

Green Energy and Technology

Salvatore Giuffrida ·  
Maria Rosa Trovato · Paolo Rosato ·  
Enrico Fattinnanzi · Alessandra Oppio ·  
Simona Chiodo *Editors*

# Science of Valuations

Natural Structures, Technological  
Infrastructures, Cultural Superstructures

 Springer

# **Green Energy and Technology**

Climate change, environmental impact and the limited natural resources urge scientific research and novel technical solutions. The monograph series Green Energy and Technology serves as a publishing platform for scientific and technological approaches to “green”—i.e. environmentally friendly and sustainable—technologies. While a focus lies on energy and power supply, it also covers “green” solutions in industrial engineering and engineering design. Green Energy and Technology addresses researchers, advanced students, technical consultants as well as decision makers in industries and politics. Hence, the level of presentation spans from instructional to highly technical.

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Editors

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*Editors*

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**The Public Private Partnership for the Effective Enhancement and Management of Existing Property Assets: The Case of Torrevicchia Complex (Rome)** ..... 377  
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# The Public Private Partnership for the Effective Enhancement and Management of Existing Property Assets: The Case of Torrevecchia Complex (Rome)



Francesco Tajani, Pierluigi Morano, Spartaco Paris, and Felicia Di Liddo

**Abstract** In the present research the analysis of the financial feasibility of a Public Private Partnership (PPP) intervention, related to the enhancement and management of a social housing complex, has been carried out. With reference to the redevelopment initiative of Torrevecchia area located on the western periphery of the city of Rome (Italy), the Discounted Cash-Flow Analysis (DCFA) has been implemented. The study aims to verify the efficiency in the use of the PPP operational tool through the assessment of the costs and the revenues deriving from the renovation and the expansion of the considered complex. In the analysis, a periodic fee paid by the Public Administration to the private investor has been considered and determined, able to ensure the financial sustainability of the initiative and to comply with the regulatory constraints in the Italian context. The redevelopment initiative analyzed demonstrates the relevant role played by PPP procedures in the context of urban regeneration and functional reconversion of collective interest properties, able to identify a compromise solution between the current contraction of the public spending capacity and the financial feasibility of the territorial investments.

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**Keywords** Public private partnership · Enhancement initiatives · Existing public assets · DCFA · Financial feasibility

## 1 Introduction

A significant issue related to the enhancement of existing property assets concerns the scarce public economic resources to be used for their physical recovery [2, 10, 15, 16, 20]. An inadequate assessment of the functions to be introduced and a scarce attention to the property management phase represent a fundamental risk for the renovation initiative success [5]. It is known, in fact, that often recovered properties remain unused due to the lack of resources for their management. In this sense, the procedures of Public Private Partnership (PPP) allow to involve private financial resources able of carrying out building and/or urban redevelopment operations [1, 19, 25].

Currently, the management measures of existing assets constitute an important stimulus in the private construction sector, due to the sharp decrease of the real estate market and the Public Administration budget cuts. Furthermore, the strong need of the managing entities to provide for the restructuring of their property asset must be added, mostly built in the decades following the World War II, which inexorably is coming close to the end of its life cycle without adequate recovery interventions.

The scarcity of public economic resources and the high specialized skills required in the transformation and management processes make it increasingly necessary to use forms of collaboration between the public sector and private investors [6, 7, 9, 14, 21].

In the Italian context, the property asset enhancement is regulated by Art. 58 of the Law Decree No. 112, June 25, 2008 [4]. According to this regulation, to proceed with the reorganization, management and enhancement of the Regions, Provinces, Municipalities and other local property assets, each public Entity identifies the properties located in the competence area that are not appropriate for the institutional intended uses and are suitable to their enhancement or disposal. The inclusion of the properties in the recovery plan determines the consequent classification as available assets, taking into account the historical-artistic, archaeological, architectural and landscape-environmental constraints. Therefore, the specific plan is analyzed by the competent entities, in order to make the aforementioned definitive classification.

A considerable importance role is played by Art. 27 of the Italian Law Decree No. 201, December 6, 2011—Urgent provisions for the growth, equity and consolidation of public accounts—, converted into Law No. 214, December 22, 2011, which introduced the “Unit Territorial Enhancement Program” (PUVaT), as a governance tool for the best use of public properties [18]. The PUVaT is aimed at starting, implementing and concluding, in a specific time, an enhancement process for the properties in line with the territorial development guidelines and with the economic planning that may constitute, within the economic and social reference context, a stimulus and attraction element of sustainable local development interventions and public services.

The need to overcome the economic limits and to recovery the current building stock has led to the implementation of public utility initiatives that can determine a sufficient profitability for private subjects. For some specific sectors, such as telecommunications or energy management, the ability to generate profits is more evident, for other ones, defined as “cold” works, the profitability deriving from the realization of the project must be encouraged through public contribution forms, so that the private investors can make bear the risks of the investment.

## 2 Aim

The present research concerns the framework outlined. The study analyzes the feasibility of a redevelopment initiative of a public property asset, represented by the social housing buildings of Torrevicchia (Rome, Italy), through a PPP procedure that provides the involvement of a private investor for the renovation, the expansion and management of the complex. In order to ensure the sustainability of the initiative for the private operator, a financial sharing of the Public Administration through a periodic monetary amount has been provided, able to define the convenience threshold of the private balance sheet and to comply with the regulatory constraints imposed by the Italian Legislative Decree No. 50/2016, art. 180, par. 6. According to this regulatory provision, the total monetary subsidy burdened by the Public Administration “[...] *must not exceed 49% of the total investment cost of the PPP initiative, including any financial charges*”.

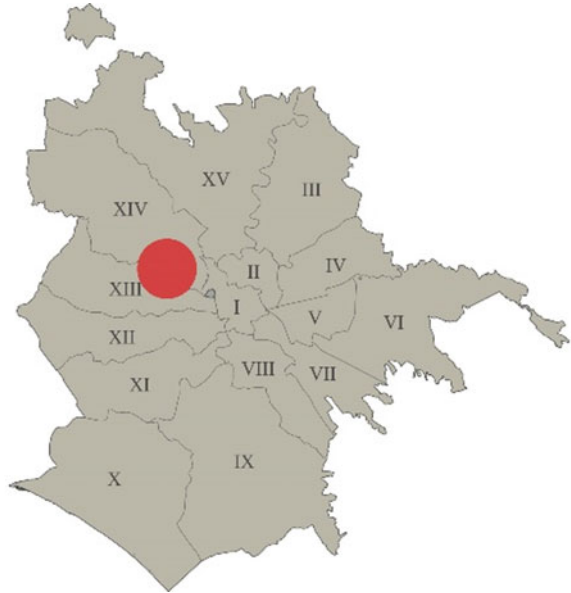
The paper is structured as follows. In Sect. 3, the case study and the current state of the building typologies of the complex of Torrevicchia are described. In Sect. 4, the redevelopment initiative to be assessed is illustrated. In Sect. 5, the Discounted Cash-Flow Analysis (DCFA) is implemented for verifying the private convenience of the initiative, by calculating the periodic fees to be paid by the Public Administration that ensure both the sustainability of the private balance sheet and the compliance with the Italian regulatory provisions. Finally, in Sect. 6 the conclusions of the work are discussed.

## 3 Case Study

### 3.1 Description of the Social Housing Complex of Torrevicchia

The case study concerns the redevelopment project of the social housing complex of Torrevicchia, located in an urban area on the western periphery of the city of Rome (Italy). The complex is owned by the Agency for Public Residential Buildings in the Rome municipality (ATER), an economic regional public institution that manages a

**Fig. 1** Social housing complex of Torrecchia (red circle) in the city of Rome

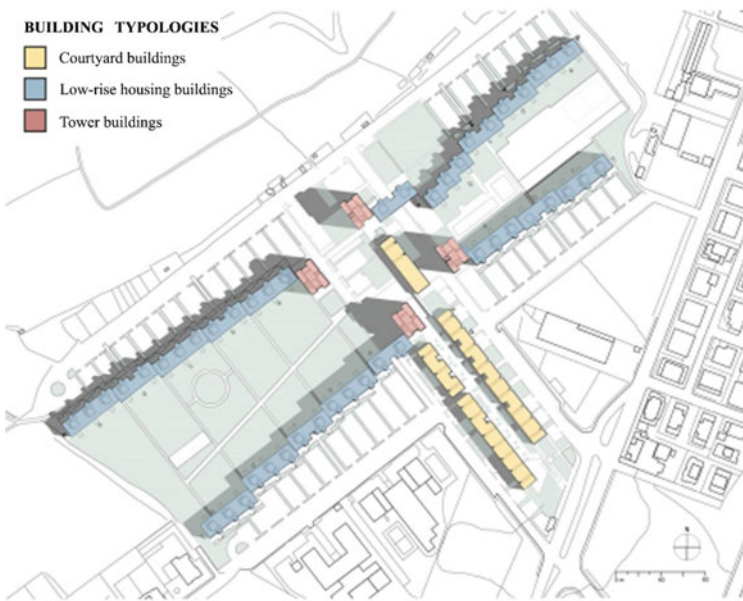


property asset composed by 48,000 residential units, especially social housing ones. Until the 1960s, Torrecchia area was used for agricultural purposes with small few houses to serve the large agricultural farms. In the following years, the area was affected by a rapid urban expansion, aimed at better getting connected to the city. Despite the presence of numerous green spaces that are not urbanized as a result of the expansion of the second half of the twentieth century process, the district is devoid of equipped public parks. Figure 1 shows the location of the social housing complex of Torrecchia in the urban context of the city.

The Torrecchia complex (Fig. 2) is a social housing intervention carried out on an area of about 24 hectares using funds provided by the Law No. 584/1977. The complex has been built around a central square, defined by four tower houses characterized by fifteen floor levels with offices, a bar and a social center. A high-altitude pedestrian path connects the square to Via di Torrecchia, around which two 3-storey high buildings are placed. In particular, on the ground floor level stores are located, whereas the other two levels are occupied by residential units. In correspondence to the square, four low-rise houses from four to six floors branch off. Thanks to the buildings localization, two green spaces are respectively intended for a small public park and sports equipment. In brief, the Torrecchia complex is divided into three building typologies (Fig. 3): courtyard buildings, low-rise housing buildings and tower buildings.



**Fig. 2** The social housing complex of Torrevecchia



**Fig. 3** The different typologies of buildings in the complex of Torrevecchia

### 3.1.1 Courtyard Buildings

The courtyard buildings are the most underused typology of the complex and they allocate only 8% of the entire population of the case study. They are developed on two parallel blocks, in addition to an isolated one in the complex center, with part of the ground floors intended for commercial use and storage rooms. The courtyard



**Fig. 4** The courtyard buildings

buildings involve three levels, with the first floors served by stairs overlooking the internal courtyard.

The main criticalities found for the courtyard buildings concern: the generalized problems of meteoric water infiltration, both at the roof level and in the joints of the prefabricated elements on the facade; the lack of thermal comfort, especially in the summer; a low insulation quality of the building envelope; the lack of heat mitigation systems. Furthermore, a strong degradation state in the quality of the finishings, especially on the facades, has been detected, due to the lack of adequate periodic maintenance interventions.

Figure 4 shows the courtyard buildings (yellow ones) of the social housing complex of Torrecchia.

### 3.1.2 Low-Rise Housing Buildings

The low-rise housing buildings are the most spread typology in Torrecchia complex, as they allocate 62% of the total population. The typological distribution includes three flats per floor level served by a staircase. In particular, the social housing complex is combined in two—scale buildings—8 in all—or three-scale—overall 10 buildings.

To accommodate the morphological characteristics of the area, the buildings' heights vary between four and seven floors. Moreover, each building has the entrance hall and storage rooms on the ground floor, whereas the other levels are intended for housing. Finally, at the last floor level there are the technical rooms.



**Fig. 5** The low-rise housing buildings

The main critical issues of the low-rise housing buildings refer to the bad salubrity state of the toilet rooms, where the air exchange is performed by natural ventilation through the shafts. The present problem becomes evident as the shafts heights increase—and therefore the number of rooms to be served. Furthermore, the lack of thermal comfort in the houses due to a low insulating quality of the building envelope and the lack of heat mitigation systems represent other relevant negative aspects. In the single-sided apartments, this critical issue is amplified by the lack of natural ventilation inside the rooms. Finally, a progressive decay state in the finishings quality, especially on the outside spaces, is detected.

Figure 5 shows the low-rise housing buildings (blue ones) of the social housing complex of Torvecchia.

### 3.1.3 Tower Buildings

In the Torvecchia district there are four identical tower buildings which allocate 30% of the complex inhabitants. They are developed on fifteen levels above ground and a basement for storage rooms. On the remaining floors there are houses with a typological distribution of six apartments per floor of two different types. Starting from the thirteenth level, there are two apartments per floor up to the final level where there are technical rooms.

Generalized problems of meteoric water infiltration and bad salubrity conditions are found. Then, especially in the summer seasons, the lack of thermal comfort and of heat mitigation systems are detected.



**Fig. 6** The tower buildings

Figure 6 shows the tower buildings (purple ones) of the social housing complex of Torrevecchia.

## 4 The Redevelopment Initiative

### 4.1 *The Renovation of the Existing Buildings*

Considering the specific characteristics of the building typologies of the case study considered in the research, the interventions identified have been grouped into three types (“A”, “B”, “C”).

The *intervention A* concerns the courtyard buildings. The project refers the improvement of the energy efficiency of each building through the construction of a new building envelope, both opaque and transparent, and the installation of new systems supported by production of energy from renewable sources. The intervention will also sort out the problems of infiltration from roofs and accessibility to the ground floors of the buildings. The planned workings involve operations to be carried out especially on the outside of the houses and, therefore, the removal of tenants from their houses is not required.

The *intervention B* concerns the low-rise housing buildings. The project aims to the improvement of the building energy efficiency through the new envelope realization, and the installation of new systems for the energy production from renewable sources.



Compared to the intervention A, there are no building workings on the roofs as they have recently been carried out. Similarly to the intervention A, the project B does not provide for the transfer of building tenants from their houses.

The *intervention C* refers to the tower buildings. This typology is the most expensive, both for the number of current critical issues detected and for the difficulty of building realization due to the height of them. Furthermore, by considering the building sizes, the aspects concerning the structures must also be taken into account. In particular, the project C provides for—in addition to all the workings planned for the intervention A—the improvement of the building structures. The initiative involves buildings' exterior and interior parts; therefore, it is necessary to provide for the temporary transfer of tenants to other accommodations.

## 4.2 The PPP Procedure

The hypothesis assumed in the present research is that a PPP procedure is implemented for the effective renovation of the existing buildings of the complex of Torrevecchia. In addition to the benefits deriving from overcoming the constraints on public spending and on budget balances, the use of the PPP can generate different advantages for the community in terms of management efficiency, quality of workings and effectiveness of services for the community [8, 17]. In particular, it is assumed that an onerous and written agreement is established between the public subject (i.e. the ATER) and a private investor for a fixed time period (equal to 25 years), in order to refurbish the existing buildings and provide for the ordinary maintenance up to the planned deadline. In exchange for these burdens, the private investor is remunerated through (i) the free ownership transfer of a building land plot, to be transformed in housing units to be sold, (ii) a periodic fee paid by the public subject, that is necessary to ensure the private convenience of the redevelopment initiative, but that cannot exceed the threshold fixed by the Italian Legislative Decree No. 50/2016 (i.e. 49% of the total investment costs, including any financial charges).

In Fig. 7 the localization of the building land plot to be freely transferred to the private investor for the effectiveness of the PPP procedure is shown.

The building land plot extends for approximately 25,000 m<sup>2</sup> and is located not far from the social housing complex of Torrevecchia. The hypothesis assumed concerns the construction of new buildings in the southern part of the lot, near the main road axis, occupying an area of about 11,000 m<sup>2</sup>. The remaining part will be equipped for public use: the project solution, in fact, includes a square (about 1,000 m<sup>2</sup>), different green spaces (about 9,000 m<sup>2</sup>) and some parking areas (about 1,900 m<sup>2</sup>). Table 1 shows the articulation of the public and private surfaces of the building land plot.

In order to summarize the steps required by the PPP procedure in analysis, in Fig. 8 the succession of the executive phases related to the realization of the new housing units on the building land plot and the renovation of the existing buildings of the complex of Torrevecchia is reported.



**Fig. 7** Localization of the building land plot to be transferred to the private investor

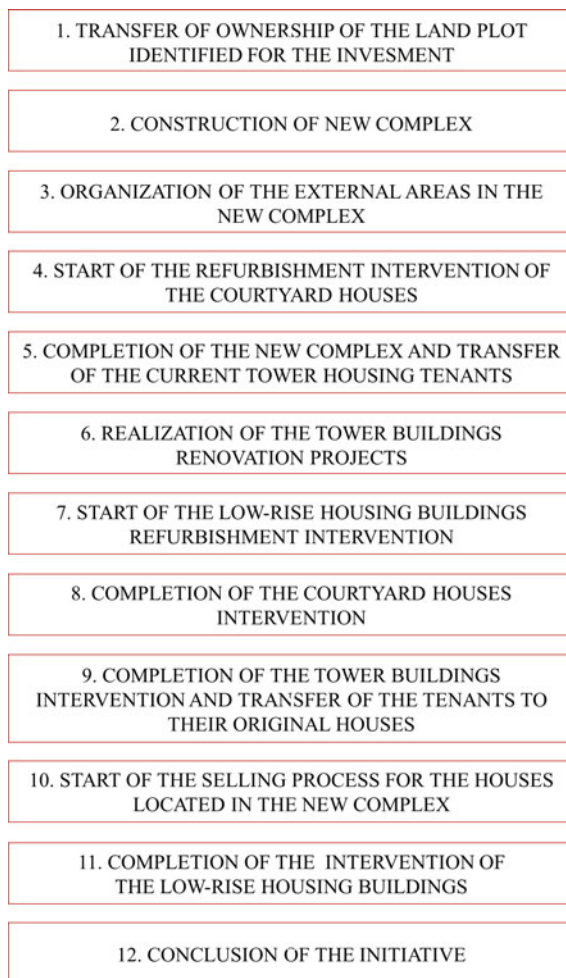
**Table 1** Public and private surfaces of the building land plot

Building land plot surface (m <sup>2</sup> )	25,161
Surface for public use (m <sup>2</sup> )	13,932
Surface for private use (m <sup>2</sup> )	11,229
Total number of floor levels (n.)	5

## 5 Implementation of the DCFA

In order to verify the financial feasibility of the redevelopment intervention of Torrecchia, it is necessary to define if the project will be able to generate an adequate profit for the private investor. The participation of a private operator, individual or—more frequently—in a corporate form, in a process of recovery and transformation of a public property or an urban area, presupposes the satisfaction of the financial criterion of the initiative, i.e. its capacity to remunerate the capital initially invested and to provide a monetary surplus.

**Fig. 8** Executive phases related to the realization of the new buildings and the renovation of the existing buildings



With reference to the case study, the assumptions of the analysis can be summarized as follows:

- the period of the analysis is equal to 25 years, divided into 50 semesters in the temporal distribution considered in the DCFA development;
- the minimum annual return rate expected by the private investor is equal to 10%. This amount has been determined taking into account the risks of similar initiative in the reference market;
- the discounted rate used for the DCFA is considered equal to the minimum annual return rate expected by the private investor (=10%). As the analysis period has been divided into semesters, the used discounted rate is equal to 4.88%;
- the analysis is carried out considering the current and constant prices.

The cost (investment and management) and the revenue items necessary for the development of a DCFA are assessed as follows.

**Costs**

**Investment costs.** They are related to (i) the realization of the new complex and (ii) the renovation of the existing one.

The first one concerns the realization of housing units, the square, public green spaces, parking areas and roads. With reference to the new houses, in the Table 2 the temporal distribution of the respective construction costs are reported.

The renovation of the existing complex involves the refurbishment costs of the courtyard buildings (intervention A), the low-rise housing buildings (intervention B) and the tower buildings (intervention C). For each typology, the refurbishment costs are assessed by consulting local operators and the data reported in the “Building typology prices” list [3]. In Table 3 for each building typology, the total surface, the unit and the total refurbishment costs of the recovery intervention are summarized.

With reference to the temporal distribution of the refurbishment costs, Tables 4, 5 and 6 show the assumption considered for each building typology. It should be observed that the interventions B and C start in the 8° semester, at the end of the courtyard buildings intervention. This assumption takes into account, on the one hand, the possibility to lighten the total investment costs for the private investor, by spreading them over the analysis period (especially for the intervention B), on the other hand, the contingency that the intervention C provides for the temporary transfer of tenants to other accommodations during the corresponding workings.

Among the investment costs, the technical expenses and the concession charges are included. The *technical expenses* represent the fees for technicians and professionals and are assumed equal to 6% of the sum of the total construction and refurbishment costs. The *concession charges* are determined in percentage of the total construction and restructuring costs of the initiative, with reference to published municipal tables.

**Table 2** Temporal distribution of the construction costs of the new housing units

Housing units							
Semesters	1°	2°	3°	4°	5°	6°	7°
Costs (%)	5	10	20	20	25	15	5

**Table 3** Total surfaces, unit and total refurbishment costs of the recovery intervention

Intervention	Typology	Total surface (m <sup>2</sup> )	Unit cost (€/m <sup>2</sup> )	Total costs (€)
A	Courtyard buildings	13,614	450	6,126,300
B	Low-rise housing buildings	73,826	385	28,423,044
C	Tower buildings	25,800	780	20,124,000
<b>Total</b>				<b>54,673,344</b>

**Table 4** Temporal distribution of the refurbishment costs of the courtyard buildings

Intervention A—courtyard buildings													
1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°	...	
–	–	10%	15%	15%	25%	20%	15%	–	–	–	–	–	

**Table 5** Temporal distribution of the refurbishment costs of the low-rise housing buildings

Intervention B—low-rise housing buildings									
1°	...	8°	9°	10°	11°–22°	23°	24°	25°	...
–	–	5.56%	5.56%	5.56%	5.56%	5.56%	5.56%	5.56%	–

**Table 6** Temporal distribution of the refurbishment costs of the tower buildings

Intervention C—tower buildings											
1°	...	8°	9°	10°	11°	12°	13°	14°	15°	...	
–	–	15%	15%	20%	20%	20%	10%	–	–	–	

In the specific case, these charges will pay in correspondence of the 3°, 5° and 7° semester.

**Management costs.** They are determined taking into account the operating costs ordinarily burdened by ATER and by consulting local market operators. In this sense, it is assumed that, from the end of the realization process (in 25° semester), during the agreement period the private investor has to provide for the management costs of the Torrevicchia complex. Therefore, the annual management cost is estimated equal to about 0.7% of the refurbishment costs, that corresponds to 182.500 € for semester, be paid from 26° semester up to the end of the analysis period (50° semester).

**Overheads.** These costs are related to the expenses for the real estate company constitution—assessed equal to 2% of the construction and refurbishment costs—and the marketing expenses—assessed equal to 2% on the revenues related to the sale of the new housing units. These costs are temporally distributed over the entire analysis period.

**Financial charges.** These costs identify the interests on the capital borrowed for the realization of the investment. The annual interest rate considered is equal to 1.38% (=0.69 for semester), as provided for similar operations by Banca d'Italia, and it is calculated on the negative financial exposures that the private investor will incur during the realization of the project.

**Taxes.** These costs are assessed according to the ordinary fiscal expenses (IRES, IRAP) provided by the Italian laws. They are assumed equal to about 30% of the positive cash-flows obtained by the difference between the revenues and all the previously listed costs.

## Revenues

The project hypothesis considered in the research provides that the revenue items for the investor will derive from (i) the sale of the housing units and (ii) the periodic fee that the Public Administration must pay to the private.

**Sale of the new housing units.** The assessment of the revenues to be obtained from the housing units selling is connected to the analysis of the current property prices in the urban area in which Torvecchia complex is located and to the determination of the most likely market value by considering the higher attractiveness expected following the redevelopment initiative. The unitary market value assessed is equal to 3,300 €/m<sup>2</sup>. Table 7 shows the temporal distribution assumed for the sales.

**Periodic fee.** It is hypothesized that the Public Administration will pay a monetary amount for each semester of the entire analysis period. This assumption is mandatory to ensure the convenience of the entire operation for the private investor, i.e. the minimum annual return rate equal to 10%: otherwise, the project would be characterized by a negative Net Present Value (NPV) and consequently it could not be realized. At the same time, the actualized total amount of the periodic fees must be lower than 49% of the sum of investment costs and financial charges, in order to comply with the regulatory constraints imposed by the Italian Decree No. 50/2016, art. 180. Therefore, the periodic fee is assessed (i) by considering a “full” down payment from the 7° semester, whereas for the previous semesters reduced amounts are provided (=25% for the 1° and 2° semesters, 50% for the 3° and 4° semesters, 75% for the 5° and 6° semesters), (ii) by ensuring the satisfaction of the private convenience threshold, i.e. an annual return rate equal to 10%, (iii) by verifying the regulatory provision, i.e. that the actualized sum of the periodic fees is lower than 49% of the sum of the total investment costs and the financial charges of the entire operation. Taking into account an annual rate equal to 3% for the actualization of the public periodic fees, the “full” down payment paid by the Public Administration and able to satisfy the conditions described above is equal to 1,260,000 €. This amount, on the one hand, is able to ensure the financial convenience of the investment for the private operator, as the NPV is equal to 54,244 € and the Internal Return Rate (IRR) is equal to 10.08%, on the other hand, is compliant with the regulatory provision, as the actualized sum of the public periodic fees (=40,571,359 €) is lower than the sum of the total investment costs and the financial charges (=43,385,637 €).

In Fig. 9 the development of the DCFA is reported.

**Table 7** Temporal distribution of the new housing unit sales

New housing units							
Semesters	6°	7°	8°	9°	10°	11°	12°
Sales (%)	20	20	20	20	10	5	5

SEMESTER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16,...25	26,...50
<b>INVESTMENT COSTS [€]</b>																	
<i>Construction of the new complex</i>																	
Housing units	1,359,660	2,719,320	5,438,640	5,438,640	6,798,300	4,078,980	1,359,660										
Square					18,266	18,266	24,355										
Public green spaces					79,659	79,659	106,212										
Parking areas					20,878	20,878	27,837										
Roads					87,307	87,307	116,410										
<i>Rehabilitation of the existing complex</i>																	
Courtyard buildings			612,630	918,945	918,945	1,531,575	1,223,260	918,945									
Low-rise housing buildings								1,579,058	1,579,058	1,579,058	1,579,058	1,579,058	1,579,058	1,579,058	1,579,058	1,579,058	1,579,058
Tower buildings								3,018,600	3,018,600	4,024,800	4,024,800	4,024,800	2,012,400				
<i>Technical expenses</i>		247,661	495,321	990,643	990,643	1,238,304	742,982	247,661									
<i>Concession charges</i>			167,919	167,919	167,919	167,919	167,919										
<b>TOTAL [€]</b>	<b>1,359,660</b>	<b>2,966,981</b>	<b>6,714,511</b>	<b>7,348,228</b>	<b>8,875,807</b>	<b>7,054,969</b>	<b>3,701,932</b>	<b>6,039,078</b>	<b>4,597,658</b>	<b>5,603,858</b>	<b>5,603,858</b>	<b>5,603,858</b>	<b>3,591,458</b>	<b>1,579,058</b>	<b>1,579,058</b>	<b>1,579,058</b>	
<b>MANAGEMENT COSTS [€]</b>																	
OVERHEADS [€]	33,021	33,021	33,021	33,021	33,021	33,021	331,269	331,269	331,269	182,145	107,583	107,583	33,021	33,021	33,021	33,021	182,500
<b>TOTAL COSTS [€]</b>	<b>1,392,681</b>	<b>3,000,002</b>	<b>6,747,532</b>	<b>7,381,249</b>	<b>8,908,829</b>	<b>7,386,239</b>	<b>4,033,202</b>	<b>6,370,347</b>	<b>4,928,927</b>	<b>5,786,003</b>	<b>5,711,441</b>	<b>5,711,441</b>	<b>3,624,479</b>	<b>1,612,079</b>	<b>1,612,079</b>	<b>1,612,079</b>	<b>215,521</b>
<b>REVENUES [€]</b>																	
Housing units						14,912,400	14,912,400	14,912,400	14,912,400	7,456,200	3,728,100	3,728,100					
Periodic fee	315,000	315,000	630,000	630,000	945,000	945,000	1,260,000	1,260,000	1,260,000	1,260,000	1,260,000	1,260,000	1,260,000	1,260,000	1,260,000	1,260,000	1,260,000
<b>TOTAL REVENUES [€]</b>	<b>315,000</b>	<b>315,000</b>	<b>630,000</b>	<b>630,000</b>	<b>945,000</b>	<b>15,857,400</b>	<b>16,172,400</b>	<b>16,172,400</b>	<b>16,172,400</b>	<b>8,716,200</b>	<b>4,988,100</b>	<b>4,988,100</b>	<b>1,260,000</b>	<b>1,260,000</b>	<b>1,260,000</b>	<b>1,260,000</b>	<b>1,260,000</b>
<b>CASH-FLOW [€]</b>	<b>-1,077,681</b>	<b>-2,685,002</b>	<b>-6,117,532</b>	<b>-6,751,249</b>	<b>-7,963,829</b>	<b>8,471,161</b>	<b>12,139,198</b>	<b>9,802,053</b>	<b>11,243,473</b>	<b>2,930,197</b>	<b>-723,341</b>	<b>-723,341</b>	<b>-2,364,479</b>	<b>-352,079</b>	<b>-352,079</b>	<b>-352,079</b>	<b>1,044,479</b>
<b>FINANCIAL CHARGES [€]</b>																	
		-7,411	-25,925	-68,169	-115,062	-170,615	-113,538	-30,845									
<b>CASH-FLOW (POST TAXES) [€]</b>	<b>-1,077,681</b>	<b>-2,692,413</b>	<b>-6,143,457</b>	<b>-6,819,419</b>	<b>-8,078,890</b>	<b>8,496,073</b>	<b>12,025,660</b>	<b>9,832,908</b>	<b>11,128,411</b>	<b>2,815,135</b>	<b>-723,341</b>	<b>-723,341</b>	<b>-2,364,479</b>	<b>-358,420</b>	<b>-358,420</b>	<b>-358,420</b>	<b>1,044,479</b>
NPV [€]	54,244																
IRR [% annual]	10,08																
IRR [% semestrial]	4,92																

Fig. 9 Development of the DCFA for the case study

## 6 Conclusions

With reference to the PPP tools for the enhancement of public property assets, in the present research the financial feasibility assessment of a real case study, concerning the redevelopment of the social housing complex of Torrevecchia (Rome, Italy) has been carried out.

According to the redevelopment project of the Torrevecchia complex, the existing properties are renovated in terms of technological, structural and plant engineering efficiency. Houses that are currently characterized by an evident degradation state, due to the lack of adequate periodic maintenance interventions, will be totally refurbished. In general terms, the enhancement and management processes of the existing Torrevecchia complex and the new realization intervention aim at the improvement of the life quality of the area inhabitants and users, with renovated, energy-efficient, hygienically healthy houses and public spaces.

The implementation of the DCFA have allowed to verify the capacity of the initiative to adequately offset the risks for the private investor. In this sense, the cooperation between the Public Administration and the private investor represents an answer to the need for effective strategies, aimed at finding new functions for disused buildings or abandoned areas.

The project feasibility has been confirmed by the assessed NPV and IRR values and by the analysis of the sustainable periodic fee to be paid by the Public Administration to the private investor. In particular, the public contribution assessed represents an optimal Pareto frontier of two conflictual goals: *(i)* the financial convenience of the initiative for the private investor; *(ii)* the compliance with the regulatory provision (Italian Decree No. 50/2016, art.180). The dual aim that leads to the determination of the public down payment gives interesting implications in the DCFA implementation.

Further insights of the research may concern the application of a sensitivity analysis on the results obtained, e.g. by considering different convenience thresholds of the private investor or different cost items and relative amounts, in order to define the critical variables of the analysis that might cause relevant variation in the outputs. Furthermore, it could be interesting to analyze the social benefits deriving from the enhancement initiative of the Torrevecchia complex through a Cost–Benefit Analysis [22], in order to assess the investment sustainability for the local community according to the social, energy retrofit and environmental needs.

**Notes:** The work must be attributed in equal parts to the authors.



## References

1. Adair A, Berry J, McGreal S, Deddis B, Hirst S (2000) The financing of urban regeneration. *Land Use Policy* 17(2):147–156
2. Calabrò F, Della Spina L (2018) La fattibilità economica dei progetti nella pianificazione strategica, nella progettazione integrata, nel cultural planning, nei piani di gestione. Un modello sperimentale per la valorizzazione di immobili pubblici in Partenariato Pubblico Privato. *LaborEst*, 16
3. Collegio degli Ingegneri e Architetti di Milano (2019) *Prezzi Tipologie Edilizie*. DEI Tipografia del Genio Civile. Quine Business publisher
4. Decree Law No. 112, 25 June 2008
5. Del Giudice V, De Paola P, Torrieri F (2014) An integrated choice model for the evaluation of urban sustainable renewal scenarios In: *Advanced materials research*, vol 1030. Trans Tech Publications Ltd., pp 2399–2406
6. Glumac B, Han Q, Schaefer W (2018) A negotiation decision model for public–private partnerships in brownfield redevelopment. *Environ Plan B: Urban Anal City Sci* 45(1):145–160
7. Guarini MR, Battisti F (2014) Benchmarking multi-criteria evaluation methodology’s application for the definition of benchmarks in a negotiation-type public-private partnership. A case of study: the integrated action programmes of the Lazio Region. *Int J Bus Intell Data Min* 9(4):271–317
8. Hodge GA, Greve C (2007) Public–private partnerships: an international performance review. *Public Adm Rev* 67(3):545–558
9. Kaganova O, Nayyar-Stone R (2000) Municipal real property asset management: an overview of world experience, trends and financial implications. *J Real Estate Portfolio Manag* 6(4):307–326
10. Las Casas G, Scorza F, Murgante B (2018) New urban agenda and open challenges for urban and regional planning. *International symposium on new metropolitan perspectives*. Springer, Cham, pp 282–288
11. Law Decree. No. 201, 6 December 2011
12. Law No. 214, 22 December 2011
13. Italian Legislative Decree No. 50, 18 April 2016
14. Leung BY, Hui EC (2005) Evaluation approach on public-private partnership (PPP) urban redevelopments. *Int J Strat Prop Manag* 9(1):1–16
15. Liu J, ED Love P, Smith J, Regan M, Sutrisna M (2014) Public-private partnerships: a review of theory and practice of performance measurement. *Int J Prod Perf Man* 63(4):499–512
16. Macdonald S, Cheong C (2014) The role of public-private partnerships and the third sector in con-serving heritage buildings, sites, and historic urban areas. Getty Conservation Institute, Los Angeles, CA
17. Oppio A, Torrieri F (2016) Supporting public-private partnership for economic and financial feasibility of urban development. *Procedia-Soc Behav Sci* 223:62–68
18. Salvo F, De Ruggiero M, Zupi M (2015) The valorization of public real estate. A first outcome of the experiences in progress and a methodological proposal. *XLIII Incontro Di Studi Ce. SET Sviluppo economico e nuovi rapporti tra agricoltura, territorio e ambiente* 67:135–146
19. Tajani F, Morano P, Di Liddo F (2019) Complementarietà dei ruoli dei soggetti coinvolti in procedure di partenariato pubblico privato per l’efficacia degli interventi e la diversificazione dei rischi di mercato: analisi di fattibilità di un progetto di valorizzazione nella città di Roma. *Laborest*, 18
20. Tajani F, Morano P, Di Liddo F, Locurcio M (2019) An Innovative interpretation of the DCFA evaluation criteria in the public-private partnership for the enhancement of the public property assets. In: Calabrò F, Della Spina L, Bevilacqua C (eds) *New metropolitan perspectives: local knowledge and innovation*. Smart innovation, systems and technologies, vol 100. Springer, Berlin, pp 305–313

21. Tajani F, Torre CM, Di Liddo F (2019) Financial feasibility assessment of public property assets valorization: a case study in Rome (Italy). In: International conference on computational science and its applications, July 2019. Springer, Cham, pp 82–93
22. Trovato MR, Giuffrida S (2018) The monetary measurement of flood damage and the valuation of the proactive policies in Sicily. *Geosciences* 8(4):141
23. [www.aterroma.it](http://www.aterroma.it)
24. [www.bancaditalia.it](http://www.bancaditalia.it)
25. Zou PXW, Wang S, Fang D (2008) A life-cycle risk management framework for PPP infrastructure projects. *J Financ Manag Prop Constr* 13(2):123–142