Osvaldo Gervasi · Beniamino Murgante · Sanjay Misra · Chiara Garau · Ivan Blečić · David Taniar · Bernady O. Apduhan · Ana Maria A. C. Rocha · Eufemia Tarantino · Carmelo Maria Torre (Eds.)

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Computational Science and Its Applications – ICCSA 2021

21st International Conference
Cagliari, Italy, September 13–16, 2021
Proceedings, Part VI

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Preface

These 10 volumes (LNCS volumes 12949–12958) consist of the peer-reviewed papers from the 21st International Conference on Computational Science and Its Applications (ICCSA 2021) which took place during September 13–16, 2021. By virtue of the vaccination campaign conducted in various countries around the world, we decided to try a hybrid conference, with some of the delegates attending in person at the University of Cagliari and others attending in virtual mode, reproducing the infrastructure established last year.

This year's edition was a successful continuation of the ICCSA conference series, which was also held as a virtual event in 2020, and previously held in Saint Petersburg, Russia (2019), Melbourne, Australia (2018), Trieste, Italy (2017), Beijing. China (2016), Banff, Canada (2015), Guimaraes, Portugal (2014), Ho Chi Minh City, Vietnam (2013), Salvador, Brazil (2012), Santander, Spain (2011), Fukuoka, Japan (2010), Suwon, South Korea (2009), Perugia, Italy (2008), Kuala Lumpur, Malaysia (2007), Glasgow, UK (2006), Singapore (2005), Assisi, Italy (2004), Montreal, Canada (2003), and (as ICCS) Amsterdam, The Netherlands (2002) and San Francisco, USA (2001).

Computational science is the main pillar of most of the present research on understanding and solving complex problems. It plays a unique role in exploiting innovative ICT technologies and in the development of industrial and commercial applications. The ICCSA conference series provides a venue for researchers and industry practitioners to discuss new ideas, to share complex problems and their solutions, and to shape new trends in computational science.

Apart from the six main conference tracks, ICCSA 2021 also included 52 workshops in various areas of computational sciences, ranging from computational science technologies to specific areas of computational sciences, such as software engineering, security, machine learning and artificial intelligence, blockchain technologies, and applications in many fields. In total, we accepted 494 papers, giving an acceptance rate of 30%, of which 18 papers were short papers and 6 were published open access. We would like to express our appreciation for the workshop chairs and co-chairs for their hard work and dedication.

The success of the ICCSA conference series in general, and of ICCSA 2021 in particular, vitally depends on the support of many people: authors, presenters, participants, keynote speakers, workshop chairs, session chairs, organizing committee members, student volunteers, Program Committee members, advisory committee members, international liaison chairs, reviewers, and others in various roles. We take this opportunity to wholehartedly thank them all.

We also wish to thank Springer for publishing the proceedings, for sponsoring some of the best paper awards, and for their kind assistance and cooperation during the editing process.

We cordially invite you to visit the ICCSA website https://iccsa.org where you can find all the relevant information about this interesting and exciting event.

September 2021

Osvaldo Gervasi
Beniamino Murgante
Sanjay Misra

Welcome Message from the Organizers

COVID-19 has continued to alter our plans for organizing the ICCSA 2021 conference, so although vaccination plans are progressing worldwide, the spread of virus variants still forces us into a period of profound uncertainty. Only a very limited number of participants were able to enjoy the beauty of Sardinia and Cagliari in particular, rediscovering the immense pleasure of meeting again, albeit safely spaced out. The social events, in which we rediscovered the ancient values that abound on this wonderful island and in this city, gave us even more strength and hope for the future. For the management of the virtual part of the conference, we consolidated the methods, organization, and infrastructure of ICCSA 2020.

The technological infrastructure was based on open source software, with the addition of the streaming channels on YouTube. In particular, we used Jitsi (jitsi.org) for videoconferencing, Riot (riot.im) together with Matrix (matrix.org) for chat and ansynchronous communication, and Jibri (github.com/jitsi/jibri) for streaming live sessions to YouTube.

Seven Jitsi servers were set up, one for each parallel session. The participants of the sessions were helped and assisted by eight student volunteers (from the universities of Cagliari, Florence, Perugia, and Bari), who provided technical support and ensured smooth running of the conference proceedings.

The implementation of the software infrastructure and the technical coordination of the volunteers were carried out by Damiano Perri and Marco Simonetti.

Our warmest thanks go to all the student volunteers, to the technical coordinators, and to the development communities of Jitsi, Jibri, Riot, and Matrix, who made their terrific platforms available as open source software.

A big thank you goes to all of the 450 speakers, many of whom showed an enormous collaborative spirit, sometimes participating and presenting at almost prohibitive times of the day, given that the participants of this year's conference came from 58 countries scattered over many time zones of the globe.

Finally, we would like to thank Google for letting us stream all the live events via YouTube. In addition to lightening the load of our Jitsi servers, this allowed us to record the event and to be able to review the most exciting moments of the conference.

Ivan Blečić
Chiara Garau

Organization

ICCSA 2021 was organized by the University of Cagliari (Italy), the University of Perugia (Italy), the University of Basilicata (Italy), Monash University (Australia), Kyushu Sangyo University (Japan), and the University of Minho (Portugal).

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Geomatics in Forestry and Agriculture: New Advances and Perspectives (GeoForAgr 2021)

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Geographical Analysis, Urban Modeling, Spatial Statistics (GEOG-AND-MOD 2021)

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12th International Symposium on Software Quality (ISSQ 2021)

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10th International Workshop on Collective, Massive and Evolutionary Systems (IWCES 2021)

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Land Use Monitoring for Sustainability (LUMS 2021)

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Contents – Part VI

Urban Transformation Interventions: A Decision Support Model for a Fair *Rent Gap* Recapture

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Abstract. The second post world-war period has been widely characterized by urbanization phenomena related to the urban rent formation dynamics. The scarcity of public financial resources and the growing privatization of the benefits generated by several territorial initiatives have highlighted the need for negotiation tools capable of ensuring a fair redistribution of the rent gap deriving from urban transformation interventions. For this reason, the institution of the "extraordinary urbanization contribution" in the 2014 in Italy represents a significant regulatory support, that legitimizes public administrations in acquiring a share of the private extra-profit. The implementation of this national legislative provision has not been yet sufficiently applied at the local level, due to the lack of a univocal and codified methodology. The aim of this work consists in defining a decision support model that can be adopted in the negotiation phases between public and private subjects, in order to determine the most convenient financial conditions that ensure the law provisions. In particular, by applying the computational logic of Operational Research, the model is able to determine the amount of the main urban planning parameters that affect the balance sheets of the public-private initiatives.

Keywords: Urban rent · Rent gap theory · Public-private partnership · Decision support model · Operational research

1 Introduction

In the second half of the Nineteenth century, the urban rent phenomenon has compromised the sustainable development of European cities. In the 1970s, the spread of industrial centers to the rural outskirts of cities led to a decline in central urban areas, favoring the growth in demand for infrastructure and services in peripheral areas originally intended for agricultural activities. This condition has led to the attribution of new building potentials to the land located on the urban edges, generating an increase in the

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value of them and the ruin of al lot of central areas [1]. Afterward a turnaround occurred: in the last decades of the twentieth century, the main capital cities have been involved in the urban gentrification phenomenon, a spontaneous process of recovery and redevelopment of degraded central neighborhoods with a population turnover of middle-upper classes, which affected the real estate market dynamics [2, 3]. Relying on systematic observations of urban ground rent variations due to the gentrification conditions, [4] provided an explanatory model - named the *rent gap theory* - based on three pillars: housing value, capitalized land rent and potential land rent. In the long run, urban land rent may increase or decrease due to the continuous changing of the real estate demand for new highest and best uses. The model stated by Smith has been considered a relevant contribution into the urban rent field of research, because it set the conditions to develop a supply side view of the rent's mechanism which arise into the urbanization dynamics. Therefore, the greater the gap between the potential land rent and the capitalized ground rent in a place, the more attractive it is to invest capital for development/redevelopment interventions [5]. In this way, it establishes the role of the urban rent as a synthetic indicator for public and private investment choices for maximizing the expected capital gains [6].

Several researchers have tried to verify the existence of the rent gap theory at the scale of individual properties worldwide [7–9]. As argued by [10], the rent gap is also extremely related to processes operating on different spatial scales within the cities. [11], by considering the metropolitan scale of New York, highlights that, while the urban city center emerging as the target for real estate investment, areas located farther away from the central ones suffer from a process of disinvestment and decline. These interrelated processes of investment and divestment of the suburbs closely link to the city center are the basis of the observable social and demographic changes occurring throughout the entire metropolitan area [12].

Other researchers, taking into account the main typologies of endogenous factors of urban development that affect the rent gap formation mechanism [13, 14], have recently improved the Smith's theory: social [15], tourism [16], sustainable planning [17–19] and taxation issues [20–22] are the main addressed point of view.

In the Italian context, the scarcity of financial resources of the public administration (PA) has raised the need to adopt negotiation instruments in collaboration with the private sector, capable of recovering, through a redistributive approach, a share of the urban rent achievable as a result of urban transformation interventions. Recent regulatory provisions on urban planning - at national and local level - have helped to support the spread of public-private partnership (PPP) models aimed at regulating and managing private capital gains [23]. In this regard, the models based on the principles of non-financial compensation have made a significant contribution to the regulation of the dynamics of profit privatization [24]. However, the current socio-economic conditions resulting from the 2007 economic crisis and aggravated by the Covid-19 health emergency, confirm the growing need for decision support tools that allow the PA to allocate more financial resources for the community [25–27].

2 Aim of the Work

The Italian urban planning legislation has been recently improved with the institution of the "extraordinary urbanization contribution" (Law no. 164/2014 and Law no. 76/2020) – that granted to the PA the chance to limit the privatization of the urban rent gap that derives from "*interventions on areas or buildings in urban planning variant or in derogation*", by acquiring a share (at least 50%) of the private extra profit generated, to be used for public purposes. The regulatory State requirements, however, avoid an efficient implementation due to the lack of a codified methodology that the PA could adopt to determine the amount of the extraprofit that can be acquired to ensure the minimum financial conditions of both the parties involved.

The present research is part of the framework outlined. In particular it is aimed at developing a decision support model that can be adopted by public and private subjects involved into urban planning variants process, taking into account those concerning the revision of the building parameters provided by the regulatory instruments in force, in order to identify the most convenient financial conditions. Based on the computational logic of the Operational Research (OR), the model determines the combination and the amount of the most important parameters involved in the negotiation phases that can affect the urban rent gap formation, by considering physical, financial and urban planning constraints that characterize two scenarios: in the first one (named *ante variant*) all the urban parameters and indexes are established by the local disposition and therefore are known; in the second scenario (named *post variant*) it is necessary to determine the amount of the parameters that define the balance sheet of both the parties involved and ensure the acquisition of the extraordinary urbanization contribution, that is the prerogative of the PA.

The model is elaborated from a public point of view: the target variables considered translate into mathematical terms the purposes of preserving the natural environment, by promoting affordable housing and reducing the soil sealing into the *post variant* scenario. In this way, the proposed model supports the urban planning decisions that need an efficient methodology for assessing *i)* the financial feasibility of the PPP initiative, *ii)* the extra-profit for the private entrepreneur (i.e. the urban rent achievable), *iii)* the possibility for the PA to make further requests (in addition to those mandatory, according to the law) to the private entrepreneur, ensuring the conditions of minimum financial convenience.

The PA can use the proposed model from the earliest negotiation phases for clearly identifying the financial convenience margins, in terms of urban rent gap generated by the *post variant* scenario, such as to be able to allocate the share allowed by the urban planning legislation for public purposes, thus avoiding a complete privatization of it. The private entrepreneur, instead, can adopt the proposed model in order to verify his personal financial sheet and the convenience that derives from the initiative.

The paper is structured as follows: in Sect. 3 an overview of the main PPP tools currently adopted to avoid the privatization of the urban rent gap generated by transformation interventions is carried out. In Sect. 4 the model is explained, by describing the variables, the constraints and the objective function of the algorithm. In Sect. 5 the potentialities of the proposed model and future insights of the research are discussed.

3 Negotiating Tools Aimed at a Fair Urban Rent Recapture for Financing the Public City

As part of the management tools for the implementation of urban plans, the "integrated programs" represent one of the most significant innovations introduced in the 90's in Italy. In particular, in the execution plans that allow a variation in the intended use and private volumes, the national legislator has recognized a fundamental role in the PPP for the achievement of high levels of efficiency and effectiveness. The perimeter within which the public and private subjects operate concerns the extra-profit generated by the modifications to the parameters provided by the current regulatory plan. In other words, the variation in the urban rent of buildings intended for PPP transformation is the characterizing aspect of the integrated programs. The negotiation activity of the PA, therefore, becomes the path through which recover part of the extra-profit determined by the choices of the plan for public purposes. Furthermore, the ability to mobilize private resources that allow public ones to exploit an important leverage effect is not to be underestimated [28].

The characteristics of the privatization process of urban rent suggest that its regulation must take place by creating conditions of higher equity in its distribution. The need for *win-win* solutions that take into account this trend has led to the spread of innovative instruments that involve non-financial compensation, in order to overcome the limits of traditional instruments of expropriation [29]. The non-financial compensation, properly, consists in the concession by the PA of building rights that the private subject can either use or sold [30].

Recent developments in Italian planning practice concerns new development rights that are used by local planning authorities for community facilities and services by capturing some betterment value. Over time the use of these tools has increased constantly [31]. Moreover, the introduction of a betterment value tax has the potential to support efficient planning through a more reasonable distribution of the costs and benefits of urban transformation interventions. Those who benefit most from the urban rent generated, therefore, also contribute to the costs incurred. A betterment value tax is also able to regulate land speculation by acquiring resources to contribute to the planning system. In India, for example, about $ 17.5 billion have been invested in infrastructure, and the government has also decided to implement a land value tax to capture the increase in land value that could result from this public investment [32].

According to [33], different approaches to urban rent capture can be distinguished:

i) negotiation solutions; *ii)* information and persuasion; *iii)* fiscal interventions and *iv)* regulation. In all of these cases, the basic principles often refer to the theory developed by [34], called "*Windfalls for wipeouts*", for justifying this recapturing of extra-profits. The public subjects which release regulations that cause a reduction in property value should compensate landowners for such "wipeouts". However, at the same time, public activities that increase property values should allow the recapture of it by the government: thus, it recaptures the "*windfalls*" that it creates.

4 The Model

The proposed model is structured on the computational logic of goal programming, a branch of OR, that focuses on the application of analytical methods for problem solving and decision-making uncertain conditions [35]. The usefulness of OR in providing a systematic and scientific resolution to government, military, manufacturing, service but also in several business problems is widely recognized in the scientific literature [36]. OR is often utilized in uncertain urban planning decision-making contexts, which are characterized by scarce financial resources and different possible alternative solutions subject to different constraints [37, 38].

In the present research, the urban planning problem to be solved consists in the determination of the amount of the gross floor surface (GFS), for the intended uses considered, to be built and sold in the *post variant* scenario. In particular, the costs and the revenues that take place in this scenario must be such as to:

- cover the higher transformation costs incurred by the private entrepreneur compared to the project planned before the transformation scenario (*ante variant* scenario),
- repay the share of the extraordinary urbanization contribution foreseen and finally guarantee the financial convenience of both the parties involved in the initiative.

For these reasons, the variables of the model are four and represent the most influencing urban planning parameters on which is focused the early stage of the negotiation between the PA and the private entrepreneur:

i. the gross floor area of the properties that the private entrepreneur has to build and sell on the real estate market with the current prices (GFS_f);
ii. the gross floor area intended for social housing units (GFS_{sh});
iii. the share of the private surface where the entrepreneur has to build the properties (S_{bv});
iv. the share of the private surface where the entrepreneur has to build the private green spaces (S_{gs}).

The percentage share of the extraordinary urbanization contribution (c_{su}) constitutes an exogenous variable. It can be fixed by the PA due to the needs for the local community. It should be highlighted that the S_{bv} and S_{gs} surfaces are variables that directly refer to the GFS to be built. Therefore, the amount of the quantity of GFS_f and GFS_{sh} constitute the main variables of the problem, whereas the S_{bv} and S_{gs} contribute to the definition of the intervention constraints.

The constraints of the model are of two different typologies: *i)* physical-urban planning and *ii)* financial. The first ones derive by taking into account the ordinary division of the total land plot (S_t) into the public surface (S_{pa}) - intended for infrastructure and public buildings -, and the private one (S_{pe}) - where the entrepreneur will have to realize the building volumes (S_{bv}) granted by the PA and allowed by the urban planning buildable index (I_e) -. In particular, in order to include the needs of the growing demand for social housing units that the PA must face, the total gross floor surface (GFS_t) to be realized consists of two shares: *i)* the one that the private entrepreneur has to build and

sell on the local real estate market at current market prices (GFS_f); *ii)* the one intended for social housing units (GFS_{sh}), to be sold at low-price in the local real estate market.

The intended uses allowed are supposed to be known and are established as a percentage of GFS_f fixed by projectual purposes, therefore, three different coefficients that represent each extent are introduced:

- α for the gross floor surface of residential units (GFS_h),
- β for the gross floor surface of commercial units (GFS_c),
- γf or the gross floor surface of office units (GFS_o).

The minimum bounder of the surface intended for public buildings (S_{pa}) is determined due to projectual purposes as a share δ of the total land plot ($S_{pa} \geq \delta \cdot S_t$.). The upper bounder of the surface for the private building volumes (S_{bv}), instead, is established according to the urban parameter of the coverage ratio (R_c) of the total land plot and the minimum bounder of the floors number is equal to the ratio between the GFS_t and the S_{bv} surface. Two coefficients – *a* and *b* – are introduced to determining the extent of the private green spaces (S_{gs}) and the public roads (S_r) that respectively depend on the S_{pe} and S_t surfaces. The minimum size of the private surface S_{pe} for parking ($S_{parking}$) is established by total building volumes (Vol_{tot}), i.e. with reference to Italian Law No. 122/1989, for which 1 m^2 of parking per each 10 m^3 of new building is to be realized, by supposing that each floor of new buildings has an average height of 3 m.

Table 1. Physical and urban planning constraints.

$S_t = S_{pe} + S_{pa}$	(1)
$Spe = Sbv + Sgs + Sparking$	(2)
$GFS_t = I_e \cdot S_t$	(3)
$GFS_t = GFS_f + GFS_{sh}$	(4)
$GFS_f = GFS_h + GFS_c + GFS_o$ $GFS_h = \alpha \cdot GFS_f$ $GFS_c = \beta \cdot GFS_f$ $GFS_o = \gamma \cdot GFS_f$	(5)
$S_{pa} \geq \delta \cdot S_t$	(6)
$S_{bv} \leq R_c \cdot S_t$	(7)
$Nf_{,max} \geq GFS_t/S_{bv}$	(8)
$S_{gs} \geq a \cdot S_{pe}$	(9)
$S_r = b \cdot S_t$	(10)
$S_{pe} = Vol_{tot}/10 = (GFS_t \cdot 3)/10$	(11)

The balance sheet of the financial advantages of the PA and the private entrepreneur is assessed taking into account the cost and revenue items generated by the *post variant* scenario compared to those of the *ante variant* one. The items considered are described

in Table 2 and the existing interdependencies among them are explicated in Table 3, such as to allow the definition of the financial constraints of the model.

Table 2. Cost and revenues items considered.

Construction cost (K_c)	Parametric construction cost (€/m^2) determined according to the different allowed intended uses (Eq. 12 of Table 3)
Parking ($K_{parking}$) and green private spaces (K_{gs}) construction cost	Costs for the construction of parking plots (Eq. 13 of Table 3) and private green areas (Eq. 14 of Table 3) calculated on the basis of the unit costs (€/m^2) of construction established in the price list drawn up by the Order of Architects and Engineers of Milan in 2019 for the Civil Engineering Typography [39]
Urbanization fees (K_{ou})	Primary and secondary urbanization fees are calculated in accordance with the provisions of Art. 3 of Law no. 10/1977, i.e. applying the unit values (€/m^2) reported in the appropriate municipal tables according to the intended use and the type of intervention to be carried out. Construction fees are, instead, calculated for each intended use as a percentage of the individual construction cost. The items are summarized in Eq. 15 of Table 3 by applying an average parametric cost that refers to the GFS_{pe}
Technical expenses (K_{te})	The expenses for the commitments of planning, construction management, and the other operations required by the initiative, are calculated as a percentage - equal to 5% - of the total construction cost (Eq. 16 of Table 3)
General expenses (K_{sg})	The expenses deriving from the management of the entire initiative are calculated as a percentage - equal to 4% - of the total construction cost (Eq. 17 of Table 3)
Commercialization fees (K_{cf})	The amounts necessary for the advertising and marketing of the building products of the intervention are assumed to be equal to 2% of the market value of the products (V_{mt}) obtainable from the *post variant* scenario (Eq. 18 of Table 3)

(*continued*)

Table 2. (*continued*)

Financial fees (K_{ff})	The price of use of the bank loan of the private entrepreneur for the implementation of the initiative is calculated as a percentage of incidence - equal to be 6% - of the total transformation cost items (Eq. 19 of Table 3)
Transformation revenues	The revenues from the sale of the realizable surfaces are obtained by multiplying the unit asking prices (€/m^2) of each intended use, indicated respectively with r_h, r_c, r_o, r_{sh} and $r_{parking}$ - by the corresponding gross floor surfaces (Eq. 20 of Table 3)

Table 3. Existing interdependencies among the cost and revenue items.

$K_c = c_{cu,h} \cdot GFS_h + c_{cu,c} \cdot GFS_c + c_{cu,o} \cdot GFS_o + ccu,sh \cdot GFSsh$	(12)
$K_{parking} = c_{parking} \cdot S_{parking}$	(13)
$K_{gs} = c_{gs} \cdot S_{gs}$	(14)
$K_{urb} = c_{urb} \cdot GFS_{pe}$	(15)
$K_{te} = 5\% \cdot (K_c + K_{parking} + K_{gs})$	(16)
$K_{sg} = 4\% \cdot (K_c + K_{parking} + K_{gs})$	(17)
$K_{cf} = 2\% \cdot V_{mt}$	(18)
$K_{ff} = 6\% \cdot (K_c + K_{parking} + K_{gs} + K_{urb} + K_{te} + K_{sg} + K_{cf})$	(19)
$V_{mt} = r_h \cdot GFS_h + r_c \cdot GFS_c + r_o \cdot GFS_o + r_{sh} \cdot GFS_{sh} + r_{parking} \cdot S_{parking}$	(20)

It should be emphasized that the profit of the private entrepreneur is not included within the cost items: in fact, the absence of the theoretical conditions of perfect competition and long-term equilibrium allows to take into account the normal profit expected by the investor in the market value which is assessed in the transformation of the area [40].

Once the cost and revenue items of the initiative have been defined, the conditions of financial convenience for the private investor and the PA are determined.

In the case of the private investor, the transformation value in the *post variant* scenario (Vt_{post}), function of the variables of the model, must be higher than the transformation value in the *ante variant* scenario (Vt_{ante}):

$$Vt_{post}(GFS_f, GFS_{sh}, S_{bv}, S_{gs}) > Vt_{ante}$$

For the PA, on the other hand, the urbanization fees (ΔO_{urb}) and the extraordinary urbanization contribution ($c_{su} \cdot (Vt_{post} - Vt_{ante})$) in the *post variant* scenario must be

higher than the loss of value (ΔS_{st}) related to the reduction of surface to be allocated according to urban planning standards:

$$\Delta O_{urb} + c_{su} \cdot (Vt_{post} - Vt_{ante}) > \Delta S_{st}$$

In this case, given the plurality of aspects to be taken into account simultaneously, the objective function is of a complex type and, in mathematical terms, it can be translated into the following expression:

$$Max!(w_f \cdot GFS_f + w_{sh} \cdot GFS_{sh} + w_{gs} \cdot S_{gs})$$

The inclusion of the weights w_i, where i indicates the i-th variable of the objective function, allows to take into account the importance of each variable in pursuing the goal. In Table 4 the algorithm of the model is reported.

Table 4. Algorithm of the model.

Variables	$GFS_f, GFS_{sh,} S_{bv,} S_{gs,} c_{su}$
Objective function	$Max!(w_f \cdot GFS_f + w_{sh} \cdot GFS_{sh} + w_{gs} \cdot S_{gs})$
Constraints	Vt_{post} (GFS_f, GFS_{sh}, S_{bv}, S_{gs}) > Vt_{ante}
	$\Delta O_{urb} + c_{su} \cdot (Vt_{post} - Vt_{ante}) > \Delta S_{st}$
	Table 1

5 Conclusions

The urbanization phenomena that occurred after World War II were closely linked to the influences of the process of the urban rent formation. The analysis of the factors that contributed to the formation of the rent gap highlighted the role of urban rent as a synthetic indicator of the expected profitability of investments in the different urban areas. Starting from the model of the "rent gap theory" formulated by Smith (1979), there have been numerous contributions by Authors for analyzing the factors that affect the urban rent formation process on both local and metropolitan scale. In recent years, the studies have focused on the increase in land and property value generated by public investment and privatized by directly linked owners. The scarcity of public resources, however, have highlighted the need for negotiation tools and decision support models capable of fairly regulating urban rent with the aim of allocating greater resources for the local community.

The institution of the extraordinary urbanization contribution in Italy in the 2014 have outlined the legitimization of the PA to acquire a share of the surplus value generated by the urban variant interventions carried out in PPP forms. However, the absence of a codified methodology has affected the implementation of the regulatory provisions at the local level.

This research, therefore, is part of the framework outlined. The aim has been to define a decision support model that can be useful in the negotiation phases between the PA and private entrepreneur in the context of interventions that provide for a revision in the building parameters established by the current regulatory instruments.

The proposed model, structured by applying the computational logic of Operational Research, has the potentialities to identify the conditions of higher convenience for the parties involved, by determining the amount of the urban planning parameters to be negotiated. Furthermore, by guaranteeing the conditions of minimum financial convenience and the payment by the private entrepreneur of the minimum value of the extraordinary urbanization contribution required by the national law, the proposed model can be applied by public and private subjects to ensure a fair redistribution of the extra-profit generated by the urban variant interventions.

Future insights may concern the application of the proposed model to a real case study to verify its effectiveness. In particular, some limitations concerning the lack of the importance attributed to each variable can be overcome with the inclusion of appropriate weights and with the variation of the percentage of extraordinary contribution in a given range (e.g. between 50% and 100%). In this way, it would be possible to determine the Pareto front of the objective function considered, by determining the amount of the urban planning parameters negotiated by varying the percentage share of the extraordinary urbanization contribution that the private entrepreneur must transfer to the PA.

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