Sustainable Initiatives of Industrial Archaeology Conservation and Reuse: The Case-Study of the St Paul's Storage in Rome

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Abstract. The aim of this work is the economic-financial evaluation of a restoration and functionalization project on the former "St Paul's storage", an example of industrial archaeology in Rome. The term "industrial archaeology" denotes an interdisciplinary approach to studying past industrial sites, specifically in relation to their impact on the territory or with a view to their possible preservation. Industrial sites often consist of buildings lacking particular aesthetic qualities, designed solely to meet production needs. Consequently, they are rarely undergoing historical-artistic protection constraints by local Superintendencies, and their existence is jeopardized by urban regeneration processes. The "voids" left by the decommissioning of factories are frequently situated in strategic locations within cities. These areas become attractive for economic stakeholders involved in transformations, including administrations and businesses. However, repurposing the buildings, once designated for production, presents challenging issues, ranging from land pollution to high management costs, due to their considerable size. The ensuing study aims to demonstrate the economic sustainability of these actions on industrial archaeology, aligning with the needs and requests of the population and in perspective to become potential strategy-nodes of the sustainable development.

Keywords: Industrial archaeology · Sustainable practices · Co-participatory process

1 Case Study Description

St Paul's store dates back to 1928, when it was built under the name *Littorio* Depot to house the first electric tram vehicles to reach the Basilica of San Paolo. The substantial restrictions on trams in Rome resulted in a steady fall in the garage's tram utilization. As a result, starting in the 1970s, it was mostly used for buses until its closure in 2000. Since then, as with other structures of its type, several suggestions for reuse have been proposed, but none have been materialized, and the warehouse remained abandoned. Similar case studies include the renovation of *Testaccio*, a former nineteenth-century abattoir in Rome

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that was decommissioned in 1975 and repurposed in 2000 while preserving its original features for use as a Department of Architecture campus and a branch of the Museum of Contemporary Art MACRO. The *Guido Reni* District features 23 separate, adaptable rooms in a post-industrial design, all of which were created from an old barrack by the *Cassa Depositi e Prestiti* Group. The major renovation of the former ATAC *Vittoria* terminal produced the *Prati* Bus District. The city of *Prato*'s former *Campolmi* shearing factory, which was once an industrial complex for the manufacturing of textiles, has been transformed into the Textile Museum and municipal library while maintaining its historical layers and original structure.

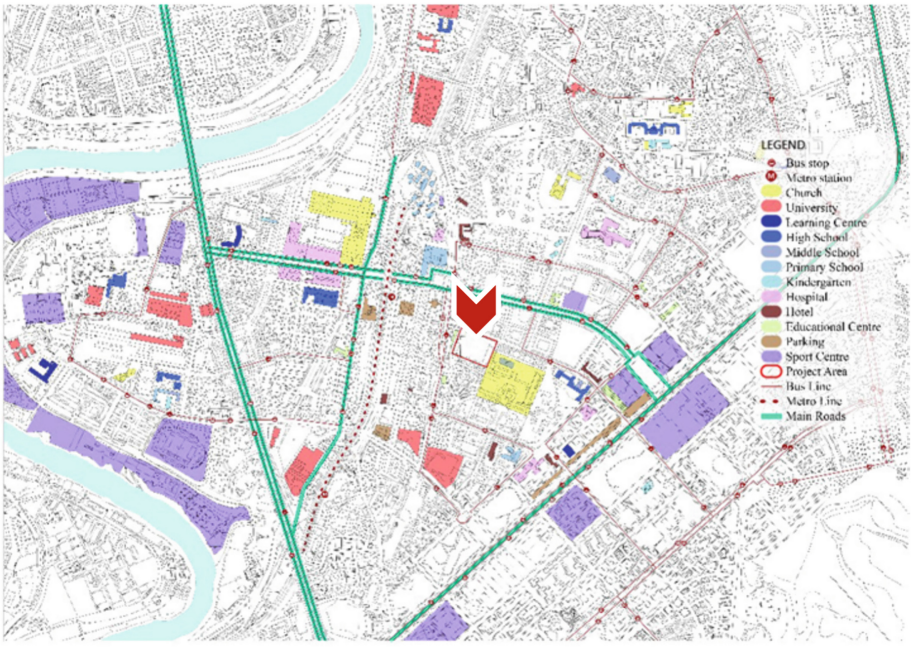

Fig. 1. Main services and connections in the neighborhood near the depot.

The project is located in Municipio VIII of the municipality of Rome. The population amounts to 128,914, with a density of 2501 – 7000 inhabitants per square kilometres, mainly composed of families with children. Namely, the case study is placed in Rome, in the *Ostiense* district between *Alessandro Severo* and *Settimio Severo* St., and, as seen in Fig. 1, it is encircled by several facilities and services.

Before the twenties, the *Gazometro* was near the southern border of Rome, but the area developed significantly over the years into a district and now it is mostly built-up. Beyond the *Gazometro*, the *Garbatella* was constructed and, going further South, the St. Paul's Church was an important point of attraction. The opening of many new tram lines has resulted in the requirement for a public transportation depot in this area.

Since it was built at a higher level in the fifties, the large depot is now underground instead of being on top of *Alessandro Severo* Str. The structure is made of reinforced concrete and has four large arched roofs that are supported on pillars (Fig. 2).

The degradation analysis is presented n Fig. 3. It is a graphical and technical elaboration describing the pathologies and failures of an existing building. The purpose is to analyze the "defects" that the studied building exhibits in order to identify the most appropriate "treatment" to address the issues it manifests. The degradation analysis is a process regulated by the "UNI 11182 Cultural Heritage" standard and is the foundation of every recovery or restoration project in Italy.



Fig. 2. Tram depot entrance

The sports and wellness centre, complete with a gym, sauna, and swimming pool, as well as leisure and eating sections and student cultural spaces, are all part of the depot's revitalization project. The upper floors house classrooms and labs for the architecture faculty of Sapienza University in Rome, while the lower levels house administrative spaces and services.

In order to prove the case study's economic-financial viability, the following methodological approach was taken:

i. *Socio-urban context analysis* (Sect. 2). In order to support the initial project intents and compare the demands of the people with the services already provided, a SWOT analysis (2.1) and an online survey (2.2) were created.
ii. *Cost-revenue analysis* (Sect. 3). The characteristics of the San Paolo Deposit Requalification Project are estimated in terms of construction and management costs, as well as primary and secondary revenue sources. These are based on the interests expressed

by the community, as well as the meanings of demand and supply in the reference market.

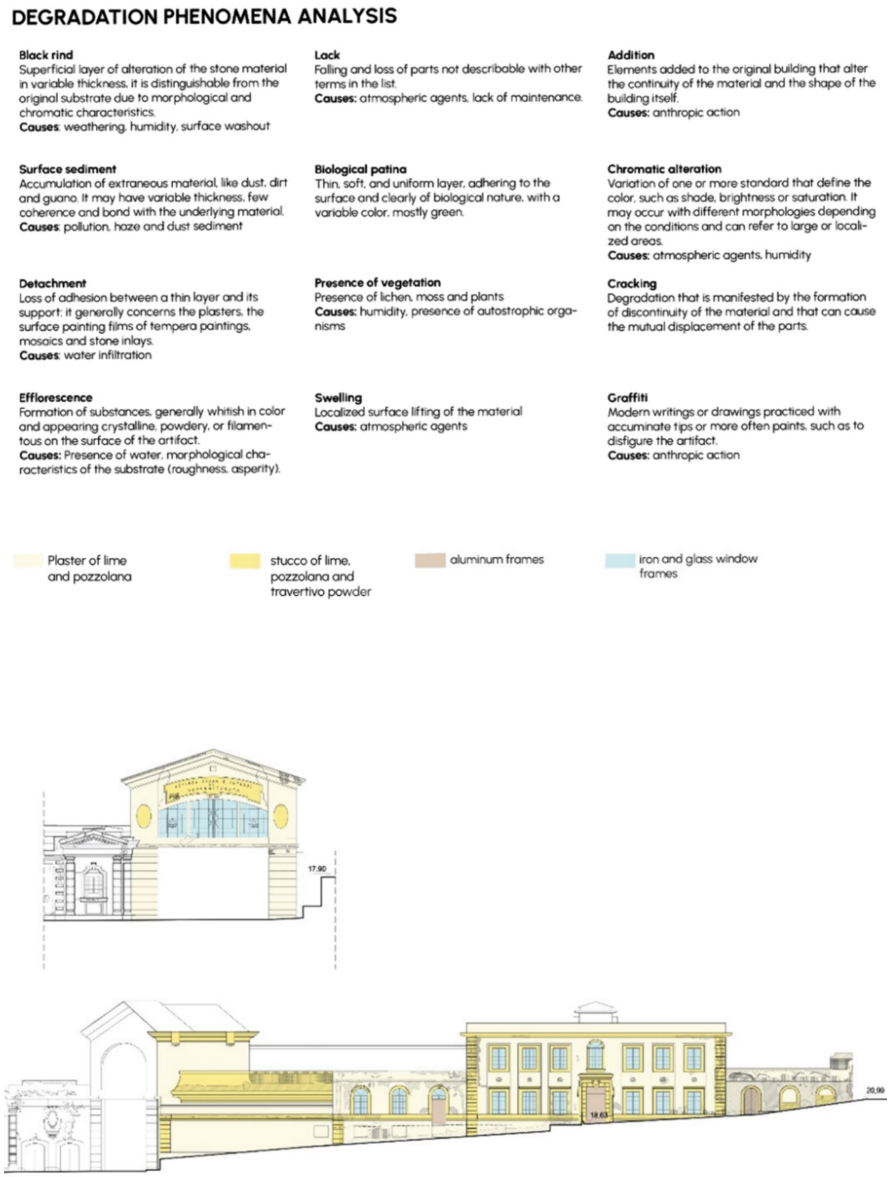

Fig. 3. Degradation phenomena analysis

2 Socio-Urban Context Analysis

The economic-financial feasibility analysis of the St. Paul deposit recovery project is developed by first analysing the urban context of reference and then comparing its potential to the analysed recovery intervention. This involves creating a SWOT matrix (2.1) to express the project's significant and less characteristics, considering potential risks and opportunities for growth in the context that might result from a recovery project, such as that under analysis. Second, to ensure the coherence of the project's intentions, a survey is designed (2.2) to capture the population's demands and quantify the willingness to pay for investing in the realization of particular functions of interest. The two sub-sections are explored below.

2.1 SWOT Analysis

The SWOT matrix is a strategic planning tool used to assess the strengths, weaknesses, opportunities, and threats of a project. The analysis can focus on the internal environment (strengths and weaknesses) or the external environment (threats and opportunities). The SWOT analysis identifies possibilities and risks within the environment in which the intervention of our investigation is placed. In addition, the project's strengths and weaknesses have been discussed [1–4].

The analysis was undertaken initially from a broad viewpoint, analyzing the entire neighborhood, and then more precisely, focusing on the project area. Among the building's qualities, it is crucial to highlight the importance of collective memory in the neighborhood since the former St. Paul depot acts as a reference point for the locals.

SWOT	S	W	O	T
Analysis	Strenghts	Weaknesses	Opportunities	Threats
Garbatella district	- **Key position**: easy to access to main public transport (subway, bus, ...); - **High presence of public green area**; - **High presence of schools and academies**: it allows education from the youngest to university student; - **Numerous attractions** like: "San Paolo fuori le mura", lot of sports centres; - **Commercial road**: excellent distribution of all kinds of shops.	- **Lack of parking**; - **Public green area abandoned and too much degradated.**	- **High presence of attractions for student**; - **High presence of public transport** which encourage the arrival of many people; - **Possible connection between green areas and attractions**; - **High presence of hospitals and clinics**.	- **Intervention limits** given by the PRG (public service at urban level) and by the **architectural constraint** of cultural interest.
St Paul's Storage	- **Collective memory** of the building: currently use as a market for the sale of local products (San Paolo District); - **Architectural value of the building.**	- The building is surrounded by **one-way streets**: difficult to vehicular access; - **Poor visibility**: the building is undergrounded compared to street level; - **Poor maintenance of the sidewalk** and limited usable pedestrian space. - **Large abandoned public green area.**	- **Volumetric and structural power** of the building; - Maintenance of a **collective memory** (historical recognisability).	- Very **degraded** building; - **Roof always in contact with the sun** (completely absent on the facades); - **Natural light is almost absent** (it is present only in some points thanks to the presence of skylights; - **Large nearby green area neglected**.

Fig. 4. SWOT analysis

As a result, the identity of the building has been viewed as an important aspect in architectural decisions. Figure 4 summarizes the SWOT analysis results.

2.2 Survey of the Local Needs

A survey was performed to assess the project proposal by potential users of the spaces, namely that are destined to the exhibition [5–7].

The questionnaire received 31 replies, with around 55% coming from those aged 19 to 25. The survey intended to better understand the neighbourhood's lacking services in order to suggest a concept that would meet the requirements of both residents and visitors.

77.4% of respondents said they are students. Income is distributed pretty evenly: 32.3% report earning less than €15,000 per year, 32.3% between €15,000 and €28,000 per year, and 35.5% between €28,000 and €50,000 per year. According to the survey, 87.1% do not live in the reference neighborhood, yet more than 32% have heard of it, and 35% know and visit the region.

According to the survey (Fig. 5), the places designated for cultural activities, green spaces, and leisure were the ones that voting users valued the most. This finding is consistent with the social and urban study that was done earlier since there are green spaces, but they are generally neglected or in bad shape, and there are no cultural or recreational sites.

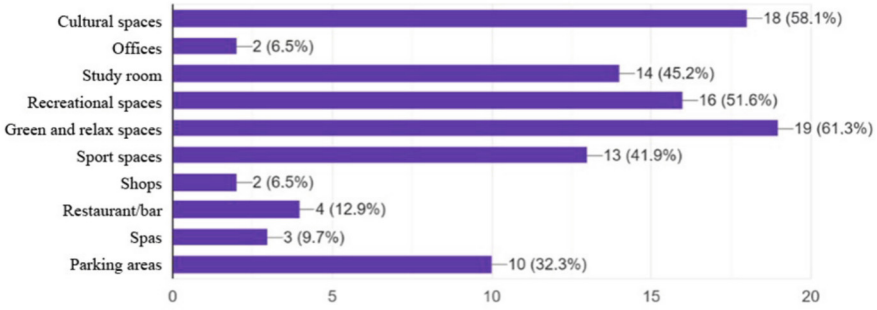

Fig. 5. Bar chart for the question: "What services do you think are missing in the neighbourhood?"

Based on the aforementioned results, an initial market investigation on the "willingness to pay" for the proposed service was conducted. The data obtained (Fig. 6) indicates that 45% of the public would be willing to pay between 5 and 10 euros per entry.

The third and final part of the survey (Fig. 7) is dedicated to understand the macro-themes that can be present in the project and concern common interest issues. The macro-themes derive from the extrinsic characteristics of the analysed territory. The overall survey results point to: crime reduction (14 responses), increase in the young population (18 responses), greater attractiveness of the area (19 responses), and improvement of public green spaces (18 responses).

In conclusion, it can be stated that the proposed project meets the needs of the users. Despite the higher percentage of residents being over 50, the survey responses

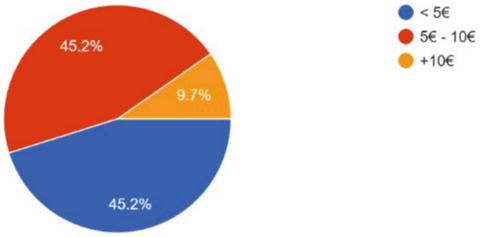

Fig. 6. Pie chart for the question: "How much would you be willing to pay for admission to access the services proposed in the previous question?"

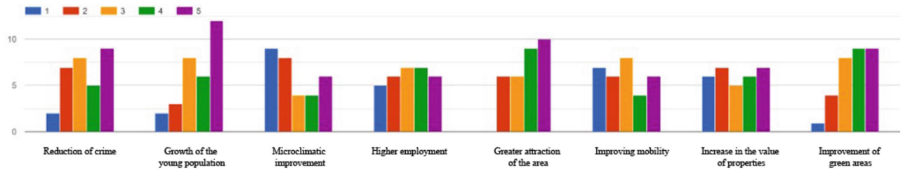

Fig. 7. Histograms for the question: "What effects on the neighbourhood do you expect from the redevelopment of the depot?"

demonstrate that the area is widely frequented by young people due to the presence of schools and universities. Therefore, the project has been calibrated based on the high number of students, which is its primary target audience.

3 Economic and Financial Feasibility of the Intervention

Financial evaluations have been conducted using the Discounted Cash Flow Analysis (DCFA) to give a comprehensive picture of the medium- to long-term implications of the development project. The goal of this approach technique is to evaluate each intervention's sustainability. In order to use DCFA, it is necessary to make some assumptions about the duration of the study and the discount rates that will be used in the assessment, as well as to identify income and cost components that help determine the operation's viability. The study time is set at twenty years, in accordance with the custom of the average investor, who tends to sell the asset that is being evaluated after a fair amount of profitable operations.

3.1 Direct and Indirect Revenue Appraisal

To determine the market value of the project offices, we conducted a direct market assessment, comparing similar properties to ours and utilizing floor space as a technical distinguishing factor [8]. After entering surface area data, we calculated the unit price (per square meter) for each comparison. We next proceed to create the pricing scale, which is just an ascending arrangement of unit prices based on the previously described market survey. Our unit pricing (20.88 €/sqm), calculated as the average of the reported data, falls within the analysis-range.

Otherwise, the search for the unit pricing of exhibition spaces necessitated more particular study since, in the spatial research horizon, there were few equivalent or consistent case studies with the leasing technique we hypothesized - namely, a fixed fee upon "entry" rather than monthly leasing of the building.

In addition, several indirect sources of revenue were evaluated, based on the questionnaire answers. These included the arranging of workshops, conferences, and study rooms.

3.2 Intervention and Management Costs

The theoretical idea of production cost—the total of all the expenses an entrepreneur must incur for a production cycle to continue—is applied to the building costs. To ensure a more comprehensive assessment, the building costs are determined using a metric calculation that is generated using software, employing the unit price of the Lazio Region's price list as a point of reference for the works' costs estimation.

It is projected that the cost of uncommon maintenance will account for 15–20% of the building cost, while the cost of routine maintenance would account for 5–10% (Fig. 8). The total annual cost is obtained from the sum of construction costs (for the first three years), fixed costs, management costs and costs for routine maintenance and extraordinary maintenance (Fig. 9). Both fixed and operating costs were estimated based on the assumption of use and capacity of the structure: the estimated costs were 35% in

Electricity	n.	Total Power	Time	Energy	Rate	Total annual
		(kW)	(h)	(kWh)	(€/kWh)	€
Lighting	70	28	4,863	136,164.00	0.16	21,786.24
Video surveillance system	20	0.01	8,760	87.60	0.16	14.02
Elevator	2	5	8,760	43,800.00	0.16	7,008.00
Cutting machines	1	0.08	4,863	389.04	0.16	62.25
3D printers	1	0.12	4,863	583.56	0.16	93.37
Plotter	2	0.60	4,863	2,917.80	0.16	466.85
Air conditioning	10	-	-	33,852.00	0.16	54,163.20
TOT.						83,593.92 €

Management costs	€
Cost for staff	
Screener (x2)	29,900.00
Bookkeeper	18,000.00
Costi operativi	€
Maintenance and cleaning charges	30,000.00
Electricity	75,550.00
General costs	€
Management	4,800.00
TOT.	158,250.00

Maintenance (from the fifth year)	
Ordinary	5-10%
Extraordinary	15-20%

Fig. 8. Management and fixed costs

COSTS					
	Construction	Fixed costs	Management	Maintenance	Total
1° year	66,500.00 €	- €	- €	- €	66,500.00 €
2° year	23,614.85 €	- €	- €	- €	23,614.85 €
3° year	53,342.00 €	- €	- €	- €	53,342.00 €
4° year	-	27,866.67 €	52,750.00 €	- €	80,616.67 €
5° year	-	27,866.67 €	52,750.00 €	- €	80,616.67 €
6° year	-	41,800.00 €	79,125.00 €	- €	120,925.00 €
7° year	-	41,800.00 €	79,125.00 €	- €	120,925.00 €
8° year	-	58,520.00 €	110,775.00 €	- €	169,295.00 €
9° year	-	58,520.00 €	110,775.00 €	- €	169,295.00 €
10° year	-	83,600.00 €	158,250.00 €	- €	241,850.00 €
11° year	-	83,600.00 €	158,250.00 €	- €	241,850.00 €
12° year	-	83,600.00 €	158,250.00 €	- €	241,850.00 €
13° year	-	83,600.00 €	158,250.00 €	- €	241,850.00 €
14° year	-	83,600.00 €	158,250.00 €	- €	241,850.00 €
15° year	-	83,600.00 €	158,250.00 €	- €	241,850.00 €
16° year	-	83,600.00 €	158,250.00 €	- €	241,850.00 €
17° year	-	83,600.00 €	158,250.00 €	- €	241,850.00 €
18° year	-	83,600.00 €	158,250.00 €	- €	241,850.00 €
19° year	-	83,600.00 €	158,250.00 €	- €	241,850.00 €
20° year	-	83,600.00 €	158,250.00 €	- €	241,850.00 €
21° year	-	83,600.00 €	158,250.00 €	- €	241,850.00 €
22° year	-	83,600.00 €	158,250.00 €	- €	241,850.00 €
23° year	-	83,600.00 €	158,250.00 €	- €	241,850.00 €
24° year	-	83,600.00 €	158,250.00 €	- €	241,850.00 €
25° year	-	83,600.00 €	158,250.00 €	- €	241,850.00 €

Fig. 9. Total annual costs

the fourth year, 50% in the sixth year, 70% in the eighth year, and 100% from the tenth year onwards.

3.3 Discounted Cash Flow Analysis

The analysis of the financial feasibility of the intervention includes an analysis of costs and revenues for the construction and management phases over 25 years.

To conduct a cost-profit analysis, it is necessary to calculate the cost of construction, the total operating expenses (including management and maintenance), and tariff returns depending on potential users. The Discounted Cash Flow Analysis is used to calculate the net present value of return flows minus costs, discounted at a conventional rate of 3 per cent, and the IRR or discount rate, which, applied to the return flow minus costs, resets the net present value [7, 10–14].

The subdivision of the construction costs was assumed over three years according to the construction phases, organizing the interventions in chronological order.

The estimate of revenue is made assuming for the first three years, that is, for the construction phase, no income. Starting from the fourth year, considering a use and a capacity of 35%, a daily income was assumed based on the market analysis carried out before. The revenue comes from the rental of the conference room and offices, from the entrance fee to the study rooms and laboratories, estimated by the survey. The procedure was repeated for the following years, assuming a use and a capacity of 50% from the sixth year, 70% from the eighth year and 100% from the tenth year onwards.

By analyzing the costs and revenues mentioned above, we can determine the cash flows obtained from the project (Fig. 10), which allows us to calculate the net present value of the project and the internal rate of return.

The IRR is equal to18% and the NPV is equal to 4,030,460.90 Euro.

CASHFLOW				
Time	Costs	Earnings	Total	Cashflow
1° year	66,500.00 €	- €	- 66,500.00 €	- 66,500.00 €
2° year	23,614.85 €	- €	- 23,614.85 €	- 90,114.85 €
3° year	53,342.00 €	- €	- 53,342.00 €	- 143,456.85 €
4° year	80,616.67 €	93,500.00 €	12,883.33 €	- 130,573.52 €
5° year	87,786.07 €	93,500.00 €	5,713.93 €	- 124,859.59 €
6° year	120,925.00 €	143,510.00 €	22,585.00 €	- 102,274.59 €
7° year	120,925.00 €	143,510.00 €	22,585.00 €	- 79,689.59 €
8° year	169,295.00 €	211,820.00 €	42,525.00 €	- 37,164.59 €
9° year	169,295.00 €	211,820.00 €	42,525.00 €	5,360.41 €
10° year	256,188.80 €	307,340.00 €	51,151.20 €	56,511.61 €
11° year	241,850.00 €	307,340.00 €	65,490.00 €	122,001.61 €
12° year	241,850.00 €	307,340.00 €	65,490.00 €	187,491.61 €
13° year	241,850.00 €	307,340.00 €	65,490.00 €	252,981.61 €
14° year	241,850.00 €	307,340.00 €	65,490.00 €	318,471.61 €
15° year	263,358.20 €	307,340.00 €	43,981.80 €	362,453.41 €
16° year	241,850.00 €	307,340.00 €	65,490.00 €	427,943.41 €
17° year	241,850.00 €	307,340.00 €	65,490.00 €	493,433.41 €
18° year	241,850.00 €	307,340.00 €	65,490.00 €	558,923.41 €
19° year	241,850.00 €	307,340.00 €	65,490.00 €	624,413.41 €
20° year	249,019.40 €	307,340.00 €	58,320.60 €	682,734.01 €
21° year	241,850.00 €	307,340.00 €	65,490.00 €	748,224.01 €
22° year	241,850.00 €	307,340.00 €	65,490.00 €	813,714.01 €
23° year	241,850.00 €	307,340.00 €	65,490.00 €	879,204.01 €
24° year	241,850.00 €	307,340.00 €	65,490.00 €	944,694.01 €
25° year	270,527.60 €	307,340.00 €	36,812.40 €	981,506.41 €

Fig. 10. Development of the Cash flows

4 Conclusions

The research focuses on an industrial structure of historical and architectural importance that should be preserved via recovery, even if it is economically costly. The goal of this study is to give an objective assessment of the viability of the interventions under consideration, that is, their potential to favorably integrate into the reference environment and attract a large number of users, particularly students and young people. That purpose is intended to offer economic and social benefits to a hypothetical private investor. Furthermore, using the net present value (NPV) and internal rate of return (IRR) as financial sustainability criteria, it may be concluded that the project is economically viable. Apart from conducting an analytical analysis, it is imperative to emphasize the utilization of surveys as a fundamental instrument for involving citizens in project decision-making. This is done with the aim of achieving both financial and social benefits from the work. This is applicable to both urban industrial archaeology conservation and reuse projects.

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