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 · Yeliz Karaca (Eds.)

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Computational Science and Its Applications – ICCSA 2020

20th International Conference
Cagliari, Italy, July 1–4, 2020
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Preface

These seven volumes (LNCS volumes 12249–12255) consist of the peer-reviewed papers from the International Conference on Computational Science and Its Applications (ICCSA 2020) which took place from July 1–4, 2020. Initially the conference was planned to be held in Cagliari, Italy, in collaboration with the University of Cagliari, but due to the COVID-19 pandemic it was organized as an online event.

ICCSA 2020 was a successful event in the conference series, 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, industrial and commercial applications, and plays a unique role in exploiting ICT innovative technologies. The ICCSA conference series has provided 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 general track, ICCSA 2020 also included 52 workshops in various areas of computational science, ranging from computational science technologies to specific areas of computational science, such as software engineering, security, machine learning and artificial intelligence, blockchain technologies, and of applications in many fields. We accepted 498 papers, distributed among 6 conference main tracks, which included 52 in workshops and 32 short papers. We would like to express our appreciation to the workshops chairs and co-chairs for their hard work and dedication.

The success of the ICCSA conference series in general, and of ICCSA 2020 in particular, vitaly depends on the support from 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 wholeheartedly thank them all.

We also wish to thank our publisher, Springer, for their acceptance to publish the proceedings, for sponsoring part of the Best Papers Awards, and for their kind assistance and cooperation during the editing process.

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

July 2020

Osvaldo Gervasi
Beniamino Murgante
Sanjay Misra

Welcome to the Online Conference

The COVID-19 pandemic disrupted our plans for ICCSA 2020, as was the case for the scientific community around the world. Hence, we had to promptly regroup and rush to set in place the organization and the underlying infrastructure of the online event.

We chose to build the technological infrastructure using only open source software. In particular, we used Jitsi (`jitsi.org`) for the videoconferencing, Riot (`riot.im`) together with Matrix (`matrix.org`) for chat and asynchronous communication, and Jibri (`github.com/jitsi/jibri`) for live streaming sessions on YouTube.

Six Jitsi servers were set up, one for each parallel session. The participants of the sessions were helped and assisted by eight volunteer students (from the Universities of Cagliari, Florence, Perugia, and Bari), who assured technical support and smooth running of the conference proceedings.

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

Our warmest thanks go to all the volunteering students, 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.

Our heartfelt thanks go to the keynote speakers: Yaneer Bar-Yam, Cecilia Ceccarelli, and Vincenzo Piuri and to the guests of the closing keynote panel: Mike Batty, Denise Pumain, and Alexis Tsoukiàs.

A big thank you goes to all the 454 speakers, many of whom showed an enormous collaborative spirit, sometimes participating and presenting in almost prohibitive times of the day, given that the participants of this year's conference come from 52 countries scattered over many time zones of the globe.

Finally, we would like to thank Google for letting us livestream all the events via YouTube. In addition to lightening the load of our Jitsi servers, that will allow us to keep memory and to be able to review the most exciting moments of the conference.

We all hope to meet in our beautiful Cagliari next year, safe from COVID-19, and finally free to meet in person and enjoy the beauty of the ICCSA community in the enchanting Sardinia.

July 2020

Ivan Blečić
Chiara Garau

Organization

ICCSA 2020 was organized by the University of Cagliari (Italy), University of Perugia (Italy), University of Basilicata (Italy), Monash University (Australia), Kyushu Sangyo University (Japan), and University of Minho (Portugal).

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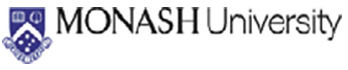

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Contents – Part III

International Workshop on Computer Aided Modeling, Simulation and Analysis (CAMSA 2020)

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The Effects of Urban Transformation Projects on the Real Estate Market: A Case Study in Bari (Italy)

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Abstract. In the present research the effects of urban transformation projects on the housing prices have been analyzed. With reference to a redevelopment initiative in the peripheral area of the city of Bari (Southern Italy), the study has been carried out on a sample of two hundred residential properties, sold in the period 2017–2019 and located in the peripheral district. The main influencing factors considered by sellers and buyers in the negotiation phase have been collected. The application of a data-driven technique has allowed to identify a statistically reliable model through which the functional relationships between the variables considered and the selling prices in the current state have been detected, and the new market values generated by the redevelopment project have been then determined, in order to compare them with those relating to the current state. The results obtained point out an increase in the values of the sample properties as a result of the redevelopment project, confirming the empirically expected outputs.

Keywords: Urban redevelopment · Property enhancement · Urban quality · Housing market · Residential selling prices

1 Introduction

The urban transformation processes play an important role in the context of public policies aimed at promoting the renewal of cities and satisfying the community needs. The issue of recovery and functional reconversion of degraded urban areas and/or public properties has been widely dealt with in the reference literature and in the urban planning practice [1, 4, 5, 11, 13, 14, 16, 22].

The property enhancement initiatives, intended as actions for the renovation of the existing property assets [8], on the one hand, and for the redevelopment of abandoned public spaces in terms of urban regeneration, determine environmental, economic and social externalities that are reflected on the qualitative levels of the urban system [2, 6, 20]. In this framework, the assessment of the effects deriving from the implementation of an urban transformation project in quantitative terms aims at *i)* weighing

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the quality level of urban spaces, *ii)* supporting the decision-making processes in the territorial redevelopment initiatives and *iii)* verifying their effectiveness. Currently, in fact, most urban systems have wide degraded areas. It's about the degraded housing, insufficient or inadequate facilities, ineffective public transport, large abandoned former industrial areas, environmental risks and problems, unattractive and disconnected urban services, widespread unemployment and relevant social problems, such as poverty, low levels of education, aging populations, etc. The decentralization process of the production system from central to more peripheral areas is the main cause of the "emptying" and consequent abandonment of wide urban areas. The recovery initiatives of these spaces allow both to reuse entire portions of cities no longer used for their original functions, and to start wider regeneration and reorganization processes of the urban system. Currently, the public policies of urban territory government, which have no longer been engaged in the strategies for expanding borders, focus on the planning of effective redevelopment initiatives in degraded and/or abandoned areas of cities, in order to improve the level of urban quality, in terms of "appropriate" equipment and infrastructure, adequate to the effective demand of the population who lives in the requalification territories [19]. So far, these areas have been considered places of social unease maximum concentration. Currently, instead, the degraded areas are considered a resource for public and private operators: for the public subject, in fact, they represent an opportunity for a growth of the city image and to demonstrate the skills and efficiency of the administration and to attract capital and private investors; for the private subject, on the other hand, a degraded urban area represents the opportunity for financial earnings deriving from the enhancement of the existing property asset and/or transformation of urban spaces.

The recovery of the underused urban areas represents an important stimulus for a new economic development of the city, not only for quantity of surface but also for physical and environmental qualities, due to the often strategically relevant locations that these areas occupy for the organization and the proper functioning of the entire urban system.

2 Aim

The present research concerns the framework outlined. The aim regards the analysis of the effects that urban transformation projects - property enhancement or public spaces redevelopment initiatives - produce on the real estate market in terms of variation in the housing prices.

In particular, the study intends to define a model for the *ex ante* assessment of the variation in the housing prices produced by an urban transformation project. The evaluation tool will be able to constitute a procedure to support the decision-making processes in the redevelopment of property assets or the re-functionalization of public spaces and it can be used on an urban scale by the several subjects involved in the decision phases of urban planning. Furthermore, on a micro-urban scale, the model can be focus on a single initiative or different projects. The model proposed will address, on an urban scale, to Public Administrations or, in the case of cooperation between the public and private sectors (Public Private Partnership - PPP), to private investors, with

the aim of defining the most suitable place, among the various identified, where to concentrate the available financial resources.

The analysis is applied to the city of Bari (Southern Italy), with reference to an urban redevelopment project currently in progress.

The paper is structured as follows. In Sect. 3 the case study, related to the initiative for the regeneration of the San Girolamo waterfront located in the peripheral area of the city of Bari (Southern Italy), has been described and the variables considered in the model have been identified. In Sect. 4, the methodology implemented has been explained and the main criteria used to assess the reliability of the returned models have been specified. In Sect. 5, the implementation of the method to the case study related to the current state has been illustrated and the results obtained in terms of specific statistic performances and empirical reliability of the functional relationships returned by the technique have been presented. In Sect. 6, with reference to the situation post intervention, some considerations on the results obtained have been discussed. Finally in Sect. 7 the conclusions of the work have been reported.

3 Case Study

3.1 Current Use

The case study concerns the urban redevelopment of the San Girolamo waterfront located in the peripheral area of the city of Bari (Southern Italy). Figure 1 shows the San Girolamo waterfront localization in the urban context of the city.

Fig. 1. San Girolamo waterfont localization (broken red line) in the urban context of the city of Bari (Color figure online)

The San Girolamo waterfront, in the homonymous district north-west of the city of Bari, extends for over a kilometer between Lama Lamasinata and Lama Balice.

With reference to the neighborhood and to the area overlooking the coast, there is a relevant demand for public services not satisfied, above all due to the lack of collective

spaces such as "places for socializing". In particular, currently the commercial intended use located on the buildings ground floors along the coastline are often unused and the promenade is considered exclusively as a fast crossing on the edge rather than as a service axis of the neighborhood. Finally, especially in the west area, on the border with Lama Balice, there are ruins and old and unused buildings characterized by widespread environmental degradation. In Fig. 2 San Girolamo waterfront current state is shown.

Fig. 2. San Girolamo waterfront current state

3.2 The Urban Redevelopment Project

The urban redevelopment project considered provides for the recovery and the functional transformation of the San Girolamo waterfront (Fig. 3).

The intervention aims to determinate a new landscape and environmental configuration overlooking the sea and new ways to use the spaces, by involving the economic and social sectors of the neighborhood in consistency with the sustainability principles and taking into account the environmental conditions.

The project, currently in progress, intends to give a new image of the San Girolamo district, through the redevelopment of the relationship between the urban asset and the sea, by creating new urban spaces and using the natural element of water to enhance the urban landscape.

Furthermore, the redevelopment initiative will encourage economic and social activities for the purpose of a wider socio-economic regeneration of the neighborhood, also through the enhancement of the current public areas characterized by a high degradation state.

The redevelopment of the waterfront provides for the pedestrianization of the road axis with the creation of an "square on the sea" of 8,000 square meters on two levels with about 600 seats facing the sea, and the introduction of new urban functions currently not sufficiently enhanced and equipped such as: service activities, places for leisure, sport, swimming, socialization.

The project proposal aims at introducing implications on a territorial scale, locating on the sea a structure able to attract, due to its exceptional nature, also scientific and tourist interests.

In addition, the project intends to act at the landscape level, in order to protect the seafront from the physical aggression of the water, which progressively causes the coast erosion, through protective elements physically and biologically compatible with the environment and using local natural materials (limestone boulders).

With reference to the coastline, some operations are planned to create new spaces for bathing - in particular four new beaches.

Among the objectives of the project, the rationalization of the mobility system in the neighborhood should be highlighted, through the proposal for a more efficient roadway with a prevailing pedestrianization and cycling on the seafront and with the provision of a new urban water transport which connect the urban areas of Torre a Mare, Palese and Santo Spirito and the cruise terminal of the city of Bari.

Finally, the urban redevelopment project involves the introduction of a structure - the Aquarium - which will constitute a strong architectural sign towards the sea, integrated with the nautical activities and over the water.

The new San Girolamo waterfront will transform the appearance of this part of the coast, becoming a relevant example of urban redevelopment between the city and the sea.

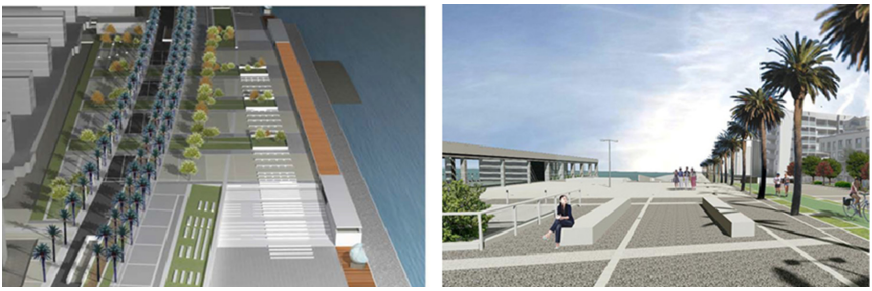

Fig. 3. San Girolamo waterfront redevelopment project

3.3 Variables of the Model

With reference to the peripheral urban area of the city of Bari, in which the project considered in the present research is located, the study sample consists of two hundred residential properties sold in the two-year period 2017–2019 (in particular from the second half of 2017 to the first half of 2019).

For each property the total selling price, expressed in euro (P - dependent variable), and the factors most influential on the residential prices (independent variables) have been collected. As confirmed by the real estate agents operating in the specific housing market, the factors identified represent the characteristics considered by buyers and sellers of residential properties in the negotiation phase. Thus, several real estate operators located in the peripheral urban area of the city of Bari have been consulted.

A list of different intrinsic (relating to the property) and extrinsic (relating to the urban context) factors has been shown to them and it has been asked to indicate the most requested ones by potential buyers and/or to add any missing variables.

In particular, the independent variables considered in the model have been as follows:

1. the total surface of the property (S), expressed in square meters of gross floor area;
2. the number of bathrooms in the building (B);
3. the presence of the lift in the building where the property is located (A);
4. the quality of the maintenance conditions of the property (Sc), taken as a qualitative variable and differentiated, through a synthetic evaluation, by the scores 1, 3 and 5, respectively corresponding to the categories "to be restructured", "fit for habitation" and "restructured";
5. the maintenance conditions of the public spaces adjacent to the property (Sa), assessed through a scale of scores (1, 3, 5) attributed by panels of experts (sociologists, landscape architects, etc.), where the score "1" indicates a bad maintenance conditions of the public spaces, the score "3" a good state and the score "5" an excellent state;
6. the road private and public vehicular traffic (buses) level of the building area (T), assessed by a team of experts (sociologists, landscapers, architects, engineers, etc.) through a scale of scores defined as follows: score 1 indicates a road characterized by high traffic intensity, score 3 indicates a medium traffic intensity, score 5 indicates a road characterized by low traffic congestion;
7. the distance of the property from the nearest railway station (Ds), calculated in kilometers it takes to walk to it;
8. the perceived quality of public space level in the area in which the property is located (Qp), assessed on the basis of affirmative or negative items, to which a sufficiently representative sample of users assigns a numerical score that ranges from "1" (disagreement with the verbal expression) to "5" (agreement with the verbal expression). This perceived quality assessment technique has been borrowed from the studies carried out by Fornara, Bonaiuto and Bonnes [3, 9] for the evaluation of the perceived residential urban quality. In particular, the items considered are the following:

– you can meet bad people,
– people often behave uncivilly,
– late in the evening there is the risk of dangerous encounters,
– the streets are safe enough;

9. the perceived environmental quality level of the area in which the property is located (Qn), assessed through numerical judgments on the basis of the scores scale from "1" (disagreement with the verbal expression) to "5" (agreement with the verbal expression), assigned by a sample of users sufficiently representative of the urban area. The items considered are:

– this neighborhood is generally not polluted,
– this is a quiet neighborhood,
– residents' health is threatened by pollution,
– he heavy traffic in this neighborhood is very annoying,
– there are green areas for relaxing,
– going to a park means travelling to other parts of the city,
– the green areas are well-equipped;

10. the perceived urbanistic quality level of the area in which the property is located (Qu). This variable is determined through six items, to which a sample of individuals assigns a numerical judgment on the basis of their subjective perception of the quality level. The selected items are:

– this neighborhood is too cut-off from the rest of the city,
– his neighborhood is well-connected with important parts of the city,
– the city-center can be easily reached from this neighborhood,
– in the neighborhood there are enough green areas,
– it is easy to cycle around,
– going into this neighborhood means going round in circles;

11. the perceived social quality level of the area in which the property is located (Qs), assessed by means of an articulated system of items. In particular, a subjective judgment is assigned by a sample of individuals, expressed in numerical terms from "1" (total dissent from the verbal expression) to "5" (total consent). The items considered are:

– this neighborhood is well-served with stores,
– there are all kinds of stores,
– stores do not provide a wide range of products,
– stores are not well-distributed,
– stores selling the most needed products can be easily reached,
– this neighborhood is well-equipped with sports grounds,
– various sports can be played,
– sports grounds are insufficient,
– this neighborhood is not well-equipped to host cultural events,
– there are often cultural events,
– libraries are adequate for residents' needs,
– this neighborhood has good school facilities,
– schools can be easily reached on foot,
– schools are located in bad-quality buildings,
– children and teenagers are forced to move from this neighborhood to go to school,
– social services are inadequate,
– the local health service is satisfactory,
– the local health service is inadequate.

It should be highlighted that the variables Qp, Qn, Qu, Qs concern the perceived urban quality, assessed through subjective judgments of an interview sample. In particular, these factors have been included among those most influential on the residential prices, as they consider the opinion of the population and/or frequent and occasional users of the urban area and they transform the expressed opinions in quantitative terms. Thus, these variables take into account the community perceptions of the urban quality into the selling price formation.

4 The Method

The methodological approach applied in the present research is the Evolutionary Polynomial Regression (EPR), which integrates the best features of numerical regression with genetic programming [10]. EPR is a hybrid data-driven technique that uses a multi-objective Genetic Algorithm in order *i)* to combine numerical and symbolic regression methods using polynomial structures, *ii)* to search those model expressions that simultaneously maximize the accuracy of the data and the parsimony of the final mathematical functions.

Set the dependent variable (Y) and the independent variables (Xi), defined the parameters useful to return the function form able to define the functional relationship $Y = \mathrm{f}\ (Xi)$, the generic expression of the non-linear model implemented in EPR is summarized by Eq. (1):

$$Y = a_0 + \sum_{i=1}^{n} \left[a_i \cdot (X_1)^{(i,1)} \cdot \ldots \cdot (X_j)^{(i,j)} \cdot f\left((X_1)^{(i,j+1)} \cdot \ldots \cdot (X_j)^{(i,2j)}\right) \right] \qquad (1)$$

where a_0 is an optional bias, n is the number of additive terms, the length of the polynomial expression (bias excluded), a_i represents numeric parameters to be identified, X_i are the explanatory variables candidate to be selected by the model, *(i, l)* - with $l = (1,\ldots, 2\mathrm{j})$ - is the exponent of the *l-th* input variable within the *i-th* term, f is a function chosen by the user among a set of possible mathematical expressions. The exponents *(i, l)* are also selected by the user in a range of possible real numbers. The parameters a_i are evaluated by the Least Squares Method.

The EPR implementation involves the selection and generation of a series of different models whose functional form is the best combination of the input variables Xi, identifying for each one the exponents *(i, l)* and the numerical coefficients a_i.

The EPR main advantage is that the genetic algorithm underlying the procedure does not require the exogenous definition of the mathematical expression and of the number of parameters that fit better the data collected, but the iterative process itself returns the best solution [21]. Thus, the EPR overcomes the classical multiple

regression method, as it selects only the "good" solutions and rejects the "bad" ones in order to obtain the best performance of the final results. Moreover, EPR applies an evolutionary multi-objective genetic algorithm as an optimization strategy based on the Pareto dominance criterion aimed at *i)* maximizing the model accuracy through the satisfaction of appropriate statistical criteria for the verification of the equation; *ii)* maximizing the model's parsimony through the minimization of the number of terms (a_i); *iii)* reducing the complexity of the model through the minimization of the number of the explanatory variables (Xi) of the final equation.

The key idea of the EPR method concerns the search of the best functional form of the price function in which each term is a combination of the independent variables with a numerical multiplier coefficient and a proper exponent.

The accuracy of each algebraic expression generated by the EPR technique implementation is checked by the Coefficient of Determination (CoD), defined in Eq. (2):

$$COD = 1 - \frac{N-1}{N} \cdot \frac{\sum_{N} \left(y_{detected} - y_{estimated}\right)^2}{\sum_{N} \left(y_{detected} - mean\left(y_{detected}\right)\right)^2} \tag{2}$$

where $y_{estimated}$ are the values of the dependent variable estimated by the methodology, $y_{detected}$ are the collected values of the dependent variable, N is the sample size in analysis. The CoD value varies between 0% and 100%. The closer the CoD value is to 100%, the higher the statistical performance of the model returned by EPR. The technique EPR returns a set of mathematical expressions characterized by a different level of statistical accuracy and a different complexity level of the algebraic structure. The analysis of the compromise solutions between the statistical performance and the complexity of the expression allows to select the most suitable models according to the specific application. With reference to the real estate sector, so far EPR has been generally used to determine the price function $Y = f(x_1; x_2; \ldots x_n)$ in order to identify the explanatory factors most influential in the mechanisms for the formation of the housing prices in different territorial contexts and to analyze the marginal contribution of each of them on the prices [15, 17, 18].

5 Application of the Method of the Case Study (*Ante-project* Situation)

With reference to the current state (*ante-project* situation), the EPR method has been implemented considering the structure of the generic model identified in Eq. (1) without function f selected and with the dependent variable Y as the natural logarithm of the total selling price ($Y = ln(P)$) [7, 12]. Each additive monomial term of the mathematical

expression is assumed as a combination of the inputs - the explanatory variables *Xi* - raised to the proper numerical exponents. In particular, in order to have a wide range of models, the candidate exponents belong to the set (0; 0.5; 1; 2) and the maximum number *n* of additive terms in final expressions is assumed to be eight.

The implementation of the econometric method has generated several solutions, each one characterized by a different number of additive terms, combinations of the variables and a different level of CoD. With reference to the peripheral urban area of the city of Bari where the study sample properties considered in the research are located, the model defined by Eq. (3) has been selected as able to explain the mechanism of formation of selling prices in the current situation in the specific urban area.

This model is characterized by a high CoD value (+79.48%) and it considers all the explanatory variables considered in the analysis.

$$Y = +1.69 \cdot Ds^{0.5} \cdot Qu^{0.5} \cdot Qn^{0.5} + 0.35 \cdot Sc + 0.65 \cdot A^{0.5} \cdot Ds^{0.5} \cdot Qp^{0.5} + 5.66 \cdot B^{0.5} \cdot Sa^{0.5} \cdot T^{0.5} Qn^{2} \cdot Qs^{2} + 6.34 \cdot S^{0.5} - 2.76 \cdot S + 8.32 \quad (3)$$

The mathematical expression of the model of Eq. (3) does not allow to immediately verify the empirical coherence of the coefficients signs of the explanatory variables selected, being the same variable present in more terms and/or combined within the same term with other factors. In the present research an empirical approach has been used, in order to verify the empirical consistency of the functional relationships returned by the EPR implementation on the study sample and to define the marginal contribution of each factor selected by the model. In particular, the procedure adopted constitutes a simplified exogenous approach which, instead of determining the partial derivative of the dependent variable with respect to the *i-th* variable, provides for the variation of the *i-th* variable analyzed in the variation interval in the observed sample, keeping the mathematical terms of the other variables are constant - i.e. equal to the average value for the quantitative variables and 1 for the other dummy variables. Figure 4 shows the functional relationships obtained for the study sample considered.

6 Determination of the Housing Prices After the Redevelopment Initiative (*Post-project* Situation)

The proposed model for the assessment of the effects of the urban redevelopment initiative considered in the city of Bari on the housing prices provides for this mandatory assumption: the function that links the selling prices and the intrinsic and extrinsic factors that contribute to their formation after the initiative (*post-project* situation) remains the model obtained by the implementation of the algorithm EPR in

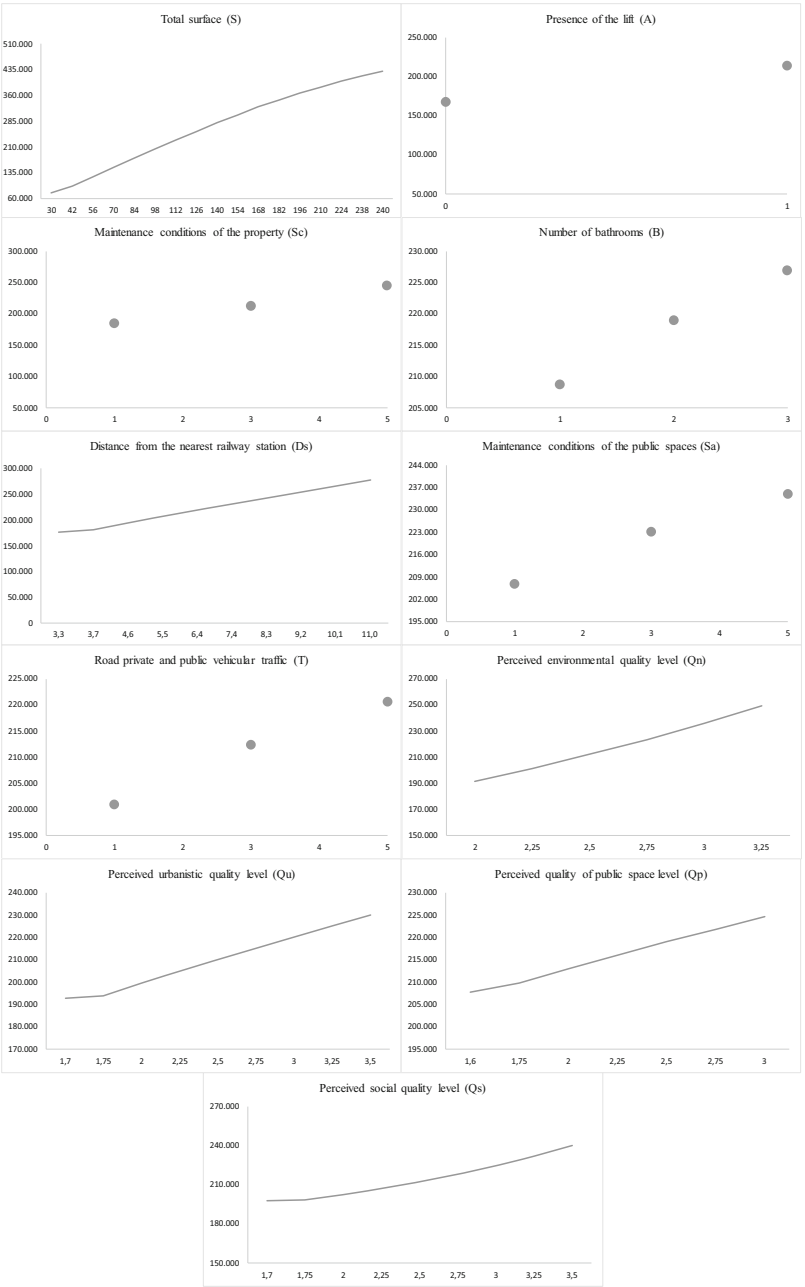

Fig. 4. Functional relationship between the explanatory variables selected by the model and the housing prices in the current state (*ante-project* situation)

order to identify the functional relationships between prices and explanatory variables in the current state (*ante-project* situation), i.e. the model of Eq. (3).

It is assumed that in the *post-project* situation the structural dynamics of the real estate market and, in particular, of the residential sector are the same of the current state. Therefore, the most influencing factors for the sellers and the buyers in the processes of selling prices do not change compared to those considered in the *ante-project* situation. The values of the extrinsic variables for which a variation is expected have been replaced in the model, using the same operating methods implemented for the definition of the same variables in the current state. With reference to the intrinsic and extrinsic variables that are not modified in the *post-project* situation, the values of these characteristics previously determined and/or calculated do not vary. Therefore, it is possible to determine the new selling prices of the sample properties, assessed as a result of the project realization. The results obtained in terms of comparison between the estimated *ante-project* prices and the prices assessed after the implementation of the redevelopment initiative, confirm the outputs empirically expected in terms of growth in the market values of the properties located in the area of the redevelopment. In particular, the average price increase assessed is approximately equal to +32%.

The propagation effect of the redevelopment initiative on the housing prices highlights a direct functional link between the proximity of the property to the requalified waterfront and the positive variation of the expected values. In fact, it should be noted that the residential properties of the study sample that overlook the new waterfront are those most involved.

With reference to the nearest properties to the urban redevelopment project, significant variations of selling prices have been assessed, also equal to +140%. Therefore, this confirms the strong relevance that the San Girolamo waterfront initiative could be on the urban context in which it is located, in terms of urban quality level improvement. In fact, the project solution is aimed to rehabilitate the waterfront portion and the neighborhood by overcoming the public services lack, the current collective spaces degradation state and by contrasting the social exclusion.

The new public urban space realization will allow the promotion of economic and social activities able to trigger off wider urban development processes, among which the increase in value of existing property asset represents an important factor of the more general economic recovery.

With reference to the case study considered in the present research, in Fig. 5 a flow chart shows the main steps implemented in order to analyze the effects of San Girolamo waterfront redevelopment project on the housing prices in the peripheral area of the city of Bari.

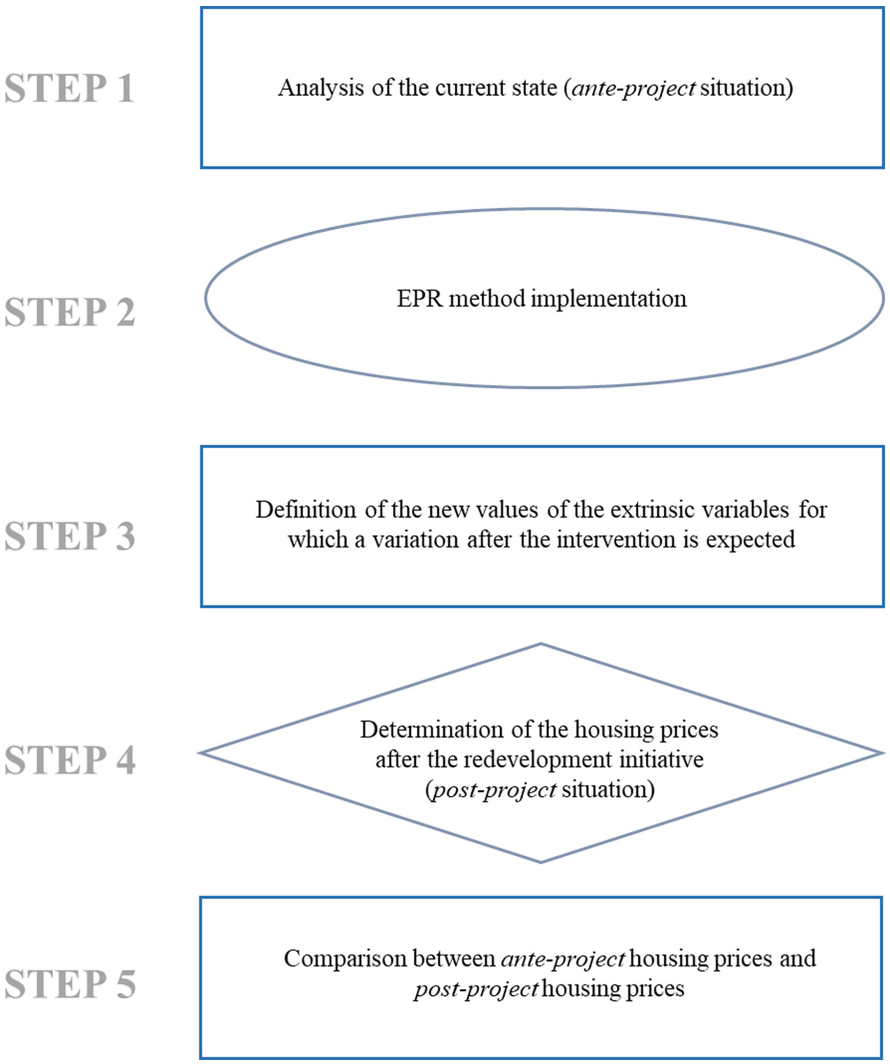

Fig. 5. Flow chart of the main steps implemented in the analysis

7 Conclusions

The processes of urban transformation - property enhancement or public spaces redevelopment initiatives - constitute operations of public spaces recovery on different scale, modifying the physical and functional structure of the urban system and producing several effects on the surrounding context and, in a gradually lower form, on the city.

With reference to the current need to support the public administrations and the private investors through valid evaluation tools in order to guide urban planning

processes towards effective choices in the medium and long term, in the present research a model for the *ex ante* assessment of the variation in the housing prices that an urban transformation project generates, has been developed. Referring to an urban redevelopment project currently in progress in the peripheral area of the city of Bari (Southern Italy), a study sample of two-hundred residential properties has been collected. The methodology EPR has been implemented in order to identify the main factors that are influent in the phenomena of housing price formation in the current state (*ante-project* situation). In order to analyze the effects of San Girolamo waterfront redevelopment project on the housing prices, the new values of the extrinsic variables selected for which a variation is expected as result of the redevelopment initiative, have been assessed. Using the model generated by the implementation of the EPR technique related to the current state, for each property the new prices have been determined and they have been compared with those assessed in the *ante-project* situation.

The analysis has been limited to the geographic context of the peripheral area of the city of Bari in which the project is located.

Further developments may be carried out to study the "complementary" and additional effects of San Girolamo waterfront redevelopment project on the housing prices in the other city areas and, more generally, on the entire urban system of the city of Bari. The new waterfront could constitute a landmark not only for the peripheral San Girolamo district, but also for the entire city of Bari.

The present work is part of a research of high and current interest. In particular, the proposed model aimed at assessing the effects of an urban transformation initiative on the real estate market will be able to support the decision-making processes and to integrate the traditional financial and economic tools currently implemented for the feasibility analysis of the projects. Finally, further insights may address *i)* the application of the proposed procedure in other national and international territorial contexts and the experimentation of the same technique for the study of the complementary effects of different contemporary transformation projects, *ii)* the comparison of the models obtained by the EPR implementation with the output generated by other techniques (e.g. Artificial Neural Networks, Cellular Automata, spatial analysis, ecc.).

Aknowledgements. The authors declare that the contents of the paper are based on data and information developed within the "Innonets" Project founded by the Interreg Greece-Italy Program and are aimed at promoting the Project itself. For more information see http://interreginnonets.eu/en.

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