The Assessment of the Public and Private Conveniences in the Urban Transformation Interventions: An Optimization Model for the Value Recapture Adoption

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Abstract: - In the field of urban transformation interventions, the "privatization" of the potential indirect benefits is a crucial issue. In fact, if not adequately recaptured and managed they can favor the private developers or owners by reducing the share of acquirable public resources intended for the realization of new infrastructures and services. For this reason, the Extraordinary Urbanization Contribution (EUC) was introduced in Italy in 2014 with Art. 16, co.4 of DPR n. 380/2001 to allow an equitable redistribution - between the public and private subjects involved - of the surplus value generated by urban variant interventions. The lack of univocal guidance for determining this contribution has made its application difficult, therefore the work aims to provide a rational and methodological rigorous decision support model intended for the public administration for assessing the surplus value generated by complex urban variant intervention. Its methodological structure is based on goal programming optimization principles. In particular, the innovative contribution of the model is to provide the assessment of the surplus value of "complex" urban variant interventions, or those for which the inclusion of the "time" factor could affect the results and the conveniences of the parties involved. For these reasons, different discount rate values are assumed. The main findings regard the possibility of being used for supporting the public administrations in the correct application of the national regulations, also consistent with the value recapture and value sharing research streams, and for identifying the extra-profit margins and conveniences of the private subject involved.

Key-Words: - Extraordinary Urbanization Contribution, PPP, Assessment Model, Value Recapture, Optimization Model

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1 Introduction

Urban transformations are one of the main strategies conducted to improve urban quality, understood as the appropriate endowment of equipment and infrastructure, which should be adequate for the related demand, [1]. The actual context is characterized by a high dynamism of the community needs and therefore urban planning should be structured to meet the novel needs and provide essential infrastructures. For these reasons, the adoption of Public Private Partnership (PPP) has become widely used in urban transformation interventions for reasons related to improving urban quality despite the scarcity of public financial resources.

The involvement of private subjects in this type of operation allows the PAs to take advantage of private managerial and entrepreneurial skills, as well as financial availability. The use of PPP is an alternative financing solution that offers a series of benefits related to the increase in the potential of infrastructure endowment for the same public resources used, the rationalization of the process of

investment identification, and the allocation of risks and revenues according to the possibilities and needs of the project participants. However, there are also critical issues related to the complexity of the process and the proper identification of stakeholders to whom to allocate risks. In particular, it can be noted that urban regeneration interventions generate several indirect effects, such as changes in property values (increase and decrease) that benefit private subjects, leading to the issue of privatization of these benefits, [2].

In recent decades the avoidance of privatization has played an increasingly important role in the structuring of PPP interventions, to the point of creating what in the literature is called *value sharing/value recapture/land value recapture*, whose principles are based on the appropriate redistribution of the benefits derived from urban transformation interventions. The forms of *value sharing* and *value recapture* range from fiscal regulations to urbanistic regulations (*betterments and windfalls for wipeouts*) up to the recent institution in Italy of the Extraordinary Urbanization Contribution (EUC) with the letter d-ter to co.4 of Article 16 of the Consolidated Construction Act (D.P.R. n. 380/2001), introduced by Law No. 164 of 2014 and amended by Law No. 76 of 2020.

This is a contribution to be paid by the private subject to the PA in an amount not less than 50% of the surplus value generated by the interventions on areas or properties in urban planning variant or in derogation; this amount is calculated by the municipal administration and is reserved for the realization, in the context in which the intervention falls, of public spaces, infrastructures, and services, [3]. The transposition of the normative at the regional and then at the municipal scale appears fragmented, non-transparent, and confusing, especially about consistency with the dictates of Estimation: in fact, the application of the regulations provides for the substantial determination of the transformation value, which therefore should be conducted, both on the methodological and on the operational profile, respecting the cardinal principles of estimative methodology. Moreover, when the complexity of urban transformation interventions requires the analysis of the time factor, the regulations do not provide provisions on how to determine the surplus value. In a situation of scarcity of public resources, it is necessary, in addition to a rationalization of collective public spending, to give the possibility to access to funding sources through processes of equitable sharing between the public and private sectors that can assess the complexity of such kind of interventions, [4].

In this sense, Italy stands in line with other more virtuous European countries such as Spain and England by giving the possibility to apply the principles of better distribution between public and private subjects of the surplus value that can be generated. In this way, the correct determination of the EUC can support the acquisition and allocation of more resources to initiate virtuous city development that can meet the new and dynamic needs of citizens by avoiding the "privatization" of benefits but supporting the sharing of costs, [5].

There are several forms of PPP oriented towards social and environmental issues, to reduce the privatization of benefits. Indeed, the tendency of investors to make investments with objectives different from the exclusive maximization of profit, therefore in line with the Sustainable Finance principles, has led to the spread of new forms of PPP that strongly depend on the effective and measurable social and/or environmental impacts achieved.

The principles that guide these novel PPPs pertain to the ones of Impact Finance, born after the economic crisis of 2008 into which the limits of the maximization of the profits have been highlighted. Moreover, the growing environmental and social critical issues that the governments must face after the requirements set within several official disclosures, such as the Paris Agreement, Kyoto Protocol, Green Deal, and Sustainable Development Goals, have contributed to the formation of PPP forms that both achieve the established environmental/social impacts by guaranteeing the conveniences of the public and private subjects involved.

Among the most innovative PPP forms, there are the Social Impact Bonds (SIB) which consist of bonds intended for the implementation of public utility interventions with remuneration for investors only in case of actual generation of positive social impacts. These are bilateral contracts between the parties involved to achieve certain measurable social impacts, in which the risk of failure is borne by the entity funding the initiative, [6].

Other instruments have been created to guarantee investments in projects that have a positive impact on the environment. The most used are the Green Bonds, or debt instruments issued in the renewable

energy sectors, sustainable waste and water management, biodiversity protection, and energy efficiency. These instruments are used to finance projects with a positive impact on the environment and to increase the availability of capital needed for the transition to a more sustainable economy, [7].

With regard to the focus on the equitable distribution between the benefits of the private investor and the positive impacts for the community resulting from urban transformation interventions, there are tools related to the recapture of surplus value, such as *value recapture*, *value sharing*, and the *land value recapture*.

The principle underlying these PPP forms refers to the recovery, in favor of the community, of the increases in the value of the land generated by actions other than those of the landowner, as public investments in infrastructure or administrative actions causing changes in rules and regulations to draw on these added values to improve the performance of land management and to finance infrastructure and provision of urban services, [8]. The principle of these policies agrees with the Vancouver Plan of Action, the founding document of the United Nations Human Settlements Program (UN-HABITAT), which states that increases in land value should be subject to appropriate community recapture, [9].

For interventions carried out in PPP, it is therefore essential, in addition to a regulatory recapture of value, a fair distribution of this value, also called surplus value. In this context, the negotiating activity of the PA must allow regulation of the privatization of the value generated by creating conditions of equity in its distribution, identifying win-win solutions between the public and private sectors, [10].

Adequate taxation and distribution of the surplus values allow to: *i)* obtain resources to dedicate to the maintenance of the city and a qualitative and quantitative improvement of the public spaces; *ii)* spread of social housing policies that will bring the profitability of this sector closer to that of the pure market and reduce the earnings expectations of real estate operators; *iii)* reduce the capacity for corruption within the real estate sector, [11].

In Europe, the use of land value acquisition tools is widespread, for example in Spain the local contributions to building activities to cover the construction costs of infrastructures and/or public spaces connected to real estate development projects are called *cargas de urbanizaciòn;* in San Francisco Bay (USA), *"Public Benefit Zoning"* provides a system whereby owners destined to enjoy the surplus land from the planned development works acquire limited income and engage in interventions for the benefit of the community.

Italy is inserted in this context with the introduction of the EUC with the aim of regulating the capture and redistribution between the public and private sectors of the surplus value generated by interventions on areas or buildings in variant urban planning or in derogation to existing instruments. The allocation of this contribution is left to the local authorities, highlighting issues related to the procedures for estimating the surplus value generated by interventions carried out in variance and the exact percentage of EUC to be used, [5].

2 Aim

The aim of the work is to provide a mathematical optimization model for defining the main urban planning parameters that can i) make PPP urban variant interventions financially feasible and convenient for private subjects and, at the same time, ii) allow the PA to acquire further public resources by correctly applying the EUC regulations to the surplus value generated by the urban variant. The research analyzes both the “ante” and “post” urban variant situations for determining the surplus value in compliance with the income approach method of the Discounted Cash Flow Analysis (DCFA), to detect the “time” effects through the discount rate values on the main urban parameters from which the conveniences of the public and private subjects involved depend. The analyzed intervention concerns the private subject who requests the PA to change the permissible volumes to be built in an urban area. With reference to the “ante” and “post” variant situations, the DCFA is used to evaluate the transformation value of the initiative. The work represents the further development of a previous study carried out by, [6].

The model can be a valuable support for the development of the public city through the activation of urban regeneration interventions in compliance with Sustainable Development Goals (SDGs). This model can support the definition of urban planning policies that can put private entrepreneurs in a condition for which, without affecting the financial feasibility of the initiative, they can guarantee to the

PA the adequate payment of urbanization charges and additional contributions related to the implementation of interventions of social utility (e.g., social housing, green spaces, cultural spaces, etc.). In particular, the model can provide support in the negotiation stages during which it can be used to determine the construction parameters and additional costs of urban redevelopment operations to identify their benefits.

The research is structured as follows. The "Model" section illustrates the proposed model with the identification and explanation of the variables, constraints, and objective functions. The "Discussion" section reports the potential and limitations of the proposed model. Finally, the last section exposes the conclusions of the work and the possible future developments of the research.

3 Model

The proposed optimization model is aimed at determining the optimal morphological and financial structure of the urban variant for which the EUC should be calculated. To achieve this goal, the DCFA is applied for determining the transformation value referring to the "ante" variant situation. For the determination of the Net Present Value through the DCFA, the following assumptions are used:

-The distribution of the cash flows takes place over 7 years, subdivided into 14 semesters;

-The total costs are the sum of the realization and management costs, which comprise the urbanization charges (residential, commercial, and offices), the technical expenses, the green surfaces construction, the car parking, the residential buildings, and the commercial/offices units and marketing expenditures;

-The expected revenues of the private subject involved are the ones generated by the saleable GFS on the free real estate market;

The discount rate values are assumed to be different to try to detect the variations produced by the "time" factor on the urban variant balance sheets. The discount rate values vary according to the 3.00%, 7.50%, 10.00%, 12.50%, and 15.00%. It is important to highlight that the discount rate represents the expected return on investment for the private subject, therefore in the present research different values are proposed for analyzing the variation and the effects produced on the urban variant's parameters, therefore also its financial structure.

The combinations of the urban parameters that define the morphological and financial features of the urban variant are provided by the model. Moreover, the obtained outputs also help to identify the surplus value intended for the PA and the private developer involved. With reference to the canonical assessment of the most likely transformation value of the intervention in both the "ante" and "post" urban variant condition, the inclusion of the "time" influence, i.e., that each item is distributed over time within the considered period, is performed to detect the risk and the related complexity of the project. In the present research, the assumptions for the calculation of the transformation value regard an urban variant project that provides for the realization of several building units, therefore, the revenues and the costs of the urban variant transformation are represented in Eq. (1):

$$V_t = V_{mt} - (K_c + K_{ps} + K_{pg} + K_{upsc} + K_{tf} + K_{mg} + K_{mk} + K_{floan}) \quad (1)$$

Where: V_t is the transformation value of the urban variant of which the surplus value is under assessment; V_{mt} is the market value of the transformed units that represents the total revenues generated by their sale on the market; K_c is the buildings' construction cost; K_{ps}: parking spaces' realization cost; K_{pg} is the cost linked to the private green spaces' realization; K_{upsc} is the urbanization charges (primary, secondary and of construction); K_{tf} is the technical fees for the professional workers involved; K_{mg} is the management expenses of the intended uses; K_{mk} is the commercialization costs of the building units; K_{floan} is the assumed interest on the capital loan of the private developer for the implementation of the intervention.

More specifications on the variables, the morphological and financial constraints, and the objective function that define the algorithm of the model are below described.

4 Variables

The model is based on four variables that constitute the main urban parameters related to the land use distribution of the intervention and its financial structure. The mentioned variables are:

- The share of the total Gross Floor Area (GFA) of the building units [m^2] that the private subject realizes and sold on the local real estate market (GFA_{pp});
- The share of the total surface of the land plot on which the private building units [m^2] will be realized (S_{privb});
- The share of the total surface of the land plot on which the private green spaces [m^2] will be created (S_{privg}).
- The share of the total Gross Floor Area of the buildings [m^2] for the social housing units (GFA_{shu}).

In fact, by imagining dividing the entire land plot of the urban variant into two main shares - the first related to the public works and the second one where the private developers will realize the building units according to the established intended uses - the variables related to the Gross Floor Area (no.1 and no.4) represent the most important urban parameters. Variables no.2 and no.3, respectively S_{privb} and S_{privg}, are strongly affected by the GFA variations. To better explain how all the variables are connected and what they represent it is important to highlight that S_{privb} is the surface resulting from the sum of the gross surfaces of all floors, above and within the ground that, for all the intended uses, it shall be measured on the external perimeter of the floor, including the horizontal projection of walls, fixed and mobile stairs, lifts and elevators rooms, technological services, and system; whereas S_{privg} is the surface of the private housing units made by the private developer and intended for the planting of native tree species capable of increasing the amount of CO^2 absorbed, as well as increase the permeable surface area to reduce the consumption of natural soil and the risks associated with it, such as floods and landslides. Therefore, the quantification, in terms of extension, of the variables S_{privb} and S_{privg} can vary according to the m^2 intended for the GFA_{pp} and the GFA_{shu}. In other words, the GFA_{pp} and GFA_{shu} surfaces identify the urban parameter of the "post" urban variant situation around which the bargaining between the private subject and the PA takes place because is from their extension that derives the respective conveniences.

The percentage value of the Extraordinary Urbanization Contribution (EUC) is imposed as known data of the model due to the application of the art. 16, co.4 of DPR n. 380/2001 and it is assumed to vary between 50% (minimum value set by national legislation) and 100%. The threshold of 100% represents the value of the EUC beyond which the private developer would have no margin of benefit, in terms of extra profit, because all the surplus value generated by the urban variant would be given to the PA.

5 Constraints

The assessment of the surplus value generated by the urban variant involves the consideration of the financial terms that characterize the intervention and its morphological structure for providing an efficient evaluation of all the potential benefits. Therefore, the proposed model is based on two types of constraints. The first one concerns constraints arising from the morphological structure and land-use subdivision of the area involved in the operation and the second type concerns the financial terms of the intervention. The first type of constraint is shown in Table 1.

Table 1. Morphological and land use constraints of the model

MORPHOLOGICAL AND LAND USE CONSTRAINTS OF THE MODEL	
$S_{tot} = S_{priv} + S_{pub}$	**(1)**
$S_{priv} = S_{privb} + S_{privg} + S_{park}$ $S_{pub} = S_{pr} + S_i$	**(2)**
$GFA_{tot} = I_{build} \cdot S_{tot}$	**(3)**
$GFA_{tot} = GFA_{pp} + GFA_{shu}$	**(4)**
$GFA_{pp} = GFA_{res} + GFA_{com} + GFA_{off}$ $GFA_{res} = \alpha \cdot GFA_{pp}$ $GFA_{com} = \beta \cdot GFA_{pp}$ $GFA_{off} = \gamma \cdot GFA_{pp}$	**(5)**
$S_{pub} \geq \delta \cdot S_{tot}$	**(6)**
$S_{privb} \leq R_c \cdot S_{tot}$	**(7)**
$GFA_{tot} / S_{privb} \leq N_{f,max}$	**(8)**
$S_{pg} \geq \varepsilon \cdot S_{privb}$	**(9)**
$S_{pr} = \eta \cdot S_{tot}$	**(10)**
$S_{park} = Vol_{tot} / 10 = (GFA_{tot} \cdot 3) / 10$	**(11)**

Constraint no. 1 refers to the division of the total plot area (S_{tot}) into the private area intended for the developer's construction of building volumes (S_{priv}) and the public area (S_{pub}) for infrastructure and public structures.

The explanation of these two components into which S_{tot} is divided is given in constraint no. 2. Specifically, S_{priv} is expressed as the sum of the surface of the buildings (S_{privb}), the private green spaces (S_{privg}), and the area for private parking (S_{park}); the S_{pub} is defined as the share for public streets (S_{pr}) and the area dedicated to the implementation of urban standards (Si).

Constraint no. 3 shows the calculation of the achievable GFA_{tot} according to its buildability index (I_{build}) established by municipal regulations, which makes it possible to determine how much is allowed to be built on the total surface of the intervention area. Constraint no.4 shows the subdivision of GFA_{tot} into its components dedicated to the GFA_{pp} and the social housing GFA_{shu}. For GFA_{pp} is proposed a mix of uses that consists of a housing (res), commercial (com), and office units (off). In constraint no. 5 this distribution is expressed as a variable percentage of the GFA_{pp}, according to three coefficients: for residential units (GFA_{res}) α = 70%, for commercial units (GFA_{com}) β = 20%, and offices (GFA_{off}) γ = 10%. Constraint no. 6 shows the calculation to determine the minimum size of the public area, or as a percentage (δ) equal to 70% of the S_{tot}. In constraint no. 7 and no. 8 are reported respectively the data relating to R_c, or the ratio between the surface area covered by the buildings and the land area of the plot in which it falls, and $N_{f,\,max}$ or the maximum number of floors allowed by the municipal regulations. With the introduction of two percentage coefficients ε (10%) and η (10%), respectively the extent of the private green area (S_{privg}) and the public road area (S_{pr}) are calculated (constraints no.9 and 10). The private parking area (S_{park}) is determined with constraint no. 11 and is determined as established by Law No. 122/1989 for which it is planned to build 1 m^2 of parking for every 10 m^3 of new construction, assuming an average height of 3 m for each floor.

The type of constraints concerning the financial conditions of the convenience of the construction of the urban variant for the private investor and the PA, compared to the "ante" situation, needs to be carefully analyzed. It should be noted that in the "post" variant situation there are unknown parameters, and they are represented by the 4 model variables (GFA_{pp}, GFA_{shu}, S_{privb}, S_{privg}). For the determination of these variables, it is necessary to establish the benefit conditions of stakeholders. In particular, for allowing the PA to obtain more revenues from the "post" variant situation, consisting of the costs of urbanization (ΔK_{urb}) and the effective share of the EUC (c_{extra} (Vt_{post} - Vt_{ante})) compared to the loss of urbanization standards (ΔS_i) arising from the realization of the urban variant intervention. For the private subject, the convenience is represented by a greater volume, in particular, GFA to build and sell,

by increasing the extra-profit margins compared to the "ante" variant condition.

The financial constraints of the model are expressed for the PA in Eq. (2) and for the private developer in Eq. (3):

$$\Delta K_{urb} + c_{extra} \cdot (Vt_{post} - Vt_{ante}) \geq \Delta S_i \quad (2)$$

$$Vt_{post}\,(GFA_{pp}, GFA_{shu}, S_{privb}, S_{privg}) > Vt_{ante} \quad (3)$$

For the determination of the transformation values that refer to the "ante" and "post" variants, the necessary cost and revenue items are in Table 2 show.

Table 2. Financial constraints of the model

Cost items	
$K\_build = c_{build,res} \cdot GFA_{res} + c_{build,com} \cdot GFA_{com} + c_{build,off} \cdot GFA_{off} + c_{build,shu} \cdot GFA_{shu} + c_{build,park} \cdot GFA_{park}$	**(12)**
$K\_p = c_p \cdot S_{park}$	**(13)**
$K\_privg = c_{privg} \cdot S_{privg}$	**(14)**
$K\_urban = c_{urban} \cdot GFA_{pp}$	**(15)**
$K\_tech = 4\% \cdot (K\_build + K\_park + K\_privg)$	**(16)**
$K\_management = 5\% \cdot (K\_build + K\_park + K\_privg)$	**(17)**
$K\_marketing = 1\% \cdot V_{mt}$	**(18)**
$K\_loan = 5\% \cdot (K\_build + K\_park + K\_privg + K\_urban + K\_tech + K\_management + K\_marketing)$	**(19)**
Revenue items of the transformation assessment	
$K\_transf = r_{res} \cdot GFA_{res} + r_{com} \cdot GFA_{com} + r_{off} \cdot GFA_{off} + r_{shu} \cdot GFA_{shu} + r_{park} \cdot GFA_{park}$	**(20)**

Constraint no.12 expresses the construction cost of buildings (K_{build}) determined on a parametric basis (c_{build}) in €/m^2 considering the different allowable functions defined in the urban variant (residential, commercial, offices, parking, and social housing units). The construction cost of parking (K_{park}) and private green spaces (K_{privg}) (co.13 and co. 14) is calculated by considering the unit costs (€/m^2), c_{park} and c_{privg}, derived from the costs of recently realized similar works. The co.15 reports the primary, secondary, and construction urbanization costs (K_{urban}) established in accordance with Article 3 of Law No. 10/1977, applying to the private areas of new construction (GFA_{pp}) the values in €/m^2 indicated in the appropriate municipal tables according to the intended use and the type of intervention to be carried out. The co.16 describes the technical expenses (K_{tech}) which include the expenses for the technical commitments required by the transformation intervention and are considered in this case as a percentage of 4% of the total construction cost ($K\_{build} + K\_{park} + K\_{privg}$).

Overhead expenses ($K\_{management}$) are shown in co. 17 and are the expenses arising from the management of the entire operation; these are calculated as a percentage (set at 5%) of the total construction cost ($K\_{build} + K\_{park} + K\_{privg}$).

The co.18 expresses the marketing costs ($K\_{marketing}$), which include the amounts required for advertising and marketing the buildings of the operation, equal to 1% of the estimated and obtainable revenues (V_{mt}).

The financial charges (K_{loan}) in co. 19 refer to the hypothetical capital borrowed by the private subject to carry out the intervention. In this case, the loan capital is assumed to be used for the entire operation and is determined as a percentage of the incidence (assumed to be 5%) of the total cost items ($K\_{build} + K\_{park} + K\_{privg} + K\_{urban} + K\_{tech} + K\_{management} + K\_{marketing}$).

Regarding transformation revenues (K_{transf}) these are reported in co. 20 and represent the market value of the transformed area after the realization of the variant. This value is derived from the revenues of the sale of the areas for each of the uses, from the unit sales prices (€/m^2) found in the local real estate market and are applied to residential ($r_{res} \cdot GFA_{res}$), commercial ($r_{com} \cdot GFA_{com}$), office ($r_{off} \cdot GFA_{off}$), social housing ($r_{shu} \cdot GFA_{shu}$) and parking ($r_{park} \cdot GFA_{park}$) areas.

All equations refer to a specific *i-th* time of the analysis period for the DCFA application, i.e., each cost will be different at each *i-th* time based on the expenses related to the same time.

6 Objective Function

The model makes it possible to transform in mathematical terms the possible and different objectives that the PA would achieve with the approval and realization of the urban variant. In this case, by indicating with w the relative importance of each aspect, it is possible to express the sub-objectives pursued by the PA that concern the

environmental, social, and economic spheres. From the environmental point of view, the reduction of natural land consumption through the increase of green areas is followed (Max! $w_{\_privg}$ - S_{privg}); the other one concerning the social sphere is expressed by the increase in demand for social housing through the allocation of part of the GFA to social housing units (Max! $w_{\_shu}$ - GFA_{shu}). The economic sphere relates to the financial convenience of the private developer through the increase in extra-profit margins resulting from the GFA to be built and sold (Max! w_{pp} - GFA_{pp}).

Therefore, according to the work's purposes, the objective function of the model is represented in Eq. (4):

$$\text{Max!} \ (w_{\_privg} \cdot S_{privg} + w_{\_shu} \cdot GFA_{shu} + w_{pp} \cdot GFA_{pp}) \quad (4)$$

7 Discussions

The present research would try to fill the existent gap in a rational procedure for assessing the surplus values that a complex urban variant can generate.

Therefore, by starting from a canonical assessment of the transformation value, a methodology based on the optimization principles is proposed by also including the "complexity" issues of those transformation interventions that take place over several years. Different values of discount rate could contribute to efficiently detecting the effects of the time and the risk on the potential surplus value that the urban variant can generate.

In this way, the PA can use the proposed model for efficiently assessing the surplus value and the possibility of acquiring more public resources through the EUC percentages, whereas the private subject can adopt it for verifying its extra-profit margins and carry out effective negotiations regarding the extensions and amount of the urban parameters on which its convenience depends.

The main limitation of the proposed model could concern its high level of technical and mathematical programming skills that are required for its structuring and implementation. However, future developments of the work could concern the improvement of this aspect by creating a model that is more simply usable in any context and practical need.

8 Conclusions

The pursuit of SDGs, in particular, goal no. 11 "Smart Cities and Communities", requires the activation of new urban planning strategies; the complexity that characterizes these operations and the contraction of financial resources currently affecting the public sector makes it necessary for public and private entities to collaborate in the implementation of these interventions, [12], [13]. Such complex operations are generally carried out in PPPs, so it is crucial to establish, during the negotiation phase, the conveniences that stakeholders can draw from these interventions.

In fact, in addition to the advantages offered by the use of alternative financing solutions such as PPPs for the activation of complex interventions on the territory, there are also critical issues concerning the indirect effects generated by these operations that benefit private subjects, leading to the issue of the privatization of these benefits.

To regulate the privatization of the benefits from land transactions, there are a series of rules internationally regarding the capture and redistribution between the public and private sectors of the surplus value generated by urban transformation operations, which are based on the principles of value recapture and value sharing, whose founding concept refers to the recovery of increases in land value generated by interventions other than those of the landowner, for the benefit of the community. These tools allow managing the phenomenon of differential urban rent for the benefit of society, using the capital resulting from complex interventions and investments on the territory, for the realization of public works.

In this context, the EUC was introduced in Italy in 2014 with the aim of regulating the capture and redistribution between public and private of the surplus value generated by interventions on areas or buildings in urban variants or in derogation from current instruments. However, this rule leaves it up to the regions and municipalities to determine how to estimate the surplus value and the percentage to be considered; the lack of univocal guidance regarding the determination of this value generates a confusing framework that makes the application of this rule difficult.

The purpose of this work was to outline a rational calculation model for evaluating the surplus values generated by complex urban transformation interventions that the PA can adopt for determining

the EUC. This model has allowed the prefiguration of the optimal combination solutions of the main urban parameters for the balance of public and private subjects while respecting morphological, urban planning, financial and market constraints. A rigorous methodological procedure was proposed for assessing the transformation value of the intervention in both the "ante" and "post" urban variance situation, by considering the inclusion of the time factor through the DCFA application with different discount rate values. Indeed, the consideration of this factor makes it necessary to consider the accurate choice of an appropriate discount rate and EUC percentage according to the different possible objectives to be pursued.

With this model, it is possible to express mathematically, through the objective function, the aims that are to be pursued with the activation of interventions in the urban variant, considering aspects related to environmental, economic, and social spheres.

The model can provide support, both to the PA and the private decision-makers, in the negotiation stages since it allows to the determination of possible solutions that ensure the balance between the needs of both parties, according to the determination of the urban parameters and the financial structure.

Future developments in the proposed research could regard the application of the proposed methodology to a real case study by also comparing the data obtained with other assessment and optimization models for the same variant to determine the transformation value and the surplus value.

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