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BEYOND ALL LIMITS

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RESEARCH AND EXPERIMENTATION

DESIGN, TECHNOLOGY, NATURE: A CROSS-CUTTING APPROACH

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Abstract. The special series issue of Techne journal – an expression of SITdA, the Italian Society of Architectural Technology – shares the contents that emerged in the "Beyond All Limits" Conference (2022) held under the scientific patronage of SITdA. The topics of the papers can be identified in disciplinary fields presenting an interaction between people, technology, society and nature, and also ecosystemic sensitivity. The papers reflect the viewpoints of several institutional and academic representatives, associations engaged in the field of university education, many scholars and researchers of different scientific-disciplinary domains of design culture and innovation. Today the scientific community is aware that such an approach can significantly contribute to the sustainable evolution of the design urbanistic and architectural area in its trans-scalar, multidisciplinary and challenging dimension, overcoming technocratic responses to a demand that requires integration of the humanistic and technical-scientific dimensions.

Keywords: ecosystemic dimension; sustainability; environmental design.

The theme of "Beyond All Limits, International Conference on Sustainability in the Field of Architecture, Design and Urbanism" is taken up in this issue of the TECHNE Special Series. It presents updates on the cultural and scientific contents that emerged in the 2022 event held at Officina Vanvitelli – San Leucio Belvedere Monumental Complex in Caserta, organised by the Department of Architecture and Industrial Design "Luigi Vanvitelli", University of Campania.

Resuming and actualising the themes discussed in the 2022 Conference-held under the scientific sponsorship of SITdA, the Italian Society of Architectural Technology-the global dimension of design is addressed under conditions of uncertainty about the founding values of our society. The debate that emerges is significant, and concerns some challenges that intercept social, environmental and economic issues such as the relationship between global and local contexts.

The topics of the papers can be identified in the interaction between people, society and nature, but they are also based on recovering a sense of belonging to places and communities, or to an ecosystemic sensitivity. The topics of the Conference defined a theoretical and operational vision of activities centred on the global dimension of design with a clear reference to a broad movement of thought and practice that should take place around the idea of a New European Bauhaus.

The papers are focused on topics like life cycles, circular economy, ecosystemic dimension, interaction between cities, people and environment. We must have the awareness of being actors in a planetary challenge that sees aspects in anthropic production and artefacts within biological cycles that cannot be disturbed any longer. The research activity requires continuous disciplinary interactions. Indeed, today we are aware that such an approach can significantly contribute to the sustainable and environmental evolution of the design area in its trans-scalar, multidisciplinary and challenging dimension. Hence we can overcome technocratic responses to a demand that requires the integration of humanistic and technical-scientific dimensions.

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CHANGING LIMITS INTO OPPORTUNITIES

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The third issue of the TECHNE Special Series is devoted to a selection of scholars, whose extended abstracts were accepted and published by DADI Press in the II Edition of "Beyond All Limits", the International Conference on Sustainability in Architecture, Planning and Design held at the Officina Vanvitelli, in San Leucio, on 11-12 May 2022 (under the patronage of SITdA, among others).

The interest for the initiative that guided the formulation of this reserved Call derives from the explicit intentionality to go *beyond all limits* in exploring the cross-border disciplinary territories generated by the bio-culture paradigm as a powerful generative lever to define new scenarios, approaches, methods and tools facing the challenges of the "post-Anthropocene".

In the age of complexity, the imperative of interdisciplinarity underlying the expression "Beyond all limits", rather than referring to the idea of an unlimited potential, looks at the need to explore border territories to integrate different perspectives and methodologies in a relationship of mutual cross-fertilisation. This is even more necessary considering the growing specialisation of knowledge and skills, within sectoral disciplinary paradigms, very often confined within rigid conceptual structures that may limit our ability to understand and address global challenges.

Thus, the studies and the design researches collected in this Special Issue bring out a plurality of approaches emerging in the field of architecture, planning and design, approaches that intersect contexts articulated at various scales of intervention with assessments referring to environmental resources, historical cultural heritage, and to the naturalistic values that characterise the local identities involved. Even with a critical look at improper – when not distorted – value enhancement processes determined by the globalised linguistic models of the real estate sector, often practiced in the European context.

A first thematic area concerns contributions that address the challenge of territorial reorganisation and development of fragile and internal areas, with examples related to the adaptive reuse of historical industrial heritage (the former SITOCO of Orbetello and the "internal area" of Matese, in the province of Caserta). These contexts, which are currently abandoned or in decline, are still endowed with a rich heritage of historical-cultural, environmental, technological, and social resources, which offer significant potential for the development of strategies aimed at the integrated enhancement of both natural and anthropic capital (circular use of resources, NetZero Soil-Energy-CO_2-Waste approach). The process is also supported by the local stakeholders and by the resident communities' commitment to co-creating knowledge and co-designing a new vision for the future development of their territories.

The conservation and reuse of landscape and architectural heritage is a strategic challenge both for urban and territorial regeneration, and for achieving sustainability and decarbonisation objectives. As highlighted by the contribution on evidence from 100 Resilient Cities, cultural heritage still plays a marginal role in resilience planning, with actions often limited only to the aspects of economic valorisation and promotion of tourism. There is little attention, for example, to respecting historical stratigraphies and the values of previously existing structures, which can conversely constitute an important lever for the activation of widespread regenerative dynamics (Doha case study).

The adaptive processes of rediscovery, conservation and reuse of historical heritage – articulated through territorial and "network-based" models – not only enables reactivation of spaces and buildings that have lost their original functions, but also triggers processes of collective reappropriation guided by the needs of local communities (which Zanuso called "design reappropriation"). This, in turn, can catalyse and generate new cultural, environmental and socioeconomic values (S. Maria in Grotta and S. Michele in Gualana, Sessa Aurunca, in the province of Caserta).

Shifting from the scale of adaptive reuse to that of urban regeneration opens up the prospect of design strategies oriented toward the transformation of the existing city, articulated through the application of urban planning instruments and the integration of nature-based solutions (Grupo de Viviendas Antonio Rueda in Valencia) to the notable theme of the landscape space of urban waterfronts, and to the redevelopment of informal/illegal settlements and residual spaces (overpasses), viewed in their fruitive and perceptive dimensions, also with methodological proposals focused on the user (human-centred design). Finally, with a critical analysis dedicated to the evaluation of the economic impacts of tactical urban planning (Milan case study).

Several studies focus on the role of participation and collaborative co-design experiences in urban regeneration processes, renewing and updating the methods developed by Giancarlo De Carlo, and also taking advantage of the potential offered by new digital technologies (BIM, ICT platforms, IoT, Digital Twin, etc.). The university facilities (student accommodation, research and training spaces) are – not by chance – a recurring field of research and experimentation. They are an effective engine not only for an eco-sustainable reuse of the building heritage, but also for urban revitalisation with the collaboration of composite and interdisciplinary research groups, and the creation of physical and virtual living labs that promote social inclusion, strengthening the identity of communities.

On the front of the ecological transition of cities and territories, the reconnection between city and nature ("From leaves we live" by Patrick Geddes) constitutes the field of reflection

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of studies focused on aspects such as digital representation for natural heritage (project "De+Humans"), Life-Centred Design, and the binomial "environmental quality/quality of life", in a perspective that tends to enhance the richness of interspecies ecosystemic interactions. By blurring the boundary between natural and artificial, technologies and digital environments can integrate with environmental components to form new landscape habitats featuring the One-Health dimension (Active Design for the healthy city).

Finally, the world of fashion design, invested by the challenges of the green and digital transition (biomaterials, digital manufacturing and transformation of production processes, etc.), registers the need to reconfigure itself according to processes of eco-systemic sustainability aimed at counteracting the rationale of fast fashion and the consumerist model of waste.

This is a warning also for so much *fast architecture* – homes, gardens and urban parks, squares, commercial and workplaces, etc. – conceived as consumer objects for the real estate market and, therefore, designed to be ready for use with a ready scenographic effect. Quite the reverse of what centuries-old history of European cities and the long-term formation and sedimentation of its landscapes should have taught us.

DESIGN DISCIPLINES AND THEIR POTENTIAL CONNECTIONS FOR SOCIALLY SUSTAINABLE SCENARIOS

NOTE

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The content of this Special Issue draws upon the scientific debate initiated during the "Beyond all Limits: International Conference on Sustainability in Architecture, Planning, and Design", held in May 2022 at Vanvitelli University, Naples. The discussion focused on the latest international approaches to sustainability, as applied to the fields of planning, architecture, and design, and interpreted through the principles of the New European Bauhaus (NEB).

Hence, focusing on novel design, operational and cultural strategies, aligned with the three pillars of the New European Bauhaus (NEB)-Sustainability – Aesthetics, Inclusion and a human-centred vision – can provide insights into rethinking the very meaning of sustainability, which is increasingly invoked while being at risk of becoming a mere slogan or rhetorical device. In the current context, the ecological transition and its social and cultural implications need to bridge the widening gap between institutional declarations and the everyday practices of citizens. This requires moving beyond a purely technical view of sustainability that lacks its ethical and social dimensions. The trajectory initiated with the "Beyond all Limits" Conference and continued in this Special Issue of TECHNE aims to investigate underexplored themes of sustainability, viewed as a cultural, social, and political act capable of renewing-through the experimental dimension of design disciplines-not only the forms of the built environment but also the deeper meaning of our contemporary living.

Planning, architecture, and design towards an ecological and inclusive transition

The New European Bauhaus (NEB) represents a European initiative complementary to the Green Deal. Through aesthetics and inclusion, it integrates the cultural dimension of sustainability into urban transformation processes and the built environment. The vision is to promote sustainable, inclusive, and innovative cities, architectures, and artefacts to improve the quality of life of European citizens (European Commission, 2021). By invoking well established concepts, the NEB places environmental and economic sustainability at the centre, alongside human well-being and social equity (Raworth, 2017). It promotes self-balancing systems that do not exploit people or resources, and it fosters urban development that is not only ecologically sustainable but also capable of mitigating social inequalities.

Design disciplines are evolving towards increasingly integrated and dynamic approaches capable of addressing both emerging and existing problems. Urban planning, architecture, and design play a crucial role in this scenario, promoting innovative solutions to global and local challenges, and experimenting with evolutionary processes characterised by stakeholder engagement and co-creation (Manzini, 2015). These approaches, applied at different scales, act as levers to integrate the multiple aspects of sustainability, encouraging the active involvement of institutions and local communities as true protagonists of change who contribute operationally to defining new models of sustainable urban development (Gehl, 2011).

Numerous studies have analysed the modalities of social stakeholder engagement in the planning, design, implementation, and management phases of urban regeneration or energy requalification interventions within larger scale European initiatives, such as the promotion of Positive Energy Districts (PEDs) in Europe. In these initiatives, the active involvement of citizen associations, local entities and non-profit organisations, as well as service companies, from the early decision-making phases has proven essential in defining the objectives of the interventions with greater incisiveness, identifying the actual needs of the communities, optimising available energy and economic resources, and structuring virtuous models of ecological transition (Ferrante *et al*., 2023). Therefore, the contemporary city, along with its architectural content and low impact artefacts, must be increasingly conceived as a "social product", a result of interactions, conflicts, and co-construction processes (Harvey 2013) to make the principles of sustainability, equity, and inclusion concrete.

Urban planning and regeneration: pathways to an equitable and sustainable future

In a global context grappling with the intricate balance between increasing urbanisation, the constraints imposed by natural resources, and environmental justice, the challenge lies in experimenting with integrated urban planning strategies oriented towards sustainable models. These models must simultaneously address the climate crisis, social inequalities, and energy poverty (Pratt, 2023). Urban regeneration practices are situated within this dynamic and adaptive perspective, aiming to transform and revitalise urban spaces by responding to the emerging needs of the community, and fostering a balance between innovation and heritage preservation. Urban regeneration is configured as a complex system of relations involving financial, human, environmental, material, and energy resources, promoting their rational and efficient use through multidisciplinary approaches at various scales (Figueiredo *et al*., 2022).

The inclusion of communities in decision-making processes is a key element for regenerating degraded urban areas. In this regard, the active participation of citizens in the design and management of public spaces, conducted through various forms (co-creation, collaborative governance, shared management, informal practices), can contribute not only to the acceptance

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of urban transformations but also to the creation of more equitable and sustainable environments. However, this necessitates an appropriate and profound transformation of the approach to "designing cities and for cities", which must increasingly confront socio-demographic and climatic changes, energy issues, land consumption problems, and significant social tensions already present in large urbanised areas. Such transformations are essential to foster a continuum between the built environment and communities.

Architecture, sustainability, and innovation: envisioning an integrated cultural and ecological design paradigm

Within the framework of the New European Bauhaus, architecture is considered a privileged tool for fostering dialogue between the past and the future. It draws out the beauty and cultural resources of the territory, while simultaneously experimenting with flexible and progressively adaptable measures to address climate change in a realistic and action-oriented perspective.

In an era marked by the increasing and inescapable pervasiveness of digital technologies and artificial intelligence, design processes are undergoing profound and structural transformations. Indeed, there is the potential to enhance performance response (functional, energetic, structural, etc.) and manage high levels of complexity. The shift from a linear and sequential approach to a systemic one opens up new possibilities for the conception of solutions that respond not only to technical and functional needs but also to criteria of environmental and social sustainability and historical-cultural value (Ferrante and Romagnoli, 2023), now recognised as intrinsically interconnected dimensions.

In this scenario of digitalisation, advanced simulation models offer the opportunity to design places, spaces, and architectures that respond to the needs of plural communities, fostering social cohesion and prefiguring a more equitable and conscious use of available resources. Associated with this design complexity, architecture will be increasingly called upon to explore forms of conceptual and operational hybridisation and contamination that require deep interaction between multiple and transdisciplinary knowledge. This outlines a new ecology of architectural design, which integrates heterogeneous competencies and reflects the inevitable and constitutive interrelation between the technological, environmental, social, and cultural dimensions of "doing architecture".

This approach finds its fruitful application in interventions for the conservation and reuse of existing heritage, where the integration of various disciplines allows to simultaneously address spatial, technological, and environmental aspects, without neglecting the important action of highlighting the importance of local identities. In such experiments, architecture becomes a crucial tool for building a deep and sustainable relationship between humans, the environment, and culture, promoting a dialogue that not only respects and preserves the past but also renews it in harmony with contemporary needs and challenges.

Collaborative design at the intersection of innovation and sustainability

Design is fully embedded within this profound paradigm shift, adopting a collaborative approach that places values such as inclusion, beauty, and sustainability-across its environmental, social, and economic dimensions-at the forefront. By designing artefacts, products, and services connected to urban environments and social contexts, design effectively addresses contemporary needs, balancing innovation with tradition and tackling both global and local challenges in an integrated manner.

Its experimental nature, enriched by the use of digital technologies, has transformed design into a powerful tool for co-creation, capable of engaging end-users and fostering the development of collaborative networks among local enterprises. Design thus stimulates a circular economy, enhancing the cultural and natural heritage of local territories. Where new forms of enterprise and economic development emerge, design becomes a driving force for change, making collaboration among designers, artisans, small and medium enterprises, and local administrations essential for creating sustainable and inclusive urban systems. No longer conceived as a separate or elitist element, design now serves the community, identifying increasingly specialised trajectories-such as strategic design, design thinking, universal design, and visual design-to achieve tangible impacts on cities with social and environmental effects. Exemplifying this are low-tech urban furniture projects, industrially produced with sustainable materials, which are often proposed and managed (from the bottom up) by groups of young designers. These projects create meeting points that foster intergenerational mixing without segregation, engaging neighbourhood residents and using tools of urban ergonomics (Bonino and Mancini, 2021) with the aim of bringing urban design back to a human-centred scale.

Based on this analysis, multidisciplinary and collaborative approaches employed across design disciplines-from urban planning to architecture and design-prove indispensable in addressing the complex challenges posed by environmental and social sustainability. The integration of ethical principles, the transfer of procedural best practices, and the involvement of all relevant social stakeholders are crucial for ensuring interventions that respond not only to immediate needs but also generate responsible and enduring transformations for cities and territories.

Looking ahead, it is legitimate to ask what possible, probable, and preferable scenarios may arise, with the awareness that the path outlined by the New European Bauhaus demands constant and adaptive commitment to the interconnectedness that is increasingly needed today.

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Abstract. "Beyond all Limits: International Conference on Sustainability in Architecture, Planning, and Design" is the title of a conference resulting from the cooperation between three universities, namely Çankaya University of Ankara, the University of Campania "Luigi Vanvitelli", and the University of Strathclyde in Glasgow (which replaced the University of Plymouth in 2021). The second edition, held in May 2022 at Officina Vanvitelli, located at the San Leucio Belvedere in San Leucio-Caserta, was organised by the Vanvitelli University, which assumed responsibility for the event. The conference aimed at exploring sustainability in ways that would reflect and contribute to the latest international approaches. The event covered the fields of architecture, planning, and design, and was framed within the context of the NEB (New European Bauhaus), launched by the European Commission in 2021 to promote the three pillars of Sustainability, Aesthetics, and Inclusion. The NEB initiative is an interdisciplinary and creative endeavour that aligns with the objectives of the European Green Deal, emphasising human-centred design and promoting a novel lifestyle paradigm where sustainability and style converge, thereby catalysing the green transition across various economic sectors, including construction, furniture, fashion and other domains of daily life.

Keywords: social sustainability; social innovation; social actor; cold sustainability planning.

Introduction

While sustainability has undoubtedly become a fundamental principle of human existence, it is equally true that, thirty-eight years after the publication of the Brundtland Report *Our Common Future* (WCED, 1987), this concept risks losing its meaning due its increasingly superficial appropriation by marketing and media rhetoric, with mentions of "alliances for sustainability", "sustainable cities", "green cars", and so on. Like many other positive principles of our time, sustainability risks losing its ethical foundations, once exposed to the demands of the voracious neoliberal economy.

Is our planet becoming less sustainable, despite the efforts made and advocated by scholars? To what extent are ordinary individuals, who are not part of the scientific community, truly committed to living sustainably and even altering their lifestyle in the name of this principle? This is the scenario that Alex Langer, the Italian politician, environmental journalist, pacifist and essayist, described in 1994, when he declared: «The environmental transition will happen only when it becomes socially desirable» (?).

The core of the issue lies in shifting the understanding of sustainability from a purely "technical" and abstract notion to one that views it as a foundational principle of human relations and a new vision for the future. As environmental thinker Vandana Shiva with Kartikey Shiva write in *Oneness vs. the 1%: Shattering Illusions, Seeding Freedom* (2018): «We are one earth family, one humanity. We are connected through our diversity, intelligence, creativity and compassion». Indeed, by emphasising the "sentiment" of responsibility, the Brundtland Report addresses the issue in ethical and moral terms. Section 3, titled "Sustainable Development" from Chapter 1, "The Global Challenge" includes the well known statement that summarises the entire report: «Humanity has the ability to make development sustainable to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs» (WCED, 1987). These words envision growth as the result of the harmonious balance between social, economic, and environmental factors, promoting an equitable, inclusive and sustainable society in the long term.

To remain consistent with the foundational philosophy of the Report, we need to recognise the value of social sustainability: «[...] which is notably absent from public debates [...], as most discussions focus on the economic and environmental paradigms [...]» (Moralli, 2022). But how can we conceive of sustainability without human rights, gender equality, social harmony, and the right to dignified work for all? These aspects are what make social sustainability a cornerstone of sustainable development, if not the most strategic of the three pillars.

This Special Issue of TECHNE offers a more direct analysis of the various facets of social sustainability, calling attention to the role of communities, territories, and local identities within broader processes of transformation in contemporary cities.

Social sustainability: my/our responsibility

When it comes to environmental sustainability, citizens can make a significant impact by changing their lifestyle without waiting for institutions to take the lead. As Giampaolo Fabris suggests in his book *La società post-crescita. Consumi e stili di vita* (2010), individuals can engage in virtuous practices, such as recycling correctly. The impact of this behaviour, while seemingly trivial, could potentially have a significant social effect, particularly in terms of providing a compelling testimony. However, it would be naive to ignore the disproportionate environmental damage caused by the unsustainable policies of lobbies, multinational corporations, criminal organisations, and warring nations that outweigh the actions of virtuous citizens. It is an unequal struggle!

In contrast, the contribution of individuals to social sustainability may appear minimal. This is evident when we look at the 17 Sustainable Development Goals outlined in the UN Agenda 2030 (General Assembly of the United Nations, 2015). These are the goals that the United Nations Assembly committed to in September 2015, aiming to end poverty and ensure global access to education, healthcare, and dignified, regularly paid work. The use of terms like "ending", "ensuring", and "promoting" in the document places the responsibility squarely on the shoulders of nation-states, leaving citizens in a state of passive waiting.

However, there have been multiple instances in which grassroots actions, including some quite well-known ones, have led

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to tangible changes, even resulting in new laws. One notable example is the case of Riace.

Riace, a small town in Calabria, Southern Italy, famous for its ancient *Warriors* housed at the Magna Grecia National Museum of Reggio Calabria, is regarded as a positive example of immigrant reception policies. However, that model is now nearly dissolved following accusations and legal challenges involving the town's former mayor, Mimmo Lucano. In 2009, on the occasion of the twentieth anniversary of the fall of the Berlin Wall, Wim Wenders remarked:

The real utopia is not that the Berlin Wall came down - it is that which has been happening in some towns in Calabria, especially in Riace [...] I saw a town that had the capacity to solve, through welcoming refugees, not the actual problem of refugees, but its own problem of continuing to exist, resisting death caused by emigration and depopulation (Perfetti and Ronconi, 2021).

This statement by the German director encapsulates the Riace experiment, which began in 1997, when eight hundred Kurdish migrants arrived on the coast near Riace. At that time, Lucano, who was a schoolteacher, decided to open the doors of his small town to these newcomers in an effort to repopulate the historical centre. His efforts were inspired by international refugee reception practices. The migrants arriving in Riace were provided shelter and essential services, including dignified housing, healthcare, legal assistance, groceries for a week, personal and domestic hygiene products, and clothing. But there is more to the story. Over time, Riace transformed into an example of virtuous reception policies, with a newly repopulated historical centre housing migrants in abandoned homes and repurposed shops, which prompted the return of former residents. Maria Luisa Ronconi highlights one of the key strengths of the Riace Model:

Equal treatment of the local workforce and a business-like approach were adopted in Riace to manage local facilities [...] and organise craft workshops. These were not run by migrants and/or residents alone but by what became an integrated, multiethnic community (Perfetti and Ronconi, 2021).

In Riace, integration was not conceived of and achieved as a one-way process, where migrants were expected to assimilate into the host society. Instead, it manifested as *mixophilia* - the positive mixing of locals and migrants - the opposite of *mixophobia*, which instead leads to the creation of «communities of similar people» gathered within the guarded spaces of gated communities, such as those found in the United States (Bauman, 2005).

Unlike the hyper-selective legal procedures practiced in the West, which draw sharp distinctions between legal and illegal immigrants, fuelled by a fear of foreigners (who, if not as terrorists, are described as thieves coming to steal from the host society and its "rightful" citizens), the essence of the Riace Model seems to lie in a deeply rooted propensity for warmly welcoming foreigners - a concept that transcends pity and is anchored in very ancient, almost 'mythical', times.

In the case of Riace, we should then speak of "hospitality" - the universal principle adopted by ancient cultures toward foreigners. This is distinct from the unidirectional and compassionate act of "reception". Jacques Derrida, reflecting on the concept of hospitality rooted in ancient cultures, notes that words like the Greek *xénos* and the Latin *hospes* made no distinction between the "host" and the "guest". He claims:

Hospitality is culture itself and not simply one ethic among others. In so far as it has to do with the ethos, that is, residence [...] the familiar place of dwelling, in as much as it is a manner of being there, the manner in which we relate to ourselves and to others [...], ethics is hospitality; ethics is so thoroughly coextensive with the experience of hospitality (2018).

For this reason, speaking of an "ethics of hospitality" would be tautological.

A poignant example of the sacred value of hospitality for ancient cultures is found in the *Old Testament* (Genesis, 19), when Lot offers his daughters to save his guests from the Sodomites. However, as philosopher Umberto Curi (2022) points out, the paradigmatic poem of hospitality is *The Odyssey*. Curi highlights several exemplary episodes, including the one in which Mentor and Telemachus, after leaving Ithaca in search of Ulysses, land on the island of Pylos. «[...] they reach the royal palace just as a feast is about to begin [...] and they are welcomed and invited to partake in the food, without ever being questioned about their origins». It is only after being welcomed unconditionally that the foreigners are asked to reveal their identity and intentions, as «[...] for at least a thousand years - from the time of Homer to the early Christian era - *xenia* was one of the fundamental institutions of ancient Greek civilization» (Curi, 2022).

This discussion of unconditional hospitality, which becomes a practice of taking care of the "foreigner", emphasises the potential of a creative openness to encountering the other, something opposed to the *mixophobic* hysteria that grips contemporary society. Furthermore, Lao Tzu's ancient teaching, invoked 2,500 years later by Amartya Sen and Martha Nussbaum, posits the notion that individuals do not merely «[...] bear needs, but also abilities» (Manzini, 2018). What happened over roughly twenty years across the so-called Calabrian ridge of solidarity and reception - encompassing the small towns of Riace, Badolato, and Caulonia Stignano - demonstrated an unusually open approach to the foreigner that was beneficial to all host communities. It led to the repopulation of historical centres by migrants

and had «[...] socio-economic and cultural effects on the social and economic fabric of marginal and disappearing communities» (Perfetti and Ronconi, 2021). It is also important to note that the Calabrian experience inspired new laws, including Law number 189 of 2022, which established the SPRAR (Protection System for Asylum Seekers and Refugees) «[...] that now involves 137 municipalities, providing hospitality to up to 20,000 people» (Perfetti and Ronconi, 2021).
What, then, could the Riace Model mean for us? What is its cultural, political, economic and social legacy?

Social innovation

In his book *The Rise of Meritocracy* (1958), British sociologist and politician Michael Young introduced «social innovation» as a paradigm to combat social inequality. Though much has changed in the last two decades, the Riace Model still stands as a positive example of social innovation. Another historical example is the American Civil Rights Movement of the 1950s and 1960s, which led to monumental legal changes, such as the Civil Rights Act of 1964 that ruled against racial discrimination in public spaces and workplaces, and the Voting Rights Act of 1965, which eliminated racial discrimination in voting. Another example that should be mentioned is the Bangladeshi microcredit project for small enterprises and low income individuals developed in the 1970s by Muhammad Yunis, the founder of Grameen Bank.
It is, therefore, worth examining the theme of social innovation and its connection to social sustainability, and introducing the figure of the social actor. Melissa Moralli writes: «[...] in a framework of sustainability, the creative and reflective capacity of social actors shows that innovation can be a form of social sustainability [...]» (2022). So, who are these social actors? They are individuals, informal groups, associations, private and social enterprises, and public administrations, all of whom work together to pursue common goals (Moralli, 2022).
However, we must be cautious, as we can speak of social innovation in two ways, precisely when innovative initiatives have a positive impact that exceeds previous efforts, and if innovation creates not only positive social effects, but also environmental and economic ones. Otherwise, it would not aid sustainable development (Chahinian, 2022). This means that social innovation needs to be implemented and subjected to verification at a subsequent stage, and cannot merely remain an abstract concept.
Moving to the very different context of architectural design education, it is worth mentioning the well known work of Riccardo Dalisi. Dalisi was a unique "social actor" who, in the 1970s, turned the streets and courtyards of Naples' suburban neighbourhoods into outdoor classrooms. He created temporary "hybrid communities" of underclass children and students, using "animation" as a participatory design tool in the Rione Traiano and Ponticelli districts. If we were to assess the impact of his work in the lumpenproletarian district by focusing on its political effects over time, we could certainly argue that what Dalisi did in Ponticelli was, at least in its initial phase, an act of social innovation, which countered the devastating plans of those who, years earlier, would have wanted to demolish the neighbourhood. Unfortunately, Dalisi was unable to prevent the interventions that followed the earthquake of 1980, which proved to be both an architectural disappointment and a social failure. However, measuring social innovation solely by its effect on territories does not do justice to new aspects that, in a way, break from the past. Dalisi's novel approach to participatory design and education left a lasting mark on design culture that was championed by Giancarlo De Carlo in his journal "Spazio & Società", as well as by Alessandro Mendini with the 'Radicals' when he was Editor of "Casabella", and Andrea Branzi, the author of *La Casa Calda* (1984).
Equally notable is Dalisi's work in Rua Catalana, the street lined with copper, iron, and tin artisan workshops in the heart of Naples. Dalisi was able to revive the area by working with skilled craftsmen, many of whom were generally engaged in repetitive tasks before his arrival. The façades of Rua Catalana still display traces of this fruitful collaboration, which involved public institutions. The initiative not only acknowledged the value of the artisans' work, but also contributed to their economic well-being.
In *Politiche del quotidiano*, Ezio Manzini writes about "transformative" social innovation, which «[...] transforms what is already in place, inspiring changes toward sustainability» (2018). Manzini highlights seemingly irrelevant examples of transformative social innovation, such as «[...] leaving the car at home and walk or bike, or starting a carpooling initiative [...] that create a discontinuity that changes the system on a local scale [...]» (2018). These actions should not be underestimated, as over time they accumulate, generating «systemic changes on a greater scale» that ultimately affect institutions and politics. Manzini's words suggest that «transformative social innovation» encompasses two key aspects. First, the individual social actor-designer who takes charge of the process:
[...] does not only participate in the debate on public matters, but actively practices and manages what he discusses, working for himself, for the people he works with, and for society as a whole, enacting forms of participation in which the decision-making phase is directly connected to its implementation (Manzini, 2018).
Additionally, collaborative projects often yield results that would be impossible to achieve alone.

Conclusions: The limits of "cold planning"

"Cold planning" can be understood as the process of conceiving, discussing, and implementing actions aimed at social sustainability and/or social innovation, whilst excluding from the investigation all factors that cannot be quantified or measured from the investigation. These factors, which belong to the sphere of irrationality - like emotions, difficulties, or friction with contexts - are nevertheless often crucial aspects of the decision-making process. In the descriptions of social innovation projects, it seems that everything runs smoothly, without jolts or shocks, and that their implementation follows a constant linear progression. Therefore, if you want to get an idea of what social innovation means, with all the burden of human passions and the friction with an unfavourable context that "social actors" must face to support their goals, you should (re)watch one of Ken Loach's films, *The Old Oak*, from 2023. The friendship born between a young Syrian refugee girl and a pub manager - despite the failure of their social innovation project - breaches the community in a small town in the North-East of England, and is embodied in a shared 'value' through a project that is even wider and more unifying than first imagined. A movement of social inwardness that the word resilience cannot fully capture.

Thus, the effort required of specialists is to move beyond the confines of "cold" planning. Even when executed with the best of intentions, such planning becomes rigid, focused on concepts, carefully avoiding the slippery nature of irrationality, an inherent aspect of human existence. The commitment required of specialists is to overcome the limitations of a "cold" design that, even with the best intentions, closes itself off from concepts that carefully avoid the slippery entanglement in the sphere of the irrational, an unavoidable variable of human life. A cultural commitment to model a different approach is, therefore, required. This approach must be applicable not only in the phase of discussion and the implementation of a social innovation project, when the designers are social actors, but also in training tasks, when they are educators. We must acknowledge that social innovation and social sustainability cannot be subservient to the hegemony of technique, as their intrinsic nature is intricately intertwined with the liquid plane of interaction between individuals and communities. The genesis of a social innovation project can be traced back to a profound sense of responsibility, a concept that is encapsulated in Adriano Olivetti's work as an enlightened entrepreneur who encompassed and harmonised the aesthetic, political and economic dimensions.

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MSHEIREB, DOHA: THE URBAN REGENERATION OF A DETERIORATED HERAT. AUTHENTIC CONTEMPORARY AND CULTURAL LOCALISM

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Abstract. Doha, the capital of Qatar, used to be a port town on the eastern part of the peninsula of Qatar. Historically, the town shared cultural commonalities with other Gulf cities, particularly relying on fishing and pearl diving as the main feature of its economy. The old town, which was characterised by compact urbanism, extended families living in courtyard houses and shaded allies, was totally abandoned after the oil discovery and the flow of unprecedented financial resources in the late '70s and early '80s. This paper provides a critical narrative of the urban regeneration process that took place in the heart of Doha. It interrogates the new vision that was articulated to revitalise the old heart of the city and bring people back to such a valuable part of its urban fabric. The paper examines the Design Strategies used in the project to move from adaptive reuse to holistic urban regeneration. It analyses the use of oil and Gas revenues to help the city go beyond the western illusions and urban spectacle, and argues that the project is a manifestation of a needed transformation from the urbanity of an image to the urbanity of meaning. Such city transformation is essential for constructing a more dynamic and vibrant identity for the city.

Keywords: Urban Regeneration; Doha Qatar; Architecture and urban heritage; Cultural localism; Authenticity; Cultural continuity in urbanism.

Introduction

Unlike plenty of architectural and urban projects in Qatar and Gulf cities, the Msheireb project is creating a tangible impact. Interviews conducted with local people and expatriates living or visiting the project revealed interesting outcomes. Most of the urban projects in the Gulf are moving between the Western model, particularly when designed by western architects and designers, or the fake representation of traditional architecture. Yet, the results of the interviews illustrated a new category, which can be best described as the authentic contemporary structured on cultural localisation. The interviewed local people's narratives were inspirational because they reasoned about a different set of lessons learned from the project. These lessons are relatively different from what architects and urban designers are interested in, they while analyse or research the project. An old Qatari man sitting at Sahat Al Wadi, proudly said: «his project shows how westerners can learn from us, instead of us imitating them all the time».

The Gulf context

While each city on the Gulf has its own narrative, yet the similarities in main governing factors led to common issues and challenges particularly in the domain of urban development. A prime factor is the radical shift in all Gulf states' economy due to the discovery of oil. For the first time in their history, Gulf States began to get regular revenues from selling oil. This trade was amplified during the first oil boom in the '70s. The availability of such unprecedented financial resources coupled with a desire to imitate the west and reject the old and traditional built environment resulted in a deliberate process of heritage destruction, erasing full chapters from the urban fabric of Gulf cities. The intimacy of the Gulf city is lost. More recently, Gulf cities, under the effect of the urban development model constructed by Dubai, were engaged in a regional competition to build the highest, the biggest and the tallest.

At present, Gulf cities are facing new urban complexities and challenges. Hence, envisioning the future is particularly significant, considering two fundamental challenges, namely the post-oil era and the post-COVID era. The Post-Oil Era suggests providing an answer to the essential question of how to decarbonise cities. Multiple strategies emerge in Gulf cities, and the process of planning and adopting can be observed with considerable concentration and determination. A prime factor is moving towards Transit-Oriented development (TOD). The move toward TOD facilitated the decentralisation process of metropolitan urbanity (Wippel, 2014; Alraouf, 2019). The coherence of Gulf cities began to focus on avoiding urban fragmentation and city sprawl by restitching the urban fabric via public and green spaces. Revisiting the concept of streets in Gulf cities and how to consider streets as places for people, and not highways for cars, is another indication of city transformation. As for the post-COVID era, a new urban condition was experienced during the COVID crisis, particularly the imposed lockdown. Hence, emphasising the humanisation process of urban settings in contemporary cities is essential. Public spaces are city saviours, a notion which was proved right during the COVID period. There were plenty of behavioural and functional changes observed during COVID, including the increasing interest in walkability, green spaces, transforming roofs into family roof gardens and gathering spaces. In sum, Gulf cities are transforming on different levels, and a new architectural and planning discourse is significantly needed.

Contextualising Qatar urbanity

The major transformation in Qatar's urbanity was the direct result of structuring Qatar Vision 2030, the document guiding the development process in the state, acknowledging the post-oil challenges (QNV 2008; QNDF, 2016). The second major transformation was winning the bid for hosting the FIFA World Cup 2022, which was declared in 2010. Such accelerated transformations paved the way for a new identity for Qatar's emerging urbanity. A move from oil-based economy to knowledge-based economy facilitated the creation of a strong direction towards projects like universities, museums and research centres, in addition to heritage preservation (Kamrava, 2013; Roberts, 2015; Alraouf, 2018; 2022). The new move replaced the old construction trend or more accurately imitated western cities in building skyscrapers and giant shopping malls.

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The narrative of Msheireb, the heart of Doha

After the first oil boom in the '70s, Qatari Families moved rapidly from the old city centre to the suburbs of Doha to areas where they can exhibit their wealth and enjoy modern lifestyle (Al-Buainain, 1999; Alraouf, 2012). With the passing of time, the area lost most of its affluent community to migration as people moved to other regions, leaving much of the historic neighbourhood neglected. In the early 21st century, crucial questions were formulated addressing such a unique part of Doha. Why was the heart abandoned and left to be deteriorated? How to restore, repair and re-weave the city? Msheireb was analysed on different platforms as a case of urban regeneration (Gharib, 2014; Alraouf, 2021). Historically, Msheireb was the real heart of Doha and one of its more vibrant places. Yet, the active heart was abandoned because of a dominant dream for Qatari families to leave the old part of the city and move to the peripheries to build new western villas and replace their old, traditional houses.

The Heart of Doha (Msheireb) aims to bring Qataris back to the severely abandoned old centre of Doha. "Bringing people back to the heart of Doha" was the initial slogan used to promote Msheireb's mega mixed-use development when first declared in 2008 by HH Sheikha Mozah Al Missned, The Qatari first lady at the time (Sh Moza, 2006). The aim of the project was to bring local people back to their roots to rediscover a sense of community and togetherness. The project's slogan was regeneration of an inner city that will create a modern Qatari centre embedded in tradition, where global cultures will meet but not melt (Melhuish, Degan and Rose, 2016). A focus on challenges like social diversity and cultural relevance was considered in the evolution of the Masterplan (Law and Underwood, 2012). In doing so, the consultant and developers incorporated traditional patterns of Gulf architecture and urbanism to create a contemporary Qatari architectural and urban language in a scheme that innovatively balances modernity with traditionalism (Jaidah and Bourennane, 2009; Alraouf, 2016; Jodido, 2014). Msheireb is a mixed-use development project comprising office space, retail, leisure facilities, different housing types, hotels, museums, as well as cultural and recreational places. According to Msheireb properties, Msheireb covers 31 hectares, but the gross floor area (GFA) reaches 76 hectares (760,000 m^2). It is located in the Mohamed Bin Jassim District at the heart of Doha, adjacent to Amiri Diwan, Souq Waqif, and Al Koot Fort. The project consists of five main quarters comprising three extended governmental buildings including the National Archive. Msheireb project is designed as urban villages for future residents to satisfy their needs within walking distance. The layout is planned to allow a pedestrian-friendly environment, hence social interaction. As Gharib (2014) argues, the project is a step to move from locality to globalisation as Qatar is consistent in balancing its local assets with global aspirations (Fig. 1).

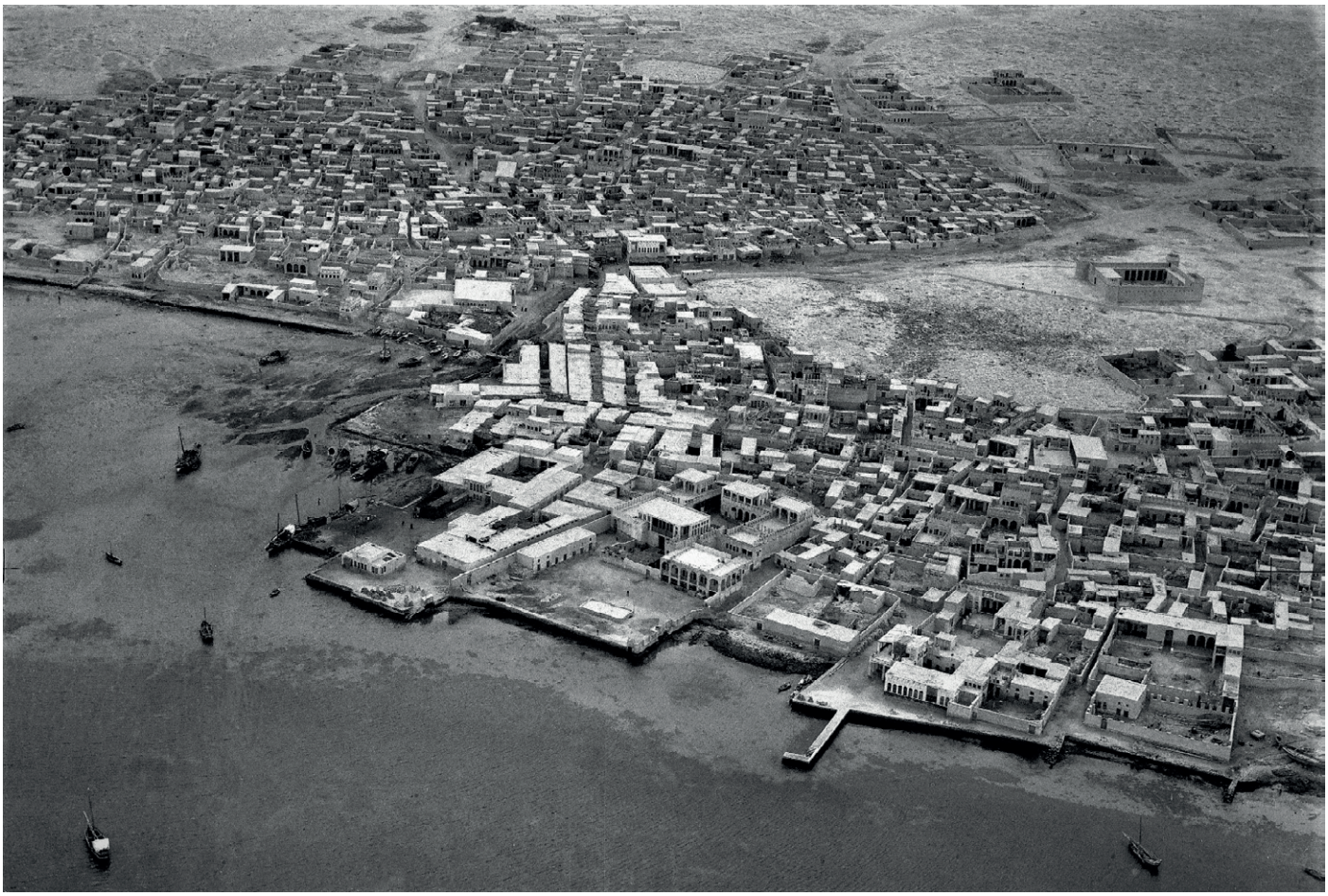
The project aspires to restore the lost shine to a location that is close to the hearts of all Qataris. Hence, it is crucial to bring it back to life. The project was also marketed as it aims to reduce the city's urban sprawl and revitalise the old centre. The project, which was initially named "Heart of Doha", was described as a "city within a city" that merges the best characteristics of the past with the modern technologies. Most of the Gulf real estate companies use slogans to emphasise the sustainable nature of their new projects. For example, Msheireb presents itself as the world's first sustainable downtown regeneration project, which uses traditional Qatari architectural language and aims to achieve one of the highest concentrations of LEED certified buildings in the world. The developers emphasise their commitment to using timeless techniques inherited from the traditional built environment.

The alternative development process: a research-based architectural and urban strategy

Unlike most of the projects in Gulf cities where the element of time is almost irrelevant due to the overwhelming desire to build swiftly, Msheireb adopted another route. This route was characterised by extensive research to articulate planning, urban design, and architectural guidelines. How can planning and design be deferred to focus on governing standards and guidelines, and the production of the language of architecture and urbanism that are unique for both the context and the project (Melhuish, 2014)? A major factor in the success story of the project is the outcome of the significant decision to divide the development process into two stages. The first one is about conducting a holistic research journey to understand cultural, social, economic and architectural values and use it to formulate comprehensive architectural and planning guidelines (Gharib, 2014). The second is providing all architects and planners working in the project with these guidelines, and hence guarantee a common understanding between all the participants in planning and designing the project in a harmonious manner.

The research process started with holistic resources compiling the different narratives about architecture and urbanism in the Gulf and in Qatar, including anthropological, maritime, and social studies. It includes a search for a more contemporary language of architecture. This emerging language of architecture is new and contemporary. It stems from meticulous analysis of the Gulf and Qatari traditional architecture. Consequently, the research journey ended up with two sets of integrated languages for the architecture and urban nature of the project. These

01 | The old context of the project in the late fifties before the impact of oil and the start of the modernisation process (Source: ministry of urban planning archives)



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languages will guarantee harmony in spatial, social, formal, environmental aspects of the project without compromising the creativity and the individuality of every architect involved. The value of this research journey and its outcomes were not only reflected in the planning and design of Msheireb but open a wide spectrum of future research and practice.

The mature interpretation of heritage in Msheireb

The project provides a mature understanding of the value of heritage on different levels. This can be seen on four main levels as illustrated below. Qatar`s heritage is represented in every traditional building in different eras, and is not limited to a specific timeframe. The conceptual approach of the project refrained from the classical way of copying the tradition by adhering, instead, to four levels of mature interpretation of the heritage. A four-level matrix of understanding the value of Qatari heritage, instead of a direct interpretation of what existed.

The First Level: Respect All History Chapters and Avoid Selecting

Doha transformed from its existence as small fishing village to the early days of oil exploration, to a capital city for energy within six decades of development. Such a process of transformation and change was the first level of our understanding of the value of the heritage. The Msheireb project is concerned with the importance and the acknowledgement of each chapter of our history. So, it refrains from selecting a single timeframe or an era of the city's history. Rather, it adopted a more holistic understanding of heritage as the accumulation of the country's history that continues to evolve.

The Second Level: Re-establishing Heritage Value

The project is calling for the positive manifestation of local heritage. It avoids conserving or preserving the heritage buildings, and leaving them as closed monuments within the city centre. Heritage buildings are telling their story at Msheireb. They exhibit the value of their existence by having contemporary roles

where it can serve the local community. For instance, four traditional houses were preserved and rehabilitated to contribute to the contemporary life of the city as well as tell their history. The four heritage buildings transformed into museums stand at Msheireb to exhibit not only their historical value but also the anatomy of the space, the beauty of using local materials, the courtyard, the harmony of new and old, besides respect for history and modern technology.

The Third Level: Heritage as a Source of Inspiration
The value of heritage as a creativity inspiration platform is of paramount significance in the narrative of Msheireb. The project provides a model for how to use heritage as a platform for a new creative chapter, a chapter of today that is a continuation of the past, and is yet modern. At Msheireb, the past was looked at as a source of inspiration, a reference book one learns from to create a new chapter in the ever-evolving history of the city.

The Fourth Level: Heritage Stimulating, Creating a new Narrative for the Context of Msheireb
Project integration and coherence were a great challenge. Hence, a research-based design and planning process were adopted to guarantee the harmonious and integrated outcome. Therefore, three-year process research with the support of researchers, academics, professionals, architects and urban planners, both local and international, gathered to come up with the guidelines and principles on what the project would build upon. The result was a unique creation of new architectural language, which formulates the guidelines for over one hundred architects and engineers working on the project. The new architectural language is just like any spoken language. Every architect can use its vocabulary to create his or her poem, words or building. This is what gave Msheireb its diversity with unity, and unity with diversity. Such harmony cannot be created without the new architectural language, and it was clearly achieved at Msheireb.

Cultural continuity, connectivity and inclusiveness in Msheireb

One of the strong aspects of the project is related to urban and visual connectivity with the adjacent Souq Waqif, the most significant heritage area in Doha. The levels of connectivity can be seen in the architectural language extended from the façades of Souq Waqif and the Heritage quarters to the façades of Msheireb buildings but in a very abstract and modern way. Another level of connectivity is related to cultural amenities. From the galleries and cultural centres at the Souq, the connection is extended to the project via the presence of four museums occupying four traditional houses that were preserved and rehabilitated during the construction of the project. A third level of connectivity can be seen in the actual urban and movement relations between the Souq and the project. A major urban public space is connecting the two projects and allowing for excellent visual adaptation and preparation for a better perception of the project. Hence, the project is providing an excellent case of a vibrant urban centre characterised by mixed-use development, namely urban diversity. The significance of the project is related to its ability to provide a successful example of the needed mixed use development coupled with transit-oriented development, and open to diversified community and user groups. Such features are substantially needed for Qatar's future, particularly the principle of moving towards a post-carbon paradigm and more reliance on sustainable and people-friendly modes of development and urbanity.

The architectural and urban significance of Msheireb

The project is characterised by authentic yet contemporary architecture. The language, which is called contemporary Qatari architectural language, resulted from analysing the old traditional architecture of Doha and other Gulf cities to understand its concepts, principles and deep layers, rather than merely focus on visual vocabulary and copying the past. On the urban level and as opposed to plenty of projects in the Gulf, the project has no leftover spaces that can be pointed out. The fact that the project has No leftovers is a result of a planning process to produce an integrated project, not a typical land division that produces fragmented and scattered urbanisation. All the voids of the project are positive and encompass the qualities which Alexander (1979, 2012) discussed. The voids are an integral part of the project's urban fabric where all of them are playing crucial rules in attaining the vibrancy of public life. Therefore, the availability of small public spaces and pocket gardens is an additional positive feature of the project and its focus on people (Fig. 2).

Conclusions and final thoughts

The Importance of the Project can be seen from different aspects:

- creating an unprecedented sense of belonging to the previously abandoned heart of the city;
- achieving a sense of pride. The project is not a group of skyscrapers as seen in different Gulf cities. A new level of pride emerged between local community members as they realised that the project is not the tallest tower, but a balanced approach between valuing the past and considering the future. Additionally, the project won heritage conservation and sustainability awards both regionally and globally;
- raising awareness about the available "Metro as a mode of

02 | The project is constructing an inspirational dialogue across the bay where observers can see the juxtaposition between two main urbanities in Doha; the Image-based west bay with its glitzy skyscrapers vs the human-based urbanity of Msheireb.

| 02

urban movement and Walkability as a healthier way of life. A new level of social awareness regarding the vitality of public transportation" (walking/public transport/connection to the metro network);

– providing new architectural and urban aesthetics: the new modern, the authentic, the creative vocabulary. A new level of aesthetics of construction and urbanism has changed the taste and mentality of society.

Influencing the rest of the city, particularly the adjacent context, and creating a model for local people to adopt. In this sense, I would argue that Msheireb sets a precedent for the needed social paradigm shift from consumers to citizens. Advocating happier instead of stressed city dwellers by optimising integration, socialisation, slower city rhythm and nurturing the city is immensely important. The projects, as numbers illustrate, achieved density without high rise, which is the future of cities to be more human-based, compact, walkable and, hence, healthier. For the first time since the official start of urban planning activities in Qatar, the project moved beyond the typical process of subdivision, implementing principles and concepts generated from the old traditional city fabric. Msheireb is a project of reinvented historic fabric rather than land subdivisions. While preserving its own identity and character, the project managed to avoid the extravaganza clearly observed in most Gulf cities. A real mixed-use development, which is not a gated community but rather a public centre accessible to all and adjacent to public transportation. A manifestation of a precedent in the built environment development in the Middle East and the Gulf where a real estate development company "Msheireb" is sponsoring such a profound research study. But more significantly, to use its findings in an actual project to come up with a new paradigm in the notion of urban regeneration within the Middle East and the Gulf.

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WHAT DESIGN HAS DONE AND MIGHT DO FOR THE SUSTAINABLE CONTEMPORARY CITY

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City and design: some premises

The historical trajectory of Italian design, defined until twenty years ago by designers trained as architects, is essential for the perception of design as the planning and production of urban equipment of formal quality. That occurred with a strong sense of authorship and often with little connection to the context and the purposes the use of urban spaces would require, especially in terms of sustainability. Otherwise, the conviction of the need to keep the two thoughts – architecture and design – integrated with each other may allow to consider both as closely interconnected legacies equally worthy of consideration today.

Concerning the specificity of the relationship between design and city, the scope is to consider the two disciplines as deeply connected and to plan, in the near future, a new way of using – and teaching – both as different but united to achieve the goal of improving the quality of our cities not only from a formal point of view.

Retracing, within a historical flow, the mutual link between design and cities since the very beginning of their relationship seems useful to understand and recover the original meaning of the city designed for its citizens. Indeed, however much it has changed over the centuries, it seems urgent to keep it in mind in order to return to using design as a service to the community.

Hence, we can conventionally place the beginning of this genealogy in the industrialised West, at the time of the great reforms of the city of Paris ordered by Napoleon III (Tamborrino, 2005; Zucconi, 2022).

The idea of setting up a more modern capital city, dotted with service buildings (from schools to theatres, to planned open-air public spaces, and large avenues), with the aim of achieving magnificence but also hygiene and public health, led to the conception, production and use of equipment that had never existed before. Street lighting, benches, public toilets and sign supports are mass-produced in cast iron structures with painted sheet metal finishes. They require existing manufacturers to acquire patents for the production of large metal objects through electroplating and electrolysis processes, to all intents and purposes the first results of industrial design (Dellapiana 2024).

The Industrialised elements, such as the ones listed by Adolphe Alphand (Alphand 1867-1873) in his regulatory work, are present in every corner of the city. They convey the presence of the State (and its "public" meaning) and care for citizens, who will be able to sit along the avenues, use toilets, deposit rubbish, and be informed about the latest events. They also contribute to the image of the city shared by the citizens themselves, somehow what we now call city branding, which is also useful for stimulating the growing consumer society (Trentmann 2017; Dellapiana, 2025).

Following Napoleon III's *grandeur*, in many European cities people and administrators started to talk, legislate and act in the name of 'public art', referring not only to urban facilities but also to squares and gardens designed with the contribution of architects and artists (De Laborde,1856), the mix that will generate the category of designers. The influence of urban equipment is also quickly recognised in its negative social effects in terms of accentuating inequalities between classes and groups of the urban population. For example, the large number of advertising billboards in the streets of large cities is favourably received for their intrinsic quality and the birth of a real 'aesthetic of the street' (Kahn, 1901), besides highlighting the discomfort of those who cannot even imagine approaching the products or experiences advertised: «Was this useless provocation necessary to communicate to the underprivileged of the opposite tenement block that climates, springs, valleys, mountains, woods, a holiday in the mountains, at the seaside, in the countryside, reinvigorate the weak.... [...]?» (Descaves, 1886).

However, the products are created and spread as a consequence of the new vision of the service city. The network of Paris metro stations, to mention a very well known case in point, is a perfect example of an industrialised object, structures made of cast iron components that can be assembled according to the location and importance of the station, covered either in whole or in part with pressed sheet metal that always has the same decorative elements.

Similar phenomena occur in Vienna and in other European capitals, which are equipped with urban facilities at various scales in accordance with the city design (Magnago Lampugnani, 2021).

After World War II, the expansion of cities made it difficult to harmonise urban facilities and design.

Moreover, designers begin to be distinct figures from architects, and the two trajectories tend to separate.

The size of cities and the critical economic and social situation as well as the very compressed timeframe make it impossible to proceed as at the end of the previous century. They provide urban 'decorum' along with the provision of services, while opportunities for social conflict are accentuated.

City and design: conflict points and practical solutions

Different trajectories are defined in which design, increasingly specialised (industrial, visual, strategic), demonstrates that it can, or cannot, have an effect on the city, particularly in connection with the effects on the social and environmental framework. Examples of design integrated with urban planning and administration policies are rather rare, despite many theorists, such as the American activist Jane Jacobs expressing the

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01 | Bus Stop in Curitiba

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need for reactive planning, taking into account the different scales involved at the basis of urban complexity (Jacobs, 1961).
One is the legendary case of The city of Curitiba in Brazil (state of Parana), which doubled its inhabitants in 1940 within a few years, and where rapid industrialisation caused severe social imbalances (the well known South American slums) and a very high degree of pollution[1].
In 1972 Jaime Lerner, an architect, became the mayor of Curitiba and instituted his plan for a sustainable city by adopting a design approach. Not an action of traditional urban planning nor new infrastructures, but a «soft revolution» aimed at an efficient social impact achieved thanks to small artefacts managed following concrete strategies guided by a *learning-by-doing* philosophy, namely the typical design approach. In this regard it is perhaps worth remembering that the debate on the legacy of the Bauhaus and the subsequent Ulm school was effectively present in Latin America thanks to Tomas Màldonado and Gui Bonsiepe, before and after they moved to Europe (Fernández and Bonsiepe, 2008).
Lerner identified several integrated lines of action for which design and designers worked without focusing on the dominant stylish approach, but rather on functionality, economy, flexibility, affordability and, in synthesis, social impact (Fig. 1).
One of the biggest innovations that Curitiba put in place was a *Bus Rapid Transit System*. Roads with express lanes for buses, specially designed coaches for quick boarding, and cheap and uniform ticket prices have helped Curitiba maintain a quick, cheap and low emission transit system. Streets allocated for pedestrians only and designated bike lanes have also contributed to this. Bus stops that could be changed according to traffic intensity and time slots have changed the efficiency of public transportation and made all areas accessible, even to inhabitants of peripheral and poor areas, to provide easier access to work and sociability. In an interconnected way, the city administration paid attention to the green public spaces, planting 1.5 million trees in Curitiba since the 1970s, and building 28 public parks. Furthermore, to combat flooding, which had previously submerged the city, Curitiba surrounded the urban area

with grass fields, saving itself the cost and environmental expense of dams. To maintain the fields, the city uses sheep rather than mechanical means, saving money and oil, while providing manure for farmers and wool. Curitiba recycles around 70 percent of its garbage thanks to a programme that allows for the exchange of bus tokens, notebooks and food in return for recycling. The underlined idea was not only to protect the environment, but also to boost education, increase food access, and facilitate transport for the city's poor. In order to collect the garbage, all industrially manufactured equipment neglects the formal aspect to get straight to the point of social and economic function. This kind of social impact, design-oriented efficiency and avoidance of the 'cuteness' of contemporary design did not collide with the presence of great works of architecture, such as the local museum designed by Oscar Niemeyer (another author deeply involved politically) in 2002.

The Instituto de Pesquisa e Planejamento Urbano de Curitiba (IPPUC) continued its work despite changes in administration until 2004, becoming a worldwide model of green and smart city, somehow guiding public policies also "against" design, preferring the possible social impact to profit and aesthetic factors. This is the case of the Sao Paõlo administration which, in 2007, intervened with the Lei Cidade Limpa and had 15,000 billboards and more than 300,000 oversized signs removed over a few months (Harris, 2007). In this case it was not just a question of general aesthetic aspects. Indeed, the law, introduced by the social democrat mayor Gilberto Kassab aimed to reveal the degraded areas of the city, the *favelas*, and those where foreign workers were exploited in illegal factories hidden by the *billboards* themselves, as well as fighting a symbolic battle against the large multinationals (Goodyear was also among those 'expelled'). The identity, however uncomfortable, of the former Brazilian capital was stated.

Graphic and visual design are not only 'enemies' in cities with aspirations of social justice. They have also been used for social purposes with some interesting results, despite the common feeling that tends to associate the proliferation of urban visual signs with the dystopian visions shown in Ridley Scott's film Blade Runner (1982).

By way of example, and limiting ourselves to the last ten years (Mahdawi, 2015), the French artist and graphic designer Nicolas Damien caused a stir by virtually 'stripping' the commercial districts of Tokyo of *billboards* and illuminated signs. His fellow countryman Etienne Lavie covered the Parisian advertising boards with reproductions of art classics, this time for real. In 2015, the Teheran administration authorised the replacement of the city's advertising apparatus with giant posters of ten Persian art classics for ten days. In 2014 a *crew of* New York street artists, Re+Public, released the free app NO AD, which uses an augmented reality system to frame the Big Apple's subway stations and replace advertisements with artworks[2].

However, the use of urban art approaches could polarise urban spaces by making them landmarks often without attention to context, social impact and everyday use, looking more to consumption, advertising and the market (city-branding) than to the needs of the population. Furthermore, it contributes to increasing the alienating gentrifiers of neighbourhoods as in the case of the controversial digital and interactive billboard by Tom Wiscombe Architecture on the Sunset Boulevard, LA (2022) (Miranda, 2022), or Thomas Heatherwick's *The Vessel* in New York (2019).

On a smaller scale and with certainly less negative effects – but close meanings – the growth of this kind of authorship, in architecture as well as design, originates a large number of objects for street furniture, site-specific installations or multiples, which become a sort of "catalogue" from which administrators and officials can choose to give certain areas a distinct character. Authored benches or public lighting systems offer formally very interesting, sometimes outstanding, examples of industrial design that help reinforce city branding, but they do not care about the social impact on the community dedicated to their use.

Design and cities. Next steps

Contemporary cities feature a number of experiences proposed and managed (often from below) by groups of young designers who, with the typical philosophy of design thinking (breaking down problems, solving them separately and recomposing them), merge the design and production of street furniture (industrial design) and the design of public spaces, based on compatibility with urban development largely managed by real estate (Fig. 2).

Just to mention one, the case of NoLo in Milan (2019) used the name "tactical urbanism". It consisted in using industrially produced low-tech equipment with sustainable materials; the visual management of spaces at street level with reversible interventions to define pedestrian and leisure areas and vehicular flow, and to create meeting points for various groups of citizens (from young to silver) without separation, involving neighbourhood residents. The success of the first step of this initiative, also from the point of view of safety and greater equity in terms of access to services, prompted the Milan administration to identify several urban areas in the *Piazze aperte* programme in which to apply the same procedures[3].

In light of what has been briefly explained and extracted from the historical flow, from the origins of industrialised society, it seems clear that the current need for collaboration between the different scales of the project to achieve a socially, as well as environmentally and economically, sustainable result has required

02 | Tactical Urbanism in Piazza Dergano, Milan, 2021

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several changes of perspective. Design, originally conceived as a general (and revolutionary for the time) reference to a concept of citizenship borrowed from the outcomes of the bourgeois revolutions, experienced socio-political phases, alternately attempting to address inequalities or somehow favouring them. In addition to new planning tools, the aforementioned tactical urbanism or urban ergonomics (Bonino and Mancini, 2021) can be traced back to what design can do for cities, with the aim of bringing urban design actions back to the dimension of the human body, since the principles of ergonomics were initially conceived in response to the critical use of the serial product.
It is otherwise also essential to use new interpretative tools such as environmental history (Barber, 2020) or trans-species history (Colomina and Wigley, 2016) with regard to both the history of architecture, which is already well underway, and the history of design, which still needs reinforcement (Scodeller, 2023) to encourage new sensitivities to support both design and public policies.

NOTES

[1] https://www.institutojaimelerner.org/ (March 2025).

[2] https://www.cultofmac.com/298127/ad-turns-new-york-subway-street-art-wonderland/ (March 2025).

[3] https://www.comune.milano.it/aree-tematiche/quartieri/piano-quartieri/piazze-aperte (March 2025).

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BEYOND OR WITHIN THE LIMITS? A MISLEADING DILEMMA FOR CURRENT TECHNOLOGICAL PROCESSES

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Abstract. The concept of limit offers an opportunity to summarise some milestones in the evolution of technological processes. Although this concept is theoretically and empirically problematic in the light of contemporary scenarios, both as a factor that generates processes and as a demarcation between nature and artifice, it remains essential in at least two areas, namely innovation and sustainability. Indeed, a series of material and immaterial limits influence, and sometimes impair, implementation of the technological processes. The incentive to manage these limits has often acted as a lever for innovation, both in terms of processes and products. Above all, dealing with limits has been at the heart of the orientation towards sustainability since its inception. The scientific community and the general public have come to terms with the finite nature of non-renewable natural resources and with the need to limit emissions. In both cases, the limit is used as a warning, with fear of the transition from alarm bell to death knell for the planet. The concept of limit is also relevant to the adaptation strategies to Climate Change. However, the concept of limit as something that clearly establishes a "within" and a "beyond" has supported a misleading dilemma in the face of the development of global economy. A change of approach is, therefore, called for, replacing the opposition of the limit by the integration of the continuum, bearing in mind that the right time and the right measure have always been an indispensable qualitative range for technological processes characterised by ethical principles.

Keywords: Limits; Technological Process; Technological Product; Climate changes; Innovation.

From the limit to the continuum

The limit is a concept to which any technological process (understood as a sequence of human actions leading from the identification of a need to its satisfaction, through the production of an artefact) can refer. The way in which technological processes relate to the limit is changeable, and its evolution can be traced with reference to both the Past and the Present. Indeed, the relationship with the concept of limits in a given context often implicitly expresses the underlying reference values. Although there has been no shortage of theoretical contributions on the comparison of virtuosity, economic, and user or need values, the tendency to consider technology as "value-free" still persists, just as the technological imperative ("the temptation to always strive for the greatest technical achievement or complexity currently possible") often still justifies a conception of creativity as "innovative, adventurous, unrestrained" rather than "tempered by responsibility" (Pacey, 1983).

A reading that pits creativity against responsibility is the result of the cultural context of the last quarter of the 20th century. It reflects a Manichaean stance on the limits of technological processes, characterised by numerous overlaps with the issue of energy supply. The limit, in fact, is a concept ignored by the intoxication of industrialisation in the 19th century, demonised by the myth of progress in the early 20th century, and emphasised by the orientation towards sustainability at the end of that century. Such a perspective seems reductive and inadequate to face the challenges of the contemporary world. There is a need for a less simplistic interpretation to resolve the dilemma of staying within or going beyond all limits, a key theoretical question of technological processes in the 21st century.

The ability to activate technological processes has given humans an increasingly dominant role over nature, setting in motion an inexorable trend that has culminated in the Anthropocene, an era in which the overall material output of human activities ("anthropogenic mass") exceeds all "natural biomass" (Elhacham *et al.*, 2020). Underlying the quantitative superiority of technological products over nature is an enduring qualitative aspect. As a matter of fact, the vast majority of such products, from ancestral artefacts to handicrafts or industrial products, find their raison d'être in the extension of what can be achieved naturally. The effect of overcoming limits establishes the premises of a deep-rooted opposition between nature and artifice, in that nature imposes limits, and artefacts overcome them.

The terms of this contraposition are consistent with the polysemic character of the concept of limit itself, and the density of its meaning in relation to human existence (Ialenti, 2023). The polysemy of the term 'limit' is reflected in the semantic ambivalence of overcoming limits achieved by technological processes. Overcoming natural limits enhances human potential, also leading to our miserable conditions, at least according to the world view recognisable in Judaism and Greek mythology, at the roots of Western culture. In this approach, the artefact is not forgiven because it is the result of disobedience that has upset the idyllic balance between man and nature envisaged by the supernatural will in creation. The Tree of Knowledge in Eden, through which Satan tempts the ancestors, may symbolise the essence of the technological process (the immaterial aspects). The tamed fire, used in metallurgy and stolen from Zeus by the Titan Prometheus to give to man, may symbolise the tangible essence of the product (the material aspects). Thus, overcoming natural limits is at the root of the demonisation of technology, which has manifested itself since the advent of the First Industrial Revolution, and is always associated with sudden innovations and the ethical controversies they generate. This demonisation has been counterbalanced by the glorification of technology as an all powerful panacea in constant evolution, bent on transcending all limits. Demonisation and glorification have underpinned an enduring conflict between nature and artifice.

It should be added that in the contemporary scenarios the very notion of limit as a factor originating in technological processes has become blurred, forcing its revision or replacement. Indeed, as noted in the last quarter of the last century, such processes have lost their essence as a tribute to human needs, and have loosened their connection to specific spatio-temporal contexts (Jonas, 1979). Moreover, recent and increasingly urgent technological developments, triggered by digitalisation, have brought about disruptive changes in production, management and gov-

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01 | The "Blue Marble". The iconic photograph of the Earth taken on 07/12/1972 by the Apollo 17 space mission, which demonstrated even to the uninitiated the finite nature and fragile balance of the planet inhabited by humans (https://www.nasa.gov/image-article/apollo-17-blue-marble/; General Permission Granted)

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ernance systems, but also in the cultural roots of the concepts of Time and Space (Castells, 2010), both of which are closely linked to the concept of limit. This highlights how the concept is being challenged by flows that displace places, and by an instantaneous "timeless time", which defies measurement. In order to move beyond the simplistic contrapositions that prevailed until the last century, and in search of a methodological renewal adequate to contemporary challenges, the concept of continuum can be used to flank or even replace that of limit. Rather than focusing on contraposition as a category of thought, the tendency today is to look at the connections that can be discerned, even between domains that retain a distinguishable identity. For example, the contraposition between rural and urban domains is now considered unsuitable for describing the contemporary reality studied by Human Geography (Dymitrow, 2018). The "urban-rural continuum" is proposed as a testbed for unitary approaches that constitute a methodological "bonding agent", which can be applied to any context, such as the bioclimatic approach (Germanà, 2021).

In line with this juxtaposition or replacement of the concept of limit with that of continuum, the opposition between nature and artifice also tends to change its connotations. In the case of technological products in particular, which are essentially artificial, there is now a tendency to focus on the natural component in terms of the raw materials and energy resources used in their production. But even more significant is the shortening of the distance between the natural and the artificial, which can be seen in technological advances in the most diverse fields of application (medicine, agriculture, materials science), and which has made the argument heuristic even in the theoretical field. The artificial-natural distinction is "conceptually and empirically problematic", and reality is seen as a set of "intertwined phenomena rather than phenomena that are merely natural or merely artificial" (DesRoches *et al.*, 2019).

Areas of permanence of the concept of limit

If the limit as a factor giving rise to technological processes is in many ways a problematic concept, there are areas in which it is still fundamental today. A first area is the implementation of technological processes, which at all phases must deal with a varied set of limits, both material (resources) and immaterial (skills), which influence it, even to the point of impeding it in extreme cases. The detachment of technologies from the spatio-temporal contingent and dematerialisation are factors that tend to make the limitations affecting technological processes less easily identifiable. However, the incentive to go beyond the limits continues to be an important lever for technological innovation, pushing for more effective solutions in many respects (materials, resources and time required; achievable performance), with important consequences for the final product, as countless examples in varied application fields demonstrate.

A second area can be found in the explicit emphasis on the concept of limit that the orientation towards sustainability has placed since its inception in the last quarter of the 20th century, from the need for awareness of the "Limits to Growth" (Meadows *et al.*, 1972), to the definition of the maximum tolerable limit of global warming (UNCC, 2016).

Precisely, the awareness of the limits of natural non-renewable resources, previously considered inexhaustible (Fig. 01), helped to initiate this orientation, undermining the production paradigm consolidated with the advent of industrialisation, geared towards unlimited development, and upholding the principle of circular production. The aim is to reduce to zero the extraction of raw materials from nature, and the production of emissions and waste from processing and post-consumption.

The concept of limit in this case is well defined by objective data, which unfortunately show that the proliferation of institutional efforts, policy documents and scientific advances in recent decades have not significantly affected the trend of the global economy. Indeed, it continues to apply voracious production models that largely exceed the limits of resource reproducibility. The "circularity gap" is widening globally as the date of global "Earth Overshoot Day" continues to be anticipated. The alternative of secondary materials has fallen by 21% in five years, reaching only 7.2% of production in 2023, and «in the last six years alone we have consumed over half a trillion tonnes of materials – almost as much as in the whole of the 20th century» (Circle Economy, 2024).

Even at the other end of the linear production, the limit retains a role of precise guidance, both in reducing waste (by monitoring the "National recycling rate", the sole indicator of target 12.5 of the SDGs, to "significantly reduce the generation of

02 | As a technological tool, Icarus' artificial wings could only function at a safe distance from the humidity of the sea and from the heat of the sun (Germanà, 2025). Bas-relief "The Fall of Icarus", dated 17th century, Musée Antoine Vivenel, Compiègne, France (Public Domain)

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waste through prevention, reduction, recycling and reuse"), and in setting a limit on emissions of greenhouse gases, known to be responsible for Climate Change (CC).

Using the concept of limit, the transition from alarm bells to death knell for the planet is rapid, as demonstrated by the "Planetary Boundaries Framework" approach, a set of scientifically determined values to delineate the safety zone, as opposed to the uncertainty zone and the danger zone, with respect to nine major categories of human-environment impacts on the natural balance known in the Holocene (Rockström *et al.*, 2009). In such a framework, the concept of limit inevitably proves divisive. Indeed, in the CC approach, for example, it opens a gulf between denialism (which fuels indifference) and catastrophism (which fuels 'eco-anxiety'), both attitudes that justify inaction.

The search for CC mitigation and adaptation strategies goes beyond this gulf, in a realistic and action-oriented perspective. Unlike mitigation actions (which are considered preventive, because they aim to reduce the causes of CC and will not prove decisive in the short to medium term), the adaptation actions (which take into account the inevitable transformation of climate scenarios and tend to mitigate their effects) quickly raised the issue of their limits, in terms of environmental-physical, economic, and technological dimensions (Adger *et al.*, 2009, p. 337). Based on the recognition that adaptation can only be limited, and taking into account the multiplicity of actors and the complex variability of factors affecting adaptation, a distinction has been made between "hard" limits, that do not change, and "soft" limits, which may change over time (Klein, 2014; IPCC, 2023). In particular, soft limits change because they are "largely associated with human systems and are primarily influenced by a range of socio-economic, cultural and biophysical constraints" (Thomas *et al.,* 2021).

Beyond or within the uncertain continuum

The dilemma of whether to go beyond or stay within limits has proved to be a misleading one for contemporary technological processes. The very concept of limits is problematic. As a matter of fact, quantifying thresholds reduces the complexity of phenomena and produces segmentations rather than the interconnections that are needed today (Butera, 2021).

Awareness of limits and the need to stay within them underpinned the hypothesis of sustainable development, which the inertia of the previous economic-productive paradigm, based

03 | The turtle pushed by a sail is the symbol used during the Renaissance to depict the motto Festina lente. Fresco by Lorenzo Sabadini dated 1565, Palazzo Vecchio Firenze. Creative

| 03

on industry/consumerism pairing, proved to be a mirage on a global scale in just a few decades. Rethinking the concept of limits can help avoid overly ambitious goals, and the inaction of catastrophism or denialism, setting the scene to proceed (according to the Latin motto *Festina lente*, without delay but with caution) (Fig. 03) with small steps, «pushing for measures that are flexible and can be progressively adapted to changes in the scale of the problems and in public understanding of the situation» (Bardi, 2011).

The deepening of the limits of CC adaptation is a theme that has led to the replacement of "incremental adaptation" with "transformational adaptation", which imposes a systemic reorganisation and revision of goals and values (Klein, 2014). The same result leads us to consider technological processes within an imperfect definition, finding support in the uncertain continuum represented by the appropriate time and extent, within which Icarus' artificial wings could have worked (Fig. 02).

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NOMADIC COMMUNITY WORKSHOP TO CO-HABIT THRESHOLD SPACES

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Participating

«New technologies are constantly appearing and disappearing, offering us unfiltered glimpses of life in parts of the world we will probably never visit, much less understand», argues Lesley Lokko in introducing "The laboratory of the future" for the 18th Venice Biennale's 2023 International Architecture Exhibition, adding that seeing simultaneously near and far is also a form of "double consciousness". The introductory reflection narrates an unresolved tension, which must push us to grasp with greater depth the complexity of the contemporary global and local, human, and non-human, especially in the context of a systemic cultural project such as Participation in an international exhibition.

We are under the illusion that we can always know more and better about the other – beings, places, or lives that are distant – thanks to glances and views provided by relational digital tools which, although certainly innovative, interactive, widespread, and available, are effectively too fast and ephemeral to fully understand.

Even the staging of the classic temporary national exhibition Pavilion under the banner of self-referentiality, uprooted from both the context of origin and the context of placement, encourages the visitor to ephemeral knowledge and passive fruition, often demonstrating that it cannot or does not know how to bridge distances, rather that it sometimes seeks to amplify them, from a dualist, colonialist, often arrogant, socially unsustainable perspective.

"How will we live together?" Hashim Sarkis, curator of the previous edition of 2020, proposed a discussion on complexity by inviting participants to actively rework the soul, meaning, and value of the five individual words of the title and the concepts, which these, at once, underline and make explicit.

The contribution illustrates experiences, methods, and approaches of design in situated research-action activities, in which the academic community operates in direct contact with the territories and notably explores the research project entitled "Laboratorio Nomade di Comunità". Here Community Design applies approaches and methodologies that consider 5 main elements of the project, namely place, nature, people, values and time (Fig. 1), placing itself as a founding and propulsive part of "Ospite, Ospitante", the National Participation of the Republic of San Marino in the 2023 International Architecture Exhibition at the Venice Biennale.

Pavilion, autopoietic listening organism

In a vision that prioritises community, strategic, systemic, transdisciplinary, and hybrid design becomes a tool for social innovation and sustainable development, fostering the self-determination of local communities. Even through the vital architecture of a Pavilion, we can offer alternative ways of living generously together. We must, however, be honest and acknowledge that to gain a deeper understanding of other regions of the world (Aime, 2015), it is necessary to concretely test diversity, enriching exhibition experiences with real experiences in our own places of life or elsewhere, not just by looking, but by interacting, by listening humbly and closely.

To the concept of a Pavilion understood as a given, closed, and concluded object, alien to the context, catapulted and indifferent to the place to which it emigrates, it is necessary to counterpose the idea of a Pavilion as an open and evolving organism, a cell that intertwines with others (Ingold, 2019), that roots itself and intentionally assimilates from the place, in order to reinterpret itself and evolve, in an inclusive process of the other, in search of a kind of autopoiesis, that is, «the property that all living systems have of self-organizing and continually redefining themselves according to the relationships that exist between the elements that compose them. A system is autopoietic if it generates resources, contents, and meanings from itself and develops autonomously» (Maturana and Varela, 2001).

The project analysed is developed over three years and uses Venice as its experimental location, namely a section of the Castello sestiere – "Sestiere" identifies a name of Venetian neighbourhoods –, that is delineated by Campo San Lorenzo. The San Marino Pavilion, set up in the "Fucina del Futuro", stands as an antithesis to the traditional exhibition approach, in which the user is often a passive actor, transforming the exhibition spaces into an organic and dynamic machine of cultural and social activation. The aim is to constantly, consciously, and curiously involve citizens, children and the elderly, designers and researchers in participatory activities, meetings, confrontations, and workshops. The methodological approach integrates into a single and articulated ecosystem of intervention the study, confrontation, and design with the resident and transit population, the analysis related to value creation, the critique of project impacts on multiple levels, and the degree of involvement of the implicated communities. Not just a classic exhibition then, of solo architecture, but an experiential space of doubt, in which a slow and articulated process of studies, projects, and collective and participatory actions aims to intercept and enhance the encounter between beings from local and visiting communities. A micro threshold space between hosted institutions and host citizens, of not belonging to one or the other, a permeable place of listening in which contradictions can manifest and shape interspecies, multispecies, posthuman pollinations.

The paper highlights the role of design as a mediating agent between individuals and territory, strengthening the link between resident, temporary, and academic communities.

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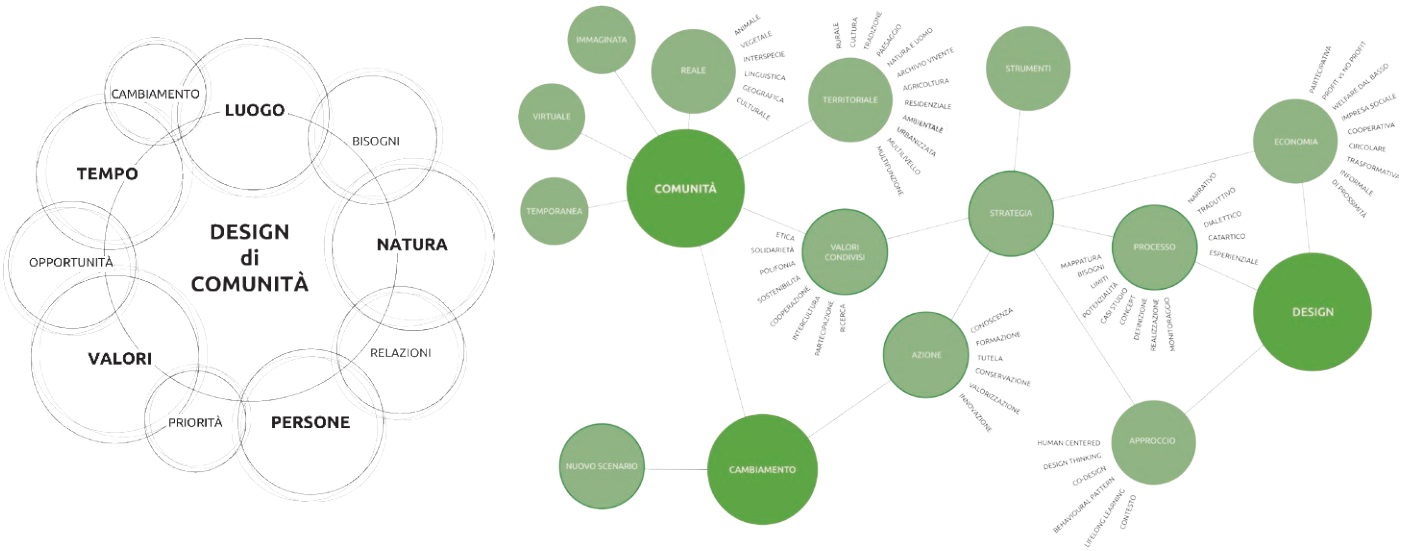


Fluid communities and indigenous projects

The effects of the capitalist-industrial development model are evident in contemporary society, where the anthropocentric vision has reduced land to a mere resource to be exploited, leading us toward an eco-catastrophic condition (Magnaghi, 2010).

For several decades now, critiques of this model have been consolidated, proposing alternative, transformative, social, and solidarity-based, localised and self-sufficient economies. Territorial planning has also begun to move in this direction, considering the anthropic context from an evolutionary perspective in which city and natural landscape are considered an integrated and systemic organism that rests on local ecological, cultural, and social resources to foster processes of self-determination of communities in the management and development of their living space (Magnaghi, 2010). Around this dialogue, design becomes a tool for identifying, recognising, strengthening local identity, and promoting sustainable social innovation processes, activating, and facilitating networks of collaborations between local actors, and generating cultural, environmental, economic, and social value (Villari, 2012).

We find it useful in this context to take the small local community as the focus of design reasoning.

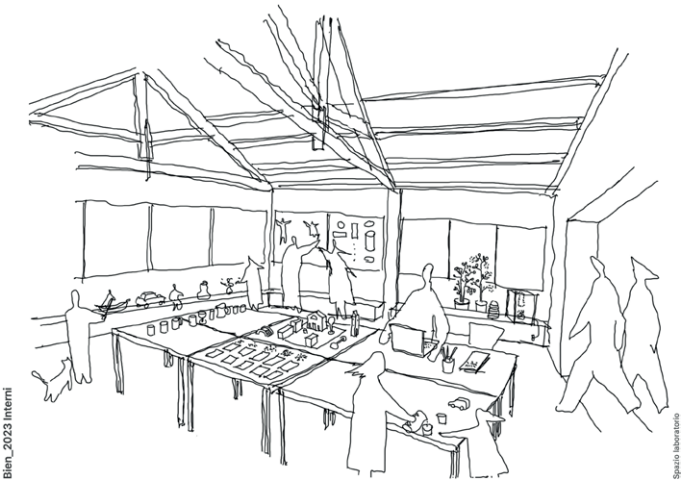
«The health of a territory, its resilience in the face of catastrophic events, its maintenance, and its very aesthetic quality require that there be a community that cares for it». Beginning in *Design When Everybody Designs*, and more recently in *Politiche del quotidiano*, Ezio Manzini clearly expounds the link between Community and place. He defines a series of factors, methodologies, registers, and guidelines. He also reminds us that there is a silver lining in today's much disquieting existential condition, which Zygmunt Bauman has called liquid modernity, hyper-accelerated, fragmented, uncertain, and progressively more complex, in which values are more fluid, volatile and seemingly elusive.

Indeed, at the local level, we can consider ourselves much freer than in the past from barriers, stereotypes, and atavistic prejudices. Hence, we can take advantage of the opportunity to feel welcomed as part of a community with which to design our present and develop indigenous participatory projects of Inclusive Design and for social innovation, taking on the concept of community as a space of opportunity.

By incorporating local resources and specificities, the community-centred approach actively engages communities in project creation, fostering a system of cooperation and participation (Villari, 2012; Varini *et al.*, 2019). Organic communities can assist in addressing the ambiguity and individualism of liquid modernity (Bauman, 2014). They are always evolving due to historical, economic, and cultural dynamics.

Villari (2018) identifies three levels of "community engagement", namely design "for, with, and driven" by the community. The first refers to structured design processes, intending to create value for a specific community by acting at a systemic level. In the second, co-design and co-creation processes involve the community in the path of territorial enhancement. In the third, design is not explicit but traceable to practices of social and political activism in which it is the community itself that adds value to the territory it inhabits. The expert designer assumes the role of facilitator, accompanying citizens in building resilient ecosystems and caring for local commons through participatory methodologies

02 | Flexible use of the Pavilion, archive and image by Riccardo Varini



and co-creation processes (Rizzo, 2009; Manzini, 2015). Design becomes an agent of environmental transformation while assuming an educational and formative role (Dalisi, 1978).

Activating and decolonising

The participation of San Marino has enhanced the capacity of educating communities to interact with learning communities, promoting the renewal of the place's material and immaterial culture, and creating new opportunities for confrontation and the development of physical and virtual networks between different actors (Varini, 2023). This area is resisting the processes of gentrification and depopulation of the inhabiting local community, still preserving many authentic forms of local Venetian life. These include small neighbourhood businesses such as tailors, hardware stores, newsstands, stores, and neighbourhood bars, as well as neighbourhood services, including nursing homes, libraries, a convent, and some schools. In addition, the Campo is used as a venue for public demonstrations and collective events. Given the peculiarities of the Sestiere, the project intentionally proposed an unusual approach of listening, integration, discussion, participation, and imagination, in which the space was transformed into a space-connector thanks to the participatory actions of the resident hosting communities, passing communities, and academic host communities (Varini, 2023).
The theoretical and applied research project revitalised spaces and common areas for seven months through a very rich series of co-design activities (Fig. 2) such as meetings, seminars, workshops, roundtables, and exhibitions, led by national and international actors – with the inaugural participation of the New European Bauhuas. The approach was embedded in four themes defined by the Pavilion curatorship, namely Community, Religion, Food, and Multi-species. Given their theoretical-practical nature, the project activities, also classifiable as academic Third Mission activities, became instrumental to the role of the University as an activator of other territories. Therefore, an initial phase of analysing evaluation models related to the same was useful, subsequently opting for an interpretation of the project through a methodological approach related to theoretical domains of social design, co-design, systemic design, and community design in which the community component plays a decisive role. With respect to these considerations, for a qualitative monitoring evaluation of individual project activities, it was decided to use the Circular Value Flower (CVF) model applied in numerous action-research activities by scholars Leclercq & Smit (2023).

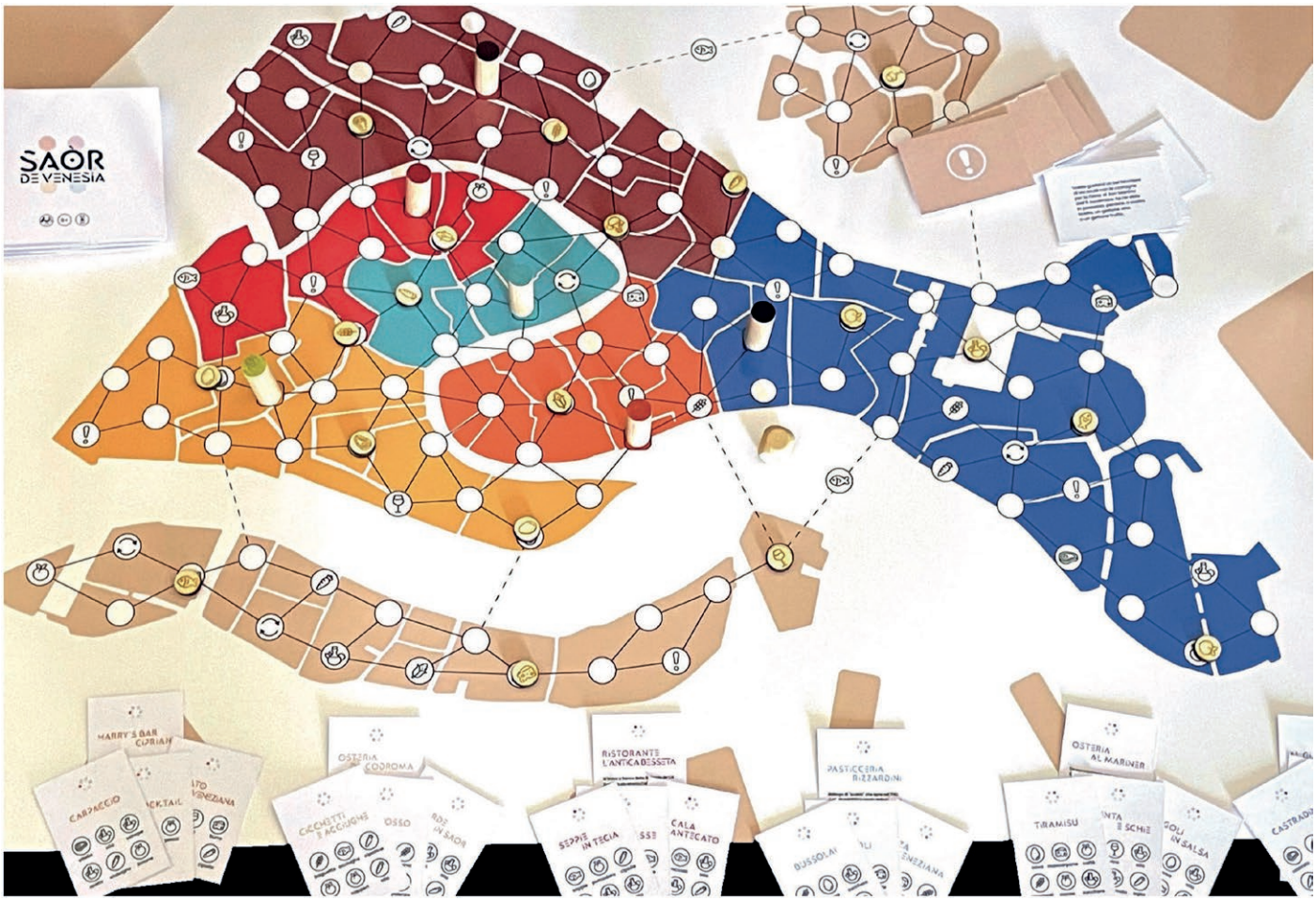
Circular Value Flower

The CVF model enables the definition of how, when, and to what extent communities can be considered virtuous ecosystems, playing a key role in the transition towards more sustainable frameworks typical of the circular economy, while promoting greater energy, social, and economic resilience. Specifically, it analyses the collaborative closure of resource cycles at the local level, highlighting value creation on multiple levels.
It is structured into five levels, with project initiators and their ambitions at the centre of the flower. The first level analyses the capital that can be activated within the community; the second examines resource cycles such as water, energy, and materials; the third identifies potential partners, including institutions, businesses, NGOs, and designers, while the fourth focuses on spatial interventions on buildings, infrastructure, and public spaces. The final level represents the values generated – social, economic, ecological, aesthetic, and cultural – offering a framework for analysing circular initiatives in neighbourhoods. The model is implemented through two diagrams. The first is a visual representation of the flower's five levels, while the second uses concentric circles to show the qualitative value of each level and the relationships between different elements. The case studies analysed through the CVF provide a visual representation of the impact that projects have on specific territories.
The impact analysis of the "Laboratorio Nomade" project was carried out in progress, initially through data collection of internal activities within the pavilion, later evaluating community engagement levels (Villari, 2018) and, finally, assessing the impact using the CVF.
The monitoring phase gathered textual, photographic, and video material, producing a database (Amatori, Guerra, & Varini, 2025) that highlighted an extraordinary sample of 36 different activities carried out over 7 months, classified using a multidigit system that includes:

- a sequential number indicating the chronological order of activities;
- one or more uppercase letters such as C (Community), R (Religion), F (Food), M (Multispecies) to indicate the macro-themes identified in the Pavilion's curatorial process;
- one or more lowercase letters such as r (research), e (event), m (meeting), s (seminar), w (workshop), and x (exhibition) define the type of activity.

03 | Board game about the flavors of Venice, Design by Y. Boui, P. Garofalo, R. Manenti, D. Passatempi, R. Varini

03 |



From the database, two activities were selected as samples for evaluation based on their typological, thematic, and temporal diversity:

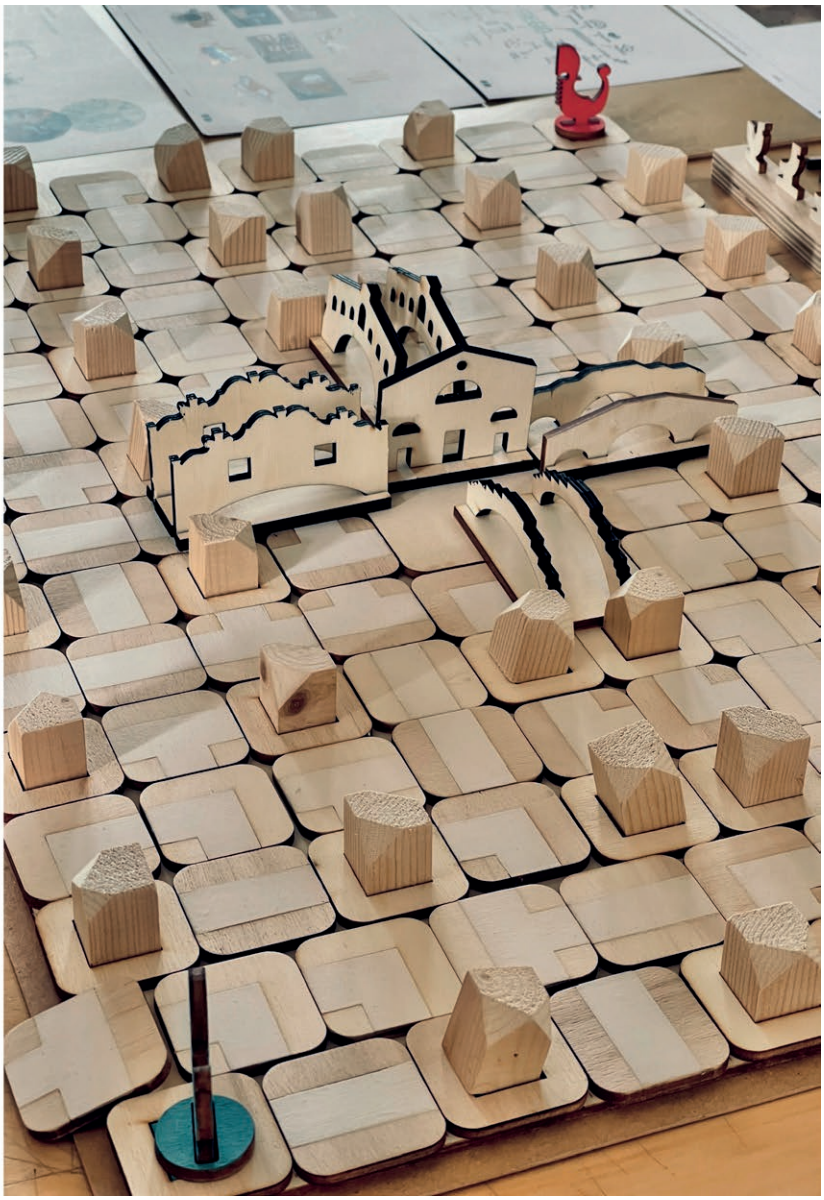
1. Food, ritual, conviviality, experience (10.1-CFw). This workshop explored conviviality, nourishment, and hospitality rituals through an analysis of the Venetian context and local food practices. Participants experimented with new ways of interacting with public space through food. The collective culinary design, presented to the community, stimulated reflections on the use of public space.
2. Fuori Tutto! (24-Ce). The final event transformed the dismantling of the pavilion into a neighbourhood market, where furniture was put up for sale to encourage its reuse within the community. Through an auction or controlled-price offers, the project promoted circularity, reduced transportation costs, and strengthened the connection with the territory, turning the end into a moment of sharing and sustainability.

The CVF model was adapted to the San Marino community hosted in San Lorenzo and, thanks to the researchers Chiara Amatori and Anna Guerra, it was integrated with the categorisation proposed by Villari (2018), which effectively assessed local community engagement. The analysed case studies reveal that the community was actively involved in the activities, reaching a medium-high level of engagement, assuming the role of promoter and activator of initiatives, as seen in the case of "Fuori Tutto!". Public space proved to be a key element in both activities, whose social value was highly representative.

Inhabiting threshold spaces

The application of the Circular Value Flower analysis model has enabled a qualitative and systematic measurement of the engagement level of both local and transient communities, showcasing how design can activate networks, enhance territorial resources, and generate significant social and cultural impacts.

04 | Board game about the urban planning of Venice, Design by G. Cianca, P. Garofalo, E. Marchi, E. Scarpellini, R. Varini



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A crucial aspect that emerges is the need to develop tools for monitoring impacts over different time frames, to understand whether and how the effects of activities take root within communities and the territory. The issue of generated value and its measurement remains an open field of research, requiring a multidisciplinary dialogue between eco-design, sociology, economics, and urban studies.

The Biennale experience has also sparked critical reflection on the system of international exhibition events, which operate within a hierarchical rationale often detached from local contexts, while also providing alternative opportunities for co-generation, creating spaces for integration and transformation. Thus, anthropological, and sociological contributions are becoming increasingly relevant to design knowledge, fostering horizontal approaches to the biographical, collective, and institutional dimensions of the relationship between the self, the other – whether a person or an object – and action, in a continuous and negotiated dialogue.

From this perhaps unconventional approach to design, we like to imagine that a new, authentic, and deeper sense of care

for people may emerge, acknowledging their specificity and uniqueness. This also includes special attention to those transitional spaces between cultures and different contexts, which communities ultimately represent – threshold spaces between public and private, nature and artificiality, city and architecture, centre, and periphery, urban and rural, South and North.
As Burckhardt suggests, it is possible to reactivate both the client and the user– not in the sense that we now expect them to produce deterministic and fixed programmes, but rather that they too may contribute to defining only what is necessary, leaving space for those who will participate in the process in the future to express their views.
The context of Insula of San Lorenzo, within the vibrant Sestiere of Castello, appeared to be the ideal setting for hosting the San Marino National Participation at the 2024 Biennale, thanks to its distinct characteristics as an urban threshold space, a historical crossroads between the institutional core of Piazza San Marco and the artisan area of the Arsenale, between the distracted tourist and the proud, deeply rooted local community.

ACKNOWLEDGMENTS

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Digital enjoyment and local identity: an integrated pathway for psychophysical well-being

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Abstract. This research investigates innovative strategies and presents experimental insights to enhance cultural and landscape identity through the integrated design of naturalistic paths and digital tools, such as UAS and Virtual Tours. The objective is to develop a holistic model of cultural engagement that combines on-site physical experiences, immersion in nature, and in-depth knowledge acquisition. Particular attention is given to the exploration of distinctive decorative elements, such as ornamental motifs found on elevated architectural structures, which are often difficult to access. The proposed model, exemplified through its application to the Amalfi Coast, serves as an adaptable framework for the sustainable value enhancement of other territorial contexts with similar landscape and cultural characteristics.

Keywords: Identity; Natural pathways; Psychophysical well-being; Amalfi coast; Interlaced arches.

Introduction

In recent years, there has been a growing focus on innovative design projects aimed at enhancing territorial Heritage Identity. These initiatives are not only intended to promote individual and collective well-being but also to preserve the cultural and historical identity of places. This approach often involves the application of digitisation processes leveraging advanced technologies for data acquisition and communication. Such tools make it possible to virtually access otherwise inaccessible or difficult-to-reach locations, thereby expanding opportunities for cultural and environmental connectivity.

This study aims to explore two main directions. Firstly, it examines the integration of digital technologies with natural environments to redefine how these spaces are experienced, while simultaneously fostering an understanding of local identities and encouraging new lifestyles rooted in a renewed harmony between individuals and the natural world. Secondly, it emphasises the adoption of slow and immersive practices, such as wellness walks, which foster meaningful connections and contribute to psychophysical well-being.

The Amalfi Coast, with its unique blend of natural landscapes and historical architecture, serves as an ideal case study for these reflections. It stands as a quintessential example of Heritage Identity, characterised by distinctive decorative motifs located at the top of architectural elements such as bell towers and apses, which are often challenging to observe in detail from the ground (Fig. 1).

To overcome this limitation, this research advocates for the use of non-invasive digital technologies, such as Unmanned Aerial Systems (UAS), to capture detailed, spherical images and three-dimensional data.

The integration of cultural acquisition with psychophysical well-being is concretised through the design of a virtual tour along a specially curated route. This tour aims to offer participants a comprehensive cultural and natural immersion experience, demonstrating a replicable model for the sustainable enhancement of other regions with similar cultural and environmental characteristics.

The use of these technologies prompts additional considerations regarding the remote accessibility of such cultural assets. By addressing physical barriers, it broadens the concept of accessibility through a mutual exchange of perceptions between the real and the virtual. For example, this could involve installing fixed optical sensors in architecturally or environmentally significant locations. These sensors could reproduce real-time, immediate, *hinc et nunc*, perceptions of the surroundings and/or intricate details.

Such multidimensional approaches not only enhance the understanding of the hidden details of local heritage but also strengthen the emotional connection to the territory. Participants, often unaware of the rich cultural and natural assets surrounding them, can uncover new meanings and deepen their sense of belonging. This fosters more responsible and attentive behaviours towards the conservation of heritage.

Hence, a return to nature not only provides a refuge from the alienation and hectic pace of contemporary Western lifestyles but also serves as an educational tool. It raises awareness of sustainable actions essential for safeguarding our species and the planet.

Wellness paths for the knowledge and enhancement of territorial identity: state of the art

It is plausible to assert that contemporary society's disconnection from the natural world has its roots in a gradual historical process, which intensified during specific periods and likely peaked in the 20th century. During this era, urbanisation accelerated significantly, and the advent of advanced technologies progressively diminished the necessity for direct interaction with nature in the performance of daily activities. In this context, the increased consumption of natural resources was accompanied by a growing detachment from their origins, fostering a perception of nature as something extraneous and irrelevant to human existence.

This growing alienation from the natural environment, coupled with the tendency to spend most of one's life in enclosed, sterile, and unstimulating spaces, has led to a loss of cultural connection with the surrounding territory and serious repercussions on mental and physical health. This phenomenon, termed "nature-deficit disorder" (Louv, 2005), transcends individual discomfort, carrying profound implications at a societal level.

In response to this situation, the necessity of re-establishing an

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01 | Geolocation of Intertwined Arch Architecture in the Amalfi Coast, elaboration by R. Iaderosa and M. Cicala

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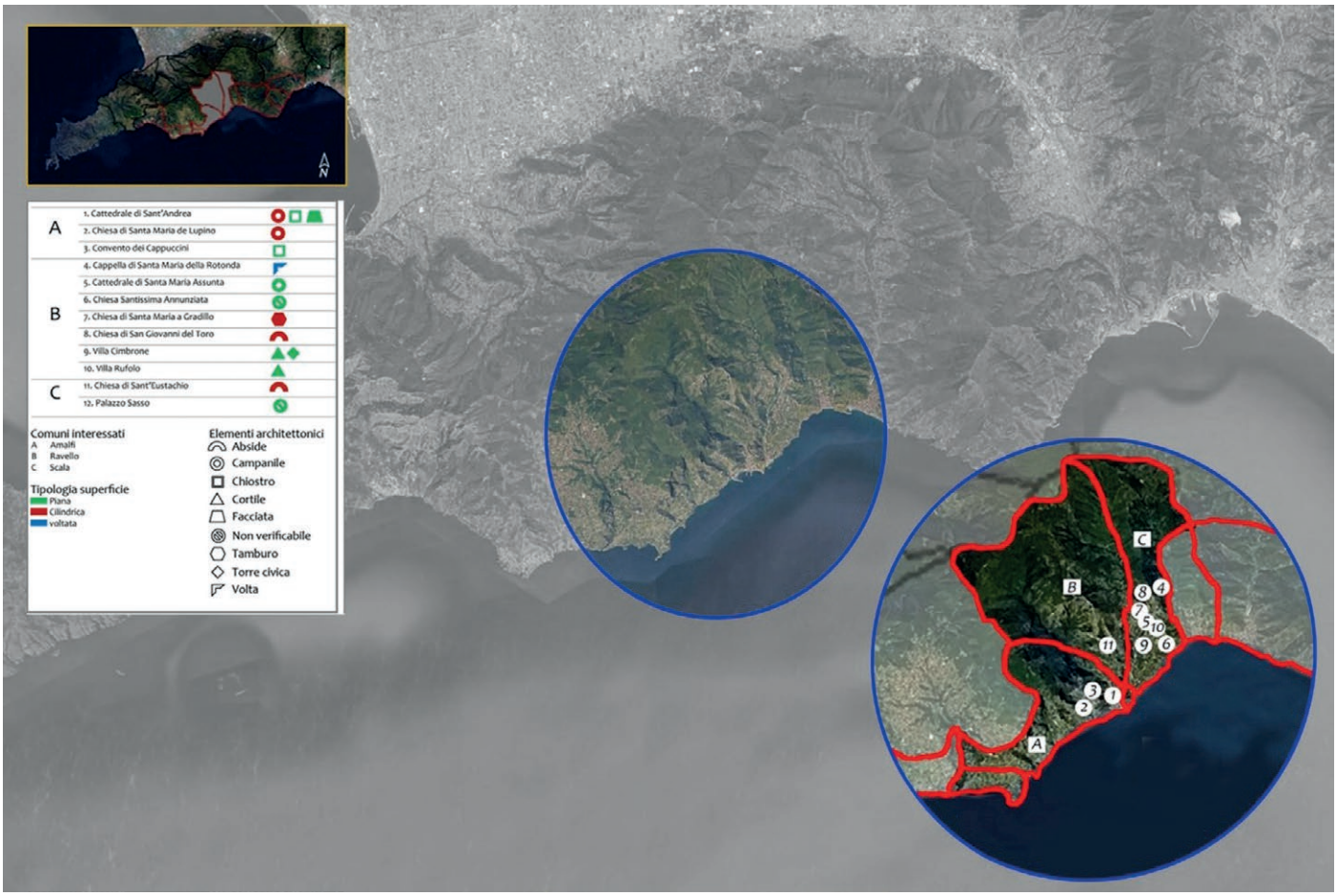


authentic connection with nature emerges not only as a matter of personal well-being (Wilson, 1984) but also as a response to a broader global ecological crisis. Returning to nature entails rediscovering an ancestral bond with the environment and fostering a renewed sense of empathy toward it, an essential prerequisite for adopting sustainable behaviours and promoting the rediscovery and appreciation of local territories.

Forest Therapy, a practice originating in Japan under the name *Shinrin-Yoku* (forest bathing), exemplifies how a return to nature can be systematically organised to maximise its benefits (Bradley, 2018; Yoshifumi, 2018; Felber, 2020). Originally designed to enhance physical and mental health through mindful immersion in forested environments, this practice has inspired similar approaches in various global contexts. In Europe, such practices have been further enriched to include educational pathways, knowledge-sharing experiences, and interactive methodologies. A notable example is Italy's educational forests, which merge sensory experiences with activities aimed at teaching biodiversity and environmental sustainability. Similarly, the UK's *Nature Connection* programmes integrate individual well-being with cultural and environmental understanding of the landscape (Richardson *et al.*, 2015; Lumber *et al.*, 2017). These approaches extend beyond immersive natural experiences to structured, multidimensional pathways that promote a deeper understanding of the territory, its ecological uniqueness, and its cultural significance.

By combining well-being with knowledge, these initiatives bring participants closer to both the natural world and the complexity and richness of their surroundings. This fosters an emotional and intellectual bond that enhances awareness and empathy toward environmental stewardship.

At the European level, a distinguishing feature of these practices lies in their adaptability to diverse territorial contexts, emphasising local peculiarities. Nature walks offer participants a unique opportunity to broaden their awareness by engaging with new perspectives and deepening their understanding of

02 | Synthesis Image of the Multimedia Communication of the Study Research, elaboration by R. Iaderosa and M. Cicala

| 02

familiar places. The educational component of these pathways is equally significant, as it promotes ecological values and encourages sustainable behaviours, laying the foundation for a more mindful and respectful relationship between individuals and the environment (Kaplan and Kaplan, 1989).

However, to ensure that the reconnection process with nature is genuinely effective, it is essential to base it on well-defined protocols. These protocols should combine sensory stimuli, opportunities for personal and communal reflection, and cultural insights into the locations traversed. The absence of a clear methodology risks not only diminishing the psychophysical benefits but also undermining the broader goal of fostering knowledge and safeguarding the territory.

The potential of such practices has been significantly enhanced through transdisciplinary approaches and the integration of digital technologies. These innovations have extended the experience beyond the physical moment of the walk itself, offering new avenues for interaction and engagement with natural and cultural heritage.

The use of apps, online platforms, virtual tours, interactive maps, and multimedia content enables participants to access additional information about the sites they visit. Furthermore, it is essential to clarify that the long-term maintenance of these technological systems requires the development of an integrated management and updated strategy. This entails defining protocols for periodic monitoring of both hardware and software, as well as adopting modular and scalable solutions. Such solutions will enable the proposed model to be adapted to different territorial contexts, ensuring its replicability and continuous updating of the technologies in use, in line with technological advancements and local specificities.

While digital technologies have historically been associated with detachment from nature, contemporary scientific discourse has highlighted their potential to foster reconnection with it. From a psychophysical well-being perspective, research has shown that immersive and/or virtual experiences, when combined with physical presence in nature, can enhance the restorative effects of walks. This approach uniquely enriches the understanding of less visible elements of the landscape and local architecture.

For instance, integrated digital surveying techniques allow for the collection of extensive quantitative and qualitative data on architectural and natural features along pathways that are difficult or impossible to access physically. These data, processed using established or innovative methods, can be transformed into three-dimensional models and/or interactive representations accessible either on-site or remotely. This capability addresses the growing need for global accessibility, regardless of physical challenges or geographic distance from points of interest.

Well structured virtual tours that prioritise visual and sensory details, such as panoramic views, architectural highlights, and significant landscapes, could engage multiple senses, including hearing. However, replicating the full wellness experience remotely remains a challenge, underscoring the need for further exploration in future studies.

This study focuses on the opportunities that digital technologies provide for making complex and hard-to-access architectural elements, such as the ornamental patterns of intertwined arches in the Amalfi Coast, accessible and comprehensible (Fig. 2).

The concept of overlapping and interweaving circular elements, while reaching its peak in Islamic art and Maghreb-Hispanic culture, has roots in classical traditions. Specifically, the intersection of two circles passing through each other's centres forms the *vesica piscis*, or "mystical almond", a geometric figure imbued with spiritual and cosmological significance. This motif traverses epochs and cultures, evolving within diverse contexts. In Byzantine and Romanesque traditions, the intertwining of arches took on greater symbolic and figurative significance, extending from the decoration of objects to complex architectural surfaces. A quintessential example is the Great Mosque of Córdoba (784 CE), a hallmark of Islamic art in Spain, where interlaced arches merge structural and decorative functions. This integration creates a visual dynamism that conveys both solidity and lightness (Gámiz-Gordo *et al*., 2021; Cantizani Oliva *et al*., 2023

Over time, the architectural use of interwoven arches evolved from a structural element into a purely ornamental feature, characterised by a progressive fragmentation of form. This evolution culminated in the emergence of the lattice motif, where the intricate subdivision of geometric surfaces reflects the aesthetic progression of Islamic art. Architectural decoration in this style acquired a distinctly geometric character, exemplified in the stunning works along the Amalfi Coast.

Notable instances include the Cloister of Paradise in Amalfi (1266–1268) and the courtyard of Villa Rufolo in Ravello (late 13th century), where the interwoven arch motif achieves a harmonious balance between elegance and complexity. These examples illustrate the integration of cultural influences into a local architectural language, enhancing the heritage identity of the region.

Transposing this motif onto cylindrical or curved surfaces poses greater complexity, as the geometric structure must adapt to the volumetric peculiarities of the form. In such cases, the en-

gineering challenge intertwines with sophisticated aesthetics, resulting in unique configurations, such as the intricate interweaving found on the bell tower of the Amalfi Cathedral. The creation of such solutions demands an in-depth study of proportions and intersections, highlighting the intrinsic connection between art and mathematics that characterises the entire development of interlaced arches.

Furthermore, the ability of these interwoven arches to harmonise functionality with meaning makes them a central element of architectural heritage, worthy of further study and enhancement (Zerlenga, 2008). These structures, often concealed by dense natural surroundings or located in remote areas, present a challenge for direct observation. As a result, the use of technologies that enhance their accessibility and appreciation becomes essential, allowing these masterpieces to be more fully appreciated and understood in their historical and aesthetic contexts.

Naturalistic and Digital Paths Between Nature and Culture: Enhancement and Accessibility of Intertwined Arches

The Amalfi Coast, with its extraordinary synthesis of natural and cultural heritage (Zerlenga, 2006), serves as an ideal laboratory for the development of innovative territorial enhancement models. Recognised by UNESCO as a World Heritage site, this region stands out for its harmonious integration of landscapes of natural beauty with architectural elements of priceless historical and artistic value, capable of evoking a deep contemplative and regenerative dimension.

In this context, the design of integrated routes that combine natural exploration with the conscious enjoyment of architectural heritage effectively addresses contemporary needs for accessibility and the promotion of psychophysical well-being (Kaplan and Kaplan, 1989).

The immersive experience in the landscapes of the Coast, characterised by mountainous ridges, cultivated terraces, and panoramic sea views, stimulates documented benefits for human well-being, promoting relaxation, stress reduction, and a profound sense of connection with the natural environment. At the same time, the interaction with the architectural heritage, through the discovery of interwoven arches on curved surfaces, enriches the cultural experience. These arches, known for their geometric complexity and high symbolic value as evokers of universal concepts of harmony and order, become the focal point of an ongoing experimental study that combines tradition and innovation.

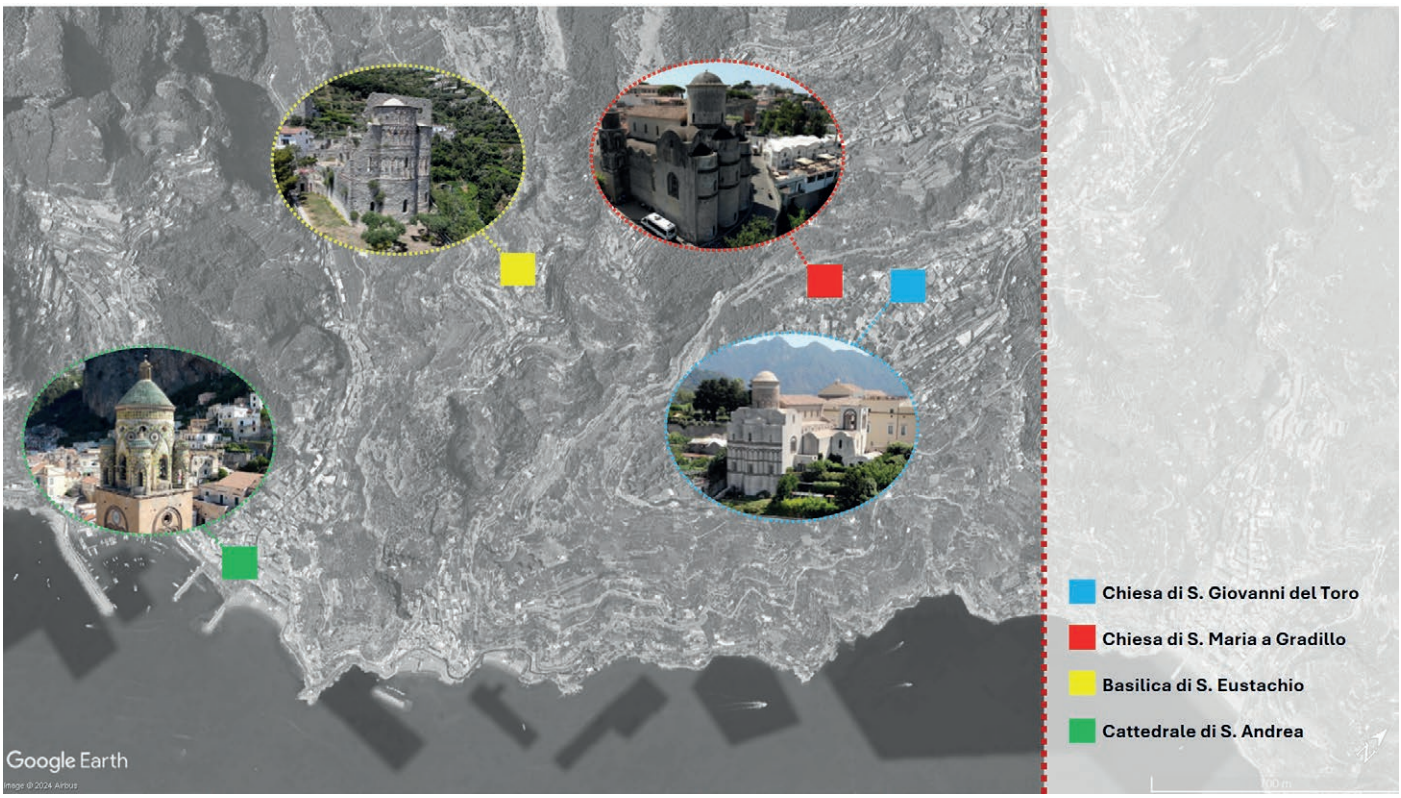
Often located in elevated or remote positions such as bell towers, apses, and drums, the interwoven arches have limited physical accessibility, necessitating the adoption of an interdisciplinary and technological approach. Their enhancement requires not only the use of advanced methods for knowledge acquisition, such as digital remote surveying via aircraft (Galasso and La Placa, 2020), but also the design of experiential strategies that stimulate psychophysical well-being through movement, contact with nature, and cultural enrichment. This dialogue between physical and virtual experiences not only facilitates access to cultural heritage but also contributes to creating a holistic dimension of well-being, where aesthetic contemplation and personal regeneration intertwine.

The proposed study suggests a structured itinerary connecting four iconic sites on the Amalfi Coast, namely the cylindrical drum of the Church of Santa Maria a Gradillo, the apse of the Church of San Giovanni del Toro, the ruins of the Basilica of Sant'Eustachio, and the bell tower of the Cathedral of Sant'Andrea (Fig. 3). Each site has been carefully selected not only for the historical and artistic significance of the interwoven arches that define it but also as the representation of a harmonious interaction between cultural heritage and the surrounding natural context. This itinerary follows existing natural trails, offering unique panoramic views of the Mediterranean, where different cultures have produced architecture characterised by different typological and aesthetic models (Clévenot and Degeorge, 2000), immersed in the scents and sounds of the Mediterranean scrub. These paths not only foster a deep connection with the natural environment, with documented beneficial effects on psychophysical well-being, but also allow for the rediscovery of the architectural richness of the territory through an enriching and inclusive cultural experience.

The first stop on the itinerary leads to the Church of Santa Maria a Gradillo, located in the historic centre of Ravello, at an altitude of about 365 metres above sea level. The cylindrical drum of the church stands out for its interwoven arches arranged in a rotational symmetry of order eight, representing a prominent example of medieval decorative art. The arches, characterised by intersecting skewed curves, create a visual effect of dynamic continuity, symbolically evoking the concepts of cyclical cosmic harmony. This geometric complexity is not incidental but reflects careful design based on harmonic proportions and mathematical models typical of medieval architecture, linking aesthetic and symbolic dimensions.

The second stop is at the Church of San Giovanni del Toro, also in Ravello, located at about 380 metres above sea level. The triple apse of this structure is embellished with two-tone interwoven arches made by alternating yellow and grey tufa blocks in a carefully calibrated sequence. This bichrome pattern not only enhances the perception of depth and movement but also highlights the close correlation between form and function, giving the arches an aesthetic and symbolic value that transcends mere decoration. The harmonious curves of the arches, perfectly in-

03 | Identification and Graphic Visualization of the Architectural Foci Along the Path, elaboration by R. Iaderosa and M. Cicala



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tegrated with the apse structure, direct the gaze upward in an ascendant movement symbolising spiritual aspiration.

The third stop is at the ruins of the Basilica of Sant'Eustachio, in the town of Scala, at about 580 metres above sea level, the highest point of the route. The triple apse of the basilica is adorned with interwoven arches enriched by bichrome inlays that emphasise the complex geometries of the arches through a studied chromatic contrast. The arches, conceived as an integral part of the structure and not merely as ornaments, embody a symbolic meaning related to the concept of interconnection between cultural and natural elements. The precision of the geometric configurations testifies to the high technical and theoretical level reached, capable of translating mathematical and symbolic principles into architectural forms.

The final stop leads to the bell tower of the Cathedral of Sant'Andrea in Amalfi, located about 20 metres above sea level. The interwoven arches of the uppermost order of the bell tower are enhanced with polychrome maiolica in green and yellow, reflecting a synthesis of Eastern and Romanesque stylistic influences. The rhythmic arrangement of the maiolica and the complexity of the skewed curves of the arches create a decorative motif that symbolically evokes the eight point star, a cosmic representation of universal order and harmony. This bell tower stands out not only as an architectural symbol of the city but also as a masterpiece of balance between decoration, structure, and spiritual meaning.

The study of these architectural elements required the use of indirect surveying techniques for their documentation, driven by several methodological and practical considerations. The interwoven arches are often located in elevated and difficult-to-access positions, such as on drums, apses, and the upper orders of bell towers. Their geometric complexity and the delicacy of the decorations necessitated an approach that would avoid invasive interventions, which could potentially damage the historical structures or the surrounding landscape. The use of digital photogrammetry played a crucial role in generating high resolution three-dimensional digital models, capturing geometric, chromatic, and material details with a level of precision unattainable through traditional techniques (Fig. 4).

This approach not only enabled faithful documentation of the current state of the structures but also allowed for the analysis, through geometric reconstructions, of the proportions and relationships underlying the design of both planar and skewed interwoven arches (Zerlenga *et al.* 2022), which are characterised by their decorative motifs closely bound to the surface on which they lie (in the case of the curved type studied) (Migliari, 2003;

04 | GUI of the Virtual Tour – Lapentor software, , elaboration by R. Iaderosa and M. Cicala

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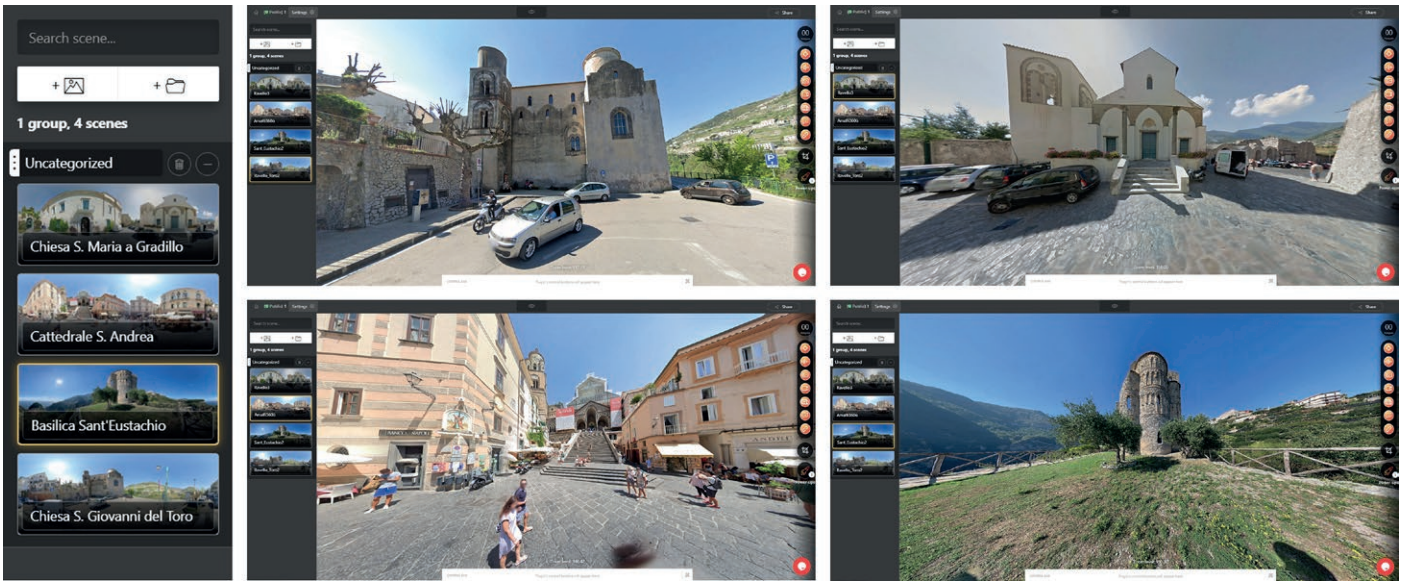


Sgrosso, 1996), as well as the rhythm regulated by symmetries of different geometric natures (translatory and/or rotational) (Weyl, 1962).

This phase of knowledge and reconstruction will be integrated along the naturalistic paths connecting the sites of interest via a network of stations equipped with QR codes, designed to provide immediate access to high definition multimedia content, including detailed 3D models and interactive virtual tours. This technological solution aims to complement the exploratory experience on-site with advanced digital tools, enabling an experience that transcends the limits of direct perception and offers an in-depth analysis of the architectural and decorative components. Visitors will be able to explore geometric and material details, often not visible to the naked eye, in a context that combines scientific rigor with educational outreach. This approach represents an innovative model for heritage enhancement, capable of enhancing knowledge and accessibility through a synergy between physical and digital experiences (Figs 5, 6).

In conclusion, the adoption of indirect surveying techniques not only preserves the integrity of historical sites but also expands the possibilities for access and enjoyment of heritage. The digital documentation produced serves as an essential resource for research, and helps overcome physical barriers, ensuring inclusive access, even remotely. This approach fits within a model of sustainable enhancement, where technology is not merely an operational tool but becomes a means to foster continuous dialogue between individuals, architecture, and landscape.

From an educational standpoint, this interdisciplinary approach provides an effective platform for the dissemination and awareness of heritage. The combination of physical and digital exploration helps preserve the integrity of places, while expanding the opportunities for interaction. Furthermore, remote accessibility democratises the experience, making it available even to those who cannot physically reach the sites. This strategy highlights digital technologies as crucial tools for promoting widespread knowledge and shared responsibility toward heritage.

The intertwined arches of the Amalfi Coast, symbols of a dialogue between tradition and innovation, assume a new role in contemporary cultural narratives. This model, integrating physical movement, knowledge, and well-being, addresses the needs of responsible tourism, aimed at reducing environmental impact (overtourism) while maximising social and cultural benefits. Furthermore, the interdisciplinary approach adopted for enhancing the intertwined arches serves as an adaptable model of excellence in the fields of cultural and landscape sustainability, laying a solid foundation for future applications in similar contexts.

Conclusions

This study explored the potential of an integrated approach that combines advanced digital technologies with naturalistic paths aimed at enhancing landscape and cultural heritage. The intertwined arches of the Amalfi Coast, expressions of a decorative tradition blending Byzantine, Islamic, and Romanesque influences, are at the core of an analysis that highlights not only their historical and artistic value but also their role as mediators in a new relationship between culture, nature, and well-being.

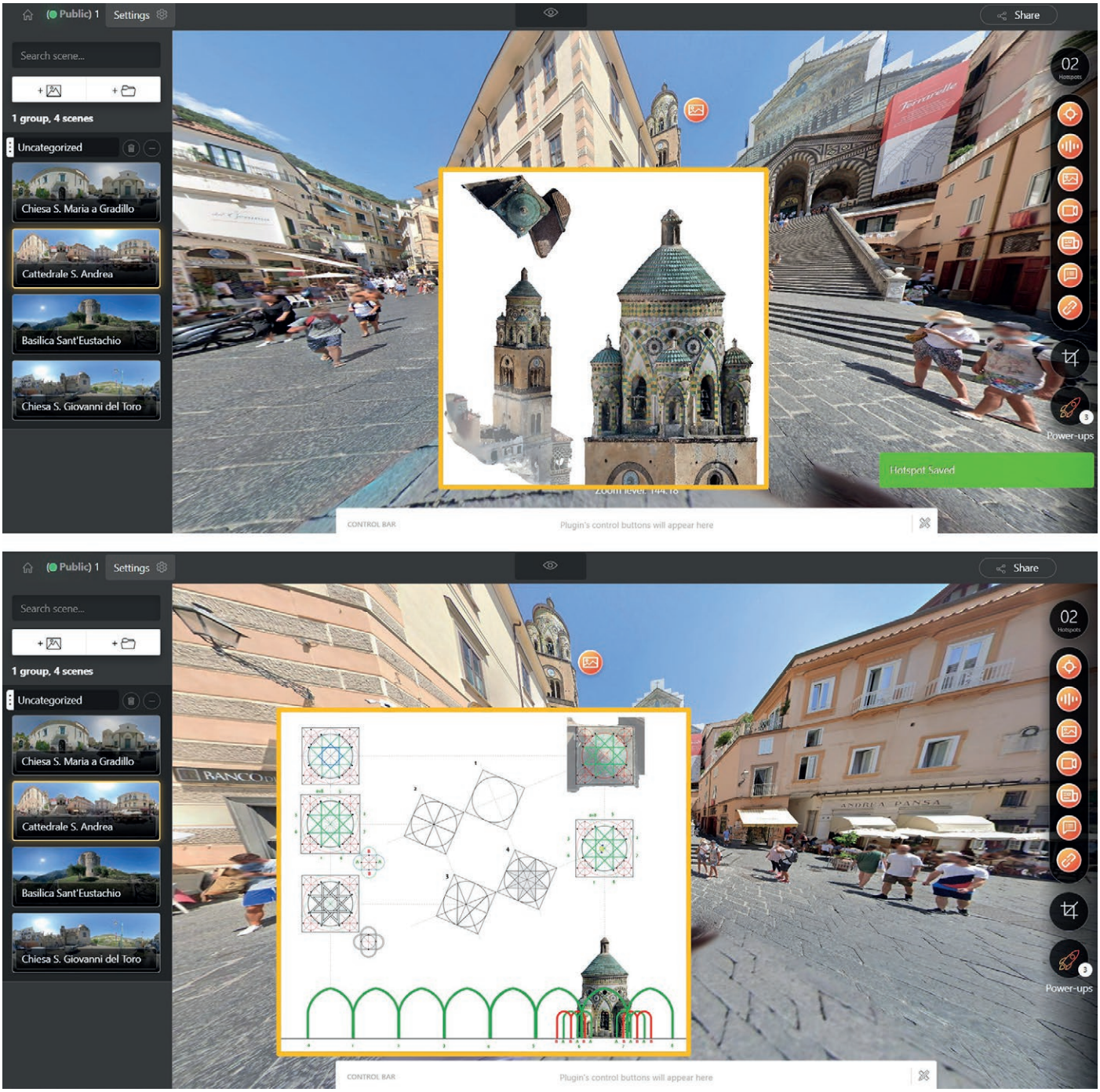
05 | GUI of the Virtual Tour – Basilica of Sant'Eustachio in Scala (SA). Image hotspot: a) textured polygonal model; b) study and geometric analysis of the ornamental motif, elaboration by R. laderosa and M. Cicala

Their digital representation, integrated into the design of itineraries connecting sites of great landscape and cultural significance, allowed the development of an experiential model capable of addressing contemporary needs for accessibility, sustainability, and inclusiveness. Walking along the paths of the Coast, immersed in Mediterranean landscapes, the scents of the Mediterranean scrub and the sound of the sea stimulates a sense of psycho-physical regeneration.

This effect has been further enhanced by the ability to access three-dimensional models and virtual tours of the intertwined arches, made available through strategically placed QR codes along the pathways. This process aims to demonstrate that the enhancement of cultural heritage should not be limited to mere material preservation but should also include contemporary narratives capable of fostering dynamic interaction with the public.

06 | GUI of the Virtual Tour – Cathedral of Sant'Andrea in Amalfi (SA). Image hotspot: a) textured polygonal model; b) study and geometric analysis of the ornamental motif, elaboration by R. Iaderosa and M. Cicala

06 |



Although the experimentation has already sparked interest among residents and tourists, providing initial qualitative insights into their engagement, a systematic data collection has not yet been conducted. To deepen the analysis of the impact of this initiative, the next phase of the research will include the administration of a specifically designed questionnaire. This tool will allow for the collection of both quantitative and qualitative data on public perceptions, usage patterns, and levels of engagement, contributing to validating the effectiveness of integrating physical experiences with digital tools in cultural heritage enhancement.

Indeed, it is believed that adopting a participatory approach, supported by a solid empirical data foundation, is essential for developing replicable models in other cultural and landscape contexts. From this perspective, the digital representation of the intertwined arches of the Amalfi Coast is not merely a virtual

transposition but holds a symbolic value of sustainability and regeneration. It promotes harmonious interaction between tradition and innovation, outlining potential developments for future approaches to the enjoyment and preservation of cultural heritage.

ATTRIBUTION, ACKNOWLEDGMENTS, COPYRIGHT

The chapters *Introduction* and *Conclusions* were written by Ornella Zerlenga; chapter one *Wellness Paths for the Knowledge and Enhancement of Territorial Identity: State of the Art* was written by Rosina Iaderosa; chapter two *Naturalistic and Digital Paths Between Nature and Culture: Enhancement and Accessibility of Intertwined Arches* was written by Margherita Cicala. Images and sections not directly cited should be considered as equally created by the authors.

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Spacecraft for well-being. Heritage, design, renewable sources for new lifestyles

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Abstract. The paper describes the design method developed by the multidisciplinary research group comprising Heritage design, Ecodesign, Home Automation and Renewable Sources for the design of small demountable structures. The design process is characterised by attention to aspects related to health and well-being in order to orient contemporary habits through the use of spatial devices capable of distracting attention from the ways of continuous connection with the digital world. The "spacecraft", small dismountable structures, characterised by home automation systems, renewable energy and sustainable materials, can constitute a "joyful spatial system" for manual making, listening to stories between different generations, cultivating cultures and reading books. They are designed to support the functions carried out in public buildings with specific uses, such as hospitals, social centres and retirement homes.

Keywords: Spacecraft; Eco-design; Home automation; Renewable sources; Cultural heritage.

The systemic approach of eco-design

Eco (*ôikos*) is the prefix for the composition of words derived from Greek used in modern times, namely house, family and social organism. Hence the heterogeneity that characterises the definition of eco-design. It is the design of a product, a social or economic system, respecting the environment, both concerning dimension, having to deal with the territory, and subject, for the necessary knowledge and/or relationship with the environmental characteristics where the artefact will be located, up to the use of appropriate materials for the project (Morelli, 2024). In the early 1970s, the debate on environmental issues was characterised by heterogeneous expressions, including scientific studies, political activism, movements and associations. There was a growth in the attention of biologists, physicists, demographers, and doctors who quantitatively evaluate the unsustainability of urban development, besides the emergence of a political sentiment as a form of commitment to the defence of collective health, questioning the myth of progress and unlimited prosperity with respect to technological and scientific innovations. Indeed, already in the sixties the interest in the defence of the environment had shifted from nature conservation through Pro Natura, Italia Nostra and WWF Italy, to the fight against pollution, the impoverishment of natural resources, and the increase in population (Formia, 2023).

Current eco-design practices such as reduction, reuse, maintenance, recycling, dematerialisation of the product-service (Violano, 2024), use of renewable energy, minimisation of polluting emissions, choice of materials, analysis and their certification, contribute, among others, to the Bill of Rights for the Planet, developed during EXPO 2000 in Hanover (McDonough, 1992; McDonough and Braungart, 2010), namely the 17 Sustainable Development Goals. Eco-design observes how design has contributed to the implementation of these sustainability goals (Chou, 2021) and some manifesto-texts, giving a holistic vision of "making design in a sustainable way", from Pope Francis' Encyclical *For the Care of the Common Home* (2015) to *The Assisi Manifesto* (2020), which sees among the first signatories the Symbola Foundation, the Sacred Convent of Assisi, Institutions, Companies and Banks of international and national importance.

The echo of history

A reflection on the relationship between man and nature that follows Henry David Thoreau's pioneering reflections on green thought stems from the analyses G. Perkins Marsh presented in his book *Man and Nature*, published in America in 1864, translated and published in Italy in 1870 (Marsh, 1864). Looking at the American situation, Marsh described for the first time the enormous damage that had occurred in nature due to anthropic intensification, which was producing worrying phenomena of desertification and deforestation, launching his warning not to repeat similar destructions in the Mediterranean landscape, from which he hoped to draw a valuable lesson for future generations (Settis, 2017). Marsh, who settled for about two decades in Italy, defined the intensive exploitation of the land for the expansion of "land occupation in cities" a growing phenomenon that well described the significant repercussions in terms of landscape occupation and evident changes in the relationship between individual property and the common good. The macroscopic movement of land colonisation in America had been accompanied in Europe by massive industrialisation, with immediate consequences for air and water pollution, evoked in literature in the smoky and grey image of the imaginary city of Coketown in C. Dickens' 1854 masterpiece *Hard Times*. It would later be J. Ruskin who would prophesy the imminent dangers for nature and the need for a concerted effort in its defence. The fumes of the factories were changing the natural colours of the London sky, and in these artificial thickenings he glimpsed the bewilderment of an entire society in the making, identifying in the uncontaminated landscape, in the beauty of nature, and in the values of history the sources of a strong moral lesson in recalling a civic responsibility of the community, to which the new protectionist movements were turning (Beltramo, 2019).

Examples of socially progressive human interventions that did not prevail over nature, but on the contrary were in dialogue with it, were already to be attributed to the Shakers, a religious community active in the American Northeast in the eighteenth century. A great spirit of utility derived from the values of sim-

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plicity and commonality tended to enhance the sincerity of the materials available, cherry and maple woods, wicker and natural fabrics. It was the crisis of agriculture in the second half of the nineteenth century that directed the Shakers in the search for new forms of livelihood, similarly connected to nature, which pushed them towards the foundation of chair factories and the production of wooden objects (Vitta, 2011).

With a rare ability to align functionalism and transcendence, experimenting with an aesthetic code destined to last over time, the Shakers aimed to create heaven on earth, an earthly paradise within which the useful and the necessary aspired to embody both spiritual and physical beauty. However, the romantic idea of *homo faber*, capable of building objects of survival and drawing just enough on nature, was destined to vanish under the shock wave of modernisation, not only of production processes, but also of markets and economies on a global scale. With the division of labour, even the creative mind and the hand that makes are almost definitively dissolved. In the world of design, the solitary figure of the designer, who embodied art and technique in a single entity, would soon be replaced by that of multiple specialised actors who were entrusted with the task of generating projects intended to meet the generalised needs of a vast and unspecified audience of users. The transition from the handcrafted one-piece to the large series of industrial production would not only make the objects the result of a lucid design programme aimed at following the demands of the market, but would definitively remove them from the rationale, availability and times of nature. «From then on, designing the world», Vitta states, «meant above all building it, embodying it in matter and energy so that the human being could find satisfaction with it» (Vitta, 2011).

Within this evolutionary framework, the very origin of the dichotomy between design and eco-design can be traced back to Richard Buckminster Fuller for whom design integrated with technology could really revolutionise construction and, at the same time, improve human life. Fuller, a scientist and thinker beyond the boundaries of individual disciplines, paid attention to sustainability and the environment for the first time. In his projects he clearly identified the problem common to design, architecture and many other areas. The concept of "spaceship earth", the limited amount of earth's resources that can no longer be replenished, still has great relevance today, serving as a warning to humanity about its role in protecting the planet through intelligent design. Fuller explores the processes of mass production and industrialisation to rethink how living could evolve, namely through large-scale efficiency, waste reduction, and less use of resources (Fuller, 1969).

World War II interrupted the flow of reflections arising from these researches and, in the following season, that of the continuous growth of the city to be rebuilt in its primary infrastructures prevailed over the other lines of thought. The human home has played a primary role in the design processes, which have been entrusted with the task of instilling confidence and hope through new ultra-modern and functional domestic landscapes inspired by the great mirage of economic recovery. While the already fragile bond between man and nature was about to be definitively broken, removed and confined to the inaccessible dimension of the "reserve", there have been new attempts at reappropriation that through "Land art", an art form born in the United States of America in the mid-60s, has intervened on natural territories, deserts, salt lakes, grasslands, seas, etc. The definition of "Land art" and Earth Workers included all the artistic operations that, at the crossroads between New York and the boundless places of the American West, were carried out by a group of artists, proponents of nature, disillusioned with the society of rampant consumerism, crushed by the nuclear threat, and eager to evaluate the power of art outside the institutionalised environment of exhibition spaces and dedicated urban areas.

The numerous artistic movements dedicated to documenting the way in which time and natural forces have managed to change objects and gestures were born from a general concept of defiance of contemporary conventions, which resulted in a real countercultural revolution. The emerging artistic sensibility proved to be critical and nostalgic, alternating nihilistic aggressiveness with the shaping force of new material landscapes that expressed the sense of necessity and the desire to protect the territory, on a large scale.

Contesting the idea that the designer's task was to constantly create new needs, even at the cost of introducing poor quality, useless or harmful products to the market, Victor J. Papanek emphasised the importance of democratisation of design work and a responsible approach to design. This approach would be able to address the problems and contradictions of development, such as the uncontrolled exploitation of the environment and natural resources, the destruction of local cultures and traditions due to globalisation, growing social inequalities and neocolonial dynamics generated by "advanced capitalism". Only by integrating a clear vision of current reality and a utopian drive for change would industrial design carry out its mission in an innovative and effective way (Papanek, 1971).

It was E. Sottsass who sensed and made the state of crisis his own, entering into a close relationship with the codes of Land art through landscape photography, reworked with the elementary sign of architectural traces. Ephemeral structures he composed by wandering through plains, deserts, mountains and valleys. Minimal constructions to be lived in metaphorically in which man was placed in direct connection with the environment, without either mediation

01 | Drawings for the destinies of man, photograph by E. Sottsass, 1972 (from Ettore Sottsass Design Metaphors, Milan exhibition, 29 September 2023 – 15 September 2024)

02 | Virtual architecture, 1973; Boyfriends. I designed a vase for my girlfriend, 1977, photographs by E. Sottsass (from Ettore Sottsass Design Metaphors, Milan exhibition, September 29, 2023 – September 15, 2024)

or filters. The posthumous book *C'è il Pianeta* re-proposes the photographic collections of forty years of Sottsass' travels (Figs. 1, 2). A visual and conceptual portrait of a catalogue that blends the observation of nature with that of human experience, capturing not only physical scenarios, but also emotions, reflections and deeper connections. Sottsass treats every element, whether natural or artificial, as part of a larger design, intertwined with the human condition, within a poetic and cosmic dimension at the same time (Sottsass, 2017).

Within this historical reconnaissance, Marsh's premonitions take on particular significance in relation to the current environmental crisis. His appeal to civic responsibility and landscape protection, which are proposed as places for the reactivation of the connection between man and nature, directly inspires the spacecraft project. The echo of this vision is reflected in the choice of local and natural materials and in the pedagogical approach that orients the project towards a regenerative function, both social and environmental. However, the reference to Marsh is not to be understood as directly attributable to specific material choices, such as those made by Aalto with the use of wood. The two positions are not assimilable. Indeed, Aalto develops an aesthetic of sensory well-being through form and materials, while Marsh elaborates a systemic and pre-ecological vision of the balance between man and the environment. It is, therefore, an ethical rather than a disciplinary consonance that binds these approaches, and it is useful for tracing a value horizon for the project.

In the vision of eco-design, the comparison with the territory is central, both from a dimensional and multidisciplinary point of view. The project looks at the specificities of the local context, traditions, materials, including future problems and potential. A holistic approach, spanning a variety of disciplines, allows for the development of more conscious and innovative solutions to contemporary challenges, from design to eco-design, both from an ecological and social point of view (Antonelli, 2021).

Spacecrafts, definitions and models

The multidisciplinary research group characterised by historical, design and technical skills, starting from the assumption of a necessary change in contemporary habits, designs and conforms spatial devices for manual skills. They favour intergenerational relationships, defined as "spacecraft", small demountable structures, "laboratories of doing", featuring home automation systems and renewable energy, eco-sustainable materials, "joyful space systems" suitable to improve the quality, well-being and lifestyle of people. The term "spacecraft" should not be understood exclusively in the sense of vehicles built to operate in space and re-enter the Earth's atmosphere, therefore associated with temporary structures. The objectives and functions of the project appear clearer by referring to the two separate terms "space" and "crafts". The principles of "Arts & Crafts", a movement whose purpose was the revaluation of craftsmanship against the overwhelming industrial production and the decline of taste observed in the latter half of the nineteenth century (Vitta, 2011), place the manual skills of man, his needs and the value of time at the centre. They hover as an incipit in the conformation of these small spaces designed to trigger disconnection from the digital world, favouring, instead, a concrete connection with the environment and people, grafting themselves next to and in support of public buildings, such as hospitals, social centres and retirement homes.

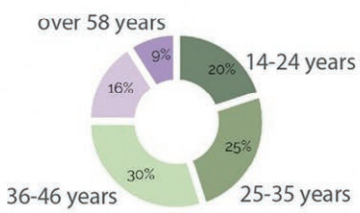
Design suggestions come to us from interventions carried out at the service of structures with already consolidated typologies, such as the project by Padilla Nicás Arquitectos (2021), "Rooftop Garden of the O'Donnell Maternity Hospital" in Madrid, Spain, where the roof of the hospital was transformed into a recreational garden for inpatient children, or the project for the internal courtyard of the Sheffield hospital, curated by artist and designer Morag Myerschough (2022), where the space can host laboratories, workshops and performances, involving families and hospital staff. The nursery school in Guastalla, designed by Mario Cucinella Architects, presents a sequence of wooden frames in the shape of a "whale" with the function of orienting the child toward the different educational spaces (Fig. 3).

The innovative contribution of spacecraft lies in the fact that they are models formally developed according to the place and needs; typologically, small buildings of a seasonal nature;

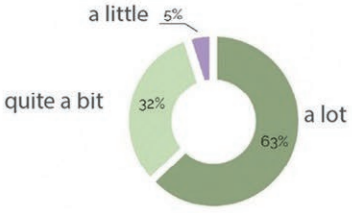
03 | Case studies: Roof garden of O'Donnell Maternity Hospital, Padilla Nicás Arquitectos, 2021; Garden of Joy Courtyard, Myerscough M., 2022; Nursery School, Mario Cucinella Architects, Guastalla, Italy, 2012; Bloc Salle de Bains Les Arcs 1800, Perriand C., Centre Pompidou. 1975

topologically, grafted offshoots, inclusions, derivations, at the service of the users of the buildings adjacent to them to promote people's well-being and introduce a new lifestyle. This approach, although fuelled by a set of design intentions, is based on a structured methodology, which starts from the analysis of the environmental, urban and social context – conducted through metric surveys, inspections, interviews and questionnaires, according to the rationale of co-design. It defines the objectives, the structuring of the activities, the evaluation of results, analysing objective data of measured parameters, finally reaching the selection of materials according to sustainability criteria, which can be verified with tools such as Life Cycle Assessment (LCA), up to the possibility of disassembly at the end of their life. Indeed, the critical issues related to the heterogeneous composition of the modules are recognised, and design solutions are envisaged for the separability of components, their reuse or correct disposal according to the principles of circular economy.

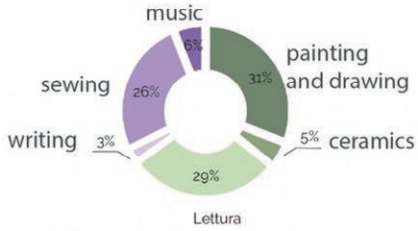
04 |



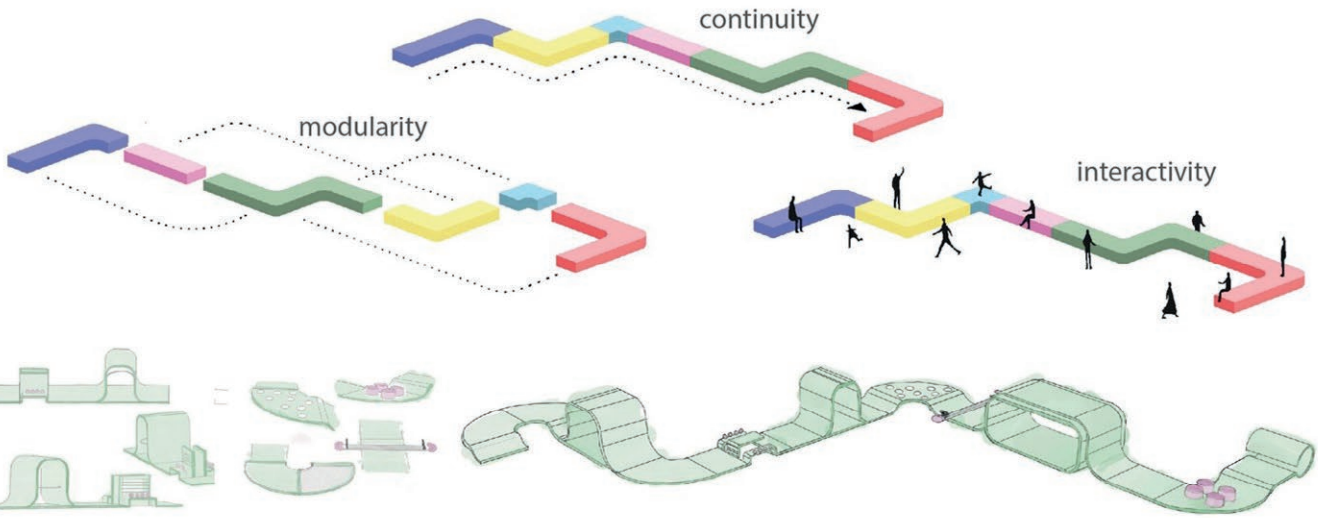
age group



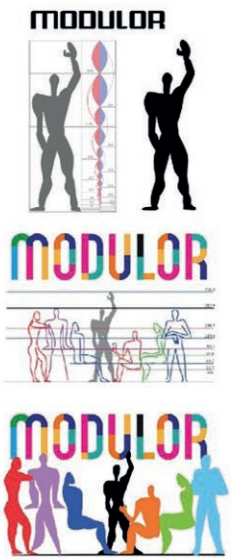
How important do you think the presence of play areas near the hospital is?



would you prefer laboratory activities on



Hence, the eco-design process starts from the investigation of the natural, cultural, economic, social resources of the place, surveying topographies and urban structures, followed by an environmental and sensory analysis, up to the detection of local economic resources. The second phase of analysis concerns the area in which the installation of the artefacts was hypothesised, detected through metric and photographic inspections, followed by the morphological and typological investigation of the surrounding buildings, with an in-depth analysis of the needs and criticalities of the local inhabitants, the administration of questionnaires, in order to propose innovative solutions to improve the stay and experience inside the spacecraft (Figs. 4, 5).
Two spacecraft proposals are described below: a linear model placed around the hospital in Foligno (PG); a block model inserted between a primary school and a multipurpose centre in Montebello (PG).
In the first case, the intervention is placed around the hospital complex, designed in the '70s, whose semantic matrix is that



INTERVIEWS

"comfort space"

"everyone must share spaces"

"enrich the city of Montebello"

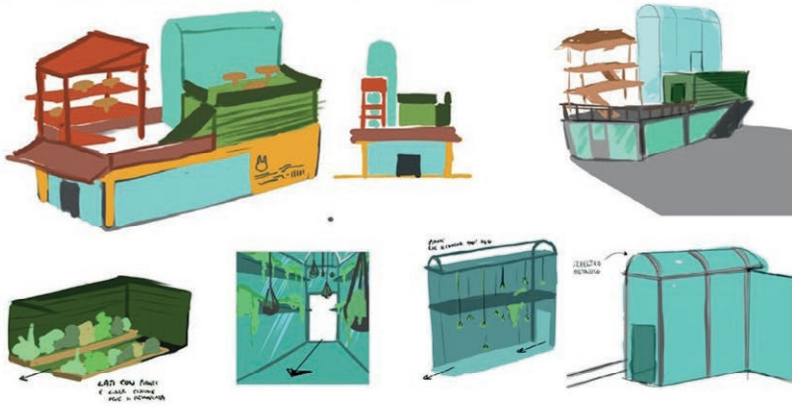
"a place in harmony with the landscape"

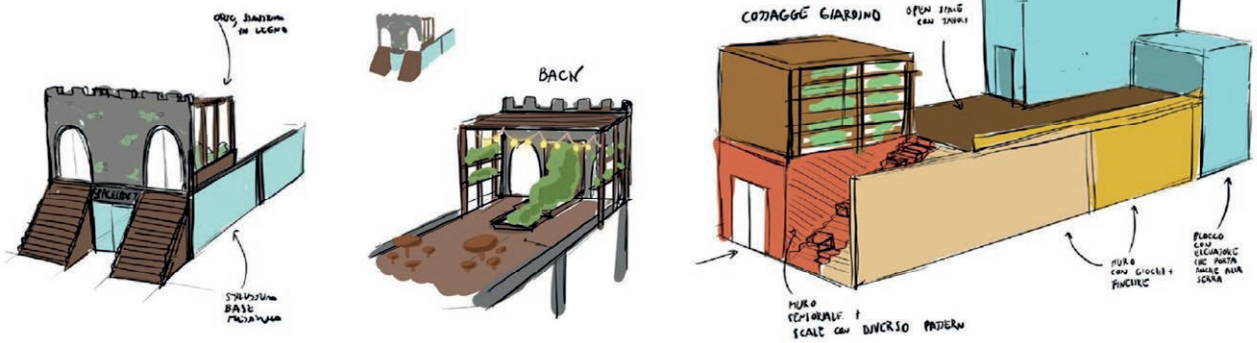
"we expect it to improve local well-being"

"spaces as a meeting point"

"a place that can bring together people of all ages"

"keep in mind people with disabilities and the elderly"





of the fortified 'citadel', a tribute to the history of Foligno. The hospital is surrounded by a green belt along which a panoramic promenade unfolds, with a view of the Church of St. Paul the Apostle by M. Fuksas and D. Mandrelli (2009). "Craftiroll" is a "ribbon" street furniture system (cf. "Kontinuität" by M. Bill, 1966) composed of modules that together allow different compositions of a playful path, characterised by games and gymnastic equipment, and small laboratories that host different reading, resting and manual skills. The frame of the structure is made of steel, the flooring and the external cladding is made of recycled rubber, memory foam for the seat padding, Alcantara fabric for the internal covering, cork for thermal insulation, GL24H laminated wood, corkpan, rice husk and paracord, high intensity polyethylene and mineral fibre panels (Fig. 6).

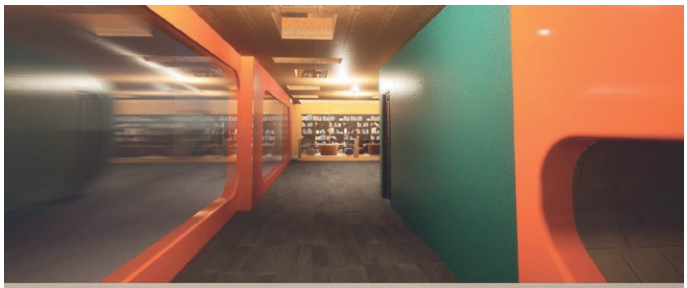
The second "Modulor" model is located in Montebello. Its historical fabric consists of two units located near the parish church and the Colonnetta. The intervention area is located between an elementary school, a multipurpose room with ad-

06 | Models of the eco-design process, "Craftiroll" project

07 | Models of the eco-design process, "Modulor" project

| 06

| 07



joining recreational club, and two small equipped green areas. To acquire in-depth knowledge of the desires of future users of spacecraft, didactic-exploratory workshops were organised with students of the school, structured in three phases, namely "historical", "natural" and "creative". The first two featured cognitive inspections on the history and environmental characteristics of the area of intervention. The third, thanks to the contribution of an empathic tutor, addressed graphic and material restitution by the children of possible usable environments desired by them. "Modulor" spans two floors. On the ground floor there are stairs used both to access the upper floor, such as urban steps, block toilets, a laboratory area and an elevating room-library, which allows everyone to reach the upper floor, which houses a vegetable garden, a greenhouse and a large terrace. In this case, steel and tempered glass were used for the frame and the greenhouse, Polyethylene terephthalate (PET) for the windows, Wood Plastic Composite (WPC) for the external steps, solid wood for the garden structure (Faresin A., 2012) (Fig. 7).

Home automation systems for the well-being of users

Spacecrafts have been imagined as innovative cockpits where, thanks to home automation systems designed and included within the various experiments, it is possible to ensure comfort and guarantee regeneration to the users of the spaces (Racha-Pacheco *et al.*, 2023). This is followed by a series of solutions adopted within the projects and concerning energy conversion systems, lighting, sound diffusion, tools for controlling the temperature and air quality of the environments, tools for physical well-being and support tools for inclusion (Wang, 2010).

To cover the electrical needs of the rooms, photovoltaic films were opted for, very flexible devices suitable for different applications thanks to their low environmental impact, during the operational phase of the life cycle, and their lightness and structural thinness.

Recessed LED systems with a colour temperature of 4000K and equipped with infrared presence sensors were used for uniform artificial indoor lighting. The motion sensor can detect the presence of a moving body up to two metres away, and turn off after a set number of seconds of no detection, thus saving energy and improving nighttime safety. The sensor is sensitive to both motion and the amount of infrared energy it detects. Similar systems were also used for the exterior of artefacts, such as decorative light or lighting. Daylighting, if properly designed, can provide a wide range of benefits, including improving the visual environment, circadian rhythm, as well as occupant satisfaction and productivity, reducing the energy load for electric lighting. This is why it was decided to insert electrically activated chromogenic glass capable of transforming from transparent to opaque, and to control the passage of heat and light by switching from bidirectional to unidirectional. The heating requirement is guaranteed by electrically powered refrigeration machines/heat pumps.

Another aspect common to all spacecraft concerns the systems for measuring temperature, humidity, noise levels and air quality. For the latter, sensors are able to detect the presence of pollutants such as fine dust, carbon dioxide and harmful gases. The systems send signals when concentration levels exceed attention or danger levels.

As far as the piped sound system is concerned, there are speakers resistant to external agents and water. The acoustic system allows music and sounds to be distributed evenly in all environments, creating an immersive sound experience.
The areas dedicated to physical well-being have been equipped with specific intelligent furnishings. The stretching roll in the "Craftiroll" spacecraft is a Body Pressure Measurement System that measures and detects contact pressure distribution between the human body and a support surface. The Muscular Switch sensor has been inserted in the same environments, capable of perceiving very weak and short-lived muscle contractions from any part of the body. An activity tracker sensor has also been placed to measure heartbeats, besides an oxygen meter capable of measuring the heart rate thanks to a pair of LEDs and photodetector. The volume of blood inside an artery changes during heartbeats. This fluctuation can be detected through an optical system, applied to a part of the body rich in blood vessels, such as the fingers.
In the passages of entry and exit of the spacecraft there are thermal stress meters, capable of detecting important quantities for climatic comfort, such as the temperature of the wet bulb and the dew point. Heat stress indices provide tools for assessing hot environments and predicting the likely thermal stress on the body. The automated systems include the automatic irrigation system, connected to soil moisture sensors that guarantee optimal irrigation. The system has a container for collecting rainwater, thus helping to reduce water waste.
Equally interesting is the microLED screen that allows to create displays of any format, customising the size and ratio of the screens to fit any space.
In addition to automated intelligent home automation systems, tools managed directly by users are installed to improve the performance and comfort of the environments. Among these, the voice assistant allows you to control the various devices, lighting, heating, air conditioning and irrigation, through voice commands.
Inside the spacecraft there are "finger readers", electronic rings that allow the blind to read a book. The prototype, developed by the MIT Media Lab, converts text visible on the screen into an accessible form, such as text-to-speech or braille playback.

Conclusions

The theme of well-being in a holistic sense, starting from people to the environment and/or *vice versa*, is made possible only through an innovative and co-evolving look, allowing the development of new spatial solutions, such as those illustrated. Spacecrafts are innovative, shared spatial models, oriented towards the well-being of the community, to encourage human relationships, manual skills, collaboration, creativity, and the sharing of ideas. Designed to serve buildings or public spaces through a "kit-of-parts" system, they do not require interventions on the existing heritage for installation, and provide sustainable solutions, verified through the LCA. Indeed, they assess environmental impacts that could potentially derive throughout the lifecycle of the artefact, from the initial phase, to its use and final disposal of the structure. In addition to environmental aspects, the project pursues social objectives by promoting inclusion, participation and intergenerational cohesion. The home automation module integrates numerous smart devices (sensors, voice assistants, photovoltaic films, automatic irrigation systems, microLEDs, etc.), which contribute to innovation, accessibility of spaces and energy sustainability, in a project that aims to encourage disconnection and reconquest of slow time. The project assessed the limits and potential risks related to digitisation, assessing its consistency with the general objectives of reconnection with nature, promotion of manual skills, and psychophysical well-being. In this sense, cautious design has oriented the choices towards a balance between technological innovation and functional sobriety, preserving the principle of the centrality of the human being in space.

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Exploring Life-Centered Design through a bottom-up analysis of case studies

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Abstract. This paper explores Life-Centred Design (LCD), an emerging concept aiming to overcome anthropocentric approaches by addressingall forms of life in the design process. Through a bottom-up analysis of case studies, it identifies the distinctive traits of LCD compared to other post-human approaches. The findings highlight the strong integration of foundational LCD principles, such as sustainability and systemic thinking, while revealing challenges in implementing co-design practices, non-human agency, and prioritising non-human interests. Addressing these complexities is essential for advancing LCD into a practical framework capable of tackling Anthropocene challenges.

Keywords: Life-Centred Design; Posthuman Design; More-than-human Design; Ecosystemic Design; Non-human agency.

Introduction: beyond the anthropocentric era

The dominance of humans over nature, characteristic of the anthropocentric era, has led to the current situation, succinctly captured by Monteiro, who asserts that the world operates as if it were designed, and because it does not function well, a collective effort is required to redesign it (Monteiro, 2019). Over the years, movements advocating for the transcendence of the Anthropocene have gained momentum, as reflected in the 17 global Sustainable Development Goals outlined by the UN Agenda 2030. In parallel, proposals aimed at overcoming the Human-Centred model have recently emerged in the field of design. Indeed, reversing the anthropocentric concept necessitates a shift in humanity's approach to its interaction with the ecosystem and its responsibilities in this regard. Design, understood as the human ability to shape the environment, can play a crucial role in modifying human relationships with non-human entities, thus positioning design as the discipline capable of leading the anti-anthropocentric transition.

The human capacity to harness energy, coupled with an incessant creative drive, has shaped the Anthropocene – an era in which humanity faces unprecedented challenges in ensuring a sustainable future, not only for its own species but for all life forms on the planet (Lovelock, 2020). The suffix "-cene," derived from the Greek *kainos*, has traditionally been used to denote geological epochs. The introduction of the term Anthropocene into scientific discourse is attributed to ecologist Eugene Filmore Stoermer of the University of Michigan in the early 1980s. During this time, society began to express specific needs and develop a distinct identity, characterised by a way of life markedly different from that of prior eras. In this context, the concept of Human-Centred Design (HCD) was developed by Donald Norman to address the emerging needs of his time (Norman, 2019). Although this period may appear simpler than the present, it was marked by profound social, economic, and cultural transformations, the effects of which continue to shape our society today.

It was within this framework that Stoermer coined the term Anthropocene, emphasising the transformative power of human activity and the damage it was causing the planet. Globalisation further accelerated this process, intensifying interconnections between human communities and amplifying anthropogenic impacts on a global scale. Since 2008, the term Anthropocene has been increasingly adopted by scientists to describe the rapid extinction of numerous species and the resulting ecological instability caused by human actions. This concept soon transcended the scientific domain, becoming a key reference in the humanities, arts, and social sciences, offering a lens through which to interpret global challenges affecting both the Earth's ecosystem and humanity itself (Haraway, 2016). The Anthropocene defines an era in which human activities have altered natural balances so profoundly that they threaten the very foundations of life on Earth. This awareness has prompted critical reflection on humanity's collective responsibility toward the planet and future generations, urging society to seek genuinely sustainable solutions to the global ecological crisis.

Humanity has shifted from a phase of coexistence with the environment to one where its capacity to transform nature has become dominant (Burlando and Nevoso, 2022). Technological progress and social development have transformed humans into key agents capable of significantly altering landscapes, exploiting resources on a large scale, and modifying entire ecosystems. This growing influence necessitates an increasingly conscious responsibility toward the environment, highlighting the need for an ethical and sustainable approach to planetary management (Pozzi, 2022).

Several approaches aimed at overcoming the anthropocentric paradigm have emerged in the field of design in recent years. These approaches are categorised under various definitions, such as post-human or more-than-human, each with distinct methodologies, goals, and theoretical foundations (Vacanti *et al.*, 2024).

This article focuses on the Life-Centred Design (LCD) approach, which seeks to transcend human needs by placing all life forms at the centre of the design process (Lutz, 2024). LCD advocates for biological ecosystems and non-user communities that have, until now, lacked representation in the design process (Paoliello *et al.*, 2025). Its long-term goal is to restore natural ecosystems

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by creating new relationships between nature and human society through design. By analysing case studies, this paper aims at highlighting the unique characteristics of the LCD approach, which distinguishes it from other theories focused on surpassing the boundaries of Human-Centered Design.
The problems arising from the Anthropocene are now universally recognised, and the movement to address these issues, supported by institutions like the UN and the EU, is active in both theoretical literature and applied projects. However numerous schools of thought have emerged during this disruptive transition, all moving toward the same objective but with notable distinctions. While these differences are well-defined in the literature, the same cannot be said for projects attempting to concretely move beyond the human-centred concept. This ambiguity can lead to confusion for designers, who, after rejecting clear and established HCD principles, may find themselves disoriented when seeking equally clear references in new paradigms. Clear boundaries and methods are essential for establishing these emerging design currents. This paper aims to define these boundaries through a bottom-up approach focusing not on the literature to define LCD characteristics but rather extrapolating them through analysis and exclusion of case studies framed within a post-anthropocentric perspective. By defining these elements, this contribution aims to demonstrate that LCD, more than other approaches, can offer the most effective responses to the current global challenges.

State of the art: more-than-human design directions

Scientific research is characterised as a process in constant evolution and expansion. The ability to transcend what has already been acquired is one of the distinguishing features that enables human beings to enhance the living conditions on the planet. Hence, progress signifies the birth and extinction of new and old theories, methods, and objectives that are redefined and updated (Kuhn, 2009). The theory concerning the onset of scientific revolutions is invoked in this context, specifically referring to the gradual and slow opposition to the Human Centered design approach. Indeed, we are witnessing the emergence of a trend that favours a more inclusive paradigm, aimed at involving and integrating not only human beings but all forms of life with which they interact into the design process.
This broad vision has gained traction thanks to the contributions of prominent researchers and thinkers. Haraway (2016) addresses this issue from an anti-speciesist perspective, inviting a reflection that extends beyond the needs of the human species to holistically embrace the needs of all living beings with which humanity interacts. The exclusive focus on human needs has often resulted in significant neglect of the demands of other non-human actors, causing large-scale environmental damage and enduring complexity (DiSalvo *et al*., 2010; Foth *et al*., 2021). Within this conceptual framework, it has been hypothesised that overcoming the anthropocentric view is not merely desirable but essential for ensuring sustainable adaptation and prosperity within the current ecological and social context (Harari, 2018). Although human-centred design has long been regarded as a cornerstone and undisputed principle in the field of design, the necessity for its continual renewal is becoming increasingly evident, so that it can accurately reflect the emerging challenges of our time and provide appropriate responses to such demands (Coulton and Lindley, 2019). Manzini shares the ideas of philosopher Latour, who, through Actor-Network Theory (ANT), proposes a relational ontological view that equates human beings with all other elements present on Earth. Manzini is thus dedicated to identifying ways to engage all actors, so that even those who have traditionally been excluded from design processes, such as non-human actors, can have a voice (Tassinari *et al*., 2021). Following this scenario, a series of related but distinctly different terminologies has been identified, which precisely delineate the interpretive nuances adopted by various researchers within this advancement beyond the anthropocentric view. In 2022, a literature review was conducted that sought to provide a lexical order to the topic, aiming to comprehend the various fields of design in which this new perspective is applied. The results of this investigation have revealed several significant issues. Among these, it is noteworthy that 23% of the examined contributions pertain to environmental concerns, particularly damages generated by a design approach focused exclusively on human beings (Vacanti *et al*., 2024). In such a context, thispaper intends to specifically focus on the potential for a radical transformation of the current situation, highlighting how a significant paradigm shift could occur if non-human actors are actively considered in the design process. This approach implies a recognition of their importance and agency, placing them at the centre of the design reflection. It is essential that these actors are acknowledged as co-protagonists in the design process. From this perspective, the ecosystem, understood as a complex web of relationships among the various players involved, must become the core of the design itself. This entails a substantial revision of traditional methodologies, which have historically favoured an anthropocentric view, often at the expense of the needs and necessities of other living actors. The idea is to develop a holistic approach that considers the interconnections and dynamics characterising ecosystems, so that each project can not only address human needs but also respect and enhance the complexity of ecological interactions. From this point forward, this concept will be referred to as Life Centred Design (LCD), a theme that has been previously addressed by many and nev-

ertheless still presents difficulties in identifying a specific and univocal definition. In fact, as early as 1972, Papanek referred to a more inclusive design, emphasising the importance of considering the ecological implications of design practices and how design should respond not only to the needs of human beings but also to those of all elements of the natural world (Papanek, 1972). Although the term Life Centered Design is not explicitly used, his ideas anticipate contemporary thought that encourages a more holistic and interconnected design approach.

With another connotation and from a slightly different perspective than the one presented here, although always exclusively oriented toward the human being, the same concept had been previously articulated in earlier years and in different contexts, such as engineering (Lau, 2004). This consideration prompts reflection on the fact that the theme has been felt for a long time and is finally emerging with sufficient momentum to define a new design approach. This conception of design does not merely focus on the utility or aesthetic value of a service, product, or intervention but recognises life – understood as a set of interconnected ecosystems that are essential to various design processes – as the central subject around which the entire project is articulated. Thus, LCD is not just a change in terminology but marks a profound innovation in the ways of conceiving and implementing projects, pushing towards greater ethical and environmental responsibility.

The adoption of this perspective is intended to encourage a more sustainable design practice that respects natural balances, creating spaces and solutions that not only meet human needs but also contribute to the well-being of all forms of life with which humanity shares the planet. In doing so, the aim is to initiate a process of coevolution between humans and nature, where design practices harmoniously integrate with the rhythms and rationale that underpinecosystems (Lutz, 2023). Subsequently, an analysis of a series of case studies that fall precisely within this specific design approach will be presented, characterised by an equivalent significance attributed to human beings and other living actors involved in the process, such as plants and animals.

Methodology: case selection and parameters definition

The methodology adopted for this research focused on analysing projects representing of the Life-Centred Design paradigm, selected for their distinctive contribution to sustainability and the integration of living systems. The selection was guided by the objective of solely exploring projects involving organic life forms, avoiding those centred on the relationship between humans and technology. This approach is inspired by the paradigm described by Borthwick *et al.* (2022), which advocates for moving beyond anthropocentric models toward a more holistic and multispecies perspective.

The case studies were identified through a review of projects - from 2008 to 2024 - labeled with terms such as *more-than-human*, *post-human*, and *multispecies*, analysing academic sources, online platforms, and design websites. Among these, we selected those that stood out for their virtuous contribution to environmental sustainability, the integration of living ecosystems, and respect for biological dynamics.

The selection of the projects was based on the following criteria (Fig. 1):

1. to involve living systems such as plants, fungi, animals, or microorganisms;
2. to demonstrate a positive impact on the environment for all agencies involved;
3. to raise relevant ethical or aesthetic issues;
4. to possess innovative and scalable potential.

The parameters used include the ten criteria proposed (light blue in Fig. 2) by lifecentreddesign.net (LifeCenteredDesign.Net, 2021), besidesan additional 9 criteria (pink in Fig.2) developed by the authors:

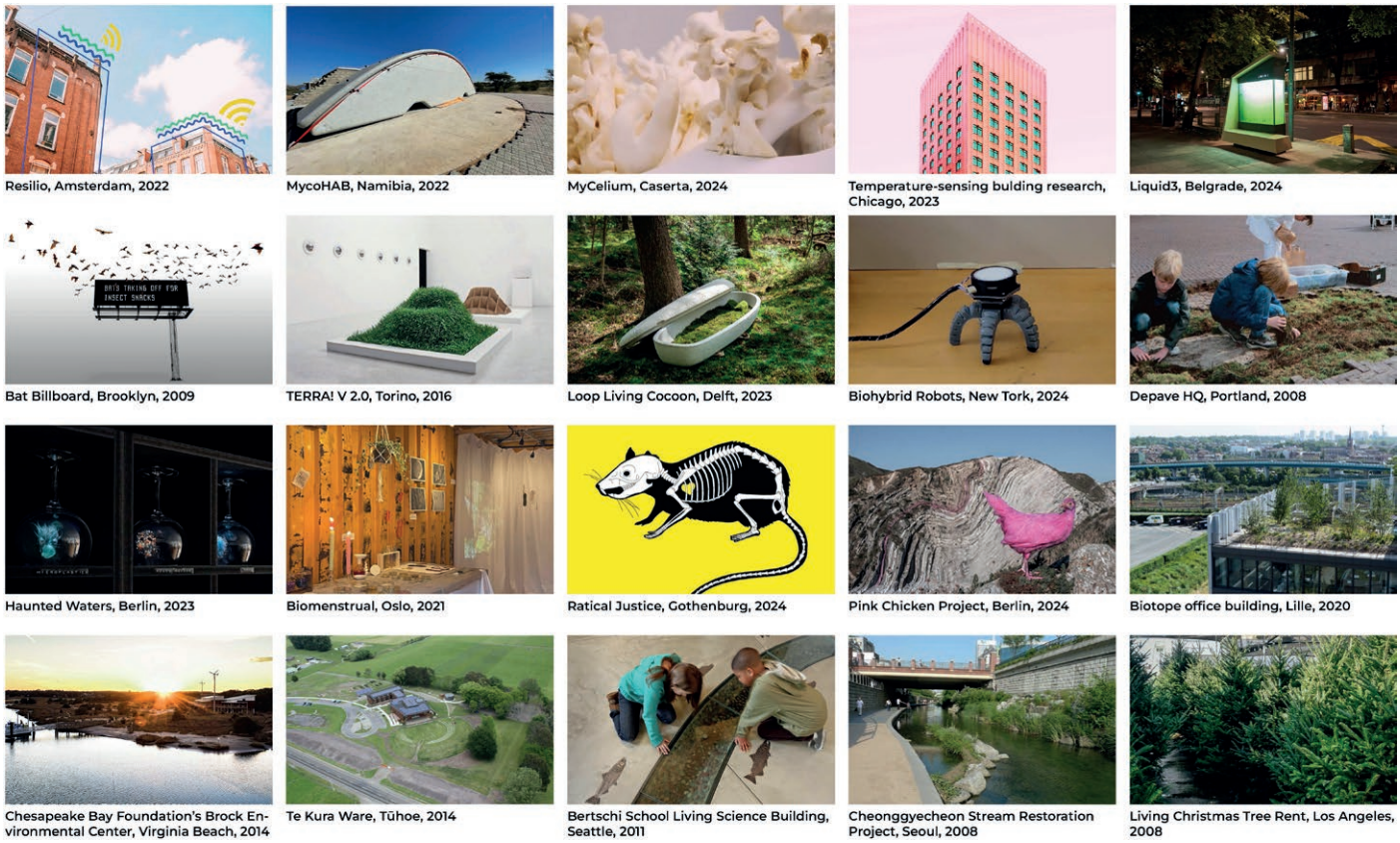
1. *purpose over profit*, prioritising ethical and sustainable goals over economic profit;
2. *inspired by nature*, encouraging imitation and learning from natural systems;
3. *interconnected system thinking*, adopting a systemic approach to understand the interconnections between project elements;
4. *lifecycle-aware holistic approach*, considering the complete lifecycle of materials and design solutions;
5. *long term thinking&doing*, promoting an intergenerational vision;
6. *sufficiency*, emphasising the responsible use of resources;
7. *equal and thriving*, aiming to ensure equity and prosperity for all species involved;
8. *de-centring*
9. *reimagining*, encouraging the rethinking of anthropocentric hierarchies;
10. *acknowledging all lifeforms*, recognising and respecting all forms of life.

To these parameters, we added further relevant dimensions that emerged during our research and were supported by the academic literature on the topic (Fig. 2). These include:

co-design with users, to evaluate the direct involvement of human stakeholders in the design process;

1. *non-human agency involvement*, to measure the presence and active role of non-human entities in the project;
2. *technology involved*, to describe the interaction between technological solutions and living systems;

01 | Summary of the case studies analysed (collage image edited by the authors)



3. *impact on local non-human agency* and *impact on the ecosystem*, to analyse the direct effects on local non-human entities and the broader ecosystem;
4. *priority to non-human interests*, assessing the project's ability to centre the needs of other species;
5. *promoting bio/ethical behaviours*, verifying whether the project fosters actions aligned with ecological and ethical principles;
6. *connecting people to nature*, understanding how the design facilitates meaningful relationships between humans and the environment;
7. *retrofitting existing situations*, identifying projects that reinterpret previouslyexisting contexts;
8. *measurable impact*, assessing whether the project has clear and tangible metrics for success or change.

A methodological framework integrating these parameters was developed for analysing the projects, as represented in our table (BLANK UNTIL FINAL ACCEPTANCE, 2024). The analysis was structured in two main phases. In the first phase, the cases were mapped and categorised based on emerging themes, such as environmental sustainability, habitat regeneration, and the use of biological materials. Subsequently, a critical and comparative evaluation was conducted to identify trends and significant differences among the projects, with particular attention to their practical applications and theoretical implications (Fig. 3). Despite the accuracy of this approach, we acknowledge that the selection of cases may be influenced by biases related to the availability of documentation or the cultural perspective of the team. Furthermore, the lack of quantitative data for some projects limits the generali validityof the results.

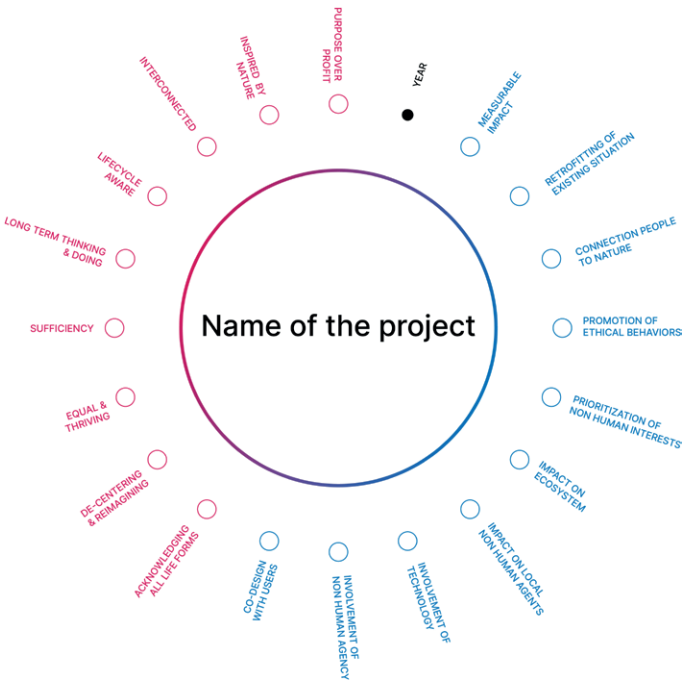
Case study analysis: taking inspiration from nature

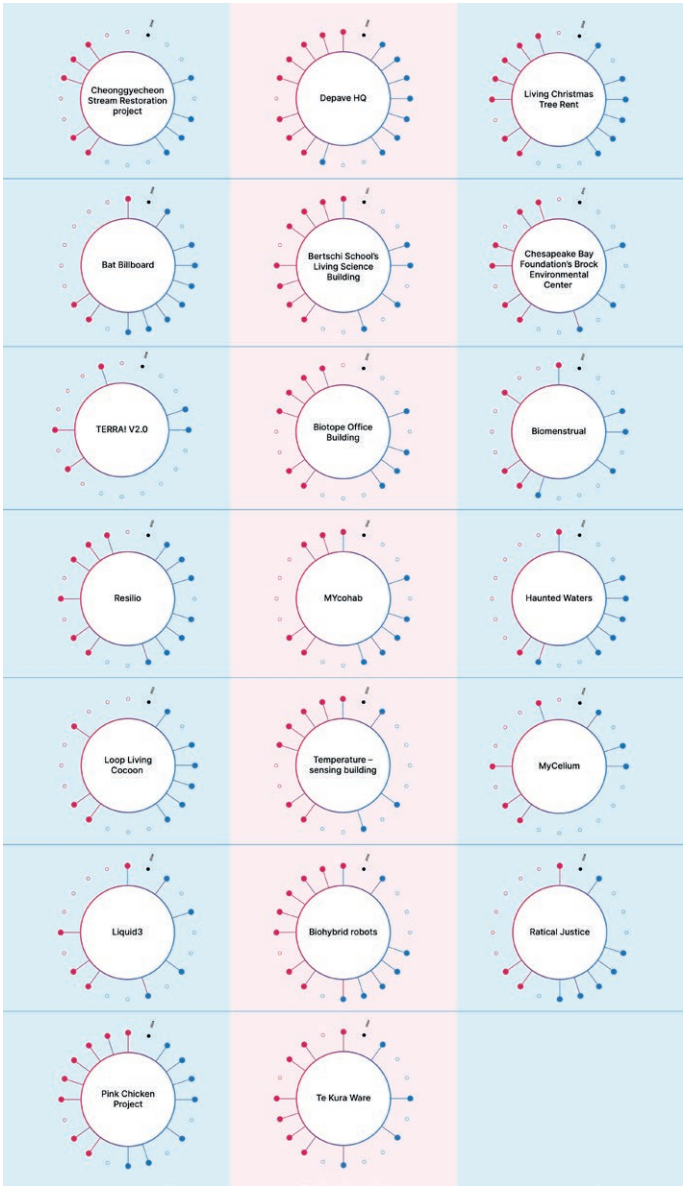
The analysis of the selected case studies highlights both the potential and the complexity of implementing Life-Centred Design principles. Most of the projects analysed (about 60%) have reached the stage of concrete implementation, while 15% are still in the prototyping phase and 25% remain speculative. This distribution reflects the exploratory nature of Life-Centered Design, which often operates at the boundaries of technological and conceptual innovation.
A further interesting aspect concerns authorship and the type of organizations involved. Although most of the projects can

02 | Key to parameters taken into account for the case study analysis (illustration by the authors)

03 | Infographic of selected case studies and their compliance with the analysis parameters (illustration by the authors)

02 |





03 |

be attributed to independent initiatives, often carried out by design studios or individual designers, cases linked to academia underscore the crucial role of universities and research institutes in promoting frontier experimentation. Other projects are linked to companies or community entities, highlighting a diversification of the actors involved in the field and the importance of active community participation as a cardinal principle of this design approach. More generally, such heterogeneity reflects the interdisciplinary and collaborative nature that characterises the field, where the sharing of resources and expertise appears to be key to addressing complex challenges.

Certain trends emerge from the parameter analysis. Frequently activated principles, such as "inspired by nature" and "impact on ecosystem", reveal their centrality to this paradigm. Conversely, parameters like "co-design with users" and "non-human agency" are less often addressed, suggesting significant challenges in integrating human stakeholders and non-human entities into the design process. A strong correlation is observed between "purpose over profit" and "impact on ecosystem", indicating that ethically driven projects often achieve a positive environmental impact. Similarly, projects that emphasisze "long-term thinking & doing" tend to involve more active roles for non-human agencies, highlighting the alignment between long-term strategies and multispecies collaboration. However, the simultaneous activation of multiple parameters remains relatively rare, suggesting that most projects focus on specific priorities rather than adopting a fully holistic approach.

Recurring themes among the projects include environmental sustainability, community involvement, and the integration of living systems and technology. For example, initiatives such as waterway regeneration, low-impact housing, and the use of innovative biomaterials reflect a commitment not only to reduce environmental harm but also to foster synergies between human and natural systems. These trends suggest a strong correlation between Life-Centred Design, technology use, and user engagement. Life-Centred Design thus emerges not only as a design practice but also as a theoretical framework that challenges traditional anthropocentric design conventions. The diversity of the cases analysed also demonstrates the wealth of pathways that Life-Centered Design can offer. Indeed, projects implemented as concrete interventions highlight the transformative potential of design, while the presence of unfinished or experimental initiatives reveals the importance of specula-

tion as an engine for innovation. This balance between pragmatism and experimentation is one of the field's most distinctive features and an essential element in understanding its impact and prospects.

Discussion and takeaways One of the most interesting emerging topics in the field of Life-Centred Design is the integration of living systems and technology, an area that is redefining the boundary between the natural and the artificial. This theme emerges in projects that use biological organisms or living materials as active components of design solutions, often in combination with advanced digital or technological systems. The integration of living systems into design is a response to global challenges, such as climate change, biodiversity loss, and depletion of natural resources. This approach moves away from traditional practices that see biological materials as passive, focusing instead on dynamic and sustainable processes. Projects in this area aim not only to create functional products or spaces but also to foster a more harmonious coexistence between humans and the natural environment. Examples such as MyCelium, Biohybrid Robots, and Living Cocoon perfectly embody this theme. MyCelium explores the use of the filamentous structure of fungi as a sustainable material for products and infrastructure, reducing the environmental impact of synthetic materials and promoting a speculative idea of design as a "cultivable" process. Biohybrid Robots are an even more advanced frontier, where living organisms are combined with robotic components, which can use signals from living organisms such as fungi to generate motion, effectively being commanded by natural elements beyond human control. Although this type of project raises ethical and philosophical questions, it is undeniable that it opens extraordinary possibilities for robotics and bioengineering by decentralising the role of humans over the control of technology. Living Cocoon uses living materials to create a biological coffin that promotes natural decomposition and enriches the soil, exacerbating the cyclical relationship between humans and nature, as well as between death and life, speculating on how ecosystem care, the concept of zero waste, and the downsizing of man's role must necessarily also lead to the transformation of cultural rituals and practices.

In conclusion, the case study analysis highlights that the foundational parameters of Life-Centred Design retrieved from LifeCenteredDesign.net are frequently activated, demonstrating their strong presence in current projects. However, secondary parameters like "co-design with users", "non-human agency", and "prioritisation of non-human interests" present significant challenges for integration. "Co-design with users" shows weak or even negative correlations with the foundational principles, likely due to tensions between engaging human stakeholders and decentring anthropocentric priorities. This highlights the complexity of maintaining user collaboration without reintroducing human-centric biases into the design process. Similarly, the inclusion of non-human agency remains challenging, requiring a fundamental shift in design practices to actively involve non-human entities in decision-making processes. While this parameter shows a moderate correlation with long-term strategies, its overall activation is less frequent, emphasising the need for methodologies that better incorporate non-human actors as co-protagonists. "Prioritisation of non-human interests" is another critical frontier for Life-Centred Design. Despite its conceptual alignment with the paradigm, operationalizing this parameter in practice is inherently difficult. Designers face significant ethical challenges in balancing human and non-human priorities, especially in cases of conflict, and lack clear metrics to evaluate success in prioritising non-human needs. These difficulties underscore the need for speculative and experimental approaches that push the boundaries of traditional design paradigms.

Projects analysed in this study illustrate that Life-Centered Design is making significant strides in embedding its core principles, while also laying the groundwork for more holistic and inclusive design methodologies. Addressing the challenges associated with co-design practices, non-human agency, and the prioritisation of non-human interests will be essential for advancing Life-Centred Design from a theoretical framework to a fully actionable approach capable of responding to the multifaceted challenges of the Anthropocene. This could lead to radical rethinking of design, where the role of the designer becomes more like that of an ecologist or cultivator, a professional engaged in designing the conditions for the growth of complex systems that integrate technology and biology by behaving like living forms.

In conclusion, this research highlighted persistent challenges in fully embedding LCD principles, particularly in fostering non-human agency and prioritizing non-human interests in design processes. Future research should explore strategies to operationalize these aspects, potentially drawing from disciplines such as ecology, ethics, and artificial intelligence. Expanding the scope to include a more diverse range of case studies, both geographically and across different design domains, could further refine our understanding of LCD's potential. Moreover, although this study provides valuable insights into the principles and applications of Life-Centred Design (LCD) through a bottom-up analysis of case studies, the qualitative nature of the analysis limits the ability to generalise findings across broader contexts, as many of the projects examined remain speculative or in early development stages. Therefore, the integration of quantitative methodologies, such as environmental impact

assessments or user engagement metrics, could enhance future studies. Additionally, interdisciplinary collaborations with scientists, policymakers, and industry professionals may help bridge the gap between theory and practice, facilitating the transition of LCD from an emerging paradigm to an actionable framework for tackling Anthropocene challenges.

ATTRIBUTION, ACKNOWLEDGMENTS, COPYRIGHT

The paper is overall the result of the joint work of the authors. Specifically, the initial definition of the framework of the investigation is by F. Burlando, the preparatory state of the art analysis is by I. Nevoso, the definition of the methodology is by A. Vacanti. The research, identification, classification and analysis of the case studies is by C. Porfirione, A. Vacanti, I. Nevoso and F. Burlando. The research was carried out under the supervision of N. Casiddu.

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Fashion's future: the power of biomaterials and digital manufacturing for systemic sustainability

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Abstract. In an era where fashion mirrors the excesses of a society driven by disposability, the garment emerges as a transformative device to reimagine our relationship with identity, technology, and the environment. This paper delves into the transformative potential of biomaterials and digital manufacturing in redefining fashion as a sustainable and ethical practice. Situated within the post-Anthropocene discourse, the analysis interrogates the environmental and social implications of these innovations, weaving together theoretical perspectives and exemplary case studies that illuminate the convergence of living matter and additive technologies as a space for new ontologies and aesthetic possibilities. The paper critically addresses the existing barriers, which hinder widespread adoption advocating for a systemic model that integrates innovation, ethics, and environmental consciousness.

Keywords: Biomaterials; Digital Fabrication; Systemic Fashion; Self-growing materials; Entangled Ecosystems.

Introduction

Fashion, in its essence, has always been more than mere clothing, it is a codified language, a dynamic intersection of materiality and meaning, power and resistance, ephemerality and permanence. Across history, garments have functioned as socio-political statements, markers of identity, and repositories of collective memory. Yet, within the rationale of late capitalism, fashion has undergone a profound ontological shift, increasingly alienated from its artisanal roots and cultural significance. Baudrillard describes fashion as a simulacrum: a self-referential system that thrives on perpetual reinvention, where obsolescence is not an accident but a structural necessity (Baudrillard, 1970). In this hyper-consumerist paradigm, garments cease to be objects of use and, instead, become fleeting signs in an accelerating cycle of production, consumption, and disposal. The consequences are tangible: ecological devastation, labour exploitation, and an erosion of craftsmanship in favour of algorithmic trends and mechanised excess. By examining the potential of emergent technologies to recalibrate the ethics and aesthetics of fashion, this paper interrogates these tensions while exploring whether a paradigm shift that reconciles sustainability with innovation, material intelligence with human agency, is not only possible but imperative.

In the context of the post-Anthropocene era, Morton's philosophical concept of "hyperobject" appears particularly adequate to frame a contemporary understanding of what fashion is today, namely a complex, widespread, and interconnected system (Morton, 2013). As a "hyperobject", fashion has consequences that transcend the "here" and "now", affecting the entire terrestrial ecosystem and making it necessary to critically question its role as a tool for ecological, social, and cultural transformation. The effects of the fashion industry on our ecosystems are now well-known, and these data are well established. Indeed, the fashion industry contributes to 10% of global carbon emissions and to 20% of water pollution (McKinsey, 2020), making it one of the most urgent industrial sectors for action. The research on new materials and manufacturing technologies offers unprecedented opportunities to address this crisis; the one evaluated in this paper relates to this intersection and the potential of biomaterials to redefine the very concept of fashion, mitigate damages, and actively contribute to ecosystem regeneration (Everett, 2022).

Contemporary fashion reflects a system of overproduction fuelled by an economic model that prioritises immediate profit over sustainability. The fast fashion culture embodies what Guy Debord calls the "société du spectacle", where the production of ephemeral goods and the image take on greater value than the intrinsic one (Debord, 1967). This approach embodies the manifestation of extractive capitalism, which treats nature as an infinite resource, and waste as an external issue (Moore, 2015). The urgency of redefining such an unsustainable system involves many fields of competence; among these, biologists took significant traction, giving rise to a rapidly evolving field of "biodesign". This area of design employs living materials, such as cultured tissues and microorganisms, to support the vision of organic design, allowing nature to shape objects following an initial human intervention. When living organisms replace conventional materials like plastics or wood, the implications extend far beyond aesthetics or functionality, challenging traditional notions of progress and terrestrial co-existence. This shift pushes design into the moral realm, provoking reflection on deeply ingrained beliefs and ethical considerations (Myers, 2019).

This contribution seeks to situate itself at the convergence of these experimental domains, aiming to critically interrogate the role of biobased textiles in fashion as agents of transformation, shifting fashion to a paradigm of resilience and symbiosis (Papanek, 1985).

Rethinking sustainability beyond the Anthropocene

In response to the current state of affairs, numerous critical movements have come into being. Kate Fletcher points out that fashion, as a cultural and industrial phenomenon, has the potential to drive systemic change (Fletcher, 2014), introducing the now well-known concept of "slow fashion", which favours quality over quantity (Gwilt, 2014). From this perspective, some limitations of distributed additive manufacturing and biomaterials, linked to slower times, can lead to a meeting point. This approach encourages a more conscious and sustainable relationship between producer, consumer and environment: «fashion is not just about what we wear, but about how we relate to the world» (Fletcher, 2014).

In line with this movement, designers wield significant power by crafting scenarios and prototypes that influence behaviour.

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01 | Biocouture collection by Susanne Lee, 2013. These jackets are entirely hand-stitched from grown bacterial cellulose using a stencilled fruit print created with a mix of blueberries and beetroots, Credits: Susanne Lee

| 01

Michel Serres, in his work *Le contrat naturel*, calls for a "natural contract" between humanity and the planet, recognising the need for an ethical balance between production and sustainability, acknowledging the deep relationships between human and natural ecosystems, which are, and should not be, distinguishable anymore (Serres, 1990). Indeed, as Parisi argued, biomaterials disrupt the linear narrative of production and waste, suggesting a cyclical temporality that aligns with ecological interdependence rather than industrial determinism (Parisi, 2021). This marks a departure from the Cartesian separation of nature and culture, reimagining fashion as a human endeavour and a collaborative act with non-human agents.

In this perspective, the use of materials like mycelium, algae, and bio-engineered tissues can represent a significant step towards an entangled vision of fashion design. Research on biomaterials is garnering increasing attention indeed, foregrounding the exploitation of renewable resources, promising a biodegradable and ethically aligned alternative to plastics and animal leather.

The impact of biomaterials

While conventional textiles remain tethered to plant-derived fibres or petrochemical synthesis, innovative explorations, such as *BioCouture* by Susanne Lee, are among the first to manifest tangible applications and to interrogate the potential of microorganisms as architects of biomaterials, not only for fashion but for broader material ecologies (Fig. 1). Through the alchemy of fermentation, bacteria orchestrate the assembly of cellulose microfibrils, yielding a supple, compostable medium that, like its traditional counterparts, can be shaped and sewn, yet signifying a profound ontological transformation in how we conceive textiles and engage with them (Lee, 2013).

Despite the disruptive meaning of this project, self-growing materials still need to be improved in terms of durability, water resistance, and biodegradation control to offer a sustainable commercial alternative.

Several scholars have explored the creation, or 'cultivation', of such a new material. Alexander Bismarck and Mitchell Jones of the University of Vienna contributed significantly to researching the use of fungal species to create sustainable alternatives to traditional leather (Jones *et al.*, 2020). Their work focuses on producing skin-like materials using agricultural by-products, such as sawdust, which are colonised by fungal mycelium. Their research has only recently become integrated with additive manufacturing, presenting promising prospects for configuring a fashion system able to merge the advantages of a digital supply chain with the use of biomaterials. Digital fabrication operates in this area as a morphogenetic vector, capable of shaping growth environments and support structures for biomaterials, enabling hybrid forms to emerge. Beyond mere formal replication, additive and subtractive digital technologies articulate a situated and responsive design practice, one that embraces the unpredictability and autonomy of living matter, giving rise to artefacts that are simultaneously designed and cultivated.

In recent years, the fashion world has witnessed numerous experiments in a larger, more commercial direction. The California-based biotechnology company MycoWorks pioneered this sector, specialising in producing leather-like materials using mycelium, the root structure of fungi (MycoWorks, 2024) (Fig. 2). The mycelium cultivation process is inherently circular. The material grows using organic waste and is produced with minimal water and energy consumption. This material has excellent technical properties such as durability and adaptability.

In September 2023, MycoWorks opened the world's first commercial-scale Fine Mycelium™ production facility in South Carolina. The 136,000-square-foot plant enables the cultivation of Reishi™, supplying millions of square feet annually to luxury

02 | MycoWorks' proprietary Fine Mycelium™ platform has enabled a new class of premium, non-animal materials that are the next evolution in mycelium, Credits: MycoWorks

03 | The founders of Simplyfiber, Maria Intscher and Owrang Phil Cohen. New York brand first product is a 3D printed and 100% biodegradable shoe, Credits: Simplyfiber

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03 |

industry partners, a significant milestone in scaling sustainable materials within the fashion market. The company has also partnered with Hermès and Stella McCartney to create sustainable luxury products, demonstrating the scalability and applicability of mycelium in the high-end fashion industry (Casadei, 2023).
Stella McCartney has long been a pioneer in sustainable fashion, and her recent commitment to using biomaterials is another step forward. In 2022, Stella McCartney launched the Frayme Mylo bag, the first luxury accessory made with biomaterial (Stella McCartney, 2023). The designer has adopted Mylo, a soft and flexible innovative material derived from mycelium (85%) and and lyocell (15%), a regenerated cellulose fibres material. The mycelium is harvested as a 'foamy layer', uniquely mimicking the microstructure of collagen, giving the final material a supple warmth and sponginess not achievable otherwise with fully synthetic option. Through digital traceability, McCartney can record the origin of materials and production processes, ensuring that each step complies with social and environmental responsibility principles (Kele, 2023).
The materials analysed are all linked by the *fil rouge* of generating a virtuous circle for the entire ecosystem. Indeed, as Kate Fletcher points out, sustainable fashion is related to its production process and its potential to regenerate environmental resources (Fletcher, 2014). The challenge shifts from minimising the impact of fashion on natural ecosystems to finding new paths to actually take part in it constructively.

The rise of a Systemic Model

The recent convergence of digital manufacturing and biogrown materials has emerged as a *locus* of profound transformation, embodying the potential of technology to radically reconfigure fashion's ontological and material foundations. This synergy heralds a paradigm shift, enabling on-demand production, mitigating waste, diminishing transportation emissions through localised fabrication, and fostering unprecedented avenues for sustainability. Within this evolving landscape, the fashion industry is actively interrogating the interplay between technological innovation and sustainability, reimagining both the substance of materials and the very *ethos* of production itself. Simplifyber and Scarlett Yang are an example of pioneering the integration of biomaterials and 3D printing, creating an alternative to traditional textile manufacturing like spinning, weaving, cutting, and sewing (Fig. 3). The process makes use of a liquid cellulose solution derived from plant-based materials, such as wood pulp, which is poured into moulds and dried into biodegradable products. This method reduces traditional manufacturing steps by 60% and cuts material waste by 35% (Everett, 2022). The final garments are non-toxic and 100% natural, ensuring they can be fully recycled (PR Newswire, 2022).
Similarly, Scarlett Yang uses algae extract and silk cocoon protein to create biodegradable textiles that respond to environmental conditions like humidity and temperature, altering their

shape dynamically. These garments decompose entirely in water within 24 hours, making them an exemplary case of closed-loop sustainability (Specialty Fabrics Review, 2021). Her project, "Decomposition of Materiality", integrates bio-design, digital fabrication, and 3D digital simulation software to produce garments with minimal waste (Yang, n.d.). Digital fabrication enables indeed the integration of environmental sensing systems, such as humidity, temperature, and pH sensors, directly into the manufacturing workflow, allowing the real-time modulation of growth conditions and structural parameters in biomaterial-based design. Through closed-loop feedback systems, environmental data can be translated into computational inputs that guide material deposition, nutrient diffusion, or structural porosity, resulting in artefacts that dynamically adapt to their surroundings during the fabrication process itself.

The cases of Simplifyber and Scarlett Yang showcasing methods that significantly align with the principles of closed-loop sustainability (Everett, 2022), setting a new standard for the industry.

The adoption of biomaterials and digital manufacturing must not remain confined to isolated case studies but rather be embedded within a structured implementation framework. At an operational level, this necessitates 'incentives for enterprises' to transition towards additive manufacturing and bio-based materials, 'regulatory frameworks' that enforce supply chain transparency and digital traceability, and 'educational programmes' designed to equip emerging designers and manufacturers with expertise in bio-fabrication and advanced sustainability practices. The systemic transformation of fashion requires not only technological advancements but also a restructuring of the industry's socio-economic fabric, aligning sustainability with economic feasibility.

Navigating the challenges

The integration of advanced technologies and novel materials in fashion remains, for the most part, an ephemeral incursion into the commercial realm, rooted in experimentation rather than in systemic transformation. The prohibitive costs of research, development, and production, coupled with the inherent challenges of scalability and the inertia of entrenched industry paradigms, relegate these innovations to the margins of speculative practice. Furthermore, the temporal lag in production, alongside unresolved issues of durability and washability, complicates their migration into broader industrial and commercial circuits. A truly sustainable fashion model necessitates a scalable approach that accommodates the diverse realities of production, from global conglomerates to small, local enterprises. Yet, this imperative is fraught with asymmetries. Indeed, small and medium-sized enterprises (SMEs), constrained by structural limitations, risk exclusion from these technological advancements, thereby perpetuating dependence on unsustainable modes of production and exacerbating global inequalities (Ellen MacArthur Foundation, 2017).

Despite these hurdles, investments in bio-based materials within the fashion sector are steadily rising. The vegan leather market is projected to approach a valuation of $90 billion by 2025 (Grand View Research, 2022), and recent surveys also reveal that 90% of respondents favour the use of next-generation leathers, with 62% willing to pay a premium for such products, particularly among Generation X and Millennials. The nascent commercialisation of bio-based fashion through digital production embodies the germination of a future where the confluence of innovation, ethics, and environmental consciousness redefines the very fabric of human creativity and its relationship with the planet.

Conclusions

As an industry and cultural phenomenon, fashion is a crucial point of departure for addressing the challenges of the post-Anthropocene. The paper highlighted the opportunities offered by the adoption of biomaterials and the additive digital manufacturing production model, besides the structural and ethical limitations that hinder their systemic diffusion. «Thinking together with technologies and species invites us to imagine a common future», with these words Donna Haraway (2016) suggests a paradigm of *simpoiesis* based on collaboration and interconnection in which fashion can be reinterpreted as a hybrid system where technological innovation and sustainability successfully converge. Emerging technologies offer tools to pave the way in this direction by reducing waste, improving transparency, and responding to an increasingly awareness-driven market. However, as Jason W. Moore (2015) points out: «Sustainability cannot be a luxury; it must be the framework of production itself», thus implying that more than the simple introduction of technical innovations is needed, if they remain trapped in a linear economic model.

The transition to sustainable fashion necessitates a radical paradigm shift, one that reconfigures our understanding of the interconnected triad of production, consumption, and nature. In this context, Bruno Latour (2017) invites us to reimagine humanity's position within the ecological web in "Third Landscape", arguing that our collective survival hinges upon an ethical mode of coexistence with the planet. This ontological realignment requires us to move beyond anthropocentric paradigms, recognising that fashion, as both a cultural and material practice, must align itself with the rhythms and limitations of the Earth: «We cannot think of modernity without reconsidering our place within the terrestrial system» (Latour, 2018). Fashion, as a cultural expression and production system, can

become a tangible example of this new alliance, integrating the principles of regeneration and environmental care.

However, this shift cannot be solely technological. It must be deeply cultural, reshaping not only the materials and methods of production but also the very way we perceive and engage with fashion as a social and ecological act. Cultural transformation will indeed be pivotal. Consumers must be reoriented to perceive their purchases not as mere status markers, but as ethical gestures, acts of accountability toward the environment and future generations. Fashion, in its most profound essence, is not merely a mirror of the present but a projection of our potential, a promise of what we might yet become, namely a humanity capable of weaving garments and of interlacing relationships founded on respect and symbiosis with the Earth. In a world precariously balancing innovation and sustainability, Suzanne Lee's work serves as a potent reminder that we are not merely producing clothing. We are cultivating a paradigm shift, wherein biology emerges as the most profound and generative force in the reimagination of fashion (Lee, 2007).

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''From leaves we live''. Patrick Geddes in Naples

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Abstract. The paper focuses on the years of Patrick Geddes' (1854-1832) training as a biologist and the research he carried out in Naples between 1879 and 1881 at the Zoological Station founded by Anton Dohrn in 1872. In those years, Geddes made a series of discoveries on the symbiosis between marine organisms that led him to formulate the theory of "reciprocal accommodation" in evolutionary terms. His exploration of the topic of symbiosis, central to the debate on the "struggle for survival", placed him in the context of a specific strand of studies on cooperation and mutual support which made him one of the forerunners of ecological thinking. At the height of the Victorian era, his thinking joined that of other exponents and groups who, like him, opposed contemporary industrialisation and advocated different models of development and cities, not only in Britain.

Keywords: Symbiosis; Mutual aid; Participation; Regeneration; Naples Zoological Station.

Introduction

One of the undisputed fathers of ecological thinking is Patrick Geddes (1854-1832). A biologist, botanist and one of the founders of urban studies, he was among the first to apply transdisciplinary cognitive surveys for urban regeneration based on the participation of inhabitants. As noted: «His widespread interests were not the result of a pursuit of pure knowledge, but of an attempt to clarify and emphasize – in an increasingly specialized world – the inter-relations between all branches of knowledge for the benefit of human life» (McGrath, 1996). To him we owe the famous motto: «Think Global, Act Local», as well as: «By leaves we live». Lewis Mumford, who was his most famous pupil and divulgator in America, described him not «as a bold innovator of urban planning, but as an ecologist, the patient investigator of historical filiations and dynamic biological and social interrelationships» (Mumford, 1955).

In his early years as a biologist, Geddes was introduced to those ecological principles that would guide him throughout his life and form the basis of his urban and social studies. As young scientist, he devoted himself to a series of experiments to verify the presence of chlorophyll in certain marine animals. This led him to formulate a theory of "reciprocal accommodation" in the context of contemporary research on symbiosis formulated by Anton de Barry in 1879 (Sapp, 1994).

Within a few years of the publication of *The Origin of Species* (1859), the subject also became central to testing whether there was a principle that governed life and its origin based on natural selection for the gradual transformation of species, different from the one indicated by Charles Darwin (1809-1882), i.e. the "survival of the fittest", which ended up establishing that interspecies competitiveness dominated the "struggle of the living". Although Geddes was prompted by Thomas Henry Huxley (1825-1925) to carry out his studies on symbiosis, he reached very different positions from his master, for whom nature was a bloody spectacle, hence his famous motto: "Nature, red in tooth and claw".

The Naples Zoological Station

After a short period at Cambridge, where he studied embryology, Geddes was employed in 1876 as a demonstrator at the Royal School of Mines, where his mentor, the biologist Thomas Henry Huxley, was a lecturer. It was Huxley who, in 1877, awarded Geddes a scholarship to London's University College, where he met Charles Darwin, and who a year later encouraged him to carry out research on a particular species of "chlorophyll-containing" marine worm at the Zoological Station in Roscoff (1872).

In the late 19th century, the so-called "chlorophyll-containing animals" were a much-discussed case among scientists and the subject of a long taxonomic dispute. Were they plants or animals or yet another species? The most common belief was that the chlorophyll observed in many different invertebrate species was an endogenous product. This belief was challenged in the early 1880s, thanks in part to the contribution of Geddes, who showed that chlorophyll was not produced by these organisms because it could be removed without harming its hosts (Sapp, 1994).

Soon after the stay in Brittany, Geddes decided to move to Naples for a few months, to continue his research related to this topic at the Zoological Station directed by Anton Dohrn.

The first letter found in the historical archives of the Naples Zoological Station dates back to 28 January 1879, in which Geddes wrote to Dohrn from Paris informing him that he would not be able to arrive for about ten days due to his busy schedule. He inquired whether the species he had named *Convoluta schultzii*, *Echinus sphaerae* (*sea urchins*) and other species were present in the waters of Naples and said that he was considering arriving by steamship from Marseilles (Geddes, 1879).

Dohrn, who was born in Szczecin, had come to Naples in 1870 with the specific intention of building a zoological station there, which he had built between 1872 and 1873 at his own expense on a piece of land in the Villa Reale still lapped by the sea and ceded at no cost by the City Council (1840-1909) (Heuss, 2011). Assisting him in the project, in addition to the architect Oscar Capocci and engineer Giacomo Profumo, was his close friend Adolf von Hildebrand (1847-1921) (Florio, 2015). The Station immediately specialised in morphology, a branch of biology, whose main field at the time was embryology. Dohrn had been introduced to these studies by his professor in Jena, the biologist Ernst Haeckel (1834-1919), the greatest populariser of evolution in Germany, known for his "recapitulation theory" according to which the main stages of evolution, i.e., phylogeny, are repeated in the development of an embryo. Haeckel is also credited with the introduction of the term ecology in 1866, but also with the later reading of Darwin's theories for ratial purposes.

In 1875, at the Station's late inauguration party, Dohrn expounded Darwinian theories to the large audience of Neapoli-

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tans invited to the music room embellished with sculptures by Adolf von Hildebrand and frescoes by Hans von Marées (1837-1887). Darwin was one of the greatest inspirers of the Station's program as well as Dohrn's correspondent and donor of precious volumes for the library (Florio, 2015; Groeben 1982).
Starting with the Ostend laboratory established by Pierre Joseph Van Beneden in 1843, numerous research institutions were established in Europe on the coast, including the French institute in Roscoff and the Triste Station, a branch of the University of Vienna (1975). The one in Naples was, instead, configured as an autonomous institution, disassociated from universities or local administrations, and was strongly characterised by the presence of an aquarium open to the public. Based on a design by the English engineer William Alford Lloyd, author of the 1868 Hamburg aquarium and the 1871 Crystal Palace aquarium in London, it was inaugurated in August 1874. It immediately became an important destination for the 30.000 tourists per year (out of a population of more than 500.000) who on average visited Naples in the mid-19th century and thus an important source of funding for the institute (Groeben, 2010).
The Station became a compulsory stop for young biologists, including Geddes. Under the agreement with the British Association signed between 1875 and 1914, he had the opportunity to occupy a so-called "study table" from 26 February to 4 April 1879 and from 8 October to 14 November 1881. This meant that he did not only have a desk, but also access to various bibliographic sources and, above all, the possibility of taking marine samples in situ to study them (Dohrn, 1881, 1882).
The laboratories with saltwater tanks for live and preserved animals, all caught in the nearby waters of the Bay of Naples, were equipped with state-of-the-art equipment, including the indispensable microscopes with Zeiss lenses, produced in Jena at that time and perfected by Ernest Abbe (1840-1905), a mathematician and physicist, Dohrn's friend and university colleague. Geddes described the Neapolitan Station in an article in *The Scottman* of 14 July 1879: «The entire upper storey is reserved for purposes of scientific research, and consist chiefly of laboratories, containing in all twenty-four tables, each of which is a condensed laboratory in itself, being supplied with several small working aquaria, each having a constant stream of salt-water passing through it. […] Most of the tables open for non-resident workers have thus been let, and over one hundred naturalists, many of them of European reputation, have already taken advantage of the exceptional facilities offered there for carrying on their special lines of investigation. The marine fauna of the Bay of Naples is exceedingly rich and varied, and by means of dredging carried on by the aid of a steam yacht, a constant supply of the necessary specimens is maintained. These are utilized partly in stocking the public aquarium, and partly in supplying the working tables» (Geddes, 1879 a).
Once the descent of man from other animals had been revealed once and for all, the sea with its elementary life forms became a rich world for scientists to study in search of the origin of life and its evolution. Geddes himself described the enormous potential of studying embryos from the sea, lamenting the absence in his homeland of an institution like the Neapolitan one, and planning one inspired by it: «Highly desirable as it is to have a complete list of all the denizens of our seas, it is for the purpose of elucidating life problems, still more important to know their life history, especially in its earliest or embryonic stage, for it is to the embryo that the believer in the doctrine of descent must look for confirmation of his views, as well as for guidance in building up a scientific genealogy of the animal kingdom. The study of embryology, however, necessitates not only the collection of specimens but also the preservation alive during a lengthened period of observation, and in the case of marine animals, this can only be affected by means of salt-water aquaria.[…] A movement is, however, at present on foot for the establishment of zoological station on the Aberdeenshire coast in connection with the University of the Granite City, and the moderate sum has already been subscribed, in aid of the scheme, which, if carried out, we probably lead to the foundation of many similarities institution on our coasts» (Geddes, 1879a).
Back in Scotland, Geddes wrote twice from Aberdeen to the Station (on 12 May and 10 June), this time to Hugo Eisig (1847-1920), one of Dohrn's principal assistants who was to become Deputy Director in 1909 (Geddes, 1979c). These were mostly requests for certificates and orders for boxes with a range of marine species, including *molluscs*, *balanoglossus*, *algae* and jellyfish. One of the facility's additional services of the Station was to send "big boxes" – sort of small portable aquaria containing live marine species – on order to Europe, ensuring that they arrived at their destination "in excellent preservation", as Geddes himself confirms in his letters and according to the procedure he describes in his article (which led to supplying even the Crystal Palace Aquarium!): «collections of the marine animals of the bay, preserved so as to be afterwards fit for dissecting purposes, are forwarded, as required, to various Continental Universities to teaching purposes. Live specimens are also occasionally sent long distances, sometimes by post, as when the curious little fish, *Amphioxus*, was thus forwarded alive and safely to the Crystal Palace Aquarium» (Geddes, 1879c).

The museum of Stonehaven

In addition to his studies on the symbiosis between algae and micro-organisms, Geddes was sent by Huxley to Naples to draw inspiration from this re-

nowned institution throughout Europe and to replicate it in Scotland. It was not long (August 7, 1879) before the young biologist became the director of his marine museum: the Marine Scottish Station in the Stonehaven countryside, 15 miles south of Aberdeen. He gave a detailed account of it in two articles in The Scotsman on 14th July and on 22nd September 1879 (Geddes, 1879a, 1879b).

We learn the news from the letter with a photo (missing) dated 4th September 1879 written by Geddes from Perth to Eisig: «This is a portable wooden house like that of the Dutch naturalist: in fact Dr. Hubrecht kind has gave me the idea when I had the pleasure of meeting him in Naples» (Geddes, 1879d). As we learn from the same letter, Ambrosius Hubrecht, curator of the Rijksmuseum van Natuurlijke Historié in Leiden, had shared with Geddes his stay at the Station, before becoming the renownedbiologist specialising in embryonic studies of tarsids.

The Stonehaven Station was set up together with the biologist James Cossar Ewart, who specialised in the study of horse-zebra hybrids, Conservator of the Museum at University College London (where he had attended laboratories with Geddes) and Professor of Natural History at Aberdeen University where Huxley had become rector in 1872. It was equipped with two boats, fishing gear for collecting specimens, a laboratory, a shop, a zoological library and tanks for public display of marine animals. It had a mostly didactic purpose and it was Geddes himself who was responsible for welcoming visitors and explaining the various species on display. Once the summer was over, it was dismantled and reassembled at various locations in Scotland. In his letter of 4 September 1879, Geddes also mentions his forthcoming trip to Mexico, in the aftermath of his failure in the competition at the University of Manchester, where he came second after Cambridge embryologist Milnes Marshall, giving his address where he received mail until April 1880: "pl. Banco de Londres, Mexico". The British Association for the Advancement of Science had awarded him a grant for research in palaeontologyand zoology in Mexico, with the task of sending rare species to Europe from the remote country. Patrick's brother Bob, a director at the National Bank, also worked there. This stay marked a turning point in Geddes' career, as an illness caused him to temporarily lose his eyesight, permanently preventing him from using a microscope. His return began a period in which his university career and scientific research were increasingly complemented by social and urban studies.

The theory of "reciprocal accommodation"

Geddes' stay at the Dohrn Station was important above all from a scientific point of view, as can be seen from his publications from those years (Geddes, 1879e). He studied the nature and function of the yellow cells he observed in Naples in the marine protozoa known as *Radiolarians*, which Huxley called *Thallassicolla*, showing that the filozoon (the term Geddes coined for the yellow cells) and the cells of the Radiolarians were mutually beneficial.

Moving to Edinburgh in 1880 to obtain the professorship in Botany (which he won in 1888 at the University College of Dundee), he got back in touch with the Neapolitan Station, this time writing a letter dated 5 April (Geddes, 1880) to Paul Mayer (1848-1923), another important collaborator of Dohrn's since 1874. The letterhead of his letter read School of Medicine, Zoological Laboratory, Edinburgh, and Geddes specified that as he had moved to Edinburg to start lectures on Zoology (as a private lecturer), he had to prove to the University that he was in possession of the specimens, diagrams and all the teaching apparatus necessary for his confirmation. To this end, he asked Meyer to send him from Naples 'the sooner the better' a list of preparations, perhaps taking advantage of some English scholars returning to his country (this is confirmed in the following letter to Meyer dated 7 June). As mentioned above, he returned to his study desk at the Neapolitan Institute from 8 October to 14 November 1881. The correspondence kept at the Zoological Station ends here[1].

In October 1881 he set out his theory of "reciprocal accommodation" in a paper entitled *Symbiosis of Algae and Animals*, which was first read at Edinburgh University Medical School and then published in *Nature* a year later. The conclusion summarises its scope: «For a vegetable cell no more ideal existence can be imagined than that within the body of an animal cell of sufficient active vitality to manure it with carbonic and nitrogen waste, yet of sufficient transparency to allow the free entrance of the necessary light. And conversely, for an animal cell there can be no more ideal existence than to contain a vegetable cell, constantly removing its waste products supplying it with oxygen and starch and being digestible after death. […] In short, we have here the relation of the animal and the vegetable world reduced to the simplest and closest conceivable form. It must be by this time sufficiently obvious that this remarkable association of plant and animal is by no means to be termed a case of parasitism. If so, the animals so infested would be weakened, whereas their exceptional success in the struggle for existence is evident» (Geddes, 1882).

Conclusion: the urban implications

Geddes' studies on the symbiotic relationships observed in marine organisms characterised by an ecology based on "reciprocal accommodation" were the basis for interpreting other types of relationships as well, including those between humans in the city, even the poorest one considered in Victorian age, in the middle of the race of capitalism, a parasite (Samyn, 2020).

From these years onwards, Geddes began to openly take sides within the circle of thinkers who opposed progress because of the form it was taking in Britain at the height of the industrial revolution. In his book *Ruskin Economist*, published in 1884, he formulated a political economy that was a synthesis of culture, science and the environment. The same year he was among the founder of the "Edinburgh Social Union" thus contrasting the measures of the Improvement Act for Edinburgh (1867) under which unhealthy housing was simply torn down. This was followed by membership in Arts and Craft in 1889, in conjunction with the association's convention in Edinburgh, which Geddes attended with William Morris.

In 1886 Geddes married Anna Morton with her he went to live to James's Court a slum in the city, which was rather run-down and infamous, and to which they devoted to repopulate and create what we today call urban mixite: an urban society composed from different populations.

Colin Ward highlights how Geddes' position is at the antipodes to that carried out in those years through large-scale gutting that eliminated the genius loci, since, in his vision, an old building properly renovated can be reused for modern uses (Ward, 1976). But the issue pertains not only to the physical sphere of buildings, but rather to the social dimension of neighborhoods that must be considered as urban communities, governed by the coexistence of different classes. Thus, applying evolutionary principles to human society as it relates to the space in which it has settled, even considering the housing condition of the "parasite people", contribute to the improvement of society, to which these generally marginalised people also contribute.

Morton had been working in London with Octavia Hill (1838-1912), as well as with Henrietta Barnett (1851-1936), both of whom focused onimproving the housing conditions of the poor people (Whelan, 1998). Many of the activities carried out by the Geddeses were inspired by their legacy, namely micro-interventions carried out together with the inhabitants, in which the creation of public spaces and gardens played a fundamental role. Within the "Edinburgh Social Union", Geddes dedicated himself to decoration, starting from window embellishments with plants and flowers (Ciacci, 2021).

In this light, the reuse of historic buildings for students and professors' residences that he initiated in those years should also be read. The University Hall and the Ramsay Garden were projects based precisely in repurposing pre-existing housing into places of study for new residents who would bring, with their culture, added value to the old neighborhood (extending the university to the city, outside the classrooms).

It is not surprising that Pëtr Alekseevič Kropotkin (1842-1921), who between 1890 and 1896 formulated the theory of "mutual aid", at the heart of the principle of solidarity, along with the geographer Élisée Reclus (1830-1905) and the zoologist Éli Metchnikoff (1845-1916), visited the Geddes family in 1886 (Ferretti, 2016). Openly opposed to what was crystallising as "social Darwinism", and thus to competition as an evolutionary factor, Kropotkin found himself perfectly aligned with Geddes' ideas. In his text *Mutual aid: a factor in Evolution* published shortly afterwards (Kropotkin, 1902), the Russian prince had identified each point on an "evolutionary ladder" as the dominant motif of mutual aid, a factor of natural balance and progress between peoples. It was Kropotkin who introduced Reclus to the urban renewal projects the Geddeses were carrying out. The French geographer is known to have attended the Edinburgh Summer School in 1893 and 1895 organised by Geddes. The Outlook Tower (1905) was its continuation (Meller, 1990).

From his scientific discoveries and through these meetings, Geddes would increasingly outline his position based on "reciprocal accommodation" in an evolutionary sense, which would orient his approach as a scholar of urban phenomena. Indeed, rom this ecological perspective he will write his most famous text *Cities in Evolution* (1915), and he will base his chair on Sociology in Bombay from 1920.

NOTES

[1] The 30 January 1888 letter to Dohrn from Edinburgh, the 28 January 1888 'letter of application', and the 8 March letter to Dohrn from Edinburgh are archive gaps.

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Informal and Italian illegal settlements: two city visions

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Abstract. The informal city is configured and articulated as a spontaneous, sprawling or illegal city. Each of them present recurring and distinctive characteristics also in relation to specific territorial contexts. After outlining the scientific background of informal and illegal cities, and summarising the Italian specificities of the last ones, the paper focuses on the dualism between the informal and the illegal city found in the analysis of the technical literature on the subject regarding spatial planning. The aim is to bring out affinities and differences between the two city models to contribute to the formulation of the correct contents of urban planning tools for their redevelopment and/or regeneration to transform especially Italian illegal cities into liveable neighbourhoods.

Keywords: Informal city; Spontaneous city; Illegal city; Sustainable regeneration; Spatial Planning tools.

The informal settlements_ Cultural and scientific background and critical framing of the debate

Squatter settlements present in different shapes in the urban built environment of the world and are the outcome of a process that has been advancing steadily for more than half a century, spatially manifesting a socioeconomic and cultural malaise of a large part of the urbanised population in opposition to or in the absence of physical planning rules. Urban Geography Glossary (2008) defines spontaneous settlements as outward expansion of population centres, citing growing urbanisation added to the lack of services (Ekandem *et al*., 2014).

The definition of "spontaneous settlement" is only one of several names by which this phenomenon is identified. A term widely used in the global vocabulary to label this trend is squatter settlement. In his research *Defining Squatter Settlements*, H. Srinivas (2005 exposes how the flow of migration has created a growing demand for construction in recent decades. This has not always been met in time and has, therefore, led to migrants being faced with the need for shelter that could be adapted to their needs. The problem is two-fold, precisely the lack of means on the part of migrants and the apathy of governments in dealing with migration. The consequence has often been drastic, namely the illegal occupation of available space and land. This has only aroused the dislike of institutions and citizens, who perceive spontaneous settlements as an invasion and a social evil however, this situation has also highlighted another serious issue, which is adequate housing for all.

According to data compiled for the *Global Report on Human Settlements* (Un-Habitat, 2009), about one billion people lived in informal settlements at the time, and still do in 2022. According to the new UN Habitat report, 25% of the world's population lives in informal settlements (https://data.unhabitat.org/pages/housing-slums-and-informal-settlements). The UN-Habitat agency speaks of rising figures even in 2013. According to research conducted at the Rights Observatory by Álvaro Puertas Robina, architect and secretary general of Habitat International Coalition (HIC), more than 1,9 billion people still lived in slums at the end of 2019 (https://www.osservatoriodiritti.it/2020/01/07/baraccopoli-significato-nel-mondo/). Areas in Latin America, such as Argentina with Villas miseria[1], Peru with Barriadas[2], Brazil with Favelas[3] and Africa with Bidonvilles are mostly affected by the self-made city "Slum" phenomenon. The phenomenon of informal building and urban planning is also present in the European sphere, specifically in the Mediterranean belt, and involves Spain with Suburbios (1930) and Barrios marginales (1940-1970), Turkey with Gecekondu[4] (Fig. 1) Tunisia with Gourbvilles[5] (Bertini, 1994), the southern part of France, Greece, and Italy with widespread and/or illegal settlements.

The multiple definitions of spontaneous settlements have created so much confusion over the years that the concept itself is difficult to understand. However, it should be clarified that the definition of an informal settlement refers to the physical conditions of this type of urbanization, and not to its legal nature, an aspect we find in the unauthorised ones. The accurate translation of the term is illegal settlement.

To better understand this phenomenon, it is necessary to reread the history of housing, which over the centuries has seen the status of housing construction change from an autonomous activity, carried out under the control of users, to a bureaucratised and controlled system. This change is inextricably linked to the concept of housing, which increasingly becomes a product of the market, moving away from its conception as a complex process proper to human beings. Bureaucratisation tends to increasingly reduce user control over their own lives, and to blur the right to do for themselves what they can do, passing the burden into the hands of the state, and thus producing an unsustainable expense for it.

The available literature, starting in the 1970s, produced by researchers such as Ward, Fichter, Illich and Turner himself, highlights very critical positions with respect to the ability of the state and institutions to respond to certain basic needs. From the studies of these authors, the state and the market have shown themselves incapable of producing housing capable of satisfying human needs. The first victims of this new system are the weaker segments of the population who pay with systematic exclusion from decent housing.

The phenomenon of informal settlements is not attributable only to developing countries. Indeed, there is a certain background of experience in the history of the most developed nations. The most common form we find in the previous century

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mostly belongs to agricultural squatters and, in some cases, to pioneers. What has always limited their development is a traditionally rigid attitude towards the respect of property rights. The history of illegal settlements in the United States is linked to the regulation of property rights. In 1841 with the Preemption Act, the government sanctioned the possibility of purchasing land by families who had settled there for more than fourteen months, agreeing with them very low and accessible prices. Other relevant cases in the USA concern the period of the Great Depression of 1930, a period in which the numerous unemployed and homeless built illegal settlements in abandoned areas, often in swampy or border areas. The national government responded by strengthening the borders and building low-cost public housing. In these cases we are talking about phenomena that do not present numbers comparable to realities such as Latin America or Africa and are therefore easier to absorb, especially if addressed quickly.

Origins: Thesis supported on the dualism between informal planned cities

The origin of the term "informal sector" is attributed to Keith Hart, an English anthropologist, who introduced this concept in a paper presented at a 1973 conference on an indigent working in Accra (Ghana). The International Labour Organization recovered this term in a study on the urban economy in Kenya, using it to describe small-scale economic activities and unregulated employment. Unofficially, the term was already in use in some research, for instance that of Arthur Lewis (Lewis, 1954) in the 1950s. The economist focused on informal work and its economic aspects but neglected the spatial sphere and emerging forms of urbanisation. Yet, it was Lewis who first began to separate two different environments, precisely the formal and the informal.

In the late 1970s, Caroline Moser offered a description of informality linked to the settlements and their inhabitants, focusing on the antithesis nature of these environments to traditional planning models. It is evident how, in the early debates, informality appeared as a social and economic phenomenon, and only later was it linked to urbanism. In official documents, the phenomenon was officially analysed, for the first time during the 1976 Habitat Conference in Vancouver (Un-Habitat, 2009). The earliest writings on the subject are the productions of Charles Abrams (Abrams, 1964) and John Turner (Turner, 1968). The former illustrates the process as a conquest of urban areas dictated by the law of force at the expense of the force of law. The second extols the outcome of self-production, recognising it as a very successful solution to housing problems in urban areas in developing countries.

Abrams in the dossier *Squatter Settlements:the problem and the opportunity*, exposes and analyses the data inherent to migratory flows towards large cities, arguing that the growing problem of squatters is to be blamed on the shortcomings of political management (Abrams, 1966). Criticism is levelled at political actions that in some cases tend to ignore the proliferation of this phenomenon, to the point of no longer being able to manage it. The researcher starts from the concept of the need for shelter, which drives parts of populations to occupy vacant land to the detriment of private owners and the state itself. The resulting economic damage is not only immediate, but risks being exponential due to the impossibility of reclaiming land, which, as the years go by, sees the number of occupants grow frighteningly to the point of making eviction impossible.

In the 1970s and 1980s, at the height of its discovery, the phenomenon became a subject of study for sociologists, anthropologists and economists and less so for architects and town planners. These years saw the spread of what can be described as a dualistic approach, which contrasts formal and informal. The former seen as a planned system opposed to the latter, considered merely a non-planned form. However, this tendency ignores the complex system of dynamics encapsulated in this concept. Also in Italy, Fera and Ginantempo, in a 1985 study, define illegal and spontaneous self-building as a phenomenon that occurs where the legal building market is absent or unable to meet social demand. The scholars differentiate between those who own land and build without authorisation based on their own needs and those who must look for a roof and land to manage themselves. However, from the point of view of land transformations they are different ways in which squatting has spread.
This idea has also been analysed over the decades by various practitioners. Sfter a study in Lagos (Nigeria), Rem Koolhaas (Koolhaas, 2006) extols the creativity of residents and their promotion of new forms of housing. Ananya Roy elaborates on what Koolhaas stated, and defines the informal field as subaltern urbanism (Roy, 2011,). Hernando De Soto, on the other hand, focuses his attention on the lack of growth of some African realities, blaming the informal sector that does not allow their development, stifling their possibilities (Benjaminsen *et al*., 2009). This set of reflections constitutes what has been called a dichotomous oppositional approach. In contrast to these, there are other theories that classify informality as a production of space, a possibility of connection between opposing and divergent realities. Felipe Hernandez proposes the theory of intermediate space (Hernandez *et al*., 2010), an alternative that leaves ample room for unprecedented forms developed by creativity. Instead, Oren Yiftachel identifies informal settlements as a grey space between the white of legality/approval/security and the black of eviction/demolition/death (Yiftachel, 2009). The idea of grey space, linked to permanent areas on the fringes of cities, is open to various evolutions. The author defines a bleaching process and a blackening process. The reflections proposed by Hernandez and Yiftachel highlight how planning practices, combined with informal practices, form a single system. The study of informality can be summarised in three phases. In the first phase, between the 1970s and 1980s, we find the dualist school, which conceives informality as a set of marginal activities excluded from the formal sphere. The second phase, between the 1980s and 1990s, is marked by the spread of multiple interpretations. Among the most relevant are the legalist approach, characterised by the view of informality as a set of positive forces in a formal context linked to power strategies. In the 21st century, after a few years of apathy with respect to the phenomenon, a phase marked by a renewed interest begins, particularly in the relations with the globalisation processes that are changing the economic, social and political geography of the world.

The Italian illegal settlements_Cultural and scientific background

The issue of illegal building and town planning is addressed in this section with an eye above all to the town planning tools useful for the redevelopment of illegal/illegal settlements, and in particular to identify: a) the boundary of these settlements; b) the techniques involved in their subsequent redevelopment; c) the type of tools available for abuses committed in areas at anthropic risk, especially seismic risk. Among the three possible approaches (repressive, mitigative and inclusive), the only practicable solution – mitigative – is to provide for specific variants of the municipal plan for the redevelopment of abused places and the urban reintegration of the parts of the territory affected by this problem (de Biase and Losco, 2023).
Building illegality is more than half a century old. An emblematic case is Rome, where the relationship between the spontaneous Borgate of the 1950s (see, for example, the Mandrione Borgata) and the building units of the 1930s (e.g., the Borghetto Latino, a nucleus that arose during Fascism, between 1932 and 1935, in the Appio Latino district) and the consolidation into off-plan Borgate districts of some barracks and suburbs already present in the 1920s (e.g., the Magliana or the Acilia Borgata of 1924) seems indisputable.
In this case the kinship between the spontaneous hamlets of the 1950s (see, for example, the Mandrione suburb) and the building nuclei of the 1930s (e.g. the Borghetto Latino) and the consolidation into off-plan hamlets of some barracks and Borghettos already present in the 1920s (e.g. the Magliana or the Acilia suburb of 1924) seems indisputable.
It was in the 1930s, during the Fascist period, that the emergence of the degraded suburbs was recorded in Rome. In fact, the regime proceeded with extensive and important demolitions in the historic centre and, at the same time, for the mass of the population expelled from it, it created a number of settlements of very low building quality, lacking the main services and generally located in the open countryside, possibly a long way from the historic centre, in some cases many kilometres from the consolidated city: Pietralata, Borgata Gordiani, Primavalle, etc. These settlements were flanked by the first self-built illegal housing, made up of shacks that, in most cases, were in very poor sanitary conditions (Cellammare, 2010). During Adolf Hitler's visit in May 1938, a trompe l'oeil backdrop was created along Via Tiburtina to conceal the spontaneous settlements that had sprung up during those years (Berdini, 2010).
As Cellammare writes in 2019, Rome is traditionally characterised

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by weakness and inability to govern the city and illegal occupation demonstrates this. The process of recognition and recovery of illegal settlements in Rome is long. In 1962, 44 illegal building nuclei were identified (F1 zones); in 1978, with the variant to the PRG, 84 "O Zones" were delimited; in 1997, the so-called "Piano delle Certezze" identified another 80 illegal areas defined as toponyms. The sizing of these areas was carried out in the 2008 PRG, and refers to specific recovery plans. If it is therefore clear that the phenomenon is long and complex, it is equally clear that the urban planning instrument has tried to intervene, providing for specific interventions to resolve the phenomenon (https://www.mapparoma.info/mappe/mapparoma33-labusivismo-a-roma/). In Italy, the distortions in urban development were determined, starting from the second post-war period, by a series of causes, such as the rapid transformation of the country from agricultural to industrialisation and the growing demand for housing. These are situations for which planning has not been able to play the typical role of controlling the development of housing stock and urban transformations. There are many reasons for this inability, precisely the absence or complexity of legislation, the lack of supervisory action, the inability to adequately repress illegal interventions. In the 1970s, building squatting was determined by a clearly identifiable demand, supported by a lower-middle class, workers and artisans, and by a consequent supply, prepared by small or improvised builders who are the main protagonists in large cities and their suburbs. They construct properties that they sell illegally to buyers who are as needy as they are uninformed. In the latter half of the 1980s, the scenario changes considerably. The builders are no longer the turnkey organisers of the business. The driving force becomes the owner of the land, who already owns it as an agricultural plot or buys it fractioned from third parties. He has the unauthorised housing built, often repaying the company with part of it, reversing the mechanism of the previous decade. The housing is sold when it is not kept for himself or his family. The phenomenon was further perfected in the 1990s. Organised companies hardly intervene any more in the construction of unauthorised buildings. Small teams of workers and craftsmen, either totally irregular or permanently employed in construction companies, carry on the construction until completion, in an exclusive relationship with the landowner. From the early 2000s to the present day, the phenomenon of unauthorised building has been moving towards a kind of marginalisation. Owners of land with buildings that are generally wholly owned, who extend or raise them, create additions, build unauthorised constructions (garages, basement volumes), on buildings that are sometimes already unauthorised and regularized by a building amnesty or subject to amnesties that have not yet been administratively defined. Illegal construction is just one of the most evident symptoms of a distorted modernisation and failure of some paradigms of urban planning discipline (Zanfi, 2008). The reasons for the success of the term illegal settlement are in its immediate representative effectiveness. At the same time, the word evokes the idea of the anomalous use of a resource, namely the soil, of its overuse, of a practice that benefits those who practice it to the detriment of others and the entire community (Fig. 2).
This term entered the Italian collective imagination following the Agrigento landslide and building collapse of 1966, when the hill of Girgenti collapsed under the weight of the most incredible speculation and dragged with it the product of an intricate combination of building entrepreneurs and local politicians, who had systematically eluded constraints and regulations by erecting tall buildings on a landslide slope. The disturbing view crushed by

the telephoto lens of the "Greek Temple of Concordia" dominated by skyscrapers thus becomes the metaphor of an opulent illegal construction that destroys the city and the landscape.
A country where speculators can deface cities, destroy coastlines, destruct the landscape with impunity, can do all this and more without paying personally and without answering to public authorities.

The illegal settlements: critical framing of the debate
Leaving aside the classification of the different types of abuse, it is important to remember that the way of producing suburbs outside the plan forecasts shows a much more structural distinctiveness that goes far beyond the discrepancy from urban planning tools. Spontaneous periphery is configured as an actual mode of growth of the urban periphery in which the role played by the institutional centres of government of supply and demand (state and market) is secondary to the self-organising capacities of users.
It is essentially a way of producing low-cost suburbs, or at least ones suited to the investment capacities of low and middle-income households. The condition for the phenomenon to occur is the establishment of two orders of anomalous relations within the urban intervention models. The first is related to the way space is physically organised, and can be generalised when similar conditions of urban intervention occur. The second concerns the guarantees that regulate the relations between the agents involved in the various phases of the settlement process. Indeed, given the difficulty of generalising structurally different situations, it is impossible to identify it except by contrast with what is considered orthodox in the specific context situation.
One argument used to justify illegal culture is that it has been able to provide a housing response to families who had no market alternatives. It is certainly true that the amount of public housing built in Italy has always been far less than the population's actual needs, and it is equally true that migration flows in the first two decades of republican Italy were so intense as to make it difficult to control the transformation of the territory. But the cause-effect relationship is not so straightforward. Turin and Milan have not experienced building abuse, except to a marginal extent and limited to small extensions or changes of use of non-residential premises. In Rome and throughout the South building squatting is rampant, creating neighbourhoods, buildings and production facilities. Here too, post-World War 2 Italy shows two faces.

Thesis supported and Concluding considerations

At the end of the 1980s, the need for a different or alternative urban planning instrumentation, which could replace the more traditional urban planning tools for a strategic rethinking of the city, was emphasised in the Italian urban planning scene. The crisis of traditional urban planning instruments was already evident: the armamentarium of operational town planning had proved ineffective.
The entire decade 1980-1990 places Italy clearly behind Europe in the recovery of the growing dysfunctions of cities. While in the more advanced countries new tools had been developed and operational for some time, our country remained anchored to a traditional conception of urban planning discipline, built on the rules of prohibition or on the rationale of attributing building rights to individual land. In those years, the end of the era of building expansion and the economic recession led to a profound rethinking of urban structures and a strong demand for redevelopment, recovery, reconversion – including social – of large portions of the city.
The poor operational capacity demonstrated by the planning system, combined with a growing weariness towards any kind of procedural engineering mechanism, have perhaps accelerated a process that has already been underway for some time. The situation has led, in urban planning culture circles, to a comprehensive reflection on the principles and tools of territorial governance[6] and, in practice, to the so-called level of constraints, with an interpretation of urban planning as a taxing tool, aimed at imposing what cannot and must not be done. The latter is the objectionable predominant solution in the mid-1980s. From a constant process of identification of the plan with the constraint, a further reason for intolerance towards urban planning and its tools has arisen. The arrival of the Nineties determines a radical change of direction. The scenario in which urban intervention is carried out has almost definitively changed, and from the phase of expansion outside or close to the inhabited centre, the so-called growth of the city within the city is identified as the most suitable solution to respond both to housing and urban quality needs and to the needs of the building market. It is not possible to entrust important urban redevelopment interventions to the plan conceived in the Eighties. After the complex planning phase, today, thanks also to the spread of community policies, other types of tools are starting to assert themselves which, placing themselves halfway between the traditional urban plan and the actual building-urban project, seem capable of responding to the new needs of regeneration of the city. The scientific and cultural debate surrounding this type of settlement process of the *informal city* oscillates between the definitions of *spontaneous city* and *illegal city,* often giving a positive connotation to the former, and a negative one to the latter. Two ideological conceptions of the city confront each other:
– the *spontaneous city* tends to emphasise the unplanned, do-it-yourself character, the protagonism of the inhabitants and a city that is often defined as self-built. In this sense the

meaning oscillates from a neutral connotation – linked to its non-formal character – to a positive one, linked to the direct and social production of the city by the inhabitants;
– the *illegal city* tends to emphasise the illegal aspect of the behaviour and consequently the negative effects on the growth/development of the city, including those related to land consumption, environmental damage and lack of facilities. The negative interpretation is related to the image of the degraded city and generally, linked to this interpretation, to the proposal of policies related to the control and repression of illegality.

Actually, these are two dimensions of the same process, two valid points of view but both insufficient to view the phenomenon. Moreover, as Cellamare (2019) wrote, while it is true that «the dimension of informality assumes [...] often a - seemingly - positivised, if not even romanticised character [...] it is also true that it is a rather problematic material, social and symbolic place». Instead, it is often a place of great conflict and tension, and it is not taken for granted that forms of self-organisation will develop. In reality, there are common characteristics of the two types of phenomena, such as the process of self-building, in the initial phase of the squatting phenomenon also the need for shelter, the tendency to occupy interstitial spaces and, above all, the search for proximity to connecting infrastructures. While this is true, there are also differences, one of which is the social class of the inhabitants who, in most spontaneous settlements, have a very low income, whereas they belong, at least in recent times, to the middle classes in the squatting phenomenon.

Despite the differences in conceptions and definitions, the real substantial difference between the two lies in the political attitude. The spontaneous city is itself an illegal city, even if the substantial difference can be seen in the *ownership of the land*. Indeed, part of the shantytowns is located on public land (clearings, buffer strips, etc.) expropriated from private individuals while, generally, the illegal settlements arise, in most cases, on land owned by the builders or the *squatters themselves*. This last aspect highlights the political problem of managing public goods, and the fight against illegality.

NOTES

[1] An informal settlement formed by precarious houses is called a villa miseria. They take their name from Bernardo Verbitsky's novel Villa Miseria también es América (1957), which describes the terrible living conditions of internal migrants during the so-called Infamous Decade.

[2] Barriada slums are poor areas on the outskirts of large cities. There are more than 800 slums in Peru, called today's youth, an expression that hides the sad reality of these neighbourhoods.

[3] The term favela refers to Brazilian slums, generally built on the outskirts of major cities. The dwellings are built with a variety of materials, from simple bricks to scraps salvaged from garbage, and very often the roofs are made of asbestos cement.

[4] The term Gecekondu is derived from the fusion of Gece and Kondurmak, which mean night and put suddenly, respectively, and stands for the informal neighbourhoods typical of Turkey. The debate over these settlements began in the 1940s when the country's major cities, such as Ankara, Istanbul and Izmir, were affected by the massive phenomenon of immigration that saw the emergence of new construction outside any physical land planning instrument and without any building permits. Over the years, national policies have produced various attempts at resolution by adopting in some cases the path of amnesty and depriving the term itself of direct reference to informal settlements.

[5] The earliest forms of spontaneous settlement date from the 1930s, until then the building types were those of the dar, a traditional single-family house with an interior courtyard (wust al-dar, the patio), located in the historic centre; the continuous multi-story collective building that, repeated in series, forms the blocks of the part built by the French immediately abutting the medina; and the isolated single-family house, villa or pavillon, of the suburban neighbourhoods that define on the territory a veritable garden city (citè jardin). To these types are added a set of rural precarious dwellings and rural stable dwellings called houch, which together form the gourbvilles. These were built and inhabited mainly by the rural population that still migrates to the main urban centers (Tunis, Sousse, Sfax, Bizerte).

[6] In the XXI Congress of Bologna (1995) the INU launched a proposal to reform the rules and principles of urban planning.

ATTRIBUTION

Within this contribution, which is the result of a joint elaboration by the authors, personal contributions can be identified as specified below: *Paragraph 1 – The informal settlements – Cultural and scientific background and critical framing of the debate* (Claudia de Biase) and *Paragraph 2 – The italian illegal settlements – Cultural and scientific background* (Salvatore Losco). *Abstract* and *Thesis supported and Concluding considerations* are the result of joint elaboration. This work is the outcome of the research carried out by the two professors also within the framework of technical-scientific conventions, stipulated with the Departments of Architecture and Industrial Design and Engineering of the University of Campania *Luigi Vanvitelli* with the Municipalities of Orta di Atella (Ce), Terzigno (Na) and the Province of Caserta.

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The role of cultural heritage in resilience planning: evidence from 100 Resilient Cities

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Abstract. As a container of accumulated experiences, cultural heritage connects past, present and future by transmitting knowledge to future generations through tangible/intangible assets. With this potential, cultural heritage can significantly contribute to community resilience, yet available resilience strategy documents place limited emphasis on cultural heritage. Based on this observed lack of systematic consideration, this paper analyses the resilience strategy documents presented in the 100 Resilient Cities Programme, and discerns six approaches towards cultural heritage, namely ignorance, economic development tool, identity construction, social component, physical integration tool, and comprehensive consideration. The paper discusses further ways cultural heritage can enhance community resilience.

Keywords: Resilience; Community Resilience; Cultural Heritage; Heritage Resilience; Resilience Planning.

Introduction

Urban and rural settlements embody the inherited cultural, social, political, economic, and technical knowledge, practices and assets throughout the history of societies. Although these values are aimed to be documented, conserved and sustained by global and local actors, some remain hidden in daily socio-cultural and socio-spatial practices of communities. Cultural heritage, as a container of accumulated experiences, connects past, present and future by transmitting this inherited knowledge to future generations through tangible and intangible assets (UNESCO, n.d.). The know-how embedded in cultural heritage holds great potential for the challenges faced by urban and rural settlements today, such as climate change, extreme natural disasters, globalisation, urban growth, wars and terrorism, and recently health crises such as epidemics, pandemics and beyond. Sustained cultural assets accommodate the traditional knowledge, which is proven historically through successes and failures against the challenges faced, and bearing the potential to bring the members of communities together through shared values, practices and spaces. As urban and rural settlements are increasingly threatened by an emerging array of risks today, resilience becomes crucial in coping with them (Berkes *et al.*, 2003; Altay-Kaya, 2019), and cultural heritage holds a substantial role in enhancing resilience (Fabricatti *et al.*, 2020).

Resilience planning and community resilience

The contemporary risk environment, characterised by disasters and crises that are caused by climate change, wars, terror or economic crises, poses a concrete threat to communities and cultural heritage. Resilience planning, a prominent approach in planning practice (Eraydın and Taşan-Kok, 2013), developed in response to this current landscape of uncertainty, aims at making cities and communities prepared for unexpected or projected threats, enhancing their capacity to cope with them and to adapt to change, while investing in development potentials (Adger, 2000; Nelson *et al.*, 2007).

Resilience perspective is significant with its comprehensive, multi-dimensional and multi-scalar undertaking, upholding universal values like human rights, democracy and sustainability (Altay-Kaya, 2021). Resilience planning accepts that unexpected problems will occur, and for better coping, cities and communities should develop strategies in relation to their prevailing vulnerabilities and adaptive capacities (Nelson *et al.*, 2007). Ecological, social, economic and urban dimensions should be comprehensively considered in resilience planning (Beatley, 2009), while operationalisation of the plan (Altay-Kaya, 2019) and cyclical feedback are equally important (Foster, 2006). Community resilience is described as the ability of communities to cope with disturbances based on their social, economic, institutional and physical capacities, most specifically based on their ability to work together for a common objective (Berkes and Ross, 2013). «Knowledge, skills and learning», «Community networks», «People-place connections», «Community infrastructure», «Diverse and innovative economy", and «Engaged governance» are the six attributes of community resilience asserted by Maclean *et al.* (2014). Similarly, values, knowledge, skills and learning ability, agency and self-organisation capacity are among the factors enhancing community resilience (Berkes and Ross, 2013). In this regard, learning from former experiences and learning from the past are critical inputs for resilience (Lu and Stead, 2013). This includes using inherited local knowledge, traditions and practices that are strongly connected to cultural heritage. Cultural heritage thus reveals its true potential for fostering resilience, while resilience planning ensures the conservation of cultural heritage and its transmission to future generations.

Heritage may become the direct focus of resilience planning, where cultural heritage is at risk in face of identified risks such as climate change, natural hazards, wars, and urbanisation. Even if not explicitly targeted, heritage holds a strong potential for building up resilience for communities in many aspects. This paper aims to underline this latent and under-valued potential. Claiming that heritage is an important tool for building resilience, the paper discusses the highlighted interactions between cultural heritage and resilience. It then examines the way cultural heritage had been referred to in the resilience plans of major metropolises in the world, developed under the framework provided by «100 Resilient Cities Network» (100RCN), named later as «Resilient Cities Network» (RCN).

The interplay between cultural heritage and social resilience

Cultural heritage, as documents of the history of humanity, refers to the existence of cultural identities and sense of belonging, by bonding humans with their physical surroundings (Labadi *et*

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al., 2021). Such bonds are created through a cultural accumulation, since prehistoric ages, which can be represented by various tangible and intangible, movable and immovable cultural assets (Mason, 2002). Traditionally, cultural heritage conservation theory focused on the material aspects of heritage, emphasising the preservation of monuments and artefacts (Smith, 2006). However, in recent decades, there has been a paradigm shift towards more inclusive, community-based approaches that focus on the social attributes of heritage (Poulios, 2014). Consequently, the scope of cultural heritage has expanded to include all forms of cultural traces including archaeological findings, historic buildings, traditional tissues, modern built-environment, customs, production modes, handicrafts, narratives and beyond (ICOMOS, 1994; 1999; 2008).

Cultural heritage includes the historical layering of knowledge through time. Sustained cultural assets accommodate the traditional knowledge, enriched through cumulative successes and failures against challenges (Jigyasu, 2013; 2019). Heritage plays an essential role in shaping and conserving cultural identities of communities by providing links to the past, a sense of belonging and continuity of knowledge, practices and values across generations (Holtorf, 2018). Hence, it is a vital dimension for community resilience, whose potential contribution to other development dimensions is undervalued and neglected.

The growing importance of cultural heritage in international policy documents

Considering heritage as an input in resilience planning emerges in the international agenda through cornerstone documents for cultural heritage conservation. The Faro Convention (Council of Europe, 2005) shifts focus from heritage to people (Fabricatti *et al*., 2020) by conceptualising "heritage communities" as «people who value specific aspects of cultural heritage which they wish, within the framework of public action, to sustain and transmit to future generations» (Council of Europe, 2005: 2b). The role of individuals, shared interest and responsibility, sense of belonging, and self-organisation capacity are indirectly revealed in the document as resilience components that can be enhanced by heritage communities.

The Hangzhou Declaration establishes direct relations between cultural heritage and resilience by stating that conserving the historic environment and safeguarding the relevant traditional knowledge, values, and practices enhances community resilience (UNESCO, 2013, p.8). The document directly refers to cultural landscapes, cultural practices, values and traditional knowledge as resilience components enhanced by heritage. Again, the Sendai Framework for Disaster Risk Reduction 2015–2030 (UNDRR, 2015) sets a direct relationship between cultural heritage and resilience by emphasising the part played by cultural heritage in understanding disaster risk (article 24d) and the protection of cultural heritage, including cultural institutions and historical sites as an investment in disaster risk reduction (article 30d).

The overarching role of heritage in achieving the «Sustainable Development Goals (SDGs)» (UNESCO, 2015) is thoroughly explored in the report titled «Heritage and the Sustainable Development Goals» prepared by ICOMOS (International Council on Monuments and Sites). The document underlines the potential to be harnessed from cultural heritage through cultural landscapes, practices, knowledge, resources and values for reaching SDGs and resilience (Labadi *et al*., 2021). Culture is referred to in the report as a major resource for creativity, innovation and problem-solving for resilience (Fabbricatti *et al*., 2020).

The above-mentioned major international documents show that cultural heritage's critical role for community resilience is increasingly recognised. On a similar stance, the recent literature on cultural heritage highlights the necessity to include it within resilience strategies (Fabbricatti *et al*., 2020; Holtorf 2018; Iavorone *et al*., 2019; Jigyasu, 2013). Yet, cultural heritage is still considered independently in common planning practice rather than being integrated as a structural component of resilience. Moreover, the positive reciprocal interactions between community resilience and cultural heritage need still to be unveiled. In this direction, this study seeks gaps in current resilience planning practices by analysing existing approaches to cultural heritage in urban resilience strategy documents (plans) published in the former 100RCN database, which covers the resilience plans of multiple cities worldwide, developed within their resilience framework and exemplifying different local contexts (100RCN, 2019).

The Analysis of different approaches in 100RCN urban resilience plans

The 100RCN was formerly a project of The Rockefeller Foundation, initiated in 2013. The programme aims at building resilience against social, physical and economic challenges of the century by establishing a global network of cities and providing resources for building resiliency strategies (100RCN, 2019). Until 2019, 74 cities had published their resilience plan online. Due to the ending of funding by The Rockefeller Foundation in 2019, the database is no longer available online. The Network pursues its activities under a new initiative, «Resilient Cities Network» (RCN). The resilience framework developed by 100RCN is still available (RCN, 2024). The presented research aims to identify prevailing approaches regarding cultural heritage in these urban resilience plans. The research comprises a three-staged content analysis examining the urban resilience strategy documents (100RCN, 2019).

Tab. 01 | Approaches in 100RCN urban resilience strategy documents

City	Report Name	Category
Athens	Redefining the City: Athens Resilience Strategy for 2030	Comprehensive Consideration
Byblos	Resilient Byblos: Connecting With Our Past, Creating Our Future	
Melaka	Resilient Melaka: Creating a thriving, liveable and smart Melaka	
Ramallah	Resilient Ramallah 2050	
Thessaloniki	Resilient Thessaloniki: A Strategy for 2030	
Colima	Colima Resilience Strategy	Physical Integration
Glasgow	Our Resilient Glasgow: A City Strategy	
Miami	Resilient Greater Miami & The Beaches	
Pune	Pune Resilience Strategy	
Rome	Rome Resilience Strategy	
Accra	Accra Resilience Strategy	Social Component
Amman	Amman Resilience Strategy	
Atlanta	Resilient Atlanta: Actions to Build an Equitable Future	
Bristol	Bristol Resilience Strategy	
Montevideo	Montevideo Resilience Strategy	
Pittsburgh	Pittsburgh's Resilience Strategy	
Puerto Rico	Resilient Puerto Rico	
Santiago	Human & Resilient Santiago	
Seattle	Seattle-Future City: Resilience Roadmap	
Surat	Surat Resilience Strategy	
Vancouver	Resilient Vancouver: Connect, Prepare, Thrive	
Juarez	Resilient Juarez: Resilience Strategy	Identity Construction
Louisville	Resilient Louisville	
Rio de Janerio	Resilience Strategy of the City of Rio de Janeiro	
Santiago de los Caballeros	Resilience Strategy Santiago de los Caballeros	
Tulsa	Resilient Tulsa	
Wellington	Wellington Resilience Strategy	
Bangkok	Resilient Bangkok	Economic Development Tool
El Paso	Resilient El Paso	
Kyoto	Resilient Kyoto	
Santa Fe	Santa Fe Resilience Strategy	
Semarang	Resilient Semarang: Moving Together Towards a Resilient Semerang	

The first stage (data extracting) analyses all information related to cultural heritage within the plans. The keywords searched are culture, heritage, traditional, historic, asset, and conservation. Secondly, the overall vision of the documents, identified challenges, and defined goals to release any approaches towards cultural heritage are skimmed. In doing so, headings, sub-headings, graphics, and diagrams where strategies/ policies/ plans/ actions directly related to cultural heritage, conservation, or use of traditional knowledge are identified.

The second stage (thematic examination) aimed at evaluating the prominent approach of the plans towards cultural heritage. Accordingly, documents were evaluated with respect to the predefined thematic questions, inquiring specifically whether cultural heritage is part of the identified challenges or goals, whether it is directly referred to, what the thematic stance towards cultural heritage is, its level of integration with the city, and what the specific conservation strategies are. These questions aimed to reveal cultural heritage strategies, policies or actions in the plans.

The third stage (evaluation) aims to classify how resilience strategies address cultural heritage based on the content and thematic analyses conducted at stages one and two. According to the analysis conducted, resilience strategy documents are classified into six categories with strategies differing in their level of consideration of cultural heritage. The identified categories are "ignorance", "economic development tool", "identity construction", "social component", "physical integration" and "comprehensive consideration". The categorisation of heritage approaches in plan documents, excluding the ignorance category, is presented in Tab. 1.

Prominent approaches towards cultural heritage in 100RC plans

The research findings reveal that the first category, ignorance, comprises the largest group of cities, which scarcely set any goal or principle regarding cultural heritage. Certain cities of the world rich in historical background are unexpectedly in this group. Paris is one example. The only action related to cultural heritage in the Paris strategy document (action 23) focuses on changes in heritage regulations for increased responsiveness to climate change. New York is another example. Cultural heritage is only distinct in the Energy actions (action 6), which aim to improve energy efficiency in historic buildings. In Washington DC, there are actions related to the cultural plan that primarily focus on preserving existing cultural institutions.

The second group of plans put economic growth at the heart of cultural heritage policies. These aim at increasing tourist activities to create both a driver sector and employment opportunities. Here, cultural heritage is considered an economic development tool, and renovation, refurbishment, rebuilding actions are the focus of interventions. In Bangkok for instance, heritage communities are aimed to be trained for entrepreneurship to support tourism and service sector development (goal 8). In Sante Fe, to invigorate the tourism market, the plan aims to revitalise cultural heritage by creating employment opportunities (action 25). Finally, in Kyoto, under the pillar titled «Linking Economy and Culture», cultural heritage is expected to foster economic development, as well as to benefit from economic development itself.

The third group of plans approach cultural heritage as a source for the construction of urban identity. The preservation of cultural heritage is considered for developing and strengthening cultural identity in these plans. In Louisville, goal 3.3. focuses on cultural heritage's contribution to creativity, knowledge, traditions, culture, meaning, and vitality. In Tulsa, shaping a shared identity for the diverse communities of the city is aimed to be achieved through cultural heritage. Finally, in Santiago de los Caballeros, the loss of cultural identity is defined as a challenge for the city, and developing a sense of belonging to the city, culture and history is set as a goal.

Plans that developed strategies towards cultural heritage by aiming at achieving social resilience form the fourth group, namely the social component. Documents in this group introduce principles designed to create awareness, promoting local culture, and integrating educational programmes. Intangible cultural heritage is brought forward to enhance social connections with cultural traditions, customs and handicrafts. For example, Vancouver identifies social cohesion and connection to culture as key indicators of community health and well-being, but also as a component of disaster resilience. Bristol aims at promoting «cohesive and engaged communities» by creating a «sense of collective identity and mutual support» grounded on the inclusive local cultural heritage, encouraging cultural diversity and safeguarding spaces where residents interact together. Finally, in Amman, cultural heritage is accepted within the social assets of the city along with conserved cultural traditions and customs. Amman identifies cultural heritage also as a historical asset with its historic buildings, archaeological sites and its old marketplace.

Within the fifth group, cities consider cultural heritage as part of decisions regarding urban systems by emphasising their physical integration into the city. Connection of cultural assets and sites to certain parts of the city by means of urban regeneration, improvements on transportation networks and green systems were the general aim. In Colima, there is a direct action on the refurbishment and reconstruction of buildings that have high cultural, historical, and architectural value. In Glasgow, retrofitting historic buildings to ensure long-term fitness for function and promoting climate adaptation is a planned action. Finally, in Rome, one of the main resilience challenges is identified as the «maintenance of the city's cultural heritage», and the goals on promoting cultural life, urban regeneration and landscape and natural heritage in the urban environment are proposed in response to that challenge.

The sixth and final group consists of cities that developed a comprehensive consideration of cultural heritage through economic development, community engagement, protection of culture, social cohesion, empowerment of community members, cultural identity and urban policies in a comprehensive way. Athens, Thessaloniki, Melaka, Byblos and Ramallah are the representatives of this category. In Athens, for instance, cultural heritage is considered an asset to foster urban identity and belonging, as part of a creative economic development, as part of the urban natural/green systems, as part of food policy and cultural activity planning. The Maleka resilience plan puts tangible and intangible cultural heritage assets at the core of their strategies to create engaged communities, a liveable city and collective governance. The aim is to assure the conservation of tangible/intangible heritage, enhancing economic development, promoting urban identity and belonging at the same time.

Conclusion

The research proves the lack of a systematic consideration of cultural heritage in the resilience planning practice conducted as part of the 100RCN between the years 2016 to 2019. Many cities – 55% of the plans – lack a specific focus on cultural heritage in their plans. However, treating cultural heritage only as a tool for economic development is problematic as heritage values and social components of cultural assets are ignored. The sustainability of cultural heritage relies on the togetherness of both economic and socio-cultural values. The economic focus distinguishes the tourism sector as the main source of economic benefits, although traditional vocations can bring equal benefits. Cultural heritage can most effectively support resilience when it is considered with all the above-mentioned dimensions together, in a comprehensive way. The last group of documents provide enlightening insights in terms of specifying various roles of cultural heritage at once.

This paper aims to reveal the positive outcomes emerging from the synergies between cultural heritage and community resilience. It is claimed that while cultural heritage brings on major assets for enhancing resilience, resiliency helps the protection and conservation of cultural heritage values. In this manner, the sustainability and existence of movable/immovable and tangible/intangible cultural heritage is crucial in making cultural heritage «an active component of urban resilience» (Jigyasu, 2019). Cultural heritage, the inherited knowledge, traditions and practices embedded in the local culture, supports promoting belonging, assuring better community engagement, developing strategies that will fit into the local context and beyond. These aspects prove to be important criteria to achieve resilience policies. There is still the need to elaborate on these interactions in more detail.

This study suggests that the conservation of cultural heritage should be an aim per se in resilience planning, while cultural heritage should be considered comprehensively in resilience

planning processes for their potential contribution in terms of knowledge and technique, and their role as social catalyst. Cultural heritage policies can be included in all dimensions of resilience planning, rather than being subsumed under sectoral plans. A comprehensive approach in resilience planning where heritage is a structural component comprises the elaboration of physical, environmental, socio-cultural, socio-spatial, economic, knowledge-related and governance-related dimensions of cultural heritage together. Cultural heritage can, therefore, become a significant concern in resilience planning, with growing awareness at the individual, community and institutional levels.

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Evaluation methods for waterfront public spaces: insights from different spatial scales in chinese and international cities

ESSAYS AND VIEWPOINT

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Abstract. This research explores the evaluation methods for waterfront public spaces based on different project scales. It categorises the evaluation methods into three levels: large-scale, medium-scale, and small-scale, and proposes the most effective evaluation strategies for each. This study selected waterfront spaces in 38 Chinese cities and 17 international cities as case studies to analyse spatial evaluation methodologies and high-frequency keywords across varying spatial scales. Based on a systematic review of literature published in the past five years, the research employed term frequency analysis to investigate narrative patterns in academic discourse, supplemented by a data-driven analysis of 120 papers for keyword extraction and thematic categorisation. The results indicate that at the macro scale, design evaluation optimises the placement of planning points; at the medium-scale, feedback can be used to adjust spatial layouts and functions; and at the micro scale, dynamic updates of service facilities are possible. This study provides effective methods for more precise analysis of user needs and design optimization strategies.

Keywords: Waterfront public spaces; Evaluation methods; Scale; Design optimisation strategies.

Introduction

Waterfront public spaces play a crucial role in representing the vitality and image of a city, with their spatial design being essential for shaping the city's brand and cultural soft power. As urbanisation progresses, the design of waterfront spaces has become an important element not only in meeting the daily needs of residents but also in showcasing the city's characteristics and attracting tourists. However, current urban waterfront space design faces several prominent issues, particularly in the evaluation system. There is a lack of systematic monitoring and assessment mechanisms, unclear spatial needs in different design scales, and an absence of sustainable evaluation models. Furthermore, there is a shortage of methods that are detectable, traceable, and repairable. Thus, the challenge of establishing a scientific, continuous, and assessable evaluation method based on the varying needs of waterfront spaces at different scales remains a critical issue to address.

In China, approximately 480 cities are situated in major river basins, including the Yangtze, Yellow, and Pearl Rivers, covering over 80% of the total number of cities in the country. As an integral part of these cities, the design and evaluation of waterfront spaces have become particularly important. However, in academic research within China, waterfront space evaluation is often overlooked or undervalued. According to statistics from CNKI (https://www.cnki.net) over the past five years, research on waterfront space design has primarily focused on themes such as waterfront vitality, environmental assessment, and landscape planning. By analysing the abstracts of 120 typical papers, we found that although most studies address spatial design evaluation, keywords in paper titles do not easily lead to relevant evaluation methods, making it difficult to conduct comprehensive searches, and limiting the widespread attention and development of waterfront space evaluation methodologies. Therefore, this paper aims to explore waterfront space evaluation within a larger research framework using keyword analysis. The goal is to help scholars better understand and utilise relevant terms while revealing the deeper challenges behind the fragmentation of research. By placing different keywords, cultural contexts, and academic terms within a specific context, we aim to gain a comprehensive understanding of the connotations of waterfront space evaluation methods. In this process, special attention is given to the representation of waterfront spaces in terms of regional networks and local complexities, as well as to identifying key factors influencing the development of evaluation methods.

Through text data analysis, this study seeks to examine the current status and development of waterfront space evaluation, identify the common challenges and opportunities faced by urban waterfront spaces, and provide theoretical and practical references for academic research and design practice. Ultimately, the aim is to promote the innovation and improvement of waterfront space design evaluation systems, enhance the role of waterfront spaces in sustainable urban development, and elevate the quality and cultural value of cities.

Literature review

Waterfront public spaces are integral components of urban planning and design, offering unique environmental and social functions. The quality of waterfront space design directly influences the city's image, residents' quality of life, and ecological sustainability. Therefore, how to scientifically and effectively evaluate the design and functionality of waterfront spaces has become a key issue in both academic research and practical applications. Existing evaluation methods for waterfront spaces primarily involve three dimensions, namely geographic big data analysis, landscape space aesthetics, and spatial structure. These methods focus on different evaluation goals and approaches, but a systematic, scale-adapted evaluation framework has yet to be established in practical applications.

Geographic big data analysis dimension

In the realm of geographic big data analysis, waterfront space evaluations typically utilise tools like OpenStreetMap, Baidu Maps, ArcGIS, and other spatial information systems to quantify relevant indicators of waterfront areas using road network data and spatial information. The key to this evaluation method is the clear definition of the study area and waterfront types.

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The first step involves a comprehensive analysis of the current state of waterfront spaces, including environmental quality, existing issues, and comfort levels (Liang *et al*., 2023). Subsequently, a scientific indicator system is established, typically following the Analytic Hierarchy Process (AHP), which builds an evaluation structure comprising goal, standard, and indicator layers (Yang *et al*., 2024). The advantage of this method lies in its data-driven and quantitative nature, providing detailed geographic and environmental context, thereby offering theoretical support for comprehensive analysis and optimisation of waterfront spaces (Wang *et al*., 2023).

Landscape space aesthetics dimension

From the perspective of landscape space aesthetics, waterfront space evaluations focus more on human sensory and psychological experiences, emphasising visual perception, tactile experiences, environmental ambiance, and the interaction between humans and nature. Data for these evaluations are primarily collected through field surveys, interviews, and observational photography, assessing aspects such as visual perception, environmental comfort, and spatial atmosphere (Liu, 2022). The construction of evaluation indicator systems considers not only the aesthetic characteristics of the environment but also user demands, behavioural patterns, and psychological responses, especially concerning the differences in the needs of various functional areas and user groups (Jin *et al*., 2024). Moreover, landscape space aesthetics evaluation systems emphasise a comprehensive analysis of ecological environment, local culture, and historical heritage, constructing evaluation frameworks from the dual perspectives of space quality and human behaviour (Liu *et al*., 2023).

Spatial structure dimension

The spatial structure evaluation method primarily focuses on the usability of waterfront spaces, evaluating factors such as accessibility, facility completeness, and activity diversity. In this dimension, the first step is to define the scope of the waterfront space and analyse the environmental quality based on the needs of different functional areas (Xue *et al*., 2024). The evaluation focuses on aspects such as the transportation system around waterfront spaces, including road networks, pedestrian pathways, bicycle lanes, and recreational facilities (e.g., rest areas, restrooms, lighting), as well as safety features. Facility completeness directly impacts the usability and safety of the space, while activity diversity examines whether the space can accommodate various cultural, recreational, and sports activities. This evaluation method is more flexible, emphasising user experience, and has a high degree of subjectivity and adaptability (Cheng, 2018).

Limitations of existing evaluation methods and research needs

Despite progress made in various dimensions of waterfront space evaluation, existing methods still exhibit limitations. Notably, the evaluation methods for waterfront spaces of different scales (such as local waterfront areas versus large-scale waterfront regions) are not clearly distinguished, and the current evaluation frameworks tend to focus on a single dimension, lacking a comprehensive evaluation of different levels of space. Therefore, this study aims to collect literature and analyse data to systematically summarise the factors influencing various evaluation dimensions, exploring methods suited for evaluating waterfront space design at different scales, with the goal of providing more accurate optimisation criteria for waterfront space design.

The main contribution of this research is the integration of geographic big data, landscape aesthetics, and spatial structure into a multi-dimensional evaluation framework suitable for waterfront spaces of different scales. Through the comparison and analysis of various evaluation methods, this study aims to provide theoretical foundations and practical guidance for the optimisation of waterfront space design, promoting the sustainable development of waterfront spaces and the improvement of urban environmental quality.

Methodology

This study conducted a systematic review of 103 Chinese and 17 international case studies published between 2021 and 2024 to evaluate emerging trends and knowledge gaps in waterfront space design and evaluation research. The selected literature was categorised into nine thematic groups based on research focus: 1) spatial vitality analysis, 2) environmental performance assessment, 3) landscape planning frameworks, 4) quality enhancement strategies, 5) safety evaluation systems, 6) ecosystem service valuation, 7) constituent element studies, 8) human well-being impacts, and 9) socio-cultural value exploration.

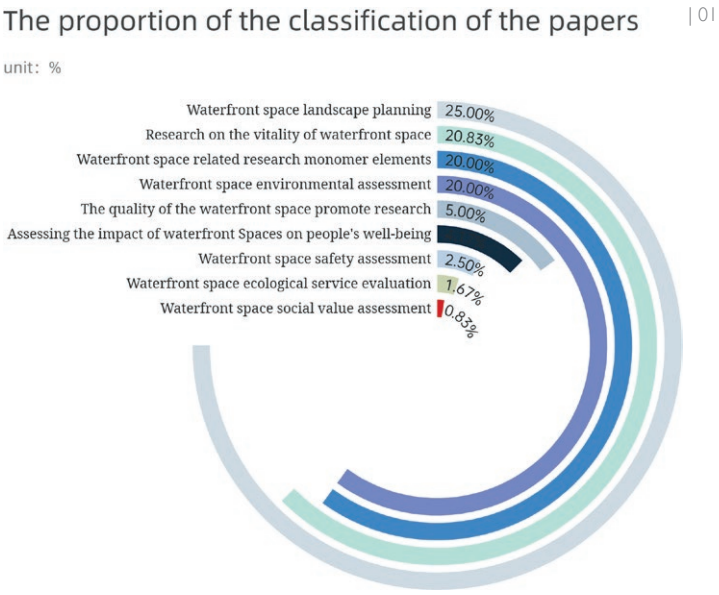
The analysis revealed a predominance of planning and design-oriented studies (68% of total literature), with primary emphasis on landscape aesthetics (42% of design papers), connectivity with adjacent urban fabrics (35%), and user experience metrics (23%). Methodologically, 81% of these investigations employed mixed-method approaches combining field surveys (n=89), in-depth interviews (n=67), and geospatial analysis via GIS platforms like ArcGIS (n=58). Notably, only 12% incorporated longitudinal data tracking, highlighting a critical methodological limitation in temporal dimension analysis.

Although planning and design is the dominant direction, the research on the quality assessment of waterfront space environments is still at a relatively early stage, accounting for only 20% of the 120 papers reviewed in this study. This proportion sug-

01 | The proportion of the classification of research papers

02 | Word cloud referring to waterfront space design

03 | Frequency statistics of hotspot occurrences



Keywords	Frequency	Keywords	Frequency
Waterfront area	475	Waterfront space	139
Planning and design	384	Waterfront environment	114
Urban waterfront space	314	Waterfront public space	112
Landscape design	259	Urban waterfront	76
Urban waterfront	221	Ecological environment	73
Waterfront landscape	219	Water environment	66
Urban design	219	Urban waterfront landscape	55
Strategy research	175	Waterfront environment	55
Public space	162	Ecological restoration	53
Waterfront area	162	Design research	37
Waterfront landscape design	154	Landscape evaluation	14

gests that, while landscape aesthetics and environmental evaluation methods have been applied preliminarily in waterfront space research, the overall quantity remains limited, and there are significant gaps in the systematic theoretical framework and evaluation methods. Therefore, the evaluation system for waterfront spaces in China is still underdeveloped and requires further theoretical refinement and practical expansion.

In the analysis of keyword trends, the most frequently appearing terms in the past five years include "planning design", "landscape design", and "urban waterfront space", reflecting that the primary focus of waterfront space research is still on urban planning and design, particularly in the context of urban waterfront spaces. Research on waterfront space evaluation at different scales (large, medium, small) is relatively scarce, with particularly limited studies on landscape evaluation. By analysing these keywords, we can identify the current hotspots and gaps in waterfront space research, providing important insights for future studies.

Based on literature collection and data analysis, this research offers an in-depth exploration of the current state of waterfront space evaluation, highlights key issues and development trends in waterfront space research, and provides a theoretical foundation for improving the domestic evaluation system for waterfront spaces.

Result

Total search results and proportions

A total of 120 papers related to waterfront space research were collected from CNKI and Google Scholar, covering 55 cities globally, with 38 from China and 17 from abroad. These articles are roughly divided into seven categories, namely waterfront space vitality research, environmental assessment, landscape planning, quality improvement research, safety assessment, ecological service evaluation, research on specific elements within waterfront spaces, human well-being impacts, and social value. Among these, the largest proportion of articles focus on waterfront space planning and design, accounting for approximately 25%, followed by environmental quality assessment, waterfront vitality research, and studies on specific elements like climate and vegetation, each representing around 20%. Other categories make up smaller proportions (see Figs. 1, 2, 3).

Distribution of Studies in Domestic and Foreign Cities

In China, waterfront space research is mainly concentrated in cities such as Shanghai, Beijing, Wuhan, and Suzhou. Shanghai has the highest number of studies, with 13, followed by Beijing, Wuhan, and Suzhou, with 8, 8, and 7 studies, respectively (see Fig. 4). These data indicate that waterfront space research tends to focus on major cities or regions with a significant presence of waterfront areas. Internationally, the distribution is more balanced, with cities like Kyrenia and Seoul, each contributing two studies, and the remaining cities having one study each (see Fig. 5).

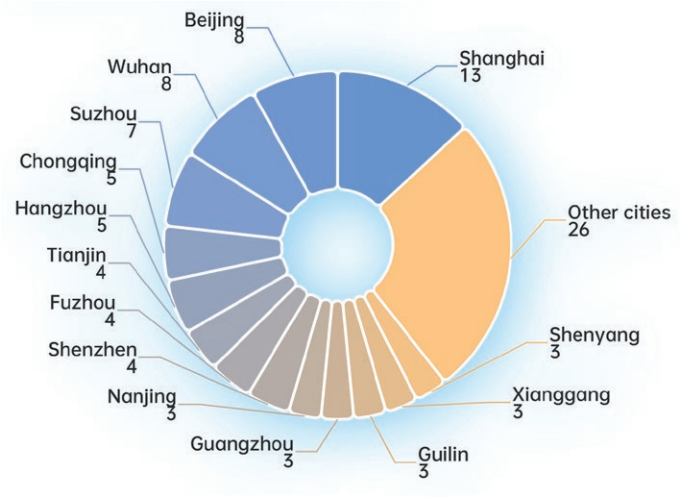
Environmental quality assessment: focus on specific elements and human well-being

Environmental quality assessment is not only concerned with spatial studies but also places significant emphasis on

04 | Scale picture of research key words in Chinese cities

05 | Scale picture of research key words in foreign cites

04 |



| 05

the analysis of individual or specific influencing elements. A comparison of results from CNKI and Google Scholar reveals that Google Scholar contains more studies focusing on individual elements within waterfront spaces, such as the plants, climate, or temperature of these areas. For instance, one article titled *Landscape Aesthetic Value of Waterfront Green Space Based on Space-Psychology-Behavior Dimension: A Case Study along Qiantang River (Hangzhou Section)* uses multi-source data and qualitative and quantitative analysis methods to assess the aesthetic value of waterfront green spaces along 12 representative locations in the Qiantang River region, considering spatial, psychological, and physiological dimensions. Furthermore, international studies tend to explore human well-being more deeply. For example, *The Impact of Attributes of Waterfront Accessibility on Human Well-being: Alexandria Governorate as a Case Study* uses statistical survey methods to compare human well-being (HWB) between two areas with different levels of proximity to the waterfront. The study also surveys respondents' personal characteristics, such as age, education, and health, alongside their psychological perceptions.

Discussion

The research results, derived from China National Knowledge Infrastructure (CNKI) and Google Scholar, encompass 120 papers related to waterfront space research across 55 cities, with 38 domestic and 17 international locations. Among these, studies on waterfront space planning and design account for the largest proportion, approximately 25%. Research on waterfront environmental quality assessment, vitality studies, and specific elements such as climate and vegetation are also prevalent, each representing around 20% of the total. Domestic studies primarily focus on major cities such as Shanghai, Beijing, and Wuhan, while international research shows a more balanced distribution across various locations, with studies concentrated in cities like Kyrenia and Seoul. Notably, foreign studies often delve deeper into the impact of specific elements on human well-being, showcasing a broader focus on the social and psychological dimensions of waterfront spaces. Based on findings from the literature, the optimisation strategies for waterfront space design can be summarised into three main levels, precisely macro-level optimisation, meso-level optimisation, and micro-level optimisation.

Macro-Level optimisation: improving service efficiency of planning layouts

At the macro level, the full-process design evaluation method enables a comprehensive analysis of waterfront spaces through big data platforms, optimising the planning layout. By analysing indicators such as spatial density, accessibility, and service types, we can identify areas with low service efficiency and their potential issues. The key process involves simulating design scenarios and optimising existing service points whether by adding, removing, relocating, or repurposing them. This helps reduce service point vacancy rates, enhancing coverage efficiency and resource utilisation. The optimisation process makes waterfront space planning more rational, effectively improving overall space usage and reducing resource waste.

Meso-Level Optimisation: Enhancing Service Function Adaptability

At the meso level, multi-source data feedback provides insights into the strengths and weaknesses of different service functions at various points. By evaluating the functionality of each service point and incorporating feedback from users, we can ad-

just the spatial layout and functional settings of specific nodes more precisely. These adjustments maximise the strengths of the service points, better meeting the diverse needs of users and improving space utilisation and resident satisfaction. In waterfront space planning and design, there are often differences in usage and functional requirements across different regions. Adjusting the functional layout of specific nodes can enhance spatial flexibility and adaptability, ultimately improving overall service quality.

Micro-Level optimisation: dynamic updates of service facilities
At the micro level, feedback from monitoring data enables effective adjustments to the internal service facilities at public service points. Real-time monitoring of facility usage allows for the timely addition of urgently needed facilities or replacement of those underutilised. This ensures that the service facilities continually meet user needs. This dynamic approach not only makes facility configuration more precise but also embodies a model of dynamic management. As residents' needs evolve, the service facilities must be updated and iterated rather than remaining static. Therefore, the implementation of dynamic management in waterfront spaces enables them to better adapt to changing user demands, enhancing service flexibility and long-term benefits.
Through these three levels of optimisation, the proposed method promotes a more user-centered and efficient design process for urban waterfront spaces. It emphasises a sustainable and adaptive approach, where space functions, layouts, and service facilities are continuously refined to improve the overall user experience and service effectiveness

Limitations and conclusion

This study analyses waterfront spaces in 31 cities across China and proposes evaluation methods tailored to large, medium, and small-scale waterfront spaces. The results highlight the most effective evaluation strategies at each scale:

- macro-Level: The full-process design evaluation optimises waterfront space planning, enhancing overall efficiency. Through analysis of spatial density, accessibility, and service types via big data platforms, areas with low service efficiency are identified, and optimization suggestions are provided;
- meso-Level: Based on feedback from users, the spatial layout and functions of specific nodes can be adjusted accurately, maximising the strengths of service points, increasing utilization rates, and improving user satisfaction;
- micro-Level: Monitoring data feedback allows for the adjustment of service facility configurations at public service points, enabling dynamic management and ensuring timely updates to meet evolving resident needs.

Overall, this study presents a systematic framework for waterfront space design evaluation, helping urban waterfront space designs to respond to user needs more precisely, to optimise design plans, and to enhance space utilisation and satisfaction. Although the proposed methods are limited in practice, they offer significant theoretical insights and practical guidance for future research and evaluation of waterfront spaces.
Despite offering effective strategies for optimising waterfront space design at different scales, this study has several limitations. First, the case cities were limited to 31 cities in China, which, while representative in the context of waterfront space design and evaluation, may not fully reflect the diverse geographical, cultural, and developmental contexts across other global regions. Thus, future research could expand the sample to include cities with varying economic levels, cultural characteristics, and geographic environments to test the applicability and universality of the proposed methods.
Second, the frequency analysis employed in this study, a quantitative research method, effectively identified hot keywords and common evaluation dimensions in the literature but did not delve into the theoretical underpinnings or practical applications behind each evaluation dimension. The depth and complexity of evaluation methods, especially interdisciplinary assessments, require more detailed qualitative analysis to address the limitations of data-driven approaches.
Furthermore, while targeted optimisation strategies were proposed for different scales of spatial evaluation, the diverse and complex nature of urban waterfront space design suggests that more variables – such as economic costs, policy constraints, and community participation – could influence the implementation of evaluation strategies. Future research could integrate case studies to explore how these factors can be systematically incorporated into the design evaluation process to enhance the effectiveness of waterfront space optimisation.

ATTRIBUTION

Conceptualization, X.Wu. C. Gambardella; methodology, X.Wu, C.Gambardella; investigation, J.Zhong; data curation, J.Zhong; writing original draft, J.Zhong, X.Wu. All authors participated and contributed to writing the manuscript.

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The economic impacts of con(temporary) urban regeneration processes: the case of Milan

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Abstract. Considering the growing importance and widespread adoption of temporary approaches to urban transformations, the paper deals with the open research challenge of understanding the economic impacts of tactical urban interventions. Moving from a literature review on the impacts of urban regeneration projects, it proposes an investigation approach from a local economy growth perspective. This approach is applied to the "Piazze Aperte" programme, which was implemented by the municipality of Milan in 2018. Its preliminary results return a possible positive contribution of tactical urban experiences on the reference neighbourhoods' business dynamics. It seems to unfold about the different neighbourhoods' specificities and the intervention area's urban morphology.

Keywords: Economic; Impacts; Tactical urbanism; Urban Regeneration; Evaluation.

Introduction

Urban planning has undergone substantial transformation in recent decades, driven by emerging environmental, social, and economic phenomena (Haghani *et al*., 2023). These phenomena have redefined the objectives, actors, methods, and tools involved in urban regeneration processes, thus shifting from traditional, hierarchical top-down models toward more flexible, participatory, and integrative approaches (Concilio *et al*., 2021). The need to address and adapt to the complex challenges posed by contemporary urbanisation, including pandemics, climate change, and geopolitical conflicts, has highlighted the growing importance of reuse, reversibility, and temporary interventions in urban regeneration. These approaches help conserve resources and allow for greater flexibility in adapting to changing needs. This shift aligns with sustainability, resilience, and inclusivity goals (Nijkamp *et al*., 2023). Sustainable urban planning addresses global challenges like climate change, economic inequality, and social justice by prioritising adaptive infrastructure reuse to minimise waste and reduce environmental impact. Temporary interventions, such as pop-up parks, open streets, and tactical urban projects, enable cities to experiment with innovative solutions before committing to long-term investments, while fostering dynamic and people-centred environments. These efforts involve diverse stakeholders, including governments, private sectors, and communities, using innovative tools and methodologies to address urban challenges and ensure resilient, liveable cities (Urban Regeneration|UN-Habitat, 2022).
However, ongoing challenges and rapid urbanisation require continuous refinement of planning strategies to ensure long-term success.
In this cultural context, tactical urbanism and, more generally, the multiple forms of reuse or temporary use of the existing city can play a role that overcomes the response to random circumstances but can be planned as a method to face and manage contemporary urban dynamics (Madanipour 2017).
Tactical Urbanism was introduced in North America in the early 2010s through the work of Mike Lydon and Anthony Garcia in their book "Tactical Urbanism: Short-Term Action for Long-Term Change" (2015). They define Tactical Urbanism as "an approach to neighbourhood building that uses short-term, low-cost, and scalable interventions and policies to inspire long-term change." This concept builds on earlier practices like DIY Urbanism (Finn, 2014), Guerilla Urbanism (Hou, 2010), and Urban Acupuncture (Lerner, 2014). Governments, nonprofits, community organisations, or residents can spearhead these initiatives.
Starting from the earliest experiences of tactical urbanism, the concept has evolved and spread across various global contexts, adapting to each location's unique social, cultural, and urban challenges. This global proliferation highlights the flexibility and universality of tactical urbanism as a tool for urban regeneration, community engagement, and sustainable development.
In recent years, urban regeneration and tactical urbanism in Europe, particularly in Italy, have emphasised walkability (Speck, 2013) and the development of cycling infrastructure.
A recent study by Gorrini *et al.* (2023) highlights Bologna as a key example in this area. The Bologna Pedonale project created temporary public spaces and pedestrian pathways to encourage socialisation and safe access to urban areas. Key interventions included pedestrianising central zones and installing temporary infrastructure to reduce traffic and promote active mobility, thereby improving quality of life (Gorrini *et al*., 2023).
In Palermo's Ballarò district, tactical urbanism addressed urban decay through temporary design interventions, artistic installations, and community engagement. These efforts aimed to revitalise public spaces, reduce social inequalities, and enhance neighbourhood safety.
Similarly, Milan advanced walkability and cycling through initiatives like the Ciclovia, a dedicated bike lane network, and the Piazze Aperte project, transforming neglected areas into car-free zones, enhancing pedestrian access, and fostering a bike-friendly environment. Given the growing interest in tactical urbanism interventions, scholars have tried to understand their impacts and their indubitably added value to urban transformations. Scholars have recognised social and cultural impacts of tactical urbanism in enhancing social inclusion and community engagement (Santamaría-Hernández, 2018), promoting public health (Abdelkader *et al*., 2023), and creating spatial support for cultural vibrancy (Stevens and Dovey, 2022). Instead, their

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economic impacts have not been fully understood and assessed (Cariello *et al*., 2021; Rossitti *et al*., 2023).
Even if the economic impacts are not the driving force behind these small-scale interventions, given their consequences on social dynamics, their understanding is also crucial to comprehensively assess tactical urbanism's contribution to urban transformation and regeneration (Lu and Wang, 2024). Based on these premises, the study's objective is to evaluate the impact of tactical urbanism interventions on the economic system, thus providing a knowledge ground to compare the investment costs with the benefits generated, and to enrich the understanding of their social consequences. To this aim, the paper explores the economic impacts of temporary urbanism intervention, focusing on the case of Milan "Piazze Aperte".
The paper is structured as follows:

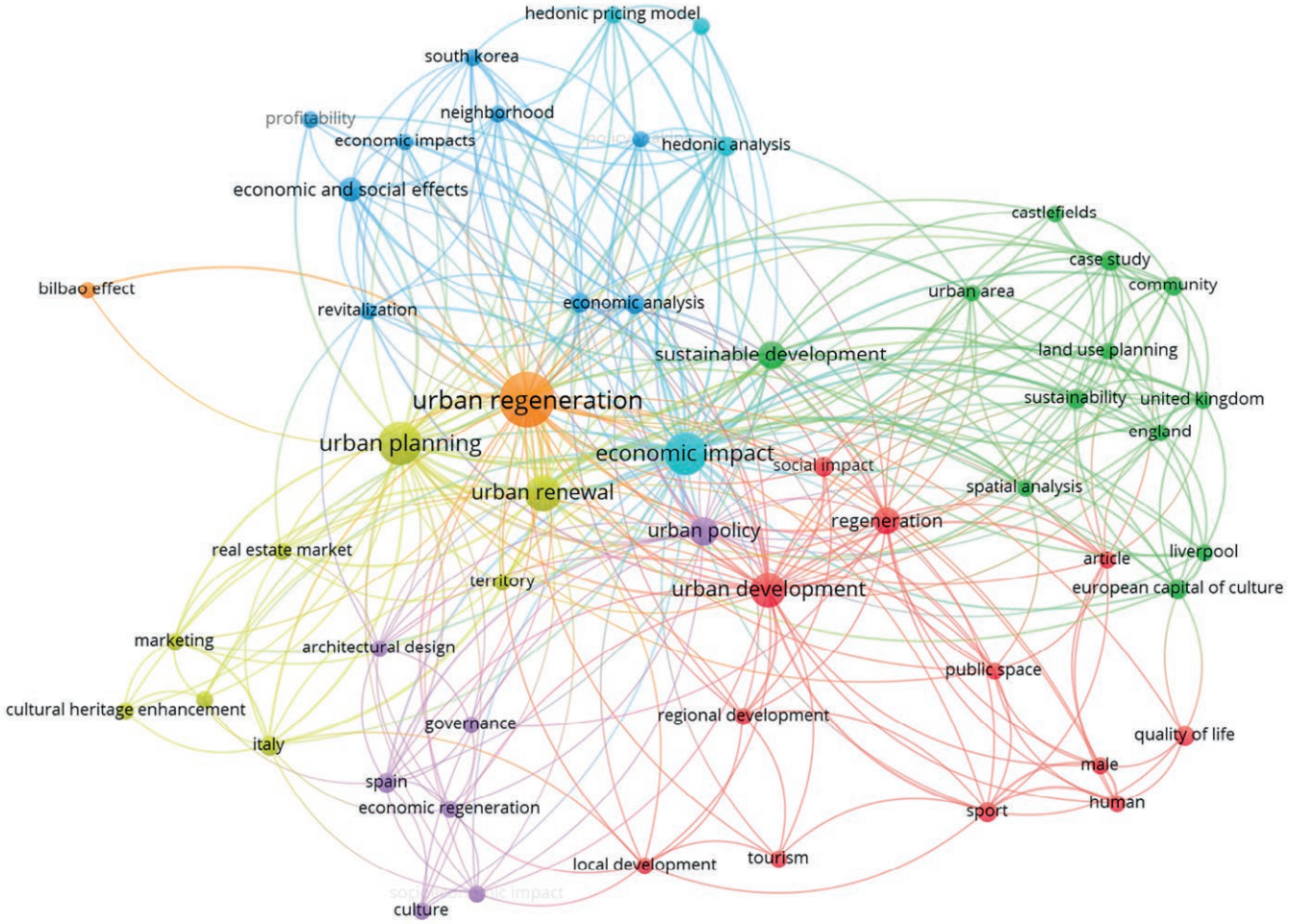
- The first section will examine existing research based on a literature review to highlight the main economic impacts of urban regeneration interventions in the short and long term.
- Based on the literature review findings, the paper proposes an investigation of tactical urbanism's economic impact from an economic growth perspective.
- The third section adopts such a perspective to focus on the "Piazze Aperte" project by analysing the specific economic outcomes of tactical urbanism experiences in terms of variation of local businesses at the neighbourhood scale.
- The final section will summarise the findings, reflect on the implications for future urban planning, and suggest areas for further research.

The economic impacts of urban regeneration projects: a literature review

A literature review has been developed to understand the correlation between the "temporary urbanism" initiatives and the economic impact on an urban environment. Still, since only a few papers discuss the role and influence of temporary urbanism or small-scale interventions, the analysis has been expanded to the broader realm of urban regeneration projects. With the support of the SCOPUS database, the following keywords have been combined: "urban project" OR "urban intervention" OR "urban regeneration" AND "economic impact" OR "economic criteria*" OR "economic effect" OR "economic consequence" limiting the subject areas at Social Sciences; Environmental Science; Engineering; Business; Management and Accounting; Economics, Econometrics, and Finance; Decision Sciences; Multidisciplinary, resulting in 87 papers. After two phases of filtering by Title and Abstract, 48 papers were selected, and then, considering the coherence with the objective of the contribution, 13 were further analysed. This literature review summarises the main findings and analyses urban regeneration projects' goals, and outcomes, focusing on economic impacts. In addition, the review of the other essential dimensions impacted by the urban projects (i.e., social and environmental implications) and their scalability to a minor scale are explained.
Considering other scholars' experiences, the primary objectives of these initiatives are economic revitalisation, cultural enhancement, and sustainable urban development. Papers explore various interventions, from heritage preservation to innovative, creative spaces, by underlying economic and social goals. Revitalisation projects often aim to attract investments and stimulate economic activity within economic development. Pareti and García Henche (2021) discuss how the transformation of the Barrio Matadero-Franklin into a cultural hub leveraged tourism and creative industries to enhance the local economy. Similarly, cultural clusters, such as the case study in Barcelona presented by Zarlenga *et al.* (2016), facilitate social interaction and innovation, driving economic dynamism. At the same time, social and cultural integration is highlighted. Indeed, the Szczecin's cultural developments (Sochacka and Rzeszotarska-Pałka, 2021) promote social identity and cohesion, demonstrating that cultural initiatives can be powerful tools for place-making and community building. Moreover, events such as the European Capital of Culture in Liverpool (Liu, 2019) and cross-border cultural programmes (Turșie and Perrin, 2020) underline the potential for cultural initiatives to enhance the quality of life and foster economic growth. Environmental sustainability is also considered. Ruiz-Pérez *et al.* (2019) propose the HEREVEA tool to evaluate urban projects' ecological and economic impacts, emphasising the need for sustainable planning in housing and infrastructure. Fig. 1 shows the most important keywords from the literature review and their correlation.
Focusing on the economic dynamics, three main outputs can be underlined, namely implications for local economies, property values, and long-term growth. Urban improvements often raise the desirability of neighbourhoods, driving property value increases. Devaux *et al.* (2018) quantified how heritage policies boosted property values in Quebec's historic districts. Also, linear parks like Gyeongui Line Forest Park in Seoul positively affected property prices and local businesses (Park and Kim, 2019). With concerns about the impact on local economies, Booth and O'Connor (2018) describe how cultural hubs, like the Museum of Old and New Art in Australia, acted as economic magnets, attracting tourism and creating employment opportunities. Other examples include festivals and events, conceived as economic drivers that increase local revenues and tourism (Devesa *et al*., 2012). Conversely, these economic dy-

01 | Keywords co-occurrences network analysis (Authors' elaboration through VOSviewer software)

01 |



namics could generate negative impacts and risks, and gentrification is a recurring concern. Projects that elevate property values and attract wealthier demographics can displace long-standing residents (Trillo, 2017; Tarazona Vento, 2017).

The principles of large-scale regeneration projects can be scaled down and adapted to minor projects and temporary interventions, which are more agile and cost-effective. Rossitti *et al.* (2023) explain how tactical urbanism enhances urban liveability and stimulates local economies in a low-cost manner. Moreover, smaller initiatives can directly engage local communities, foster inclusivity, and minimise displacement risks, providing a framework for participatory urban planning.

Urban regeneration projects profoundly reshape cities, yielding economic, social, and environmental benefits. However, their outcomes are context-dependent, often marked by trade-offs such as economic revitalisation at the expense of social equity. Scaling down these principles to tactical and temporary urbanism provides a promising path for inclusive and sustainable development.

Assessing the economic impacts of temporary urbanism: towards a local economy growth lens

The implemented literature review reveals that understanding the economic impacts of temporary urbanism is still an open research challenge. The focus on the broader realm of urban regeneration projects, instead, reveals three main interpretative dimensions that can be assumed as a reference for assessing the economic impacts of urban regeneration interventions:

– real estate market dynamics, intended as the variation in the market and rent value of the properties located near the interventions;

02 | Tactical urbanism intervention in the NIL "Loreto" (photo by M. Rossitti, 2024)

| 02

- the growth of the local economy, intended as the increase in economic activities, leading to improved living standards, job creation, and overall economic development;
- tourism growth, interpreted as an increased capacity to attract and host new tourists.

Among these dimensions, the growth of the local economy is the most interesting one to analyse the economic impacts of tactical and temporary urbanism interventions that, given their nature of small-scale and minimum intervention approach to urban transformation, struggle to influence the neighbourhood scale.

Case study analysis: the "Piazze Aperte" programme in Milan

Prologue

The willingness to understand if and how tactical urbanism interventions can generate economic impacts in their reference territorial context can benefit from dealing with a case study where these approaches have found wide application.

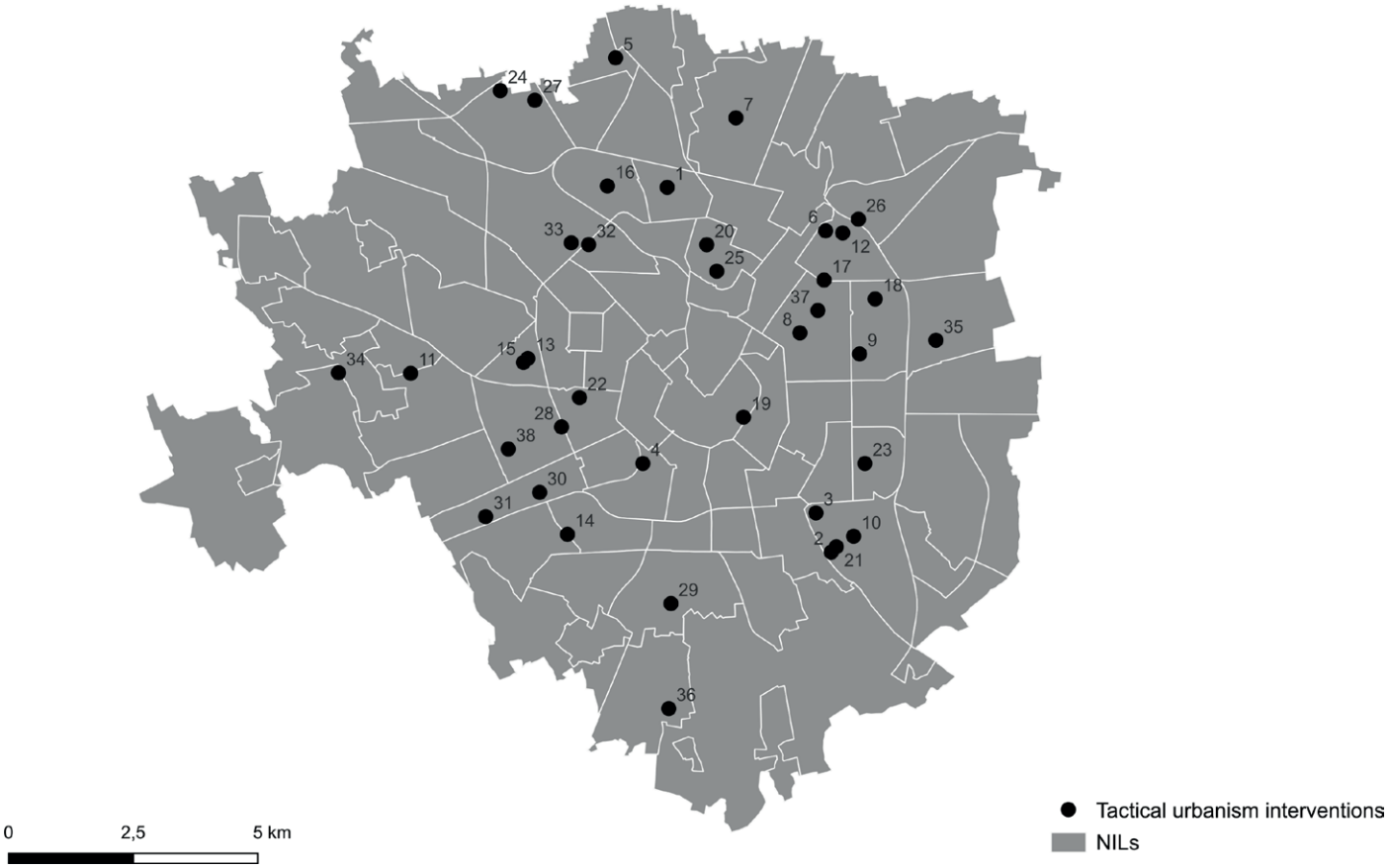
From this perspective, the Milan municipality emerges as an appropriate observation field for research purposes. Indeed, in 2018, the Milan municipality launched the "Piazze Aperte" (Open Square) programme, aimed at enhancing neglected public spaces to foster community interaction and connection within neighbourhoods through tactical urbanism techniques (Comune di Milano, 2024). After an initial testing phase, this programme was relaunched in 2019 with the call "Piazze Aperte in ogni quartiere" (Open Squares in Every Neighbourhood), and again in 2022 with the call "Piazze Aperte per ogni scuola" (Open Squares for Every School). To date, it has led to the implementation of 52 interventions that, after an initial temporary phase to test local communities' response, have, in most cases, become permanent, thus returning more than 56,000 sqm of public spaces to the city (Fig. 2). Furthermore, the suitability of the "Piazze Aperte" programme as an "economic impact" case in terms of real estate market dynamics has already been investigated (Rossitti *et al*., 2023). The analysis revealed a "weak" influence between these interventions and property prices, thus suggesting the need for other metrics to understand their possible economic impacts.

Investigating the economic impacts of the "Piazze Aperte" Programme: a local economy growth perspective

A local economy growth perspective requires identifying a proxy to express local economy growth dynamics at a sub-municipal level. International literature provides different metrics for this purpose, namely employment growth, gross domestic product (GDP), and local business[1] and entrepreneurial vitality (Garcia-Lopez and Muniz, 2013; Volintiru *et al*., 2018; Huang and Xu, 2021). Among them, the research theme's specificities lead to identifying local business and entrepreneurial vitality as the most appropriate. More in detail, such a metric can be expressed as the variation of the number of local businesses[1] since it represents the type of entrepreneurial activity best suiting the neighbourhood scale. The performed analysis is extended to the 38 tactical urbanism interventions from the "Piazze Aperte" programme completed between 2018 and 2021 (Fig. 3). The remaining 14 most recent interventions are excluded from this analysis due to the insufficient timing for evaluating, even partially, their effects. The analysis, which requires preliminary identification and spatialisation in a GIS environment of tactical urbanism interventions and commercial activities with an information layer concerning their opening date, is structured in two phases:

1. A former phase, at the neighbourhood level, that, according to the Milan municipality plan, is identified by the "Nucleus of Local Identity" (NIL). It compares the percentage variation of local businesses for each NIL hosting a tactical urbanism initiative between January 2021 and June 2024 with the average variation at the municipal level, and with the same variation in NILs not affected by tactical urbanism experiences.
2. A latter phase, based on defining an influence area with a radius of 500 metres for each tactical urbanism intervention. The percentage variation in the number of local businesses in these influence areas between 2021 and 2024 is compared

03 | Tactical urbanism interventions implemented between 2018 and 2021 within the "Piazze Aperte Programme" (Authors' elaboration on ISTAT's territorial basis and Milan Municipality's data)



to the average variation at the NIL level, thus attempting to capture tactical urbanism's specific contribution to economic growth in the reference neighbourhood.

The reference data are retrieved from Lombardy Region's "Neighbourhood Business Registry" (Regione Lombardia, 2024), while data about tactical urbanism interventions are retrieved from Milan municipality's website (Comune di Milano, 2024). Regarding the choice of January 2021 as the temporal reference for the analysis variation, it rests on the assumption that, given the COVID-19 pandemic, all the new business openings, even where interventions were carried out previously, have been recorded after this date.

Results

The two phase analysis of the relationship between tactical urbanism experiences and the increase in local businesses between 2021 and 2024, based on elaborating and processing the input data through the software "QGis", returns several insights to discuss these temporary interventions' possible economic impacts. Starting the analysis at the NIL scale does not return to a strong correlation between the variation in local businesses and the implementation of tactical urbanism interventions (Tab. 1). Only in 6 out of 26 NILs hosting at least one intervention, the variation in the number of local businesses between 2021 and 2024 is higher than the corresponding value for the whole municipality (16.3%). However, the spatial display of this relationship provides a more valuable reading of the phenomenon. Indeed, semi-peripheral and peripheral NILs interested in tactical urbanism seem to show better economic growth dynamics than the other NILs (Fig. 4).

Narrowing the analysis to the NILs affected by the interventions, and comparing the variation of local businesses in the tactical urbanism experiences' influence areas against the average value for the NILs provides more interesting results. Indeed, in 45% (17 out of 38) of the cases, the interventions' influence areas are affected by more robust growth in local businesses, thus hinting at their positive contribution to the economic vitality of the region (Fig. 5). Furthermore, the detailed reading of the results reveals that these "positive" results mainly occur about interventions shaping a public space with a pivotal position in

Tab. 01 | Percentage variation of local businesses (2021-2024) and number of tactical urbanism interventions per NIL

| Tab. 01

COD_NIL	DEN_NIL	Local businesses 2021	Local businesses 2024	Var % Local businesses (2021-2024)	No of tactical urbanism Interventions
1	Duomo	2.515	2.990	18,9%*	1
2	Brera	1.199	1.405	17,2%	0
3	Giardini Porta Venezia	3	4	33,3%	0
4	Guastalla	613	722	17,8%	0
5	Vigentina	262	318	21,4%	0
6	Ticinese	757	896	18,4%	0
7	Magenta – San Vittore	471	532	13,0%	0
8	Parco Sempione	2	2	0,0%	0
9	Garibaldi Repubblica	287	348	21,3%	0
10	Centrale	587	690	17,5%	0
11	Isola	583	675	15,8%	2
12	Maciachini – Maggiolina	265	305	15,1%	0
13	Greco	143	161	12,6%	0
14	Niguarda – Ca' Granda	293	332	13,3%	1
15	Bicocca	110	133	20,9%	0
16	Viale Monza	280	309	10,4%	0
17	Adriano	86	101	17,4%	0
18	Parco Lambro – Cimiano	173	196	13,3%	0
19	Padova	524	602	14,9%	1
20	Loreto	827	959	16,0%	3
21	Buenos Aires – Venezia	1.904	2.246	18,0%*	2
22	Città Studi	625	707	13,1%	2
23	Lambrate	140	153	9,3%	1
24	Parco Forlanini – Ortica	24	25	4,2%	0
25	Corsica	321	375	16,8%	0
26	XXII Marzo	786	890	13,2%	0
27	Porta Romana	488	555	13,7%	0
28	Umbria – Molise	274	332	21,2%	0
29	Ortomercato	88	95	8,0%	1
30	Mecenate	180	191	6,1%	0
31	Parco Monluè – Ponte Lambro	33	39	18,2%	0
32	Triulzo Superiore	15	18	20,0%	0
33	Rogoredo	56	66	17,9%	0
34	Chiaravalle	0	0	0,0%	0
35	Lodi – Corvetto	487	548	12,5%	4
36	Scalo Romana	133	155	16,5%	0
37	Ex OM – Morivione	76	85	11,8%	0
38	Ripamonti	138	157	13,8%	0
39	Quintosole	11	13	18,2%	0
40	Ronchetto delle Rane	0	0	0,0%	0
41	Gratosoglio – Ticinello	105	119	13,3%	1
42	Stadera	292	317	8,6%	1
43	Tibaldi	145	158	9,0%	0
44	Navigli	493	570	15,6%	1
45	San Cristoforo	193	227	17,6%*	1
46	Barona	57	61	7,0%	0
47	Cantalupa	14	14	0,0%	0
48	Ronchetto sul Naviglio	101	115	13,9%	0
49	Giambellino	437	504	15,3%	2
50	Tortona	357	404	13,2%	0
51	Washington	453	523	15,5%	1
52	Bande Nere	516	577	11,8%	2
53	Lorenteggio	102	112	9,8%	0
54	Muggiano	8	9	12,5%	0
55	Baggio	232	260	12,1%	1
56	Forze Armate	144	156	8,3%	1
57	Selinunte	355	403	13,5%	2
58	De Angeli – Monte Rosa	398	455	14,3%	0

COD_NIL	DEN_NIL	Local businesses 2021	Local businesses 2024	Var % Local businesses (2021-2024)	No of tactical urbanism Interventions
59	Tre Torri	55	62	12,7%	0
60	San Siro	69	79	14,5%	0
61	Quarto Cagnino	70	77	10,0%	0
62	Quinto Romano	40	42	5,0%	0
63	Figino	10	13	30,0%	0
64	Trenno	23	26	13,0%	0
65	Gallaratese	126	145	15,1%	0
66	QT 8	18	21	16,7%	0
67	Portello	123	140	13,8%	0
68	Pagano	358	403	12,6%	0
69	Sarpi	967	1.191	23,2%	0
70	Ghisolfa	252	296	17,5%*	1
71	Villapizzone	608	686	12,8%	1
72	Maggiore – Musocco	126	276	119,0%	0
73	Cascina Triulza – Expo	1	1	0,0%	0
74	Sacco	7	7	0,0%	0
75	Stephenson	8	11	37,5%	0
76	Quarto Oggiaro	186	204	9,7%	2
77	Bovisa	236	281	19,1%*	1
78	Farini	51	62	21,6%	0
79	Dergano	278	319	14,7%	1
80	Affori	237	269	13,5%	0
81	Bovisasca	35	38	8,6%	0
82	Comasina	45	55	22,2%*	1
83	Bruzzano	67	81	20,9%	0
84	Parco Nord	7	7	0,0%	0
85	Parco delle Abbazie	10	10	0,0%	0
86	Parco dei Navigli	2	2	0,0%	0
87	Parco Agricolo Sud	3	3	0,0%	0
88	Parco Bosco in Città	9	13	44,4%	0
-	MILAN MUNICIPALITY	24.188	28.134	16,3%	38

the mobility system, thus hinting at an urban morphological interpretation of these interventions' impact. Finally, it is interesting to notice that "not positive" results from the comparison are mainly related to the most recent tactical urbanism initiatives (dating 2020 and 2021). This result needs to be deepened and monitored to understand if the emergence of the impact of experiences on local business dynamics requires a specific period for maturation.

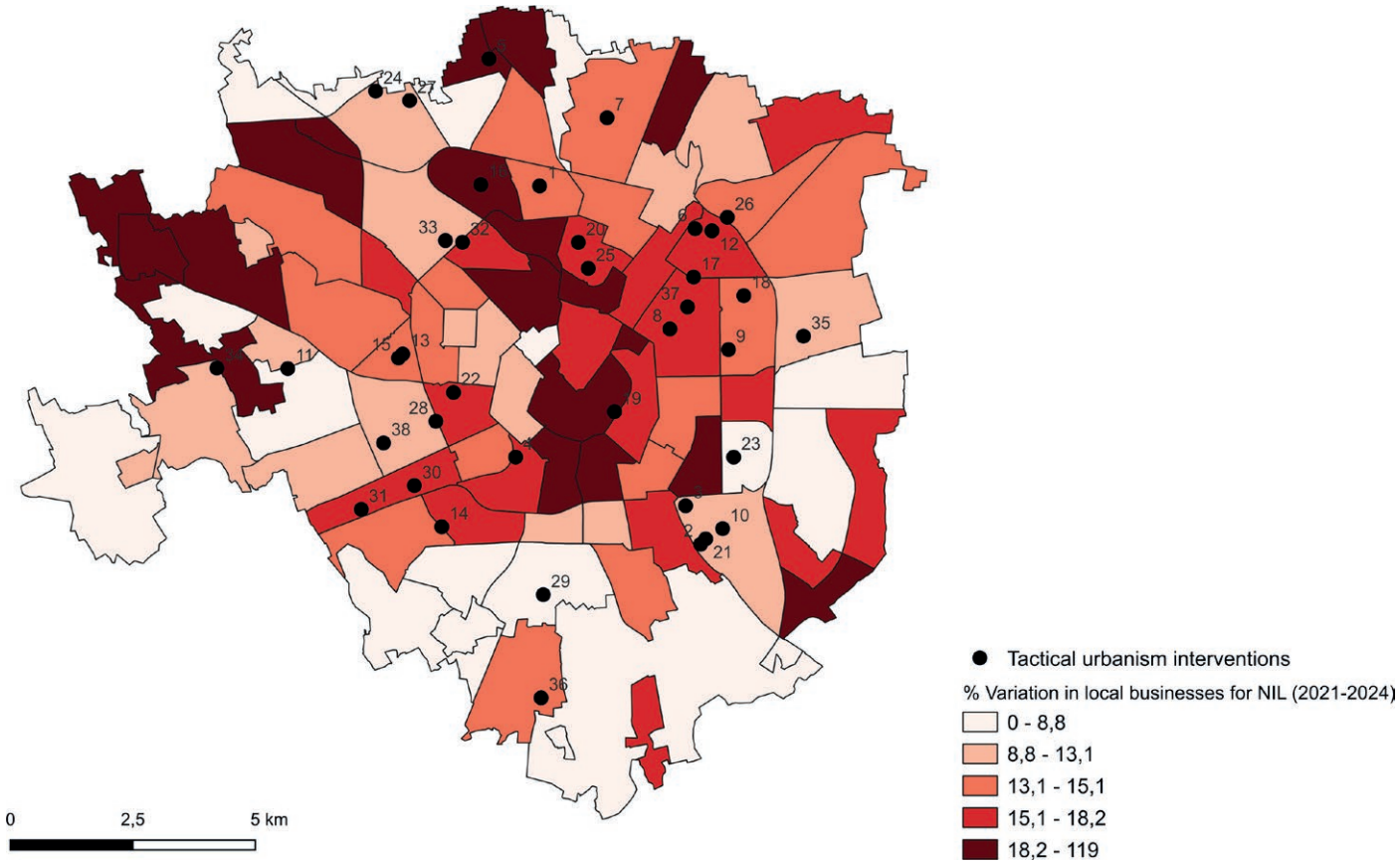
Discussion and conclusions

In recent decades, new social, economic, and environmental challenges have led urban planning to dramatically innovate its objectives and approaches by conceiving transformative interventions from a perspective of adaptation and rapid response. In this context, tactical and temporary urbanism interventions have found significant application in urban regeneration processes, and have gained increasing attention from the scholarly debate. The minimum intervention and community-oriented perspective behind this intervention has led the scientific discussion to explore the social and environmental benefits of these interventions, while understanding their economic impact is still an open challenge.

From this perspective, the research addresses this challenge by reading tactical and temporary urbanism experiences' economic impacts from an economic growth perspective. The focus on Milan municipality, based on exploring the relationship between tactical urbanism initiatives and the variation in local businesses in their influence area, hints at their positive effects in triggering growth dynamics at the neighbourhood scale. Coherently with the existing literature on the impacts of urban regeneration initiatives, these results cannot be generalised to the entire urban environment but seem to be affected by context-based factors and by the morphological nature of the intervention.

Hence, the paper's findings must be interpreted as preliminary insight into the theme of tactical urbanism's economic impacts, which needs further exploration and questioning. Indeed, the analysis is currently limited to quantitative data about entrepreneurial activities and their variation over time, which cannot fully explain the complexity of the investigated phenomenon. From this perspective, future research endeavours will be oriented to integrate the provided information layer about the supply of local businesses with an analysis of the demand for these activities and its relationship with the tactical urbanism interventions. Furthermore, approaching the "demand" side will allow to better investigate the relationship between social

04 | Percentage variation of local businesses per NIL between 2021 and 2024 (Author's elaboration on ISTAT's territorial basis, Milan Municipality's data, and Lombardy Region's Open data)



impacts and the emerging economic growth dynamics, thus critically questioning these small-scale interventions' role in triggering socially responsible urban development rather than, as observed for bigger-scale regeneration initiatives, contributing to gentrification processes and exacerbating social inequalities (Levine *et al.*, 2022). To this end, the implementation of the proposed analysis in other urban contexts, characterised by less vibrancy in terms of urban regeneration initiatives compared to Milan, can allow for a deeper understanding of the interrelations between economic growth and the social impact of tactical urbanism interventions.

NOTES

[1] According to Legislative Decree of 31 March 1998, no. 114, the local business refers to a retail activity with a sales area not exceeding 150 sqm in municipalities with a population lower than 10,000 residents, and not exceeding 250 sqm in municipalities with a population higher than 10,000 residents.

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05 | Percentage difference in the variation of local business (2021-2024) between the 500 m radius influence area of the intervention and the reference NIL (Author's elaboration on ISTAT's territorial basis, Milan Municipality's data, and Lombardy Region's Open data)

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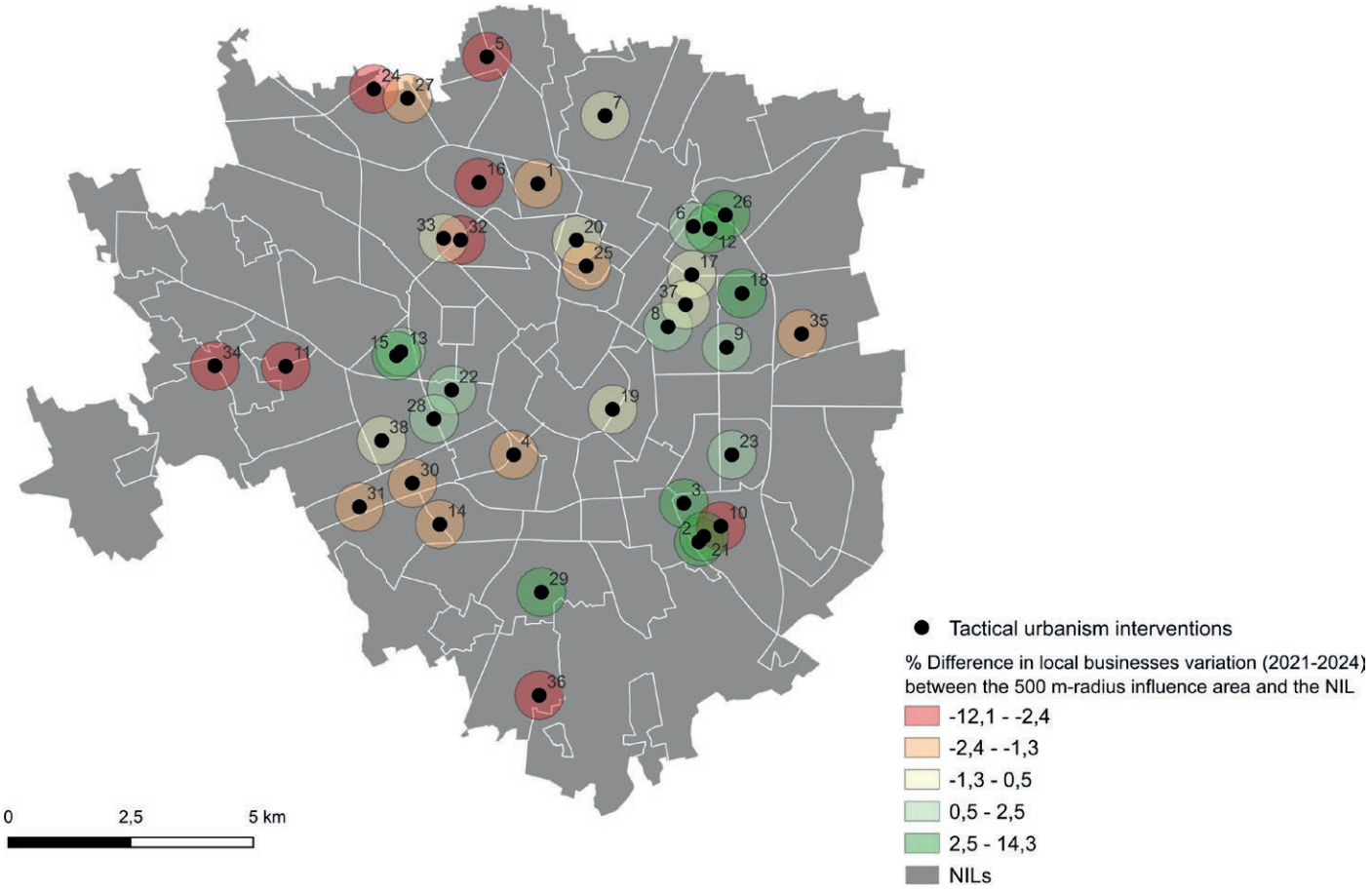

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Adaptive Reuse: generative matrices of environmental benefits guide the regeneration process for a comparative analysis of S. Maria in Grotta and S. Michele in Gualana

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Abstract. Environmental changes frequently redefine the characteristics of a monument, transforming it into an unconscious "record" and an involuntary witness to the "adaptive" processes that shape its identity over time. This paper compares two case studies that exemplify an adaptive process of conservation and rediscovery of historical heritage. The first case, with a centripetal dynamic, explores the relationship between anthropogenic interventions in the environment and their effects on built heritage, specifically the rock-hewn church of S. Maria in Grotta. The second one, with a centrifugal dynamic, addresses the redefinition of the environment by introducing new architecture, focusing on the uncovering of the rock-hewn cave of S. Michele in Gualana, which had fallen into oblivion due to the abandonment of the surrounding territory.

Keywords: Adaptive reuse; Centripetal matrix; Centrifugal matrix; Planned maintenance; Spontaneous maintenance.

Introduction to the method

The architectural heritage reflects the cultural identity and the memory of the past, integrating harmoniously with the environment. However, environmental changes, whether natural or anthropogenic, such as those induced by the climate, alter its balance and symbiotic relationship.

Often, environmental, economic, or social changes (or a combination thereof) can redefine the characteristics of a monument, or vice versa, through adaptive reuse dynamics that generate centripetal and/or centrifugal forces. Adaptive reuse, in the heritage conservation literature, is seen as a deliberate choice to preserve a heritage asset that is no longer usable for its original purpose, safeguarding it from the ravages of time and passing it on to future generations through adaptation to new uses, while carefully recognising its historical and cultural values (Damla and Kaˇgan, 2016). However, the literature presents adaptive reuse as a conscious decision by a *dominus*, from whom all the implications of the design choices within the cultural context that generated it arise. The literature (Yuan Li *et al*., 2019) does not address adaptive reuse as a spontaneous act driven by needs beyond conservation. Both deliberate and spontaneous adaptive reuse stem from a fundamental necessity, shaping centripetal or centrifugal dynamics. In the centrifugal one «the benefits are generated punctually but propagate to a more or less vast surrounding depending on the generating force of benefits the implementer has been able to generate [...], instead, in the centripetal model, the approach is holistic [...] and the benefits, generated by the wide-spread intervention, converge towards the punctiform elements inserted in the redeveloped urban environment» (Violano & Maio, 2024). The two case studies – the Church of S. Maria in Grotta (Rongolise) and the Grotta di S. Michele (Gualana) – illustrate these dynamics. The former exemplifies centripetal adaptive reuse, where local inhabitants preserve the site through religious symbolism and its role on the Via Francigena. The latter represents centrifugal reuse, transforming a religious site into a museum that reinterprets cultural identity under conservation principles.

Centripetal dynamics in adaptive reuse describe a site's ability to attract and retain cultural, social, and economic value around its core, whether physical or symbolic (Violano et al, 2024). This attraction stems from historical, artistic, and architectural significance, as well as community identity. Conservation through reuse reinforces belonging, fosters social cohesion, and stimulates economic activities.

In contrast, centrifugal dynamics, exemplified by the requalification of the Grotta di San Michele in Gualana, involve a deliberate act of a *dominus* to radiate cultural, social, and economic benefits outward. This planned transformation, aligned with modern conservation principles, enhances the surrounding urban fabric. Rather than dispersing value, centrifugal reuse amplifies and extends its impact, integrating heritage protection with sustainable development and local community engagement (Oppio et al, 2017). The ultimate goal is to demonstrate how adaptive reuse, applied according to centripetal or centrifugal dynamics, can trigger processes of reappropriation of cultural identity that lead to the regeneration of territories and the conservation of heritage. A comparative case study of S. Maria in Grotta and S. Michele in Gualana exemplifies this

The case of Santa Maria in Grotta in Rongolise

Since ancient times, the vast territory of Sessa Aurunca, the second largest municipality in Campania, has been characterised by anthropic phenomena. These have shaped its landscape, character, image, and places whose geography evokes scenic suggestions that enhance and merge with the *genius loci*, ready to suggest and dictate the architectures to be shaped and performed in its own image, amplifying the suggestions of the place.

It is a place, where Santa Maria in Grotta stands, where the elements of nature and architecture merge, where the built envionment is seamlessly part of the natural elements, where it is not clear where the natural ends and the artificial begins, where the eye perceives the architecture in the landscape accepting it as an element of the landscape (Fig. 1).

S. Maria in Grotta, is located a short distance from the hamlet of Rongolise in Sessa Aurunca (CE), near an ancient path leading from Sessa Aurunca to the Valle del Garigliano, close to the Via Francigena, in a reused tufa quarrystands. The small rock-hewn church is dedicated to S. Maria in Grotta, which, like a sentinel, overlooks the landscape entrusted to it. The presence of an active aqueduct collector carved beside one of the church's lateral chambers confirms the site's continuous use since ancient times. The tufa-carved spaces suggest a dual function, precisely one linked to water, evident in the rooms directly

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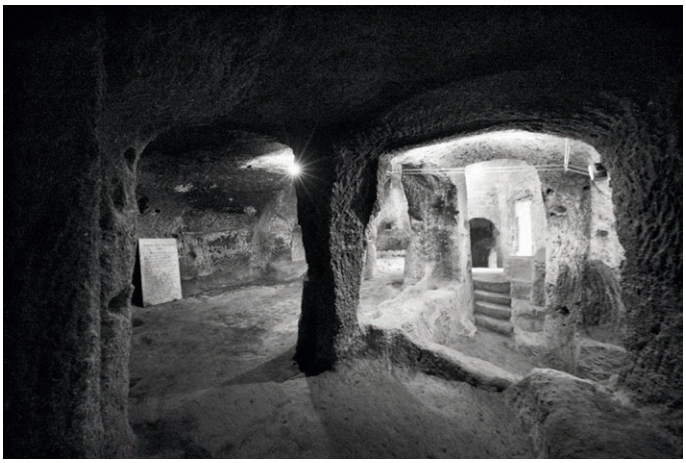
01 | Façade of S. Maria in Grotta, showcasing the harmonious interplay between human construction and natural topography

02 | S. Maria in Grotta: The interior of the cave with a truncated cone section in the tuff bank, with frescoed walls

03 | S. Maria in Grotta: Anthropised cave environments

04 | S. Maria in Grotta: A cycle of frescoes centred on the Virgin Mary, including a prominent depiction of her Dormition

01 | 

 | 03

02 | 

 | 04

connected to the channel, which seems to have a natural origin later integrated into the aqueduct system; and the other to the quarry. Over time, this space evolved into a sacred site, with frescoes adorning its walls since the 10th century. The reuse of this quarry indicates adaptive reuse of places (Fig. 2).

The façade of the small church does not reveal the rocky nature of the place. Once past the entrance portal, one enters a triangular-shaped tufa gallery with frescoed walls, at the bottom of which there is an altar and a lunette, also frescoed. A triangular shape that recalls the upper part of Sibyl's grotto in Cuma (Maiuri, 1926), a shape that most likely arose, for static reasons, from the extraction of tufa. The grotta then opens to other environments that contribute to increasing the suggestiveness of the places (Fig. 3). It is still unclear what the use of the grotto was. Perhaps created for agricultural purposes, it seems that as early as the 10th century it was used for worship, as evidenced by a panel depicting the Virgin Mary with the Child Jesus seated on a throne and wrapped in a dark red maphorion. A place where sacredness has been handed down from generation to generation, preserving the suggestion, preserving the matter that tells all this through the registers of frescoes that cover a thousand years of life (Fig. 4).

The position of the artefact, protected by the bend in the road that surrounds it, and inserted in a natural context where the presence of water feeds its ancestral suggestion, has consolidated the persistence of the *genius loci* as a tutelary deity. Nothing suggests that having crossed the anonymous entrance door, with its modest workmanship, one steps into a suggestive and enchanted spatial dimension where a sacredness can be perceived that induces the visitor to silence, along with the simultaneous discovery of new spaces that have nothing in common with what can be perceived externally.

The triangular, regular-shaped entrance suggests an initial use as a tufa quarry, a type commonly found in Cumae, such as in the Grotta della Sibilla. However, around the 10th century, the

space was converted into a sacred place. The religious sentiment of the local inhabitants spontaneously led to the adaptive reuse of the original quarry, integrating their needs for worship and gathering, as evidenced by the masonry remains built around and above the quarry. Additionally, a bell tower was constructed externally, serving as a "landmark" for the surrounding area, making the place visible from the nearby Via Francigena, thus becoming a point of reference and centripetal radiation.

The continued use over time is evidenced by cycles of frescoes, with Marian themes, that have covered eight centuries of history. Their preservation has been guaranteed through spontaneous maintenance by the local inhabitants who have cared for the site (Mohamed *et al*., 2017). The local community has been the true protagonist in the preservation of the church, through spontaneous maintenance and the transmission of the symbolic value of the place to future generations. The territorial context, such as the proximity to the Via Francigena and the historical and cultural value acquired over time, has strongly influenced the evolution of the church and its conservation.

The nature of the process, resulting from the adaptive reuse of the cave, was a spontaneous one, guided by the needs of the community and the previously existing sacredness of the place, determined by the presence of an anthropised cave also used for pastoral and Roman aqueduct purposes

In 2010, sudden water infiltrations affected the grotto, flooding the floor and causing severe condensation on the frescoed walls-an unprecedented phenomenon despite the site's proximity to an ancient aqueduct. Given its isolated hilltop location, leaks from upstream pipes were immediately ruled out.

Investigations on-site and in archives suggest that infiltrations stem from micro-cracks in the overlying road and rainwater accumulation on the tufaceous bank, exacerbated by anthropogenic alterations to the landscape. This aligns with Lorenz's butterfly effect, according to which, seemingly unrelated human interventions disrupted the site's delicate balance, potentially triggering a slow process of self-destruction within its evocative *genius loci*.

Saint Mary in the Grotto cannot be considered a mere artefact to be preserved without including the landscape and the territory that surrounds it in the safeguarding process. However, the peculiarity of the place demands reflection. What has allowed, or permitted, a structure in a somewhat isolated position, apparently devoid of a custodian or a religious[1] community, to have a continuous history? The presence of a decorative apparatus from the 10th century to the 18th century would justify the continuous use without interruption, and this would have guaranteed the minimum maintenance and custody necessary for the preservation of the artefact, but not for the last two centuries, which seem to be devoid of a continuous presence.

Saint Mary in the Grotto has represented and represents a guardian for the protection of the territory, a stop for pilgrims on the Via Francigena, a place of devotion and mystical refuge. Moreover, it is the *incolae* themselves, protected by the guardian, who represent protection of the territory, who exercise the *tutela* to protect the artefact, who have guaranteed and guarantee its continuous preservation since the 10th century. It is a suggestion to imagine the two-way relationship of respect and protection between the sacred place represented by Saint Mary in the grotto and the inhabitants of the *pagus*, but this relationship would justify the silent respect and protection on the part of the inhabitants-managers of the territory, and the sacredness that it still preserves today (Amoruso *et al*., 2020).

This relationship of mutual respect cannot, therefore, be considered confined to the spaces of the sacred but extended to the surrounding territory that generated it. The generative process is often forgotten. The generic user observes and enjoys the Cultural Heritage specularly and coincidentally with their own formation and their ability to perceive beauty, but rarely does the user associate the Heritage with the context that generated it, with the generative process associated with the technological processes underlying the creation of a Cultural Heritage.

Therefore, the Cultural Heritage cannot be dissociated from the territory that hosts it. It is both its expression and part of it, and this concept must also be extended to conservation and protection. Saint Mary in the Grotto represents the concept of a centrifugal matrix, which postulates the recovery of heritage, not only preserving it but also generating environmental benefits for the surrounding context, unconsciously promoting models of sustainable cultural, economic, and social development.

Such models can be attributed to the aspects of proactive conservation of architectural heritage, which plays a fundamental role in the protection and enhancement of historic buildings, combining innovative and traditional approaches to ensure the maintenance and sustainable use/reuse of structures (Talamo, 2013). This approach focuses on the early identification and mitigation of risks, avoiding late and costly interventions, guaranteeing, as in the case of Saint Mary in the Grotto, the minimum interventions necessary to maintain the integrity of historic buildings, respecting their material and cultural authenticity (Zhang & Dong, 2019), and maintaining the relationship and involvement of the local community. Conservation is, therefore, not limited to the building but includes the socio-cultural context, promoting the sustainable use of local resources and community participation (Darwish, 2016), even in spontaneous maintenance, characterised by emergency interventions, limited in scope and contingent on the availability of resources and immediate needs, with the active participation of local communities. Proactive conservation of architectural

heritage is, therefore, an indispensable strategy for preserving historical and cultural memory, integrating technological, participatory, and sustainable approaches to address the challenges of the future.

The case study of S. Michele in Gualana

S. Michele in Gualana, Sessa Aurunca (CE), is part of the same territorial context as S. Maria in Grotta. It is one of the 92 rock-cut churches surveyed in 2007, of which 37% were dedicated to the cult of Michael (Ebanista, 2007).

The reasons why the rock-hewn church of Saint Michael in Gualana, located in Fasani, Sessa Aurunca (CE), fell into oblivion are unknown. It could be due to political and social causes that led to its abandonment, or it could be the consequence of natural disasters, or perhaps it was a *damnatio memoriae*, a deliberate act that will destroy a monument and reclaim public spaces to redefine the identity of a place.

The complete absence of documents, references, and information in pastoral visits, as well as the lack of popular memory, suggests that it was abandoned before the Council of Trento, a neglect that led first to degradation and then to oblivion

We know what the chronicles tell us. A fortuitous discovery in the 1970s. Only after a little over 30 years from the discovery, and further abandonment, did the Diocese of Sessa Aurunca initiate a project to recover the site, not as a place for religious use. The purpose was to return to the community a space that would recover its own cultural identity through adaptive reuse with a centrifugal dynamic, reflecting modern conservation principles, and including, by an act of will, the aspects of programmed maintenance that such reuse entails. The project immediately set itself the goal of restoring the rock-hewn church as an exemplary case of how an innovative approach can revolutionise the conservation and enhancement of cultural heritage (Della Spina, 2020).

The operation involved "reinserting" the cave into its territorial context, analysing its relationships with the surrounding environment, landscapes, and human settlements, actively involving the local community in all phases of the project, from design to management, to foster a sense of belonging and responsibility, and to trigger phenomena of cultural tourism, environmental education, and scientific research (Foster, 2020).

At the heart of the concept is the adoption of a "centrifugal matrix" as an intervention methodology, which underlines the importance of considering cultural heritage not as an isolated object to be recovered, but as an integral part of a complex system of relationships with the physical, social, and cultural context to which it belongs. The cave must be "reinserted" into its territorial context, analysing the relationships with the surrounding environment, landscapes, and human settlements, actively involving the local community in all phases of the project, from design to management, to foster a sense of belonging and responsibility, and thus trigger phenomena of cultural tourism, environmental education, and scientific research.

The intervention programme also addressed the delicate issue of designing the recovery of spaces that had now lost their original characteristic of being a rock-hewn cave due to collapses, and whose morphology was not even known in the initial phase. Before the intervention, the site's original rock-cut cave morphology was obscured by collapses, leaving only a shallow 3x3 metre pit, 2.5 metres deep, filled with debris. The only visible element was the partially frescoed southern wall.

The initial phase of clearing and defining the perimeter revealed an architectural structure resembling S. Maria in Grotta, particularly in its masonry entrance. However, unlike S. Maria, S. Michele in Gualana incorporated Roman remains, including altars embedded in the masonry. Stone jambs marked the entrance, leading down steps into a compact space featuring a well and rock-hewn walls, forming a tripartite layout.

Considering the site's characteristics and the intent to restore its religious function, the project emphasises adaptive reuse as a balanced approach to conservation, sustainability, and territorial regeneration (Conejos *et al.*, 2011) (Fig. 5, 6, 7).

For its transformation into a museum, the intervention integrates the site into a broader regeneration strategy. A permanent cover over the archaeological excavation acts as both protection and showcase, preserving visibility of the façade elements, while allowing interior views through a transparent structure. This contemporary landmark, distinct yet respectful of the ancient, reinterprets the site's presence in the landscape. Unlike a traditional bell tower, it serves not a religious function but a mediating role between past and present, inviting engagement through its transparency. Positioned near the city's main entrance, it enhances recognition and strengthens the site's identity, triggering centrifugal dynamics with economic, social, and environmental benefits.

Adaptive reuse as a catalyst for territorial and community regeneration

The cases of Santa Maria in Grotta and San Michele in Gualana illustrate two distinct approaches to adaptive reuse, both responding to collective needs yet triggering different spatial and social dynamics.

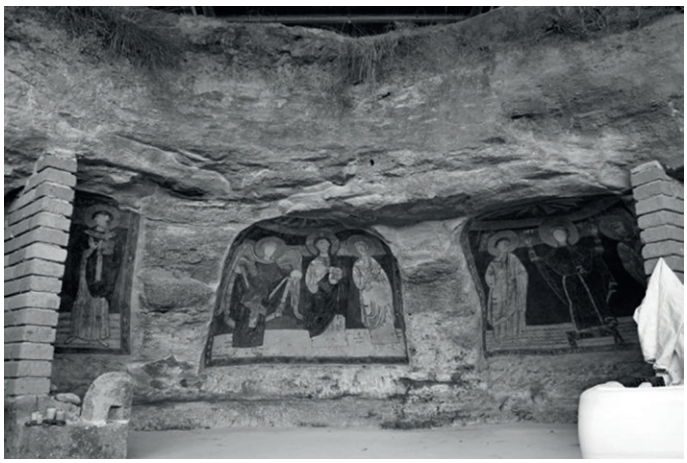
In Santa Maria in Grotta, adaptive reuse emerges spontaneously from the local community, transforming the site into a spiritual and cultural landmark associated with pilgrimage activities. This centripetal process fosters preservation and continuous maintenance, reinforcing community identity. Conversely,

05 | S. Michele in Gualana: Entrance to the archaeological enclosure safeguarding the cave

06 | S. Michele in Gualana: Interior view of the cave, oriented towards the entrance, revealing archaeological evidence of Roman occupation

07 | S. Michele in Gualana: Internal perspective of the cave from the entrance, highlighting tufa lunettes embellished with medieval frescoes


| 05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in San Michele in Gualana, adaptive reuse is initiated by a *dominus* through a structured intervention, radiating cultural, economic, and environmental benefits outward. This centrifugal process regenerates the surrounding territory, restoring lost values and reconnecting the site to the community.
Both cases highlight the role of adaptive reuse in creating value linked to identity and belonging. In Santa Maria, deep-rooted local engagement ensured the site's survival over time. In San Michele, where the absence of a community led to neglect, reuse reestablished the connection between place and people.
A site with renewed value naturally becomes a landmark, both physically-as a recognisable territorial reference-and symbolically-as an anchor for cultural identity. The bell tower of Santa Maria and the museum structure of San Michele exemplify this dual role, enhancing visibility, fostering community ties, and attracting economic and social benefits.
Scholars such as Plevoets and Van Cleempoel (2019) have highlighted how adaptive reuse can trigger virtuous processes of socio-economic regeneration, promoting inclusion and innovation. Bullen and Love (2011) underline the role of proactive conservation, while other studies explore the economic sustainability of reuse.
The intervention, in a pioneering and anticipatory manner of cultural heritage recovery policies, has abandoned the traditional restoration intervention, shifting attention towards innovative concepts that enhance heritage as a dynamic resource, where the technological approach of possible quality and the circularity of solutions emphasise the ethics of recovery. This is the case today, at a time when the international debate focuses on the integration between conservation and sustainable development (UNESCO guidelines, Faro Convention, 2005), which promote the participation of local communities in the management of heritage, foreshadowing it as an innovative intervention of adaptive reuse.

Conclusion

This paper presents two case studies, Santa Maria in Grotta (Rongolise di Sessa Aurunca) and San Michele in Gualana (Fasani di Sessa Aurunca), to demonstrate how adaptive reuse can trigger (both spontaneously and intentionally) a series of centripetal and centrifugal dynamics that generate value and modify the environmental, economic, and social fabric of a territory, while preserving heritage. The first case demonstrates how spontaneous adaptive reuse, driven by a deep connection between the community and the territory, which hypothetically began around the 10th century, has allowed for the preservation of heritage, bringing it to the present day. In the second case, the lack of a community over the centuries led to the abandonment of the place and the surrounding area. However, the adaptive reuse of the cave has enabled the activation of a series of dynamics to restore the entire territory and generate a new sense of belonging.
By applying processes of reappropriation of cultural identity through adaptive reuse, it is possible to trigger a series of phenomena that can lead to the conservation of places, even through spontaneous maintenance by the local community, reducing the risk of abandonment and subsequent degradation of heritage. It is, therefore, important for the place to fulfill a

community need in order to generate a bond. A series of forces are thus activated, benefitting both the community dimension and larger dimensions related to economic, cultural, and environmental aspects.

The reappropriation of cultural identity can also potentially represent the key to achieving sustainability goals, educating communities to care for the territory, to efficiently manage flows and resources, generating knowledge and awareness, and thus the desire to participate in global dynamics

Rather than punctual interventions "on" heritage, there is a need for interventions "within" heritage, considering the subjects as part of a broad environmental and cultural context. These interventions should be resource-generating, promoting harmonious and balanced growth of the entire territory, understood as a heritage of cultural resources. They should foster interrelations between heritage, environment, and economic realities, as well as stimulate and support civil development processes, which are fundamental for heritage conservation and can act as leverage points for generating multiplicative benefits.

NOTES

[1] The presence of a masonry elevation and limited evidence of construction suggest the possibility of a stable, albeit small, settlement, which would justify the continuity of use evident in the creation of the decorative apparatus, carried out without interruption, as stated by Torriero G. and Speciale L. in their study of the rock church of Santa Maria in Grotta, Marina di Minturno, 1994

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ATTRIBUTION, ACKNOWLEDGMENTS, COPYRIGHT

The photos in figures 1, 2, 3, 4 are by Gianni Izzo, photos 5, 6, 7 are by Antonio Maio.

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Update of Giancarlo De Carlo's participatory method: a case of experimentation

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Abstract. The essay explores an updated application of Giancarlo De Carlo's participatory method through the renovation of a hotel timeshare in Gioiosa Marea (ME), which was used by one hundred and thirty-five families. The experience integrated sociological enquiry, metric-environmental surveys, and subjective and objective tools to meet the needs of users who wished to adapt the spaces to their new living requirements. The shared design produced flexible solutions, improving functionality and comfort, and renewing the link between space and people. The experimentation allowed clients to re-evaluate the architect's role as a social and cultural mediator in the development of living space, and the designer to develop a replicable method.

Keywords: Involvement; Transitional living; Spatiality; Shared design; Domesticity.

Reflections on the architect's social role

The new media and the recent advent of artificial intelligence are progressively distancing people from critical reflection on physical space. The habit of flatly reading places distances people from the perceptive knowledge of the dimension characterising architecture, namely space. The individual, limiting himself to passive observation, does not move and, by not moving, does not define the space, thus struggling to recognise its value. In this scenario, the role of the design architect loses its meaning, overwhelmed by other professions concerned with defining images, and the recipients of architecture seem increasingly incapable of recognising their housing needs.

The project, described below, borrows some distinctive features from the tentative design work carried out by De Carlo for the housing of workers at the TERNI steelworks in Terni, which led to the construction of the Nuovo Villaggio Matteotti, completed in 1974. The architect was supported by key figures such as Gian Lupo Osti, general manager of the steelworks, architect Cesare de Seta, and sociologist Domenico De Masi. The project utilised two primary tools, namely exhibitions and interviews. The exhibitions, organised to acquaint workers with an innovative approach to architecture, were two. The first exhibition aimed to highlight residential building districts within virtuous European contexts, while the second presented the typologies of apartments that resulted from participatory planning. The interviews with potential recipients of the housing, conducted by De Masi, served to collect the needs and opinions of the prospective inhabitants of the houses. The method was intended to be concluded with a collection of feedback following a period of the recipients living in their new homes; however, the change in management at TERNI prevented De Carlo from completing his experiment. De Carlo's methodology for the Nuovo Villaggio Matteotti, which he employed in various contexts, is characterised by a fluid approach based on trial and error, where each phase influences the subsequent phase and alters the conditions under which it was initiated, in a cycle centred on «the continuous alternation of information, propositions and verifications» (De Carlo,1970). The work presented in this essay constitutes an attempt to identify new and simple tools for the same purpose, namely a test of listening and interpenetration by the designer who maintains the central role of space and, therefore, the construction of the architecture.

Collective design experimentation

The design experimentation focuses on a former noble villa constructed on four staggered levels, historically serving as a summer residence. During the 1980s, the villa was subdivided into twenty-seven mini-apartments for shared ownership, which, at the time of the experiment, were owned by one hundred and thirty-five families. The apartments are primarily utilised during the summer months, with each apartment being shared by a minimum of three to a maximum of eight families, exhibiting diverse compositions and coming from various regions across Italy. The duration of occupancy varies, with each family residing in the apartment for a minimum of one week and a maximum of four weeks. Consequently, the population residing in the apartments during this period is characterised by significant heterogeneity. The exceptional nature of this condition made it possible to draw a parallel with the Nuovo Villaggio Matteotti, where the workers, albeit with different identities, shared the same basic needs. This was the spur to develop an effective method that could be replicated in similar conditions.

Framing, investigations, and surveys

The initial design phase entails a comprehensive analysis of both the existing conditions of the site and the client's requirements. This approach aligns with De Carlo's methodology, wherein he conducted a thorough investigation of the context, including the existing dwellings for workers at Villaggio Italo Balbo. Facing the Aeolian archipelago, the villa enjoys a pleasant panorama and is part of a rich agricultural landscape, featuring olive groves surrounded by Mediterranean scrub, while the coastal strip is characterised by a mighty promontory, which closes the natural basin overlooking the villa. Since its first configuration as a timeshare in 1985, it has undergone an interior renovation in 2000, during which all the furniture was replaced.

In a continuation of the practice of utilising exhibitions and interviews initiated by De Carlo, condominium meetings were employed as opportunities to highlight the project's potential and stimulate debate. An email address was set up to gather requests and opinions in both free form and as responses to questionnaires. The method is implemented precisely with tools that, by exploiting current technologies, shorten the distance

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Tab. 01 | Household information

Category	Data	%
Family composition	- Over 60s with children and grandchildren	75%
	- Childless couples	10%
	- Younger couples with young children	15%
Geographical origin of commissioning parties	- Sicilia	56%
	- Campania	4%
	- Lazio	10%
	- Emilia Romagna	2.5%
	- Puglia	2.5%
	- Toscana	2.5%
	- Veneto	2.5%
Education level	- University or higher	72%
	- Secondary school	28%
Time-share purchase period	- Before 1985	62%
	- Between 1985 and 2000	35%
	- After 2000	3%
Villa usage frequency	- Every year	85%
	- At least 3 times in the last 5 years	6.5%
	- 1 or 2 times in the last 5 years	6.5%
	- Never	2%

between clients and designers, and allow design phases to be continued, with the aim being gradually adjusted throughout the process. The De Carlo method is complemented by a survey of the interiors, which is a means to understand the space's use. A questionnaire was sent to them with the aim of getting to know the clients with whom the project would be designed, and of later understanding whether there was a correlation with the needs of use. The results showed that the families who use the apartments are couples over sixty with children and often grandchildren, but also couples without children or young couples with small children. The level of education is high, the people are all from the south of Italy, with a strong peak from Sicily, and all of them have been multiple owners for over thirty years (Tab. 1).

An analysis of the data, in addition to the narratives shared by clients during meetings, reveals that the Villa functions as a retreat for the multi-owners. It is perceived as home.

Like the anthropic survey, the metric and photographic survey operations were carried out in several phases, and were essential for drawing up the questionnaires to be submitted to the clients and for the development of project proposals. The initial survey was conducted immediately following the conclusion of the summer season, with the aim of observing the arrangement of furniture within both interior and exterior areas. This approach enabled the observation of how the spaces were utilised. Chaos reigned in the apartments, opening the sofas and chair beds meant not knowing how to put away the decorative cushions and covers. Closing them meant having to make and unmake the bed every day, and find a place to put away the pillows. Such difficulties made most people opt to always leave the sofas and chair beds open, cluttering up all the rooms. The chairs, positioned at the sides of the beds, were used to place everything on them, but not to sit on them. Hence the need for bedside tables, for suitable spaces to store objects and clothing, and for understanding non-use of the internal dining table. However, in addition to a considerable general degradation of the villa, two fundamental needs could be observed on the outside, namely the need for shelter from the sun, noticed in the spontaneous appearance of beach umbrellas in front of the apartments and due to the use of the external dining table, and the desire to enjoy the denied panorama, given that the large shared terrace on the third level was closed on the sea side with a ca. 1.50 m high wall, which blocked the view. Everything observed, including the position of the furniture, was reported in the survey drawings so that it could be useful for proposing new usage solutions (Fig. 1).

The twenty-seven mini-apartments were found to have a surface area between 15.00 and 37.50 square metres with a variable configuration that sees four apartments develop in a single space with bathroom, only one composed of a living room/kitchen, two bedrooms and bathroom, and twenty-two with a living room/kitchen, a bedroom and bathroom. Thirteen of the latter are similar in type, and will be referred to later as bilo-standard, while the remainder are all different from each other. The first means of communicating with the clients was that of collective interviews during which needs and inconveniences emerged. A committee composed of three members elected from among them was established with the task of having more immediate communication with the designer.

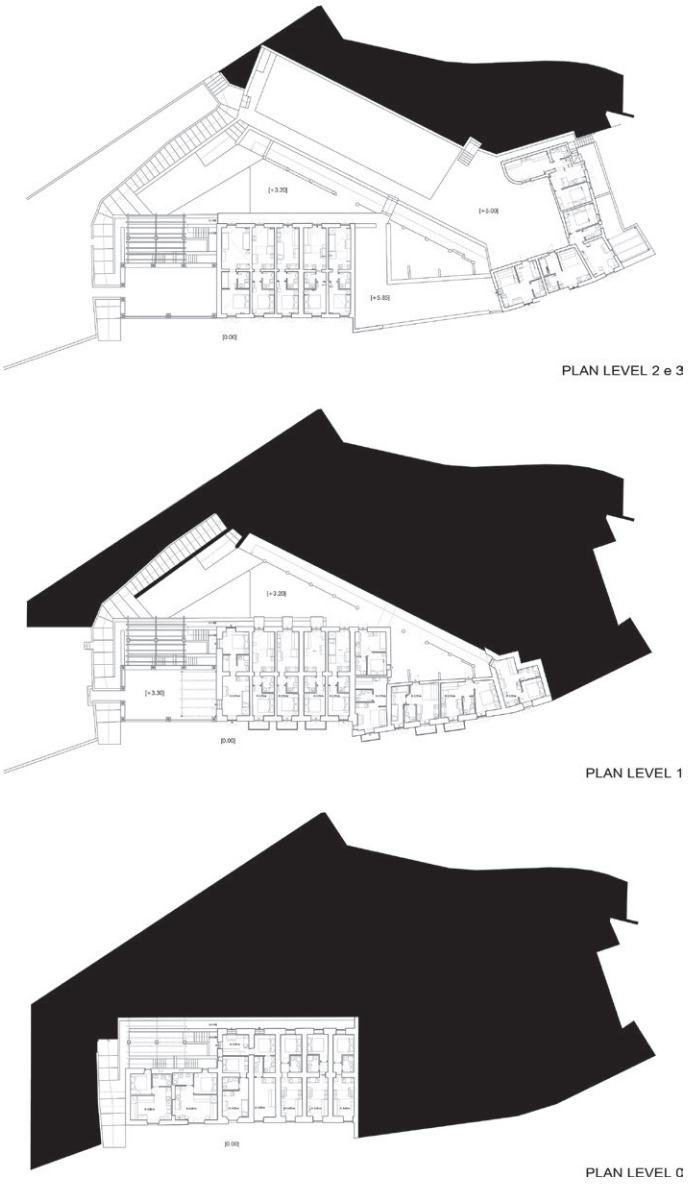
Initial results and data analysis

It is clear from the preliminary research that the changing needs in terms of home use are linked to changes in society over the last fifty years. Individualism has reduced the desire for interaction with neighbours, and the reduction in the time available for summer holidays has increased the demand for comfort. Furthermore, it should not be underestimated that until the years when the structure under study was converted into a hotel timeshare, families were still quite large and very often shared small spaces daily, whereas today young couples with one or two children are used to living in larger, more comfortable environments.

Open collection of information and model projects

In this phase, an email address was set up for the experiment, and the multi-property owners were invited to send their thoughts on the renovation of the apartments. The possibility of having the designer as the only interlocutor freed the clients from the judgement of the others. Feedback was collected over a fixed three-week period, after which design directions could be defined and make decisions on how to proceed with both the design of the spaces and the involvement of clients. The considerations received showed a strong emotional involvement, and were effective in getting the project off the ground. Two key points emerged, precisely, the inconvenience caused by the presence of architectural barriers, and the poor func-

01 | Planimetric survey of the four levels with indication of the furnishings



tionality of the existing furniture, combined with a general request for a careful evaluation of the cost-benefit ratio. Several of the owners described the furniture solutions adopted in the first project in the 1980s as better. These items were later replaced. So they were asked to send historical photographs that might be useful in reconstructing the rooms. These showed that the first furnishings were more organised and organic than those found during the surveys. Everything, from the beds to the kitchen, was made of the same material, veneered chipboard, leaving the wood in its natural colour, which gave the rooms a uniform appearance. The furniture was also built in modules, including the single and double folding beds. It was determined that the original modules, which were still present in the rooms, would be preserved through restoration due to their efficiency. To reuse the furniture that had been piled up inside the apartments, it was deemed necessary to carry out a precise survey of the same, both photographic and metric, to catalogue the pieces and create an inventory. The furniture was categorised by type and quantity, and the data compiled into tables useful both for project development and site management. During the design phase of the rooms, the furniture, restored and painted white, was moved to the apartment where it had been found.

The first plans were drawn up with the information gathered. After analysing the characteristics of all the mini-apartments, three similar mini-apartments were selected and their design was used to show the timeshare owners the new organisation of the space and the choices they intended to make in terms of furnishings, so that they could discuss and develop a strategy for refining the design and applying it to the other apartments (Fig. 2).

First project questionnaire and outdoor project

At this point, some multi-owners were sceptical about the veracity of the data collected. To change their minds, it was decided to use an objective approach that could be verified immediately, namely a questionnaire with clear instructions for the first stages of the work. Indeed, if the debates during the condominium meetings and the collection of information via email were non-scientific and, therefore, refutable methods, the questionnaire served as an incontrovertible objective tool, bridging the gap with the dialogues conducted by De Masi with the TERNI workers. The participants were invited to express their opinion on the colours to be used for the façade, with a view to enabling the clients to quickly observe the results of their choices, thus reinforcing the impression that their opinion had been given consideration. In the case of the New Matteotti Village, discussions with the workers revealed a lack of confidence that the things said would be considered. The questionnaire was also used to gather input on the type of furniture to be used, so that everyone, even those not present at the discussions, could have their say. The results of the questionnaire were summarised in tables and shown to the principals during the meetings.

The colour combination used for the sea-facing façade was the one chosen by 66% of the clients out of the three alternatives proposed, but for the upstream side the colours preferred by a further 20% were used, so that almost everyone felt their choices were respected. This strengthened their confidence in the experiment. The colours proposed recalled the palette of the sunset, the blue of the sky and the sea, the orange of the sun together with the green of the vegetation, achieving a result in harmony with the surroundings (Fig. 3 e 4).

The design of a furnishing system

For the purposes of his project, De Carlo developed five types of accommodation from a 90 x 90 cm matrix, which varied across

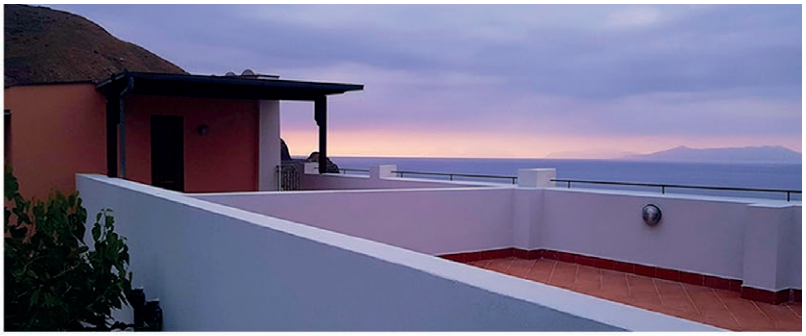
02 | Longitudinal section: flat type

03 | Waterfront view with the colours chosen by most clients

04 | Photo of the villa at the end of the renovation work. On the left the sea side elevation, on the right top the terrace with the parapet lowered, down three types of single bed

| 02

| 03



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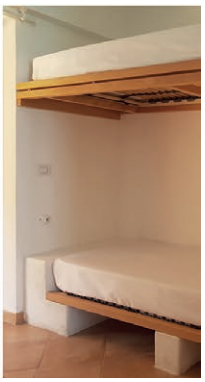
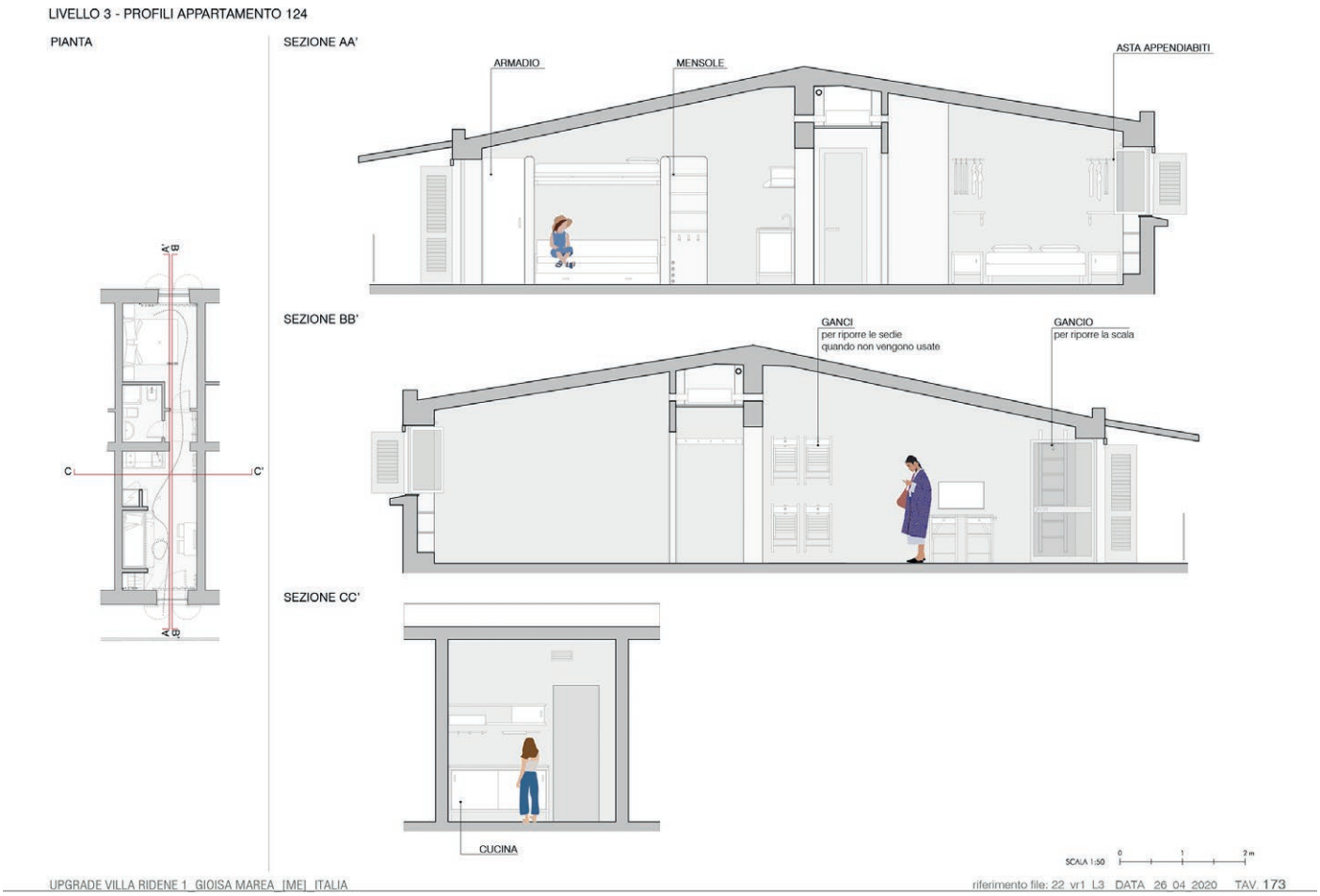


05 | Example of a table with sections of the flat.



the three floors of the buildings, thereby generating fifteen different combinations. It is evident that a schematic system is required to adapt to the nuances of the clients' needs and create harmonious variables. To embrace the principle that guided this approach to the organisation of interior space, a furnishing system was designed that could adapt to the differences between the apartments but that would give a unified image. The handcrafted system uses solid steamed beech strips with a 45 x 45 mm section, assembled with screws and bolts, without the use of special joinery joints. This system gave shape to the single beds – in three types – the double beds, the bedside tables, the wardrobes, the kitchens, and the lamps. To complete the system, a series of wall cupboards were designed with doors in ash block, painted in matt white to match the walls (Fig. 4).

Design and creation of the first flats

The first apartments to be designed and built were thirteen of a similar type. The flats are structured around a masonry system consisting of a wardrobe, a bunk bed with a pull-out, and a compartment that hides the fridge, which together with the kitchen unit defines the first room. The bedroom makes use of the existing bed, with the addition of bedside tables and open systems for storing clothes, as well as reusing, where possible, the restored original furniture. The projects were presented to the timeshare owners prior to their implementation in the form of tables with a plan comparison between the actual state and the project state and sections (Fig. 5).

Forced work stoppages and new project opportunities

The pandemic caused by the spread of Covid-19 brought work to a halt. During the months of standstill, listening activities continued by email and telephone, and during the summer season of 2020, the first completed apartments were lived in, and inspections were carried out during the use. It was revealed that, to accommodate the clients, it would have been necessary to broaden the range of possibilities. Consequently, further design solutions were developed for each apartment – two or three – and choices were made by taking into account the requests. Most people wanted closed wardrobes rather than open storage solutions. The design alternatives were accompanied by questionnaires (Fig. 6), this time for each apartment with specifics. Each timeshare owner received a document with a short text explaining the design alternatives, the questionnaire and commented graphics to help answer the questions. The graphics included the floor plan, survey, and design, and at least two sections for each design alternative,

06 | Extract from the second questionnaire.

QUESTIONARIO 2

| 06

1. Indicare la soluzione progettuale che si preferisce tra le due proposte:

PROGETTO 1	PROGETTO 2	INDIFFERENTE
TAVOLE n° 51, 52, 53	TAVOLE n° 54, 55, 56	
☐	☐	☐

NOTE [inserire eventuali commenti o proposte alternative]:

2. Indicare l'arredo che si preferisce per la camera da letto:

opzione 1	opzione 2	opzione 3	indifferente
COMODINI + MENSOLE	COMODINI + MENSOLONE UNICO	MOBILE + MENSOLONE UNICOUNICO	
☐	☐	☐	☐

NOTE [inserire eventuali commenti o proposte alternative]:

3. Quanto ritieni importante avere il sesto posto letto?

☐ NON IMPORTANTE ☐ POCO ☐ MOLTO ☐ INDIFFERENTE

L'esito di questa domanda potrebbe apportare modifiche al progetto che saranno debitamente comunicate e saranno oggetto di altra breve consultazione.

4. Quanto ritieni importante avere il frigorifero a colonna con congelatore?

☐ NON IMPORTANTE ☐ POCO ☐ MOLTO ☐ INDIFFERENTE

L'esito di questa domanda potrebbe apportare modifiche al progetto che saranno debitamente comunicate e saranno oggetto di altra breve consultazione.

Grazie per aver risposto ai quesiti posti

as well as drawings of furniture alternatives for the bedroom (Fig. 7). The impracticability of conducting direct comparisons between each client and the designer when reading the drawings resulted in the identification of effective methodologies that could facilitate comprehension of the project. This included the addition of descriptive captions within the drawings, which were found to be an effective means of communication. The remaining flats were also designed and built using the outcome guidelines.

Outcomes and implications

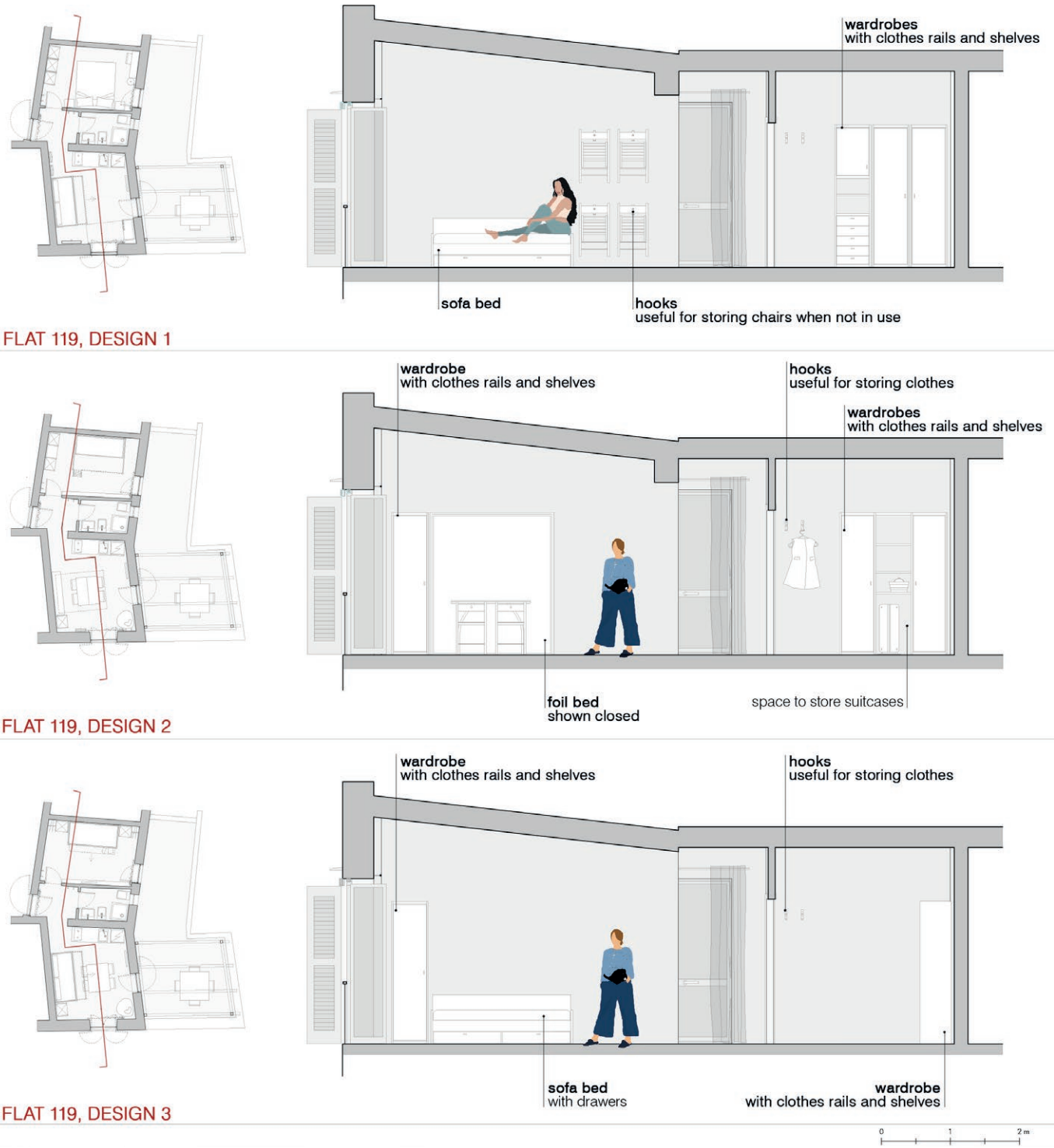
The economic difficulties experienced by some multi-owners because of the pandemic resulted in the cessation of the project, with certain elements being omitted. In particular, the existing kitchens were retained, and the additional furniture required by the results of the second questionnaire was not provided. It is unfortunate that this condition has also had a negative impact on the perception that some have had of the tentative design. While many were receptive and appreciative of this opportunity, some felt misled and betrayed. The continuous exchange and transparency with which the project was operated meant that the client placed a trust in the designer that went beyond the execution of a good project. This resulted in expectations concerning project implementation, which depends on a series of other factors not controllable by the designer, the first being economic data.

Methodological considerations

This experience has demonstrated the efficacy of participation in guiding projects, especially in scenarios involving multiple clients. The tools used, including meetings, questionnaires, data collection, historical photos, project sheets and descriptive texts, have proven beneficial. Questionnaires have given clear results, but the preparatory phase is difficult. This phase involves making lots of documents for each project. In the future, it would be better to use meetings to talk about the projects, and then do the questionnaires right after. This would ensure questionnaires only contained the questions. The production of a unique furniture system as well as the design variants were winning solutions, while the establishment of a committee did not bring any benefit to the work. It is evident from the findings of this experiment that there is a clear synergy between the utilisation of subjective and emotional involvement tools, such as interviews, and the open communication of needs, and objective tools, including questionnaires. It is imperative to emphasise that continuous communication between all parties and regular updates for the client on the project's progress are indispensable elements. In this way «the designer organizes and gives spatial form to the client's needs and commits himself to ensuring that the materialization of the work occurs in the most competent way, with the maximum correspondence between ends and means» (De Carlo, 2004, p. 32).

07 | The floor plans and a section of flat 119 are compared to understand the design alternatives, and how the boards were commented on.

07 |



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Ambiguity and interaction in city design. The impact of superblock on architecture

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Abstract. The paper presents a series of reflections on the street as a place for relations, a significant aspect of European city design. This 'new' approach focuses more on interaction and the active use of outdoor spaces, starting from criticism of some solutions proposed by the Modern Movement by Team 10 members. However, this design vision has recently gained significant traction, marking a notable shift in European city redevelopment. The text explores the concepts behind public spaces where the interaction between inside and outside is becoming less distinct.

Keywords: Architecture; Superblock; Street; Commonplace; Open City.

The street as a commonplace

A profound reflection on commonplaces has been launched in the last decades. This is not relegated to the amount of urban space in our cities but, above all, to its quality, its connection with architecture, and how public and private spaces influence each other. These aspects have always been an invariant of European and Italian cities, where, for example, some architectural features like the portico or the courtyard function as a filter between inside and outside, while, the façade organisation participates in street life, playing a crucial role in our social life by transforming the street in "urban interiors" (Norberg-Schulz, 1979). We do not want to retrace the development of urban spaces from a historical point of view but to analyse a series of essential features partly present in the work of Modern Movement masters, though, for them, the street is anachronistic (Pérez de Arce, 2018) and is perceived as an essential element of the '800 plans[1].

For Le Corbusier, the exterior is essentially framed in the wall. As stated by Robert Venturi (1966), the exterior derives from the construction of the interior. For the 'first' Le Corbusier (1965), the street is essentially the place of cars, a rectilinear space governed by a flow with a speed of "50-100 km/h". Instead, pedestrians have dedicated paths that flow towards the buildings raised on pilotis, one of the main principles of a new life model to resolve the hygiene problems that exploded in the early Twentieth Century. This, topic moved Haussmann himself to rethink entire neighbourhoods of Paris, and is reflected in the work of all the masters of the Modern era (Colomina, 2018). Detachment from the context becomes less evident in the projects after the 1940s, where increasingly permeable surfaces replace the pure and "cold" geometries, to use an expression by Zevi (1974). In the Maison du Docteur Curutchet of 1949, the white wall with ribbon windows leaves space for a large void on the street. This mechanism implies a total opening towards the public street, which remains only apparent and not functional. In the same period, the buildings designed for Chandigarh showed greater openness towards the landscape, even if this choice resulted from his research on North African plastic forms (Curtis and Doshi, 1989).

When Mies van der Rohe moved back the Seagram building volume between 1956 and 1958, he created an unexpected void in the dense urban network of New York. It is widely documented that Mies proposed this space to give the building more prominence and to observe it in its entirety (Cf. Capozzi, 2019). Still, it is equally valid that such a 'European' urban space was immediately perceived as "an oasis for office workers and passers-by," as highlighted in an article published in the R section of the New York Times in 1957[2]. The difference in level on the street becomes a seat on which many citizens are portrayed in the several photos of the building (Fig. 1), demonstrating the great interest generated by this solution[3].

The role of architecture in social life and indigenous identity was a key focus in Wright's work, contrasting with the English colonial style (Wright, 1945). As highlighted by Venturi (1966), the construction of his architecture started from the ground, resembling a biological process. This method was different from the previous ones described. The American master revolutionised the concept of "box" in favour of a thick roof and a podium to gradually approach a renewed domestic space. Above all, the massive covering, the shelter described by Giedion (1928) as the original cell of Modern architecture, mitigated the detachment between inside and outside by creating different open-air spaces[4]. This concept is more relevant today than ever, as the development of increasingly punctual structural systems releasesthe building's perimeter, opening the possibility of more permeability towards the outside. However, since the mid-1950s, attention has been turned towards urban space more focused on interactions or commonplace, trying to imitate the mechanisms of historic cities where the street became a "corridor" or an extension of the building (Rasmussen, 1964). These experimental projects aimed to recover the urban voids generated following World War II, as in Amsterdam, where Aldo van Eyck created hundreds of playgrounds around 1946. They were small but fundamental 'pocket parks' where we can find several contacts with current urban projects. Some of the Smithsons' (1967) writings on the street, where they underline its use as a vital area for social expression, recalling the famous words of Jane Jacobs (1961), who hopes for a more dense, unpredictable, and diversified urban system are also of great importance. Always Jacobs emphasises the importance of the street as a necessary place for collective life in a neutral environment. However, when this principle is missing, people can only interact in their homes or public buildings. This experimentation was mainly concentrated in the 1950s and had the merit of focusing on people's needs and on the effects of the neighbourhood organisation. Years of various spatial experiments followed until the late 1980s, when studies published by Whyte, Gehl, or Anderson (1978) unanimously described «the street as an organizational

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01 | The plaza of the Seagram Building by Mies van der Rohe in 1977. Photo: Chuck Patch

01

subsystem of the city», removing the barrier between inside and outside. In Italy, the writings of Secchi and Gregotti (1989) take up these principles and bring back the street into the 'sphere of architecture.' Secchi (1986) describes the permanence of such mechanisms in the historic city, underlining once again the critical issues in the new peripheral neighbourhoods, where the street becomes only a distribution space.

Today, we recover this relationship with the outside by rethinking the public space or the same furnishings. Recent studies, as *The City at Eye Level* by STIPO (Cf. Karssenberg *et al.*, 2017), highlight the importance of the ground floor of buildings, a hybrid area called "plinth", designed as a space for social interaction. The privacy problem in domestic spaces remains valid, but many ongoing projects propose a gradual approach to the building's façade, solving the problem with new street furniture. Among the most innovative urban operations implemented in recent years, we can briefly mention the Superblocks programme in Barcelona, the first stage of an ongoing transformation, representing a solution to rethink urban places. The phrase «an ephemeral project could thus anticipate grand plans» (Pérez de Arce, 2018) perfectly summarises the original work carried out in the last five years in Barcelona. It opens the way to an original model of public space, increasing the connections with its surroundings, new or old. Furthermore, the strategy described in the next paragraph highlights two fundamental aspects, namely the role of architecture and a renewed connection with the outside. The choice of the case study examined, the Sant Antoni district in Barcelona, is not accidental. In this specific part of the city, we find a series of projects implemented in different years that have contributed to creating a contemporary or functionally ambiguous space. The key points of this vision will be discussed in the next paragraph. As anticipated in this part of the text, these projects bring the road back into the sphere of architecture through a shared vision but with many interventions that can be carried out in different ways, times, and identities.

Barcelona: buffer zones and urban interiors

Barcelona is redeveloping different city areas with an innovative approach. Some massive interventions involve entire zones, such as the former industrial district of El Poblenou, which was affected by considerable investments to transform its productive nature into a factory of culture. Among the most renowned interventions, we can mention the Can Framis Museum by BAAS Arquitectura, where the museum opens to the city, becoming at the same time a cultural and social reference through the large square at the entrance of the lot. We also find interventions aimed at redeveloping several lots simultaneously by modulating the chessboard of Cerdà's Eixample through the Superilles programme. While it was initially possible to cross the entire city grid by car, today, part of the vehicular traffic is significantly reduced with limited traffic sectors and speeds reduced to 10 km/h. Maximum priority is given to pedestrians with spaces designed to encourage community life. Furthermore, these interventions aim to eliminate the architectural barriers present in the current road section by creating a single level that runs transversely from façade to façade. Particular attention is also paid to commercial activities with areas for loading and unloading or careful waste management, both themes preceded by an analysis aimed at preventively identifying the economic impact of the superblock on the lots involved.

Leku Studio has designed several projects in Spanish cities and is among the most active studios on this topic. In 2019, they designed the *Superilla de Sant Antoni* (Fig. 2), one of their most iconic projects, where they joined four city blocks, expanding the pedestrian area along the four main streets and creating a new square in the middle of the neighbourhood. The nature of the initiative is temporary[5], with the supply of modular furnishings and the delimitation of flows through graphics painted on the asphalt. Although the works may "not" seem permanent, they are now part of the life of the neighbourhood and blend perfectly with the recent works created in recent years, such as the Joan Oliver Library by RCR Arquitectes (2007) and the Mercat de Sant Antoni (2012-18) by Ravetllat Arquitectura. The library started the neighbourhood's renovation with a new space focused on pedestrians and a new architectural language in the typical style of Catalan architects. The building opens onto the street through a large portal from which pedestrians can reach a small internal garden, anticipating the future urban development of the neighbourhood by purposing a mechanism like the one described by Rasmussen (1964) for the Palazzo Massimo alle Colonne in Rome designed by Baldassarre Peruzzi in 1536[6]. The market, renovated in 2018 but existing since 1882, offers a new square and an original connection with the underground[7]. The strategies adopted aim to make Barcelona, piece by piece, an increasingly pedestrian-oriented city with more vegetation. The significant limitation of vehicular traffic is undoubtedly an element that opens up countless implications and is not well-regarded by everyone, especially shopkeepers, even if the higher qual-

02 | The central plaza of the Sant Antoni superblock in Barcelona by Leku Studio. Project: Leku Studio, photo: DEL RÍO BANI

| 02

ity of public space is unquestionable. The central aspect of this urban strategy is its reproducibility in different contexts, even in cities with a strong historical stratification, such as Naples.

Boundless public space The description proposed in the first part of the paper suggests that establishing an active dialogue between interior and exterior has been resolved without interruption throughout the Twentieth Century. Venturi (1966) underlines that Modern Architecture tends to reject inflection at every scale in favour of the independence of the building, «like a Greek temple» (Venturi, 1966). Functionalist urban planning or slogans such as "form follows function" have generated the illusion of solving the problems of the city and architecture through an organisation of space for dissociated functions. Immediately afterward, the protagonists of Team 10 researched different and experimental solutions, starting from social and individual needs. However, the Smithsons themselves, in the competition for the Golden Lane of 1952 or in the Robin Hood Garden of 1972[8], "fail" to design the collective aerial spaces that the residents perceive with significant discomfort (Jencks, 1973). Jordi Badia (2020), the founder of BAAS Arquitectura, underlines that the Modern architects were 'concerned' more with the construction of a language in antithesis with the academic style, leaving out some elements such as «the balcony, the molding, the cornice and the shadows cast»; for Badia. These elements «enrich the morphology of the street and the quality of the city's public space» (Badia, 2020). Contemporary architects use several spatial tricks to relate to the outside, such as attention to the lot, the role of the building in its surroundings, the point of view facing the community, or traditional materials laid innovatively. From this perspective, a city built in diversified pieces is configured, a vision advocated by Sennett (2019) in describing an open city based on interdependent lots without barriers (Fig. 3). In this context, architects are actively involved in this change as the commitment to tend toward the complex unity described by Venturi (1966) leads to unexpected relationships with the outside, and favours a diversified and ambiguous use of urban space. The superblock, the union of

03 | Sant Antoni district development in 2004, 2009, and 2021. The sequential images indicate the polarities around which the renewed urban space develops: the market and the library. Source: Image by the author

04 | Street use diagrams in Sant Antoni district in Barcelona. Drawing: Leku Studio, source: Barcelona International Landscape Biennial

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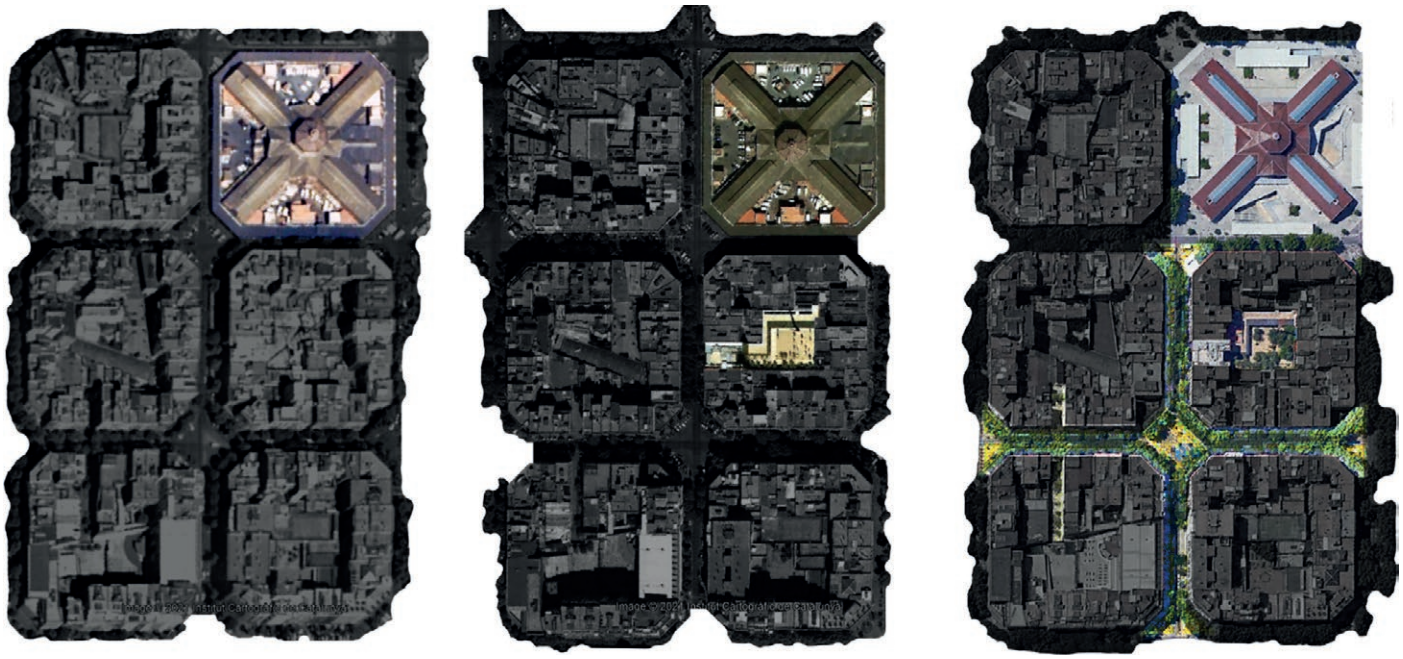

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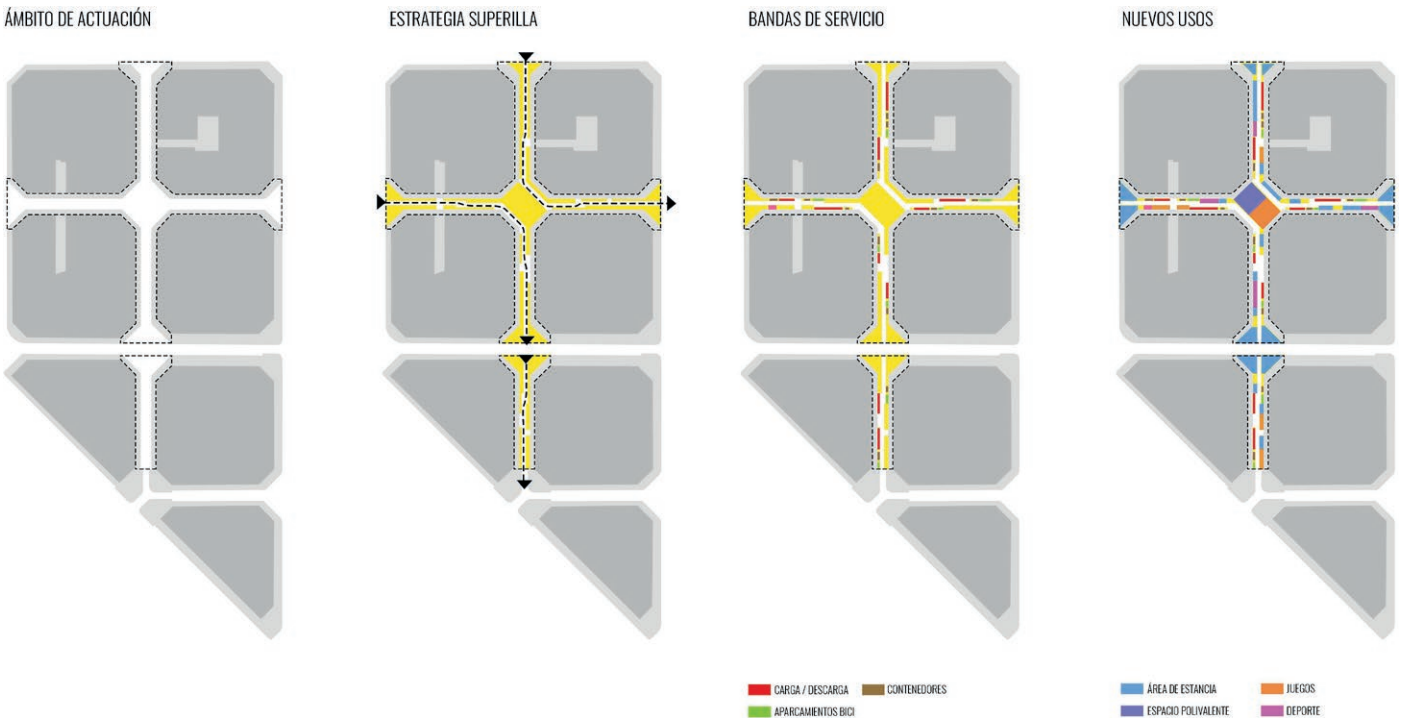

several blocks in a single neighbourhood unit, implies a city focused on relationships and interactions between citizens. It can be considered the solution to the development of detached pieces of the Twentieth Century city, re-proposing the model of the self-sufficient village, as already seen in the masterplans for Chandigarh by both Mayer[9] and Le Corbusier (Cf. Evenson,

05 | "La Lira" Theatre and new public space in Repoll by RCR Arquitectes. It is not possible to separate the building from the public space. Indeed, the project proposed to solve the urban void generated by the demolition of the "La Lira" theatre consists of a large indoor square under which the new building develops. A new pedestrian bridge connects the two banks of the river, creating an unprecedented urban space. Source: Collecció RCR BUNKA, Photo: Hisao Suzuki ©

1966). In Scandinavian countries, where these principles have already been assimilated, we witness the construction of entire neighbourhoods based on this assumption, creating an urban space at the residents' service[10]. The street becomes part of the building again and its use becomes increasingly varied, not limited exclusively to cars, bringing about both a change in the social life of citizens and a new approach of architects towards public space. In conclusion, the ground and the street have become "an organizing axis of the social fabric" (Nicolin, 2017), bringing architecture back to the ground.

NOTES

[1] Robert Venturi, in the ninth chapter of Complexity and Contradiction in Architecture, highlights how in Mies, the buildings are independent of the context like Greek temples, while in Le Corbusier, the exterior is the result of an interior. Indeed, only with Wright does the construction occurs in reverse, as if it were the result of a biological process born from the earth.

[2] In 1962, in the magazine Beverage Retailer Weekly (May 21, 1962), the square became the setting for the display of the Polaris ballistic missile. The symbol of the technological and military progress of the USA is compared to what immediately became a point of reference for global architecture.

[3] Furthermore, as highlighted in the Landmarks Preservation Commission report of 3October, 1989, this architectural choice influenced the city's urban planning regulations. This practice was encouraged by offering "a bonus of extra floor space" to those who introduced public spaces into their projects. The studio Voorhees Walker Smith & Smith curated the 1961 zoning code revision, dividing New York City into residential, commercial, and manufacturing areas. It introduced the concept of incentive zoning by adding a bonus of extra floor space to encourage developers of office buildings and apartment towers to incorporate public plazas into their projects.

[4] Like the Guggenheim Museum in New York (1959), the entrance to the building is beneath a massive horizontal volume.

[5] The first superblock projects extensively use paints to create graphic patterns on the current pavement, significantly reducing the costs of the interventions. The ongoing projects (2022 and 2023) have a higher financial endowment, and involve the replacement of the existing asphalt and a less 'temporary' appearance than the previous ones. In particular, the costs relating to the Barcelona Superblocks programme for the interventions planned for 2022 and 2023 correspond to 32.8 million euro for 'the green hubs' and 5 million euro for the 'squares'. (source: https://ajuntament.barcelona.cat/superilles/).

[6] This trick can be considered a constant in the Catalan studio, and we find it in another project drawn up in the same years, the Espacio Público Teatro la Lira in Ripoll (2011-13), in which it is impossible to identify the building's boundary from the public.

[7] This work is significant, especially in the Italian context. During the excavation, the remains of medieval walls were found and integrated into the underground works project.

[8] Jencks notes that the desire to recreate the vitality of the classic street at different levels is not supported by the characteristic elements of the same, shops, pubs, or other functions necessary to support this solution; "the street deck" only supports the flow of residents towards their accommodation, with an undoubtedly generous size, but without creating the conditions for a place of aggregation.

[9] Mayer takes the idea from the Baldwin Hills Village of '35, designed by the group composed of Reginald D. Johnson, Lewis E. Wilson, Edwin E. Merrill, Robert E. Alexander, with Clarence S. Stein and Fred Barlow, Jr. The idea was to develop 'a village within the city' with low-cost homes without giving up the necessary services. Among the main characteristics of the initiative, we find the separation of vehicular and pedestrian flows, while the road surrounds the perimeter of the rectangular site.

[10] The new Ørestad neighbourhood in Copenhagen reflects this vision. In less than twenty years, an urban project has been created where public space is continuous and physically enters the private lots, eliminating or mitigating the division between inside and outside. Among the most significant interventions, we find the masterplan curated by the Vilhelm Lauritzen Architects for the Bellakvarter neighbourhood, a large area with several brick buildings and lots of vegetation for 5.000 inhabitants. In some of the lots, there are multi-story car park disguised as office buildings. This choice releases the streets from their stalls and allocates as much surface as possible to parks, vegetable gardens, or quality greenery.

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Research on the usability of space beneath urban overpasses: a case study of Shanghai

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Abstract. This study examines the usability of spaces beneath overpasses in Shanghai, focusing on three sites along the Suzhou River. Using a mixed-method approach combining comparative case analysis and survey data, the research highlights the transformative potential of these underutilised urban spaces. Findings reveal that central sites with professional design interventions exhibit higher adaptability and public engagement, while peripheral sites face challenges from fragmented development. The study underscores the need for context-sensitive, community-focused strategies to integrate underpass spaces into the urban fabric, enhancing connectivity, social inclusion, and liveability.

Keywords: Beneath the overpass; Usability; Leftover space; Shanghai.

Introduction

The dynamic transformation of urban landscapes has brought renewed attention to the potential of underutilised spaces, particularly the areas beneath overpass, which often embody the tension between neglect and opportunity. In cities like Shanghai, where density and spatial constraints are pronounced, these leftover spaces present unique challenges and opportunities for adaptive reuse and urban renewal. Recent studies have highlighted the potential of these spaces to contribute to urban resilience, community engagement, and sustainable development by reimagining them as vibrant public spaces rather than overlooked voids (Covatta and Ikalović, 2022). By examining global and local strategies for repurposing these spaces, such as incorporating play areas, green corridors, and social hubs, researchers have underscored their value in addressing the evolving needs of urban environments, while enhancing the quality of life for residents (Aytac *et al*., 2016; Xia *et al*., 2024). This paper explores the usability of space beneath urban overpasses in Shanghai, shedding light on how innovative design and planning can unlock their potential as integral components of the city's fabric.

A crucial challenge in urban planning and architecture is the leftover space in contemporary cities. These places are discontinued in use, were disregarded during development, or have become outdated because of several urban processes (Tian, 2024). The space beneath overpasses, often seen as "leftover" or "negative", has been a focus of urban planning and architecture. These areas hold great potential for transformation into valuable public or semi-public spaces. As cities like Shanghai face rapid growth and aim for sustainable development, interest in utilising these spaces has grown. Shanghai`s rapid riverfront transformation aims to boost liveability and connectivity, yet the spaces beneath its overpasses remain underused.

As part of the Shanghai urban river planning scheme, the Suzhou River traverses the city's central district, extending to approximately 53 kilometres. To enhance road system connectivity between the river's north and south banks, numerous bridges and secondary roads have been added to the existing elevated highways and major traffic corridors, creating multi-scalar spaces beneath overpasses. While these infrastructural interventions have improved transportation efficiency along the Suzhou River, they have simultaneously generated numerous underutilised spaces beneath waterfront viaducts. These interstitial spaces, extending from the city centre to suburban areas, potentially serve as critical connectors between diverse urban environments, including public waterfront green spaces, residential zones, commercial districts, and recreational areas. However, the predominantly low-clearance nature of these overpass-adjacent spaces has largely resulted in their suboptimal utilisation, presenting a significant urban design challenge that deserves comprehensive investigation.

This paper aims to contribute to the discourse with the main research question: Can the areas located along Suzhou Creek and beneath the overpasses support urban regeneration and social inclusion? What strategies can transform these neglected spaces into valuable assets? Some urban planners advocate reclaiming the space beneath overpasses for parks, markets, or cultural use, promoting social equity and sustainability. Critics argue that noise, pollution, and poor lighting make repurposing these areas costly and potentially impractical. Shanghai's riverfront offers a valuable case study in navigating these challenges. The case study employs a mixed-method approach, integrating comparative case analysis and questionnaire surveys to comprehensively evaluate the repurposing of leftover spaces beneath urban overpasses. By triangulating perspectives from design professionals, municipal planners, and end-users, this methodological framework enables a nuanced examination of spatial reutilisation strategies. It captures the complex interplay between professional urban design intentions and actual spatial appropriation, exploring how these spaces might be reimagined as productive urban interfaces that mediate between transportation infrastructure and urban life.

Materials and Methods

Study Area

Shanghai (31°14′ N, 121°29′ E), strategically positioned in the Yangtze River Delta region of eastern China. Characterised by its unique geographical configuration, the city encompasses a complex urban landscape where natural water systems and infrastructural networks intersect critically. The Suzhou River, a pivotal hydrological feature, traverses the urban fabric, serving as a key morphological and ecological corridor that has profoundly shaped the city's spatial development. The Suzhou River's urban section demonstrates a paradigmatic case of infrastructure-induced spatial complex-

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01 | Three study sample sites along the Suzhou Creek, Suzhou River waterfront area construction plan, edited by the author

02 | Detailed site map of study areas, drawing by the author

01 |

02 |

ity, where multiple transportation modes – elevated highways, secondary roads, and riverbank pathways – generate a multi-layered urban landscape of interstitial spaces beneath transportation infrastructure (Fig. 1). These spatially ambiguous zones beneath overpasses represent a critical research domain, highlighting the tension between infrastructural efficiency and spatial potential in contemporary urban design practices.

This research deliberately selected three specific urban sites located beneath overpasses along the municipal section of the Suzhou River as research samples (Fig. 2). These sites were strategically chosen to represent diverse urban contexts and infrastructural relationships:

– Site A, located within Shanghai's central urban area and inside the Inner Ring Elevated Highway, presents a complex, multi-functional context. Characterised by high accessibility and proximity to diverse urban programmes including residential, commercial, and office spaces, this site exemplifies the most intensively networked urban fabric.

– Site B, positioned underneath the Middle Ring Elevated Highway, represents a transitional urban zone. Currently under development, its surrounding environment is predominantly composed of office complexes, public facilities, and urban riverfront parks. The site demonstrates a comprehensive and evolving urban landscape with mixed functional attributes.
– Site C, situated in the city's peripheral urban area near the Outer Ring Elevated Highway, distinctly differs from the other two. Primarily surrounded by residential districts, this site exhibits strong community-oriented characteristics and a more localised spatial identity.

These sites were selected not merely for their geographical diversity but for their distinctly different developmental trajectories:

– Site A, located beneath the Wuning Road Interchange, was designed by a relatively prominent architectural design team. It has garnered significant online visibility and experienced multiple cycles of business closures and reconstructions, particularly around the pandemic period.
– Site C, conceived as a public space and community station extending from a residential neighbourhood, emerged through a design competition. Despite undergoing a transformation process, it has struggled with both utilisation and broader public engagement.
– Site B is an emergent urban space, partially developed by individual property owners without a comprehensive design or planning strategy, highlighting the incremental and fragmented nature of urban infrastructure development.

By examining these three sites, the research aims to unpack the complex spatial, functional, and developmental nuances of urban spaces beneath elevated infrastructure, offering insights into their potential for adaptive reuse and urban regeneration.

Methodology

The methodology for this research encompasses two primary analytical approaches, namely comparative case analysis and quantitative survey research, designed to comprehensively investigate the usability of spaces beneath urban overpasses in Shanghai. As mentioned in the previous section, the comparative case analysis focused on examining the daily spatial utilisation of three research sites under the guidance of design professionals, planning departments, and client-driven transformation strategies. This approach employed a multifaceted analytical framework involving:

– Spatial Typology Comparison: A systematic examination of spatial configurations across the selected sites.
– In-depth Interviews: Qualitative insights gathered from key stakeholders involved in the design and transformation processes.
– Social Media Effect Analysis: Evaluating online visibility and public perception through digital media and communication platforms.
– The questionnaire design was meticulously crafted, drawing directly from the specific contextual characteristics of the three research sites. The survey instrument was specifically structured to:
– Assess Users' Spatial Perception: Capture respondents' subjective experiences and interpretations of spaces beneath urban overpasses.
– Measure Satisfaction Levels: Quantify user satisfaction through carefully constructed evaluation metrics.

Questionnaire survey data were processed and analysed using SPSS software (Version 27.0), employing rigorous statistical techniques to evaluate date reliability, conduct validity assessments, and generate statistically robust insights into spatial usability.

Results and Discussions

Comparative case analysis

Through comprehensive field investigations and research, we systematically collected primary site spatial information for the three research sites, including green space area, overpass coverage, structural height, and surrounding functional distributions (Tab. 1). Our analysis revealed nuanced spatial characteristics and transformation dynamics across different urban contexts.

Spatial distribution and infrastructure characteristics:

Our findings demonstrate a significant correlation between urban peripherality and infrastructural density. As one moves from the city centre towards suburban areas, overpass coverage and green space areas progressively increase. Notably, the Wuning Road Bridge underspace (Site A) is the most compact urban setting, with approximately 240 square metres of area and limited adjacent green spaces. Conversely, this site exhibits the most diverse and concentrated commercial ecosystem.

Transformation Trajectories and Functional Adaptations:

The comparative analysis of site transformations (Fig. 3) unveils distinctive evolutionary patterns:

Site A (Wuning Road Interchange)

– Experienced the most frequent design iterations and reconstruction cycles
– During the Covid-19 pandemic, remarkably repurposed as a temporary rest area for delivery workers and essential service personnel
– Demonstrated significant social equity value through adaptive reuse
– Characterised by high design flexibility and commercial potential

Tab. 01 | Detailed site map of study areas, drawing by the author

03 | Three research sites, a-1: Wuning rd. before renovation, a-2: after renovation, a-3: during the pandemic (2022 April); b-1: Middle ring rd. current situation, b-2/3: partially developed by individual property owners; c-1: Qilianshan south rd. before renovation, c-2/3: after renovation, a2/3 by Atelier Z+, edited by the author

Tab. 01 |

Object of study	Green space Renewal state	Main function	Green area(m')	Covered area of flyover (m')	Flyover height(m)	Surrounding environment
(a) Wuning Road Bridge riverside space	update completed	Entertainment and access	485	238.7	5	Although the traffic volume of Guangfu West Road passing through the bridge is not large, the noise in the bridge is not small, and the busy traffic flow of Wuning Road on the bridge brings a sense of vibration from time to time
(b) Middle ring road riverside space	updating	Entertainment and access	35000	2100	8-10	The vicinity of the node is dominated by residential functions,and the area is densely populated,which is a typical high-density community
(c) Qilianshan south Road Bridge riverside space	update completed	Entertainment and access	11600	6000	4	The neighbourhood is dominated by factories, Creative parks and residential areas

03 |

Site C (Peripheral Urban Area)

- Underwent a single design competition guided by Shanghai Urban Public Space Design Promotion Centre
- Developed as a community-service oriented station
- Incorporated limited functional elements such as calligraphy classrooms and public restrooms
- Currently experiencing substantial underutilisation, predominantly used for non-motorised vehicle parking
- Minimal interaction with surrounding community infrastructure.

Site B (Transitional Urban Zone)

- Lacks formal design intervention from professional planners
- Characterised by spontaneous private-sector development
- Emergent spaces including night cafés, clubs, and light extreme sports facilities
- Limited engagement with immediate neighbourhood users.

The comparative analysis reveals that Site A's central location, combined with its diverse commercial context, significantly reduces transformation complexity. Its adaptive capacity suggests potential for intensive, commercially-oriented functional attributes.

Tab. 02 | Basic information statistics of the samples, drawing by the author

Item	Category	Percent%		
		Middle Ring Overpass	Wuning Road and Bridge	Qilianshan south Road Bridge
Gender	Male	57.00	57.53	62.50
	Female	43.00	42.47	37.50
Age	<age 18	3.70	6.84	3.40
	Age 18-30	43.20	34.24	38.63
	Age 31-60	48.14	57.53	54.54
	>age 60	4.96	1.39	3.43
Identity	Adjoining resident	35.18	31.50	28.40
	Nearby employee	28.39	26.02	42.04
	Tourist	25.92	31.50	17.04
	Nearby business	10.51	10.98	12.88
Degree of familiarity	know well	29.01	24.65	25.00
	Know better	41.97	32.87	38.63
	ordinary	16.66	26.02	27.27
	Less familiar	8.02	6.84	4.54
	Very unfamiliar	4.34	9.62	4.56

Sites B and C, in contrast, demonstrate more challenging spatial transformation processes, characterised by either fragmented private initiatives or limited public engagement.
These findings underscore the complex interplay between urban infrastructure, spatial design, and socio-economic dynamics in reimagining underutilised urban spaces beneath overpasses.

Survey with Questionnaire
The data collection for this research was conducted over the period of November-December 2024, covering both weekdays and weekends. Electronic questionnaires were randomly distributed within the three overpass spaces and their surrounding communities, resulting in a total of 323 valid responses (Tab. 2): 162 from the Middle Ring Overpass along the Suzhou River, 88 from the Qilianshan South Road Bridge, and 73 from the Wuning Road Bridge. The questionnaires were filled out and collected under the guidance of the research team, ensuring a 100% effective response rate.
The age distribution of participants revealed a balanced representation of young and middle-aged groups, with the majority falling within the 26 to 40 years old range. However, the participation of those under 18 and over 60 was relatively low, at 4.33% and 3.72% respectively, indicating a need to better engage these age segments.
Adjoining residents and nearby employees accounted for the highest proportions of respondents, suggesting a strong interest in the research topic from these groups. While the percentage of visitors and tourists was lower than the previous two categories, they still represented a significant portion of the sample. Conversely, the proportion of on-site business owners was the lowest, potentially indicating a relatively lower level of engagement or concern about the research issue among this stakeholder group.
The analysis of respondents' familiarity with the research case revealed a notable distribution pattern. Approximately 66% of participants reported being "very familiar" or "fairly familiar" with the case, suggesting a general understanding and awareness among the sample. However, 28.38% of respondents indicated being "moderately familiar" or "slightly unfamiliar", and 5.57% even expressed being "very unfamiliar". This highlights the existence of knowledge gaps within the respondent pool, which should be considered in the interpretation of the research findings.
The data collected through the questionnaires was analysed using SPSS software (version 27.0) to assess its reliability and validity. The overall Cronbach's alpha for the scale was 0.983, which is considered a high level of reliability (coefficients of 0.70 or higher are generally regarded as indicating high reliability). All the latent variables in the scale also had coefficients above 0.7, indicating good internal consistency. Furthermore, the Kaiser-Meyer-Olkin (KMO) value was 0.990, which is greater than the recommended threshold of 0.7, and the Bartlett's test of sphericity showed statistical significance. These results indicate that the structure of the perception measurement scale is consistent with the theoretical assumptions underlying the questionnaire, validating the feasibility of the analysis.
Referring to relevant literature on recreational environments and drawing from the experiences of comprehensive parks and community parks, a preliminary investigation was conducted on three research sites located beneath overpasses. Using an Internet platform, 100 visitors and residents were randomly selected to share their recreational experiences and evaluations. The purposes of recreation, key environmental factors of concern, complaints about green space conditions, and expectations for improvement were identified from their feedback. Combining the characteristics of recreational environments and visitors' activity patterns, a preliminary evaluation system for visitors' perceptions of underpass green spaces was developed.
Factors mentioned fewer than 20 times by participants – such as the aesthetic appeal of pavement and water features, the distance to nearby sales points, air quality, and ergonomics – were excluded. While ensuring the evaluation system reflected the core environmental characteristics of green spaces under overpasses, revisions and integrations were carried out. Ultimately, the visitor perception evaluation form was structured around five perception dimensions, comprising 30 environmental perception factors.
The questionnaire consisted of two parts, precisely the characteristics of the sample group and the visitor perception evaluation form. The latter asked visitors to assess whether the actual performance of a specific environmental perception factor met their expectations during their recreational experience. A 7-point Likert scale, ranging from 1 ("very poor") to 7 ("very good"), was used as the scoring standard to capture visitors' evaluations of the actual performance of these perception factors (Tab. 3).

Discussions
The findings of this study highlight the complex interplay between infrastructural design, urban context, and the evolving

Tab. 03 | Visitors' perception measurement table of spaces beneath the overpasses along Suzhou creek in Shanghai, drawing by the author

Tab. 03 |

	Dimension classification environmental perception dimension serial number		Environmental perception factors
Accessibility	Path organization perception	3	Complete continuous walking space
		4	Guide motor vehicle deceleration
		6	Visibility and convenience of entrances and exits
	Safety and security perception	7	pilot system
			Risk buildings or structures and facilities
		8	disaster prevention facilities
			monitoring system
		17	Night lighting condition
	Aesthetic perception	22	Coordination with the surrounding environment
		15	Space openness
		18	Artistry of public facilities
		19	Vegetation viewing
Usability	Physical environment perception	1	Green space noise under bridge
		2	Overpasses cover shaded areas
			Suitable for aging and transformation
		11	wheelchair accessible passage
		12	Such as garbage cans,toilets and other public facilities are complete
			Whether the green space is smooth and undamaged
		14	Shelter from the wind and rain
		16	Whether the floor material is suitable
		20	Distribution and quantity of leisure facilities
	Activity and cultural perception	21	Whether the activity facilities are adequate

needs of urban residents. By examining three underpass sites along the Suzhou River in Shanghai, the research provides valuable insights into the usability and transformation potential of these underutilised urban spaces.

The comparative analysis of the three sites underscores the significance of urban location and development strategies in shaping the spatial utilisation of underpass areas. Site A, situated in the central urban zone, demonstrated high accessibility and commercial adaptability, driven by its proximity to a dense urban fabric and robust design interventions. Its multifunctional transformation during the Covid-19 pandemic illustrates the potential of underpass spaces to address urgent social needs while promoting equitable urban development. In contrast, Site B and Site C, located in transitional and peripheral urban zones, respectively, reflect fragmented and incremental development patterns, resulting in limited functional diversity and public engagement. These disparities indicate that centralised, coordinated planning plays a crucial role in unlocking the potential of underpass spaces. Urban residual spaces, when viewed through a solutions-oriented lens, can resolve site-specific challenges by creatively addressing functional deficits. Such spaces, if strategically planned, have the potential to mitigate urban problems and enhance spatial connectivity (Ayudya and Anggiani, 2021). The questionnaire survey revealed significant variations in user satisfaction across the three sites, influenced by factors such as location, accessibility, and the alignment of design features with user expectations. Site A, with its well integrated design and commercial amenities, garnered relatively higher satisfaction levels, reflecting the importance of aligning spatial transformations with the needs of diverse user groups. Conversely, Site C, despite being conceived as a community-oriented space, struggled with underutilisation and a lack of broader public appeal. This disparity highlights the need for participatory design processes that incorporate the perspectives of local residents and potential users to ensure the success of underpass revitalisation projects.

This study demonstrates that underpass spaces can serve as critical connectors in the urban landscape, linking residential, commercial, and recreational areas. However, their transformation requires a nuanced approach that balances infrastructural efficiency with community-oriented design. While Site A illustrates the benefits of professional design and iterative development, Sites B and C highlight the risks of fragmented, ad hoc planning approaches. These findings suggest that adaptive reuse of underpass spaces must be guided by a comprehensive urban design strategy that considers the unique characteristics of each site and engages multiple stakeholders in the planning process.

In response to the above conclusions, this study selected three cases of urban overpass space revitalisation outside Shanghai (Fig. 4), located in New York (a), Istanbul (b1/2), and Seoul (c1/2). These three projects are highly representative. Project A, located in the heart of Manhattan, New York, is situated directly beneath the famous High Line Park, surrounded by a vibrant creative and artistic industry cluster. This project capitalises on the concentration of resources and demand in the central urban area by designing a gallery within the underpass space, which not only activates the space but also integrates and interacts with the surrounding industries. Project B is located in the busy Mecidiyekoy Square area of Istanbul, and the development of the square is part of the Istanbul Metropolitan Municipality's plan to renovate the area and create a better physical environment enriched with contemporary art. Therefore, the project follows an urban design strategy, featuring a bookshop and ex-

04 | Comparative analysis of cases outside the Shanghai area, a: LISSON GALLERY, New York, USA, 2016, designed by studio MDA and studio christian wassmann, photos by Jason Schmidt.
b-1/2: Mecidiyekoy Art & Istanbul Bookstore, Istanbul, Turkey, 2021, designed by KAAT ARCHITETURE + URBAN & caps.office, photos by Orhun Ulgen Works.
c-1/2: Eungbong terrace, Seoul, South Korea, 2023, designed by YZA, photos by kyungsub shin, edited by the author

hibition space beneath the overpass. The transparent glass façade offers visual permeability to the otherwise dark underpass space during the day, while lighting design activates the area at night, providing a pleasant urban retreat for the busy crowds. Project C shares many similarities with Site C mentioned earlier. Located in a high density residential area in Seoul, it serves as a community-oriented space. The design also incorporates reflective metal materials and better considers the needs of nearby residents for small-scale gathering, activities, and relaxation. The open design elements offer a space that connects well with the surrounding community, functions as a recognisable landmark, and provides a space for rest and leisure.

Conclusion

This research provides a robust framework for understanding the potential of underutilised spaces beneath the overpasses in Shanghai, offering critical insights into their role in urban regeneration and social inclusion. The study's mixed-method approach, combining comparative case analysis and quantitative surveys, underscores the value of integrating professional design perspectives with user feedback to inform spatial transformation strategies. Key findings reveal that centrally located underpass spaces, such as Site A, demonstrate higher adaptability and public value when supported by comprehensive design interventions. In contrast, spaces in transitional and peripheral areas, like Sites B and C, face challenges stemming from fragmented development and limited user engagement. These results emphasise the importance of context-sensitive design approaches that prioritise connectivity, environmental quality, and community needs.

In conclusion, this study offers a valuable contribution to the discourse on adaptive reuse of urban spaces, providing actionable insights for planners, designers, and policymakers. It demonstrates that with innovative design, strategic planning, and community involvement, even the most overlooked urban spaces can become integral components of a city's fabric, enhancing liveability and connectivity for residents across all demographics. Future research should further explore the long-term impacts of such transformations, and expand the scope to include comparative studies across different cultural and urban contexts.

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Approaches and tools for communities' engagement in marginal areas

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Abstract. The paper aims at providing a methodological path to improve local communities' ability to re-discover the value of their local, natural, and cultural capital, and outline shared strategies for its enhancement. The defined methodological path, addressed to knowledge co-creation and co-design of visions and strategies for future development, has been tested on selected case studies in Southern Italy, both of them characterised by high levels of marginality. Preserving local identities and increasing the sense of belonging of communities to their living places are, indeed, crucial for ensuring a sustainable and shared development process in marginal areas.

Keywords: Inner areas; Marginal areas; Communities engagement; Knowledge co-creation; Co-design.

Introduction

The concept of marginality, and consequently of marginal regions/areas, has been discussed for long in scientific literature, although it is still open to multiple definitions. Marginal areas can be defined with respect to their geographical and physical isolation as well as to economic or social conditions, regardless of their geographical location (Cullen and Pretes, 2020).

The European Territorial Agenda 2030 highlights the large variety of marginal areas facing severe depopulation or suffering segregation phenomena, and emphasises the need to promote a long-term place-based strategy by "strengthening awareness and empowering local and regional communities to protect, rehabilitate, utilise and reutilise their (built) environments, landscapes, material and immaterial cultural assets".

Based on these premises, this contribution aims at providing a methodological path and effective tools to improve local communities' ability to re-discover the value of their local, natural, and cultural heritage, and outline shared strategies for its enhancement in marginal areas. To this end, different tools for knowledge co-creation and co-design of visions and strategies for sustainable development have been tested on different types of marginal areas, precisely an "inner area", characterised by geographical isolation and demographic and economic decline; an urban peripheral area, and a large public housing neighbourhood, characterised by significant phenomena of physical, social and environmental degradation.

"Inner areas" are defined as areas located significantly far from the supply centres of essential facilities (education, health and mobility), (Barca *et al*., 2014). In Italy, since the processes of urbanisation and economic growth have especially affected coastal and plain areas (Sommella, 2017), inner areas are mostly composed of small hill and mountain villages[1]. These areas suffer several problems, from the decreasing and ageing population to the lack of accessibility and economic marginality. All these problems are, however, interconnected and, due to long-term processes, often result in the loss of both tangible, such as historic centres, and intangible heritage, such as memories and traditional practices, which have contributed to preserving local culture and ecosystem services (Galderisi, 2023). Over the last decade, numerous scholars have contributed to shift attention from urban to inner areas (Copus *et al*., 2017; De Rossi, 2018; Carrosio, 2019; Cersosimo and Donzelli, 2020), highlighting their key role in ensuring a more socially and environmentally sustainable development process both at national and regional scales. Inner areas are, in fact, characterised by a significant natural and cultural heritage, whose value is often barely recognised by local communities themselves. The Faro Convention (CoE, 2005) emphasised the close link between local heritage and communities, recognising cultural heritage as the result of the dynamic relationships among communities and territories, and highlighting the key role of local communities in keeping heritage alive and transmitting it to future generations. According to the Faro Convention, cultural heritage can no longer be understood as the quantity and quality of existing cultural assets, but it largely depends on the established relationships between settled communities and local heritage. Unfortunately, in inner areas, despite the widespread presence of a significant heritage of material and immaterial resources, the abandonment processes are causing a growing loss of the relationships between local communities and their heritage, which could result in de-territorialisation processes and loss of both place and community identity (Magnaghi, 2010). Furthermore, the creation of 'heritage communities' (CoE, 2005) might enhance the sense of belonging of a given community to a given place, and the effective transmission to future generations of the peculiar values of cultural heritage.

Large public housing estates, built in most of the European cities between the 1970s and 1990s, are often characterised by significant phenomena of physical, social and environmental degradation, representing paradigmatic examples of marginal areas, although very often located close to or within large urban or metropolitan areas. However, despite their marginality, these areas are nowadays not only an important legacy, as the expression of architectural and urban planning culture has profoundly changed today, but also privileged test areas for improving, regenerating, and economically revitalising extensive degraded urban areas. Nevertheless, also in these areas, residents' participation has been recognised as crucial to a sustainable regeneration process (Hoatson and Grace, 2002).

Hence, this paper focuses on the key role of local communities' engagement, and discusses pros and cons of different tools enabling participation processes aimed both at integrating expert

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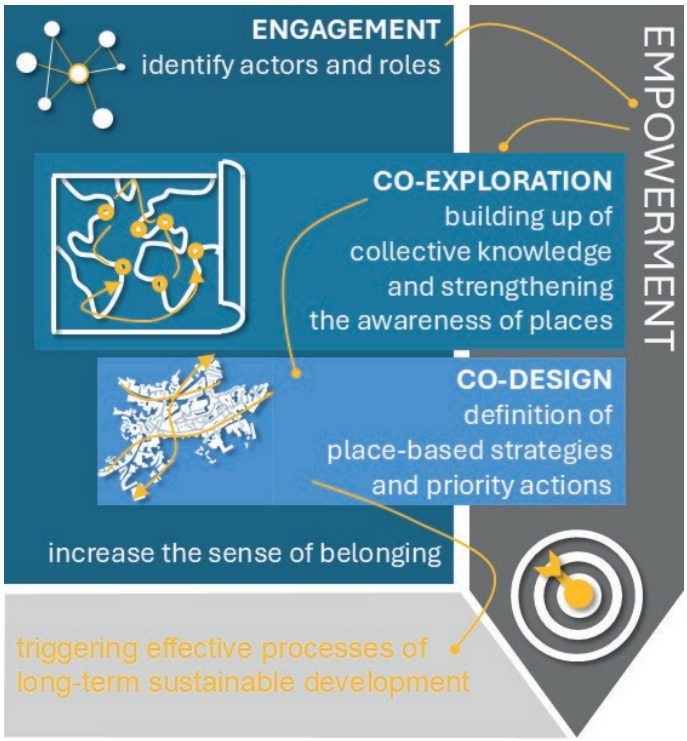
01 | The methodological path, authors' elaboration



| 01

and local territorial knowledge, and outlining shared visions and strategies for sustainable development of marginal areas. Based on different experiences developed in both inner areas and public housing neighbourhoods, the research provides an overview of the heterogeneous tools capable of facilitating the involvement of local communities in different research phases and territorial contexts. Furthermore, each tool can be appropriate to involve different categories of stakeholders (youth associations, students, entrepreneurs, institutions, etc.), and to provide different outcomes. The following paragraphs provide a methodological path and present some of the multiple tools useful to involve local communities in territorial knowledge co-creation and development strategies' co-design in marginal areas.

Community engagement: a methodological path to enhance relationships between local communities and territorial heritage

The creation of virtuous relationships between a community and its environment is an important base to enhance a territory (Magnaghi, 2010), envisioning new trajectories of sustainable and place-based development (Barca *et al.*, 2012). Many scholars (Wilson and Sanyal, 2013; Carrosio *et al.*, 2018; Pappalardo and Sajia, 2020) recognise the active involvement of communities as an effective way of activating revitalisation strategies. Such an involvement is particularly significant when marginal areas are at stake. These areas are characterised by phenomena of abandonment, marginalisation, and socio-economic decay that may lead to the progressive loss of both the relationships between settled communities and places, and the sense of belonging of local communities.

Strengthening relationships between communities and territories passes through both the co-exploration of cultural and natural local resources, and the co-design of shared strategies for triggering effective sustainable development processes.

The Framework Convention on the Value of Cultural Heritage for Society was an important step forward in the way we look at heritage, shifting the attention from objects and places to people (Fabbricatti *et al.*, 2020). It defined two fundamental concepts, namely cultural heritage and heritage community. «Cultural heritage is a group of resources, inherited from the past, that people identify, regardless of ownership, as a reflection and expression of their constantly evolving values, beliefs, knowledge and traditions. It includes all aspects of the environment resulting from the interaction between people and places through time» (CoE, 2005, art.2 a). «A heritage community consists of people who value specific aspects of cultural heritage which they wish, within the framework of public action, to sustain and transmit to future generations» (CoE, 2005, art.2 b).

Individuals and communities have the right to enjoy cultural heritage as well as the responsibility to respect it and the opportunity to enhance it. Hence, nowadays the concept of heritage goes far beyond the institutional values attributed to the relevant buildings or places, extending itself to any place to which the community attributes a collective value. In the context of marginal areas, both the link between the environmental and the anthropic system that constitutes the "territorial heritage" is still recognisable, as well as the traces of the practices that have contributed to shape it overtime (Ferraresi, 2012). However, abandonment and decay of places and practices contribute to increase the risk of losing both heritage and its collective memory. Moreover, actions aimed at re-activating collective knowledge and sense of belonging can lead to the rebirth of relationships between places and people.

The path towards the outlining of place-based development strategies goes through some fundamental macro-phases, which can be carried out by using different participatory tools and involving heterogeneous actors with different roles (Buuren, 2009; Cook and Nation, 2016) (Fig. 1):

- engagement/empowerment phase; it represents the background-phase of the entire process. Here, the key actors and their roles are identified (local institutions, citizens, stakeholders, associations, but also the role of the researchers as an active actor), as well as both the internal dynamics that contributed to weakening the sense of belonging and the existing potential that is useful to trigger new development trajectories;
- co-exploration phase; it aims at building up collective knowledge and strengthening the awareness of places and a sense of belonging. The role of researchers is addressed to mediate the process of collective knowledge and exploration of places and memories, and to support bridging the gap between existing values and future opportunities;

– co-design phase; it represents the step towards an effective local development starting from the definition of collectively worked out place-based strategies. Here, the role of researchers is addressed to guide the definition of goals, strategies, and actions, providing suggestions, best practices, and scientific support to summarise, elaborate, and prioritise them according to the existing potential.

As mediators, researchers may adopt different tools to support the participatory process, in line with the main principles of inclusion, transparency, and empowerment (Parker, 2006).

According to the macro phases described above, the process starts with the identification of a wide range of local stakeholders, including local authorities, citizens, citizens' associations, businesses, practitioners, and their involvement through individual and collective meetings to favour interactions among the various parties involved. Roles and interests of involved actors can be framed into a network of people-topics-places to organise targeted groups involved over the following co-exploration and co-design phases.

The co-exploration phase follows two parallel but integrated paths. One is the technical analysis of the territory carried out by experts and addressed to identify the main local resources, existing facilities, gaps in essential services and future projections. The other one is the collective knowledge, addressed to identify features and peculiarities of the territory, according to the direct experience of local communities. The creation of collective knowledge is usually carried out through individual interviews, focus groups, workshops and walks. To bridge the community with its own heritage, community maps can also be very useful to share and communicate political principles, social and economic needs (Perkins, 2007).

The co-exploration phase, while broadening community engagement and empowerment, lays the foundation for the co-design phase. Indeed, the latter is based on a collective intention to pursue goals and single actions under the umbrella of a shared vision, which generally arises from the recognition, as an informed community, of the values of the territorial heritage in its multiple meanings.

The co-design phase may refer to several established practices, such as Living Labs (Hossain *et al*., 2019), based on the Quadruple Helix Model and aimed at fostering co-creation and open innovation (Miller *et al*., 2018). Living Labs are one of the most widely used tools for triggering participation processes. Living Labs, which originate in the world of industrial production, aim at facilitating the identification of complex solutions, which are then tested and transformed into prototypes or, in the case of urban planning research, into territorial visions and strategies (Guida, 2023; Galderisi and Limongi, 2024). They can be physical or virtual environments in which different stakeholders work together towards a common aim, namely that of identifying strategies to cope with shared goals arising from a co-produced knowledge base, exchange of experiences, and interdisciplinary approaches.

Living Labs can be very useful to address socio-economic challenges, especially in marginal areas, since they contribute to improve social inclusion and sense of belonging of local communities. However, they might be ineffective due to a lack of willingness to participate from local community, the absence of key stakeholders and leading actors, as well as of adequate resources to sustain momentum and keep the participatory process active over time. Nevertheless, if the previous phases (empowerment and co-exploration phases) have effectively contributed to reactivate the sense of belonging of the community, Living Labs will count on a higher capacity of the local community to organise itself around common goals. Operationally, to effectively support the co-design process, researchers may contribute to identify priority actions, long and short-term tasks assigned to groups and leading actors, and potential places for transformation, capable of triggering a cascade activation of more widespread actions (Wilson and Sanyal, 2013).

Field experiences and lessons learnt

Based on the methodological path depicted above, two research projects, focused on marginal territories, scarcely resilient to current environmental, economic and social challenges, will be briefly presented, highlighting pros and cons of participation processes.

The first one specifically addresses an "inner area," the Matese area in the province of Caserta, at the northern border of the Campania region. The selected area consists of 17 municipalities, most of which host less than 2,000 inhabitants and are classified as "peripheral" by the Italian Strategy for Inner Areas (SNAI). They present several weaknesses, such as population decline and limited accessibility, but also numerous strengths, such as the relevant natural and cultural heritage (Galderisi, 2023).

The research project RIPROVARE[2] interpreted local communities' engagement as a key step of project development. Local stakeholders, citizens, and institutions were involved both in the knowledge phase and in the design phase, aimed at outlining new visions and shared development strategies to increase resilience, sustainability, and enhance site-specific resources. The participation process was based on a dual "Dialogues and Living Labs" model, which accompanied all phases of the project.

During the different steps of the research work, most of the different approaches and tools presented in the previous paragraph have been tested on the field to co-create knowledge and co-design vision and strategies for future development. In detail, heterogeneous stakeholders were involved, according to

02 | A workshop with students, grappling with the "tree of problems and solutions", photo by the authors

different goals, precisely youth, to discuss their needs and aspirations; local authorities (e.g., municipalities, regional park authority) to deepen the difficulties they have to face but also to collect ideas and ongoing or already implemented projects for the development of the area; local associations, very active in the enhancement and promotion of the local natural and cultural heritage, to understand barriers and opportunities to their activities; individual entrepreneurs and their associations, to focus on obstacles and perspectives for economic growth.

According to the outlined methodology, the participatory process was structured as follows:

- engagement/empowerment phase, which included several visits to sites, and individual interviews with local authorities and citizens to identify the main stakeholders to involve in the process;
- co-exploration phase, which included both questionnaires and unstructured interviews administered during individual face-to-face meetings with representatives of the local institutions. This phase aimed at improving expert knowledge built up through analyses carried out by the research group both on the real and potential resources, and on existing territorial gaps as well as on the implemented and on-going projects. Workshops with youths were also carried out in secondary schools and with local associations, such as youth forums, by using different tools such as questionnaires and problem and solution trees (Fig. 2). Workshops with youths contributed to deepen the challenges posed by living in these areas, and to gather ideas and aspirations for local development;
- co-design phase, carried out through living labs, structured into thematic tables. This phase involved a broad range of local stakeholders, including local authorities. The different stakeholders were divided (based on their specific areas of interest) into three thematic tables, according to the thematic axes previously identified by the research group: Innovate Matese, Enhance Matese, Re-inhabit Matese. Each table carried out a SWOT analysis, aimed at highlighting strengths, weakness, opportunities and threats of the area, and contributed to outline, through collaborative mapping, a strategic vision and a set of strategies and related actions for each thematic axis.

The outcomes of the different steps of the participatory processes were collected and elaborated by the research group into a comprehensive vision for a sustainable and resilient local development, structured into different strategies and actions; a Masterplan, synthesising the main actions to be implemented in the whole area; a "flag project", aimed at enhancing the western part of the Matese area that, according to the analyses carried out, was found to be the most affected by several weaknesses, in terms of depopulation, lack of services, accessibility, and tourist attractiveness.

Hence, the participatory process provided useful strategies and actions for triggering a sustainable development process, capable of counterbalancing current weaknesses, offering new life perspectives especially to the youth, who are still inclined to leave the area, due to the lack of essential services, of job opportunities, as well as of cultural activities, which are still mostly concentrated in urban areas.

The main difficulties arising from the participatory process carried out in the Matese area can be identified in the lack of a continuous participation of local stakeholders, especially local authorities, in the several meetings organised by the research team, and in the poor attitude of the involved stakeholders to shift from identifying problems to outlining desired solutions.

The second research work is framed into the still ongoing project "Proximity Places. A methodology for the regeneration of collective spaces in modern neighbourhoods"[3], funded in 2023 by the Italian Ministry of University and Research. The main goal of the research work is to outline and test strategies to improve liveability by enhancing available resources with a focus on public spaces, "in-between" areas, interactions within the neighbourhood. The research project involves different neighbourhoods in the cities of Turin, Rome, and Naples. In the case of Naples, the research work focuses on the public housing neighbourhood called "Parco Verde" in the municipality of Caivano.

Despite being located at the boundaries of the Metropolitan City of Naples, one of the most densely populated urban areas in Italy, the neighbourhood can be characterised as a marginal area, due to high levels of physical, social and environmental degradation. The Parco Verde neighbourhood was built in 1981-82, with post-earthquake funds provided by Law No. 219/1981. It is a critical neighbourhood both in terms of distribution and maintenance of public spaces, especially the "open" ones. Conversely, the strengths of the area include the presence of several actors in the so-called "third sector" and of numerous primary schools, which act as civic and legality supervisory bodies, worth mentioning (de Biase *et al.*, 2024) (Fig. 3).

Neighbourhood walks (promoted by joining the so-called Jane's Walks network) and unstructured interviews with different actors, particularly third-sector associations, representa-

03 | "Parco Verde": informal urban gardens in disused areas cared for by the association "L'infanzia di vivere", photo by the authors

tives of local school and religious associations have been carried out so far in this area. Both these preliminary steps contributed to start the engagement/empowerment process that is going to lead the entire research path.

In particular, some walks within the public spaces of the neighbourhood and the surrounding agricultural/urban/industrial areas were carried out in cooperation with representatives of local associations as well as of citizens. They allowed to explore latent spaces and informal uses (Di Ruocco, 2024), which are hard to discover and understand through traditional urban planning analyses. Thanks to the walks, a new understanding of the Parco Verde emerged both for the researchers and the involved local stakeholders. Moreover, the idea of a "right to the city" was implicitly strengthened, along with the duty of all actors to guarantee it by promoting a culture of "care" in such a marginal area as a starting point for new strategies and policies. The interviews highlighted considerable mistrust among the different actors involved, and diverging ideas about the future of the area itself. This suggests conflicting scenarios and non-collaborative social arenas, highlighting a limited willingness for engagement in co-design activities. These may be the reasons that have been keeping this neighbourhood anchored to its past of marginalisation and decay with limited perspectives for the future. However, it is worth noting that few courageous forms of self-organisation, such as the association "Un'infanzia da vivere" (Cellamare, 2019), are trying to partially fuel new perspectives for the future. Since the research is still ongoing, it is early to draw any conclusion. However, the research is showing how the activation of participatory processes in marginal areas, such as Parco Verde, might contribute to favour a paradigm shift, enhancing the community's trust in future perspectives, and increasing resilience of a "tough" and less malleable context. Hence, a relevant outcome of the research work could be the improvement of local community's capacity to rebuild their mutual relationships, and re-establish a "care relationship" with their heritage, especially of public spaces.

Concluding remarks

This paper has emphasised the key role of community engagement in triggering effective processes of long-term sustainable development in different typologies of marginal areas, often characterised by a "disconnection between shared imaginaries and social life" (Roy, 2024). Indeed, in these areas, desocialisation, individualisation, and deterritorialisation intersect with economic marginality, shrinking and ageing of the population, lack of living opportunities, especially for youths. All these factors risk hindering an effective participation process by reducing the willingness of users to be involved, especially for prolonged periods. However, the methodology and the different tools briefly discussed in this contribution may provide a relevant opportunity to bring out latent knowledge, strengthen relationships between people and places, and support planners and policymakers in the difficult and complex task of outlining effective and shared strategies to revive highly marginalised territories. The outlined methodology, as well as the different tools presented (interviews, workshop, walks, Living Labs, etc.), although fully tested only on one of the two presented case studies, proved to be effective in building collective knowledge, merging expert and local knowledge, strengthening the communities' awareness of places and sense of belonging, co-designing shared strategies for the enhancement of local heritage and, above all, reviving the relationship between communities and territories in marginal areas. However, only the conclusion of the research activities on the second presented case study will demonstrate whether the methodology and the proposed tools are flexible enough to trigger an effective participatory process in contexts where marginality, in all its different dimensions, has been for years a key obstacle to sustainable development.

NOTES

[1] https://politichecoesione.governo.it/media/2831/20220214-mappa-ai-2020-nota-tecnica-nuvap_rev.pdf

[2] The Research Project "Riabitare I Paesi. Strategie Operative per la Valorizzazione e la Resilienza delle Aree Interne (RI.P.R.O.VA.RE) was funded in 2020 by the Ministry of the Environment and Protection of Land and Sea (today Ministry of Environment and Energy Security). It was developed over a three-year period and involved three Italian Universities.

[3] PRIN (Research Projects of Relevant National Interest) – Tender Notice 2022. Prot. 2022XZZYA5.

ATTRIBUTION, ACKNOWLEDGMENTS, COPYRIGHT RIGHTS

The paper is the result of a shared reflection of the Authors. In detail, AG wrote paragraph 1 and revised the entire article; GL wrote paragraph 2, and GG wrote paragraph 3.

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Circular & sustainable adaptive reuse of fragile industrial heritage sites. Regenerating Ex SITOCO

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Abstract. In the fluid design boundaries of technological culture engaging with heritage-urban mine, resilient resource-the research explores innovative experimentation in disused industrial sites in fragile areas. Through environmental design and a lifecycle perspective, it proposes balanced landscape integrations aligned with evolving social, economic, and environmental needs, while addressing multiple risks. The research prioritises control actions on biophysical and morphological components, adopting a circular regeneration approach to reduce the embodied and operational energy of buildings, activating passive functioning to support an "ecologically resilient" transition. The operational, replicable, multi-scale methodology was tested in various pilot cases, exemplified in this paper by the Ex SITOCO site in the Orbetello lagoon.

Keywords: Industrial heritage; Circularity; Material stock; Adaptive reuse; Resilience.

Introduction

Dismissed industrial architectures, memories of a modern archaeology, testimonies having civilisation value, constitute a relevant context supporting the knowledge about materials and construction techniques in the evolution of production systems. Therefore, they need to be framed and valorised in a systemic way, as they contribute to determine the characteristics of contemporary territories. In this view, the absence of policies and strategies aimed at balancing the dichotomous relationship between protection and valorisation produces 'silent remains', empty spaces, places of 'broken windows' (Wilson & Kelling, 1982), reservoirs of materials of anthropic origin, which find meaning in the transition within a broader circular process that connects natural and technical systems (Braungart and McDonough, 2002).

Since the 1980s, many documents by the Council of Europe have highlighted how industrial heritage is a potential resource for society (Pickard, 2017). Within the overarching objective of renovating the EU building stock (European Commission, 2019) and regenerating the built environment to support Europe's climate neutrality targets (European Commission, 2021), heritage, especially when formally listed, might be seen as a challenge for spatial planning (Veldpaus *et al*., 2020), and calls for more innovative design solutions than the rest of the building stock (Eurocities, 2020).

TICCIH (The International Committee for the Conservation of the Industrial Heritage) states that "industrial heritage is of social value as part of the record of the lives of ordinary men and women, and as such it provides an important sense of identity" (TICCIH, 2003, Art. 2 Par. II). Furthermore, adaptive reuse of industrial heritage can turn it into a catalyst for local development, allowing the reuse and/or recycling of buildings, components and materials, while "keeping those elements that are important to the local community" (Veldpaus *et al*., 2020). However, from the social point of view, adaptive reuse practices should be participated and balanced to avoid "gentrification processes, commodification, and the exclusion of groups of people" (Veldpaus *et al*., 2020). Also, to truly make the most of industrial heritage in a sustainable way, an ecological perspective must be introduced into the strategy of its functional reuse (Fusco Girard, 2020), embracing a circular approach. TICCIH underlines how "continuing to adapt and use industrial buildings avoids wasting energy and contributes to sustainable development" (TICCIH, 2003, Art. 5 Par. V). In fact, as stated in the Leeuwarden Declaration (2018), "the re-use of our heritage reduces the consumption of construction materials, saves embodied energy and limits urban sprawl" while at the same time it allows "to undertake a deep energy retrofit, resulting in better-performing, climate-proof, healthier buildings".

In this sense, the Environmental-Technological approach provides a structured, reliable methodology to develop high quality design solutions, ensuring long-term usability, flexibility and adaptiveness of reused heritage to future needs. Adaptive reuse has a two-fold meaning: "re-functionalization, which involves interventions on the building to make it functional again, and conversion, or a change in the function performed" (Della Spina *et al*., 2023). Therefore, design strategies based on the adaptive reuse approach allow to "change the characteristics of a space based on its changed context", while at the same time "extending the life cycle of buildings with a view to sustainability with minimal interventions of grafting, integration, parasitic architecture, or subtraction" (Della Spina *et al*., 2023).

Hence, adaptive re-use contributes to the construction of more resilient and sustainable cities and the application of circular economy principles in the built environment (Leeuwarden Declaration, 2018).

Research aims

In the fluid design boundaries of technological culture engaging with heritage – urban mine, resilient resource – the research focuses on innovative experimentation in disused industrial contexts in fragile sites. Through Environmental Design and a life cycle perspective, it defines balanced integrations to the landscape, compatible with changing social, functional, economic-productive and energy-environmental needs, considering multiple risks (climatic, natural, anthropic). The research prioritises control actions on the biophysical and morphological components, adopting a circular regeneration approach, integrated with resilient design strategies aimed at reducing buildings embodied and operational energy, activating passive functioning to support an "ecologically resilient" transition.

In fact, the methodological approach, developed within a research Project funded by Sapienza University, is based on the

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intersection of the actions and tools that Environmental Design adopts in the design of systems at a territorial scale (extended and restricted scope), and in the definition of interventions on the built systems to intervene on the existing. The close interrelation of the two levels makes it possible to outline an articulation of iterative phases that develop the complexities of the interventions, operating at different scales with a lifecycle vision, for the validation of each action. Therefore, the research approach embraces sustainable development goals by trying to "retain the original environment while improving the land use efficiency and surrounding resources and environment through design innovation" (Fu & Hou, 2023).

The relationship between industrial heritage and the biophysical components (soil, water, vegetation) of the context complicates the approach to an inter-scalar design, based on the understanding of the existing and potential material and immaterial resource flows, and generated by interference or integration conditions. Starting from the definition of existing architecture as a non-renewable resource, considering also its embodied materials and emissions, the research aimed at redefining the 'end of life' phase to activate a new virtuous cycle through adaptive reuse actions. The latter were particularly oriented towards ecological effectiveness, resource efficiency, and climate neutrality of the contexts in which the industrial sites arise.

The research thus implements innovative methodologies allowing to assess and underscore the value of the dismissed industrial heritage as an urban mine (Luciano *et al*., 2023). Moreover, following the Cradle-to-Cradle theory (Braungart and McDonough, 2002), the research interpreted the reuse of dismissed industrial heritage as a way of turning something that proved to be unsuccessful into a beneficial resource for both its context and the local community (Van de Westerlo *et al*. 2010).

The experimentation on dismissed industrial sites in fragile contexts, specifically, made it possible to orient the research methodology towards three priority focuses:

- Safeguard the historical, technological, social and scientific values to identify, preserve and enhance the representative features of the building, which communicate its history and identity in the territorial context.
- Ensure the ecological quality of natural and anthropic assets, aimed at restoring/repairing ecological systems with a view to reversing the land degradation process and preventing risks, taking into account specific vulnerabilities and threat factors for the purpose of systemic risk management.
- Circular use of resources and optimisation of active and passive solutions according to a NetZero approach (Zero Soil-Energy-CO_2-Waste) to minimise waste and the use of resources and, at the same time, maximise efficiency (Baiani *et al*., 2024a).

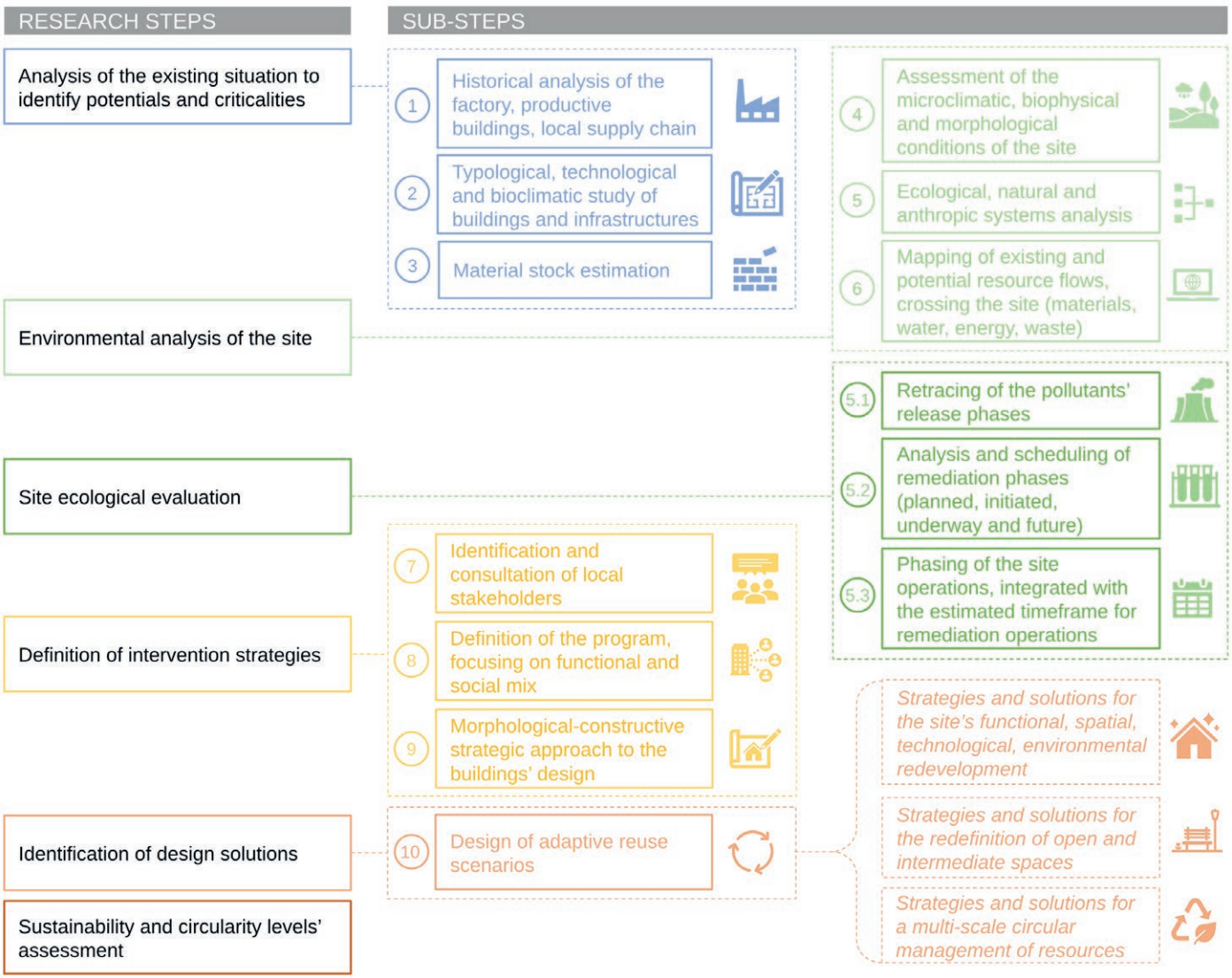
Research methodology The research developed an operational methodology in which the stages of knowledge, assessment, design and validation of the intervention of reactivation of dismissed industrial sites are tackled. Starting from the macro scale of management and valorisation policies and strategies, aimed at the recovery of such sites, the research followed a rationale of replicability of intervention modalities to be developed into specific strategies adapted to the peculiarities of each single industrial heritage site, considering the needs of the local specific stakeholders too. In the first research Phase, a review of international literature allowed to identify approaches, strategies and methods for the circular and sustainable adaptive reuse of industrial heritage. Then, best practices were collected, analysed and compared. Finally, pilot cases for design experimentation were identified, including dismissed industrial heritage sites in fragile contexts (Baiani *et al*., 2024a).

The second Phase developed and tested the assessment, design and validation methodology (Fig. 1) structured in ten steps:1) analysis of the historical evolution of the factory, productive architectures and local supply chains; 2) typological and technological study of the architecture and infrastructure on the site; 3) material stock estimation (Luciano *et al*., 2023) to understand the buildings' environmental value in terms of materials and relative embodied carbon; 4) assessment of the microclimatic, biophysical and morphological conditions of the sites; 5) mapping of the existing and potential resource flows, crossing the site (materials, water, energy, waste); 6) identification and consultation of local stakeholders to verify potential unexpressed needs; 7) definition of the functional programme, focusing on the functional and social mix to maximise sustainability in its three pillars; 8) in-depth study of the morphological-constructive strategic approach, based on the results of the previous steps; 9) design of adaptive reuse scenarios; 10) sustainability and circularity levels assessment with a framework of specific indicators related to material resources, energy, water, waste and CO_2 emissions (Baiani *et al*., 2024a).

The Research Group (RG) tested its approach to the circular and sustainable adaptive reuse of industrial heritage in a set of different case studies (Baiani *et al*., 2024a). Among the latter, a sub-group was characterised by a high vulnerability of the context, given by the site's environmental and landscape features, and by the peculiarities of the production processes, particularly by critical pollutants released over time into soil and water, requiring a major remediation phase before the proper adaptive reuse process.

The research methodology was, therefore, specified for sites characterised by a strong context fragility with the integration of three dedicated steps, including ecological evaluation of the

01 | Diagram illustrating the research methodology, the authors



site based on the presence of specific contaminants and pollutants, and then tested and validated in targeted pilot cases. The three integrative steps are: 1) a study aimed at retracing the pollutants' release phases, through the analysis and systematisation of documentary sources, to develop an awareness of the framework of environmental criticalities; 2) an analysis and scheduling of the remediation phases, planned, initiated, underway and future, again based on available documents, through which the estimated timeframe to complete remediation is understood; 3) phasing of the site operations, integrated with the estimated timeframe for remediation operations, to identify opportunities for the progressive reactivation of the site.

The cases selected to test this extended methodology include: the Ex SNIA-factory in Rome (IT) (Baiani *et al.*, 2024a); the Ex SAI in Passignano sul Trasimeno (Perugia, IT) (Baiani *et al.*, 2024b); the waste to energy plants in Colleferro (Rome, IT) (Baiani *et al.*, 2023), and the Ex SITOCO factory in Orbetello (Grosseto, IT), presented as an emblematic case in the next paragraph.

A pilot project for the circular and sustainable adaptive reuse of the fragile site of the Ex SITOCO in Orbetello

The area of the Ex SITOCO, on the Orbetello coastal lagoon, is a very large (over 300 ha) and complex dismissed industrial site, whose characterisation, started by the Italian Ministry of Environment about 30 years ago, revealed a deep degradation of the environmental matrices (heavy metal contamination of the soils, basins, deep waters). The larger context is characterised by important industrial heritage that, since the late 19th century, has taken advantage of the local resources, favoured by the land configuration, with a high landscape value.

Site conditions and background

The analysis of the site allowed to put together the stratigraphy of a complex production system developed from 1907 to 1971. It started with the production of chemical fertilisers by the Società Colla e Concimi which, in the early 1900s, covered 12% of the national perphosphate demand, using pyrite extracted from the deposits on the Island of Giglio and the Colline Metallifere of the Grosseto area. The material was transferred to the site via a navigable canal on the western lagoon of Orbetello. In the 1920s and up until 1958, the Montecatini Company, which had acquired the property (later passed on to Montedison, then to SITOCO and, since 2004, to Laguna Azzurra), consolidated and integrated the factory's layout. Its spatial organisation was based on the production cycle and the railway. The buildings were leaning against each other, converted and abandoned, while maintaining their original rationale and relationships. From the late 1950s, the railway allowed raw materials to be transported within the site via a special siding from which they were conveyed in front of the sulphuric acid building, and accumulated on the forecourt. By means of conveyor belts, the pyrite was lifted to the silos and transported to the furnace mouths, the fumes of which, through an oxidation process, were transformed into sulphuric anhydride and thus into sulphuric acid used for further processing.

The production of sulphuric acid ceased in the 1970s, and the activity continued with the production of fertilisers, which ceased between 1990 and 2006 (Fig. 2).

The Ex SITOCO site is included in the regional 'Piano di Indirizzo Territoriale' (PIT) as one of the historical-cultural values of industrial archaeology for which municipal planning must define the recovery and reuse discipline, safeguarding the façades overlooking the lagoon. The 'Provincial Coordination Territorial Plan' (PTCP) (1999) identifies the Orbetello area as part of the 'City of Water and Stone' subsystem in which it plans to create a 'commercial and tourist system vitalised by highly innovative functions in the recovered industrial areas, among which the multifunctional complex of the SITOCO lagoon, centred on an environmental research centre, stands out nationally'. The area is protected by a landscape constraint (Article 136 of Legislative Decree No. 42/2004) and is included among the Reclamation Sites of National Interest 'S.I.N. ex-SITOCO area' (Article 14, par. p-decies of Law No. 179 of 31 July 2002), due to the heavy contamination of soil and water in and around the site, with an area extended to 200 hectares in 2010.

In fact, the characterisation activities of the environmental matrices (conducted between 1995 and 2003 by ARPAT and ICRAM on behalf of the Italian Ministry of the Environment) highlighted the state of contamination of the soils due to the presence of pyrite ash, rich in heavy metals and arsenic, and the exhausted phosphorite dumps a few metres from the shore, presenting a serious risk of polluting the lagoon basin. Manganese, iron and sulphates were found in the groundwater.

The remediation project and the allocation of the relative funds, since the site is a S.I.N., was taken care of by the Ministry of the Environment, while the remediation works have been initiated and partly already carried out for the public areas by the Orbetello Municipality, and for the private ones by the Laguna Azzurra company, the current owner of the area. The time scenario for the completion of the remediation process is estimated to be around 2030.

Based on the above information, in order to reactivate a new lifecycle for the site, the research defined a broader schedule, from remediation through demolition, conservation and new construction interventions, to the progressive reactivation of the site. The remediation was divided into four phases (Fig. 3, right side): firstly, monitoring of asbestos dispersion in the soil and architectural components, and subsequent removal of asbestos-containing materials and the upper layers of soil; secondly, soil sampling for the presence of other contaminants and removal by excavation, and then backfilling of the area using certified soils; thirdly, the main contaminated aquifer is contained by sheet piling with a trench to drain the contaminated water, then treated and clarified so that it can be given back to the lagoon; fourthly, the settling basins are dredged to collect the deposits, which are screened to separate the materials and sludge; finally, the water is treated for purification. Furthermore, the research investigated alternative and integrative techniques for remediation, based on nature-centred solutions, in terms of potential benefits and costs.

Typological-technological assessment of buildings and material stock estimation

The study of the complex system of buildings was necessary because there are, next to buildings of documentary or cultural value, 'various articulations and parts of no value' (Comune di Orbetello, 2012), which require prioritisation of conservation, and adaptive reuse or demolition operations. The technological-constructive analysis of the existing buildings allowed to map, in detail, the different consistencies of the buildings, their typologies, sizes and constructive systems, as well as components and materials, with the relative levels of alteration and degradation, with particular attention to the residual performance of structural elements. The architecture's typo-morphological articulation, built over a wide period (1909-1970), is characterised by the recurring use of local materials, namely stone blocks, brick textures, concrete portals and timber or steel truss systems. The material stock estimation was developed by mapping the main materials used in the twelve building groups

02 | Typological and functional evolution of the industrial site (1906-1970), the authors with E. Farmeschi and A. Latini, photos from the Montedison Archive

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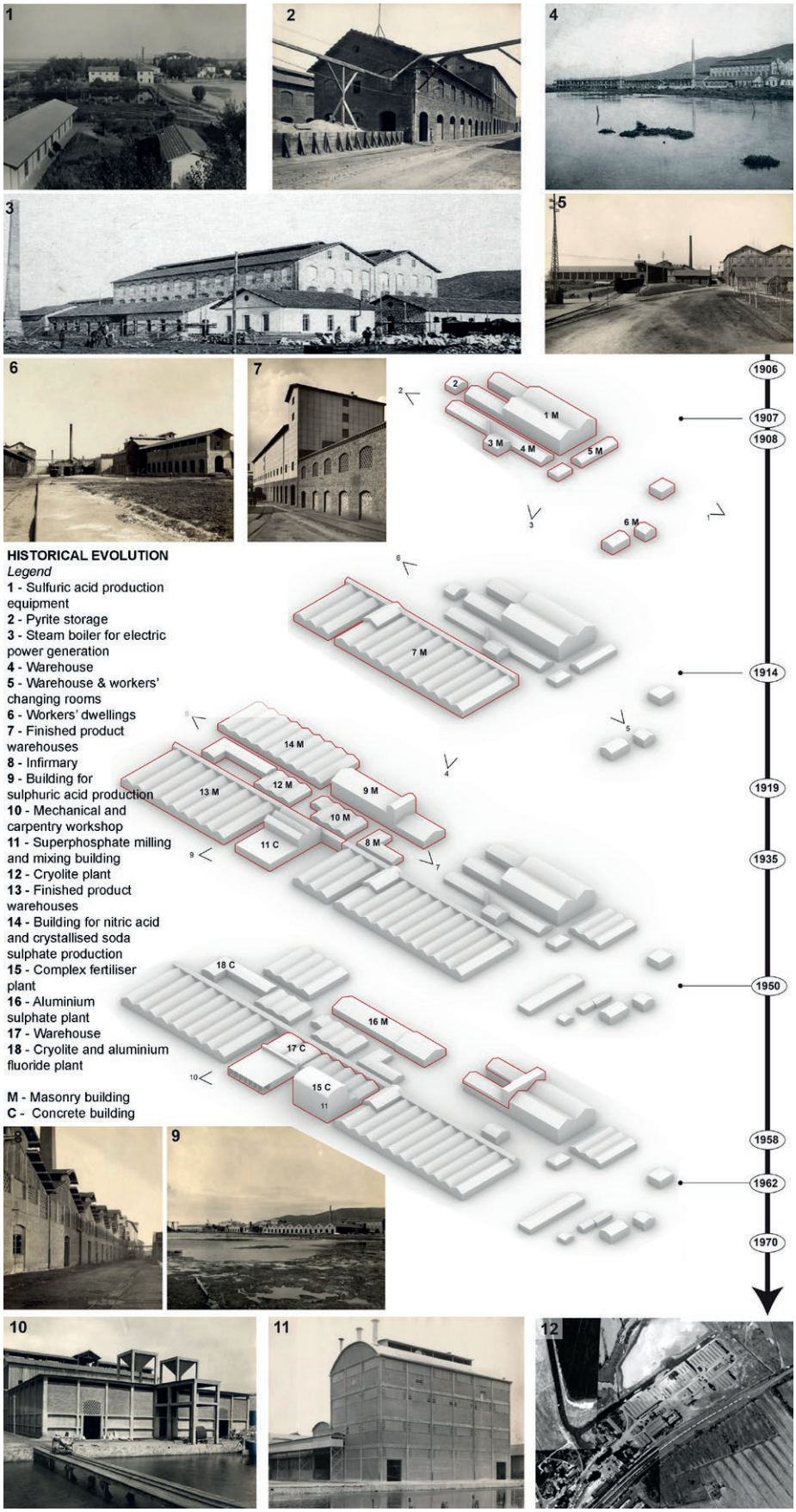
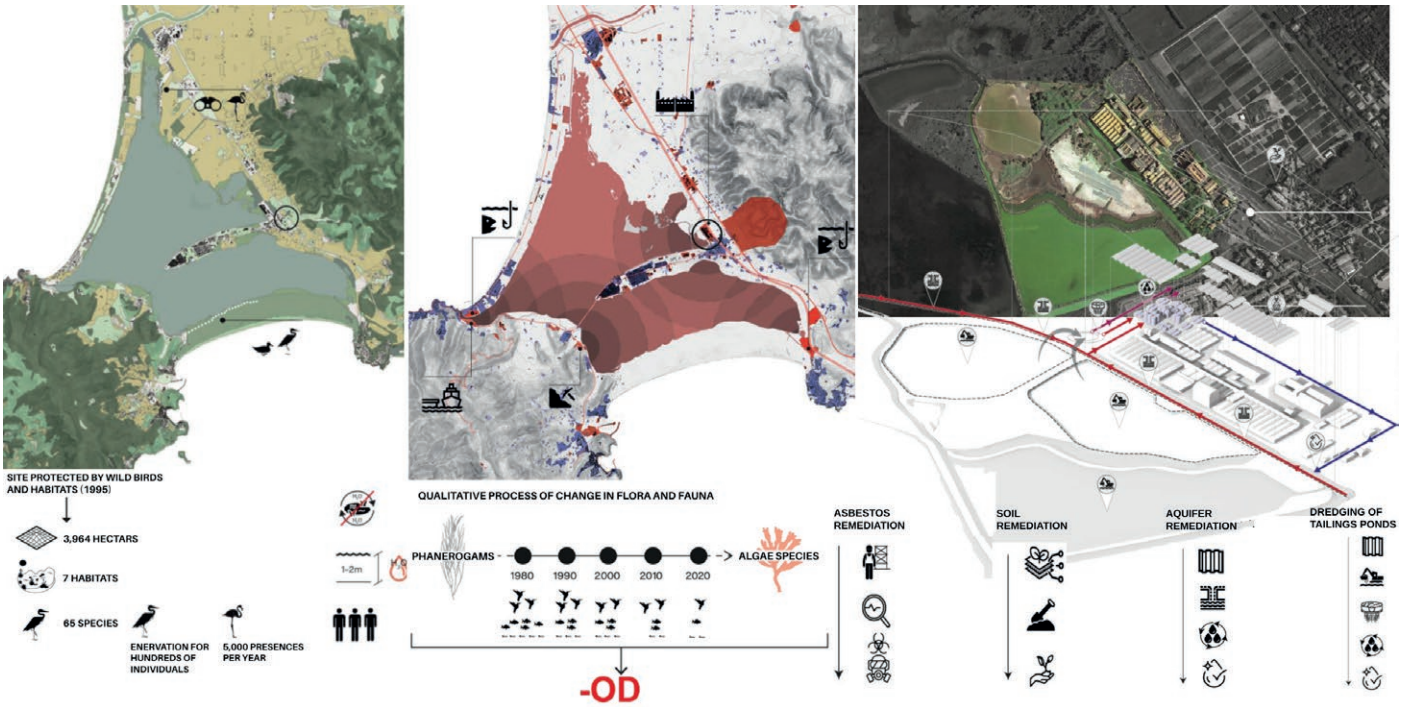


03 | Naturalistic context of the Orbetello lagoon: environmental values and water alteration process, and envisaged process of remediation of the soil, surface and deep aquifer, the authors with E. Farmeschi and A. Latini



of the site, quantifying their volume, weight and embodied carbon, using benchmark data from the Inventory of Carbon and Energy (ICE) database (Fig. 4). Overall, the material stock is composed of 24,673.340 kg of bricks, concrete, timber and steel, corresponding to around 7,600.000 kg eq-CO_2 of embodied carbon. The main material stock in terms of weight is bricks (56%), while the highest share of carbon emissions is embedded in concrete elements (47%), mainly structural frames, slabs and floors. The results of this analysis proved how preserving the buildings, especially those in bricks and concrete, or reusing their components, means taking advantage of an important mine of materials, while cutting CO_2 emissions in the reuse interventions.

The detailed assessment of the existing stock of components and materials allowed, in the next step, a clear awareness of the quality and residual performance of components, which was essential to assess the buildings' suitability for adaptive reuse – considering their historical/architectural significance, the value of the materials' stock, the spatial adaptability, the level of degradation and, thus, the consistency of the structures. Thus, buildings destined to adaptive reuse, preservation and replacement were identified (Fig. 5), proposing interventions of partial demolition of deteriorated parts that are not historically significant, acting on the original surfaces with micro-stitching, integration and consolidation. Therefore, the preservation of envelopes and structures allows for a coherent and compatible adaptive reuse, reducing soil consumption and emissions in the initial phases of the new lifecycle of the existing buildings to zero, while reactivating the original bioclimatic functioning of the different building types.

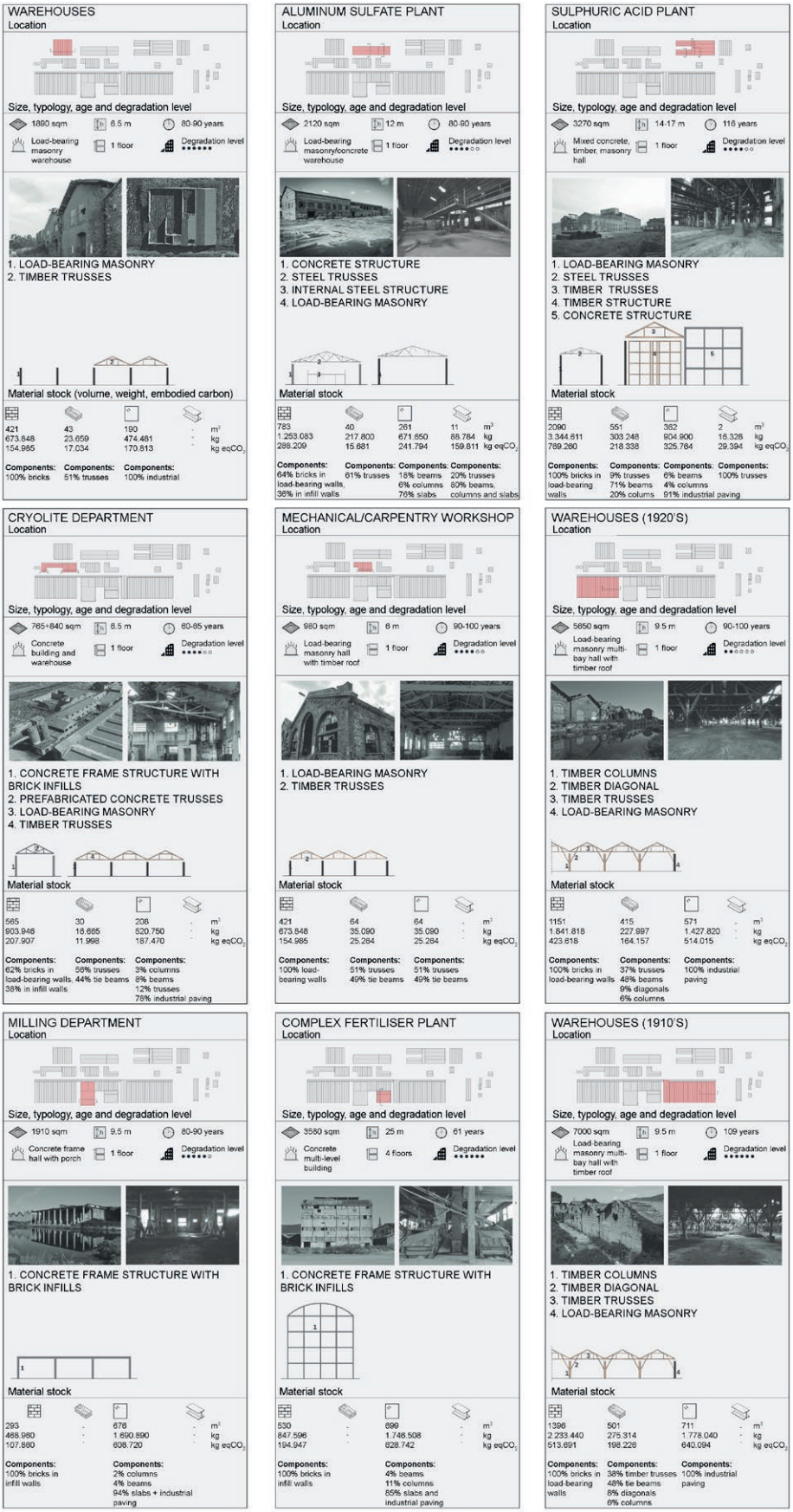
Programme definition: a new balance between social and economic goals

The preservation of the existing, collective memory of a production system characterising the local economy, was evaluated through the objective of the site being used by the community for social and collective uses, as expressed in the Dublin Charter (ICOMOS, TICCIH, 2001, p. 5) since 'maintaining the original use or a new compatible use is the most common and usually the most sustainable way of preservation for industrial sites and buildings'.

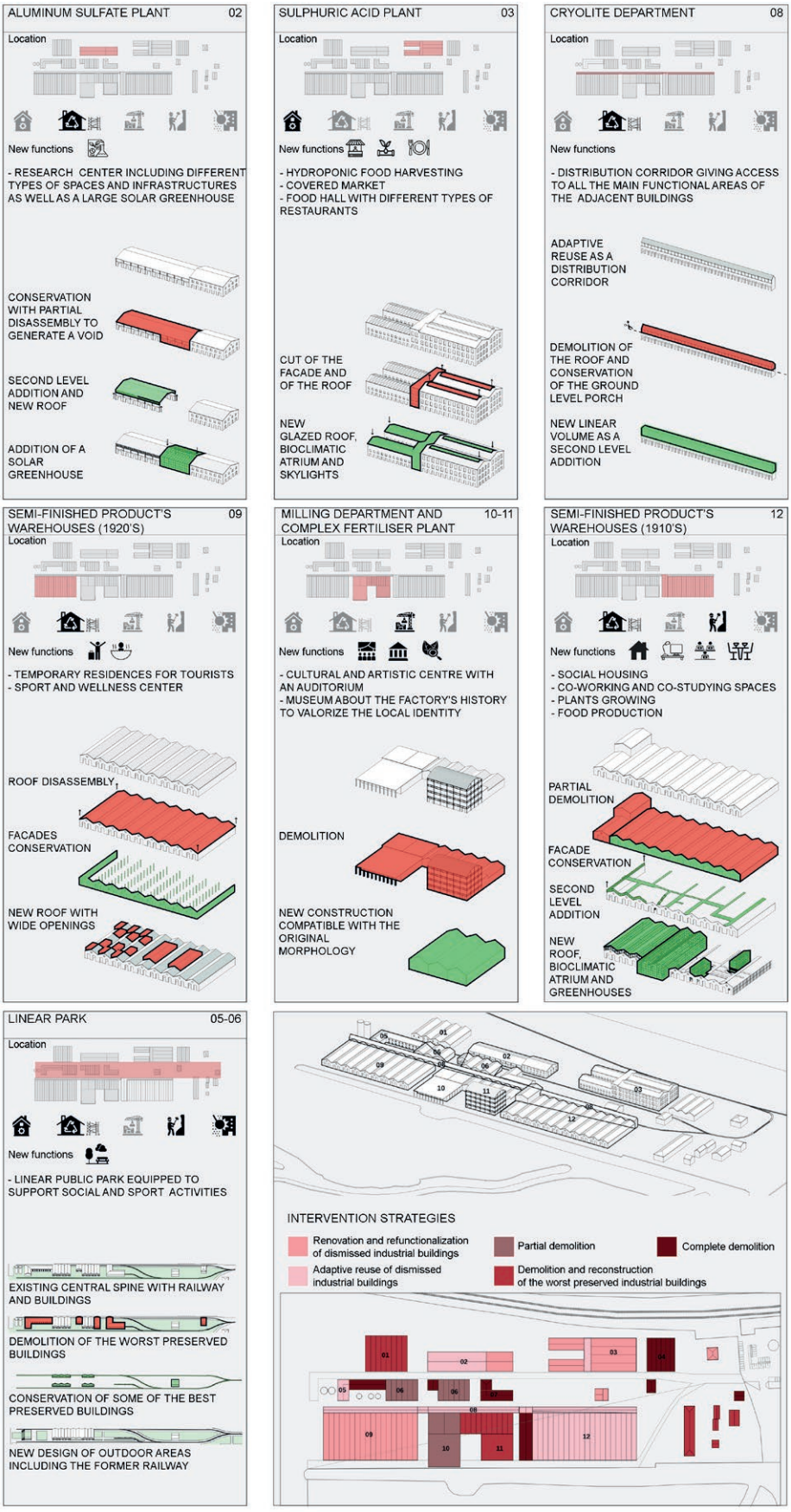
Based on consultation activities with the Orbetello Municipality, a broad framework of needs was defined on which the functional programme was outlined.

The Structural Plan of the Orbetello Municipality (2007) sees the priority of environmental restoration and securing the site as crucial for the definition of a technological and strategic pole with a high cultural value, also opening up to hypotheses of a didactic centre, linked to the lagoon, and of the creation of accommodation facilities to expand the local tourist offer.

04 |


WAREHOUSES
Location
Size, typology, age and degradation level
1890 sqm
6.5 m
80-90 years
Load-bearing masonry warehouse
1 floor
Degradation level
1. LOAD-BEARING MASONRY
2. TIMBER TRUSSES
Material stock (volume, weight, embodied carbon)
421 673.848 154.985
43 23.659 17.034
190 474.461 170.613
Components: 100% bricks
Components: 51% trusses
Components: 100% industrial
ALUMINUM SULFATE PLANT
Location
Size, typology, age and degradation level
2120 sqm
12 m
80-90 years
Load-bearing masonry/concrete warehouse
1 floor
Degradation level
1. CONCRETE STRUCTURE
2. STEEL TRUSSES
3. INTERNAL STEEL STRUCTURE
4. LOAD-BEARING MASONRY
Material stock
783 1.253.083 286.209
40 217.800 15.681
261 671.650 241.794
11 88.784 159.811
Components: 64% bricks in load-bearing walls, 36% in infill walls
Components: 61% trusses
Components: 18% beams 6% columns 76% slabs
Components: 20% trusses 80% beams, columns and slabs
SULPHURIC ACID PLANT
Location
Size, typology, age and degradation level
3270 sqm
14-17 m
116 years
Mixed concrete, timber, masonry hall
1 floor
Degradation level
1. LOAD-BEARING MASONRY
2. STEEL TRUSSES
3. TIMBER TRUSSES
4. TIMBER STRUCTURE
5. CONCRETE STRUCTURE
Material stock
2090 3.344.611 769.260
551 303.248 218.338
382 904.900 325.764
2 18.326 29.394
Components: 100% bricks in load-bearing walls
Components: 9% trusses 71% beams 20% colums
Components: 6% beams 4% columns 91% industrial paving
Components: 100% trusses
CRYOLITE DEPARTMENT
Location
Size, typology, age and degradation level
765+840 sqm
6.5 m
60-85 years
Concrete building and warehouse
1 floor
Degradation level
1. CONCRETE FRAME STRUCTURE WITH BRICK INFILLS
2. PREFABRICATED CONCRETE TRUSSES
3. LOAD-BEARING MASONRY
4. TIMBER TRUSSES
Material stock
565 903.946 207.907
30 18.685 11.998
208 520.750 187.470
Components: 62% bricks in load-bearing walls, 38% in infill walls
Components: 56% trusses 44% tie beams
Components: 3% columns 8% beams 12% trusses 76% industrial paving
MECHANICAL/CARPENTRY WORKSHOP
Location
Size, typology, age and degradation level
980 sqm
6 m
90-100 years
Load-bearing masonry hall with timber roof
1 floor
Degradation level
1. LOAD-BEARING MASONRY
2. TIMBER TRUSSES
Material stock
421 673.848 154.985
64 35.090 25.284
64 35.090 25.284
Components: 100% load-bearing walls
Components: 51% trusses 49% tie beams
Components: 51% trusses 49% tie beams
WAREHOUSES (1920'S)
Location
Size, typology, age and degradation level
5650 sqm
9.5 m
90-100 years
Load-bearing masonry multi-bay hall with timber roof
1 floor
Degradation level
1. TIMBER COLUMNS
2. TIMBER DIAGONAL
3. TIMBER TRUSSES
4. LOAD-BEARING MASONRY
Material stock
1151 1.841.818 423.618
415 227.997 164.157
571 1.427.820 514.015
Components: 100% bricks in load-bearing walls
Components: 37% trusses 48% beams 9% diagonals 6% columns
Components: 100% industrial paving
MILLING DEPARTMENT
Location
Size, typology, age and degradation level
1910 sqm
9.5 m
80-90 years
Concrete frame hall with porch
1 floor
Degradation level
1. CONCRETE FRAME STRUCTURE WITH BRICK INFILLS
Material stock
293 468.980 107.860
678 1.690.890 608.720
Components: 100% bricks in infill walls
Components: 2% columns 4% beams 94% slabs + industrial paving
COMPLEX FERTILISER PLANT
Location
Size, typology, age and degradation level
3580 sqm
25 m
61 years
Concrete multi-level building
4 floors
Degradation level
1. CONCRETE FRAME STRUCTURE WITH BRICK INFILLS
Material stock
530 847.596 194.947
699 1.746.508 628.742
Components: 100% bricks in infill walls
Components: 4% beams 11% columns 85% slabs and industrial paving
WAREHOUSES (1910'S)
Location
Size, typology, age and degradation level
7000 sqm
9.5 m
109 years
Load-bearing masonry multi-bay hall with timber roof
1 floor
Degradation level
1. TIMBER COLUMNS
2. TIMBER DIAGONAL
3. TIMBER TRUSSES
4. LOAD-BEARING MASONRY
Material stock
1396 2.233.440 513.691
501 275.314 198.226
711 1.778.040 640.094
Components: 100% bricks in load-bearing walls
Components: 38% timber trusses 48% tie beams 6% diagonals 6% columns
Components: 100% industrial paving

05 | Functional programme, intervention scenarios and design strategies for the whole site and for the single main buildings, the authors with E. Farmeschi and A. Latini



Through the Variant to the Urban Plan (2000), the area is configured as a technological centre, strategic in the context of Orbetello Scalo, with reference to activities and services connected to the water system, intermodality for connections with the islands, environmental didactics, research, tourism, trade and crafts, and management connected to the lagoon (art. 84, Zone D1).
The integration of a very complex planning framework led to the definition of a Functional Programme articulated in 4 main operational areas, compatible with the industrial architectural structure, namely residential, commercial, recreational-cultural and tertiary (services, work, research).
Consistent with these hypothesis, the research has changed perspective for the definition of the intervention programme by moving from profit-oriented scenarios to the privatisation of a large part of the area. This will be achieved through the demolition of most of the existing buildings, defining a scenario that places the public subject at the centre, introducing the central functions of social housing, co-working and the shared production of energy, services and food for self-sufficiency (Guallart, 2014) (Fig. 6). The adaptive reuse scenario defined in the research is thus oriented towards a fully sustainable and circular model, consistent with the landscape, environmental and historic-cultural protection regulations of the area, with a view to the public enhancement of the site.

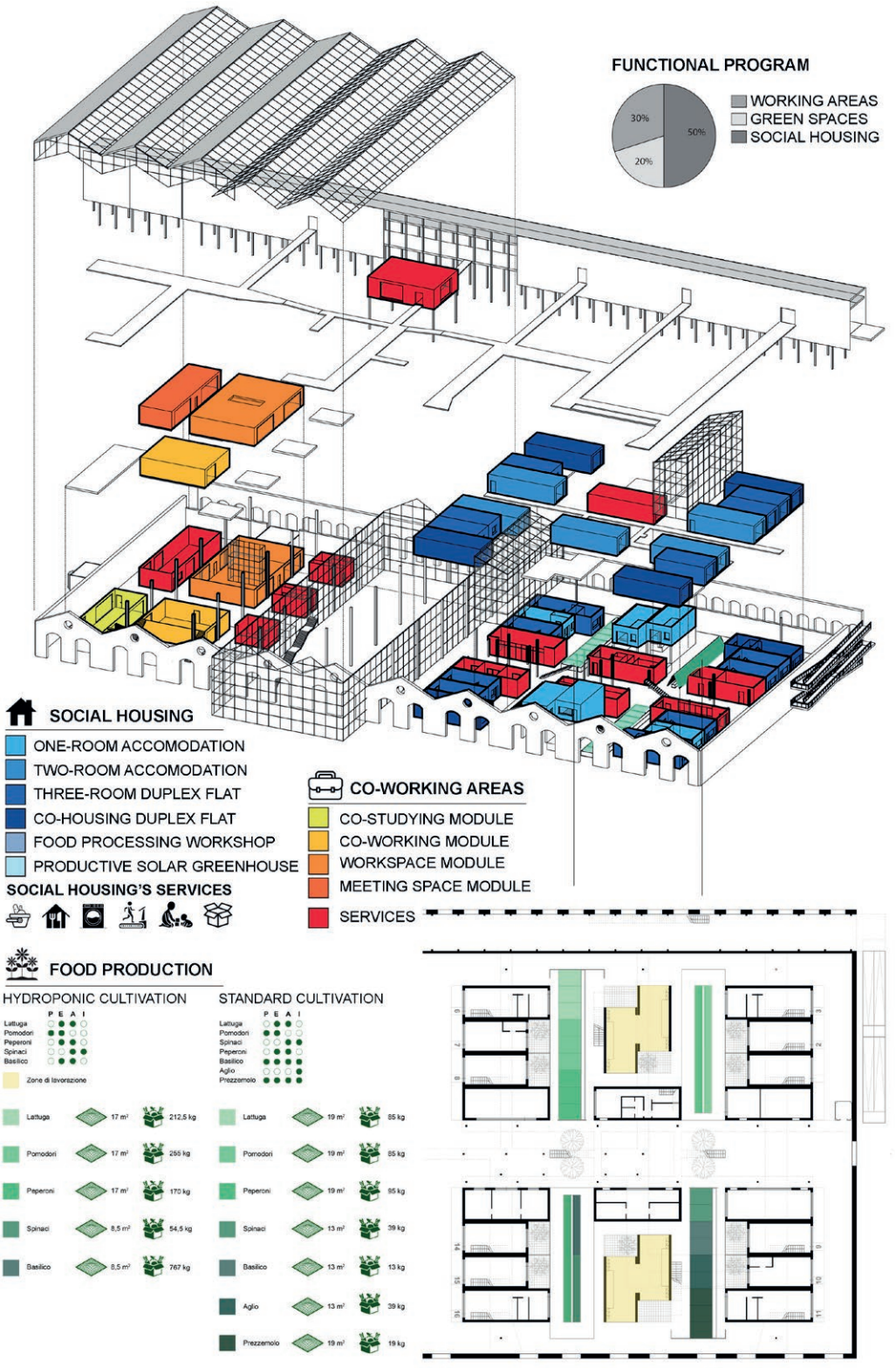
Circular & sustainable adaptive reuse: reactivating bioclimatic behaviours, adopting reversible construction systems and circular materials

In order to reduce the energy consumption and to cut the operative CO_2 emissions of the reused buildings, the research methodology prioritised reactivation of the bioclimatic behaviour of the different building typologies to underscore the value of passive operation of the built systems, containers of new functions differing from the productive ones, compartmentalised into an overlapping and integrated functional volume (Fig. 7). The integrated solar and hydroponic greenhouses, inserted in the original brick envelope, ensure an important contribution to the ecological operation of the built system, using recovered rainwater also for the irrigation of vegetable gardens and green areas intruding into the bioclimatic atriums for indoor natural ventilation and cooling.
The remaining necessary energy supply is ensured by the integration of photovoltaic systems integrated into the large opaque and transparent roofs (BIPV), which cover almost 90% of the energy needs.
The intervention methods for the adaptive reuse of the buildings of the eastern and western part of the "Semi-finished product's warehouses" aimed at material demand reduction, reversibility and flexibility, as well as to reducing embodied carbon. The design choices are, therefore, centred on the integration of cross-laminated timber modules, deconstructable, integrable and replaceable, containing shared living, study and work functions, adaptable, flexible and oriented towards overall reversibility. The different structural systems and existing envelopes allow for the compatible accommodation of functional and connective spaces, according to the box-in-the-box model. Thus, through the choice of a timber-based construction system, the reduction of CO_2 emissions over the whole life cycle is guaranteed. The use of additional natural materials (clay, silt and sand), 3D printed, to build functional shells, allows the building systems to be adapted to the different needs of the new functions, guaranteeing low impact, limited physical interference, and high morphological integration of the new elements. The envelopes, insulated internally with rice husk, constitute autonomous passive systems within the larger spaces of the building (Fig. 8).

Discussion and conclusions

The research has developed an integrated intervention model, with an approach articulated in operational phases acting in an iterative manner, to reintegrate a contaminated site into its high value landscape-environmental context and, subsequently, return it to public use, making it central to the life of the local community by reinserting it into social and economic flows.
The first operational level, referring to the remediation of contaminated soil and water, made it possible to highlight and compare some current operations with the hypotheses of exploring different soft and hard methods, with a view to integrating nature-based solutions from the earliest stages of intervention. This approach, to be defined under further conditions of alteration and degradation, could ensure the dissemination of different techniques (naturalistic engineering, hybrid technologies, technical ecological systems) to achieve a 'local' solution that could be part of the wider integrated system of green, blue and grey infrastructures.
The research then allowed to verify site valorisation aspects within the framework of expressed and hypothesised needs, selecting functions compatible with heritage and its memory, capable of giving back areas previously excluded from use to the local community, in line with transformation and regeneration objectives defined based on the consultation with the Orbetello Municipality. This made it possible to define the morpho-technological compatibility criteria for the reuse of disused industrial structures, and to construct a matrix of environmental restoration and adaptive reuse strategies tailored on the context conditions.
The Ex SITOCO area is a particularly complex site, due to the

06 | Functional programme of the eastern "Semi-finished product's warehouses" adaptive reuse: mixed use with social housing, co-working and co-studying areas, food production areas and services, the authors with E. Farmeschi and A. Latini



07 | Active, passive and ecological systems adopted in the environmental re-design of the eastern "Semi-finished product's warehouses", the authors with E. Farmeschi and A. Latini

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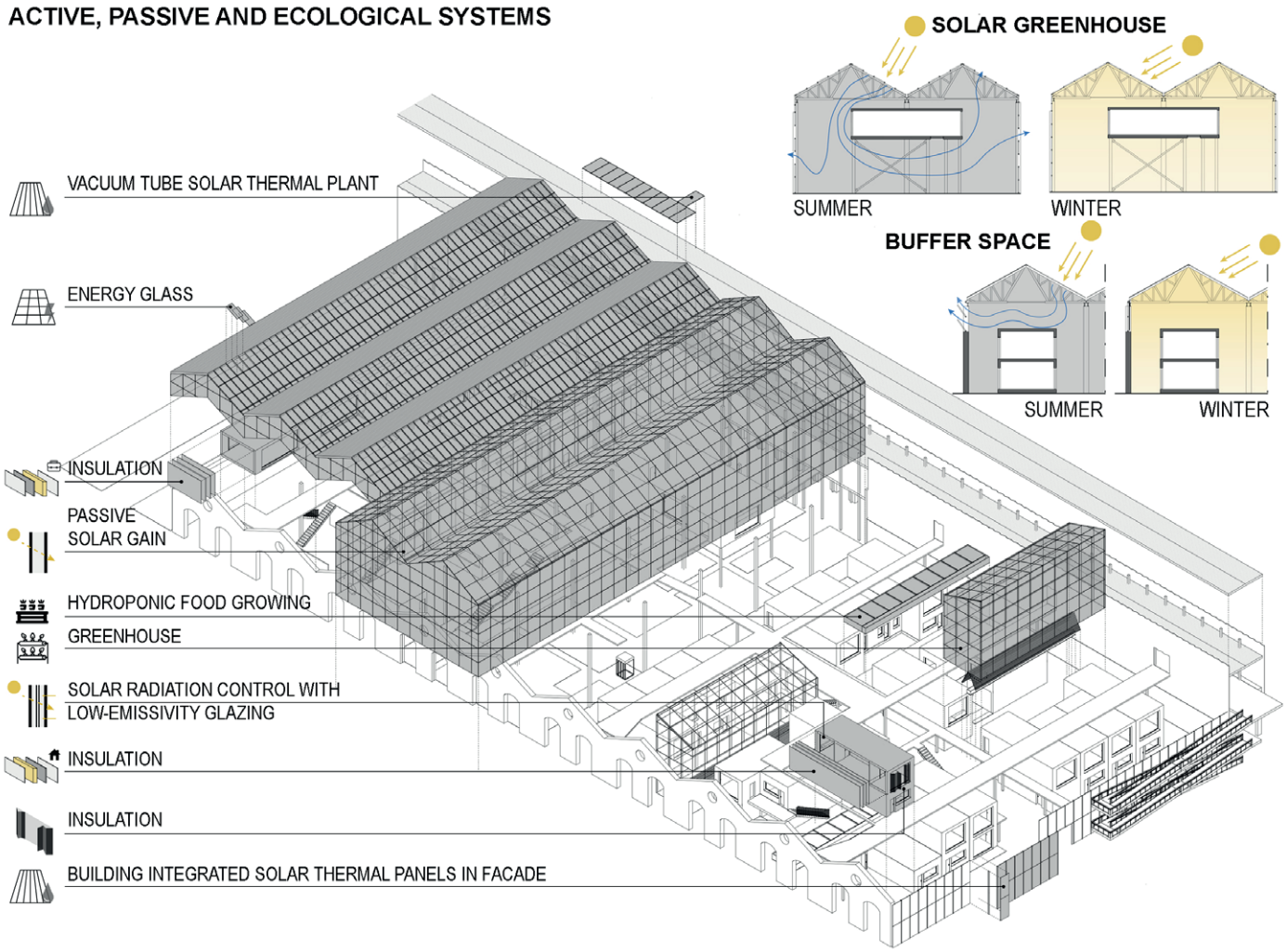
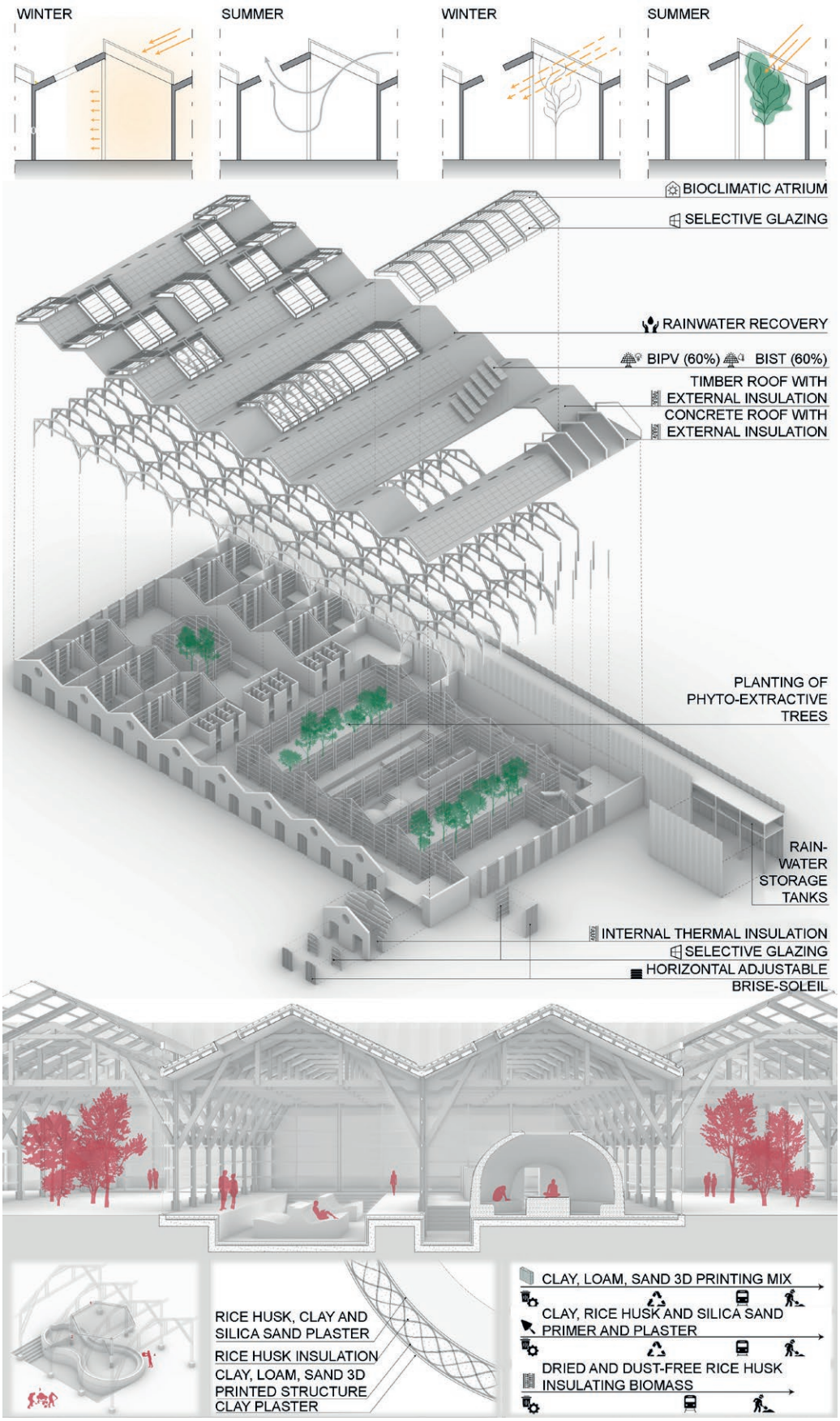


serious and dual pollution of the environmental matrices. However, a broad replicability of the main steps of the methodological process defined in the research is identified, given the extension of the disused industrial sites that, in Italy alone, according to ISTAT estimates, occupy about 3% of the national soil. A fundamental step of the research was drawing a methodological framework, articulated in different strategic levels. Through iterative phases, this allows to identify actions and technical systems for the intervention in fragile contexts, integrating the results obtained in other similar sites and filtering local specificities. The purpose is to define a framework of transferability of actions oriented to support decision-making and operational processes.

One of the limits of the research to be deepened and verified is the difficulty of scheduling adaptive reuse operations, which must consider the long times due to the preliminary, or parallel, stages of remediation, especially when sites are heavily contaminated. Often the critical situation of the sites also limits access for direct site surveys, and the estimation of the stock of materials can only be carried out in desk mode. However, even in such complexity, the assessment methodology implemented by the RG provides a solid foundation for the enhancement of industrial heritage in vulnerable sites by allowing to adopt a holistic approach throughout the design process.

Research perspectives open up in two main directions. Firstly, based on the results of the experimentations developed so far, the RG identifies the possibility of systematising a set of criteria for defining local resource recovery and reuse systems to activate, in the dismissed industrial sites, a proper circular ecosystem with zero-emission energy production. The process will make use of local biowaste to produce materials, ensuring

08 | Active, passive and ecological systems adopted in the environmental re-design of the western "Semi-finished product's warehouses", turned into a tourist and thermal complex, with the use of 3D printing techniques with natural sub-products of rice cultivation, the authors with E. Farmeschi and A. Latini



water recycling and reuse, and integrating nature-based solutions, which could be used as a design support tool/guideline. Secondly, the RG is engaged in developing a methodology for the overall evaluation of the circularity level of the intervention, overcoming the current fragmentation of the existing circularity indicators, referring to individual resource flows.
In the future implementation of such approaches, technicians, policy-makers and stakeholders will be directly responsible for the changes imposed by the process, benefitting from new knowledge and innovations for climate neutral heritage.

ACKNOWLEDGMENTS

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Temporary student housing as a driver of urban regeneration and territorial revitalisation

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Abstract. This essay explores the role of temporary student housing in urban regeneration and territorial revitalisation, focusing on adaptive reuse of abandoned buildings and underused spaces. It examines a feasibility study of a project in Lentate sul Seveso, Italy, where a former military park is being transformed into student housing and community spaces with funding from Italy's National Recovery and Resilience Plan (PNRR). The essay highlights the potential of temporary housing to foster economic, social, and cultural revitalisation, while addressing student housing needs. It also underscores the critical role of universities in collaborating with local municipalities and communities to design inclusive, sustainable solutions for long-term urban recovery.

Keywords: Spatial Design; Service Design; Temporary Student Housing; Urban Renovation; Adaptive Reuse.

Introduction

The challenges of urban transformation and territorial recovery are becoming increasingly urgent as cities and regions across Europe confront the need for sustainable development, social inclusion, and economic revitalisation. In this context, student housing and temporary living solutions emerge as critical tools, not only for addressing the immediate accommodation needs of young people but also for driving broader strategies of urban and rural regeneration. The growing urgency to address these challenges is compounded by the current state of many urban areas, where abandoned buildings and disused spaces are widespread. This vacant heritage represents both a challenge and an opportunity, as these underutilised spaces hold immense potential for sustainable development and can offer a viable response to the waste of resources. Reimagining these neglected spaces through adaptive reuse and temporary housing solutions provides an innovative way to address urban housing shortages, while contributing to broader urban regeneration efforts.

This essay explores the potential of temporary housing to contribute to enhancing the value of territorial identity, the preservation of architectural heritage, and the reorganisation of fragile and underdeveloped areas. By transforming abandoned buildings and vacant lots into functional spaces that serve both educational and community purposes, temporary housing solutions can become key drivers of urban and territorial recovery. In doing so, they not only address the immediate needs of students but also contribute to the long-term sustainability and vitality of these regions.

A key focus of this essay is a feasibility study conducted by a university on the adaptive reuse of a former military park in Lentate sul Seveso, Lombardy, Italy. The project aimed to secure funding from Italy's National Recovery and Resilience Plan (PNRR) to transform the site into a hub for student housing and community services. The project successfully obtained partial funding, but its full implementation is still ongoing. The case study serves as a practical lens through which to examine both the potential and the limitations of using temporary living projects as tools for territorial recovery and urban regeneration. It highlights how such initiatives can contribute to the revitalisation of local areas, foster social inclusion, and strengthen community ties while preserving the cultural and architectural heritage of the region.

Currently, many cities are struggling with the issue of abandoned buildings and vacant lots that contribute to urban decay. This unused space represents an underexploited resource with potential for transformation. Embracing these spaces as part of the solution to urban challenges can lead to innovative, sustainable urban futures. Understanding cities as a source of sustainability options, promoting active collaboration among diverse stakeholders, integrating various perspectives of knowledge and expertise, and encouraging experimentation with different solutions and approaches are all essential components of successful sustainable urban transformation (McCormick *et al.*, 2013). By bringing together universities, local municipalities, private developers, and the community, these projects aim to generate creative and collaborative solutions that have the potential to meet both immediate housing needs and long-term regional development goals.

The key aspect of this research lies in positioning the university not only as a knowledge hub but as an active partner in the implementation of local development policies – an approach that remains largely underexplored in existing studies. By directly engaging with municipalities, private developers, and local communities, the university has played a crucial role in bridging research and practice, ensuring that housing solutions align with broader urban regeneration and territorial recovery objectives. Leveraging interdisciplinary expertise and fostering cross-sector collaboration, this research demonstrates how universities can move beyond their traditional academic role to become catalysts for socially inclusive, environmentally sustainable, and culturally sensitive policy implementation. Through case studies and policy analysis, this paper highlights how temporary housing can serve as a transformative tool for inclusive and sustainable urban development.

Multifunctional temporary living for contemporary urban needs

Temporary living has evolved as a crucial component of urban development, addressing the dynamic needs of modern cities. It encompasses various models of transient housing that cater to specific urban demands, such as accommodating no-

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madic lifestyles, providing short-term housing solutions, and revitalising underutilised urban spaces. Temporary living is characterised by its transient nature, offering adaptable solutions that bridge space, time, and usage (Galluzzo, 2022). Temporary living models extend beyond housing to include mixed-use developments and temporary hospitality for diverse populations, such as tourists, migrants, or professionals on short assignments. These designs encourage the transformation of single-purpose spaces into multifunctional hubs, which can accommodate varied needs over time. For instance, spaces initially designed for student use can later adapt to serve as co-living or co-working environments, aligning with the broader goals of urban resilience and sustainability. Creating transformative places also contributes to the sustainability of those spaces, making them suitable in the long term (Collina *et al.*, 2022). Temporary living addresses a spectrum of urban challenges, which are often tied to the temporal and spatial dynamics of urban life, and to evolving land use patterns. An example of a temporary living project shaping urban development is the future Olympic Village in Milan, part of the Milan-Cortina 2026 Winter Olympics, which is expected to have several significant impacts on the city and the surrounding region. These effects can be categorised as urban development, sustainability, and socio-economic. The Olympic Village is anticipated to stimulate urban regeneration, like the transformations seen in previous Olympic cities, namely Sydney and Barcelona. In Sydney, the Olympic Park became a major hub for urban consolidation and commercial activity, while in Barcelona, the Olympic Village played a key role in opening up the city to the sea and promoting urban cohesion (Searle, 2012; De Clasca *et al.* 2019). The Village in Milan, designed to accommodate athletes during the event, will be repurposed as student housing after the Olympics. Located in the Porta Romana district, this project exemplifies how such developments can bridge large events and adjacent neighbourhoods, fostering long-term urban revitalisation. This approach demonstrates how flexible and multifunctional spaces can address diverse urban challenges, contributing to vibrant, resilient, and inclusive communities.

Student housing and its impact on small urban context transformation

Student housing serves as a key example of temporary accommodation solutions that address both immediate housing shortages and the transient nature of student populations. These residences not only meet the pressing needs for affordable housing but also integrate into the broader urban fabric, contributing to the revitalisation of local neighbourhoods. By doing so, student housing helps stimulate local economies, providing a boost to nearby businesses and services. Moreover, it fosters cultural exchange between students and the surrounding communities, creating opportunities for interaction and collaboration that enrich the social and cultural life of the area. Through these dynamic interactions, student housing plays a crucial role in the transformation and sustainable development of small urban contexts.

The decentralisation of higher educational institutions

Universities and campuses have increasingly been called to adopt a proactive role in addressing urban and social challenges. They now function as key agents of urban development, revitalising peripheral areas at risk of decline and initiating regeneration processes that benefit the broader city. This dual role of academic institutions – as educators and urban catalysts – underscores their growing responsibility in shaping sustainable and inclusive urban transformations (Fassi, 2020). This transformative capacity of universities is deeply connected to the spaces and services they provide, among which student housing stands out as a crucial element. Student housing should not merely be viewed as temporary accommodation for foreign students; rather, it ought to be recognised as a public service, essential for facilitating academic, pedagogical, and research endeavours, while also offering amenities and services that foster collective cultural and recreational development, thereby generating new human and social capital (Bellini *et al.*, 2020). The decentralisation of university campuses, initiated by the Bologna Declaration of 1999, has led to the development of academic spaces in underutilised urban areas, including the construction of new facilities and the repurposing of industrial sites as for instance the Roma Tre University's Testaccio Campus, the Politecnico di Milano's Bovisa Campus (Fassi, 2020). This shift primarily targeted marginal zones of large cities, revitalising them through educational and cultural activity. However, the rationale of decentralisation extends beyond the boundaries of metropolitan centres, influencing smaller cities located near major urban areas. These smaller cities, connected to large urban hubs, offer unique opportunities for integrating public infrastructure with local development.

By fostering proximity to educational institutions, tailored accommodations not only support students but also serve as a catalyst for downtown revitalisation (Charbonneau, et. Al., 2006). This integration can stimulate local economic growth, attract new businesses, and encourage urban renewal, transforming smaller cities into vibrant nodes of activity that complement their larger neighbouring urban centres. Through such strategies, student housing can contribute to sustainable urban development while strengthening the social and economic fabric of the surrounding regions.

Public Policy Strategies for Enhancing Small Urban Contexts

Policies under Italy's National Recovery and Resilience Plan (PNRR) further bolster these efforts, particularly through targeted investments in small towns and villages ("borghi"). These policies aim to revitalise historic and underpopulated areas, fostering cultural, economic, and social regeneration by creating opportunities for sustainable tourism, local business development, and infrastructure modernisation. By connecting these initiatives with broader urban and educational development strategies, PNRR funding seeks to transform *borghi* into hubs of innovation and resilience, ensuring their relevance in a rapidly changing socio-economic landscape. This alignment underscores the importance of linking academic infrastructure, such as student housing, with the revitalisation of small, historically significant places, further bridging urban and rural development goals.

An overview of student housing normative framework in Italy

Student housing plays a crucial role in improving living conditions, advancing architectural innovation, and fostering social and urban development (Bologna, 2022). In Italy, this role has been influenced by significant policy and funding shifts that have shaped its evolution. Over the years, public initiatives have transitioned from direct government management to more collaborative public-private partnerships (PPPs), reflecting broader socio-economic and urban policy trends. The subsequent overview of the normative framework is elaborated in Bertoni's thesis (2024). Law 338/2000 marked a significant turning point by formalising a co-financing mechanism to support the development of student housing. This law shifted the government's role from directly managing projects to acting as a financer and coordinator, emphasising flexibility and adherence to building standards. Subsequent decrees, such as 42/2007 and 27/2011, introduced more detailed building standards and dimensional criteria. These included mandatory spaces like study rooms and communal kitchens, aiming to balance cost-efficiency with quality standards. By 2016, decrees further reduced room size requirements while maintaining focus on maximising the number of beds. These measures contributed to the creation of approximately 11,500 new beds through 90 projects, supported by €420 million in funding.

The statistics on Italy's student housing illustrate a significant gap compared to other European nations. In 2020, Italy had approximately 42,732 university dormitory beds, less than a third of the availability in France and Germany. The challenges are compounded by cultural and systemic factors: 68% of Italian university students live with their parents, compared to the European average of 33%. Only 5% of Italian students reside in university accommodations, far below the 17% European average. Furthermore, about 40,000 out of 400,000 students who live away from home rely on public or semi-public university housing. Even among students eligible for scholarships, only about a third receive housing support (Gainsforth and Peverini, 2022; Gwosc *et al.,* 2021). The 2020 pandemic accelerated changes in the student housing landscape, supported by the EU Recovery Fund. This fund, part of the Next Generation EU programme, aims to promote ecological and digital transitions while addressing territorial disparities. Italy integrated these objectives into its National Recovery and Resilience Plan (PNRR), allocating €1,998 billion to create 60,000 additional student residence beds by 2026, raising the national total from 45,000 to 105,000. This measure represents a significant policy evolution; however, it faces challenges in its practical implementation.

Case study: a feasibility study of a former military park renovation

The renovation of a former military park into a multifunctional hub, featuring student residences and community spaces, serves as a case study demonstrating how sustainable design and adaptive reuse can meet local needs while aligning with national policies such as Italy's PNRR. Developed by a research group from the Design Department at Politecnico di Milano in collaboration with the Municipality of Lentate sul Seveso, the project aims to transform the former military park into a multifunctional hub that fosters educational opportunities and stimulates economic development in "rurban" (rural + urban) settings, fostering a link between urban and rural growth (OECD, 2020, cited in Borin, 2022). Moreover, it exemplifies the potential of adaptive reuse to create spaces that not only serve immediate functional needs but also contribute to long-term regional development.

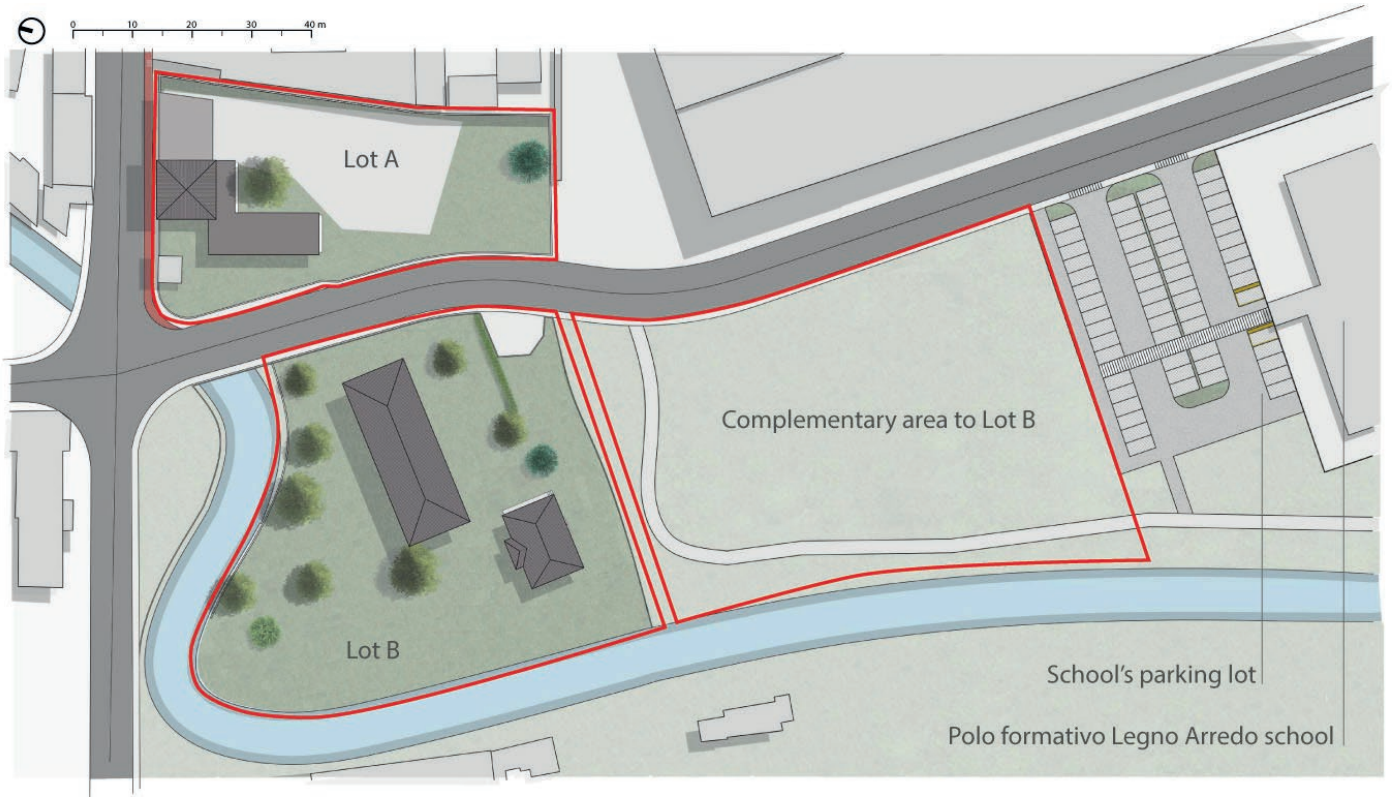
Context and aim of the project

The requalification project for the Former Military Park is located in Lentate sul Seveso, a city with strategic connections to major northern Italian urban centres, including Milan. Lentate sul Seveso has a long-standing association with the wood furniture industry, which is reflected in the presence of the *Polo Formativo Legno Arredo*, a high school renowned for its focus on furniture craftsmanship and design. The park, adjacent to this institution and within close proximity to the Lentate/Camnago railway station, has been neglected since the cessation of its military functions. Despite the deteriorated condition of its buildings, the site boasts 3,500 square metres of green space enriched by the natural course of the Seveso River, and possesses considerable architectural and cultural significance.

The primary objective is to support the educational growth of the Polo Formativo Legno Arredo, while fostering community

01 | Planimetry of the former military park's state of the art, authors' drawing

01 |



engagement. By aligning with the region's historical and cultural context, the project creates synergy between educational advancement and heritage preservation. As Manzini (2006) notes, "Macro-transformations are often the result of micro-transformations and local systemic discontinuities," emphasising the potential of localised design interventions to drive broader systemic changes.

The design process and design outputs

The intervention area is divided into Lot A for community-oriented functions, and Lot B for residential services, with an adjacent space for parking (Fig. 1).

The design includes accommodations for students, teachers, and professionals from the Polo Formativo Legno Arredo, alongside community spaces such as a children's playroom, a house of associations, and a social club. The transformation of the former military park in Lentate sul Seveso reflects a comprehensive approach that integrates policies, multifunctionality, and institutional collaboration. The project began with an in-depth evaluation of the abandoned site, identifying local needs and potential user groups through collaborative efforts with local authorities and stakeholders. This led to a feasibility study outlining services and spatial layouts aligned with Italy's National Recovery and Resilience Plan (PNRR), specifically Mission 4, which focuses on expanding educational infrastructure, including student housing. The PNRR emphasises fostering ecological and digital advancements, aiming to bridge disparities between urban hubs and smaller communities, supporting sustainable growth at multiple levels.

The project followed key stages, precisely site assessments, definition of potential users, determining a design solution for a feasibility analysis, ensuring alignment with the PNRR's sustainability and educational objectives. The redevelopment reconfigures deteriorated structures (Figs. 2, 3), introducing residential services with varied accommodation types – one-bedroom apartments, small, shared units, and larger student residences (Figs. 4, 5).

In addition to residential services, the project integrates community facilities, including an event room, community gardens, and a multi-sport field. The multifunctional spaces host a children's area, a bar/social club, and a community association centre designed for flexible use and local engagement (Fig. 6). This comprehensive design fosters connections between temporary residents and the local community, a central aspect of the project.

02 | Pictures of the state of the art of Lot A's buildings of the former military park in Lentate sul Seveso

03 | Pictures of the state of the art of Lot A's buildings of the former military park in Lentate sul Seveso

02 |

| 03

The design also reimagines the green spaces as shared vegetable gardens to foster connections between temporary residents and the local community. These gardens encourage environmental awareness, civic participation, and a sense of ownership (Twiss *et al.*, 2011). They also serve as venues for events and activities that strengthen community bonds and enhance the site's utility.

Policies, Temporary-multifunctionality and Institutional partnerships

A key feature of the project is its adaptability, with spaces designed to serve both student housing and community engagement functions. This multifunctionality ensures the longevity of the site, allowing it to evolve over time to meet diverse needs—from student accommodation to services for the elderly—and minimising the risk of obsolescence (Collina *et al.*, 2022). The concept of the "regenerative economy" (Manzini, 2006) underpins the design philosophy, transforming abandoned spaces into vibrant community hubs. Accessibility is central to the project, with universal design principles ensuring inclusivity, while flexible layouts support evolving public needs, a necessity highlighted by the Covid-19 pandemic (Stevens *et al.*, 2021).

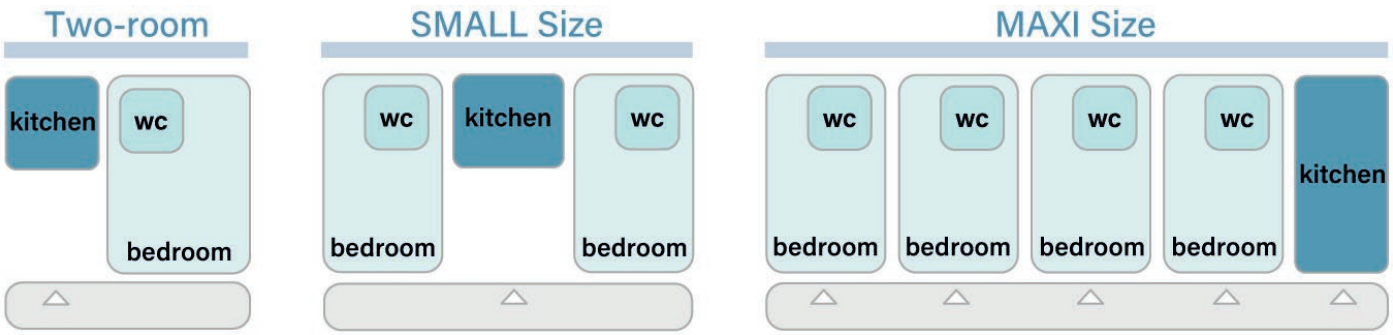
The project also balances environmental sustainability with cultural heritage preservation, respecting the site's *genius loci* (Norberg-Schulz, 1979) and enhancing its historical significance. This holistic approach – blending social, ecological, and cultural dimensions – creates meaningful environments that foster community engagement and sustainable growth (Bullen and Love, 2011). Institutional collaboration played a critical role in the project's development. Partnerships between the municipality, the Politecnico di Milano, and stakeholders like the Polo Formativo Legno Arredo and Federlegno merged academic research with local expertise. This inclusive approach engaged a diverse range

04 | Hospitality offer scheme, authors' diagram

05 | Space distribution diagram of residential accommodation Lot B, authors' drawing

06 | Space distribution diagram of activities Lot A, authors' drawing

04 |



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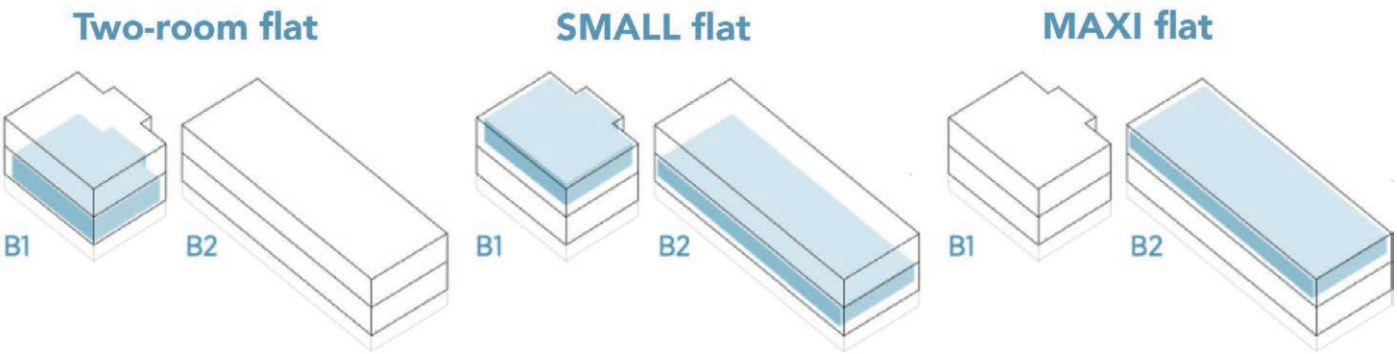


06 |

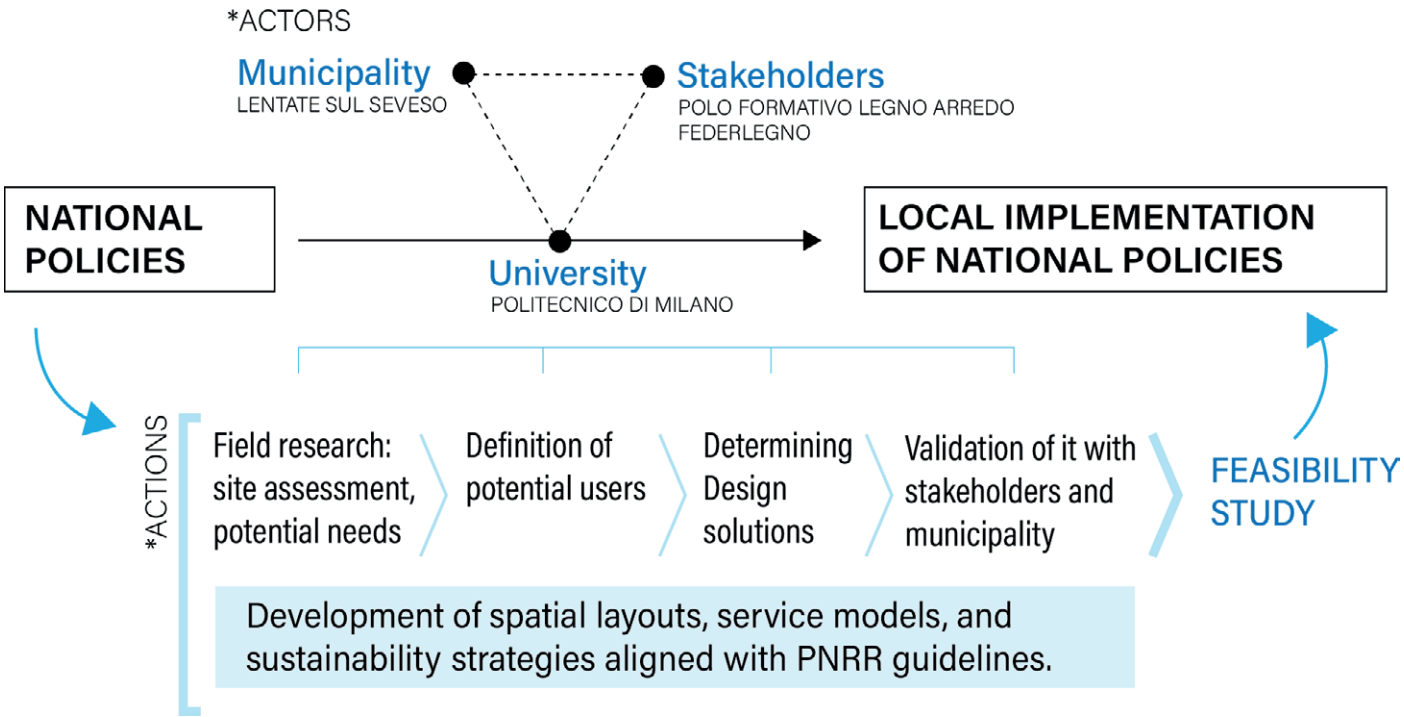
of actors – politicians, private sector stakeholders, and academics. As depicted in the conceptual map in Figure 7, which illustrates the relationships between these actors and actions, the process allowed for the local implementation of national policies. The university's contribution was used as a foundation for the adaptation of these policies at the local level.

Conclusion: integrating education, housing and local development

The Covid-19 pandemic highlighted the need to rethink urban spaces, particularly those that blur the lines between public and private, such as student housing (Honey-Rosés *et al.*, 2020). The crisis exacerbated existing challenges related to habitability, emphasising the need for spaces that balance individual privacy with community-oriented shared areas.

Student housing can play a crucial role in urban regeneration by promoting inclusivity and fostering a sense of community. It serves as a "social condenser," attracting youthful populations and contributing to urban cohesion, which is essential for overcoming the fragmentation of cities and creating more inclusive urban environments (Bellini *et al.*, 2015). This project reimagines student housing not only as functional but also as a space for cultural and social integration, offering innovative solutions to contemporary challenges.

07 | Conceptual map of relations between actors and actions in the research process, authot's diagram



Aligned with Italy's National Recovery and Resilience Plan (PNRR), the feasibility study emphasises sustainability, adaptability to green and digital transitions, and improved educational infrastructure. It also reflects Mission 4 (Education and Research), focusing on enhancing accessibility and quality in educational environments. Special care was taken to revise student housing standards, ensuring a balance between regulatory requirements and improved living conditions.

The paper highlights the potential of temporary housing to foster economic, social, and cultural revitalisation, addressing immediate student housing needs while contributing to long-term urban recovery. The multifunctional and temporal nature of such housing models offer a unique opportunity to generate positivity, creating adaptable spaces that serve different purposes over time, and which can evolve with the needs of the community. This adaptability, combined with collaboration between universities, local municipalities, and communities, provides a sustainable framework for urban regeneration. By fostering cooperation among diverse stakeholders, universities can help create resilient, vibrant communities that support both short-term needs and long-term growth, thus contributing to the broader goals of territorial revitalisation.

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Transforming urban environments: the healthy city as a common asset

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Abstract. This paper demonstrates, through the narration of a direct experience in the field, the potential impact generated by the intervention proposed as a case study, as a driver for the development of the territory in a 'Healthy City' perspective, expressing a strong potential for social inclusion and functional and spatial qualification. The research, from which it originated, highlighted the role of the University in supporting the PA in proposing strategic governance actions for the development of the territory. This is achieved through its multidisciplinary competences and its ability to draw on the exchange of visions and contributions provided by the actors involved in order to enhance the available local resources and specificities, and to foster the socio-economic well-being of the community.

Keywords: Active city; Sports infrastructure; Urban resilience; Collective well-being; Integrated approach.

Cities as Strategic Labs

«Rapid regional and global changes are transforming living spaces and lifestyles, demographic trends, and the global environment, all with important consequences for human health and well-being. Urbanisation is of primary importance among the forces affecting population health. A significant percentage of the global population lives within cities and the proportion of urban dwellers is rapidly increasing » (Thomas *et al*., 2016).

All this leads to increasing problems related to inhabitants' health and well-being, safety and general quality of life. It is, therefore, fundamentally important to identify an alternative to the city scheme that has been imposed up until now, and to turn to new regenerative models capable of interpreting cities as places of experimentation according to an evolutionary rationale aimed at sustainable innovation, with interventions capable of redefining a new local identity, improving the environmental quality, health and well-being of communities. There is, in fact, «a pressing need for cities to develop sustainably without causing more damage than necessary to the environment or the health of its citizens» (Corburn *et al*., 2020).

«Cities are an increasingly central topic in sustainable development policies. [...]. The 2030 Agenda identifies urban areas as an opportunity to implement its goals, including an SDG [Sustainable Development Goal] specifically dedicated to cities and human settlements (SDG11). The New Urban Agenda is in the same vein, recognising and supporting the role of urbanisation as a powerful tool for sustainable development in both developing and developed countries. In fact, the most demanding environmental and socio-economic challenges are concentrated in cities, but at the same time they represent centres of industrial and social innovation and strategic laboratories for the development of a new "sustainability culture", also in relation to urban regeneration policies» (MASE, 2024).

The characterisation of this new culture capable of combining sustainability with technological development is not easy to define. As a primary action, it must necessarily reframe the role of the citizen/user, which must become absolutely central.

Indeed, the city of the future must not limit itself to redesigning buildings and infrastructure, and to transforming services.

«It has a new purpose and, for the first time, it is firmly based around the needs of people, while also proactively and dynamically preserving our planet. People are no longer second to infrastructure, buildings or land use, and a more 'regenerative' standpoint is now taken, acknowledging that the city's key role is also to foster healthier mindsets and behaviours» (Key Cities, 2022).

This is the only way a city can express its potential for social inclusion as well as functional and spatial qualification.

Hence, in this context, there is a critical relationship between the city and health and «in particular between urban planning and health [...] involving a profound redefinition of the concept of health – from a sectoral health model to a multidimensional social model – and at the same time pushing for the reorientation of urban policies [...] towards the promotion of health and well-being by searching for better habitability, liveability and hospitality conditions in cities [...] putting to work a new perspective (transversal to disciplinary and intervention sectors) in order to "see" and "construct" the new urban problems and "equipment" to experiment with new solutions to deal with them» (Bellaviti, 2005).

Starting with the World Health Organisation's (WHO) concept of "health" as «a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity» (WHO, 1948), it is evident how «inhabitants' well-being and health [...] cannot be separated from the quality of living spaces and not secondarily of open space, particularly in urban contexts. Insights from research in different disciplines can be translated into actions that will improve health as long as a holistic and transdisciplinary approach is taken that is geared towards health and the perceived quality of living in the city: from biology to medicine and social and healthcare assistance, transport planning, urban design, landscape architecture, environmental protection, the design of spaces in the city and multimedia communication» (Maspoli, 2018).

Such an approach must allow for the vision of urban health to shift from an anthropocentric perspective to an eco-centric one capable of enabling the joint evolution of human health and urban environmental health. In this way, «even when it comes to environmental impacts, cities are not only places of consumption and pollution, but hubs that give rise to creative and innovative solutions for transport, energy, education, econom-

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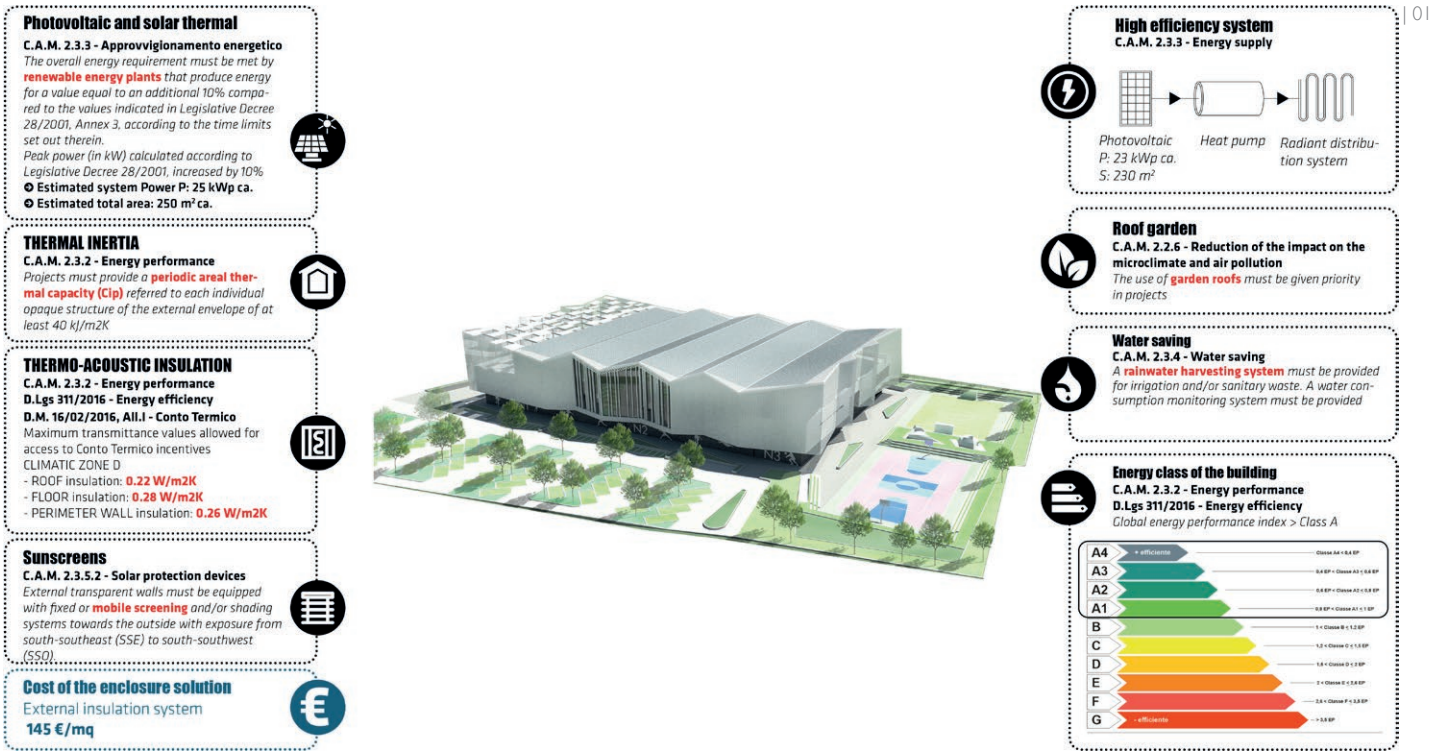
ics, housing or food systems. Such a shift from health in urban environments to healthy urban systems could change scientific and policy agendas, create benefits from connecting urban and planetary health, and have a major impact [...] to achieve sustainable development on an urban planet» (International Science Council, 2024).
Cities are thus defined as complex living systems that must be healthy to sustain healthy human lives and a healthy planet. Urban, human and planetary health are, therefore, connected. The various urban sectors, including housing, transport, the natural environment, the built environment, and the health and cohesion of the inhabitants, all become determinants of "urban health", such that the health of an individual depends on the functioning of cities and is the key to making a crucial contribution to the sustainability of the entire planet (Corburn *et al.*, 2020). Following this logic, interventions that modify the built environment to encourage physical activity among citizens also play a crucial role. In fact, «physical activity also boosts our mental health and the sense of well-being. The options for physical activity are not limited to indoor facilities [...]. There are also outdoor options, where our activity level to a large extent is determined by the environment, we move in. [...] All in all, beautiful, exciting and safe environments encourage movement, and hence, the design of the urban environment is essential for citizen's level of physical activity» (Danish Health Authority, 2020).

Innovative technological design for a sustainable and decarbonised built environment

In redevelopment processes that seek to integrate aspects of health and inclusiveness, the promotion of «multistakeholder partnerships to generate urban policies that, based on studies on the impact of health determinants in cities, can give rise to "smart" actions aimed at reducing health risks and promoting a healthy and inclusive urban environment» (Occhiuto *et al.*, 2023) is one of the objectives to be pursued. Citizens and administrations, within their different remits, should share the idea of public health as a resource by supporting and promoting policies geared towards the redefinition of new urban habitats. New living contexts in which work affecting the complex system of buildings and open spaces plays a key role in interpreting and guiding the changing needs of the community.
Urban densification phenomena, accompanied by the expansion of the built environment, have produced a sharp decrease in spaces dedicated to community activities and pedestrians and, in particular, in green spaces *pro capite* (James *et al.*, 2009). These are a limited resource, especially if we consider that many people live in urban areas where distances to green spaces increase, reducing the possibility of their frequent use. This inevitably causes a critical issue in terms of daily accessibility to open spaces and, in general, to places for the community, with repercussions in various areas such as health and social and environmental contexts (Barton and Pretty, 2010).
Public interventions that are attracting a lot of attention in Europe, and fortunately also in Italy, for their role in serving the community, include urban spaces designed for the development of user health. In the context of urban redevelopment interventions for the growth of well-being in our cities, these places, especially when dedicated to sports, can become the object of social and environmental experimentation for the benefit of the entire community.
The recent development in the academic field of research on the design of places for education and the health of users has increased significantly. This has encouraged direct dialogue between the world of research and regional administrations, giving rise to extensive experimentation with a vision of the project that addresses the theme of urban transformations from an environmental perspective to create a healthy city. This goal has the additional consequence of creating sustainable development models that are effective for the challenges urgently demanded by the changes taking place.
Approaches capable of interpreting cities as places of experimentation where the transformation of what already exists is implemented according to an evolutionary and incremental rationale aimed at innovation, with effective and sustainable interventions capable of redefining a new local identity, improving the community's environmental quality, health and well-being.
A series of experiences carried out at the University of Florence about urban redevelopment and the built heritage towards zero-energy buildings have confirmed that the sports infrastructure sector has great potential for research, experimentation and innovation, even if it is lagging. This is the case of the work developed from an active convention between the University Florence and the Municipality of Pistoia[1] to promote redevelopment actions for the definition of guidelines for an eco-compatible integrated design of healthy and inclusive environments (Fig. 1).
The study focused on the development of intervention strategies for areas to be redeveloped located on the edge of the densified city, and as an experimental case study, identified on the conversion of a devalued area into a sports/recreational area with a related project for a new Sports Hall (Fig. 2).
In the feasibility study phase, the research first defined a broad frame of reference consisting of paradigmatic examples that were analysed about the specific themes of increasing environmental and social resilience, defining adaptability/flexibility of the built environment's lifecycle, including through the

01 | Intervention strategies at area and building level according to Minimum Environmental Criteria – CAM, credits Antonia Sore, Elisa Belardi, Antonio De Pascalis

02 | Building-scale project objectives for the Sports Hall, credits Antonia Sore, Elisa Belardi, Antonio De Pascalis



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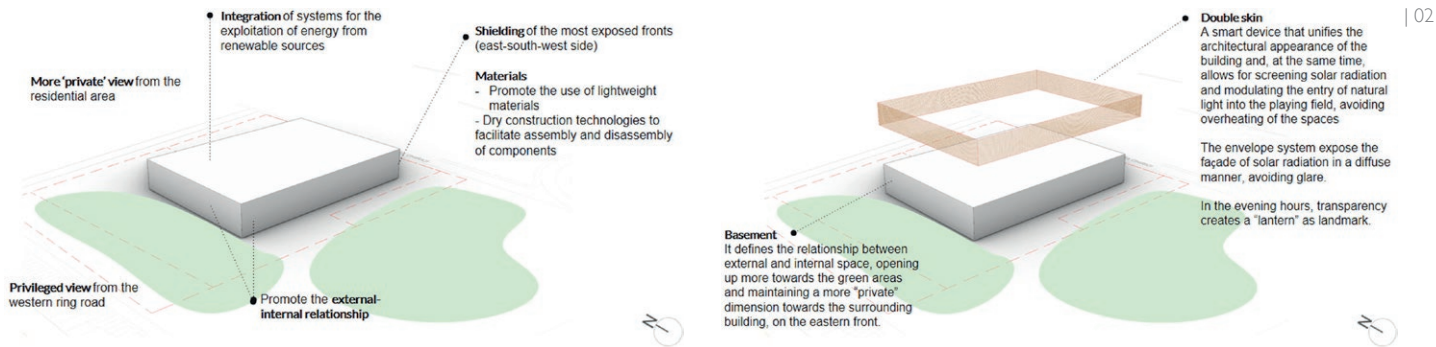

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introduction of technological and environmental innovations. Examples such as the planned social conversion of the sports infrastructures built for the 2014 World Cup in Brazil, the basketball stadium built for London 2012 that can be completely dismantled and recycled, or the sports areas of the "Stade de Suisse" for Berne 2005, or the Antalya Arena in 2015, with the largest renewable energy infrastructure and, finally, the use of innovative lightweight construction technologies and materials with high presentation (e.g., the ETFE used for the first time in sports buildings for the World Championships in Japan and Korea) (Allegri and Vettori, 2018), provide a complex reference framework on which to establish and implement, in the local setting of the Municipality of Pistoia, the innovative proposals for redevelopment of the intervention area.

A case study on the redevelopment of a suburban urban area shed light on local practices to enhance degraded urban spaces, the impacts of interventions, and the integration of health and equity aspects in the urban planning processes of the Municipality of Pistoia. The trial conducted aimed to provide tools for a local approach to support municipalities in deepening their understanding of how to implement effective and sustainable interventions in degraded urban spaces, and thereby provide optimal benefits

03 | Functional organisation of the outdoor areas with the identification of places for recreational/sports activities to serve the city, credits Antonia Sore, Elisa Belardi, Antonio De Pascalis

03 |

for the whole local community. It was an opportunity to increase activity levels and support citizens to lead healthier lives.

The key points addressed in the experiment were (WHO, 2024):

- the promotion of strategies/policies geared towards re-defining new "active" urban environments starting with the shared concept of public health as a resource;
- a project approach that contemplates the physical characteristics of the intervention while respecting the requirements of the users and the vocation of the area;
- the creation of a significant public place with a distinctive character in order to enhance its environmental and cultural features to create place identity;
- the creation of "connective" places between the interior and exterior, and between the built environment and green areas, for the development of sports activities with characteristics of high sustainability and efficiency;
- the development of good practices for community involvement and close collaboration with stakeholders.

From a strategic point of view, the objectives thus defined were widely shared and discussed with the public administration, and were based on a sustainable design approach. Choices were made that led to more solutions in keeping with and that responded to the environmental cognitive framework of the context. The aim was to redevelop the entire area with large green spaces dedicated to outdoor activities, as flexible spaces to promote the health and well-being of users, and to design a new sports building with high sustainability and energy efficiency standards, in line with national and EU directives on nZEB buildings (Peluchetti *et al.*, 2022).

The scenario that emerged from the preliminary investigation phase thus indicated three fundamental macro-themes for this project:

1. Sustainability and the reduction of the environmental impact with choices aimed at minimising the ecological footprint of the work, in terms of both energy consumption and the production chain of materials used;
2. Passive strategies for the environmental control of both the open space and the building with technological-compositional solutions capable of maximising and enhancing their effects to ensure indoor and outdoor comfort;
3. The use of renewable sources and energy sustainability to achieve the energy independence of the sports complex.

The project integrated and verified the incorporation of strategies aimed at establishing the correct balance of soil permeability in compliance with current regulations with the restoration of green areas. It also directed the choices for the construction of a building attentive to the reduction of consumption, resource optimisation and the promotion of adequate levels of indoor comfort.

The outdoor space was structured into three different functional areas, indoor, outdoor and hybrid, defined by the system of footpaths, which qualify as an integral part of the functional programme of the sports complex. Insofar as directly connected to the indoor space, they can be easily equipped and reprogrammed to accommodate different types of activities of a recreational-sporting, leisure and social interaction nature (Fig. 3).

The design and layout of the green system presents an outdoor area enclosed between the boundary of the lot and the building,

04 | Environmental sections with the identification of technological and material choices for individual areas, credits Antonia Sore, Elisa Belardi, Antonio De Pascalis

which is healthier and perceived as safe and welcoming by users, a space set up, in continuity with the sports hall building, to host recreational and relaxation activities suitable for families and non-competitive activities to be carried out independently. The arrangement of the paths and the discretisation of the outdoor space according to functionally independent areas make it possible to propose its use also by external users, especially in the summer season, as well as at the end of and/or during ongoing sporting events, at times and days other than those when the facility is open, favouring the appropriation of these spaces by citizens (Fig. 4).

The compositional choices made for the design of the Sports Hall were based on the presence of a single compact building to minimise the footprint on the ground and exploit the outdoor space in order to integrate the recreational/sports activities, structurally and functionally divided into three sections,

05 | The entrance to the new 'Palamaltinti' Sports Hall in Pistoia, credits Antonia Sore, Elisa Belardi, Antonio De Pascalis

05 |

namely a central one containing the full-height playing field, and two lateral two-level ones housing all the additional functional areas necessary for a building of this type (changing rooms, equipment room, etc.).

The insertion of a double shell to protect the building from overheating in the summer months achieves two further objectives defined in the preliminary meta-design phase:

- Make the entrance recognisable by distinguishing the main façade through the design and planning of the cladding pattern, and qualify the space in front of it as a place for waiting, meeting and interaction between spectators at events and the ordinary users of the sports hall (Fig. 5);
- Integrate technological choices with regulatory dictates so that they become the key to understanding and an opportunity to test architectural-compositional solutions that enhance innovation, testifying to the virtuousness with which the building uses and manages the context's natural resources.

By integrating much of the existing greenery with the addition of new vegetation, the project aimed to preserve the existing ecosystem and urban landscape. All these aspects facilitated the integration and visual impact of the huge transformation of this area, making the project more sustainable, resilient and integrated into the urban landscape.

Integrated approach and operative synergies

The narration of this direct experience in the field highlights the potential impact generated by the project as a driver for the development of the territory in a "Healthy City" perspective, expressing a strong capacity for social inclusion and functional and spatial qualification (Corburn *et al.*, 2020). In particular, the project outcome contributes to the generation not only of economic value in transforming places, but also has a significant impact on society in terms of improving the quality of the built environment and the well-being of the community (Tjallingii, 2015).

The strategic aspects that characterise the urban transformation intervention presented, both at the level of methodological design and from the point of view of the policies implemented, suggest a synthesis reflection that highlights its potential in terms of new spatial-functional configurations, its capacity to generate positive effects, and the opportunity to create synergies between different operational realities (Roos, 2021).

The intervention, as a regenerative approach for the community, is configured as a tool both to improve compromised contexts and to create inclusive environments to combat inequalities, including those related to health, by proposing, in this specific case, places where physical activity is accessible to all (Danish Health Authority, 2020).

This is in line with the principles of the approach known as Active Design, which emphasises the strategic importance of «places and spaces which encourage people to move more, with more opportunities for everyone to increase their activity levels and lead healthier lives» through the creation of «network of multifunctional [place and] open space [...] across all communities to support a range of activities including sport, recreation and play [...]» (Sport England, 2023) considering not only the right size but also the right location to increase awareness and visibility of the activity.

The project, which shares the idea of collective health as a resource, promotes strategies aimed at redefining new "active" urban environments by working on the capital network, «constituted by the set of spaces, facilities and services of the public city, integrated by the elements of the environmental system» (Alberti and Radicchi, 2023). By reactivating unused spaces for the benefit of the community, the urban transformation intervention was studied to increase multifunctional services redeveloped in a sports key, and to increase of the plant-based component to improve environmental performance. It activates reconfiguration processes that start from the built environment and extend to the relevant spaces, intercepting additional places of proximity (Alberti, 2020). A proximity that, given the marginal location of the project concerning the urban fabric of the municipality of Pistoia, can be interpreted not so much in a physical sense but rather «as a new model of urban well-being, reflected in "responsible" planning – summarised in the notion of civic design (Scott Brown, 1990; Alberti, 2020) – capable of responding in an integrated and creative way to social, environmental and functional needs, making the best use of available human, spatial and economic resources» (Alberti and Radicchi, 2023).

The paper, which presents the results of an experience carried out in synergy with local authorities in the area, provides an opportunity to reflect on how architectural and technological research in the environmental field can interact with professional expertise in favour of responsible design to enhance the environmental component and promote the key to technological innovation in our territories.

The results of this activity, developed in partnership with the University within the framework of a memorandum of understanding, are a strategic experience for the PA both because this experience looks to new lines of research, also within the framework of the financial support of the European Commission, and because it envisages the enhancement of the territories directly involved.

This is one of the key aspects of the work presented, precisely to reduce the distance between the research context and the territorial situation capable of concretising its results. The aim is to enhance the research, whose wealth in creating innovation lies in the strength of the networks between local bodies (universities and local authorities) and the entire business world, as well as stable collaborations between producers and users.

Lastly, the case study presented demonstrates the effective overcoming of limitations related to the difficulties of dialogue with public administrations and/or institutional figures outside the academic world, outlining how, in a rather critical economic, cultural and environmental scenario, there are margins for the successful transfer of knowledge through operational experimentation.

The highly operational and site-specific character of the project presented may constitute a limitation from the point of view of its replicability in contexts with different socio-economic and environmental peculiarities. However, the design process adopted and based on a demand-performance approach centred on the characterisation of the framework of requirements and contextual constraints of a programmatic, technical and environmental nature allows for the provision of responses articulated and differentiated according to the different inputs through the adoption of systemic strategies and related compositional, functional and technological solutions (Leone and Raven, 2018).

NOTES

[1] Research Agreement (2018/2022) under art.15 of Law no. 241 of 7/8/1990 between the University of Florence – Department of Architecture – ABITA Interuniversity Centre, and the Municipality of Pistoia "Towards Zero Energy Buildings. Redevelopment of the existing building heritage: guidelines for public administrations".

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The eco-sustainable renovation of knowledge buildings through a cross-border living lab

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Abstract. Sustainable building management requires creative interpretation of direct user needs, a skilful balance between technological innovation and applied research into the concept of "Possible Quality". Med-EcoSuRe research project proposes a pragmatic approach to innovation, whereby experimentation involving the active engagement of end users is conducted with particular focus on human-environment centred design. The objective of this approach is to disseminate effective energy efficiency strategies in university buildings through a cross-border Living Lab. Physical and virtual tools were implemented to foster dialogue and collaboration between academics, decision-makers and stakeholders, and to support university energy managers in planning and implementing innovative energy measures. This paper, starting from a rapid illustration of the results of the research project, illustrates the value enhancing actions post-closure of the project, in progress and/or planned.

Keywords: University building; Cross-border living-lab; Energy retrofit; Human-environment centred design; Perceived comfort.

Introduction

This paper explores the eco-sustainable retrofit of university buildings through an innovative approach based on a cross-border Living Lab. It reports the main results of the Med-EcoSuRe project with the aim of presenting concrete energy and environmental retrofit strategies applied to knowledge buildings, with a focus on participatory methodologies involving users, academics and policy makers.

The methodology adopted in the article is based on direct experimentation in real world contexts, supported by digital tools and collaborative platforms such as MedBeXLive, which facilitate knowledge exchange and the harmonisation of energy retrofitting practices. The Living Lab approach integrates end-user perspectives into the decision-making process, combining technological and perceptual analyses to optimise the effectiveness of interventions (Karrer, 2022).

The findings presented in the article highlight the value of the Living Lab model for university building retrofitting. In particular, the study illustrates the performance of innovative technological solutions, including the use of digital twins (Clausen *et al.*, 2021), energy performance monitoring through IoT, and the testing of retrofitting strategies. The case study of the Solar Carport, for instance, demonstrates how the implementation of photovoltaic systems can generate significant energy and economic savings, with a payback period of less than four years. At the same time, an analysis of user-perceived comfort in university environments provides strategic insights for designing more sustainable, high performing spaces. By adopting an integrated and replicable approach, this study contributes to the broader debate on the energy transition of public buildings, proposing a model based on co-creation and rea world experimentation.

Below, the researchers from the Units involved in the project illustrate the strategies adopted, the methodologies tested, and the results obtained in the context of the eco-sustainable retrofitting of university buildings, highlighting how these have been concretised in post-project improvements that are either underway and/or planned.

Creating an innovation network

Med-EcoSuRe (Mediterranean University as catalyst for Eco-Sustainable Renovation) is a project funded by the European Union through the ENI CBC Mediterranean Sea Basin Programme 2014-2020[1]. The project considered universities the most fertile ground and space to grow open innovation, to experiment with new processes and solutions providing proofs of concept and giving the possibility to educate towards more sustainable building renovation.

A university-based Cross-Border Living Lab (LL) was established to support these efforts. The Lab was designed to address and overcome the fragmentation often observed in renovation processes, particularly within Mediterranean university buildings.

This inclusive approach enabled the university community (energy managers, decision makers, academics, end users) to contribute to co-create the renovation process (Karrer, 2022) and to achieve the common goals of more sustainable university buildings in terms of Energy Efficiency, environmental impact, well-being and aesthetics, as well as increased environmental awareness of users.

The Mediterranean Renewable Energy Centre (MEDREC), a cooperation centre based in Tunisia, initiated and facilitated the establishment of a cooperation network between public and private partners from Tunisia, Italy, Spain and Palestine, promoting the transfer of knowledge on the renovation of university buildings in the Mediterranean region. The partnership of the project includes four universities, an Agency for Energy and Environment and an Association for the Internationalisation and Innovation of Solar Companies.

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01 | The space BeXLab, University of Florance

01 |

Med-EcoSuRe supported the use of an ICT platform – MedbeXlive[2] – which is an *agora* that allows rapprochement and dialogue between all actors concerned by the university building's energy efficiency. This platform facilitates cooperation and co-creation in the Living Lab community, the sharing of methodologies and results, and promote the adoption of sustainable renovation practices through workshops and seminars.
The platform is operational, providing a common ground for future cooperation, and replication of the results by:
– creating exchanges between all the registered actors, and facilitating the emergence of new projects (industrial, research, etc.);
– creating cross-border working teams around specific projects.
To ensure the sustainability of Med-EcoSuRe, a charter for the Mediterranean Cross-border LL was signed by the project partners enabling to exploit and capitalise on the LL results beyond the project lifetime. An action plan for the next five years is included defining the activities to be carried out jointly. This signed charter gives a formal status to the LL, which allows better exploitation of its results.

From the Med-EcoSuRe project to the Mediterranean Cross-Border Living Lab (MCbLL): the method

The core concept of the Med-EcoSuRe project was to envision universities as living Labs to experiment and pilot innovative and eco-sustainable renovation strategies and approaches for Mediterranean public buildings.
As collaborative ecosystems for open innovation and experimentation, based on collaboration between stakeholders (academia, companies and institutions), and enhancing the importance of the user experience in real-life settings, the Living Lab approach has been selected as the best methodology to address the complexity of building renovations in the Mediterranean region.
In the context of the project, the University of Florence was responsible for developing a dedicated methodology to exploit Living Lab for the renovation of university buildings, resulting in a two-level structure, precisely a cross-border level and a local level.
In the first case, a cross-border LL entity to connect local Living Labs in Mediterranean universities, called Med beXLive, has been defined for the exchange of best practices, sharing of knowledge, and harmonisation of tools to conduct joint research. Initialised by the network of project partners, experts in the field of building energy renovations, the cross-border Living Lab addresses region-specific climatic and cultural challenges to develop scalable and replicable renovation models, linking innovation with education to promote long-term sustainability goals for the Mediterranean area. Its strategic objectives and operational functioning have been fixed in dedicated guidelines, culminating in the creation of an online digital platform (Fig. 2) to share its activities.
At local level, as places of education, research, and technological advancement (Torricelli, 2017), university buildings can become the physical place of Living Lab (Fig. 1) where researchers, facility managers, stakeholders (innovative companies or public


temperature
humidity
illuminance
thermal fluxes
CO2
'central brain' of the monitoring system
external weather station
real-time monitored data
navigable BIM model
single sensors data
Lux
Irraggiamento
Umidità

03 | The new campus in Nablus: a. PV campus; b. PV carport system; c. PV plants: control and monitoring operations

organisations), and end-users can work together to explore innovative approaches, methods and technologies for building renovation, to test and evaluate in real-world pilot projects. The engagement of students as end-users is particularly strategic, fostering their understanding and awareness of sustainability challenges and solutions, in a long-term perspective.

Given the innovative nature of university Living Labs for building renovation, a toolkit has been delivered as project output to provide a step-by-step guide for setting up and experimenting with innovative renovation processes in pilot actions.

The local Living Lab activated in the University of Florence specifically focused on the experimentation of Digital Twin technologies (Clausen *et al*., 2021), exploring BIM (building information modelling) (Shahzad *et al*., 2022) and real-time data from IoT sensors for the development of the pilot renovation action (Rinaldi *et al*., 2020) in the university building. The experience of the advanced collaborative environment consented to spread awareness and knowledge among the academic and local community on the opportunities and challenges of the twin digital and green transition, resulting in the quality of the pilot project developed.

The case study of Solar Carport – Fine Arts Faculty – New Campus

ANNU through Med-EcoSuRe project carried out implementation of solar PV carport system in the new campus in Nablus (Fig. 3) to reduce annual energy consumption. The idea of the solar garage came up as part of the university's constant endeavour to increase the coverage of solar cell systems for the university's total consumption by exploiting the spaces (Violano *et al*., 2021), and the university's desire to spread new ideas for the implementation of solar energy projects.

Tab. 01 | Real monthly energy output of 280 KWp PV systems

Tab. 01 |

Month	Energy Output (MWh)
January	25.21
February	26.88
March	29.40
April	34.44
May	40.32
June	47.88
July	61.32
August	68.88
September	70.56
October	63.84
November	45.36
December	40.32
TOTAL	554.41

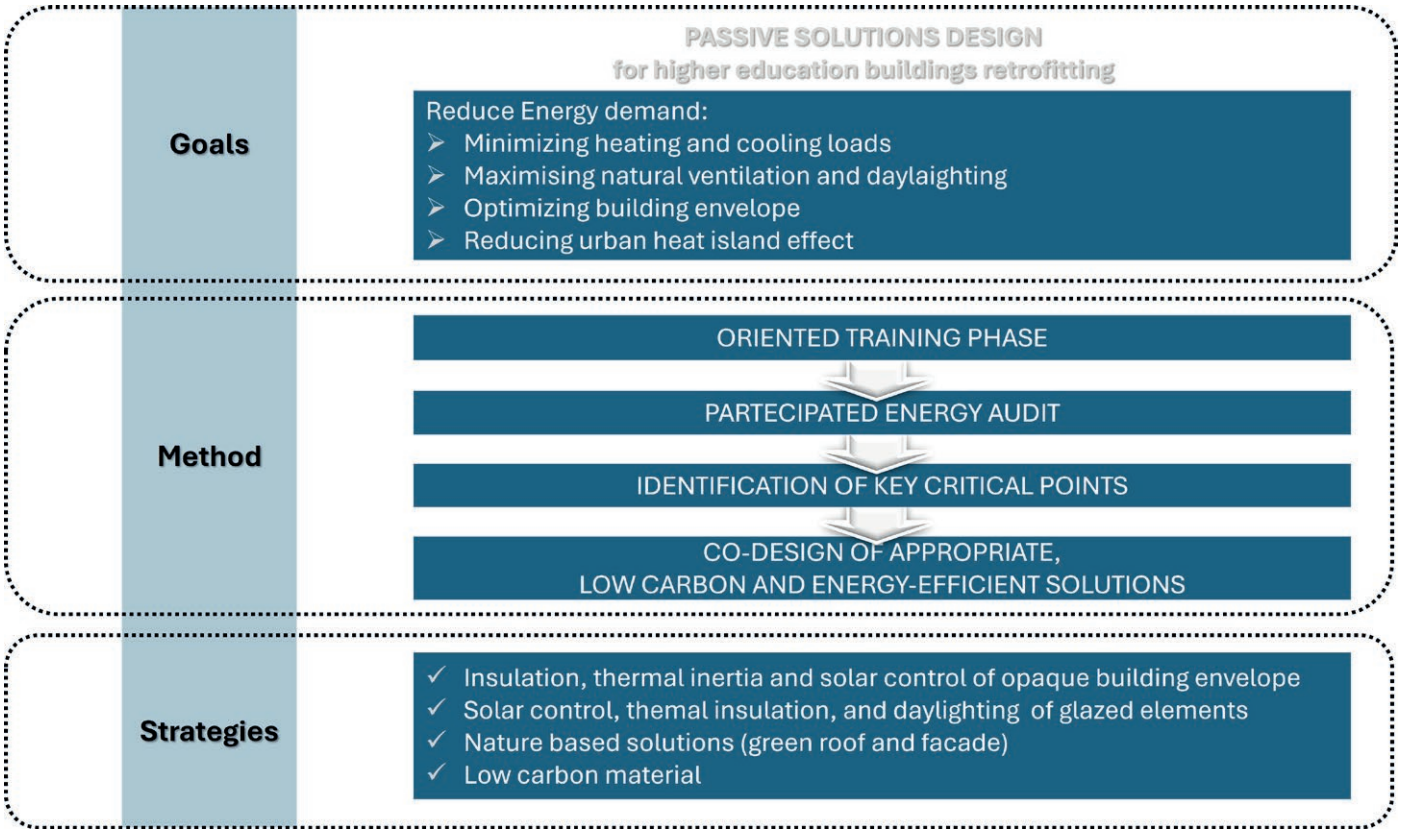
The analysis is based on real time data collected through a monitoring portal[3].
The results show that the photovoltaic plant performance depends on both insolation and environmental conditions.
According to radiation data in the area, the real output yield from 280 KWp PV systems on the rooftop of university buildings was given in Tab. 1.
The efficiency of photovoltaic (PV) systems measures the system's ability to convert sunlight into usable energy for load consumption. For the analysed periods, the system efficiency, calculated as the ratio of the output energy of the PV system (MWh) to the global radiation energy received by the PV array area (MWh), was 20% in 2022 and increased to 21% by August 2023.
The Performance Ratio (PR), which indicates the proportion of actual energy generated by the PV system compared to its energy production under standard test conditions (STC), was calculated as 86% for 2022 and improved to 91% by August 2023.
The Final Yield (Y_f), a measure of the number of hours the system operates per year or day, is determined by dividing the actual energy generated (MWh) by the maximum capacity of the PV array (MW). Over the operational period, Y_f was estimated at 2.951,82 hours, with an average solar hour availability of 5,42 hours per day.
The Capacity Factor (Cf), which varies quite a bit for solar photovoltaic systems depending on the location, reflects the ratio of actual energy generated to the theoretical maximum possible energy (calculated using the PV array maximum capacity in kW and 8.760 hours per year), was found to average 22,6% during the analysis period. This value aligns with the expected range of 10-25% for solar photovoltaic systems, where the variability is influenced by geographical and climatic conditions.
Regarding the performance result analysis, the environmental and economic appraisal reports that the CO_2 emission and electricity bills will be reduced annually according to how much energy is produced by the PV solar system since system operation, as specified below:
– the electricity bill will drop by €83.161in 2023;
– CO_2 emission will drop by 388 tons CO_2.
From an economic perspective, the investment in the PV system demonstrates a strong financial return. With a total investment cost of € 254.678,00 and annual savings of € 83.161,00, the simple payback period is calculated to be 3,06 years. This relatively short payback period highlights the cost-effectiveness of the PV system, reinforcing its value as a sustainable energy solution with tangible economic and environmental advantages.

Software simulation tool for energy retrofit

At present, actions for the rehabilitation of cities, districts and buildings are being promoted for tertiary as well as for residential buildings. However, the complexity of assessing the energy savings achieved, with enough certainty, is well known after energy efficiency improvement measures (or even worse, a combination of them with cross effects) are implemented. The tendency is to solve this issue by using an either detailed or simplified building energy performance simulation tool. Nevertheless, the estimation of the energy consumption made by these tools differs from the measured values, either due to the case definition or the assumptions considered. In the framework of project Med-EcoSuRe we have a proposal for solving both above-mentioned problems, precisely to use a simulation tool which has been corrected with climatic data and consumption measured data.
The main development work is the correction of the simulation tool using consumption data meters installed in the building, so this development is tested in three buildings and the paper (Sánchez *et al.*, 2018) shows the results of one of them. The benefits presented by this tool are the result of the previously conducted research, which focused on the automated generation of baselines through which the estimated energy situation made by the tool and the real measurement can be corrected. These baselines are stated in terms of the main energy parameters, which define a building. They are thus converted into a diagnostic protocol with which energy indicators and the expected reference values can be compared. This methodology shows the outcome of the optimal rehabilitation project in economic and energy terms.
The tested method offers direct users the opportunity to make judgements on both the building's performance (hardware system) and the way spaces are used (software system), in order to maximise comfort and minimise the use of resources. The software allows the introduction of energy saving measures, taken from a previously studied catalogue. It is possible to analyze the measures that will be used to improve energy efficiency, which implies significant modifications or substitutions in equipment, components, or systems, either referring to the elements of the enclosure or those of the facilities.
The improvement measures are developed in such a way as to provide, for each of the selected interventions, various levels of improvement (previously optimised).

04 | One of the projects developed during the International workshop "Energy Efficiency Action Plan in the Higher Education Building Sector" (Coord. A. Violano. Designers: N. Franzoso, V. Ignarra, L. Fejjari, D. Raucci, S. Argui)

04 |



Analysing the activities carried out as part of the research project and the results achieved, it emerges that the developed tool presents a relevant advantage with respect to the existing tools, since it corrects the results of the building simulation tool through actual consumption measurements. The uncertainty of using software tools to analyse the energy performance of buildings is thusreduced.

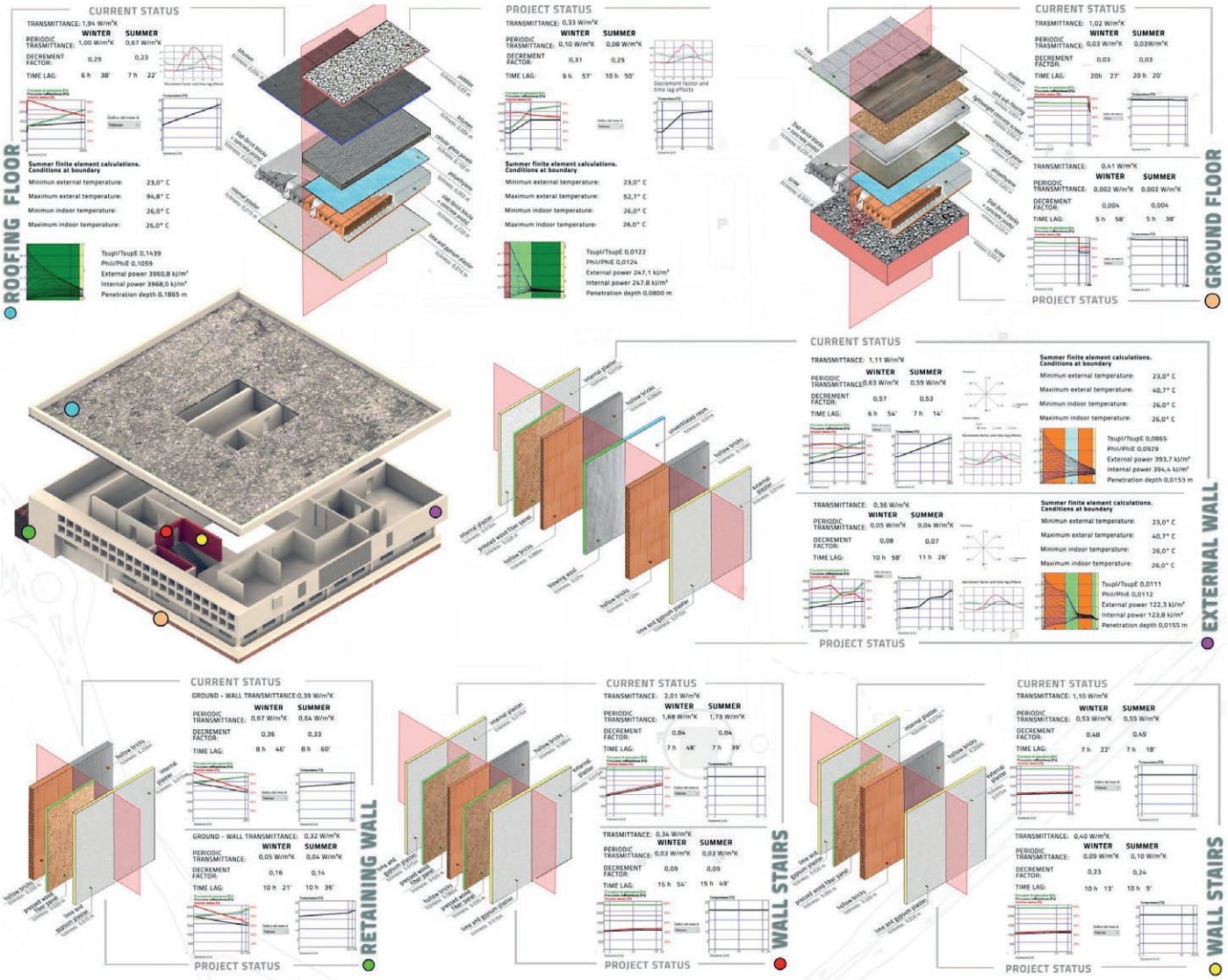
Unlike the energy performance of building simulation tools and their intricate calibration methods, a new way of correcting the results depending on the climate, actual measured consumption and characteristics of the building has been developed. More than three buildings are measured in the project, and they are used to test the software.

Finally, the software tool has an easy interface and moderate computational expenditure.

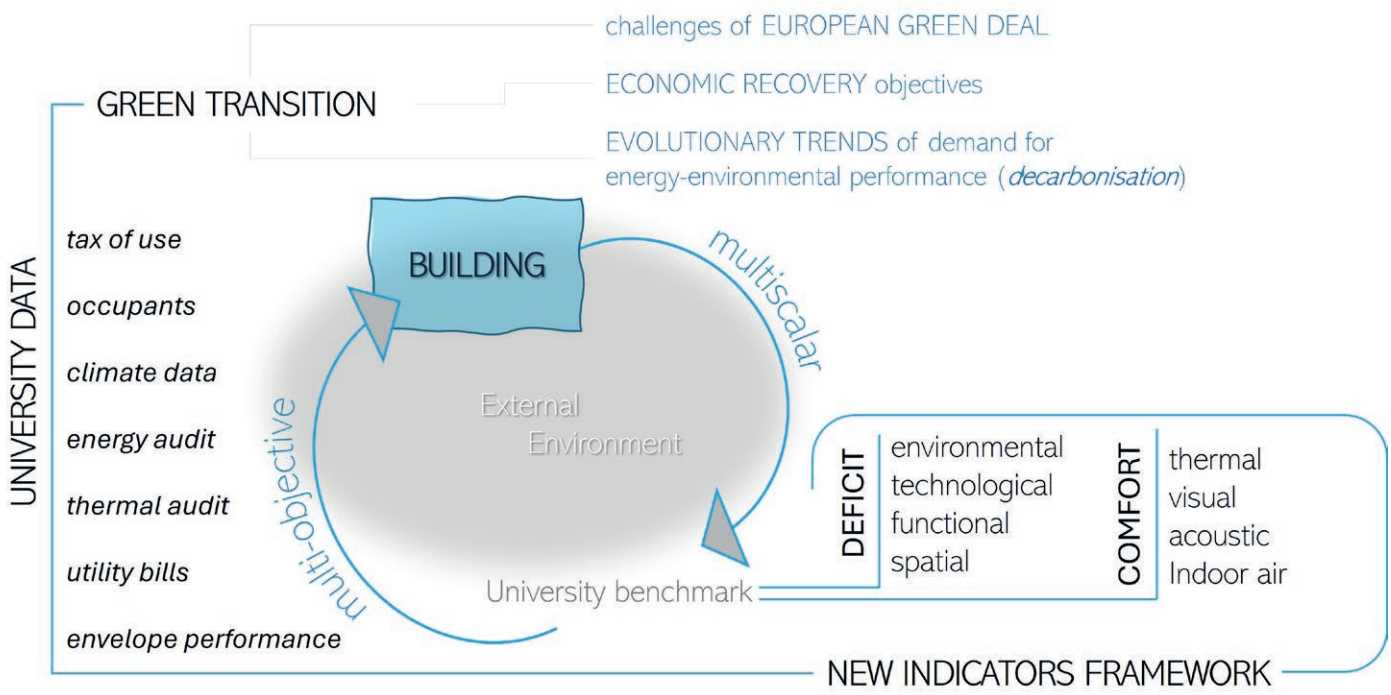
The value of International Workshops for Training and Research

The energy efficiency of public buildings has been identified as a strategic priority for achieving the 2050 decarbonisation targets in line with European directives. The retrofitting of university buildings serves as an example, both in terms of its positive environmental impact and its educational function, which engages students in innovative teaching and design experiences. In the Med-EcoSuRe research Project, UNICAMPANIA-DADI organised the international workshop "Energy Efficiency Action Plan in the Higher Education Building Sector", involving fifty-three students and ten tutors from partner Universities (Italy, Tunisia, Palestine), to provide theoretical and practical training on energy efficiency and to trigger interactive mechanisms for the co-design of high quality energy and environmental technological solutions specific to the Mediterranean climate (Fig. 4).

Starting with the stated goals of reducing energy needs, a priority action in the implementation of the nZEB methodological framework (Crespo Sanchez *et al.*, 2023), the layout of the workshop (Fig. 5), provided an initial training phase to share a common methodology necessary to make informed decisions on context-appropriate and sustainable renovation actions (Osterreicher, 2018). In the following phases, a Participatory Energy Audit (Violano *et al.*, 2021) aimed at assessing overall conditions and energy and environmental performance of the build-


ROOFING FLOOR
CURRENT STATUS
PROJECT STATUS
GROUND FLOOR
EXTERNAL WALL
RETAINING WALL
WALL STAIRS
CURRENT STATUS
PROJECT STATUS
SOUTH, EAST, WEST
NORD
HINGED DOOR WINDOW
THREE-LEAF SLIDING WINDOW
FLIP WINDOW
PERFORMANCE
REFERENCE BUILDING
DM 26/6/2015
roof
U: 0,35 W/m²K
window
U: 3,00 W/m²K
ground floor
U: 0,35 W/m²K
external wall
U: 0,43 W/m²K
PROPOSAL OF SHADING DEVICE FOR SOUTH FACADE AND TO ENSURE AN ADEQUATE NATURAL VENTILATION.
NORTH
SOUTH
STUDY OF DAYLIGHT - VELUX

06 |



ing, led to the identification of the main critical points. Passive design strategies, appropriate to the specific contexts and user needs, were derived from the analysis through an active and dynamic comparison between students of different nationalities. Technological solutions are aimed not only at improving energy performance in the operational phase, but also at reducing environmental impacts in the life cycle, preferably using local low carbon materials and Nature Based Solutions (green roofs and façades) that can also benefit the surrounding context (e.g. reduction of the urban heat island), in line with decarbonisation goals for the building sector.

These events, which saw students and lecturers in the dual role of stakeholder and designer, introduced advanced design methodologies and technological tools, tested on pilot university buildings in the Mediterranean, but replicable in similar environments, integrating academic research with professional practice in different climatic and cultural contexts.

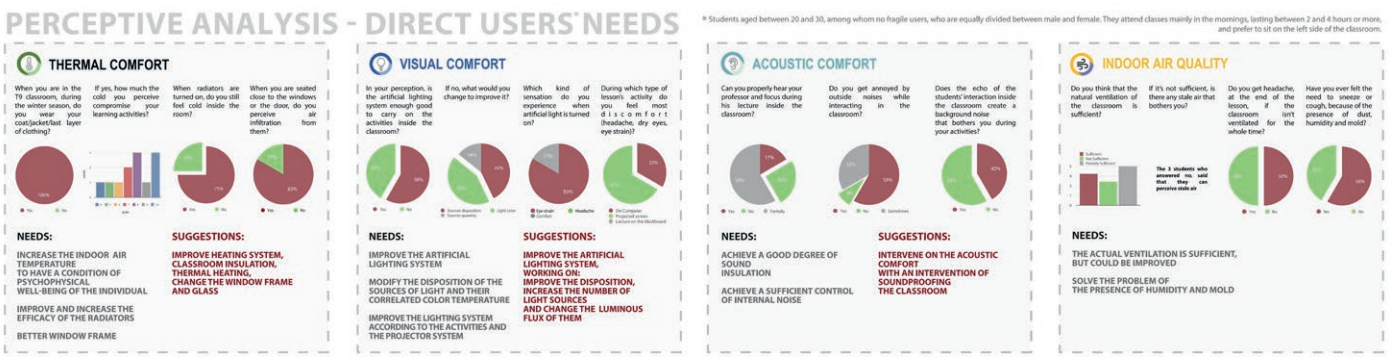
Renovation projects require a holistic approach that goes beyond the mere reduction of energy demand, and considers climatic conditions, indoor environmental comfort, embodied carbon and life cycle environmental impacts, without neglecting functional and spatial quality, involving stakeholders to effectively identify and address goals (Kamari *et al.*, 2017).

The direct involvement of students and academic staff in the rehabilitation of university buildings not only contributes to defining of effective technological solutions but also fosters cultural and behavioural change post-intervention, thereby strengthening the long-term success of decarbonisation strategies (Ahmed *et al.*, 2021).

Living Lab: a collaborative space for "sustainable energy Retrofit" and stakeholder engagement in university buildings

The MCbLL is not only a physical space for monitoring energy performance and evaluating the quality of the indoor environment in university buildings, but a virtual space for the involvement of local stakeholders (Evans *et al.*, 2015) in the evaluation of innovative solutions, improving the perception of opportunities offered by energy efficiency (Calcagno *et al.*, 2023; Trombadore *et al.*, 2023).

In addition to innovative pilot projects, Med-EcoSuRe ensures consistent and long-term stakeholder engagement, emphasising the participatory process and user-perceived comfort. «The most effective way of characterising living labs is probably to analyse actual experiences, and how they evolved over time» (Ballon and Schuurman, 2015). The Living Lab implemented by the UNICAMPANIA-DADI team tested the "Energy Friendly Retrofit" approach (Fig. 6) by combining user involvement (Ahmed *et al.*, 2021), experimentation in real-world contexts (Nansen, 2024; Quevedo *et al.*, 2024) and co-creation (Longoria



et al., 2021), which are useful for developing performance indicators and renovation strategies that promote well-being and environmental quality.

The LL, finalised to test the energy and environmental retrofit strategies for university buildings (according to MCbLL), has evaluated the measured and calculated quality of the energy consumption and performance of a university classroom (Phase A), in comparison with the quality perceived by students in relation to the comfort conditions experienced in this physical space (Phase B).

The case study is a university classroom located in climate zone C, with a useful surface area of 76 m^2 and a heated volume of 418 m^3. In Phase A, the technical characteristics of the envelope exhibited notable deficiencies. The south wall, constructed with 71 cm thick tuff blocks, demonstrated a transmittance of 0,78 W/m^2K and a time lag of 24 hours, effectively attenuating heat flow. However, the west wall, despite having a lower transmittance of 0,47 W/m^2K due to its greater thickness (121 cm), has a lower time lag (18 hours), indicating less effective performance in terms of thermal stability. The roofing slab, constructed from girders, hollow blocks and bituminous sheathing, was identified as a particularly critical component, exhibiting a transmittance of 1.44 W/m^2K and a time lag of only 7 hours. This proved to be the primary source of thermal dispersion within the structure. Additionally, the floor slab, with a transmittance of 1.75 W/m^2K, was determined to contribute considerably to the overall energy loss.

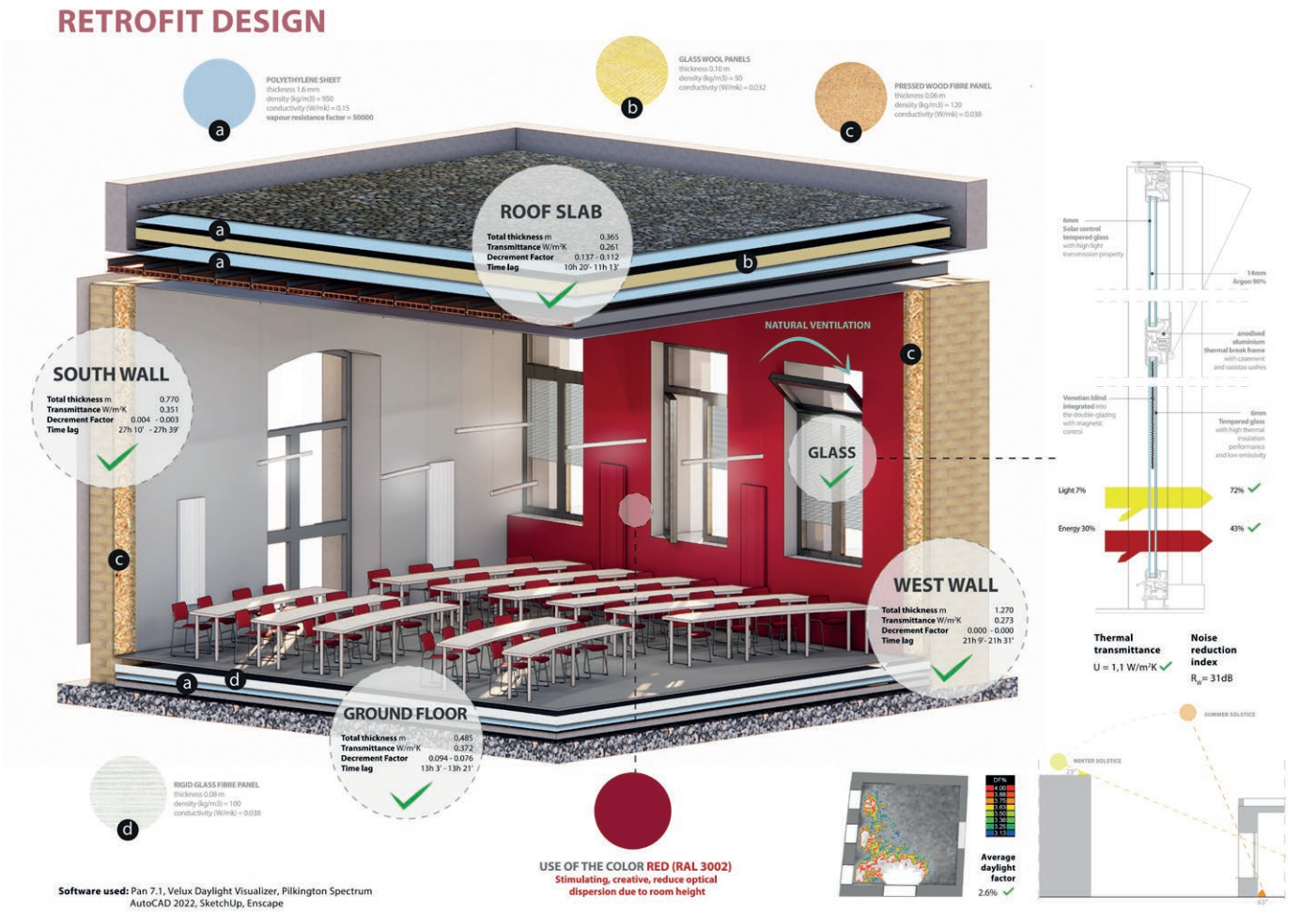
Phase B was conducted in parallel with the technological analysis. A questionnaire was administered to a sample of 100 students, regular users of the classroom, to evaluate perceived comfort (Fig. 7). From a thermal point of view, the data showed that 100% of the respondents wear an overcoat in the classroom during winter, indicating the inadequacy of the envelope and heating system, and 83% perceive air infiltration from the windows and doors. In addition, 75% of the students judge the classroom to be uncomfortable even in summer, due to the absence of a cooling system. In terms of visual comfort, 58% consider the artificial lighting to be adequate, but 43% suggest changing its layout. 67% of respondents experience discomfort when using the video projector. With regard to acoustics, only 25% report difficulty in hearing the lecturer clearly, but 58% perceive external noises from the street as adversely affecting concentration. Finally, 58% of students report the presence of humidity, despite good natural ventilation in the classroom, which is limited by the impossibility to open windows due to external noise. The combined results of these analyses highlighted the need for a holistic approach to energy and environmental retrofit (Kamari *et al*., 2019; Sánchez *et al*., 2019). The different technological solutions proposed to adapt the university classroom to the requirements of the mandatory standard (Hu, 2018) were integrated and combined with reorganising design solutions for functional spaces, including the use of colour and greenery (Crespo *et al*., 2023).

The experimentation demonstrated the effectiveness of a model that integrates technological and perceptual analyses of users to design more effective and appropriate solutions. This participatory approach not only improves the quality of the built environment but also stimulates user awareness of the benefits of monitoring comfort conditions that are not solely instrumental. The results of the experimentation provide a replicable reference point for interventions on public buildings in the Mediterranean context, with significant implications for the energy and climate transition.

Conclusions: future perspectives and proposal for a coordinated international Living Lab

Building on the achievements of the Med-EcoSuRe project, the MCbLL intends to expand its network by incorporating new stakeholders, enhancing its ICT platform for knowledge-sharing, and broadening its scope to include diverse public buildings. Key innovations, such as digital twins and participative co-creation methodologies,

08 |



will remain central to its approach, facilitating real-life experimentation and adaptive solutions tailored to varying climatic and socio-economic contexts.

To achieve its ambitious goals, the Mediterranean Cross-border Living Lab (MCbLL) must overcome challenges such as fostering long-term stakeholder engagement across diverse contexts, securing the financial and technical resources needed for advanced tools and technologies, harmonising governance across a cross-border network, and ensuring sustained funding and effective commercialisation of innovations.

Nevertheless, the future potential of MCbLL is encouraging. The initiative aims to establish an international Joint Research Centre, which will facilitate long-term collaborations and guarantee the sustainability of results through training programmes, advisory services and development strategies. By capitalising on the potential of Euro-Mediterranean initiatives and focusing on capacity-building, the MCbLL has the potential to become a reference network for integrated and cross-border strategies.

NOTES

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University communities for the green/digital renovation of public buildings

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Abstract. In the face of climate change and energy crises, the renovation of existing buildings is an adaptation imperative. Despite ambitious policies, effective progress is hindered by a limited focus on financial returns, neglecting the broader social and environmental dimensions of renovations. This paper presents a university-driven Living Lab methodology experimenting with Digital Twins to foster collaboration and engagement in the co-design of ambitious renovation projects for public buildings. Tested in a pilot project site in a historical context, the research demonstrates the potential to optimise renovation processes and outcomes. Results highlight the transformative impact of the methodology, while addressing challenges for scaling up and replication.

Keywords: Public buildings renovation; Living Lab; Digital Twin; Engagement; Co-design.

Introduction

In the global context of correlated insecurities arising from climate change and energy crises, the critical objective of renovating existing buildings, given their well-documented and substantial adverse impacts, can be considered an adaptation strategy. Despite the broad perspective of the European Union policies, building renovation efforts remain limited when translated to national and local scales. Here, while rainfall incentives are provided to economically support the renovation effort, the prevailing approach remains focused on the quantitative return on investments, neglecting the broader social and environmental benefits (Fingleton and Jammet, 2021). This approach prevents the development of a comprehensive long-term vision, and the cultural transformation to achieve the necessary radical green transition. In the run toward adaptation, if predominant top-down and technocratic approaches are revealing shortcomings (Selje *et al*., 2024), alternative community-driven, needs-based, place-based and participatory models are offering promising transformative and regenerative pathways. In the maturity context of the discourse on building renovations (Liao *et al*., 2023), although "energy efficiency first" is the imperative of EU policies, the shift towards "beyond energy efficiency" concepts appears ready to support more qualitative, effective and future-oriented strategies.

The recently concluded EU co-financed Med-EcoSuRe project[1] (Mediterranean University as Catalyst for Eco-Sustainable Renovation) investigated innovative approaches for the renovation of public buildings by taking into account the social aspects related to the role, influence and impact of the wide range of renovation actors, and the opportunities of an improved collaboration. This paper focuses on the Italian contribution to the project, led by the University of Florence, with the mission to define a Living Lab (LL) methodology to innovate the renovation of public buildings (WP3), and to test it in a pilot action (WP5). In particular, the local LL experimented with Digital Twins (DT), as the best path to support more sustainable, reliable and collaborative processes.

Initially constrained due to the overlap of the project's launch with the Covid-19 period, this vision was in line with the EU initiatives emerging in those years in the context of the ambitious green transition of the Green Deal. Launched by the EU Commission in 2021, the New European Bauhaus initiative promotes sustainable solutions for transformation of the built environment by "engaging people at a grassroots level", "incorporating the views of various stakeholders into the process of design and implementation", and "prioritising people". These human-centric and social priorities are well represented in the LL approach. Key initiative to drive energy efficiency in the building sector, the Renovation Wave Strategy sets out measures to increase the rate and depth of renovations. In particular, it promotes "digital friendly renovations", suggesting simultaneously addressing "the twin challenges of the green and digital transitions". Considering the limited adoption of Building Information Modelling (BIM) (Daniotti *et al*., 2022), the exploration of advanced digital technologies can find in LLs the ideal contexts for experimentation, enhancing the opportunities to improve renovation practices from the bottom.

Synchronising a virtual replica to the physical building, DTs represent a key enabling technology to foster, beyond enhanced prediction and analysis capacities, advanced interaction, comprehension and communication between building actors. In the case of building renovation, DTs can serve as catalysts to stimulate a collaborative and dynamic exploration and optimisation of renovation scenarios, enhancing energy performance and minimising the environmental impact of renovated buildings, as a strategic tool to support community-driven co-design processes for a shared and common vision of sustainable built environments.

Methodology

Building on the LL approach, the methodology is grounded on the idea that universities are future-oriented micro-societies, where the development and testing of innovative solutions is ideal, given their guiding roles in education, research & development and third mission.

Initially designed to address the Med-EcoSuRe project's main objective – to reinvigorate the role of university managers in building renovations, the methodology unveiled the advantages of sharing knowledge and fostering collaboration among a diverse range of actors. The LL approach was designed to create a favourable environment where interdisciplinary and collaborative teams can work together to drive innovation and effectively address the challenges of renovation, ultimately advancing renovation processes of public building "beyond just energy efficiency".

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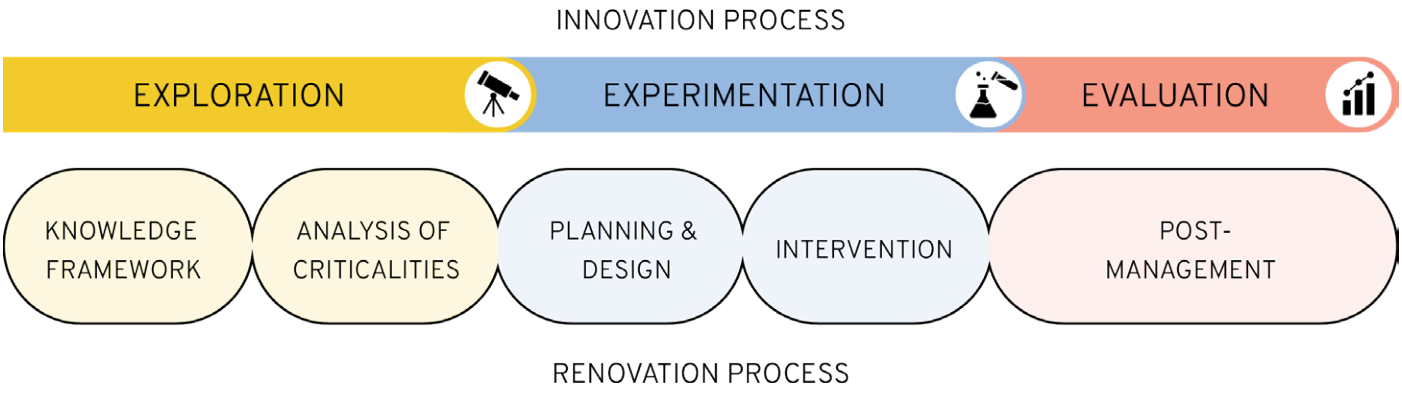
01 | Three phases of the LL methodology adapted to the five stages of the renovation process



Considering the local mission, the specific objectives of the research project was to explore, experiment and evaluate the potential of DT in the real-world pilot action to advance renovation processes of public buildings.

The Living Lab approach

Although there is no single universally accepted definition of "Living Lab" from the review of previous literature, Hossain *et al.* (2019) identify two main paradigms in the LL approach, consisting of open innovation and user innovation. The European Network of Living Labs (ENoLL) describes LLs as "open innovation ecosystems in real-life environments based on a systematic user co-creation approach that integrates research and innovation activities in communities, placing citizens at the centre of the innovation process"[2].

The literature presents a variety of definitions, reflecting the multifaceted and evolving nature of this concept. However, it is possible to identify some common elements that characterise LLs.

They take place in real-world settings, such as neighbourhoods, cities, or university campuses, allowing solutions to be tested under realistic conditions, and their social impact to be assessed through iterative user feedback. LLs are a promising tool to stimulate co-creation of tangible (e.g. products, systems, etc.) and intangible (e.g. knowledge, value, services, etc.) innovation outcomes by including diverse users in all stages of design and commercialisation processes, recognising their ability to develop solutions that meet their target needs.

To foster the process and actively engage stakeholders, LLs can use a variety of methods (multi-method approach) such as workshops, focus groups, and online collaborative platforms.

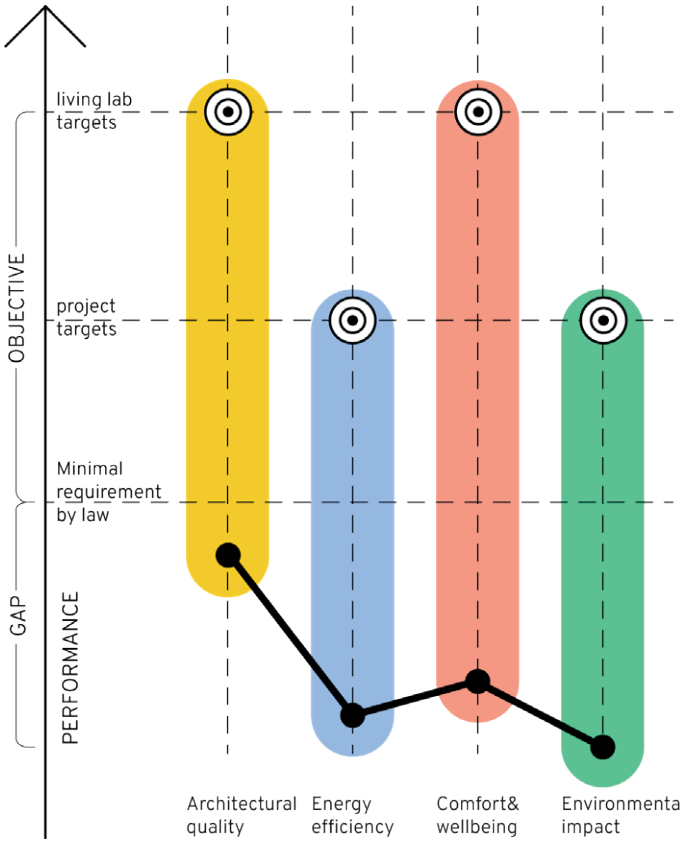
Finally, LLs are characterised by the presence of multiple stakeholders working together to achieve common innovation goals. The literature highlights the importance of public-private-people partnerships (4Ps), in which universities, companies, governments and citizens actively participate in innovation activities (van Geenhuizen, 2016). This collaboration takes the form of a "quadruple helix", which encompasses user-oriented innovation models, to take advantage of the hybridisation of ideas that leads to experimentation, and to prototyping in a real-world setting (Compagnucci *et al.,* 2021).

Living Labs have proven to be one of the most promising approaches to engage and stimulate stakeholders in co-creating innovative solutions for green energy and sustainable growth (Marksel *et al.,* 2024). The growing interest in applying this approach in various sectors, including energy efficiency and sustainability, can facilitate collaboration among citizens, businesses, institutions and other stakeholders, accelerating the development and adoption of innovative technologies and practices.

Living Lab for building renovation

The innovation development phases of the LL methodology, based on exploration, experimentation and evaluation (Malmberg *et al.* 2017), have been adapted to the building renovation process, structured into five stages (Trombadore *et al.,* 2024) (Fig. 1). The exploration phase can be considered as the 'pre-measurement' before the intervention, with the collection of data and information describing the knowledge framework of the building and the analysis of criticalities. The experimentation phase corresponds to the planning and design of renovation scenarios (mix-of-technologies) and the intervention on the existing building. The third and final phase refers to 'post-measurement' after the intervention and the post-management stage.

From a strategic point of view, the setting up of the local LL (called beXLab – building environmental eXperience) required the definition of a common mission for renovation. Looking beyond energy efficiency, the mission of the local LL is to consider renovations holistically, also accounting for their environmental impact (focusing on the integration of renewable energies and NBS), the social aspects of comfort and well-being, and architectural quality.



From a more practical point of view, the setting up of the LL required the selection of a physical space for the pilot building renovation, as well as the creation of a virtual space for the DT experimentation. The strategic location of the LL in a historical heritage context and in a School of Architecture has been calibrated in the project targets that strongly emphasise socio-cultural aspects, while respecting the architectural values (authenticity and integrity) of the site (Fig. 2).

In line with the LL features, the multi-actor methodology adopted accounts for the involvement of a wide set of actors in the renovation process. The adopted engagement methods and tools are the object of the following paragraph.

The methodology has been iteratively adjusted/adapted across the project thanks to the contribution of partners and implementation of the pilot project, serving as official trial to validate its effectiveness. The tested methodology has been capitalised in a dedicated project's output for further scaling up and replication (Renovation Toolkit[3]).

Methods and tools

The research team developed several methods and tools to engage the wide range of actors in the LL activities (Fig. 3), facilitating the collective exploration of the DT of the real-case pilot building. According to their role, for each group of actors (researchers as promoters, building and energy managers as customers, companies and institution as stakeholders, and students as "special" users), the specific activities organised and performed are presented to follow:

Researchers

As LL promoters, researchers (PhDs, post docs, seniors) led the design and management of all the LL activities, the operative development of the pilot project, as well as the definition of all the project's outputs. In particular, they were in charge of the experimentation with the DT. To initiate it, the interdisciplinary research group (architects, energy engineers and information engineers) focused on the following tasks:

- develop the BIM model of the pilot building to renovate;
- design a protocol for a real-time monitoring system (IoT sensor networks) to collect data on a specified set of environmental parameters influencing indoor comfort, and installing it within the LL spaces;
- customise the DT into an ICT hosting platform[4].

Exploited for the definition of the renovation pilot project (Calcagno et al, 2023), the DT continues to stimulate cross-disciplinary collaboration (for example, service designers are working on the definition of user-friendly interfaces for DT platforms), and it is operative for further research.

Building/energy managers

Customers of the LL's outcomes as main people responsible for the management of the university building stock, building/energy managers (from decision makers to technicians) have been involved since the beginning of the project through a dedicated survey (conducted at cross-border scale). This initial survey has been constructed to self-assess current facility management practices, giving particular attention to the identification of information and collaboration barriers. The most relevant findings highlighted common issues, including inconsistencies in building data uniformity, standardisation, and availability, as well as fragmented processes and very low adoption of digital tools. These results have been disseminated in the context of a dedicated cross-border webinar series, to enhance awareness about the common challenges, and to exchange best practices with peers. The series had the objective of sharing knowledge about the benefits of digital models in improving data reliability, fostering collaboration, and supporting informed decision-making.

At the local level, building and energy managers supplied the essential data to initiate the development of the DT. They actively participated in all technical meetings for the definition of the pilot project, conducted around the DT. These sessions highlighted the DT's potential, showcasing its ability to improve project management and predict renovation outcomes.

Given the lengthy and complex administrative and procedural processes inherent in public procurement, technicians observed that the Digital Twin (DT) significantly enhanced project delivery. It enabled seamless collaboration among diverse professionals involved in the integrated project (including architects, as well as

| 03

energy, structural, and safety engineers), while accelerating project updates, speeding up the development of the executive project, and ensuring effective control over the construction process. Moreover, decision-makers were actively involved throughout the project. At its inception, they collaborated to strategically select the most suitable university building for establishing the LL, installing the monitoring system, and implementing the pilot renovation. Regularly updated on the progress of the DT and pilot project, they facilitated a smooth authorisation process. At the end of the project, they formalised their commitment to transitioning the university building stock toward more digital and sustainable renovation practices by signing two dedicated document/project outputs, precisely a long-term renovation strategy and an action plan. Based on a EU to local policy appraisal and on a technical assessment of the existing university building stock, the first is a roadmap to identify priorities and the best renovation opportunities. The action plan listed a structured agenda of 10 key actions to drive process innovation in the management of the university building stock, focusing on collaboration and digitalisation.

Companies

A variety of private companies contributed to the LL, each playing a key role in the DT experimentation and pilot renovation:

- IoT and software companies: the development of an experimental environmental monitoring system of the environment required close contact, support and communication with companies to select the optimal set of sensors and activate the DT's data exchange;
- Manufacturing companies: designing and implementing a state-of-the-art pilot renovation involved the integration of innovative technologies and materials (notably, innovative photovoltaic panels). From the design phase, the DT was used both as a communication tool to engage with manufacturing companies and as an operational tool to manage customisation;
- Construction companies: even the construction process had to be innovative. Given the location in a historical building, the continuity of university activities, and the innovative technologies adopted, the worksite required special features. The DT facilitated smooth communication between the contracting station and construction companies, while also supporting worksite organisation;
- Consultancy companies: the adoption of innovative technologies necessitated expert guidance to manage procurement logistics and proper installation, acting as a bridge between manufacturing companies and the contracting station.

Tab 01 | KPIs for the different types of impact generated by beX Living Lab.

Type of Impact	KPIs	Achieved results
Societal	% of coverage of the quadruple helix	100%
	Number of of relevant stakeholders/users involved	> 20 researchers
		> 10 local building and energy managers > 30 Med level
		> 5 local institutions
		> 1000 students
Environmental	% of energy requirements satisfy by RES	Related to renovation results (Fig. 04)
Economic	% of reduced energy costs	Related to renovation results (Fig. 04)
Technological	% of increase in TRL of innovated technologies	DT: from basic research (TRL 1) to technology convalidated in a relevant environment (TRL 5)
Regulatory	Number of of adapted/implemented policies or directives	n. 1 signed long-term renovation strategy
		n. 1 signed short-term action plan
Academic	Number of scientific papers and/or publications/articles	> 10 scientific papers

| Tab. 01

Public organisations and institutions:
The experimental LL renovation process has been actively disseminated locally through dedicated events, targeting key organisations and institutions to showcase the potential of DT in driving sustainable and innovative renovation practices. The dialogue with the municipality, as the owner of the pilot building, and with the local cultural heritage superintendence, given the architectural constraints of the pilot site, has been stimulated by detailed technical reports, containing DT-generated data-rich renovation scenarios. This approach facilitated a favourable environment to obtain the necessary authorisations.

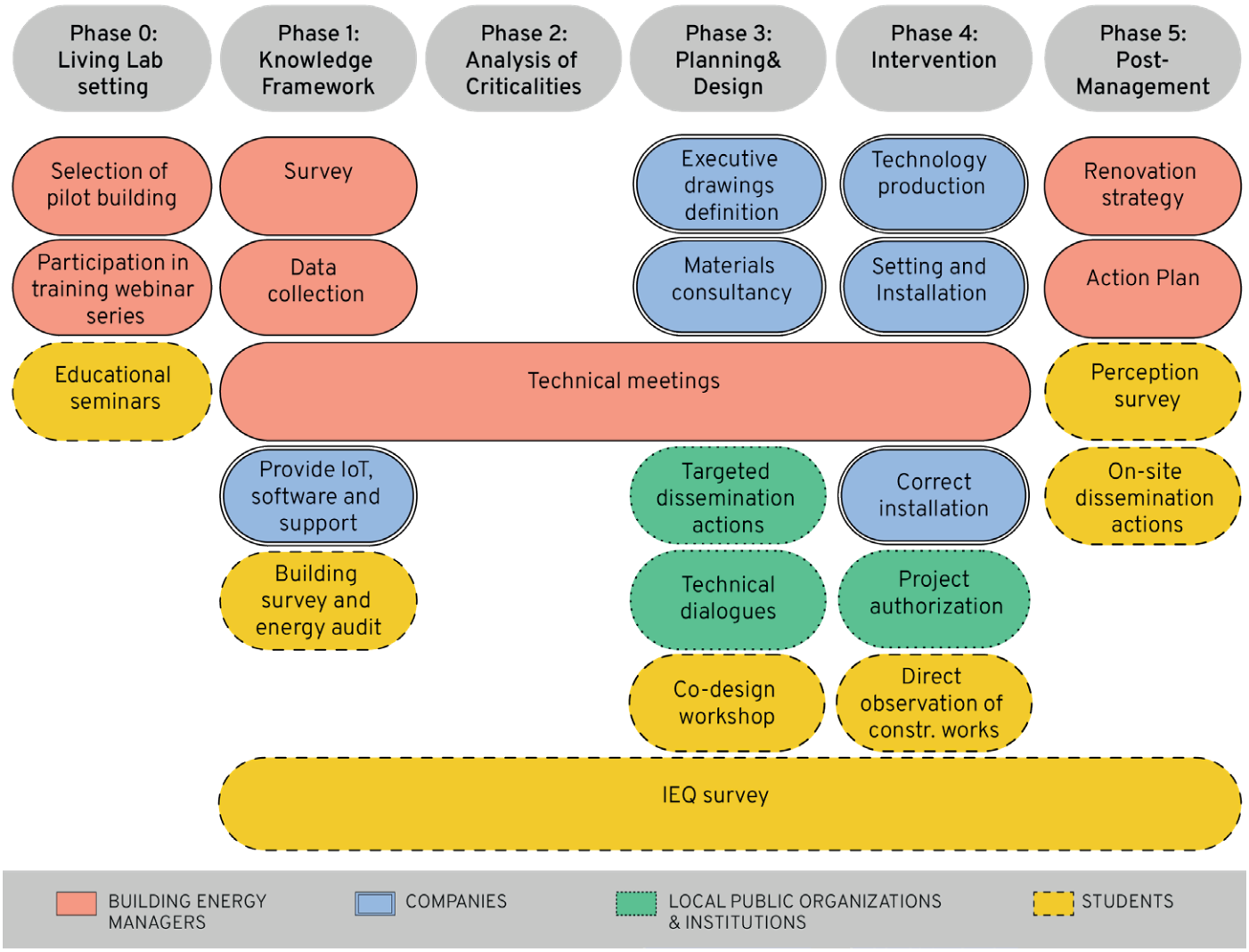
Students:
As special users of building, students of architecture have been involved in several LL activities, contributing and benefitting from the DT experimentation:
- dedicated seminars, also with international partners, advancing their knowledge on building renovation and DT, usually relegated to researchers;
- data collection to create the DT (building survey and energy audit);
- qualitative survey on the perception of indoor comfort in the LL (open space for students), stimulating a reflection on the importance of environmental indoor quality, and to retrieve qualitative data for the DT (matched with quantitative data);
- dedicated co-design workshop (see Trombadore *et al.* 2023), handling the BIM asset model of the pilot building to design, simulate and evaluate integrated renovation scenarios;
- direct observation of the pilot project's construction works, adopting advanced techniques (e.g. modularity, prefabrication);
- on-site education conveyed through dedicated posters in proximity of the pilot project and the LL, where all the process, the technologies adopted and the obtained results are detailed in an easy form;
- perception surveys on the pilot project for developing critical thinking about the architectural impact of innovative renovation measures (i.e. solar active structure, see results).

Beyond the project duration, the LL, the DT and the pilot project continue to serve as both real-life and virtual learning resources accessible to students, stimulating their interest in innovative, sustainable and digital practices.

Results, limits and discussion

Making the most of the contribution of all actors, and supported by the exploitation of the DT, the co-creation in the LL context consented to reach an ambitious renovation project in terms of innovative process and achieved renovation results.
The impacts generated by the LL have been assessed using specific KPIs, defined on the basis of Vervoort *et al.* (2024) (Tab. 1). In particular, the project reached a high societal impact, with 100% of the quadruple helix covered, more than 1000 people involved at local level, and project results increasing positive behaviour towards more sustainable practices. A good technological impact has been reached both with the validation of the DT in a relevant environment, and the full scale installation and operation of the innovative pilot project. Good results also regarded both the regulatory impact and the academic one.
In particular, the pilot project achieved important results in terms of energy efficiency, environmental impact, improved comfort and well-being, highly considering architectural quality (Fig. 4). This last point was of particular interest, given the quality of the historical heritage context of the pilot project, where the need to improve the social acceptance of renovation measures, in particular the integration of renewable sources, is more challenging.
The main intervention of the pilot project resulted in the definition of an experimental 3D steel structure positioned to the south side of the pilot building, and hosting innovative photovoltaic panels (semi-transparent and amorphous). Standing as an active solar shading device, the iconic new façade highly influences the indoor environmental conditions, augmenting energy efficiency while reducing the energy costs and the environmental impact by producing clean energy. The persistence of the pilot in the School of Architecture acts as a tangible result, daily showing the future generation of professionals and citizens the potential of renovations, such as the creative and the aesthetic quality of renewable technologies integrated into architectural solutions.
Beyond the pilot action, the most important result achieved by the project is that all the actors involved experienced in the LL a different way of renovating buildings, namely community-driven and bottom-up, acknowledging in a real-case application the role of collaboration in achieving innovative and satisfying results. Moreover, all the actors entered in contact with

04 | Pilot project results divided by renovation fields (photo credit: ETA Florence)



the DT. This allowed to spread awareness, and to educate, towards the most advanced digital technologies and opportunities. It also offered researchers the opportunity to retrieve information about the limits and challenges of the digital transition. In particular, limitations emerged in the possibility of fully developing a DT for the management of the university building stock. Indeed, even if DT technologies are almost ready to be implemented, more effort is required to advance the digital knowledge and skills of technicians in the public sector. The experience-led learning process activated by the LL, both for building/energy managers and for students, such as the produced educational outcomes (e.g. Toolkit) is a step in this direction.

Conclusions and future works

Augmenting the LL methodology with the DT is an innovative transformative path to boost the renovation of public buildings, addressing the green and digital challenges through a renewed collaborative and participative spirit. Beyond the analytic and predictive possibilities enabling advanced decision-making, DT is a valid support tool for more collaborative and engaging practices, whose experimentation in LLs is an opportunity for mutual learning and awareness raising. Beyond energy efficiency and short-term results, an innovative renovation of public buildings combining LL and DT can be an occasion to reinforce the role of actors from the bottom, laying the foundation of a cultural shift by truly supporting the urgent green shift and its persistence in the long term.

The local LL experience in Florence, with the pilot project as evidence, demonstrated the quality deriving from more collaborative and innovative processes. However, the LL adventure is just at the beginning, with a lot of future work in the pipeline. Adopting a broader perspective, the replication of the LL experience in other university contexts[5] and other typologies of public buildings (i.e., schools), is on agenda. At local scale, the didactic potential of the monitoring system, of the DT and of the pilot project should be improved by advancing the sharing

of project data and results. This requires more effort in terms of communication, and the simplification of complex data in a user-friendly way. The collaboration with the service design experts is working in this direction, with the short-term idea of creating informational totems for the fruition and navigation of the DT. The long-term perspective is to develop a dedicated app for its full exploitation, both for the university building/energy managers (expert users), with the possibility of managing the building portfolio, and for the building's end-users (not expert users), oriented to stimulate more proactive behaviours toward a more sustainable use of buildings. This is strategic in the education of young architects/citizens.

The created LL/DT, physical and digital infrastructure, is accessible for further research, looking at new collaboration and development opportunities with other disciplines and stakeholders.

NOTES

[1] Available at: https://www.enicbcmed.eu/projects/med-ecosure (30/11/2024).

[2] Available at: https://enoll.org/living-labs/#living-labs (30/11/2024).

[3] The draft version of the Toolkit is available online at: https://medbexlive.org/. The final version is the subject of an ongoing dedicated publication.

[4] Available at: https://www.snap4city.org/dashboardSmartCity/view/Baloon.php?iddasboard=MzQyNA== (30/11/2024).

[5] The creation of a network of LLs is one of the objectives of the cross-border Living Lab activated in the context of the Med-EcoSuRe project, called Med-beXLive. Available at: https://medbexlive.org/ (30/11/2024).

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ATTRIBUTION

This article has been jointly developed by the two authors. Paragraphs were written as follows: Introduction: G.C. & L.M.; Methodology: L.M. & G.C.; Methods and Tools: G.C.; Results, limits and discussion: G.C.; Conclusions and future works: G.C. & L.M.

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Digital representations for natural heritage: enhancement strategies in the "De+Humans" project

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Abstract. The New European Bauhaus, through its implementation strategies, proposes a multidisciplinary vision to promote the values of beauty, inclusion, and sustainability. The "Designing with more-than-humans" project applies this vision to the Cratere degli Astroni Nature Reserve, utilising digital narratives that blend real and artificial images to raise awareness of the human-nature relationship and territorial identity. Through a transdisciplinary approach, the team analysed key local elements, exploring physical and perceptual relationships. The digital representation, combining macro and micro perspectives, visualises the dialogue between these elements in a video-graphic work that overlays aerial footage, textual content, and AI-generated images, offering new perspectives on natural heritage.

Keywords: Digital Narratives; Visual Perception; AI Representations; Drone Footage; Ecological Awareness.

Introduction

In 2021, the European Commission launched a policy and funding initiative called the "New European Bauhaus" (NEB) aimed at promoting sustainable solutions to transform the environment and contemporary lifestyles within the framework of green transition policies.

The multidisciplinary vision proposed by the NEB seeks to achieve numerous ambitious goals, rethinking current trends and practices while identifying new strategies for a less impactful way of living. NEB initiatives encourage the creation of projects that are ecological but also inclusive and aesthetically inspiring[1], fostering positive transformations centred on both environmental and social sustainability.

The NEB positions itself as a creative and transdisciplinary movement, bridging science, technology, art, and culture. This approach integrates diverse disciplines, advancing values of sustainability, aesthetics, and inclusion. Recent research has embraced this shared design perspective, particularly in architecture, design, and communication, promoting participation, transdisciplinarity, and the integration of global and local dimensions. This last aspect is essential for the "De+Humans" project, which stems from the observation of natural heritage and the need to narrate it, fostering awareness.

The reflections presented in this research emerge from site-specific themes linked to the Cratere of Astroni Nature Reserve (Naples), aiming to develop digital storytelling processes that raise public awareness of environmental balances. This approach connects with territorial identity while exploring contemporary technological innovations and experimenting with new visual languages.

Inspirations of the "De+Humans" project

The De+Humans project was inspired by these premises, funded through the Vanvitelli University grant dedicated to young researchers, and carried out in 2023. The project has a dual nature, both theoretical and applied, aiming to experiment with digital representation processes and create design-nature hybrid products to raise awareness of multi-species coexistence and ecosystem preservation. The more-than-human approach, referenced in the project's title, is expressed through an increasingly attentive and sensitive attitude toward diversity and the multiple ways in which reality manifests itself (Ranzo, Scarpitti, 2024).

Inspired by philosophical studies -particularly the thought of Arne Næss- the project explores the ongoing reshaping of the post-anthropocentric paradigm, questioning its dominance and experimenting with technologies and aesthetic practices that embody this shift.

Arne Næss, a contemporary Norwegian philosopher, provided the theoretical foundation for the project's reflections. His work rejects a superficial view of ecology, which focuses solely on pollution and resource depletion, and advances the concept of deep ecology. Drawing from Gestalt psychology, Næss develops an ontology where reality is not composed of separate entities but perceived as a whole, in which everything is intrinsically interconnected. Replacing the conventional image of humans within the environment, he proposes a complex vision where organisms are nodes in the biospheric network, forming a web of interwoven interactions (Porro, 2023).

Deep ecology, with which Næss is often associated, is not a radical interpretation of human-nature interaction but a philosophical approach to ecological issues, rooted in a profound inquiry into things and the ways we represent them.

The discipline of representation played a central role in the De+Humans project through storytelling practices and the construction of images and the imaginary aimed at "making visible"-to use a phrase dear to Paul Klee (2004)-the existing, widespread, and intricate yet generally invisible relationships. Our everyday perspective, often rooted in an anthropocentric dimension, is invited to reconsider the position of the human being not as an element within the environment, but as the environment itself, co-constituted by all organisms in their interdependence. This is a complex yet essential shift, a seemingly simple one that radically transforms how we perceive and think about our society, which should not see itself as separate from the environment but as an integral part of it.

Harold Glasser, in the most comprehensive collection of Næss' works, describes his philosophy as "a non-dualistic, non-anthropocentric philosophy of life that upholds the interdependence and ultimate unity of all living beings while preserving their individuality. His philosophy celebrates the richness and diversity, both cultural and biological, of the Earth" (SWAN I, p. XVIII) [2].

Even more significant for the theme of representation is Næss' own assertion that our world requires both a microscope and the open, perceptive gaze of a phenomenologist-one to explore the

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01 | Astroni Crater Nature Reserve – Aerial photograph captured by drone (A. Palmieri, M. Micelisopo, 2023)

02 | Using the layering technique, textual content related to the species present in the Reserve is superimposed onto aerial images (A. Palmieri, G. Giordano, 2023)

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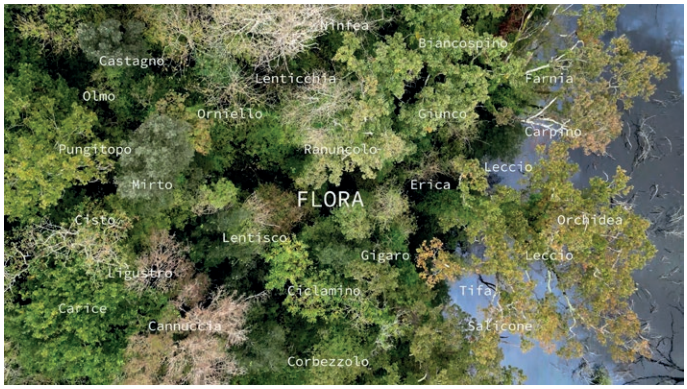

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micro-world surrounding us, and the other to observe vast territories from above. "His non-anthropocentric, relational, and respectful philosophy – toward both humans and non-humans – seems to reconcile these two perspectives: the microscopic, investigative gaze capable of capturing the diversity of the smallest beings, such as lichens and stones, and the macroscopic view that embraces vast landscapes from above, not to judge but to joyfully appreciate both totality and individuality, in a movement toward what Næss defines as Self-Realization" (Nasi, 2023).
This idea of constantly shifting perspectives and visualising reality at different scales translated into the creation of visual artifacts that explore nature through a micro/macro dualism. This approach synthesises the environment's intrinsic tensions, emphasising the dialectical relationship between visible and invisible realities, between Figuration and abstraction.

Methodology and workflow structure

With the clear objective of structuring engaging and empathetic awareness-raising actions for a broad audience, the project staged perceptual experiences and digital representations. Through drone footage, photographs with varying focal lengths, and AI-generated images, it crafted a unique narrative deeply rooted in the Phlegraean landscape of the Astroni Reserve.
The Astroni Oasis is a protected natural area – a majestic crater preserved between the municipalities of Naples and Pozzuoli, part of the Phlegraean Fields Regional Park, and safeguarded by the WWF. It represents a remarkable volcanic formation with a diameter of 2 km. Its highest point, the Torre Nocera spur, rises over 250 meters above sea level, while the lowest point, near one of the oasis' three bodies of water, is at just 9 metres above sea level (Fig. 1). The vast expanse and significant elevation changes result in a rich and diverse ecosystem of flora and fauna, characterised by an unusual inversion of vegetation. Indeed, tree species are arranged in reverse order based on altitude. Thus, Mediterranean scrub is found at the crater's highest elevations, while vegetation typically associated with mountainous environments-such as chestnut trees-thrives at sea level (Fig. 2).
This site evokes magical images, likely due to the experience of immersion in an unspoiled environment, free of human presence (except for a few containment walls, a wooden staircase, and the historic Bourbon Vaccheria, all dispersed within the vast forest). Despite its biodiversity, certain recurring elements-particularly plant species-stand out, making it possible to identify distinctive landscape markers.
The multidisciplinary team involved in the project proposed various approaches but worked collectively on these same landscape markers, following a shared analytical methodology focused on the diverse organisms present in the area. Specifically, six kingdoms were examined, serving as the foundation for interdisciplinary research, analysis, inspiration, and representation. Each group collaborated on the initial identification of species, then pursued distinct but deeply interconnected disciplinary outcomes. The six kingdoms explored were animals, plants, fungi, bacteria, minerals, and digitalia.
By reflecting on the kingdoms beyond the anthropic realm, the project investigated human-nature interaction, specifically the physical-perceptual relationships between individual elements and the human dimension. This exploration led to considerations on disproportion-understood as a deliberate omission of dimensional reference-favouring a formal and morphological analysis of analogies between parts and the whole, between elements observed at an extremely close range and the landscape seen from a broad, comprehensive perspective.
The observation of natural forms within the oasis highlighted the continuous shifts in scale inherent to the landscape. Consequently, the working methodology experimented with the development of digital representations based on the macro/micro dualism. In this context, macro refers to a large-scale view, offering a general perspective that encompasses the whole, while micro indicates a close-up perspective, accessible only through advanced optical instruments. These micro-level images, which cannot be captured using conventional analogue tools, were created using AI-based platforms, enabling the generation of

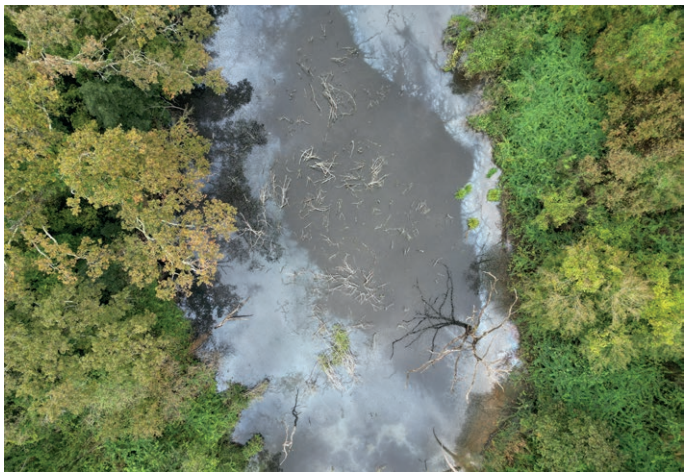
03 | Photographs of one of the site's identity-defining elements, captured from different viewpoints while varying position and focal length, altering its perception (A. Palmieri, 2023)

evocative and immersive visuals. While not aiming for scientific accuracy, these images allow viewers to transcend the physical limits of vision, fostering a deeper (both visual and conceptual) engagement with the natural heritage.
The interplay of macro and micro encapsulates the inherent tensions within the landscape, emphasising the dialectical relationship between visible and invisible realities, between Figuration and abstraction.

Graphic experimentations between layering and AI

This contribution presents part of the project's outcomes, with particular focus on representation as a tool for analysis, transmission, perception, and dissemination of existing tangible and intangible values. The final phase of the research activities culminated in an interactive exhibition, held at Officina Vanvitelli (Caserta) in December 2023. Various prototypes and artefacts were displayed during this event, expressing the shared vision of the research group. These works aimed to define a multisensory experience and foster empathetic engagement with visitors.
The exhibition was accompanied by a large-scale projection of a video based on visual storytelling, narrating the remarkable landscape of the Astroni Nature Reserve. This visual narrative combined unconventional perspectives with AI-generated images, surreal and close-up, prompting viewers to question the structure and ecological role of individual elements that define the territory's identity. Starting from real photographs taken in the Reserve, the project created representations of invisible subjects (such as bacteria) and virtual animations in which fungi, plants, and minerals seemingly came to life, dynamically aligning with the movement of aerial footage. These cognitive-visual processes invite viewers to explore natural heritage from a new perspective-sometimes incredibly distant, at other times surreally close-allowing each observer to reinterpret and reassign meaning, creating value through their individual experience and exposure to new types of images and vision technologies (Pinotti & Somaini, 2016).
The production and editing phases relied on drone footage acquisition, graphic grid generation, AI-generated imagery, and the layering technique to hybridise and overlap elements.
Hundreds of photographs were taken during numerous on-site explorations, which fostered a deep connection with the natural heritage, experimenting with varied perspectives and focusing on individual elements of the forest-elements that seemed to vanish and reappear within the dense vegetation (Fig. 3). A pivotal moment in constructing the visual narrative of Astroni was the use of drone footage, captured from multiple locations within the reserve. These aerial images revealed aspects of the landscape that are imperceptible from the ground, providing a powerful visual-communicative resource detached from the human observer's viewpoint (Crary, 2013).
In narrating the elements of this visual ecosystem, a particularly intriguing aspect was the alteration of the observer's point of view, leveraging high altitude imagery to explore micro/macro relationships and the abstract, visionary nature of the zenithal perspective. Suddenly water, for example, previously regarded as a focal point due to its aquatic plants and diverse wildlife, took on an entirely new meaning. The analogy between the reflective quality of lakes and that of mirrors led to the creation of coplanar representations of opposite viewpoints where an imaginary observer could simultaneously look above and below the "projection centre" through a natural yet technical device (Maldonado, 2005) (Fig. 4).
This heterotopic condition recalls Foucault's concept of "other spaces", particularly his reflection on the mirror as an extraordinary object: "After all, the mirror is a utopia, for it is a place without a place. In the mirror, I see myself where I am not, in an unreal space that virtually unfolds behind the surface-a kind of shadow

04 | The lakes within the reserve appear from an aerial perspective as mirrors, capturing the reflections of the sky and the earth in a single frame (A. Palmieri, M. Micelisopo, 2023)



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that returns my own visibility, allowing me to see myself where I am absent: the utopia of the mirror" (Foucault, 2011, p. 24).
With the deliberate goal of experimenting with new technological innovations, engaging with Artificial Intelligence laboratories and their growing role in visualisation and imaginary scenario construction became inevitable. These systems operate through an exploratory approach to image-making, one that does not necessarily adhere to scientifically accurate representations of tangible reality. Instead, they generate digital renderings, which act as conduits for fantastic conceptual spatial visions, placing them on equal footing with real world objects (Vitta, 2012).
To approach this work methodically, without being seduced by the infinite expressive possibilities of AI, the prolific image production followed the logical structure of the six kingdoms, resulting in a rich and evocative visual repertoire (Figs. 5, 6). Critical reflections on the role of drawing and the control of the process between image and language are complex, particularly concerning visual culture and the emerging aesthetics that AI introduces. However, it is crucial to recognise that these reflections foster a heightened awareness of the methods and implications of this paradigm shift, where the concept of design and creative process is redefined. This transformation moves away from an exclusively anthropocentric perspective, embracing a new vantage point, a shift that lies at the heart of the De+Humans project. The project aspires to propose a new way of seeing, where human perception is understood as merely a small fragment within an infinite universe.
AI-generated imagery enabled the creation of digital representations of elusive subjects-bacteria, algae, dragonfly wings, which typically evade direct human perception yet exist vividly in our mental imagery. AI thus served as a tool to give form to those thoughts, not to depict individual elements in isolation, but rather to illustrate the relationships between them.
Once again, the true value of things resides in their relationships, aligning with the vision that nature is the sum of all existing entities, considered in its holistic form, within the totality of phenomena, and forces it manifests (Sposito, 2017).
The combination of these elements was achieved through the superimposition of layers, different levels of information that enrich the representation, establishing relationships and references between the various components. Starting from drone footage taken at different altitudes (both above and below the tree canopy, with the camera oriented in multiple directions), the first layer of information is composed of geometric grids. These grids change throughout the video, serving as a framework for short textual content and AI-generated images (Figs. 7, 8). These graphic elaborations confirm how even a simple indication within an image can alter the hierarchy of represented elements, constructing a radically different perception of reality. This process induces a perceptual shift, wherein the superimposition of successive layers onto the original photograph gradually distances it from our perception, selectively highlighting or excluding parts of what we see (Dotto, 2020).
The final outputs thus result from a critical interpretation in which the dynamic nature of video editing guides the viewer's gaze, alternating focus between different subjects. This continuous and intricate sequence of frames sustains the viewer's attention, emphasising one element and then another in an engaging visual rhythm.

Conclusions

The creation of a digital videographic work with a strong emotional impact (also due to the significant presence of sound) invites reflection on the human dimension in relation to the whole, challenging the anthropocentric perspective in favour of a renewed interaction with nature. The narrative seeks to offer an interpretation of ecological issues by placing the biosphere and its interconnections at the centre, while also acknowledging that human beings themselves originate as symbiotic entities. It is perhaps within this very essence that ecological awareness is rooted (Morton, 2018).
The intended outcome of the visual storytelling strategies outlined above is to activate a process of dissemination and awareness, encouraging an integrated way of observing nature, one that engages both the body and the gaze. This approach fosters an understanding of how human life is inextricably dependent on the interconnected balance of all living beings, and highlights how the narration of ecological issues, even when employing digital tools and AI, can still retain a profound human dimension.

NOTES

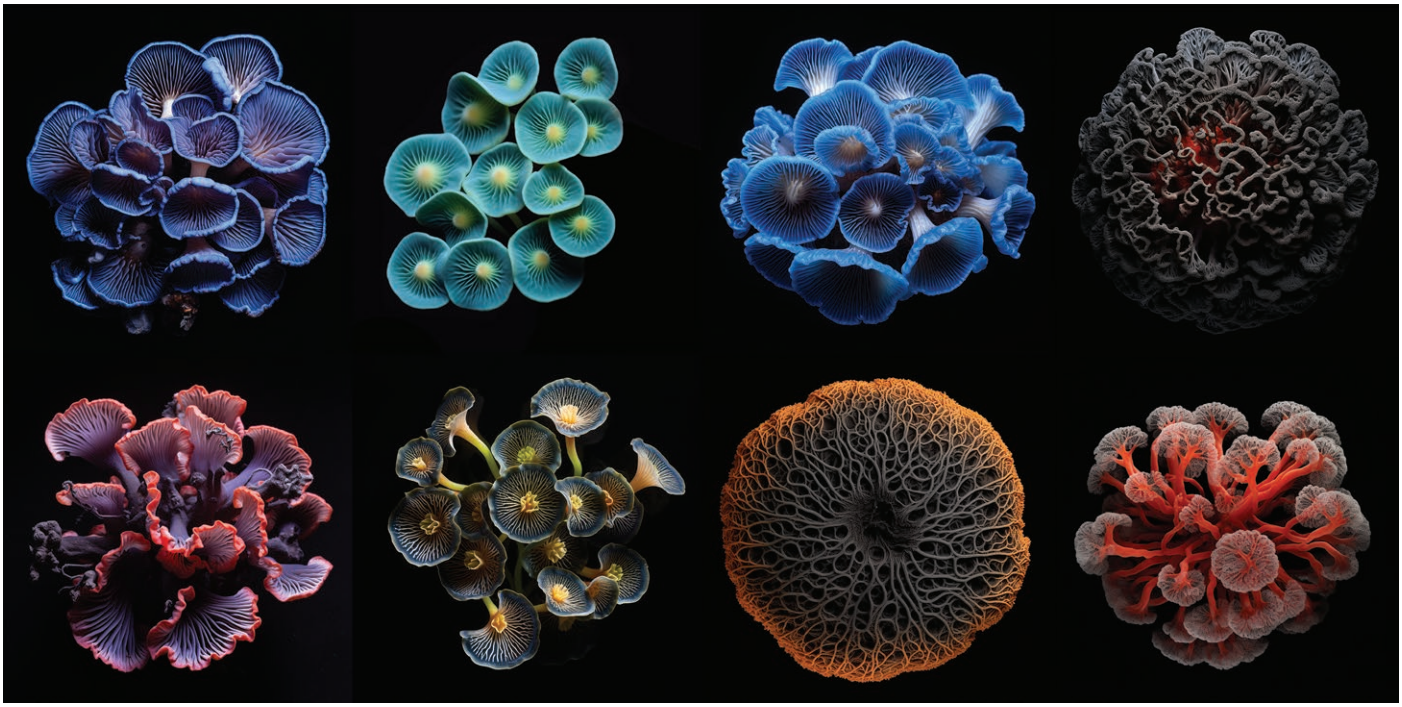
[1] Beauty, sustainability, and inclusion are the three fundamental keywords identified by the NEB https://new-european-bauhaus.europa.eu/index_en

[2] The acronym SWAN refers to the 10-volume collection of Arne Naess' life's work, "The Selected Works of Arne Naess", first made available by Springer in 2005.

[3] Concept by Chiara Scarpitti, Alice Palmieri and Giulio Giordano.

05 | AI-generated experiments, created using Midjourney, to represent the fungal kingdom (G. Giordano, 2023)

06 | Through AI animations, small animated sequences were created, generating dynamic transformations that morph and hybridise elements with one another (A. Palmieri, G. Giordano, 2023)



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07 | Edited sequences from the video, clearly showing the superimposition of real images, textual content, and AI-generated suggestions (A. Palmieri, G. Giordano, 2023)

08 | Edited sequences from the video, clearly showing the superimposition of real images, textual content, and AI-generated suggestions (A. Palmieri, G. Giordano, 2023)

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Natural solutions for remodelling: the case study of Grupo de Viviendas Antonio Rueda

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Abstract. The objective of the research is to study innovative architectural solutions that improve the quality of life in urban environments by integrating natural elements into existing housing systems. The object of the study is requalification of the Grupo de Viviendas Antonio Rueda in Valencia with the aim of creating flexible and modular living spaces that adapt to evolving user needs while promoting a symbiotic relationship between residents and the environment. The project goes beyond sustainability and environmental quality improvement by actively engaging user-centred design methodologies to identify the preferences and needs of the inhabitants. This participatory approach ensures that the proposed solutions are not only sustainable but also socially inclusive and functional. The integration of modular and flexible design strategies allows for the evaluation of different spatial configurations and material applications, assessing their effectiveness in enhancing comfort and well-being. By utilising natural and recycled materials, the research establishes a framework for a balanced design approach that strengthens human-nature connections while improving the resilience and liveability of urban housing environments.

Keywords: Balanced design; User-Centred design; Recycled materials; Modular flexibility; Adaptability.

Introduction

In the modern society that could be described as fluid and formless, a society of the present (Lyotard, 1984), of non-places (Augé, 2009), how important is it to rediscover, understand and value the Genius Loci? Especially when we are called to provide or restore environmental quality to a city, a district, a building, today more than ever there is a need to return to a theoretical approach of balanced design (Olgyay, 1981), which considers natural resources not as surroundings, but as an integral part of the project. In the current definition, the Genius Loci refers to the spirit of a place, describing it as an integral part of the place, identifying its geometric boundaries and establishing causal connections between all the elements that compose it. Over time, places have become boundary markers and centres of life, in which it is possible to identify the matrices and relationships between the people who live there. It is also possible to detect the aspects and processes that determine the character of the place through its influence on the environment, which leads to the division of places into the functions (residential, commercial, industrial) of the people who live there (Sciortino, 2020). All the characteristic elements arising from the relationship between man and the environment can thus be defined, recognising and marking the natural or artificial limits. This relationship has in some cases led to negative effects that have reversed the man-nature nexus by activating inconsistent, destructive and unsustainable transformation processes. The processing of settlements and land has been influenced by technology and the intangible, applying solutions detached from nature and its elements. Therefore, the design and construction of one's home implies a process of elevation and interpretation of space (Marini, 2016), leaving an impression that alters the environment, irreversibly affecting its balance.

The complementary dialogue between technological innovation and architectural space invites more flexibility and adaptability, responding to a dual concept of human and environment-oriented construction (Violano, 2022). To achieve such a connection, it is necessary to model and develop elements of natural origin that lend themselves to making living space flexible and integrated through the use of nature-based solutions in order to make such environments and living centres more resilient against the adverse impact of climate change, healthier and socially cohesive. The research project investigates the possibility of optimising energy performance and water consumption (Violano and Harputlugil, 2024) by integrating natural elements into urban dwellings with a focus on the human-nature connection. The design methodology combines recycled materials, biophilic design concepts and user-centred methodologies to create adaptable living environments. The Grupo de Viviendas Antonio Rueda was used as a case study to show the practical applications of these notions.

Methodology for retrofitting

The case study of the Grupo de Viviendas Antonio Rueda, located in the city of Valencia (Spain), presents a specific interest in the theme of using materials responding to the 10R strategy for the technological and environmental upgrading of existing buildings. This is achieved through a complete analysis of the housing conditions, and by adopting a historical-critical approach that integrates qualitative and quantitative data. The methodological path reconstructs the functional and constructive evolution of the group of dwellings over time, analysing their architectural and technological features, besides their social characteristics.

Currently, places are undergoing a process of obsolescence that gives rise to considerable points of reflection on the redevelopment of the urban environment (Guajardo, 2017).

The search follows several stages:

- WP1 – Context analysis: historical and social characteristics of the residential complex, identifying morphology, building types and the current state of obsolescence of the built environment.
- WP2 – Evaluation of construction and design aspects: potential of natural and recycled materials, with particular attention to their psycho-emotional impact and sustainability.
- WP3 – User-centred design: cross analysis between resident needs and preferences. This participatory approach in design means that the proposed solutions are adaptable and user-friendly.
- WP4 – Design and prototyping: creation of modular and flexible design prototypes to study configurations and mate-

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01 | Aerial and internal view of the examined housing complex

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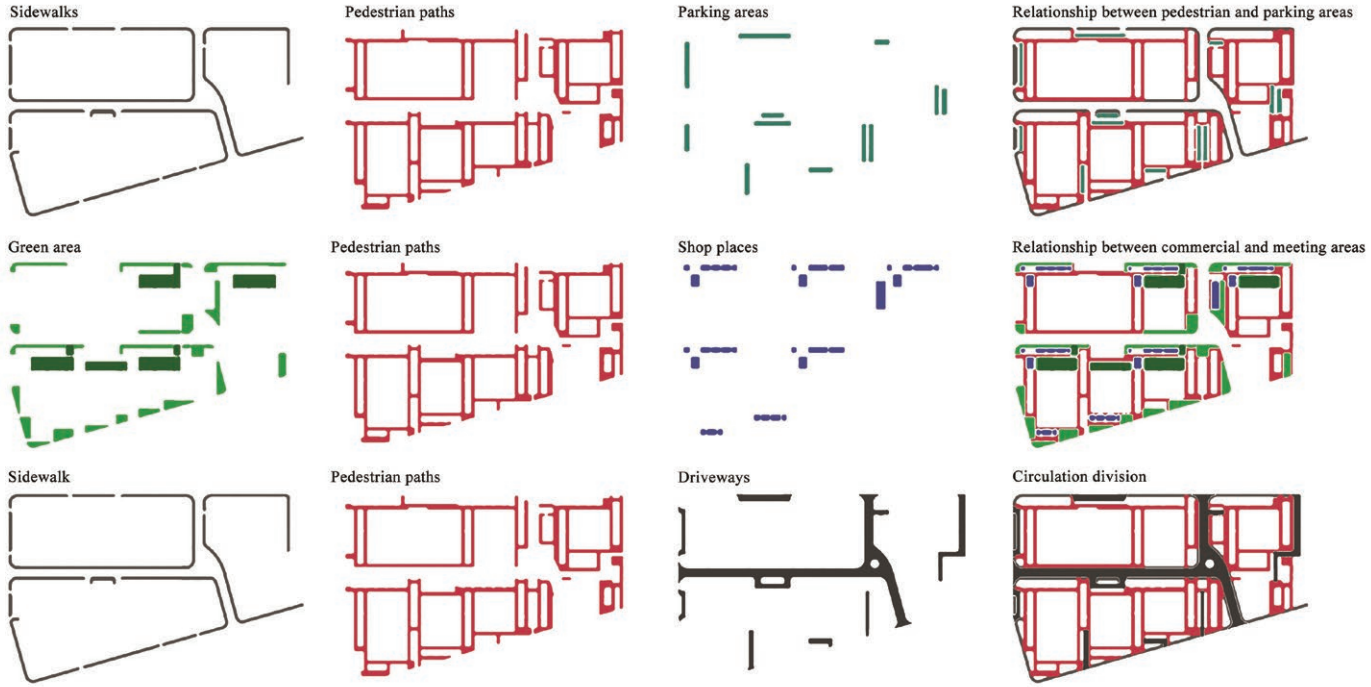
rials, allowing effectiveness in improving living conditions to be evaluated.

Phases WP3 and WP4 are the most interesting, in which research reinforces the role of participatory design, highlighting how knowledge of the needs of inhabitants contributes to the creation of more inclusive and functional spaces. Indeed, a user-centred design approach is essential to ensure that architectural solutions genuinely respond to the daily needs and aspirations of residents. Through participatory design methods, such as surveys, interviews, and focus groups, it is possible to gather qualitative and quantitative data on user preferences, habits, and challenges. This enables the development of adaptive solutions that enhance spatial functionality and comfort, fostering a stronger sense of belonging and well-being. By integrating user feedback into the design process, the project not only improves the usability and acceptability of interventions but also strengthens social cohesion and engagement within the community. The adoption of a modular and flexible design approach allows for the exploration of multiple spatial configurations and material combinations, enabling a dynamic assessment of their impact on living conditions. This adaptability not only facilitates optimisation of resources and customisation of spaces according to user needs but also enhances the resilience and sustainability of the built environment. The results demonstrate the effectiveness of the combination between natural materials, innovative design strategies and green systems, resulting in an improvement of the human-nature symbiosis. Edward O. Wilson discusses the innate human-nature empathic synergy, interpreted in the past by technological solutions based on empirical choices, but insufficient at present without the use of a control tool to verify its performance. The design approach adopted in the case study is based on the principles of circular economy, and enhances the value of local resources and waste materials. Wood obtained from the maintenance of public green areas, for example, is reused in construction, partly reducing dependence on external resources. This strategy is particularly significant in the current context, characterised by a saturated housing stock and an increasingly difficult access to new construction. The addition of autochthonous greenery in the inner courtyards contributes to strengthening biodiversity and improving the quality of life of the inhabitants, responding to the need to reconnect with the surrounding environment. The project thus serves as a model for improving the value and adaptability of existing buildings, in line with modern requirements for liveability and sustainability.

An architectural heritage: the evolution of the Grupo de Viviendas Antonio Rueda

The context analysis reveals a worrying maintenance condition of the existing social housing stock in Spain with consequent critical issues for the safety and comfort of users, who reside in housing facilities with significant criticalities. This issue is particularly important in the housing complex that is the subject of this analysis, located in the Tre Forques district of Valencia (Fig. 1). Built between 1965 and 1970, in a period of economic and social expansion, this residential complex belongs to the social housing typology. Its construction was a response to the growing demand for accommodation in the city centre, caused by the influx of population from peripheral



areas, a phenomenon amply documented by official statistics that attest to the construction of 3,347,768 buildings between 1961 and 1975. The construction of these housing estates was promoted by the policies and strategies of the Obra Sindacal del Hogar (OSH), a public organisation founded under the Franco government in collaboration with the National Institute for Housing (INV). The primary objective of these institutions was to address the housing crisis through the construction and management of social housing.

The Viviendas Bonificables Law of 1944 was an initiative of the Administration to stimulate private enterprise in the housing sector, with a focus on the construction of houses to be rented to the middle class, a segment of the population that did not have particular economic difficulties in the post-war period (Roa-Fernández, 2023). This legislation also aimed to stimulate the recovery of the building sector through the reconstruction of areas damaged or destroyed during the war, encouraging the creation of new building volumes and contributing to the re-development and regeneration of the urban context (Romano, 2024). The Grupo de Viviendas Antonio Rueda, designed by the architects Vicente Valls, Joaquín García and Luís Marés in 1965, commissioned by the Obra Sindical del Hogar of the INV, contains 1002 houses over an area of 10 hectares in a trapezoidal-shaped plot of land (DOCOMOMO, 2024).

The criteria behind the residential complex, for the architects, were the division of pedestrian and road areas; avoiding waste-land by exploiting the entire area; and encouraging relations between users through the creation of public spaces and daily-use commercial activities (Fig. 2).

Morphological analysis reveals the flexible development within the site geometry of the housing complex, showing a systemic balance between green and service areas, thus communicating a common ideal of progress and prosperity.

Each unit of the area (Fig. 3) consists of a four-storey block with a north-south orientation in the upper part, two parallel eight-storey linear blocks in an east-west direction, and single-family duplex dwellings in the middle part, which consciously take up the Cartesian Casba, according to the architects' design idea. One of the main factors taken into account when studying the distribution of the different typologies was the reduction of costs as the fundamental design criterion. Each housing unit, whose category is indicated by a letter according to its size in mq, is associated with a number denoting the floor of the unit, including the ground floor. The number following the hyphen symbol specifies the amount of bedrooms for each type of accommodation.

The total number of residences in the complex is 1002 and they are divided into:

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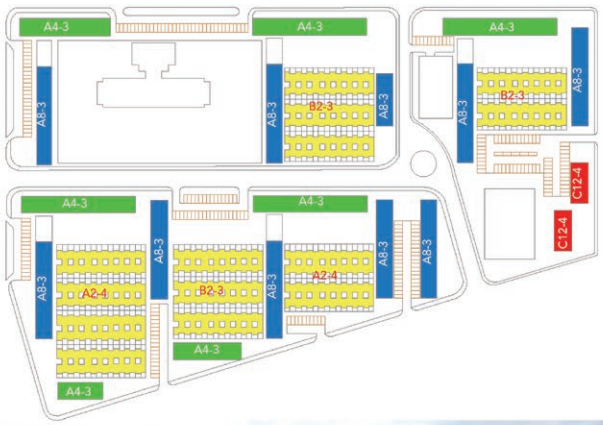


Bulding | 2 floor | Building | 4 floor | Building | 8 floor | Building | 12 floor

Category	Typology | mq	n. of housing
3rd category	A8-3 | 140 mq	560
	A4-3 | 75,97 mq	174
	A3-4 | 90 mq	96
2nd category	B2-3 | 88,80 – 76 – 90 mq	44
1st category	C12-4 | 140,14 mq	128
	total	1.002

- Type A8-3. Linear building with the largest number of apartments. Consisting of 8 floors including the ground floor, it is not a pass-through building, as it does not have cross ventilation and thus adequate internal air circulation, and it also does not have a differentiated orientation for sleeping and living areas.
- Typology A4-3. A four-storey building, of which the ground floor is used for commercial purposes. It takes advantage of the best orientation, which allows the sleeping area to face north and the living area to face south.
- Typology C12-4. These are the towers that close the project and belong to a bourgeois housing style, both in terms of the usable area of each unit and the type of location.
- Typology A2-3 and B2-3. The buildings are located in the central part of the district and consist of duplexes and single-family units. They are developed around private courtyards adjacent to the living area. The labyrinth-like union generated on the upper floor, used as the sleeping area, creates the pedestrian access paths to each unit, forming a platform that acts as a link between the various blocks. This generates an interesting play of light and shadow alternating between covered and uncovered areas.

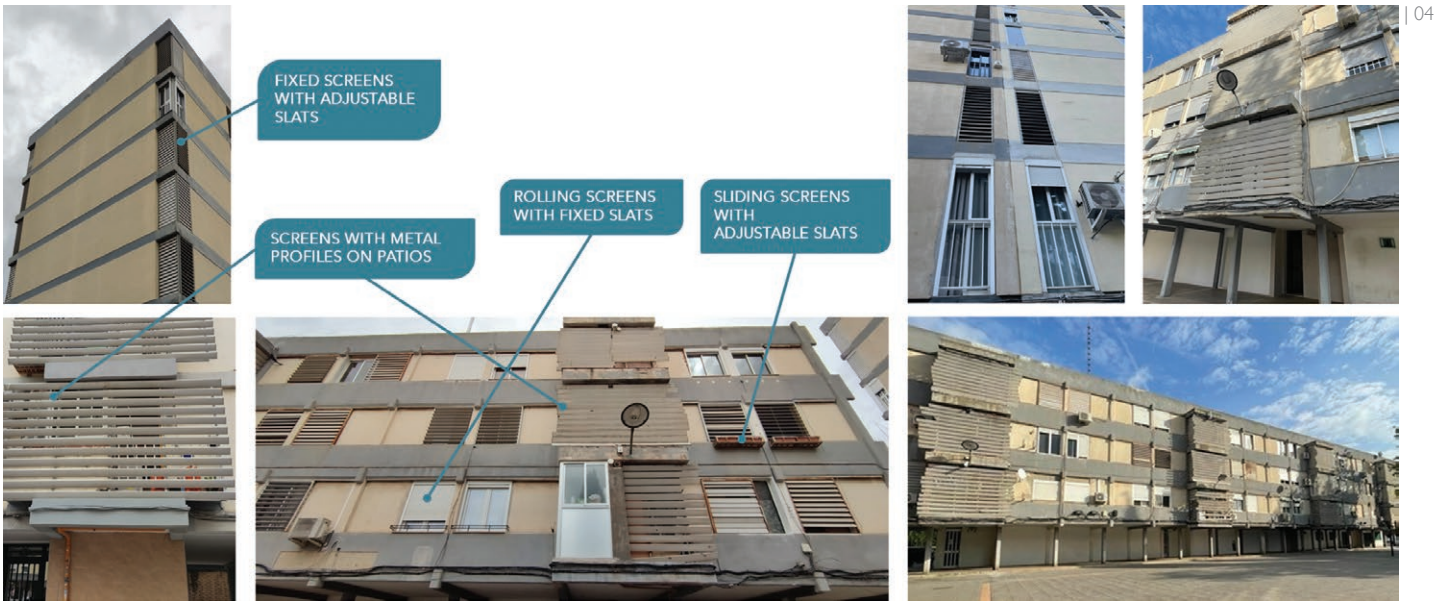
From diagnosis to regeneration: Holistic approach to sustainable retrofitting

The Grupo de Viviendas has struggled to survive the passage of time, currently finding itself in a state of obsolescence. Lack of maintenance and poor conservation have caused most of the present and visible pathologies, especially on the façades. Much of this is due to rain and runoff, which have caused staining, dampness and detachment. As far as the carpentry is concerned, poorly maintained materials have caused the lack of waterproofing and insulation, leading to their replacement by the users themselves, who have not followed uniform criteria. Incorporating new elements has exacerbated and deteriorated the aesthetics of the building, resulting in a loss of the initial design appearance (Fig. 4).

The evaluation of construction and design aspects revealed the poor construction quality of the buildings. The lack of accessibility and energy-efficient conditions due to the materials used at the time of construction and autonomous heating and cooling systems means that the vast majority of users systematically abandon these buildings in search of others with greater guarantees of comfort and well-being. At this phase, the need for a user-centred redesign was identified, considering the socio-economic context characterised by low-income families. Numerous inspections, integrated with specific interviews with the inhabitants of the residential complex, revealed widespread problems concerning the presence of mould and condensate, as well as insufficient sunlight in some housing units, which impair the wholesomeness of the environments and the occupants' well-being. In response to this evidence, the redesign favoured the use of recycled materials, optimisation of natural lighting, integration of greenery and the use of materials capable of reducing the concentration of indoor pollutants. In this perspective, the redesign is a holistic approach to sustainable building,

04 | Current condition of the buildings in the complex examined

05 | Ground floor and first floor of type B2-3, with interior and exterior views



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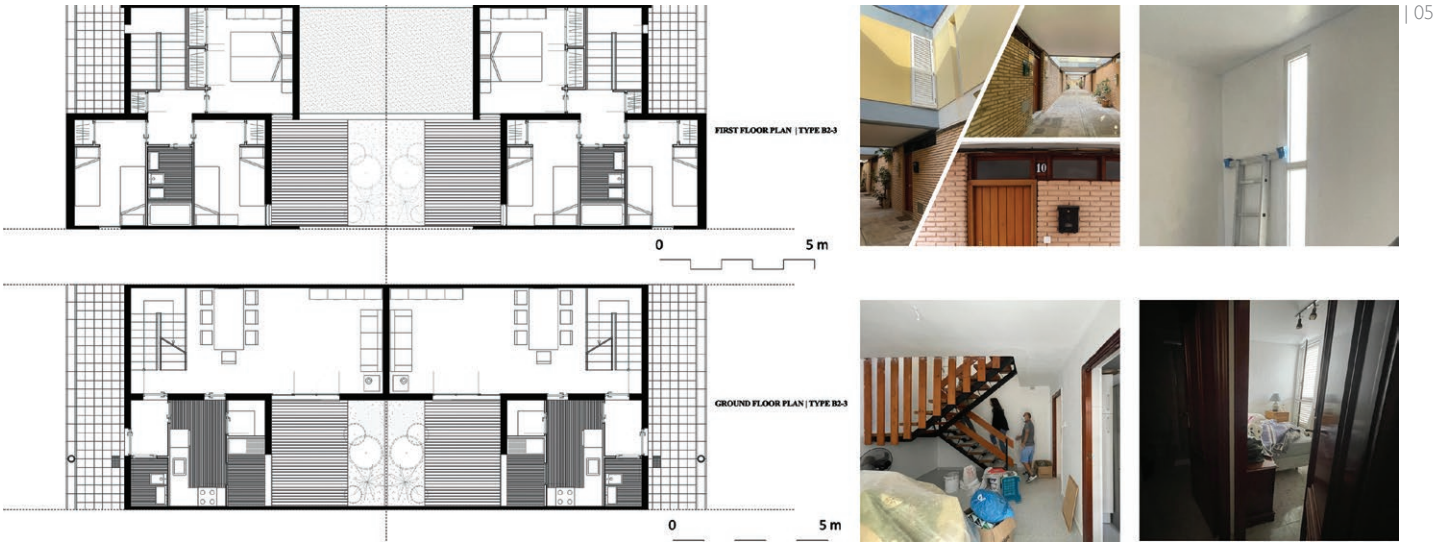


| 05

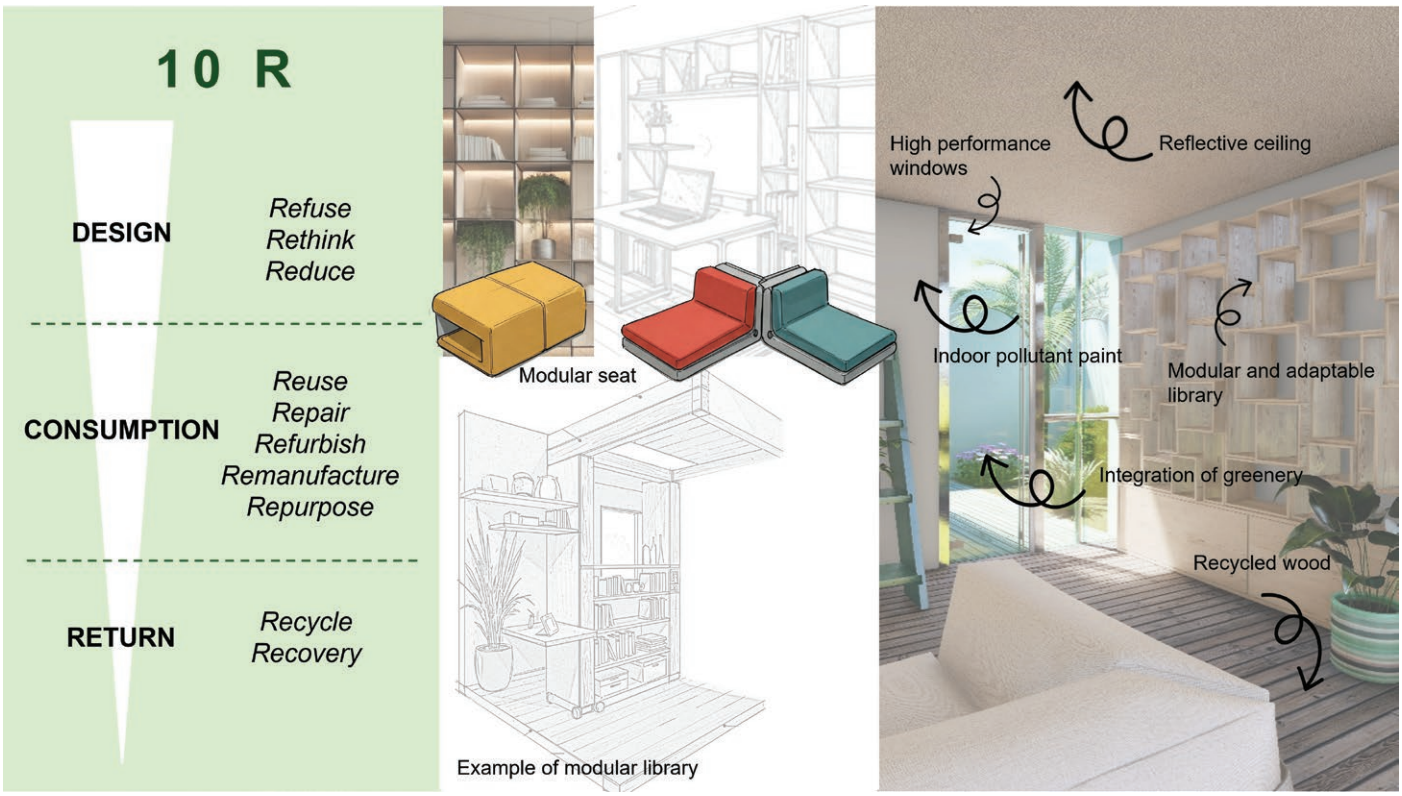
with interventions capable of combining the needs for living comfort with the principles of environmental and economic sustainability by enhancing the value of the existing building heritage and improving the inhabitants' living conditions.

Results

Designing a balanced environment that favours human-nature connections is a complex process, which requires the collaboration of different actors. The design and prototyping followed the basic principles of the 10Rs and the use of appropriate tools and strategies to create spaces that improve living comfort. An example can be found in the B2-3 building, detached and semi-detached buildings in the innermost part of the complex, with a small internal patio in common with the adjacent house (Fig. 5).

The design and construction of buildings that respond to an increasingly complex and unprecedented demand for quality of life and living require a unique approach and innovative solutions capable of establishing a creative dialogue between comfort and sustainability (Di Perna, 2022). The combination of

06 | Sketch and rendering of the interior of type B2-3



natural and/or recycled materials, the psycho-emotional use of colour, the integration of green systems to design modular, flexible and adaptable housing redevelopment are capable of triggering virtuous processes for increasing personal well-being and the human-nature symbiosis. This is also favoured by the use of recovered on site for interior spaces, e.g., wood from the maintenance of green areas for indoor flooring, the integration of vegetation into outdoor areas, such as courtyards, and the use of modular furnishings and textures in warm colours inspired by nature to create different spaces, which can be reconfigured over time to meet new needs (Fig. 6). The interconnection between modularity, flexibility, comfort and economic sustainability of the spaces reduces costs and minimises environmental impacts, ensuring their durability by helping to reduce energy consumption and running costs.

Conclusions: towards a Resilient and User-Inclusive Housing Model

The research on the requalification of the Grupo de Viviendas Antonio Rueda in Valencia highlights the profound impact that integrating natural elements and recycled materials can have on urban living conditions, particularly for low-income families. By adopting a design approach that emphasises flexibility, modularity, and sustainability, the project seeks to foster a deeper human-nature connection, which is essential for enhancing the overall well-being of community residents.

The findings suggest that employing natural materials not only revitalises the physical space but also promotes psychological comfort and emotional well-being among inhabitants. By addressing issues such as poor construction quality, insufficient natural light, and unhealthy living conditions, the redesign aims to create a holistic living environment that respects both ecological and human needs. Furthermore, this research underscores the importance of a user-centred design methodology, which actively involves residents in the planning process, ensuring that the solutions provided are genuinely responsive to their needs and preferences. The successful integration of innovative design strategies with principles of circular economy further reinforces the potential for sustainable urban housing solutions. The study serves as a model for future architectural interventions, illustrating how a balanced design that harmonises human activity with nature-based considerations can lead to healthier, more sustainable urban living environments. This approach not only preserves the Genius Loci of the area but also aligns with contemporary demands for liveability and sustainability in urban contexts.

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Innovative approaches for sustainable and inclusive growth in the Egyptian cotton industry

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Abstract. This research explores innovative strategies to revitalise Egypt's cotton value chain through sustainable agriculture, advanced technologies, and inclusive growth practices. By addressing challenges such as environmental degradation, outdated processing facilities, and socio-economic disparities, the project enhances market competitiveness and global sustainability alignment. Key initiatives include organic cotton cultivation, renewable energy integration, and targeted workforce development. Collaborative efforts with Italian stakeholders, such as the Cottonforlife programme, strengthen traceability, modernise infrastructure, and expand access to international markets. These actions foster job creation, environmental resilience, and economic growth, contributing to the Sustainable Development Goals (SDGs).

Keywords: Sustainable development; Cotton value chain; Inclusive growth; Textile industry; Environmental innovation.

Introduction. Egyptian cotton: legacy and challenges

Egyptian cotton, historically referred to as "White Gold", has long been the gold standard in the global textile industry. Its unique qualities, including exceptional fibre length and lustre, make it highly sought after by luxury and premium brands worldwide. Cultivated in the fertile regions of the Nile Delta, this cotton benefits from a moist climate and traditional hand-picking methods that preserve its superior quality.

Despite its legacy, the Egyptian cotton industry faces critical challenges today. Once a cornerstone of the national economy, «contributing 3% of GDP and employing nearly a third of the industrial workforce» (COMESA, 2019), the industry is now constrained by outdated technology, high input costs, and a fragmented value chain. Public-sector dominance in spinning and weaving has led to inefficiencies, low responsiveness to market demands, and limited integration between cotton growers and garment producers. Additionally, global competition and the rise of synthetic alternatives like polyester have diminished demand for Egyptian cotton in both the domestic and international scene.

The sector's decline has broader implications, including reduced exports, increased reliance on imports, and a growing trade deficit. As traditional cultivation areas shrink and many farmers shift to other crops, the challenges to preserving Egypt's reputation for high-quality cotton become ever more pressing. «This context underscores the urgent need for innovative strategies to modernize the cotton value chain, enhance sustainability, and reclaim Egypt's position in the global market» (Hussein, 2018).

Stakeholders

«The project adopts a multi-stakeholder approach, leveraging partnerships from the "Cottonforlife" initiative and involving key government bodies like MALR, MTI Ministry of Trade and Industry, and their affiliated institutions to foster eco-friendly and socially responsible cotton production» (Unido, Gherzi, 2021). Key stakeholders include:

- MALR and its centres, such as the Agricultural Research Center (ARC) and the Cotton Research Institute (CRI), which focus on improving cotton productivity, quality, and sustainability;
- the Central Laboratory of Organic Agriculture (CLOA), which promotes organic farming, certification, and capacity building;
- MTI-related institutions, like the Egyptian Council for Textile Industries, IMC, FEI, and Textile Export Councils, aim to strengthen Egypt's competitiveness in global markets;
- the Fashion Design Center (FDC) collaborates with the Italian Istituto di Moda Burgo, offering education, services, and entrepreneurial support in fashion design;
- the ENCPC and Kaizen Center promote resource efficiency, cleaner production, and quality enhancement;
- partnerships with Filmar, Italian institutions, and Alexbank foster knowledge exchange, innovation, and funding for start-ups.

Other key players include CATGO, which ensures cotton quality and purity, ALCOTEXA, which regulates cotton export policies, and the Cotton Egypt Association (CEA), which certifies authentic Egyptian cotton via DNA analysis.

Finally, the Ministry of Education, alongside academic and vocational institutes, supports training and curriculum development to align education with industry needs.

Methods. Innovative approaches to revitalise the cotton value chain

The transformation of Egypt's cotton industry requires a holistic and innovative approach, combining sustainability, technological modernisation, and education. «These methods address systemic inefficiencies, align with global sustainability goals, and enhance the industry's overall competitiveness» (Gherzi, 2022).

«Promoting sustainable farming practices is central to revitalizing the cotton value chain» (Cotton Commodity Briefing, 2015). Transitioning to organic farming reduces reliance on harmful chemicals, improves soil fertility, and ensures cleaner, higher-quality cotton. Pilot programmes, such as those implemented under the "Cottonforlife" initiative, have introduced organic varieties like Giza 45 and Giza 87, which have gained international recognition.

Integrated pest management (IPM) minimises the use of harmful pesticides, preserving soil health and protecting biodiversity. Training programmes focus on sustainable water use techniques, such as drip irrigation, combat resource scarcity and increase crop yields.

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«Training programs emphasize techniques to reduce pesticide use, thereby protecting biodiversity, improving soil health, and safeguarding farmers' well-being. These efforts directly address market demand for non-contaminated, eco-friendly fibers» (Uneca, 2023).

The implementation of robust traceability mechanisms ensures transparency in the supply chain. For instance, the Italian Traceability & Fashion Scheme supports Egyptian cotton producers in meeting international standards for ethical and eco-friendly sourcing.

Efficient irrigation methods, like drip irrigation, are being promoted to optimise water use and combat resource scarcity, particularly in Egypt's arid regions. Tailored soil management practices focus on preserving fertility and preventing erosion.

The modernisation of Egypt's cotton industry hinges on the ability to transform outdated processing infrastructure into a technologically advanced, efficient, and sustainable system. Traditional production facilities, particularly in spinning and weaving, have long suffered from inefficiencies, excessive energy consumption, and low responsiveness to international quality standards. To address these issues, the project promoted a comprehensive strategy of industrial innovation –leveraging international expertise, renewable energy, and digitised management tools.

A key aspect of this transformation involved the replacement of obsolete machinery with energy-efficient, digitally integrated systems. In partnership with Italian industry leaders, such as Unionfiliere and Italy's Chambers of commerce, Egyptian manufacturing plants received state-of-the-art ginning and spinning technologies that significantly improved fibre quality and consistency. These upgrades were not limited to machinery. They also included the adoption of advanced dyeing processes and automated quality control systems, which ensured standardization and reduced the margin of human error.

Compared to earlier approaches outlined in the literature (e.g., Silvestre & Țîrcă, 2019), which focus primarily on greening existing value chains in emerging markets, this initiative marks a shift toward co-designing new industrial ecosystems. It demonstrates that sustainable innovation must not only reduce environmental impact but also improve global competitiveness through digital agility and product traceability.

In practical terms, facilities participating in the programme reported a 15-20% reduction in energy consumption by adopting solar-powered equipment and streamlining production workflows. Moreover, real-time inventory and quality tracking systems enabled quicker market response times, reducing lead times by 30% and increasing order fulfilmentrates. These outcomes reflect the project's dual commitment to environmental stewardship and economic efficiency – both of which are central to the Sustainable Development Goals (SDGs) and to Egypt's Vision 2025 strategy.

A key pillar of the project has been the alignment of educational programmes with industry needs, recognising that long-term transformation of the cotton value chain requires a workforce that is not only technically proficient but also socially and environmentally conscious. This educational reform is rooted in a systemic approach, which integrates vocational training, university-level curricula, and lifelong learning strategies.

Collaborations with institutions such as the Istituto di Moda Burgo and various technical schools across Egypt have enabled the co-design of curricula focused on modern textile technologies, sustainable materials, and ethical supply chain management. These educational interventions go beyond basic training, aiming to instil a culture of ongoing innovation and accountability. Students are trained not only in technical skills but also to understand lifecycle analysis, environmental impact assessment, and international textile regulations.

The impact of these reforms is evident in the significantly higher employability rates among graduates. Indeed, vocational school alumni engaged through the programme achieved an 80% job placement rate within six months. Moreover, the integration of school-to-work pathways, including apprenticeships in textile production facilities, has bridged the gap between theoretical knowledge and practical application.

«The strategy builds on existing research emphasizing the role of education in driving sustainability-oriented innovation. By embedding sustainability principles into the core of education systems, the initiative ensures the resilience of future generations of textile professionals» (Adams *et al.*, 2016).

The revival of Egypt's cotton value chain has been significantly enabled by the strength of multi-stakeholder collaborations, bringing together public institutions, private enterprises, and international partners in a shared agenda of sustainable development. This collaborative governance model enhances policy coherence, leverages technical expertise, and mobilises financial resources.

One of the most effective partnerships has been the "Cotton-forlife" initiative, which stands out as a benchmark for transnational cooperation. Managed by FILMAR S.p.A. in partnership with ALEXBANK and Egyptian ministries, the programme blends Italian excellence in textile innovation with Egyptian agricultural heritage. The initiative's contribution spans from introducing certified organic cotton varieties, such as Giza 45 and Giza 87, to the implementation of DNA-based traceability protocols – making it a replicable model for other cotton-producing countries.

This approach marks a departure from more fragmented interventions seen in previous development efforts. It aligns with

the conclusions of those who argue that «system-level transformation requires synchronized action among diverse actors, each reinforcing the other's contributions» (Schaltegger *et al.*, 2016). Italian stakeholders have brought in not only technical solutions but also new governance tools, including certification systems, quality benchmarks, and CSR-driven funding models. The result is a value chain that is more transparent, inclusive, and competitive on the global stage. By securing long-term contracts, accessing new markets, and ensuring environmental compliance, these alliances have helped reposition Egyptian cotton as a premium, sustainable brand worldwide.

Target groups and their roles

The revitalisation of Egypt's cotton industry has depended not only on advanced technologies and institutional reforms but also on the targeted involvement of key societal groups. Recognizing the complexity of the value chain and the need for inclusive development, the project strategically engaged diverse actors – from farmers and SMEs to women, rural communities, and educational institutions. This section analyseshow each group contributed to, and benefited from, the initiative, going beyond traditional stakeholder analysis to demonstrate systemic interdependence and socio-economic transformation.

At the foundational level, cotton growers were central to the implementation of sustainable agricultural practices. Through partnerships with institutions like the Cotton Research Institute and CLOA, farmers received targeted training in organic cultivation, water-efficient irrigation, and integrated pest management (IPM). These interventions were not purely technical but part of a broader strategy to reframe cotton farming as a high value, knowledge-intensive activity.

Concrete results were visible within two cultivation cycles. Farmers trained under the "Cottonforlife" programme reported yield increases of 20% and income growth of 15%, attributed to the premium pricing associated with certified organic cotton. Additionally, the adoption of drip irrigation reduced water usage by 30%, addressing Egypt's broader concerns with water scarcity and aligning with SDG 6 (Clean Water and Sanitation). This approach extends the literature on sustainable agriculture in developing economies (e.g., Kassinis & Soteriou, 2003), offering a model where local knowledge is combined with formal innovation systems to yield quantifiable ecological and economic benefits.

SMEs serve as a critical bridge between raw material producers and global markets. The project empowered these enterprises – many of them youth led – to upgrade their production processes and align with international quality standards. Infrastructure development in industrial zones, shared procurement agreements, and access to renewable energy sources allowed SMEs to enhance efficiency while reducing operational costs.

The outcomes were significant: SMEs in spinning and weaving reported a 10% decrease in production costs, coupled with improved product consistency. Export-readiness programmes, developed in collaboration with Italian institutions, enabled several firms to secure contracts in the European luxury market. These developments contribute to the expanding body of work on SME modernisation in emerging markets (Silvestre & Ţîrcă, 2019), reinforcing the role of targeted investment and knowledge transfer.

Promoting gender equity and rural development was not an auxiliary goal but a core objective. Women in rural areas were provided with specialised training in textile design, eco-friendly dyeing techniques, and quality control. These programmes were developed in consultation with local NGOs to ensure cultural relevance and accessibility.

As a result, household incomes in participating communities increased by 25%, and over 400 women gained sustained employment or entrepreneurial opportunities. These outcomes challenge persistent gender disparities in rural economies and align with findings from Miska *et al.* (2018), who underscore the multiplier effect of women's economic empowerment on community resilience.

Institutions such as the Agricultural Research Center and Cotton Research Institute were revitalised through the integration of advanced classification tools, genetic research, and digital data systems. These enhancements transformed them from passive administrative entities into innovation hubs that actively shaped sectoral development.

Notably, the development of hybrid seeds that reduced pesticide use by 40% while increasing yield by 30% represents a breakthrough in sustainable agricultural research. This achievement supports calls in the literature (Adams *et al.*, 2016) for stronger research-practice linkages in the Global South.

Addressing Egypt's skills gap required an overhaul of vocational education. Collaborations with the Istituto di Moda Burgo and other institutions led to curriculum updates that emphasised sustainability, automation, and textile innovation. Apprenticeship programmes allowed students to gain real-world experience in modern production environments.

The results were tangible. Vocational graduates reported an 80% employment rate within six months, and 134 schools adopted new curricula aligned with industry needs. This confirms prior findings (UNECA, 2023) on the transformative potential of education when paired with industry engagement.

To ensure nobody was left behind, the project also focused on marginalised groups such as unemployed youth and low-income families. Training programmes, access to microfinance, and mentoring for start-ups were among the tools deployed.

These initiatives directly contributed to SDG 1 (No Poverty) and SDG 8 (Decent Work), offering a replicable model for inclusive economic development in resource-constrained environments. By linking productivity gains to equity outcomes, the project advances the discourse on "just transitions" in sustainable development.

Results and Conclusions. Toward inclusive and sustainable growth

The integrated strategy implemented to revitalise Egypt's cotton industry has yielded a wide array of results, demonstrating the effectiveness of coupling sustainability principles with inclusive economic development and technological advancement. These results are not merely quantitative indicators, they, also signify a systemic transformation within a historically fragmented sector.

One of the most significant outcomes has been the creation of new employment opportunities across multiple nodes of the value chain, from agriculture to textile manufacturing. The combined interventions in workforce development, SME support, and industrial modernisation contributed to an estimated 1 million new jobs, particularly among youth and women in rural areas. Over 500,000 individuals received training in sustainable farming, modern textile processes, and digital production systems.

These results exceed the projections made by earlier models of green value chain development in low and middle income countries (Silvestre, 2015), in part due to the systemic nature of the intervention. Unlike piecemeal approaches, this project embedded human capital development into each phase of modernisation, ensuring that labour market outcomes were both immediate and sustainable.

The introduction of traceability systems and alignment with international sustainability standards significantly improved the marketability of Egyptian cotton. Export data shows increased penetration in premium textile markets across Europe, North America and Asia, with several SMEs securing multi-year contracts with luxury brands. The use of technologies such as DNA-based fibre authentication and automated quality control mechanisms positioned Egyptian cotton as a globally competitive, high trust commodity.

By comparison to historical analyses (Hussein, 2018) highlighting Egypt's declining share in global textile exports, these advancements represent a decisive reversal of trend. The integration of Italian technological and design expertise was critical in bridging the quality gap that previously hindered market expansion.

Environmental benefits were equally substantial. Transitioning to organic cotton cultivation and implementing integrated pest management (IPM) led to a 40% reduction in pesticide use and a 30% reduction in water consumption. These practices contributed to improved soil health and biodiversity, supporting the long-term viability of cotton farming in the face of climate change.

On the social front, training and employment programmes targeting women and rural populations resulted in measurable gains in income, autonomy, and local economic resilience. In some pilot regions, household incomes increased by 25%, accompanied by a reduction in rural-to-urban migration. These effects align with the broader framework of social innovation discussed by Bansal and Roth (2000), demonstrating how environmental action can catalyse inclusive development.

The project directly supports multiple Sustainable Development Goals (SDGs), including SDG 1 (No Poverty), SDG 8 (Decent Work), and SDG 12 (Responsible Consumption and Production). Over 1,500 farmers received support for crop diversification and fair pricing, while 134 schools implemented sustainability-focused curricula. The deployment of 4,500 square metres of solar panels and the production of traceable organic cotton yarns further underscore the alignment between local interventions and global sustainability targets.

The outcomes of this initiative extend beyond sectoral recovery. They offer a replicable, adaptable model for other Global South economies seeking to reconcile tradition with innovation, and local empowerment with global integration. By fostering deep collaboration between public and private actors, embedding education within economic reform, and maintaining a focus on measurable impact, the project demonstrates a new paradigm for sustainability-led industrial policy.

Future work should focus on longitudinal evaluation, capturing the enduring impacts on employment patterns, ecological resilience, and export dynamics. Comparative studies with other cotton-producing nations would help refine the model and offer further validation. Ultimately, the Egyptian experience illustrates that even legacy sectors, when reimagined with scientific rigor and participatory governance, can become engines of sustainable and inclusive growth.

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