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The Evaluation in the Urban Projects Planning: A Logical-Deductive Model for the Definition of "Warning Areas" in the Esquilino District in the City of Rome (Italy)

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Abstract: With reference to the current focus on urban redevelopment issue, the evaluation of the projects plays a central role for the definition of effective urban development policies. In the present research, a logical-deductive model for the identification of "warning areas" is proposed. Given an urban area to be renovated, the developed methodological approach starts from the detection of the main existing architectural, historical and environmental emergencies in order to investigate the appreciation of the reference market for the higher or lower proximity to each considered urban pole. Thus, an econometric technique is implemented to examine the influence of each locational factor on selling prices, by assuming the property asset price increase as a proxy of the benefits generated by the urban redevelopment intervention for local communities. Furthermore, the proposed methodology is applied to the Esquilino district in the city of Rome (Italy), for which a relevant urge of urban regeneration is found, to orient the selection phases of the areas that need more attention from public entities.

Keywords: urban regeneration; urban projects; sustainable development goals; decision-making processes; residential market

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1. Introduction

The need to adopt effective tools for evaluating and monitoring urban transformation projects is increasingly prominent, and aimed at implementing inclusive, sustainable and effective urban interventions. The mechanisms of redevelopment of the urban context are connected with the social and productive changes that constantly affect cities and involve several stakeholders (public and private) whose interests and needs are varying and often conflicting.

In this sense, urban planning based on the concept of zoning and, therefore, on the definition of a city based on the distribution of functions is now outdated and, over time, has generated a significant gap between the historic center, the more recent construction areas and the peripheral ones.

At European level, the New Urban Agenda [1] and the Sustainable Development Goal (SDG) No. 11 places the urbanization at the center of territorial development policies [2], by recognizing a fundamental role to urban redevelopment initiatives capable of pursuing the objectives of sustainable development and to bridge the gap between the different parts of cities in terms of social and urban quality.

In the recent decades, in the context of urban development processes, the construction sector has mainly focused on the recovery and re-functionalization of the degraded

areas of the consolidated city, through widespread and punctual building, urban, environmental and energy [3] redevelopment initiatives on the existing real estate assets and the abandoned urban spaces.

The persistence of the economic crisis—which has worsened in the recent health emergency caused by the COVID-19 pandemic and the geopolitical situation—connected to the public attention paid to the issue of urban rehabilitation as an strategic planning tool, has oriented the real estate and construction sector dynamics, on the one hand, towards the protection of the urban landscape in its natural and built components and, on the other one, the promotion of profitable synergies between the public entity and private investors. This cooperation mechanism allows to overcome the traditional dispersion of investments and to orient building interventions towards conscious choices.

In the context outlined, the relevance assumed by regeneration within the urban governance justifies the urge to develop effective tools for the preliminary assessment of projects capable of supporting decision-making processes and providing design guidelines consistent with the characteristics of the site in which the intervention is located and with the local community demand.

The revitalization of underused areas or abandoned buildings located in the consolidated city have determined a radical change in the elaboration of plans and projects able (i) to convincingly combine the financial feasibility with the sustainability goals and (ii) to define integrated design solutions aimed at the soil saving, the improvement of the urban quality and the rigorous, responsible and effective use of private resources. Given the complexity of the topic and the variety of partners involved in these typologies of initiatives, the implementation of tools to assess and guide the development of urban investments allows to perform successful interventions. Starting from the definition of the requirement framework for orienting the functions to be introduced in the underused buildings/areas, the tools for monitoring and evaluating the effectiveness of urban projects should be applied to select the operations to be carried out, to verify the consistency with the expected results and the compliance with the fixed budget (cost control).

For example, with reference to the developing countries, within the Global Future Cities program, the SDG Project Assessment Tool—developed by UN-Habitat as a digital and easy-to-use tool—intends to assess the congruence of the single project to be evaluated with the urban sustainability goals [4,5]. The SDG tool main purpose is to improve the urban projects quality in the design phase, in order to promote the interventions with high benefits in the medium and long run. In general terms, the tool application would allow to orient a participatory process between the governments and the partners involved in the initiative, to develop strategies for optimizing the alignment of the project with the SDGs and the program objectives. In this sense, the assessment tool can be adapted to single intervention, by meeting the priorities of the different cities, analyzing the links between the specific project and the SDGs and promoting its continuous improvement.

In the current context, the economic measures introduced by governments within the National Recovery and Resilience Plan require the development of new operational guidelines at the territorial, urban and architectural scale for the urban regeneration, to support the decision-making processes of Public Administrations and to effectively manage the funding obtained. Therefore, it is increasingly urgent to define evaluation techniques through which a project solution and/or more alternatives can be appropriately analyzed, for the purpose of avoiding the start of unsuccessful and not sustainable investments.

In this sense, the intervention feasibility assessment and verification techniques capable of guiding the choices should be applied periodically during the different phases of project implementation in an iterative evaluation mechanism, by determining a constant interaction among the stakeholders to further improve projects.

Currently, in general terms, the urban regeneration projects arise from the need to limit land consumption, and, at the same time, to recover city portions from degraded and neglect conditions to increase their safety and livability. In fact, in the last decade, the urban recovery has been consolidated as a multi-participated approach to give competitive

cities, relaunching their territorial image on an aesthetic, cultural, economic and social level with particular attention to environmental field. The rehabilitation processes do not have predefined rules, but adapt to the specificities of each case and to the existing socio-economic dynamics that orient the urban requalification, especially in the most degraded areas, starting from the changing needs of the community and analyzing the current and forecast demand and supply.

In the current Italian legislation, although there is not a unique and complete definition of urban regeneration, numerous references in the national regulatory framework and several definitions—not always convergent—in the regional laws are included. Among these, the Dpcm of 21 January 2021 [6]—named "Assignment to municipalities of grants for investments in urban regeneration projects, aimed at reducing marginalization and social degradation phenomena", issued pursuant to the Art. 1, paragraphs 42 and 43 of Law 29 December 2019, No. 160 [7], provides for the financing of three-year interventions for urban rehabilitation, up to 2034, by the municipalities, establishing criteria and methods for requesting contributions.

Thus, due to the abandoned and/or underused large building stock in the Italian territory and the frequent public spaces in decay conditions, over the last decades a significant need of urban transformation initiatives has emerged. In the international reference literature, various studies have evaluated the effects deriving from interventions aimed at improving housing conditions and neighborhood services on the quality of life of usual and occasional users of the specific redeveloped area. These researches have shown that the urban recovery interventions can determine a relevant improvement in the life quality associated to the psychological well-being for an increase in the user's livability [8–10].

2. Aim of the Work

The present research aims to propose and test an operational methodological approach capable of defining, among the different urban areas included in a macro-area, those that need more attention from public entities, hereinafter referred to as "warning areas", in relation to their aptitude to be transformed and/or functional converted for uses different than the original ones.

In this sense, after the selection of a city portion to be redeveloped, the study intends to identify the main architectural, historical and environmental emergencies that represent amenities (centers of attraction whose proximity is positively appreciated on the reference market) or disamenities (urban poles or places whose proximity negatively affects the choices of buyers and sellers). In brief, the implementation of an econometric technique allows to analyze the most influencing localization factors on the current dynamics of the residential selling prices formation. The logical-deductive model could be included in the preliminary stages to the definition of one or more project solutions, by identifying the main urban areas to be regenerated and capable of determining greater benefits for the communities.

In particular, the existing residential asset increase is assumed as a proxy of the positive effects perceived by the community who lives in the considered urban area.

The main goal of this study concerns the determination of the main areas (included in a larger macroarea or district) to pay attention for the drafting of guidelines for urban regeneration interventions. The strategic lines could represent a valid support for orienting the decision-making processes of the Public Administrations or the private investor, in the situations of cooperation between the public sector and the private one (public private partnership).

With reference to the Esquilino district located in the city of Rome (Italy), for which currently a significant urgency of urban renewal is detected, the proposed logical-deductive model is implemented to guide the selection phases of the warning areas, preliminary to the design steps.

The paper is structured as follows: In Section 3 the main contributions in the existing reference literature concerning the importance of the role of the assessment in the urban

planning policies are illustrated. In Section 4 the case study related to the Esquilino district in the city of Rome (Italy) is introduced: some analysis of the historical background on the district, of the demographic data and of the existing property asset are carried out. Moreover, a study sample consisting of four hundred residential properties recently sold is detected. In Section 5 the econometric technique implemented in the analysis is introduced, its application to the case study is shown and the results are interpreted. In Section 6 the conclusions of the work are discussed and the further development are pointed out.

3. Background

The role of the assessment tools to support the complex decision-making processes within urban regeneration is crucial, as the evaluation is fundamental to verify the feasibility of the project solution and to monitor the construction and management steps of the work. With reference to the first design stages, the assessment tools assume a crucial role as they should guide the decision processes, by orienting the selection of the projects to be implemented or their realization modalities towards a specific goal. The choices mechanisms are not unique and the need to take into account different aspects (environmental, social, financial, economic, cultural, administrative, etc.) is prominent. In theoretical terms, the assessment tools should be able to bridge the urban planning, the decisions field and the behavioral sciences in order to combine the needs of the involved stakeholders (investors, communities, public governments, etc.) and to provide effective indications for the development of the urban regeneration measures.

In this sense, the evaluation involves all the planning phases, from the earliest stages of the initial embryonic project idea conception, to those of design, to the operating phase and disposal one, by considering the project life cycle. According to the time in which the assessment is implemented, it is ex-ante, in itinere and ex-post appraisal. In particular, the first (ex-ante evaluation) aims to estimate the expected future impacts of a plan/project before its implementation, by comparing different alternatives for optimizing the available resources and selecting the "best" project solution. The second type (in itinere assessment) is carried out simultaneously with the development of the plan/project for monitoring the initiative implementation, in order to verify its impacts in line with the set objectives. The last category (ex-post evaluation) intends to assess the results, to verify the plan/project compliance with the fixed goals and the actual achievement of the expected outputs. However, currently there is not a systematic and unique approach aimed at supporting the decisions of the Public Administrations for a successful planning of urban regeneration projects to be implemented.

With regards to the subjects involved in urban redevelopment initiatives various Authors [11–20] have highlighted the relevance to implement the stakeholder analysis in order to identify the roles of the different parties involved in the process and to study the interactions between them. In general terms, the urban projects or programs assessment should be based on interdisciplinary approaches able to define the "best" intervention strategy, according to, on the one hand, the specific architectural and structural requirements, and the other one, to perceptions and needs of residents [21]. The communities need constitute a fundamental aspect to be considered in the urban planning operations, as these firstly orient the choices related to the new intended uses to be provided and included in the project. Through the implementation of questionnaires, surveys, etc. capable of actively involving stakeholders interested in the initiative, the judgments or the opinions of the ordinary users, occasional visitors, experts panel or specific groups of communities should be taken into account for the selection of the "best" solution among different planned project solutions.

In the prior phases to the project approval, the evaluation should concern the multiple feasibility aspects, in order to verify the convenience in the project implementation from different points of view (environmental, technical, procedural, financial, economic-social, etc.). In fact, the need to draw up effective planning strategies within the territorial sustainable development policies is expressed in the definition of multidisciplinary assess-

ment techniques that integrate financial aspects with socio-economic and environmental criteria [22].

Within the framework mentioned, the use of multicriteria techniques [23–29] and economic financial techniques [30–34] is associated with a hybrid evaluation approaches [35–37], with the aim of identifying valid urban regeneration solutions able (i) to meet the needs of the community and (ii) to preliminarily determine the outputs of the intervention realization for the different parties involved.

The combination of different typologies of qualitative and quantitative assessment techniques has been considered beneficial compared to the single method use [38]. In the reference literature, several studies have implemented multidimensional approaches [39–45] to overcome the limits of any single method and to consider the different aspects of sustainable urban development that can activate inclusive decision-making processes and participatory mechanisms [46,47]. For example, the combinations of Multi Criteria Analysis (MCA) and SWOT analysis have been developed by Kajanus et al. [48] for the strategic natural resources' management, whereas Yavuz [49] has summarized the stakeholder analysis in a SWOT for the identification of the success factors in watershed management in Beyúehir Lake Basin in Turkey. Moreover, with reference to the transport planning, Medda and Nijkamp [50] have proposed an integrated evaluation methodology by offering a synthesis framework combining different assessments and policy analysis methods and by demonstrating that the combinatorial method is flexible and able to evaluate complex multidimensional political issues.

By highlighting the complexity that characterized the urban governance due to the plurality of points of view involved and the set of criteria that guide the decisions, Ferretti [51] has developed a multi-method framework based on the integration of three tools, namely (i) stakeholder analysis, to identify the multiple interests involved in the process, (ii) cognitive mapping, to define the shared set of objectives for the analysis, and (iii) multi-attribute value theory to measure the achievement level of the previously defined target for supporting the public policy making.

Similarly, to guide the decision-makers in planning, designing and managing complex urban regeneration plans, Della Spina [52] has assessed the feasibility of an integrated multi-dimensional and multi-level approach that combines the stakeholder analysis and the cognitive maps to identify the interests and the objectives and a MCA to define the most effective and shared alternatives and to determine a priority list of the public interventions.

A study carried out by Berta et al. [53] has aimed at proposing a multi-level decision approach, able to support the strategic urban design, with reference to the rehabilitation processes for abandoned industrial sites in urban areas. With regards to different alternative proposals for the requalification of the former Shougang/Er-Tong mechanical factory in Beijing (China) three methods have been combined according to a multi-phase design: (i) stakeholders' analysis, (ii) MCA, and (iii) discounted cash flow analysis.

Over time, within the development of urban planning tools to orient the measures and the priority intervention urban areas selection, the Geographic Information Systems (GIS) have been widely used for the collection and management of spatial data based on their geographic coordinates. However, several authors have pointed out their limited capabilities to address complex spatial decision problems, e.g., in representing choices and priorities among a wide number of objectives [54–56] e they have proposed to combine multi-criteria systems and GIS in the field of urban planning for the projects sustainability assessment [57]. Marra et al. [58] have described the possible classification criteria of urban regeneration interventions in order to achieve a better analysis of territorial policies and their effects. In their research, a review of the literature on urban regeneration criteria has carried out, by revealing that the projects have gradually shifted from being "place-oriented" to being "people-oriented". In this sense, the performance evaluations are considered to be useful tools for ensuring the outcomes of sustainable renewal [59]. For example, Hemphill et al. [60] have developed an indicator-based approach for the evaluation of transformation initiatives to deliver holistic and coherent sustainable-led strategies. Pérez

et al. [61] have proposed a new spatial decision support system for urban renewal projects at the neighborhood scale, based on six sustainability objectives for existing districts, by considering the current neighborhood situation and its expected long-term evolution, Dezhi et al. [62] have defined an assessment model of the integrated sustainability for public rental housing projects, by identifying fourteen indices, including six indices of ecological sector, five of economic subsystem and three of social one.

Kaur and Garg [63] have reviewed six most widely used urban sustainability assessment tools i.e., Building Research Establishment Environmental Assessment Method (BREEAM) for communities, Comprehensive Assessment System for Built Environment Efficiency (CASBEE) for urban development, Green Building Index (GBI) for township, Leadership in Energy and Environmental Design (LEED) for neighborhood development, and Indian Green Building Council (IGBC) for green townships and Green Rating for Integrated Habitat Assessment (GRIHA) for large development, by pointing out that most of them examines the sustainability from different perspectives by laying more emphasis on some aspects like infrastructure and resource management while ignoring others like cultural, business and innovation.

Taking into account the current prevailing urban trends, aimed at the transformation of the existing urban tissue, the analysis of the effects that an intervention of urban regeneration determines on urban quality, on the real estate market and, in general, on the local economy, constitutes a fundamental step to effectively guide the decision-making dynamics for the territorial development.

The present research is part of the outlined framework, aimed at proposing a logical-deductive model to guide the subjects involved in the selection processes related to the urban redevelopment initiatives through the "warning areas" identification.

4. Case Study

4.1. The Esquilino District

The case study concerns the Esquilino district located in the first municipality ("Municipio I") of the city of Rome (Central Italy), in the east area of the historical centre. The total surface of the study area is equal to 2.5 square kilometers and the population is composed by 25,224 inhabitants, with 36.6% of different nationalities people from the native Italian one.

Although geographically the Esquilino is a central district in the context of the city of Rome, the area is located outside the historic center and, due to its topographical regularity, is an elongated quadrilateral in correspondence with the lands interested by the railway traffic.

The main boundaries that delimit the Esquilino district are defined by large urban landmarks, both modern such as the Termini railway station and religious ones (such as the basilica of San Giovanni in Laterano, the basilica of Santa Maria Maggiore, the basilica of Santa Croce in Gerusalemme) and archaeological sites (such as the Terme di Diocleziano, the Aurelian Walls and Porta Maggiore [64]). Figure 1 shows the localization of the Esquilino district within the city of Rome (in red on the left) and the identification of the main landmarks that determine its boundaries (on the right).

In the Regulatory Plan of 1883, the district has been included as "under construction" and, after the 1861, a strong urban expansion has involved the area. From the point of view of the urban fabric conformation, the Esquilino is characterized by a regular building pattern, consisting of repeated blocks, mostly of the same size [65]. Starting from the first construction years, the crucial center of the district has been assumed by Piazza Vittorio Emanuele II, inaugurated in 1884, around which the most luxurious apartments of the district have been realized. The current configuration of the area is almost the same as the original one: in fact, the analyzes carried out on the existing property asset have allowed to verify that the construction period of most buildings is prior to 1919. Furthermore, from the early 1900s, various services and infrastructures—that are still currently functioning—have been realized, such as the Aquarium, currently the Order of Architects, Landscapers,

Planners and Conservators of the city of Rome building, the Ambra Jovinelli theatre, barracks, theaters and school buildings.

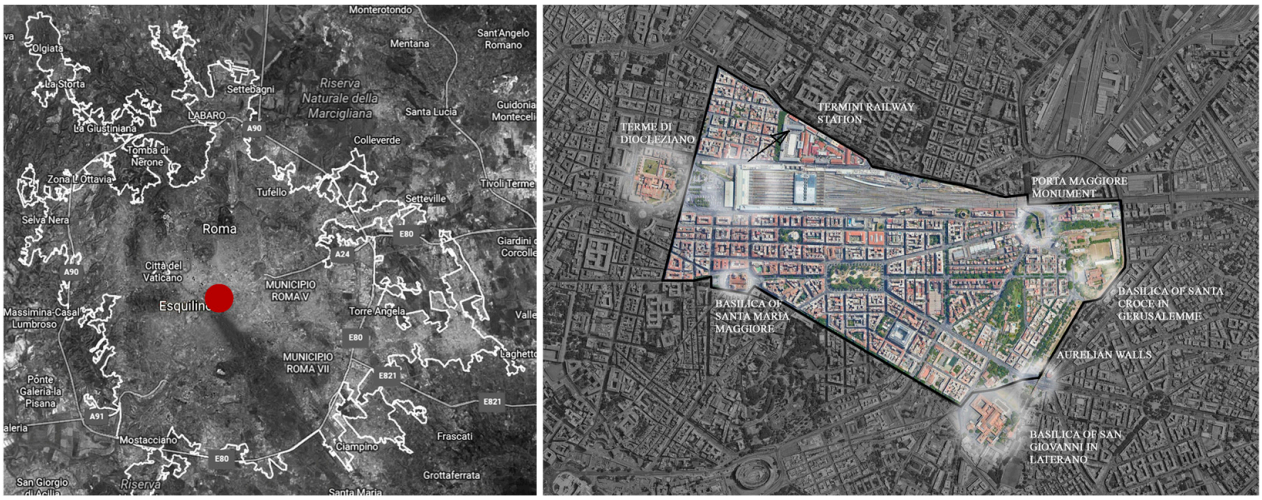

Figure 1. Localization of the Esquilino district (in red) in the urban context of the city of Rome (**on the left**) and identification of the main landmarks on the district boundaries (**on the right**).

In the 1930s both the Piazza Vittorio market and the garden in Piazza Dante, that is the biggest green space in the urban area of the Esquilino, in a current good conservative state and in front of the Secret Service Offices, have begun to become fundamental attractor poles for the inhabitants of the district and, in general terms, of the city of Rome.

With reference to the area accessibility, the subway line A crosses the neighborhood with stops at Manzoni, Vittorio Emanuele and Termini and it has been inaugurated in the 1980s. The presence of the Termini railway station, of numerous attractor poles (squares, markets, monumental buildings, etc.) and the great proximity to the historic and monumental center have led the Esquilino district to be an important destination for commuters, tourists and immigrants [66]. In this sense, already starting from 1986 significant foreigners' flows have been detected until 2004 in which non-national population represented 20% of the total one of the entire urban area [67]. Over time the progressive inclusion of the foreigners from countries with strong migratory pressure (of Bengali, Filipino and, above all, Chinese nationality), in addition to affirming the multi-ethnic area character, has contributed to determine situations of hardship, also in housing deprivation terms [68,69], by strengthening the widespread prejudice and the sense of extraneousness for the native neighborhood population. The development of an urban context "unrelated" to the local identity standards and characterized by social critical issues, contrasts with the "centrality" of the urban area, given by its geographical position. In this sense, a research of Cossetta et al. [70], aimed at investigating the dynamics that have affected the entire area of Esquilino from its construction, focuses on the radical transformation which, from a "bourgeois neighborhood", has made the district a " central periphery" in opposition to the surrounding urban areas.

In recent decades, a relevant need to define redevelopment processes capable of improving the Esquilino urban quality and, more generally, of raising the life quality for the district citizens, has been detected. Numerous Authors [71–74] have analyzed the main causes of the degradation phenomena that have involved the entire area in the last 50 years, by arguing that the urban interventions should concern strategic renewal programs in order to (i) provide a significant positive impact on the quality of life of the communities; (ii) become an opportunity to promote social participation policies, (iii) encourage local entrepreneurship.

The neighborhood widespread decadence conditions are currently recognized mainly in the Piazza Vittorio Emanuele II and in the several assistance centers and meeting places

for immigrants. It should also be pointed out that the Termini railway station, while constituting a constant transit place and the main hub for reaching the other parts of the city (through the subway) and the other municipalities (through railway station), represents an aggregation place for homeless people. Therefore, the Esquilino district is defined as a complex urban area [75,76], in which numerous contradictions can be found, i.e., tourism and crime, multiethnic culture and prejudice, architectural beauty and degradation, marginalization and acceptance.

In this sense, the regeneration interventions should be able to (i) enhance the important existing architectural and cultural emergencies, (ii) monitor the social degradation phenomena, (iii) reduce the presence of unsafe places. In the framework outlined, it should be observed that in the last few years, various spontaneous initiatives have been promoted by the district associations, with the purpose of giving the main landmarks a more central role: for example, different functional reconversion initiatives have been carried out for Piazza Vittorio Emanuele II through the promotion of events aimed at socio-cultural inclusion and integration, among which the Chinese New Year (www.piuculture.it/2019/02/capodanno-cinese-piazza-vittorio/, accessed on 25 February 2022) and the anti-racist networks protests, or targeted interventions for the arrangement of the green spaces located in the same square have been included in the FAI (Fondo Ambiente Italiano) memorandum of understanding of 2014. These first measures testify to the urgency of urban transformation to be carry out for the improvement of the urban quality of the public spaces and, more generally, of the district. The need to properly locate the infrastructures [77,78], facilities [79–81] and the green areas [82] within a specific geographical territory is a key factor for the sustainable and competitive development of smart cities. In line with the current market demand and the site physical and geo-morphological characteristics, the urban site selection phase aims at finding the best location with desired conditions that satisfy predetermined selection criteria [83]. In this sense, in the present research the localization of the areas to be redeveloped assumes a crucial relevance for urban planning policies to improve the quality of urban projects at the design stage. The logic-operative procedure implemented for the identification of the warning areas in the Esquilino district firstly provides the identification of the main intrinsic and extrinsic factors that are ordinarily considered in the bargaining phases. Then, the econometric technique implementation allows (i) to determine the most influencing variables on selling prices and (ii) to analyze the functional correlations between the variables selected and the selling prices, in order to assess the positive or negative appreciation of the market for each factor. Among the initially considered main architectural, historical and environmental emergencies (extrinsic factors), those whose proximity negatively affects the choices of buyers and sellers are highlighted and, therefore, the areas for which a higher attention from public entities should be paid are focused.

4.2. Variables

According to the aim of the research related to the investigation of the warning areas, i.e., the areas for which a greater urgency for urban redevelopment is detected, a sample of four hundred residential properties sold in second half of 2021, located in the Esquilino district and whose the selling prices and some specific factors are known, is collected. In the Figure 2 the localization of the selected residential units is reported.

For each residential unit included in the study sample a set of characteristics has been investigated. With reference to the local residential market, the existing literature and the aim of the present research, the explanatory selected variables represent the most influencing intrinsic (technological and physical) and extrinsic (locational) characteristics whose contribution to the housing prices differently affects the market appreciation [84].

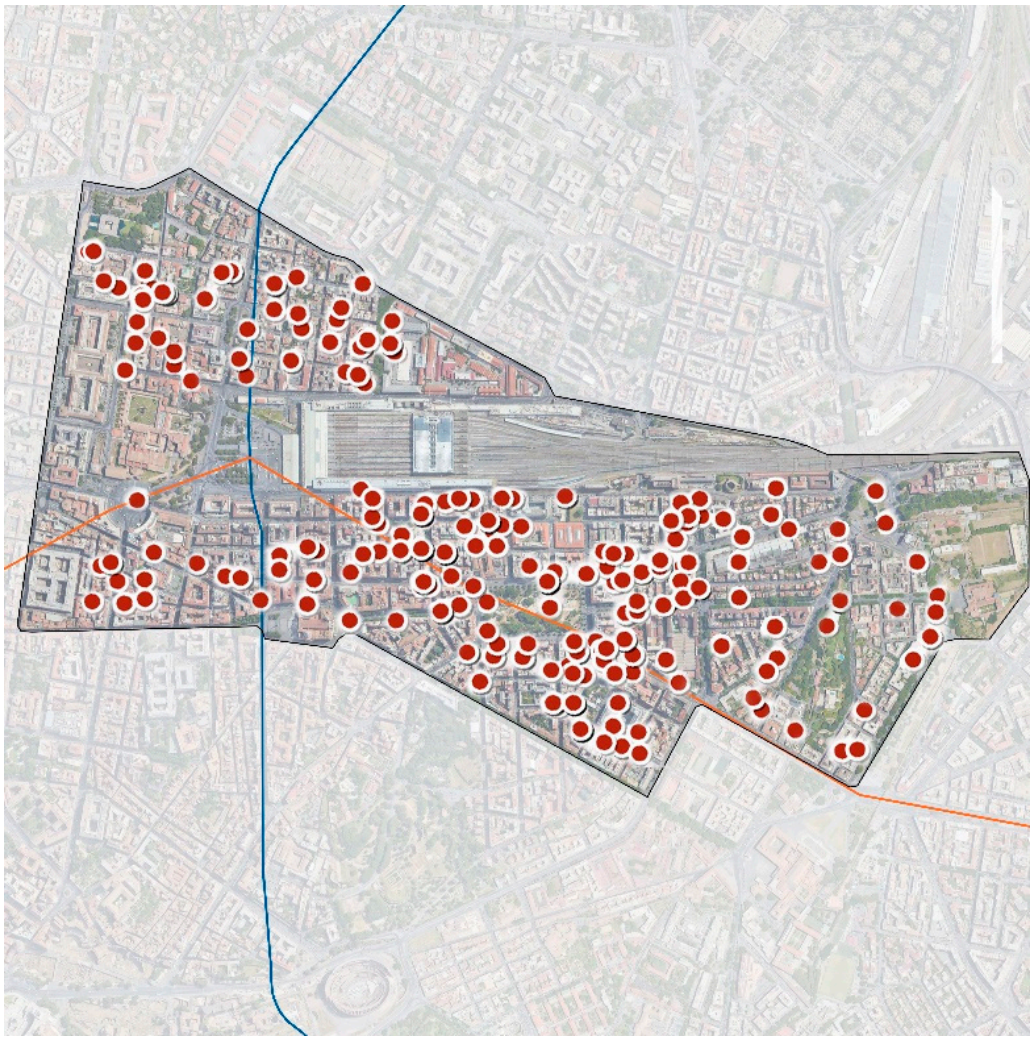

Figure 2. Localization of the residential units of the study sample considered in the analysis.

For each study sample individual, the total selling price [P], expressed in euro, is the dependent variable of the analysis, whereas the other factors considered, are organized in the two mentioned categories (intrinsic and extrinsic) and are listed below. In particular, in the present analysis the intrinsic factors are those mainly relevant on housing prices according to the indication provided for the local real estate market operators, whereas the extrinsic factors are constituted by the distance of each property from the main landmarks, i.e., public squares, historic buildings, urban parks, churches, Ministry buildings, the most important theatres, hospitals, universities, monuments, museums, railway station, subway stops, and by the general maintenance conditions of the nearby buildings. Moreover, some attractors closer to the Esquilino area but located outside the district perimeter have been included among the landmarks considered in the analysis, by assuming a likely influence of them on selling prices dynamics.

Intrinsic factors:

- the total floor area [S] of the property, expressed in m^2 of gross floor area of the property;
- the presence of the lift in the building in which the property is located [L], assessed as a dummy variable in which the value "zero" represents the absence of this service, whereas the value "one" indicates the presence;
- the floor on which the property is located [F];

- the quality of the residential unit maintenance state, defined through a synthetic evaluation, by considering the categories "to be restructured" [Mp], "good" [Mg] and "excellent" [Me] as a dummy variable. The quality of the conservative conditions has been assessed by comparing the real estate operators' information, surveys performed on web (digital photographs or user comments). The "to be restructured" condition [Mp] indicates properties for which relevant refurbishment interventions are necessary due to the bad conservative state; the "good" state [Mg] indicates habitable residential units; whereas the "excellent" state [Me] is related to properties characterized by high aesthetic and structural values with superior finishes and architectural qualities.

Extrinsic factors:

1. the distance from Piazza Dante [D], expressed in kilometers it takes to walk to it;
2. the distance from Piazza dell'Indipendenza [I], expressed in kilometers it takes to walk to it;
3. the distance from Piazza Vittorio Emanuele II [V], expressed in kilometers it takes to walk to it;
4. the distance from Piazza dei Cinquecento [Pc], expressed in kilometers it takes to walk to it;
5. the distance from Piazza Esedra [Pe], expressed in kilometers it takes to walk to it;
6. the distance from Piazza della Repubblica [Dp], expressed in kilometers it takes to walk to it;
7. the distance from Casa dell'Architettura [C], expressed in kilometers it takes to walk to it;
8. the distance from Porta Maggiore monument [Pm], expressed in kilometers it takes to walk to it;
9. the distance from the Termini railway station [Ts], expressed in kilometers it takes to walk to it;
10. the distance from the New Esquilino market [Mes], expressed in kilometers it takes to walk to it;
11. the distance from the Polyclinic Umberto I [Ps], expressed in kilometers it takes to walk to it;
12. the distance from the San Giovanni Addolorata Hospital [H], expressed in kilometers it takes to walk to it;
13. the distance from the Sapienza University of Rome Campus [Sc], expressed in kilometers it takes to walk to it;
14. the distance from the Science of Education Department—University of Rome 3 (entrance on Via Principe Amedeo) [Un1], expressed in kilometers it takes to walk to it;
15. the distance from the Science of Education Department—University of Rome 3 (entrance on Via del Castro Pretorio) [Un2], expressed in kilometers it takes to walk to it;
16. the distance from the Department of Computer, Automatic, and Management Engineering—Sapienza University of Rome [Ds], expressed in kilometers it takes to walk to it;
17. the distance from the Colosseum [Co], expressed in kilometers it takes to walk to it;
18. the distance from the Museum of the Liberation [Lm], expressed in kilometers it takes to walk to it;
19. the distance from the Biblioteca Nazionale [Nb], expressed in kilometers it takes to walk to it;
20. the distance from the Terme di Diocleziano [Td], expressed in kilometers it takes to walk to it;
21. the distance from the Park of the Oppian Hill [Pco], expressed in kilometers it takes to walk to it;
22. the distance from the Teatro dell'Opera [To], expressed in kilometers it takes to walk to it;
23. the distance from the Teatro Brancaccio [Tb], expressed in kilometers it takes to walk to it;

24. the distance from the Teatro Ambra Jovinelli [T], expressed in kilometers it takes to walk to it;
25. the distance from the Basilica of San Giovanni in Laterano [Gl], expressed in kilometers it takes to walk to it;
26. the distance from the Basilica of Santa Croce in Gerusalemme [Bsc], expressed in kilometers it takes to walk to it;
27. the distance from the Basilica of Santa Maria Maggiore [MM], expressed in kilometers it takes to walk to it;
28. the distance from the Secret Service Office [SS], expressed in kilometers it takes to walk to it;
29. the distance from the Polygraph and Mint Institute [IPZS], expressed in kilometers it takes to walk to it;
30. the distance from the Ministry of Defence [Md], expressed in kilometers it takes to walk to it;
31. the distance from the Ministry of the Interior [Mi], expressed in kilometers it takes to walk to it;
32. the distance from the Finance Ministry [Fp], expressed in kilometers it takes to walk to it;
33. the distance from the Revenue Agency Office (former Directorate-General for Land Registry and Tax Technical Services) [Mf], expressed in kilometers it takes to walk to it;
34. the distance from the Manzoni metro station [MAM], expressed in kilometers it takes to walk to it;
35. the distance from the Vittorio Emanuele metro station [VMM], expressed in kilometers it takes to walk to it;
36. the distance from the Repubblica metro station [RM], expressed in kilometers it takes to walk to it;
37. the distance from the Castro Pretorio metro station [CPM], expressed in kilometers it takes to walk to it;
38. the number of buildings whose facades are characterized by an excellent [G], or good [D], or bad [B] state of conservation. In order to take into account the different influence that the proximity to these buildings could have on selling prices, for each category selected, three detection ranges have been considered: (i) from 0 to 100 m, (ii) from 100 to 300 m, (iii) from 300 to 500 m. In particular, three different weights (3, 2, 1) have been assigned according to the localization of the buildings analyzed in three concentric circular crowns.

The extrinsic factors constitute the main attractors for the urban area analyzed in the present research. All of them (except the variables G, D and B) are expressed in distance between each residential property of the study sample and the specific landmark (i.e., square, or monument, or hospital, university department, or green area, or theatre, or basilica, or Ministry, or metro station).

In order to compare the data, the values of each variable have been normalized by the maximum value found for each category, so that a unique range of variation between 0 and 1 has been considered.

In Figure 3 the extrinsic factors, i.e., the locational variables considered, are reported. It should be observed that nine variables (Ps, Sc, Nb, Bsc, Gl, Lm, H, Co and Pco) are located out of study area bounds and they have been included among the potential influencing factors on selling prices of sample residential properties for their relevance in the urban context.

In Table S1 reported in Supplementary File the main descriptive statistics of the selling price and the influencing factors detected are reported, in order to examine the study sample composition and to, eventually, to identify the outliers to remove, so as not to affect the results consistency.

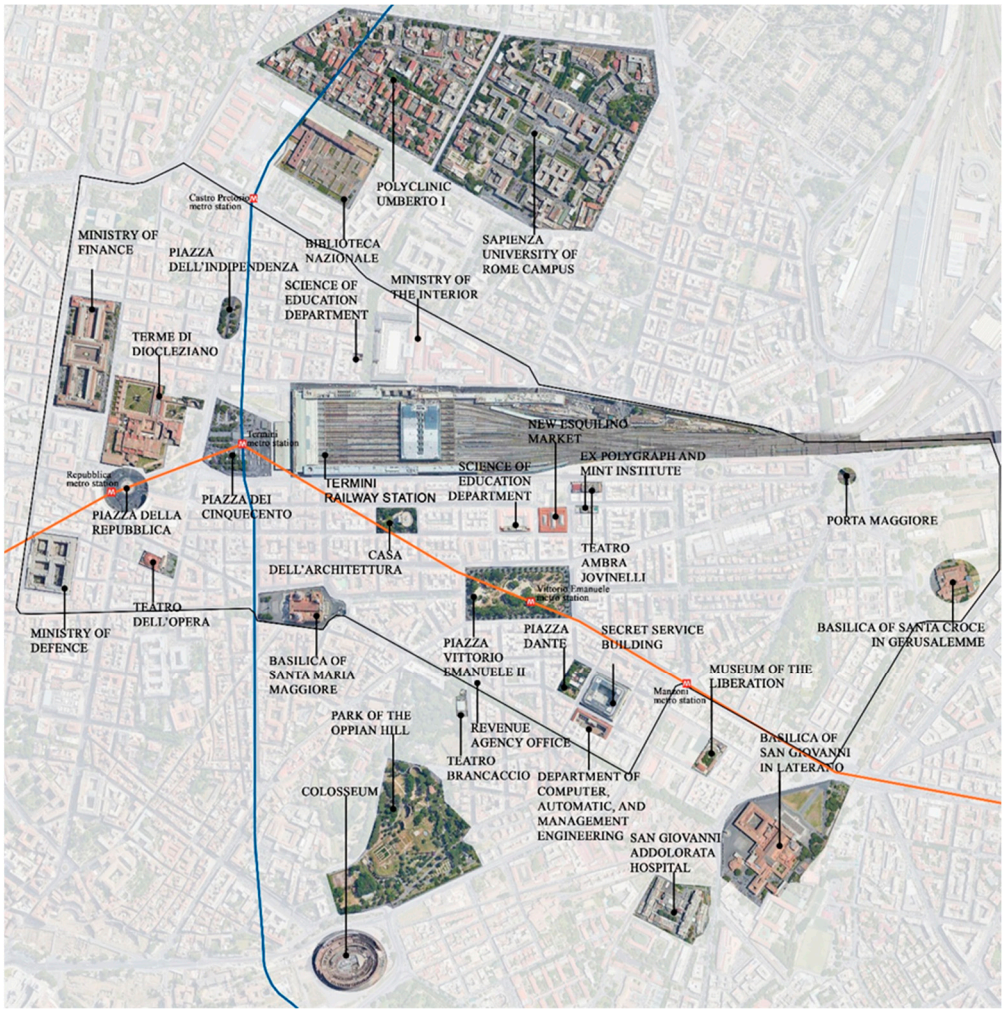

Figure 3. The extrinsic locational variables considered in the analysis.

5. Method

The methodology implemented in the present research borrows the operative logic of Hedonic Prices methods, ranking among the Automated Valuation Methodologies (AVMs). The method—called Evolutionary Polynomial Regression (EPR)—is an econometric technique that connects the best features of the numerical regression with the genetic programming [85]. The main theoretical aspects of the technique are reported in the Supplementary File in the Methodology Section. Furthermore, several researches have already used the EPR technique with reference to the real estate field, to analyze the impact of different factors on selling prices, by highlighting the potentialities of this method (i) in the identification of the most influencing variables and (ii) in the determination of the percentage contribution of each factor (independent variable) on property prices (dependent variable). In addition, in the real estate sector, the EPR implementation has concerned several issues, among which the energetic one [86], the taxation one [87], the environmental one [88], the construction costs one [89]. Moreover, the EPR technique has been applied to analyze the impacts of the COVID-19 pandemic on the Italian housing market demand [90] or to investigate the urban transformation interventions effects on the real estate market [91].

5.1. Application of the Methodology

The implementation of the EPR methodology to the case study has allowed to obtain a set of models, expressed in polynomial form in which the dependent variable is the total selling price [P] and the independent ones are selected by EPR among the intrinsic and

extrinsic factors listed in the Section 4.2. Each additive term of the mathematical expression of the models is assumed as a combination of the input variables raised to the proper numerical exponents. In particular, the candidate exponents selected in the research belong to the set (0; 0.5; 1; 2) and the maximum number of additive terms in final expressions is assumed equal to eight.

Among the several models defined by the technique, the choice of the "best" one has been carried out taking into account the statistical performance level, the complexity of the algebraic expressions and the empirical consistence of the coefficient's signs. In general terms, this step is crucial for the overall analysis, as it allows the user to select the model for the examination of the functional relationships between the explanatory variables and the total selling prices. The decision process considers the Coefficient of Determination (COD) value that is associated by EPR to each model (see Supplementary File) and the "readability" of the mathematical form, in terms of the quantity of the equation terms and the number of variables combined in each term. In this sense, the direct correlations between the factors in the model monomial terms and the selling price allow to immediately verify the empirical consistence of the coefficient's signs. On the contrary, for the variables that are repeated more times in different terms and/or are combined with other variables in the same equation term, the empirical coherence of the functional relationships between the input variables and the total selling prices should be analyzed by the user through a iterative exogenous approach.

In particular, in the research the quantification of the contribution of each selected influencing factor on the total selling prices has been performed by taking into account the variation of the i-th variable analyzed in the interval of the observed sample and keeping the values of the other variables constant and equal to the respective average value.

With reference to the case study of Esquilino district, the model chosen between those provided by the EPR technique is reported below in the following equation and the associated COD value is specified (COD = 91.98%).

$$Y = 241374.1396 \times Me \times MAM^{0.5} \times Un^{1} - 420444.125 \times S^{0.5} \times Ps^{0.5} \times Lm^{2} + 1708200.6044 \times S - 2242718.7606 \times S \times SS^{0.5} \times$$

$$To^{0.5} \times D^{0.5} + 904347.9439 \times S \times Mg \times Pco^{0.5} \times Mes^{0.5} - 36016624.6845 \times S \times Mp^{2} \times D^{2} \times MM^{2} \times Mi^{0.5} \times B + 2271385.956 \times S \times F \times Pm^{0.5} \times Ps \times Un1^{0.5} + 67172740.3005 \times S^{2} \times Me^{2} \times Gl \times Ps \times Un1 \times Fp \times D + 69920.8406$$

By considering the collected study sample, the graph in Figure 4 shows the average percentage contribution of the variables selected by EPR as the most influential factors on the total selling prices. In particular, among the 46 variables initially selected for the study, 20 factors have been included in the model generated by EPR as considered influencing in the housing prices formation processes in the Esquilino district.

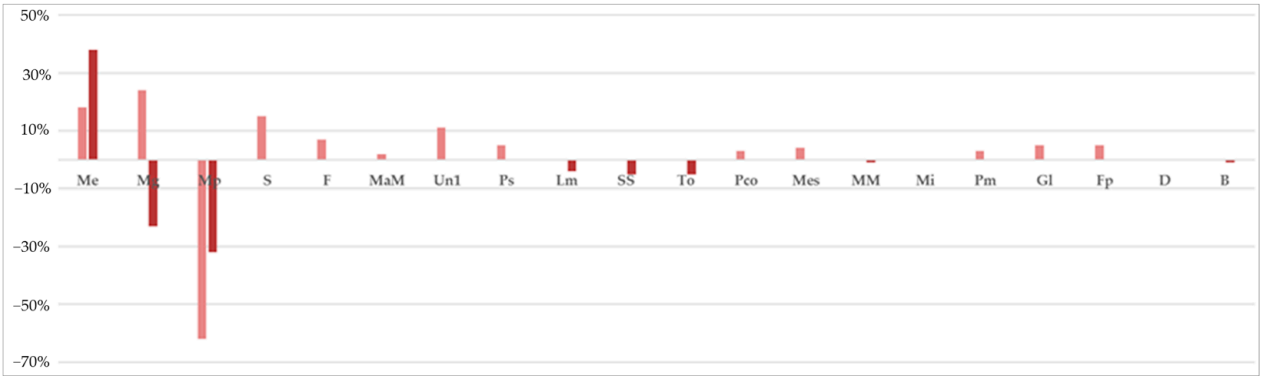

Figure 4. Average percentage contribution of the variables selected by EPR as the most influential factors on the total selling prices.

The graphs in Figures S1 and S2 in Supplementary File report the trends of the selected factors in the range of values considered for each variable for the detected study sample.

5.2. Results Interpretation

The considerations to be raised on the outputs obtained for each selected variable are illustrated below. Firstly, all expected functional correlations between the explanatory variables and the total selling prices have been confirmed by those generated by the EPR model, as the empirical consistence of the coefficient's signs of the selected factors with the dependent variable of the selling price has been verified.

With reference to the intrinsic variables selected by the model related to the quality of the residential unit maintenance state (Me, Mg and Mp), a significant contribution given by this characteristic on property prices has been observed: in particular, the functional link between to the excellent maintenance conditions of the property (Me) and the prices is direct (+18% passing from Mg to Me and +38% from Mp to Me). Moreover, the relationship between the good conservative state (Mg) and the housing prices is inverse in the situations in which the variation concerns the excellent state and the good one (−23%) and it is opposed (and therefore logically direct) from Mp to Mg (+24%). Finally, the prices of the properties of the selected sample decrease respectively by −62% and −32% in correspondence with a reduction in the property maintenance state and, therefore, passing from excellent conditions to the bad ones (−62%) and from good conditions to the bad ones (−32%). Among the intrinsic variables selected by the model, the total floor area of the property (S) constitutes, as expected, a significant factor on property prices, determining an increase in the total selling price as the surface of the property increases equal on average to +15% considering an interval of 23 m^2. In particular, a greater contribution of the surface area on selling prices in correspondence with reduced dimensions has been detected (+29% from 23 m^2 to 46 m^2, +26% from 46 m^2 to 69 m^2, +23% from 69 m^2 to 92 m^2, +20% from 92 m^2 to 115 m^2, and so on up to +8% found in the passage from 437 m^2 and 460 m^2, i.e., the maximum total area observed in the analyzed study sample). Finally, in the category of intrinsic variables, the model includes the floor on which the property is located (F), for which a direct functional link has been found, by attesting a greater market appreciation for properties placed on the highest floors of the buildings compared to those on the lowest ones, by an average of 7% passing from a floor to the next one.

With reference to the extrinsic variables D and B related to the number of buildings whose facades are respectively characterized by a good [D] and bad [B] state of conservation, interesting considerations can be developed by analyzing the functional correlations obtained considering the selected EPR model. In particular, in correspondence with a limited number of buildings characterized by a good maintenance state (i.e., from 0 to 96 properties) the total selling price decreases. Beyond this threshold, the housing values increase as the number of buildings with this condition gradually grows, highlighting the market appreciation for the higher aesthetic quality of the existing buildings. On the contrary, in the first part of the trend (graph XIV in Figure S2 in Supplementary File) the declining curve attests the presence of an urban area with possibly obsolete buildings that require relevant refurbishment interventions to restore an adequate condition of architectural and physical decoration. As regards the variable B, an inverse functional relationship between the quantity of buildings and total selling prices has been pointed out, with a constant decrease of −1% considering intervals of 27 properties. This trend is consistent with the expected results, clearly demonstrating that a greater number of buildings in bad conditions influences the residential prices, causing their decrease. In this sense, the variable constitutes a proxy of the aesthetic and architectural quality level of the existing building stock which has a more or less significant influence on the urban quality level perceived by the community and which is reflected in the market appreciation, in purchasing choices and in the phenomena of selling prices formation.

For the locational extrinsic variables, i.e., regarding the distance from the residential property to the urban attractor pole, in Table 1 the typology of the functional correlation

between the total selling prices and each variable and a brief explanation of the empirical consistence of the coefficients' signs are reported.

Table 1. Description of the functional correlations between the locational extrinsic variables selected by EPR and the total selling prices.

Variable	Functional Correlation Typology	Explanation of the Empirical Consistence
Distance from the Manzoni metro station [MAM]	DIRECT	The proximity to the Manzoni metro station constitutes a disqualifying factor that, therefore, negatively influences the selling prices, mainly given the closest buildings view on the road axis of Viale Manzoni, characterized by high standards of traffic congestion. In fact, the detected trend shows an increase in total prices in correspondence of a progressive longer distance from the metro stop, initially equal to +6% starting from a condition of property overlooking the subway at a distance of the residential unit of 250 m and, then, from a distance of 1 km from this infrastructure, with a prices growth equal to +1%.
Distance from the Science of Education Department, University of Rome 3—entrance on Via Principe Amedeo [Un1]	DIRECT	A lack of appetite by potential buyers is detected for the residential units located close to the Science of Education Department, especially due to the presence of widespread social and urban decay situation. The residential units proximity to this building represents a significant negative factor on housing values formation processes: the prices increase by +23% from a direct overlooking the university department to a distance of 100 m, by +15% from a 100 m distance to 200 m one. Then a progressive growth of distance is associated to a decrease of percentage variation of selling prices by considering distance range of 100 m.
Distance from the Polyclinic Umberto I [Ps]	DIRECT	The closeness to the Sapienza Polyclinic constitutes a factor scarcely appreciated by the local residential market, as a limited presence of commercial services in the urban areas nearby to this infrastructure is observed. Therefore, the area is ordinarily considered as a "dormitory" and the local market demand is strongly influenced by this consolidated idea, by keeping low residential prices. In fact, progressively moving away from the public health service, the total selling prices tend to increase, also given the gradual closeness to other relevant poles of the neighborhood that most positively influence the real estate values.
Distance from the Museum of the Liberation [Lm]	INVERSE	The housing prices are higher in the area immediately adjacent to the Museum of the Liberation and they significantly decrease as the distance from this pole increases (on average by 4%). In this sense, despite the marginal position of the museum with respect to the urban context in which it is located, the preference and/or the need of the local communities to move away from the busiest areas is attested, by highlighting a greater market appreciation for the quietest urban areas.
Distance from the Secret Service Office [SS]	INVERSE	The selling prices of the residential units located near the Secret Service Offices decrease respectively by −14% passing from a property immediate overlooking the building to a distance of 250 m from this infrastructure, beyond which an average reduction of −4% in residential prices is found. This phenomenon is attributable to the recent redevelopment interventions in the areas adjacent to the Secret Services Offices that likely have affected the local market appreciation.
Distance from the Teatro dell'Opera [To]	INVERSE	The decrease in property prices (−13% from the situation of direct view on the infrastructure to a distance of 250 m and on average—4% for progressively greater distances) is reasonably justified taking into account the strategic location of the theater close to a significant road artery of the city of Rome (via Nazionale). This constitutes an architectural and urban landmark for the city and the proximity to it influences the choice processes in the bargaining phases between potential buyers and sellers.

Table 1. *Cont.*

Variable	Functional Correlation Typology	Explanation of the Empirical Consistence
Distance from the Park of the Oppian Hill [Pco]	DIRECT	Firstly, it should be recalled that the Park of the Oppian Hill is located out of study area bounds and it has been included among the potential influencing factors on selling prices of sample residential properties for its relevance in the general urban context. The selected EPR model shows an increase in the selling prices progressively moving away from the main entrance to the park, by determining an increase equal to +11% passing from a situation of direct view on the park to a distance of 230 m from it, in line with the shared collective feeling of attraction lack of the park.
Distance from the New Esquilino market [Mes]	DIRECT	For the properties located near via Principe Amedeo, the main entrance to the New Esquilino market, a rise in housing prices of +13% is observed when the distance from the access increases from 0 m to 200 m. The detected trend is consistent with that expected by the main operators of the local market, as the current conservative state and the phenomena of social degradation and poor security perceived by the residents in the district reasonably justify the low market appreciation for this infrastructure.
Distance from the Basilica of Santa Maria Maggiore [MM]	INVERSE	The Basilica of Santa Maria Maggiore is a significant amenity appreciated by the residential real estate market: in this sense, the prices of properties that are located close to the religious building are higher compared to those located at a distance of 2.00 km (−13%), also due to any different factors that characterize the urban areas placed at this distance, representative of negative aspects in the choices of potential buyers of residential units.
Distance from the Ministry of the Interior [Mi]	INVERSE	With an initial limited percentage decrease (−0.9% passing from a condition of direct view on the Ministry of the Interior to a distance of 220 m from the infrastructure located near the perimeter of the area considered in the analysis) the functional correlation between the variable Mi and the selling prices is inverse. The average reduction of residential values in the range of the collected study sample (distance between 0 m and 2.2 km) is equal to −0.3%.
Distance from the Porta Maggiore monument [Pm]	DIRECT	The EPR model attests an increase in housing prices as the distance from the Porta Maggiore monument grows, due to the considerable level of atmospheric and acoustic pollution that characterizes the areas adjacent to one of the main hubs of vehicular and tram transport in the city of Rome: the total prices of the properties located 300 m from the monument are higher than +9% and, as the distance increases, they progressively grow, by reducing the percentage of variation.
Distance from the Basilica of San Giovanni in Laterano [Gl]	DIRECT	The high transit of private and public vehicles and the associated critical issues are the main causes of the negative variation in the prices of the properties adjacent to the Basilica of San Giovanni in Laterano compared to those further away. For this variable, the model shows a direct functional link between the distance and the total prices on average of +5%, in line with the expectations of local market operators. In fact, according to them, the mentioned problem constitutes a crucial factor considered by buyers in the purchase decisions.
Distance from the Finance Ministry [Fp]	DIRECT	The traffic congestion is a condition ordinarily detected on the roads adjacent to the Finance Ministry. This factor negatively affects the processes of selling prices formation related to the properties close to this infrastructure. In particular, by consulting the local market operators, the topic is strongly debated by the potential buyers.

In Figure 5 a summary of the outputs obtained in terms of positive and negative influence of the locational extrinsic variables selected by the EPR model on total selling prices is shown. In particular, in blue the amenities, i.e., the attractor poles whose proximity is positively appreciated on the reference market, are reported, whereas in red the disamenities, i.e., urban poles whose proximity negatively affects the choices of buyers and sellers, are indicated. By taking into account the aim of the present research, the red dots

represent the warning areas, for which a high attention from public entities should be paid. The graphical representation allows to immediately identify the warning areas defined by the logical-deductive model in order to support the decision-makers in the development of effective strategic urban regeneration processes.

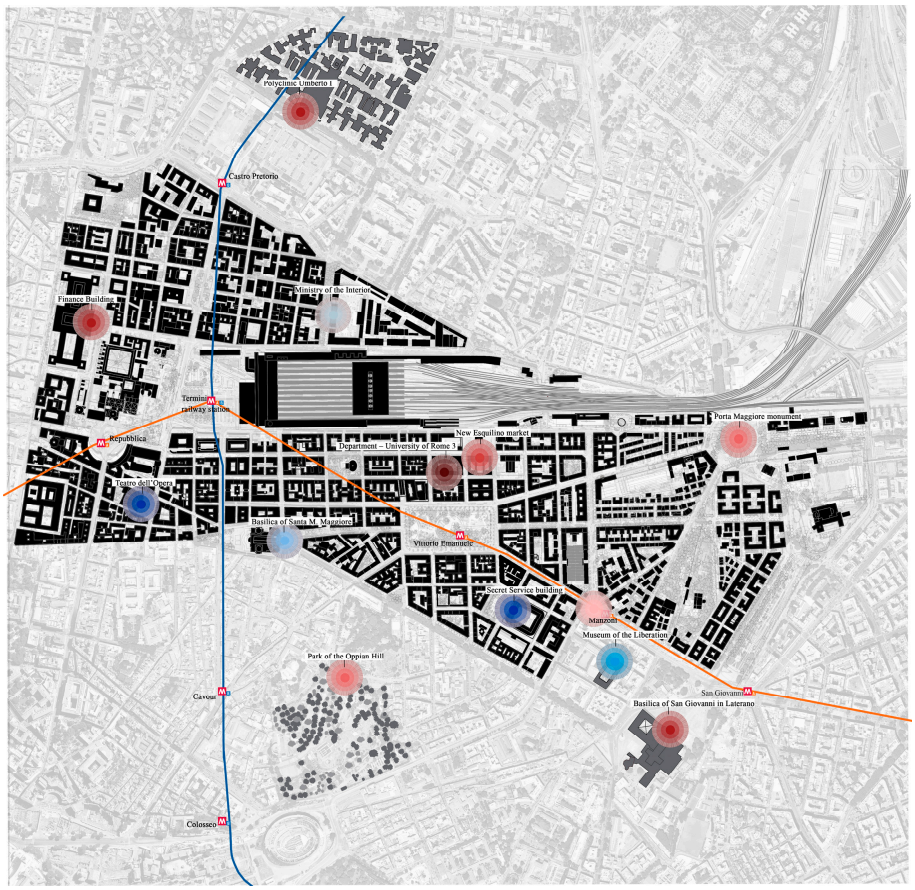

Figure 5. Identification of the warning areas (red dots) and of the urban poles whose proximity is appreciated by the reference market (blue dots).

6. Conclusions

With reference to the urban regeneration topic, strongly debated by the public decision makers for the definition of urban development policies, the present research has focused on the proposal of a logical-deductive model capable of identifying, among different urban areas included in a macro-area, those for which a greater transformation cogency is detected. In this sense, the methodological approach intends to constitute an evaluation tool to support planners, local authorities, developers and investors in defining awareness choices based on effective assessments.

Given an urban area to be redeveloped, the model involves the detection of the main existing amenities and disamenities and the collection of a study sample consisting of properties, recently sold and located in the considered area. The selling price and a set of intrinsic and extrinsic—in terms of proximity to the previously defined attractor poles—variables are recorded for each property of the study sample.

By assuming that the selling prices increase is a proxy variable of the benefits generated by the urban redevelopment intervention for local communities, the developed analysis has allowed to examine the functional links between each selected variable and the selling price.

The detected trends have attested the direct or inverse correlation between the variables (dependent = total selling price and independent = intrinsic and extrinsic considered factors) and, therefore, to verify the existence of attractor poles (amenity or disamenity)

whose proximity could influence the choices of potential buyers in a positive or negative sense. The higher or lower market appreciation for each selected urban pole has been studied in deductive terms, in order to identify the warning areas for which the subjects involved (public and private) in the decision-making processes should pay more attention. In fact, the increase in selling prices connected to a growth in the distance from an attractor pole attests the need to operate on this area, to determine a change in the observed functional relationship associated with a greater market appreciation for the proximity to the pole. On the contrary, the inverse functional link that attests a decrease in selling prices in correspondence with a progressive distance from an attractor pole indicates a more or less significant positive influence given by the closeness to that pole. Moreover, the netive correlation could indicate the need to carry out redevelopment interventions in areas further away to avoid too marked differentials in real estate values linked to the presence of urban disamenities.

The proposed methodological approach has been applied to the case study of the Esquilino district in the city of Rome (Italy). The approach has been implemented by taking into account the relevant need to define redevelopment processes able to improve the Esquilino urban quality and, more generally, to rise the life quality for the local community. In this sense, the obtained outputs could constitute a valid tool able to guide the urban planning choices, in situations in which the determination of preference and temporal priority lists for the interventions to be implemented is requested. Therefore, the logical-deductive model is flexible and can be implemented in different geographical contexts and for different intended uses (commercial, offices, etc.).

Future research insights may concern the application of the developed model to other case studies, in order to test its validity and to deepen its potentialities in terms of practical implications. In this sense, comparative analysis could be carried out in order to (i) examine the obtained outputs and (ii) investigate the results within the specific territorial context. In addition, the application of other multivariable regressive techniques could be carried out in order to provide an overall comparison between the outputs obtained in terms of the identification of the determinants on the property prices, by implementing different methodologies.

Furthermore, the results obtained (identification of warning areas) could constitute an intermediate step of a wider research aimed at investigating different project solutions for the selection of the "best" one. In this sense, the outputs could support the choice processes for effective strategic lines of territorial development, constituting a further point of view for the investigation of the urban area, which could integrate a SWOT or context analysis for an overall exam of the strengths and criticalities of the considered urban context. With reference to a large urban area for which a significant recovery need and the impossibility of carrying out the entire project in a single time are attested, the possibility to implement the global urban regeneration initiative in successive phases constitutes a valid solution—already performed in several situations. The development of functionally autonomous portions/projects connected to the redevelopment of the different attractor poles, in fact, aims at the gradual realization of the entire program. This allows to carry out an economically and socially sustainable intervention, without (i) neglecting the unitary character of the initiative and (ii) determining internal fractures in the urban area.

According to the current and global goal to pursue smart cities, the importance to provide effective preliminary evaluation tools for urban planning policies constitutes an evident focus of attention. In the future steps of this research, the literature review may be improved through a comparative table of the different approaches used for the determination of strategies aimed at smart cities design. This table will represent a useful overview of the existing modalities for the assessment of the interventions for the smart cities' development, to point out the potentialities and critical issues of each of them and to identify any integrated approaches. The logical-deductive model for the definition of warning areas proposed in this research will be part of the mentioned framework, to focus its practical implications and its contribution to the definition of effective urban projects.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/smartcities6010022/s1, Table S1: Descriptive statistics of the variables considered in the analysis; Figure S1: Functional relationships between the total selling prices and the intrinsic factors selected by the EPR model; Figure S2: Functional relationships between the total selling prices and the extrinsic factors selected by the EPR model.

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