standardized scores of the alternatives: Project 1	Project 2	Project 3	Weights of the attributes	Weights of criteria	Global weights of attributes	Priorities of the alternatives: Project 1	Project 2	Project 3
Environmental aspects	Green areas	0	1	1	0,24	0,2	0,048	0,000	0,048	0,048
	Availability of water	0	0,4	0,6	0,13	0,2	0,026	0,000	0,010	0,016
	Rehabilitation of polluted areas	0,8	0,6	0,8	0,25	0,2	0,050	0,040	0,030	0,040
	Urban waste disposal	1	1	1	0,15	0,2	0,030	0,030	0,030	0,030
	Energy consumption	0,5	0,8	1	0,21	0,2	0,042	0,021	0,034	0,042
Social aspects	Creation of new houses	0,8	1	1	0,2	0,29	0,058	0,046	0,058	0,058
	Integration	0,5	0,6	0,8	0,16	0,29	0,046	0,023	0,028	0,037
	Gentrification	1	0,6	0,75	0,18	0,29	0,052	0,052	0,031	0,039
	Public safety	0,8	0,3	0,2	0,21	0,29	0,061	0,049	0,018	0,012
	Creation of attractive functions	0,6	0,8	1	0,24	0,29	0,070	0,042	0,056	0,070
Economic aspects	Real estate improvement	0,5	1	1	0,21	0,25	0,053	0,026	0,053	0,053
	Employment opportunities	0,4	0,6	0,8	0,19	0,25	0,048	0,019	0,029	0,038
	Investment costs and resources	1	0,6	0,8	0,2	0,25	0,050	0,050	0,030	0,040
	Profitability	0,5	0,6	0,8	0,24	0,25	0,060	0,030	0,036	0,048
	Effects on local economic activities	0	0,8	0,6	0,22	0,25	0,055	0,000	0,044	0,033
Urban planning aspects	Conservation of hystoric memory	0,6	0,8	0,8	0,2	0,26	0,052	0,031	0,042	0,042
	Creation of new landscape and hubs	0	0,5	1	0,22	0,26	0,057	0,000	0,029	0,057
	Management of crowded spaces	0,3	0,6	0,8	0,16	0,26	0,042	0,012	0,025	0,033
	Accessibility and mobility	0,3	0,6	0,8	0,2	0,26	0,052	0,016	0,031	0,042
	Respect of ancient urban fabrics	0,2	0,6	0,9	0,19	0,26	0,049	0,010	0,030	0,044
	Final priorities							**0,498**	**0,690**	**0,821**

Table 5 Overall evaluation of the alternatives

From the obtained priority list it is possible to notice that the preferred alternative isProject 3 (Figure 6), followed by Project 2 (Figure 5) and then by the Gaming City project (Figure 4). These results have been further investigated by developing a sensitivity analysis on the weights of the general criteria. Table 6 shows the set of weights used to simulate different perspectives in the sensitivity analysis while Figure 9 shows the results of the process, which confirm the stability of the ranking and the robustness of the model.

	Initial priorities	Environmental perspective	Social perspective	Economic perspective	Urban planning perspective
Environmental aspects	0.2	0.7	0.1	0.1	0.1
Social aspects	0.29	0.1	0.7	0.1	0.1
Economic aspects	0.25	0.1	0.1	0.7	0.1
Urban planning aspects	0.26	0.1	0.1	0.1	0.7

Table 6 Set of weights used in the sensitivity analysis

4.4. Application of DCFA

According to the methodology described in section 3.4, a Cash-Flow Analysis has been developed for the best alternative, i.e. Project 3.

Table 7 summarises the main input for the analysis with reference to the foreseen costs and incomes. As it is possible to see from Table 7, the costs are represented by the investment cost of the transformation while the incomes are related to the incomes produced by the project. Mention has to be made to the fact that the cost of land was estimated considering the prices of the city of Beijing. An analysis of the local property market produced an average price of the land of 690 €/m^2. A similar analysis was conducted for the estimation of the incomes. In this case, the average price has been estimated as 2,390 €/m^2 for residential, 1,890 €/m^2 for offices and retail in new buildings and 1,500 €/m^2 for retail located in former industrial buildings. As far as the building costs are considered, it is important to highlight that the unitary construction costs were appraised following the comparative-unit method, that is a method used to derive a cost estimate in terms of euro per unit of area or volume based on known costs of similar structures. In this case, the construction cost was estimated as 475 €/m^2 for new residential buildings, 547 €/m^2 for new offices and retail buildings and 370 €/m^2 for refurbished buildings, as in this case old former buildings have to be adapted to the new function (retail). The on costs (which represent the general cost of the investiment process, including the expenses related to offices, particular consulting services, company formation etc) and the technical costs (which refer to the costs for designing and managing the project, as well as supervisioning the construction works) were 2% and 8%, respectively, on the total construction cost, while the marketing costs were 2% on incomes. Moreover, it has to be noticed that the analysis estimates the feasibility of the masterplan for a potential developer assuming that the project is financed by a bank borrowing. Under this assumption, the bank agrees to lend money to the developer at a “passive” (debit) rate while the bank will apply an “active” (credit) rate if the account is in credit (French and Gabrielli, 2005). The rates used in the present study are 5% for passive rate and 2.5% for active rate. Finally, it is necessary to assume the discount rate for calculating the Net Present Value produced by the project. In this case the discount rate used is 6%, that corresponds to the official discount rate used from the International Bank of China.

Value/cost	
Costs	
Land	690 €/m^2
Cleaning up	85 €/m^2
New residential building	475 €/m^2
New offices and retail buildings	537 €/m^2
Refurbishment of industrial buildings for retail	370 €/m^2
Green areas	25 €/m^2
Streets	34 €/m^2
Incomes	
New residential buildings	2390 €/m^2
New offices and retail buildings	1890 €/m^2
Refurbishment retail	1500 €/m^2
Other costs	
On costs	2% on total construction cost
Technical costs	8% on total construction cost
Marketing cost	2% on incomes
Interest	5% (passive rate) and 2% (active rate)
Discount rate	6%

Table 7 Critical variables for the estimation

A fundamental step of the analysis is represented by the timing of the project. In the case under investigation the project will be developed over 5 years and 8 months, that have been subdivided in

17 4-montly periods. It has been decided that the work will start from the northern part of the area, which is closer to the city centre; secondly, the transformation will concern the southern part, with the construction of the core of the project; finally, the third period will end the proposal, with the construction of other services, green areas and parking. Figure 10 details the time line chart for the project.

The final step of the evaluation consists in the creation of the table for the cash-flow feasibility study. As an example, Appendix B reports the cash-flow analysis that has been developed for one sub-area of the mapsterplan, which is located in the Southern-Eastern portion of the area. The application is very similar for the other sub-areas of the masterplan. From the calculation done, it is possible to evaluate the overall economic performance of the masterplan: the final NPV of the transformation is 667 millions of Euros and the IRR is 18%; according to these indicators the project can be considered as feasible.

5. Conclusions and future developments

This paper offered a creative way of combining, in the design activity, decision making support and participatory procedures through an approach that integrates stakeholders' Analysis, Multicriteria Decision Aiding and Discounted Cash Flow Analysis for the definition and evaluation of urban regeneration strategies in a complex territorial system.

In particular, with reference to the different combinations of methods experimented in the work (Table 1), it has been noticed that combining MAVT with actors' analysis seems to provide enhanced support in the structuring phase of the whole process, since it allows to link the actors to their system of objectives and therefore to identify the criteria needed for the analysis based on a formal study of the values at stake.

From the point of view of the future work, it would be remarkable to expand the results of the application including in the evaluation model also non monetary and qualitative elements, such as the social consequences and the environmental externalities, which play a fundamental role in urban processes. This could be done by developing a Cost Benefit Analysis of the project (European Commission, 2008).

Secondly it would be of scientific interest to test the stability of the financial model by means of a specific sensitivity analysis. This could be done by changing the estimation of the costs and benefits and by examining the effects of these variations on the final NPV and IRR indicators.

Thirdly, further research could explore more complex research designs for the application of the mixed methods approach (Creswell et al. 2011). In the context under investigation, the embedded design seems to be particularly promising, as it allows to consider both qualitative and quantitative methods, that are used in tandem in order to provide new insights or more refined thinking.

The proposed methodology, in conclusion, shows a promising effectiveness in supporting complex urban transformations, where a sizeable amount of claims and constraints – coming from a wide and diversified community of actors and stakeholders - is influencing the design process. The early introduction of their values and objectives, starting from the very beginning of the design activity, and the continuous feed-back between morphological choices and actors' evaluations are key points of this approach, whose aim is not to define the 'best' solution (supposing that it could exist), but instead to identify the most shared one.

The Chinese reality, finally, is an interesting testing ground and mostly a promising field of application of this methodology.

First of all because, as it has been discussed, a new consciousness about the transformations of the existing city is emerging in that context, involving a huge part of the industrial estate. The broad transformation of a large part of the former industrial settlements grown within the Chinese urban fabrics, entails a wider problem concerning the relationship with the physical dimension of history and memory, whose interpretations in eastern and western cultures are radically divergent. As synthesized indeed by the Belgian sinologue Simon Leys (1991) the European and Chinese conceptions of the past are substantially opposite and based on either a more concrete dimension, related to the physical evidence and to the authenticity of the "monument" - in the European culture – or, on the other hand in the Chinese tradition, on an more blurred and intangible relationship with the vestiges, within the framework of which a wide range of attitudes – from the complete removal to the stylistic reconstruction – could be acceptable. Four main phases (Zhang 2003) have been recognized in the development of the idea of heritage and patrimony in the Chinese culture: the "awakening of consciousness" at the beginning of the XX^{th} century, the "rise of the notion of the historical monument" around 1930's, the birth of the concept of the "city museum" in opposition to the socialist city in the 1950s, and finally the emergence of the idea of urban heritage during the modernization process of the 1980s. But the recognition of the industrial patrimony as "heritage" is even more recent and its material effects on the transformations are not yet completely defined. Thus we do believe that the application of a multi-level decision aiding process jointly with the traditional instruments of urban design - like it has been described in the previous pages - could be an interesting innovation in the urban regeneration policies that face the arduous task of defining what are the supposed values of the existing urban environment and how they can be preserved and improved.

Finally this methodology seems to fit very well with the peculiar condition of public and private interaction in the Chinese real estate market, and with the short times of the urban transformations, which show always more clearly the need for new flexible and comprehensive instruments, supporting the decision-making process during the design phases.

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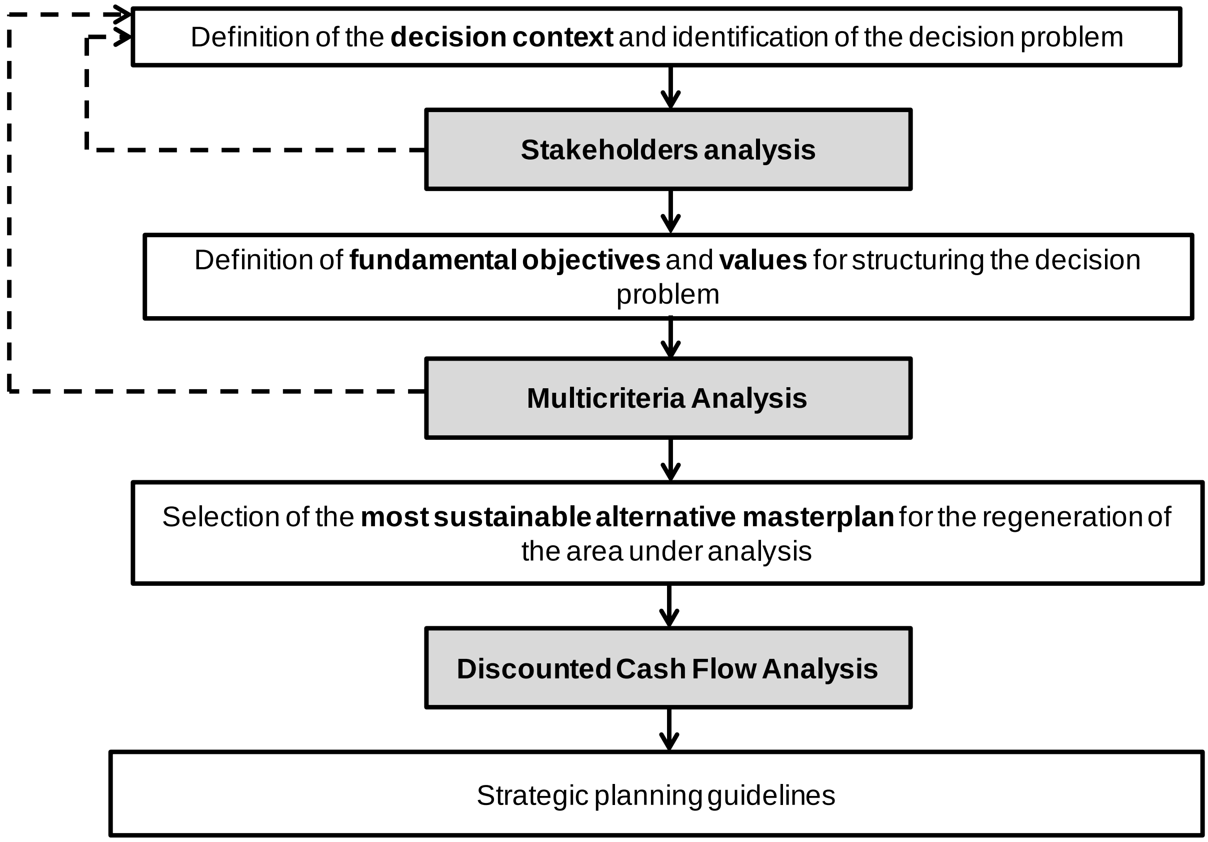


Figure 1. The mixed-methods decision process followed in the study

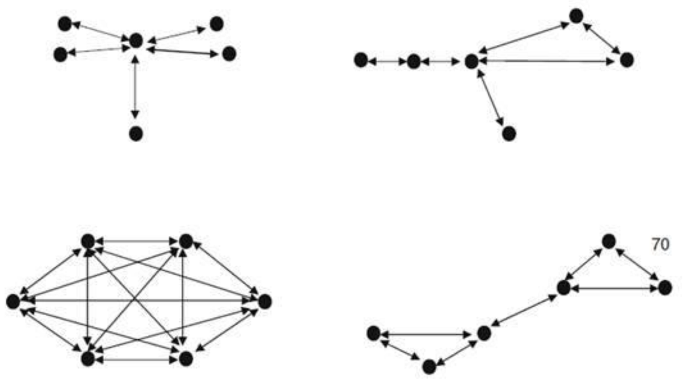


Figure 2. Possible forms of the network (source: Dente, 2014)

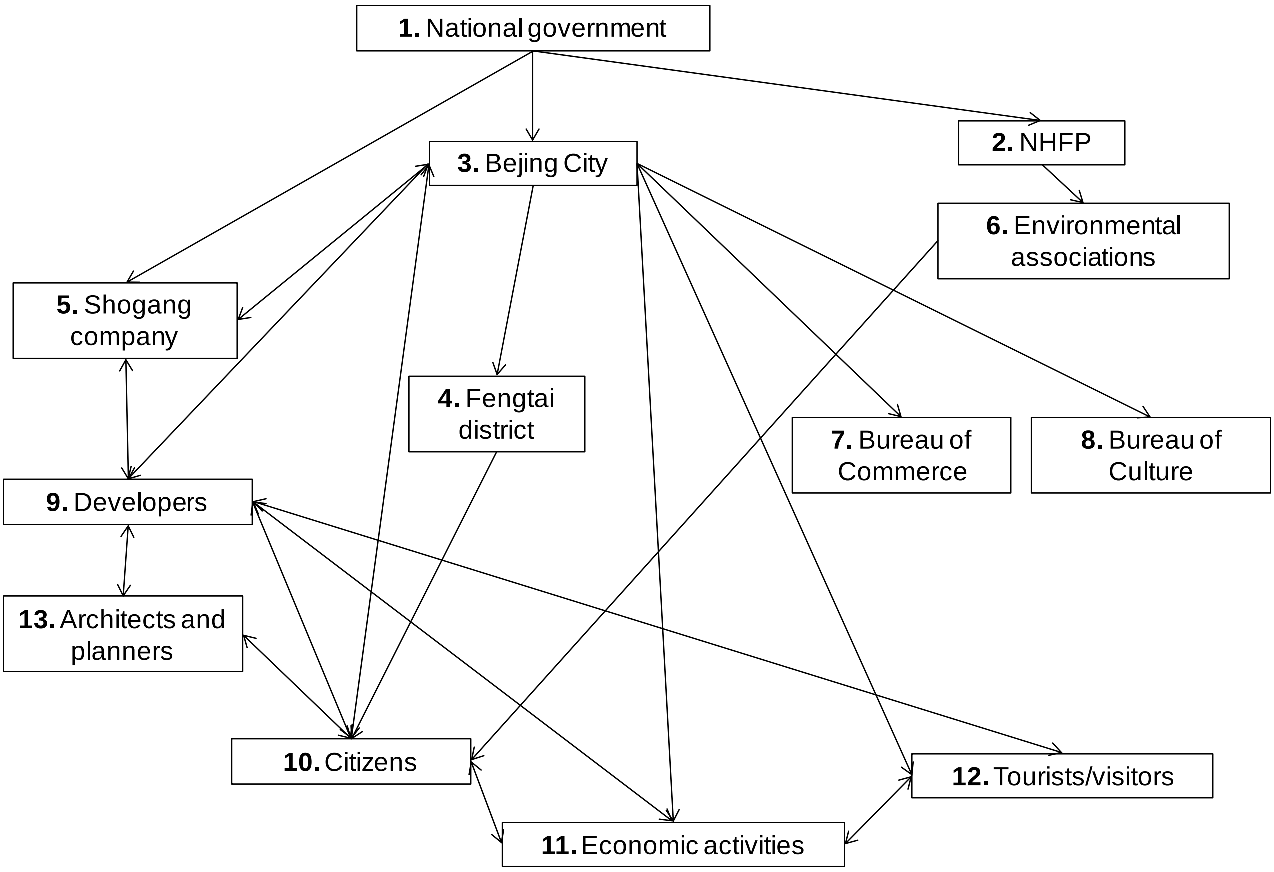


Figure 3 The decision network for the problem under investigation

Figure 4 Design scenario 1

Figure 5 Design scenario 2

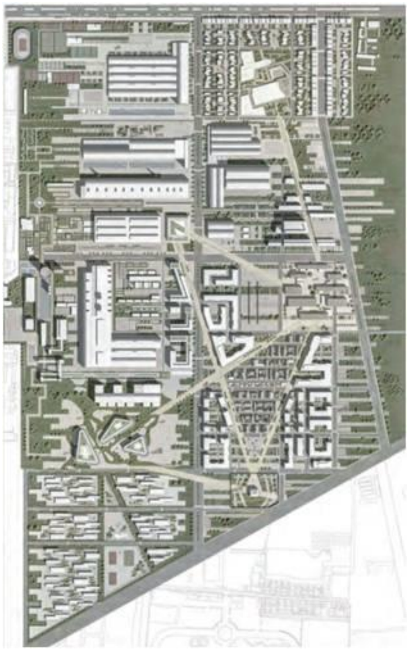


Figure 6 Design scenario 3

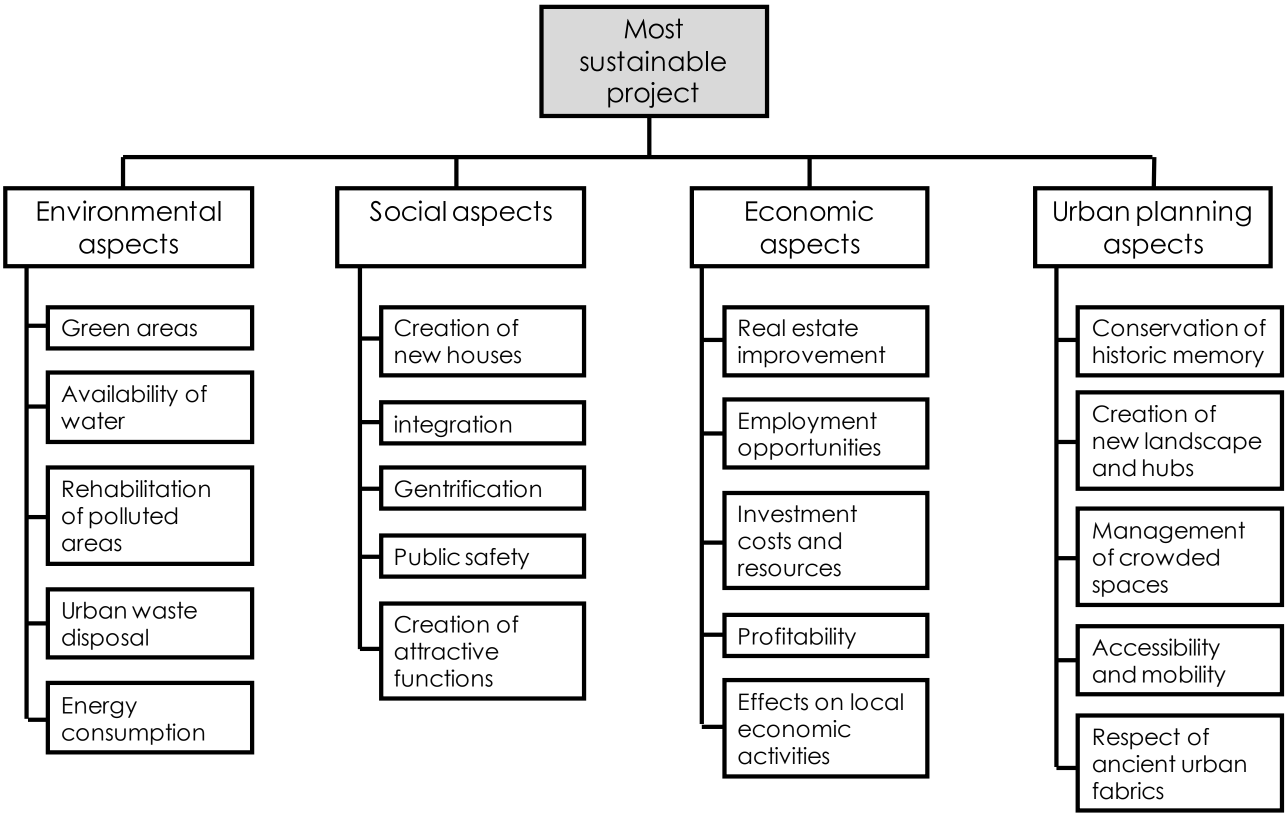


Figure 7 The value tree for the decision problem under analysis

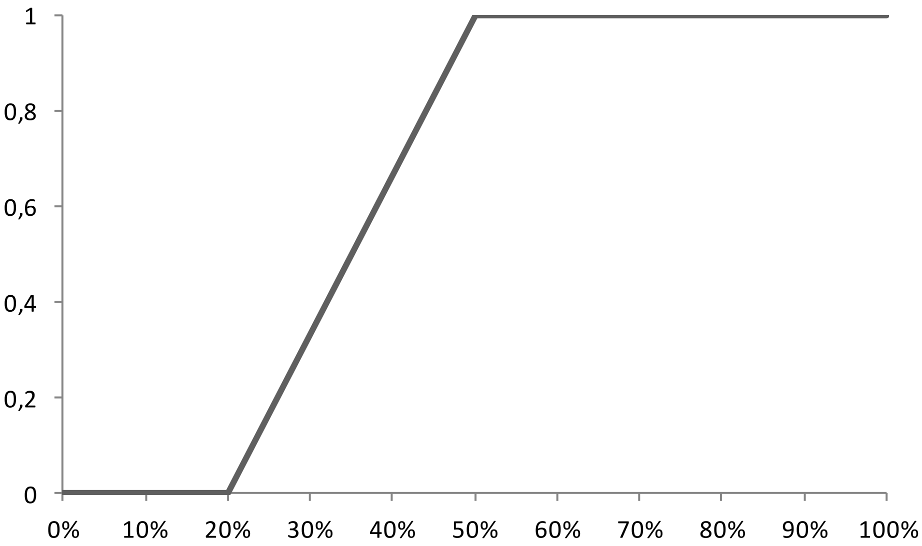


Figure 8 Value function for the attribute “green areas”

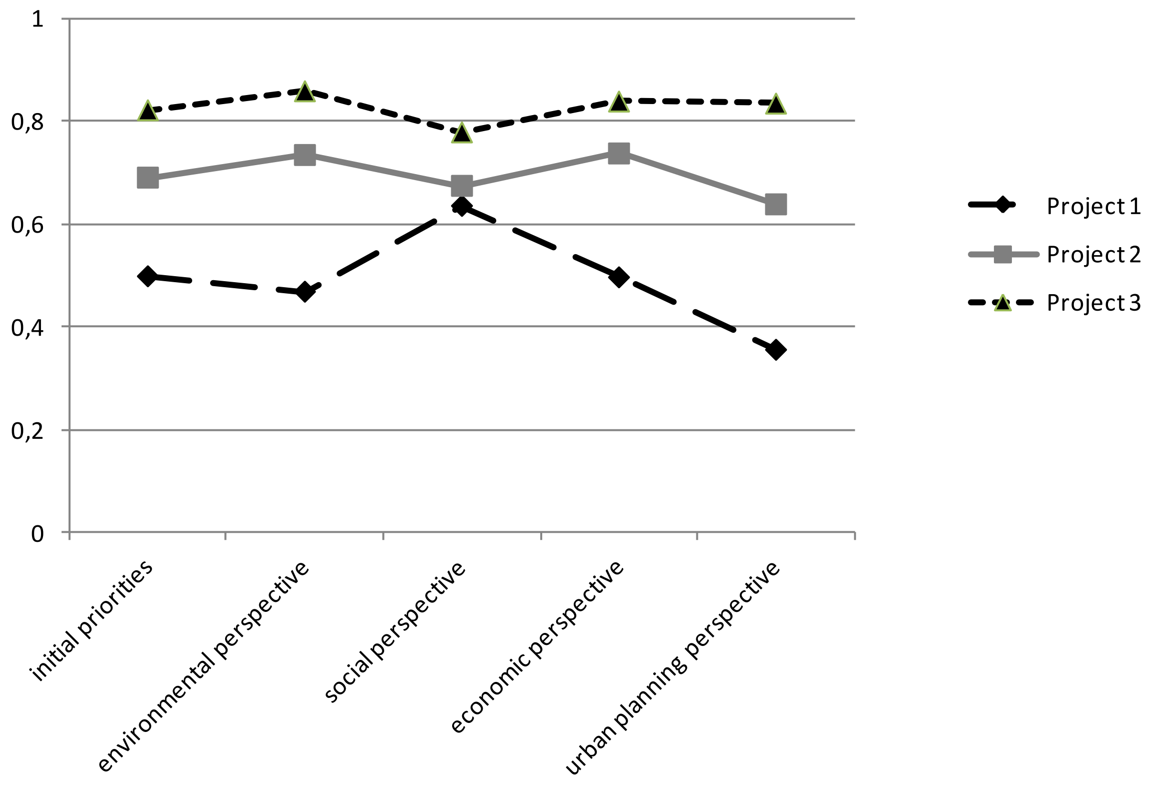


Figure 9 Sensitivity analysis results

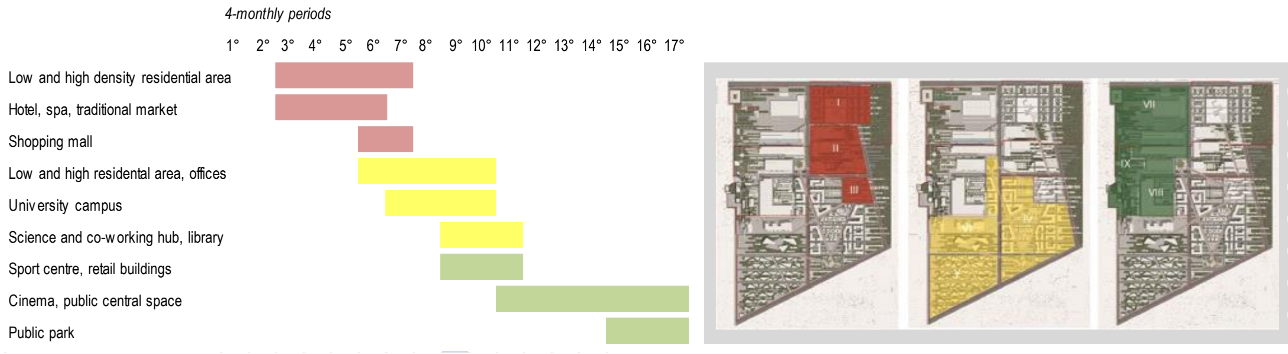
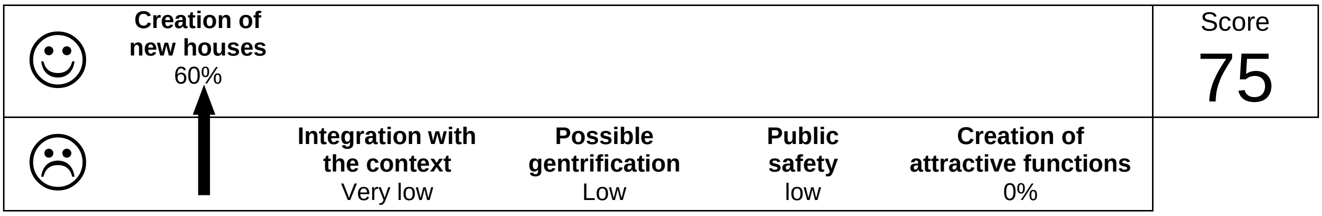


Figure 10 Time schedule for the project under investigation

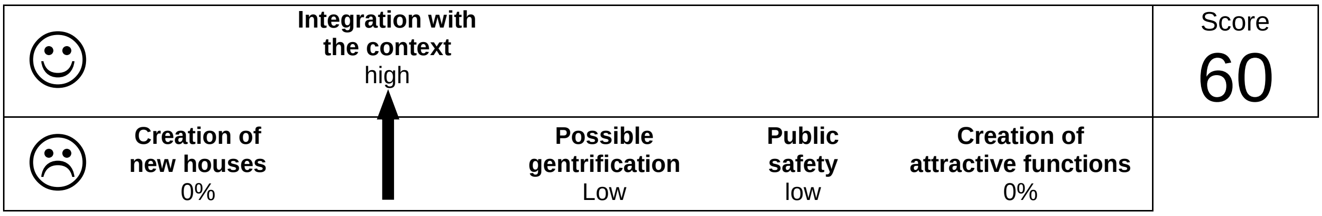
Appendix

Appendix A Questionnaire for the elicitation of the Swing weights for the "social aspects" attributes

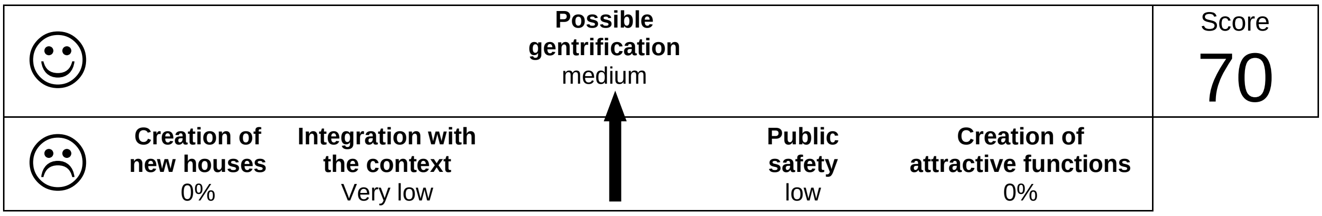
Alternative: 3



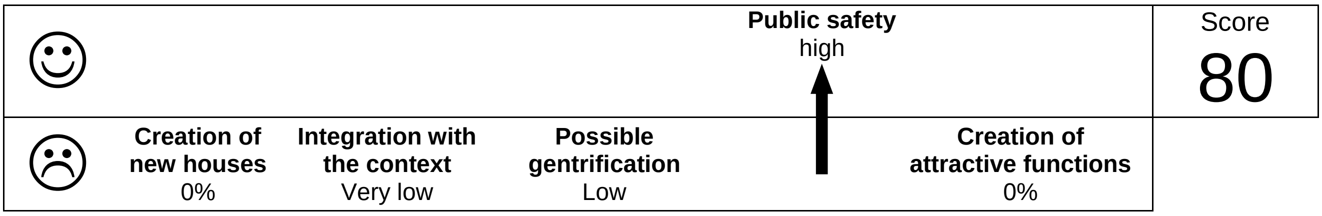
Alternative: 5



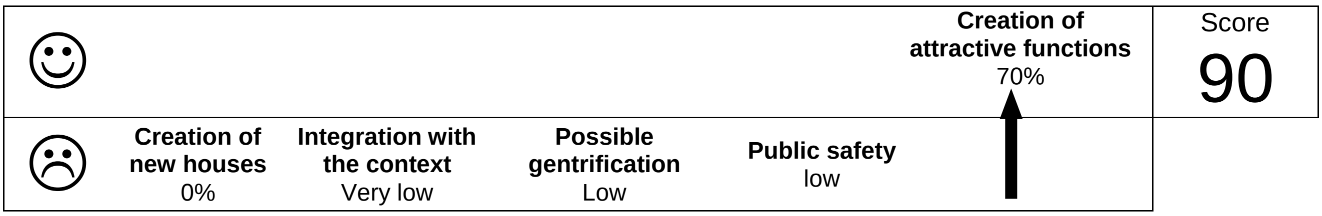
Alternative:4



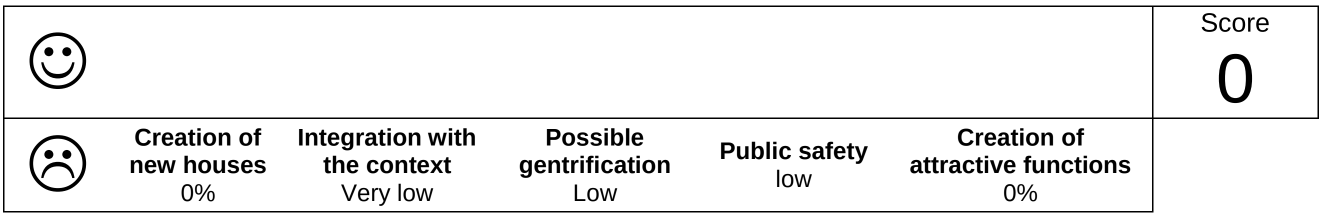
Alternative: 2



Alternative: 1



Worst hypothetical alternative



Appendix B Discounted Cash Fow Analysis for one sub-area of the masterplan

Parametric value of land		€/m²		Instantaneous costs-benefits		4-monthly periods 1°	2°	3°	4°	5°	6°	7°	8°
		690,0		€	%			Beginning of the works					
COSTS													
Land	m²	295.707		**204.037.830**	46,2%	102.018.915	102.018.915	0	0	0	0	0	0
Land reclamation				25.135.095	5,7%	12.567.548	12.567.548	0	0	0	0	0	0
Technical costs		8,0%		14.263.337	3,2%	7.131.669	7.131.669	0	0	0	0	0	0
Totale				243.436.262	55,1%	121.718.131	121.718.131	0	0	0	0	0	0
CONSTRUCTION COSTS		quantity	unitary cost € /m²										
Green and public space	m²	122.891	25	3.072.278	0,7%	0	0	0	0	0	0	0	1.024.093
Streets	m²	44.950	34	1.528.300	0,3%	0	0	0	0	0	0	0	509.433
Residential buildings	m²	266.630	475	126.649.250	28,7%	0	0	0	0	21.108.208	21.108.208	21.108.208	21.108.208
Underground parking	m²	34.710	290	10.065.900	2,3%	0	0	0	0	10.065.900	0	0	0
Offices and retail buildings	m²	69.114	535	36.975.990	8,4%	0	0	0	0	6.162.665	6.162.665	6.162.665	6.162.665
Total				178.291.718	40,3%	0	0	0	0	37.336.773	27.270.873	27.270.873	28.804.399
TOTAL CONSTRUCTION COSTS				**421.727.980**	95,4%								
MANAGEMENT COSTS		2,0%	on costr. costs	3.565.834	0,8%	237.722	237.722	237.722	237.722	237.722	237.722	237.722	237.722
SELLING COSTS		2,0%	on sales	16.605.407	3,8%	0	0	0	0	0	87.932	87.932	107.212
TOTAL COSTS				441.899.221	100,0%	121.955.853	121.955.853	237.722	237.722	37.574.496	27.596.528	27.596.528	29.149.333
BENEFITS (sales)		quantity	selling price € /m²										
Residential buildings	m²	266.630	2.390	637.245.700	76,8%	0	0	0	0	0	0	0	0
Underground parking	m²	34.710	1.520	52.759.200	6,4%	0	0	0	0	0	4.396.600	4.396.600	4.396.600
Offices and retail buildings	m²	69.114	1.890	130.625.460	15,7%	0	0	0	0	0	0	0	0
Cultural functions	m²	9.640	1.000	9.640.000	1,2%	0	0	0	0	0	0	0	964.000
TOTAL BENEFITS				830.270.360	100,0%	0	0	0	0	0	4.396.600	4.396.600	5.360.600
ECONOMIC CASH-FLOW				388.371.139		-121.955.853	-121.955.853	-237.722	-237.722	-37.574.496	-23.199.928	-23.199.928	-23.788.733
FINANCIAL CHARGES													
Exposure		*year*	*4-monthly period*			-121.955.853	-245.911.339	-250.181.111	-254.520.892	-296.268.603	-324.326.256	-352.843.953	-382.418.042
Negative interests		5,0%	1,6%	-59.887.747			-1.999.632	-4.032.050	-4.102.059	-4.173.215	-4.857.726	-5.317.769	-5.785.355
Positive interests		2,0%	0,7%	3.671.940		0	0	0	0	0	0	0	0
ANTE-TAXES CASH-FLOW						-121.955.853	-123.955.485	-4.269.772	-4.339.781	-41.747.711	-28.057.653	-28.517.697	-29.574.089
		year	*4-monthly period*										
Discount rate		6,00%	1,96%										
ANTE-TAXES NPV		186.973.669											
ANTE -TAXES IRR		18,31%	5,77%										

	9°	10°	11°	12°	13°	14°	15°	16°	17°
							End of the works		
Land	0	0	0	0	0	0	0	0	0
Land reclamation	0	0	0	0	0	0	0	0	0
Technical costs	0	0	0	0	0	0	0	0	0
Totale	0	0	0	0	0	0	0	0	0
Green and public space	1.024.093	1.024.093	0	0	0	0	0	0	0
Streets	509.433	509.433	0	0	0	0	0	0	0
Residential buildings	21.108.208	21.108.208	0	0	0	0	0	0	0
Underground parking	0	0	0	0	0	0	0	0	0
Offices and retail buildings	6.162.665	6.162.665	0	0	0	0	0	0	0
Total	28.804.399	28.804.399	0	0	0	0	0	0	0
MANAGEMENT COSTS	237.722	237.722	237.722	237.722	237.722	237.722	237.722	0	0
SELLING COSTS	107.212	107.212	2.301.130	2.301.130	2.301.130	2.301.130	2.301.130	0	0
TOTAL COSTS	29.149.333	29.149.333	2.538.852	2.538.852	2.538.852	2.538.852	2.538.852	0	0
Residential buildings	0	0	91.035.100	91.035.100	91.035.100	91.035.100	91.035.100	91.035.100	91.035.100
Underground parking	4.396.600	4.396.600	4.396.600	4.396.600	4.396.600	4.396.600	4.396.600	4.396.600	4.396.600
Offices and retail buildings	0	0	18.660.780	18.660.780	18.660.780	18.660.780	18.660.780	18.660.780	18.660.780
Cultural functions	964.000	964.000	964.000	964.000	964.000	964.000	964.000	964.000	964.000
TOTAL BENEFITS	5.360.600	5.360.600	115.056.480	115.056.480	115.056.480	115.056.480	115.056.480	115.056.480	115.056.480
ECONOMIC CASH-FLOW	-23.788.733	-23.788.733	112.517.628	112.517.628	112.517.628	112.517.628	112.517.628	115.056.480	115.056.480
Exposure	-412.477.038	-443.028.892	-337.775.324	-230.795.980	-122.062.566	-11.986.189	100.291.716	217.354.030	336.757.590
Negative interests	-6.270.263	-6.763.121	-7.264.060	-5.538.285	-3.784.213	0	0	0	0
Positive interests	0	0	0	0	0	-2.441.251	-239.724	2.005.834	4.347.081
ANTE-TAXES CASH-FLOW	-30.058.996	-30.551.854	105.253.568	106.979.343	108.733.415	114.958.879	112.277.904	117.062.314	119.403.561