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RESEARCH ARTICLE

Recovery and reuse of abandoned buildings for student housing: A case study in Catania, Italy

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Abstract
Over the past 15 years, housing supply for university students has increased significantly given the considerable attention provided by national institutions on the issue of student housing. In Italy, however, only approximately 4% of students live in university residences. Since 2001, interventions on existing buildings have accounted for approximately 60% of the overall measures proposed for new university residences; these interventions comprise most of the available public economic resources. The possibility of recovering and reusing existing buildings for university residences is remarkable for the city of Catania because most of the students are enrolled in university courses located within the historic city center. Moreover, abandoned buildings are currently a significant part of the city's architectural heritage. This research aims to develop an articulated and integrated set of frameworks to support the various phases of the design process for recovering and then reusing existing buildings as university residences. The proposed approach applies existing dimensional standards and environmental sustainability principles to a constructed building using traditional techniques.
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1. Introduction

The data provided by the latest Eurostudent report (Hauschildt et al., 2015) presents a heterogeneous image of student housing conditions in various European countries. Italy is ranked at the bottom for availability of accommodation in university residences. Despite the high demand in Italy, only approximately 4% of students live in university residences, as compared to an average of 23% in other European countries. Thus, a critical point in the current university policy in Italy is the lack of university residences, which must represent infrastructures that connect society, culture, and services and must be an important qualification and competitive factor for universities in support of teaching and research activities (Holahan and Wilcox, 1978; Proctor, 2008).

On the basis of national standards, the announcement of selection issued by the Catania Regional Office for University Students (ERSU) stated that students who live in cities that are more than 30 km from Catania and travel for more than 50 min to reach the university using public transport are considered "non-residents." For the academic year 2016–2017, the ERSU offered housing services for non-resident students enrolled at the University of Catania in 10 ERSU-managed university residences located in the city or through an agreement with private individuals. Table 1 lists the number of housing places for each residence in Catania. The ERSU provided only 698 accommodation places out of 1771 requests received. Therefore, the housing supply by the ERSU only met 39% of the actual demand by non-resident students. The students were selected using certain criteria that assess their merit and economic condition, as established in a specific call.

In addition to the unfulfilled accommodation requests, a high demand for accommodation in university residences is observed among students who either did not apply for accommodation in university residences and/or do not meet the criteria for the ERSU allocation of accommodation, thereby resorting to the private market for student room rentals or being commuters.

In this academic year, 505,194 students are enrolled at the University of Catania; this number represents more than 15% of the population that resides within the metropolitan area (this percentage is similar to that of the universities in large European metropolises, such as Milan). A total of 98.7% of the students live in Sicily (49,855), 0.7% (368) are residents of other Italian regions, and 0.6% (296) are foreign students whose presence is linked to exchange and mobility programs in the context of internationalization processes promoted by the European Union. On the basis of these data, at least 35% of the students at the University of Catania can be considered "non-residents." Accordingly, approximately 19,000 university students must find accommodation in Catania to attend their enrolled university courses. Less than 4% of the potential demand for housing by non-resident students is met by the current institutional offer of 698 accommodation places in certain residences. Therefore, most non-resident students enrolled at the University of Catania are forced to turn to the private market of rental housing (Verhetsel et al., 2017; Tallon, 2016).

Over the past 15 years, the housing supply for university students has increased significantly given the considerable attention provided by national institutions on the issue of residence, thus leading to defining a specific law for university residences that establish the minimum dimensional standards. This legislation provides for public co-financing of up to 50% of the executive project cost in the form of a subsidy promoted by public institutions or private individuals even for interventions, which are aimed at recovering existing buildings to be transformed into residences for university students.

Table 1 Student housing supply in Catania.

Residence	Men	Women	Total
Calatabiano	31	29	60
Caracciolo	35	57	92
Centro	67	89	156
Cittadella	103	62	165
Dante	14	24	38
Suore Cappuccine	0	32	32
Morano	0	40	40
Musco	0	32	32
San Marzano	29	14	43
Verona	18	22	40
Total	**297**	**401**	**698**

2. State-of-the-art university residences

University residences are a factor of social and economic development for a city given the role they play in the urban setting (Redmond and Zarli, 2017; Chronis et al., 2012). Therefore, university residences have frequently been localized within the urban setting by exploiting, recovering, or reusing buildings and/or areas previously used for other functions in several major Italian cities (Guarini and Battisti, 2013). The possibility of recovering and reusing existing buildings for university residences is particularly remarkable for the city of Catania because most of the requests for housing received by the ERSU for the academic year 2016–2017 originated from students enrolled in university courses located within the historic city center (Figure 1). Abandoned and old buildings are currently a significant part of the building heritage of Catania (Lombardo, 2012; Cascone et al., 2018a). Considering the requirement for sustainable regeneration of the urban environment, the new contributions of these buildings are crucial to the urban transformation process and the social and economic development of the city (Gagliano et al., 2014; La Rosa et al., 2017; La Greca et al., 2011).

In recent years, several studies have analyzed the performance of buildings for university residences; this performance mainly focuses on energy and environmental aspects. Abolarin et al. (2013) considered the lighting efficiency improvement of four residence halls in the University of Lagos to quantify energy saving and minimize carbon dioxide. The authors evaluated the existing electricity consumption data obtained from the energy audit combined with conversion factors to estimate the annual CO_2 contributed to the atmosphere by lighting each of the

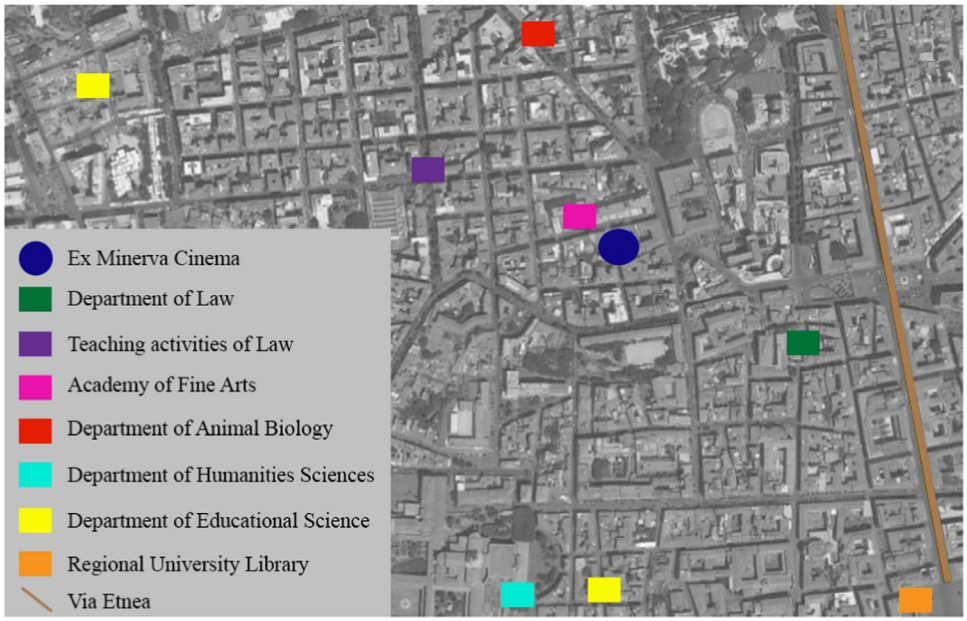

Fig. 1 Location of Minerva Cinema and several university departments in the historic center of Catania.

buildings considered. The result of the study showed that over 45% reduction in carbon dioxide emissions can be achieved by adopting simple individual measures. Emeakaroha et al. (2014) designed, configured, and implemented a persuasive feedback support system to facilitate energy conservation and carbon emission reduction. These authors used the student residence halls at the University of Kent as a use case scenario to demonstrate the applicability of the proposed system and assess its performance. Chiang et al. (2014) conducted two six-week experiments in a student residence at the University of Bath to investigate the use of visually displayed energy information presented in different ways to encourage reductions in energy use. This system resulted in a 7.7% savings over the baseline. These authors concluded that the mere presence of a display device can reduce energy use even when participants are not engaged with the display. Finally, Petidis et al. (2018) studied the existing student residential building of the Technical University of Crete, the current indoor conditions, and the energy consumption behavior of occupants to identify the proper building interventions. These authors proposed five scenarios on reducing energy consumption toward a nearly zero energy building with a reasonable payback period. In particular, the investigated scenario of thermal insulation on the building envelope presented a 10% savings, and the combination scenario, including all the interventions (i.e., thermal insulation on the building envelope, green roof, LED bulbs, and substitution of windows), achieved a total savings of up to 36%.

Only a few studies have analyzed the performance of a refurbished university residence. Joppolo et al. (2017) conducted a research to balance building conservation, user comfort, and energy efficiency at the Urbino University Colleges. These researchers aimed to reduce heating and operational costs, including a proposal for energy retrofitting. These authors monitored surface temperatures, indoor air temperature and humidity, and the building performance before and after retrofitting. The results provided suggestions for prompting conservation with sustainability for an existing building. Pritoni et al. (2016) presented results from a controlled field evaluation of occupancy-responsive learning thermostats installed in every bedroom of three high-rise university residence halls. The results showed that, despite an estimated 10–25% and 20–50% savings for cooling and heating, correspondingly, using a standard energy model developed prior to the retrofit, the control scheme only reduced by 0–9% and 5–8% energy consumption for cooling and heating, respectively, under normal operation during academic periods. Moreover, these authors provided a novel insight into improving field evaluations and refining model assumptions to predict the impact of occupancy-responsive thermostat controls well. Lou et al. (2017) proposed four student accommodation refurbishment projects to compare and contrast differing emission datasets. The results indicated that project cost and duration alone cannot be used to gauge greenhouse gas emissions. However, in terms of student accommodation refurbishment, the gross internal floor area and the number of rooms offered a predictable indicator. Mostafavi et al. (2015) used three building analysis software programs to quantify the predicted energy savings of a scheduled envelope retrofit of a university dormitory. Their study included investigating the potential energy savings created by removing and replacing all original windows and exterior nonstructural infill brick panels coupled with installing supplementary insulation materials between the new brick panels and the interior concrete masonry unit walls. Finally, a retrofit proposal was analyzed by comparing the results of each retrofit design alternative against the baseline and assessing the reduction of CO_2 emissions achieved from the proposed retrofit process.

The literature review demonstrated a lack of published research studies on refurbishment projects of existing buildings for student accommodation. Previous research has focused on analyzing energy aspects related to

retrofitting existing buildings already used as a university residence. These studies disregarded the real feasibility of the proposed interventions or the functional and distributive aspects of the residence. Moreover, the specific problems due to the change in the existing building use in a university residence were not analyzed by scientific literature. Finally, studies for revitalizing abandoned buildings into university residences remained lacking.

In this context, this research aims to develop an articulated and integrated set of frameworks to support the various phases of the design process for retrofitting existing buildings as university residences. A case study within this objective is performed to recover and reuse an abandoned building as a university residence located in the central district of Catania and adjacent to the historic center. The proposed approach applies existing dimensional standards and environmental sustainability principles to a building constructed using traditional techniques and focuses on integrating the functional recovery of the building by improving its structural safety and energy performance.

3. Case study

The objective of the first phase of this research was to limit the field of survey to a sample of abandoned buildings used in the past as cinemas. The choice was focused on this type of building because more than 10 existing abandoned cinemas are located in Catania and that the main architectural feature of these buildings is a large auditorium, thereby confirming their suitability for renovation and reuse as university residences with a limited amount of internal demolition, as suggested by Croatto et al. (2016). For each considered building, a chart has been created by tracing its historical and architectural features, including the construction materials and techniques adopted and an analysis in the current state of conservation (Carbonara, 2012).

The building previously known as the Minerva Cinema was selected for the case study (Figure 2). The construction of the Minerva Cinema was completed in February 1946, with a seating capacity of 572. The cinema began its operation in the same year and continued until 1984. The building is located at the edge of the Catania historic center in the Central San Domenico district, which is defined as Zone D in the current urban plan.

Following the historic description of the building, the constructive aspects have been studied through geometric and material survey and a map of visible manifestations of degradation on the basis of archival and documentary sources (UNI 11182-2006). For each alteration, a report composed of the morphology, chemical and physical causes, and the photographic documentation related to the manifestations of alteration were analyzed along with the consequent proposals for intervention and rehabilitation.

The present research does not only provide an example of intervention on reusing the Minerva Cinema building as a university residence but also indicate a method for retrofitting existing buildings. This method is based on technical-constructive and morphological knowledge up to the energy analysis of the building. In particular, the project for a university residence must consider multiple and specific factors, including the different types of housing, the type and quantity of services to support the residence, and the quality and characteristics of the equipment. The decisive element that guarantees the success of the university residence established in the Minerva Cinema building is represented by its location in the central area of Catania, thereby representing a potential marketing element with considerable appeal to students.

4. Results

4.1. Functional solutions

The methodology for recovering and reusing the former Minerva Cinema is defined to avoid morphological transformations that might alter the external aspect of the existing building. In particular, the outer envelope is maintained, whereas the internal part of the building is “gutted” by eliminating the existing staircase, loggia, and internal divisions and re-modeling the internal space to satisfy the new requirements. Therefore, the work on the building envelope aims only at improving the technological and energetic characteristics while maintaining the use of traditional finishing materials, such as the ventilated roof with brick tiles and continuous external insulating layer

Fig. 2 Minerva Cinema.

(thermal coat) finished with traditional plaster on the facades.

The design within the building (Figure 3) aims for functional solutions for daily activities related to the studies and the personal and social lives of students, thus focusing on the following areas:

- optimizing useful surfaces related to dimensional standards and accessibility, usability, and transformability of spaces;
- selecting materials, components, and equipment that satisfy the requirements for easy maintenance and replacement;
- reducing energy consumption to increase environmental sustainability, thereby improving the performance of the thermal envelope and introducing plant solutions characterized by high-energy performance;
- optimizing the levels of safety and environmental conditions in terms of hygrothermal, acoustic and lighting comfort, and indoor air quality; and
- providing rooms and public areas with Wi-Fi internet access and satellite TV.

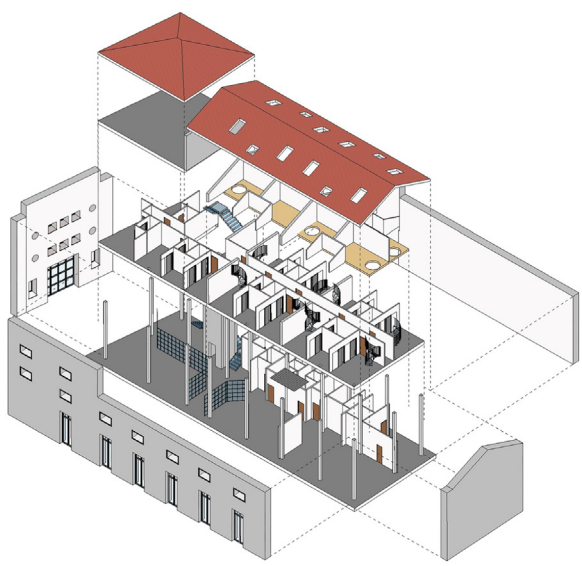

Fig. 3 Retrofitting of the Minerva Cinema building.

The general strategy for the intervention on the existing building favors a transition from the old to the new and avoids morphological transformations that alter the external perception of the existing building image. As part of this strategy, the design is supported by using technological solutions aimed at appropriately using space, attention to issues of natural lighting and ventilation, integration of heating and cooling systems, and high energy performance from the concept of a building envelope.

The proposed solutions have been obtained from previous research on healthy living and learning environments (Korjenic et al., 2010) and social interaction (Ibem et al., 2013).

Consistent with the provisions of dimensional standards, the university residence is organized in various functional areas, which are divided into environmental units. In particular, the adopted arrangement of the functional areas allows a clear location in relation to certain activities. These areas have been used in previous studies (Jaglarz, 2016) (Figure 4). Furthermore, the possibility of integration among the different functions in the same area and synergies among functions in different areas are considered.

The collective functions, entrance hall, reception, technical rooms for centralized air-conditioning systems, and toilets are situated on the ground floor. The collective functions consist of the following areas:

- a study room divided into two areas, appropriately furnished to allow individual and group studies, and separated by partially transparent glass partitions that do not reach the ceiling, thus guaranteeing the passage of light and air and simultaneously ensuring an adequate degree of privacy;
- a computer area with four individual positions equipped with a free internet connection;

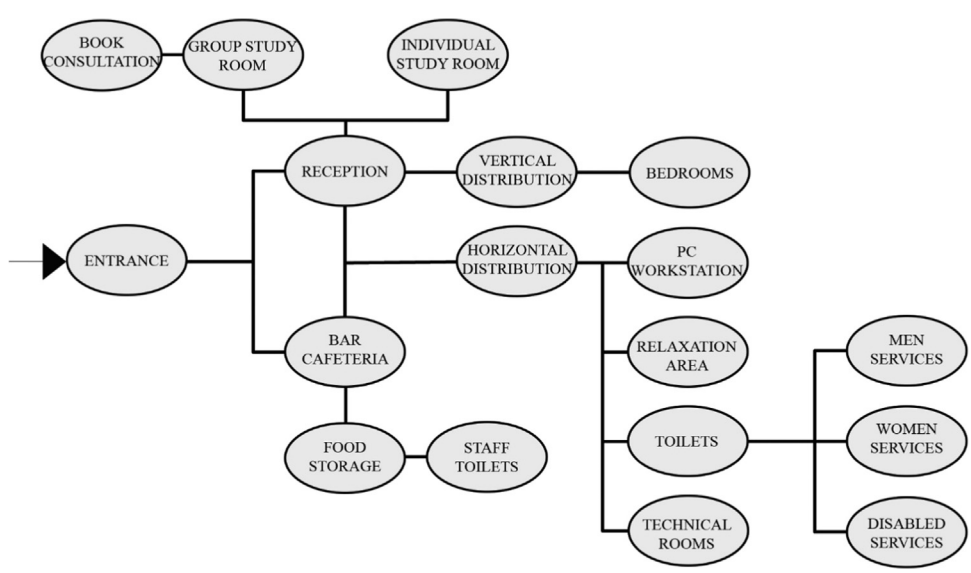

Fig. 4 Proposed layout of functions.

- a relaxing area furnished with sofas, armchairs, and tables that are arranged to encourage conversation among students and allow the viewing of the TV that is placed on the opposite wall; and
- a bar/cafeteria with a storeroom and services for staff, furnished with tables and a counter, accessible from inside the residence through the entrance hall and from the outside through two openings that are independent of the main entrance of the residence, thus making the bar/café independent of the residence.

These functions, which are also accessible to non-resident students, are designed as spaces for meetings, interactions, and dialogs for individuals and groups to exploit the residence in an active manner. Moreover, these utilities are complementary to services outside the residence, thus representing services provided to the urban community. The basic idea is that internal and external beneficiaries and individual and collective use may find new forms of cohesion that allow for social interaction and cultural enrichment and represent an essential experience for the life and educational maturity of the students, as reported by Thomsen and Eikemo (2010) and David Jiboye (2012). This approach is consistent with the strong integration that has constantly existed between the University and Catania.

The rooms for resident students are situated on the first floor and designed in accordance with two types of accommodation, namely, single and double. Both rooms have an independent bathroom and an annexed kitchen-dining room. The distribution of the rooms proposes an organizational model of a "hotel," which is characterized by a central corridor with rooms on either side. A total of 20 beds are allowed in the proposed project; among these beds, 16 are in double rooms and 4 are in single rooms, where one room has characteristics suitable for accommodating a student with disabilities.

In the double rooms, the second bed is placed on a mezzanine that is accessed via a spiral staircase located near the entrance of the room to make the mezzanine and the environment below as independent from each other as possible. The positioning of the second bed on the mezzanine complies with the obligation imposed by legislation to ensure an adequate level of privacy in the sleeping areas. One side of the environment of the mezzanine faces the environment below. The interfloor space in the area below the mezzanine is 2.80 m. The same free height, which is considered the average between the minimum (1.85 m) and the maximum heights (3.10 m), is present between the mezzanine and the roof.

The toilet is located on the lower floor and shared by the occupants of the two beds. However, the annexed kitchen-dining room is shared between two adjacent double rooms, that is, four students.

Regardless whether single or double, the rooms do not differ in form or arrangement of the furnishings, which

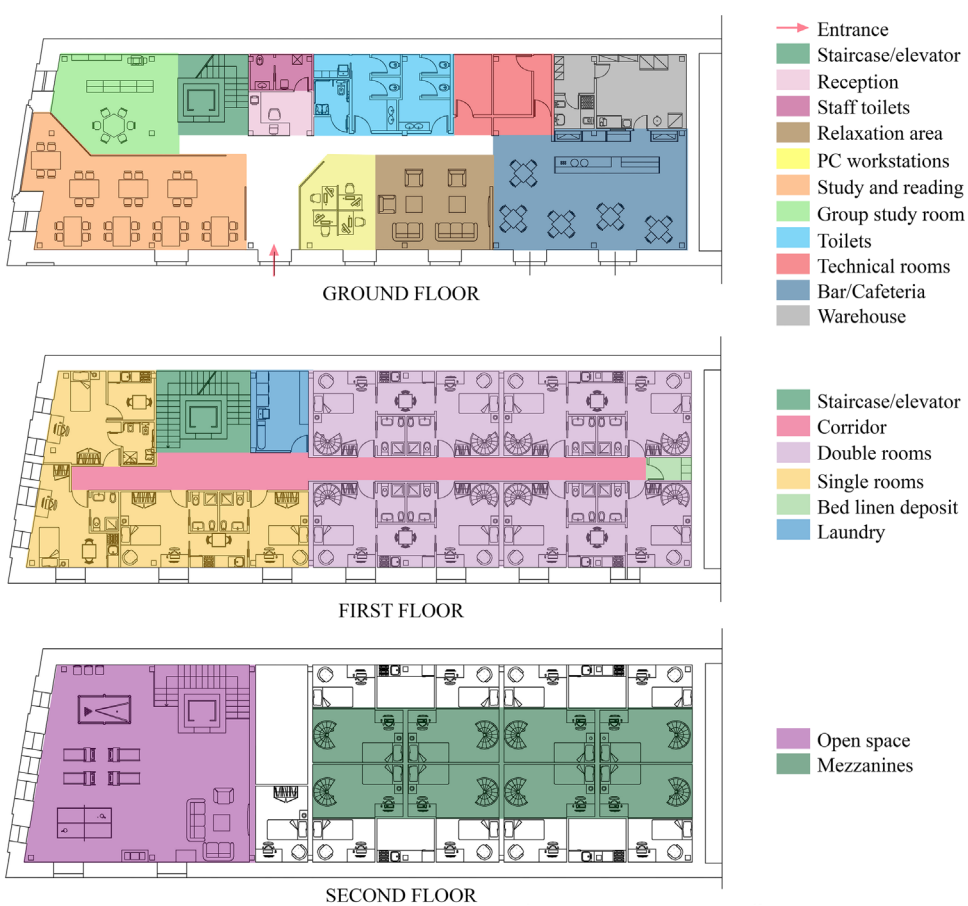

Fig. 5 Functional analysis of the new student residence.

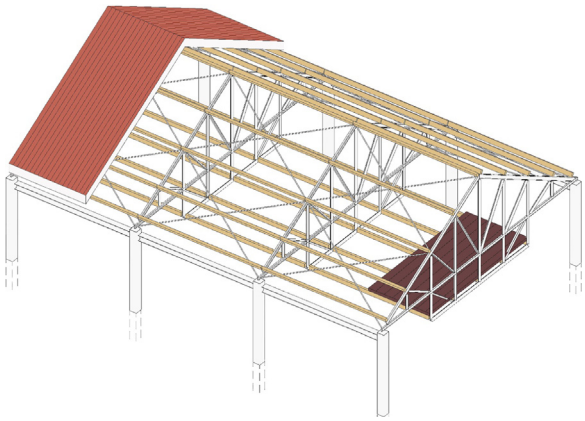

Fig. 6 New load-bearing structure using steel.

consist of a single bed, a wardrobe, a desk with a chair, and an armchair. The rooms are arranged in such a way that a passage is shared by two adjacent rooms for the inflow of water for the toilets and kitchen–dining rooms and for the discharge of wastewater.

For lighting and natural air exchange, the existing openings are used, thereby allowing the replacement of window fittings to guarantee adequate thermal comfort. In addition, the double rooms are equipped with two skylights to ensure an accurate aero-illuminating ratio for the mezzanine rooms.

On the second floor, an open space is available for physical activity, relaxation, and socialization and accessible only by resident students. A staircase and an elevator, which allows access for people with disabilities, connect the three floors in which the residence is divided. Furthermore, access without architectural barriers is guaranteed for all the rooms in the building.

The limited number of students hosted in the residence is optimal for confidential social relations. In addition, residences with less than 25 beds do not constitute activities that are subject to obstructing fire prevention authorities and do not demand compliance to fire safety requirements for hotel activities (Hassanain, 2008). Examples of these requirements are identifying the spaces for constructing a fire-extinguishing system with a specific water reserve and pumping station, enabling load-bearing structures to be fire-resistant, and creating an external fire escape in an urban area characterized by narrow streets. However, a minimum protection offered to users is installing smoke detectors and fire extinguishers. Compliance with these security measures in the proposed project can certainly be complex given the limited size of the existing building and the characteristics of the location.

Figure 5 illustrates the functional analysis of the new residence.

4.2. Structural solutions

To refurbish and enhance the building while valuing the existing features, a new steel bearing structure is designed inside the building and made independent of the existing perimeter walls to resist static and seismic loads (Bellicoso, 2011). In accordance with the project, the perimeter walls of the existing building do not have a structural function but

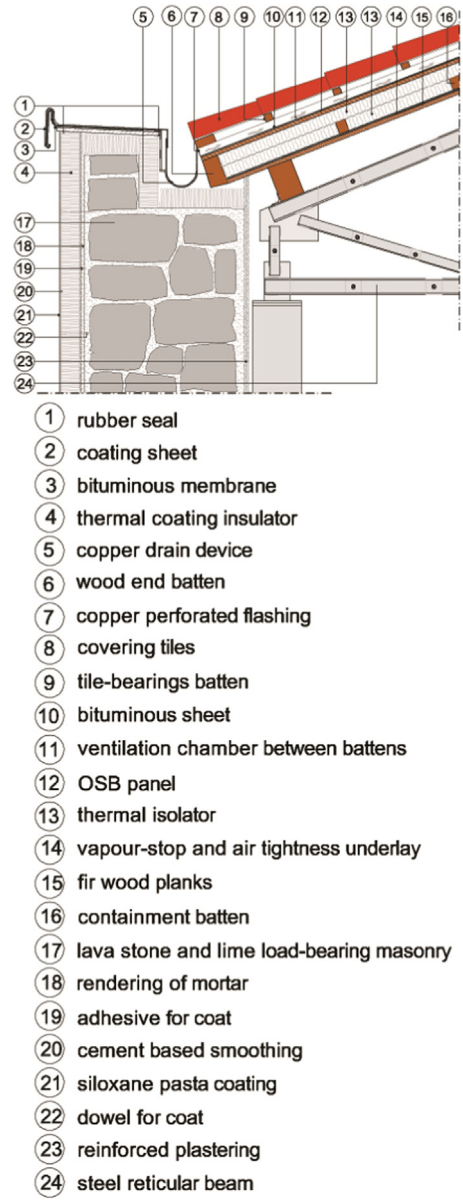

Fig. 7 Roof and wall construction detail.

only for perimeter closures because the loads, including those generated by the roof, are aimed at the new structure as a result of this intervention. The envelope no longer coincides with the load-bearing structure that simply becomes an enclosing element of the building to regulate energy flow and natural lighting (Figure 6).

The choice of steel as a structural material enables not only accentuating the difference between the existing heavy masonry structures and the new light structures but also exploiting the high resistance of steel to obtain favorable flexibility and additional space for new functions. Moreover, the new structures remain recognizable within the existing building, following a concept of juxtaposition and reversibility of the intervention.

The new load-bearing structure is organized with a regular mesh to allow flexibility and ease of transformability of the space and satisfy the priority requirement of

durability and long-term maintenance of the building components and systems.

The longitudinal and transverse frames are braced and two- or three-floor elevated to support the floor slabs and roof structure. The roof is composed of steel trusses connected to the pillars and equipped with horizontal braces. The secondary structure that bears the roof consists of lamellar wood beams placed at the nodes of the trusses. The horizontal bracing elements, beams, and wooden planks that constitute the internal part of the roof remain visible in the double rooms located on the first floor and in the open space on the second floor.

The trusses that constitute the load-bearing structure of the roof also support the mezzanines. These beams are concealed by internal partitions that separate the rooms and consist of two plasterboard panels placed at a sufficient distance to accommodate the reticular beams. The horizontal structure of the mezzanine is laminated wood and remains visible.

4.3. Technological solutions

The interventions on the building envelope are designed to satisfy the requirements of the new building use. The technological solutions adopted for the retrofitting envelope solutions respect the thermal transmittance limits established by the current energy-saving standard. The floor is realized through a ventilated cavity in the lava stone, which supports a cement-based mortar screed that is covered by a waterproof layer consisting of a high-resistance prefabricated bituminous membrane in polyester. This layer avoids the problem of rising damp that breaks through the gaps in the elements of the flooring. A layer of thermal insulation covers the waterproofing, and a dividing screed and the floor covering in fine porcelain stoneware slabs are further installed over this layer.

The roof is made of clay tiles laid on a corrugated bituminous under tile. The under tile is placed on a double understructure of rafters that permits the natural ventilation of the roof given the spontaneous convective movements of the air. This condition is guaranteed by the pierced strips for air entry and exit. The rafters are lined with a prefabricated waterproof bituminous membrane installed on the panels in oriented strand board. Under these rafters, a thermal insulation that consists of rigid panels mounted between purpose-built wood strips is installed. The internal finishing of the roof consists of wainscoting with pinewood planks nailed to the wooden purlins below (Figure 7).

The existing perimeter walls in lava stone and mortar do not follow the legal regulations on the values of thermal transmittance. The modification of the external surface by adding a continuous layer of thermal insulation is necessary. This 10 cm-thick layer aims to reduce the level of thermal transmittance of the outer walls and improve energy efficiency. This insulating layer is linked to the existing wall structure through a specific adhesive, and its adherence to the walls is further secured by wall plugs. The external finishing is realized by using a cement-based finishing product that covers the thermal insulation with a siloxane-based coating of approximately the same color as the original plaster (Figure 7).

Table 2 Comparison of thermal transmittance between the existing and proposed building envelope components.

Envelope components	U (Wm^{-2} K^{-1}) Existing	U (Wm^{-2} K^{-1}) Proposed
Wall	1.339	0.283
External door	1.661	1.926
Basement	3.474	0.302
Roof	6.579	0.203
Window	3.262	2.917

The number, shape, dimensions, and position of the original doors and windows are preserved. In particular, the existing wooden doors and windows are replaced with new wooden thermal fittings with 4 mm-thick double panes that are 12 mm apart and solar control glazes. These features achieve the dual purpose of favorable energy-saving efficiency for the building and ensuring adequate natural light to enter the rooms.

4.4. Energy and economic assessments

Energy conservation mechanisms are required in university campuses because students do not have any direct feedback on their energy consumptions, thereby leading to excess usage.

The energy performance of the existing building is examined by using dynamic simulation software and compared with those completed in accordance with the project (Table 2). Therefore, the irradiation conditions in relation to the exposure and orientation of the building, the internal thermal loads connected with the new use, and the technological solutions in terms of the type of opaque and transparent envelope are considered (Mitterer et al., 2012; Cascone et al., 2018b).

Energy is produced through a condensing boiler during the heating period and a cooling machine during the cooling period. Both devices are located in a technical room on the ground floor. The emission is conducted through radiant panels placed under the floor on the ground floor where collective functions are performed and through fan coils on the first and second floors, where private functions are held. These selections optimize the flexibility in the design phase and the comfort of the users inside the residence during the operation. The thermophysical properties of the materials are obtained from tables provided by legislation. The thermal analyses are conducted in steady and dynamic regimes to consider the importance of the thermal inertia of the components during summer. The climatic data are obtained from UNI 10349, and UNI 10375 has provided data for the summer period. The energy verification results of the existing building that maintains the present thermophysical characteristics and the predicted improved results obtained in the project are compared.

Interventions are proposed to improve the thermophysical characteristics of the building envelope that maintains the shape and color of the original materials on the basis of the information in the current regulations for energy efficiency in buildings. A reduction in the level of

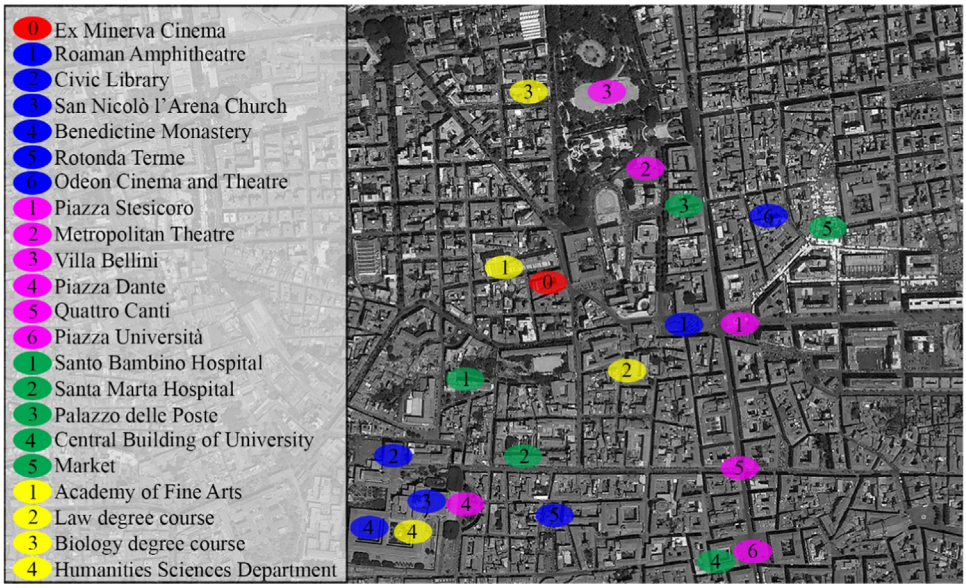

Fig. 8 Location of Minerva Cinema in the central area of Catania.

transmittance of the building envelope is obtained by adopting a completely insulated coating and ventilated roofing and installing double-glazed closures of low transmittance value. These elements allow a significant reduction in energy consumption in comparison to the existing levels (Table 2). In particular, an analysis of the results obtained by the energy consumption considering the hypothesis of maintaining the thermophysical characteristics of the existing building envelope show that the index of winter efficiency (EPi) is equal to 189.5 kWh/($m^2 \times$ year), whereas a significant decrease in primary energy consumption for heating that leads to a value of the EPi equal to 46.04 kWh/($m^2 \times$ year) shows an improvement in the thermophysical characteristics of the building envelope in the project.

A comparison of the results obtained shows a reduction of 75% in the energy requirement for heating in winter and 65% in CO_2 emissions. Considering that 10 kWh of energy corresponds to a heating power that is inferior to that of a liter of gasoil, the specific consumption of gasoil is obtained by dividing the EPi by 10. The savings in gasoil is calculated as 14.35 l/($m^2 \times$ year) because the difference between the two values of the calculated EPi is equal to 143.5 kWh/($m^2 \times$ year). If the cost of heating oil is €1.20 per liter, then a savings of approximately €6000 per year can be achieved because the total surface area of the building is approximately 350 m^2.

5. Discussion

Student residences are referred to as "new forms of housing," not because they represent an unusual way of living but because specific fruition requirements that are characterized by limited temporal dimensions of living must be satisfied. The duration of a student's stay within the residence may vary from a few hours, as in the case of those who do not live in the residence but use the services (study rooms and canteen), to several years, as in the case of students who live in the residence for the duration of their studies.

Therefore, the usual housing allowances that are consistent with stable and codified behavioral patterns must be overcome in searching for innovative solutions that can provide answers to the specific requirements of students of different age and sex, attend different university courses, and come from different cultural, economic, social, religious, family constellations, and geographical backgrounds. Thus, the residences, similar to lecture rooms, libraries, and laboratories, can become a qualifying element of university life that contributes to the process of students' social and cultural development.

A large city, similar to Catania, with a historic university, offers market conditions that can justify initiatives or even be promoted by private individuals for realizing university residences either by constructing new buildings or recovering and reusing existing buildings.

The results of this research show that, despite the initiatives of the ERSU, the problem of housing non-resident university students in Catania has not received sufficient attention even at present. However, the task of guaranteeing an adequate offer of housing services cannot be strictly entrusted to the ERSU but must be performed first by the University of Catania as an indispensable condition for increasing its attractiveness and improving its capacity to compete with other universities. The political-administrative system of the city must also play a part and consider the importance of university residences as a driving force for the local economy of the city.

The university and the city must set the goal of guaranteeing the possibility for students to attend the courses of study in which they are enrolled without facing the personal costs of inconvenience and time in commuting, or the economic costs of renting lodgings in a market that is frequently speculative and non-transparent (Vergolini and Zanini, 2015). The progressive reduction in available public resources must not result in abandoning the initiatives that can be undertaken for realizing new university residences.

In a city similar to Catania, the high demand for student accommodation can justify private investments for realizing university residences facilitated by public co-financing in terms of economic return and risk.

Philokyprou (2014) concluded that the analysis of the various effects of implementation of new uses is different from the original ones that lead to broad discussions in converting historic buildings within the philosophical framework of international principles for rehabilitation. The analysis also raises questions relative to intervention, sustainable development, and reinforcement of existing structures to meet contemporary requirements.

6. Conclusions

A decisive factor for the success of a university residence is represented by its location in a central area of the city of Catania (Figure 8), as proposed in the case study of recovering and reusing the Minerva Cinema. This constitutes a remarkable marketing element for students who are searching for accommodation. The cinema is close to several sites of the University of Catania, in which these sites can be reached on foot or by city buses, which stop less than 500 m from the building. In addition, the areas around the building are the main commercial services that are useful for daily life (supermarket, bakery, and pharmacy); the building is close to the historic center of the city, where socializing, entertainment activities (streets and pedestrian squares, pizzerias, and cinemas), and cultural activities (monuments, central university building, municipal building, libraries, museums, and theaters) are concentrated (Wang, 2012).

With this perspective, future studies must apply building information modeling to building retrofitting projects to represent the possibility of concentrating on the geometric, spatial, and performance information of the building and all its parts in a single 3D model (Becerik-Gerber et al., 2012; Volk et al., 2014). This process has a dual objective of allowing the different operators involved to interact simultaneously in the project and construction phases and verifying in real time any inconsistencies and conflicts that encourage efficient management during the entire life cycle.

An evaluation of the cost-benefit ratio of the proposed solutions is fundamental to establish the economic feasibility of the intervention for recovering and reusing a building (Akande et al., 2016). To guarantee a reasonable time for the return of investments for the proposed project, limiting costs during the construction phase through appropriate design and technological choices is necessary to achieve a reduction in construction time. Moreover, future research must evaluate the process of controlling costs and reducing wastes during the running phase by involving the occupants and adopting independent systems that regulate the consumption of drinking water, electricity, and heat for each room.

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