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Responsive University Residence

Case Studies and Design Approaches

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Abstract

In the contemporary era, university residences can be interpreted as complex buildings. They are no longer just places where students temporally sleep, eat, and study, but they are also spaces for lifelong learning, intercultural exchange, personal development, and social interaction. This complexity is enhanced by transformative external factors such as the demographic winter (caused by declining birth rates), the evolution of educational models (e.g., e-learning), the different types of users (e.g., international and multicultural students), and unpredictable emergencies (e.g., natural disasters or pandemics). Therefore, a critical reflection on the future of these large-scale infrastructures is necessary, as they may require interventions to be converted during their life cycle. In this context, an ongoing research at the Department of Architecture, Built Environment and Construction Engineering (dABC) of Politecnico di Milano is investigating how university residences can adopt the design paradigm of responsiveness (or adaptivity), which can be defined as the ability to adapt and transform in response to changing users and societal needs. By analysing a series of best practices, among both new buildings and existing ones – which partially/differently reflect the principles of responsive architecture in terms of flexibility, reusability, scalability, and resilience – the study offers critical considerations on how to design university residences. The aim of the research is to identify architectural strategies that align with the concept of adaptive reuse and the capacity to respond to change. These strategies could form the basis for a digital tool that assesses the level of responsiveness of a given university residence during the meta-design phase. Considering the significant amount of public and private investments (especially in Italy) allocated to student housing, this tool could be particularly relevant for guiding the implementation of adaptive reuse strategies in the design of university residences.

Keywords: University Residence, Responsive Architecture, Adaptive Reuse

Introduction

University residences are no longer merely spaces for rest and study; they are increasingly recognized as places for both learning and personal, social, and intercultural growth. They transcend the original concept of providing beds, and they establish themselves as strategic structural components of the university system. Over time, the university residence system has evolved from the traditional dormitory model to a complex structure closely interconnected with the urban fabric, capable of positively influencing the quality of student

life, thereby supporting the educational, cultural, and social dimensions. This transformation is also evident in the evolution of its terminology: words such as "dormitory", "college", or "student house" have gradually been replaced by "student residence" or "university residence", often accompanied by adjectives such as "collective", "social", or "temporary". This linguistic evolution highlights a redefinition of the role, functions, and meaning of these structures (Piferi 2021). Despite their strategic value, university residences cannot adequately meet current demand for accommodation in most European countries, with Italy ranking far below the continental average. However, the Italian case represents a best practice within the European regulatory landscape thanks to the Law 338/2000 and related Ministerial Decrees. The Reform 1.7 of the National Recovery and Resilience Plan includes an investment plan aimed at providing 60,000 additional places to reach a total capacity of over 100,000 by 30 June 2026 to close the gap between supply and demand. Meanwhile, major private operators are strengthening their role in the Purpose-Built Student Accommodation (PBSA) market at the European level, with high investments. In light of current – and potentially future – funding opportunities and recent social, educational and environmental changes, this paper calls for a rethink of the design of university residences, particularly public ones. In the broader context of student housing, the paper offers a critical reflection on the endogenous and exogenous dynamics that influence the design of such structures, emphasizing the need for adaptable – or, to use the terminology from the literature, responsive – design approaches. The analysis of several recent best practices in new construction and redevelopment projects makes it possible to identify architectural strategies that can respond to evolving user needs, educational models and broader social context. These reflections aim to contribute to the definition of a theoretical and operational framework useful to guide future student housing design practices towards greater levels of adaptability. Moreover, this framework could form the basis of a tool designed to evaluate the adaptability of university residences during the meta-design phase. The tool is currently under development and is structured as a multi-criteria system that correlates design approaches, sub-approaches and strategies in terms of responsiveness. This is achieved by linking them to the concept of functional areas (as defined by Italian Law No. 338/2000) and to the building layers theorized by Stewart Brand. The tool is intended to be used by designers, public institutions and housing managers, and it will enable them to identify the most responsive option among multiple design alternatives. Based on the theoretical framework outlined in this paper, the tool could become a valuable resource for optimizing the allocation of resources and investments while supporting the adaptive – and therefore responsive – planning and design of university residences.

The University Residence: a Complex Issue

University residences can be considered as complex buildings since their design and management involve greater challenges than typical constructions, as they are spaces where people live, learn, and interact. This complexity is manifested in various interconnected dimensions, due to user heterogeneity, the diversity of daily activities, the organizational processes, and the integration with the urban fabric. The university population has undergone a significant transformation in recent decades, evolving from a homogeneous group of people to a heterogenous community in terms of age, geographical origin, economic circumstances, and attendance modes. It is possible to distinguish between two groups

of students: those who are young and enrolled full-time, and those who combine their studies with work, family responsibilities, or other commitments. In addition to academic users, university residences currently accommodate individuals not directly affiliated with the university, such as professionals and tourists (Pinnelli et al. 2024; Bellini et al. 2024). Furthermore, university residences are part of a rapidly evolving context, as highlighted by the structural vulnerability exposed by the Covid-19 pandemic. Even if containment measures – such as single rooms, self-sufficient micro-apartments, and reconfigurable spaces – have been proven to be effective solutions, the crisis underscored the necessity of a significant rethink of housing and spatial models (Bellini et al. 2024). Although the pandemic has had a notable impact, it is the demographic winter that is currently shaping Europe. Italy's university system is expected to lose about 415,000 students by 2041 (a reduction of about 21.2%), particularly in southern regions. At the same time, the rapid expansion of online universities and hybrid teaching methods are reshaping the higher education system: between 2012 and 2022, enrolments in telematic universities increased by over 410%, reaching 11.5% of total university students by 2022, compared to just 2.5% of the previous decade (Area Studi Mediobanca 2024). Although these dynamics seem to be unrelated to university residences, they are deeply connected, whether directly or indirectly. In light of this, a research activity conducted at the ABC Department of the Politecnico di Milano explores the potential of introducing paradigms of adaptability and responsiveness to student residence design. These principles address not only current needs, but also future and unpredictable ones. Integrating student housing into adaptive-responsive architecture strategies could offer a valuable guide to future design.

The Principles of Responsiveness for Student Housing

The concept of responsive architecture was first introduced by Nicholas Negroponte in the 1970s to describe buildings that can be modified in real time in response to changing environmental conditions. From this perspective, a system characterized by flexibility, adaptability and resilience can be defined as responsive, as it can react and evolve in accordance with changing circumstances (Baratta 2018). Therefore, responsiveness relies on the capacity of a space or building to transform itself by integrating technological, environmental, and social dimensions, and to establish itself as an open system in which the environment and users actively participate in the transformation process. Over time, the living environment has been reinterpreted as an organism designed to reconfigure itself according to internal or external changes, rather than as a static structure (García-Luna Romero, Flores Leal 2022).

Given the absence of a universally accepted definition of adaptability, this research prefers to adopt the term responsiveness, which more explicitly expresses the ability of a system or a structure to react to evolving internal and contextual dynamics. Within the macro-concept of responsiveness, it is possible to identify several interconnected approaches, namely flexibility, reusability (fig.1), scalability and resilience (fig.2), each of which encompasses sub-approaches that often overlap conceptually. Regardless of the definitions, however, these design approaches consider time as a critical design variable and a prerequisite for potential future transformations (Hamida et al. 2023; Mfon et al. 2024). Numerous examples of contemporary university residences incorporate responsive design approaches, interpreting them through diverse spatial and technological strategies.

In terms of flexibility – a central theme of the Modern Movement and defined as a building's ability to adapt quickly, cheaply and with minimal effort – the *Campus Hall* by C.F. Møller Architects (Odense, DK, 2015) has on each floor a central distribution space that can function as a corridor, kitchen, living room, and study area. Similarly, in MySpace Student Housing (MEK Architects, Trondheim, NO, 2019), the central core hosts a multipurpose room without spatial hierarchies, while corridors and balconies, beyond their

FLEXIBILITY. The ability of a building to meet changing functional user or owner needs by changing its properties easily	
Multifunctionality	It refers to physical components of a space, which allow it to be used in different ways and for a set of known functions.
Versatility	The properties of a building, space or system that allow it to be used in different ways for different functions.
Ambiguity	A space designed to accommodate a wide range of potential uses, beyond classifications.
Generality	The ability of a building to meet changing functional purposes without changing its core properties.
Hybridization	It is the ability to blend different functions, forms, contents and contexts harmoniously, creating a cohesive and integrated architectural expression.
Personalizability	It is the process by which a user modifies, adapts or integrates elements of a space, building or object to meet their needs, tastes or identities.
Partionability	The possibility of easily dividing, reorganizing or combining installation systems into different spatial units.
Segmentability	The separation of a product into autonomous functional modules or subsystems.
REUSABILITY. The potential for the components of the building to be recycled at the end of its life cycle	
Convertibility	The building's ability to accommodate changes in its use.
Transformability	The ability of a part of a complex adaptive system to host a new function.
Adaptive reuse	It is defined as the process of extending the useful life of historic, old, obsolete, and derelict buildings.
Disassemblability	It is the ability to facilitate the disassembly of products so that their constituent elements can be more easily reused or recycled.
Dismantability	It is the ability to be demolished safely, efficiently, and quickly, either in part or in its entirety.
Disaggregatability	It is the possibility that materials and components from any dismantled building can be reused or recycled.
Upgradeability	It is defined as the sequential adaptation of existing projects and products to new requirements or technologies as they become available over time, thereby extending their lifespan.
Refitability	The ability to replace, exchange or renovate components.
Movability	Buildings can be moved or repositioned.

Fig. 1. Flexibility and Reusability. Adapted from (Schmidt III et al. 2010; Askar et al. 2021)

primary function, serve as study and meeting spaces.

The architects describe the building as "intentionally unfinished", encouraging ongoing student participation in shaping shared life. Likewise, the Grand Morillon Residence (Kengo Kuma & Associates, Geneva, CH, 2021) integrates a continuous wooden pathway within its staircase system, connecting the various buildings by workshops, restaurants, and relaxation areas. The Resa San Mamés University Residence (Masquespacio, Bilbao, ES, 2020) is characterized by a large open space, articulated through movable partitions and curtains that allow for alternating collective and private configurations, where colour-blocking techniques visually define each zone in this fluid layout. The strategy of versatility can be found in Student Housing by H Arquitectes + dataAE (Sant Cugat del Vallès, ES, 2011), where both common and private areas are conceived as flexible environments, reconfigurable through mobile and reversible architectural elements that adapt to different living styles, thanks to a dry-assembly modular system that allows dismantling and reuse of prefabricated concrete units. Similarly, Camplus San Pietro (Roselli Architetti, Rome, IT, 2022) interprets flexibility – within private rooms – using reversible metal structures that also act as a mezzanine, while the common areas are designed as flexible spaces capable of adapting to any activity required by dynamic student life thanks to a system of sliding

panels that allows the ground-floor restaurant to transform into multiple configurations, combining spatial and structural adaptability. In the Sarphatistraat Student Housing (VMX Architects, Amsterdam, NL, 2002), the only fixed elements are the service ducts, allowing large, open interiors to be freely arranged by the inhabitants. In addition to these examples, several projects are built on the concept of flexibility by adopting hybrid and multi-user forms of cohabitation and social interaction. Among the university residences that try to answer the society changes, some hybrid or multi-user typologies accommodate not only students, but also academics, elderly people, tourists, and workers. Among the virtuous examples there are the complex by Guallart Architects in Gandía (ES, 2011) which mixes student and elderly housing with a civic centre to encourage intergenerational interaction; The Florence Social Hub (Rizoma Architetture, IT, 2018), where shared amenities such as a music room, pool, and co-working areas create a dynamic social ecosystem; the Besòs Student Residence (MDBA, Sant Adrià del Besòs, ES, 2019), conceived as a hub for academic exchange and innovation; the BaseCamp in Lyngby (Lars Gitz Architects, DK, 2021), designed as a sustainable "social superstructure" for students and senior citizens; and the Mixed-Use Residence Hall (Design Collective, Philadelphia, US, 2019), which integrates student life with the surrounding neighbourhood through a public courtyard and ground-floor amenities. The importance of user customization is evident in projects such as the Olympe de Gouges University Residence (ppa architectures, Toulouse, FR, 2017) and the Fabrica student housing development in Bangkok (Fabrica Design, Bangkok, TH, 2017), or in G27 CIEE Global Institute (Macro Sea, Berlin, DE, 2015) where the configurable furniture systems enable students to personalize their rooms, as well as private bathrooms, with multi-use and modular furniture allowing small apartments to transform seamlessly between dining, study, and relaxation modes, maximizing limited space. Staying on the topic of flexibility, the Collegium Academicum (DGJ Architektur, Heidelberg, DE, 2023) exhibits a modular construction system with a flexible, partitionable structure that enables the housing units to be reconfigured over time, with each unit including a private zone and a flexible one that can be spatially adjusted by movable partitions, reflecting a participatory approach to design.

In architecture, reusability concepts refer to the potential for materials to be reused and recycled. The Camplus San Pietro, which was originally designed for healthcare and social assistance functions, has been converted into a university residence and guesthouse, demonstrating the capacity of its architectural structures to evolve through adaptive reuse strategies. Similarly, Palazzo Frisini (RTP Corvino+Multari, Taranto, IT, 2025), formerly a foundling home, is being redeveloped to provide student accommodation, breathing new life into an abandoned historic building. Residenza Collegio Benedettini (Contrafatto, Palermo, IT, 2016), designed from a former convent, is another example of the adaptive reuse of the built heritage. Aparto Ripamonti (Park Associati, Milano, IT, 2024) is a valuable example of the regeneration of a former agricultural consortium building in Milan dating back to the 1940s. Its design preserves industrial traces while inserting new steel-and-glass volumes, expressing continuity between past and present. The industrial heritage of the site is preserved and reinterpreted through the creation of new spaces for learning and community life, merging pre-existing spatial qualities with contemporary student needs. At the international level, 106 Student Housing (TVK Architects, Arcueil, FR, 2007) and the Bertelotte Student Residence (NZI Architectes, Paris, FR, 2020), both converted from

office buildings, demonstrate how adaptive reuse can represent a link between historical memory and new housing needs. In some cases, the adaptive reuse capacity is already foreseen in the design phase, giving a building the possibility to be transformed into new functions over time. Some examples are the Signalhuset (NOBEL Arkitekter, Copenhagen, DK, 2006) and Henry Koerner Hall (Atelier Kempe Thill, Berlin, DE, 2020), which can be converted into family houses, or the Student Residence and Car Park (Bruther, Baukunst, Plateau De Saclay, FR, 2020), where parking areas can later be transformed into residential units, as a structural "machine", designed for maximum reversibility of use. The strategy of disassemblability is addressed in numerous projects (Bellini et al. 2023), such as Wasa Student Village (Studio Selva, Amsterdam, NL, 2017) and Keetwonen Student Campus (Tempohousing, Amsterdam, NL, 2006) – composed of more than a thousand shipping containers – where prefabricated modules can be dismantled, transported, and reused. In terms of mobility, interesting projects include the Temporary Student Village (Vandkunsten Architects, Copenhagen, DK, 2018), built with reused containers that offer scalable and mobile student clusters, and the Urban Rigger (BIG, Copenhagen, DK, 2016), which introduces floating housing solutions that are transportable and adaptable to various urban and environmental scenarios.

SCALABILITY. It is the ability to increase/decrease the building size	
Extendability	It is the possibility of horizontal or vertical expansion of the building.
Elasticity	It is the ability to extend or partition a building.
Expandability	It is the ability to increase in volume or capacity.
Shrinkability	It is the possibility of reducing the amount of space in a building.
RESILIENCE. The capacity of a system to adapt to preserve functional continuity in the face of disruptive events.	
Intended as Survivable	The ability of a system to absorb disturbances and reorganize while undergoing change, to maintain its essential functions, structure, and identity.
Intended as Mutable to return to the initial state	The rate at which a system returns to its original equilibrium following a disturbance.

Fig. 2. Scalability and Resilience. Adapted from (Schmidt III et al. 2010; Sommer et al. 2024)

The concept of scalability is often linked to three-dimensional prefabrication, allowing student housing complexes to grow progressively. Mobile Student Housing HUB_01 (dmvA Architecten + A3 Architects, Kortrijk, BE, 2012) consists of a modular system of cells that can be added to or removed as required. In contrast, Danish Student Living (DMD Modular, Copenhagen, DK, 2022) demonstrates how existing complexes can be expanded by integrating new prefabricated modules. The latter project adds three new modular floors to a 1980s office building, providing 75 apartments within an efficient, low-impact superstructure. Resilience, on the other hand, is defined as the ability to withstand and recover from disruptions or emergencies. In architecture, it indicates strategies for adaptation and risk mitigation, and is defined as the ability of individuals, communities, and systems to survive, adapt, and grow despite shocks. The previously mentioned Urban Rigger can also be interpreted as a scalable and resilient model capable of expanding and reconfiguring itself in response to changing environmental conditions, demonstrating how floating architecture can combine environmental adaptability, mobility, and energy self-sufficiency within a single system. Although the above cases demonstrate experimental approaches to responsiveness in student housing design, most university residences are still designed as fixed structures with limited capacity for change over time. In light of the complexity of contemporary living and the ever-changing nature of student life, there is a

growing need to explore ways of incorporating the principles of responsiveness into the design of university residences. From this perspective, student residences become buildings capable of maintaining their utility over time through continuous adaptation, evolving with society and its changing needs.

Closing Considerations

This study highlights how responsiveness can become a central design principle for university residences, transforming them from static buildings into dynamic social infrastructures capable of adapting to evolving cultural, technological, and environmental conditions. In an increasingly dynamic and uncertain context, university housing should be designed to integrate reactive solutions, understood as anticipatory actions in terms of adaptive reuse. Design strategies for student residences that integrate flexibility, reusability, scalability and resilience could enable more effective engagement with contemporary complexities and anticipate future and unforeseen needs. Within these complex environments, shared and circulation spaces have significant potential to accommodate different or complementary functions, thus fostering multifunctionality, hybridization and social interaction. Given the transient nature of student occupancy and the diversity of users, it is crucial to empower residents to customize their spaces with adjustable furniture, movable partitions, and adaptable layouts, thus promoting personalization. Accordingly, university residences should increasingly incorporate spatial systems that can be reconfigured over time, featuring flexible and divisible layouts (partionability), structures and infrastructures designed for future extensions or changes in use (convertibility, transformability and scalability), and the integration of demountable, reusable or transferable construction systems (disassemblability and movability). These strategies can be achieved through structural and technical regularity and simplicity, reducing the interdependence between layers of longevity and adopting modular, standardized and prefabricated components that enhance construction efficiency, adaptability and reversibility. Concurrently, various access points, optimized spatial flows and the inclusion of surplus usable areas, convertible shared spaces, undefined environments enable effective responses to variations in occupancy and use.
Therefore, a dedicated assessment tool capable of verifying the integration of responsive strategies and sub-strategies could support architects, managers and decision-makers in evaluating these strategies. The self-assessment tool – structured into macro-areas, criteria, and indicators – would enable the verification of specific requirements through a scoring system, allowing designers to systematically manage the variables involved in the architectural design of a university residence. The tool aims to provide a methodological and operational framework to evaluate and guide the design of university residences according to a responsive approach. In this sense, the tool would allow us to evaluate how the strategies outlined above are described, with particular reference to flexibility, understood as spatial adaptability, and reusability, understood as its transformative potential. The tool could support evaluation in the meta-design phase by verifying, for example, the presence of spatial units without a predefined function, the multifunctionality of the spaces, the type of load-bearing structure and construction system, the availability of excess usable surface area, the organization of the stair cores, as well as those responsive design choices that emerge from the literature and case studies. Adopting a responsive approach would enable university residences to be conceived as experimental laboratories of adaptive architecture,

where buildings evolve in dialogue with users and social transformations. In conclusion, incorporating responsiveness into the design process ensures that student accommodation retains its usefulness over time, thereby contributing to environmental sustainability.

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