Community and developer approaches to residential adaptive reuse:

A semi-quantitative study on integration

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Abstract

Adaptive reuse contributes to multiple sustainability goals of the European Union, including *circular economy*, *climate neutrality*, and the urban housing shortage. Existing research focuses on isolated community or developer approaches, yet their effective combination remains underexplored. The present study investigates how integrating different stakeholder groups into residential *adaptive reuse* promotes *common good*-oriented urban transformation.

Therefore, the methodology applies a *semi-quantitative* approach. This includes an in-depth functional analysis of successful *adaptive reuse* case studies realized in Europe over the last decade. Moreover, an expert workshop evaluates integration strategies from different stakeholder perspectives for the *Neuperlach case study*. This comprises converting two large-scale office buildings in the southeast of Munich from the 1970s and 1990s into mixed-use residential buildings. Ultimately, a building concept synthesizes further findings under the research framework of the *three integration pillars* of *sustainable adaptive reuse*.

The key findings highlight divergent tendencies between both approaches: While community projects prioritize *affordable housing*, *common areas*, and *neighborhood space*, developer projects focus on higher-standard apartments and increased profitable office and retail space. The research findings propose *hybrid governance* under a *public-private-people partnership*, in which developers benefit from funding opportunities and cross-finance the community. However, pioneering projects rely on *financial risk mitigation* and streamlined *land-use* and *zoning plan adjustments*.

The study is based on the *New European Bauhaus* initiative and represents the link between academic knowledge and practical case studies in *adaptive reuse*.

Keywords:

Adaptive reuse, Residential, Stakeholder, Governance, Collaborat, Circular**

Zusammenfassung

Adaptive Reuse trägt zu mehreren Nachhaltigkeitszielen der Europäischen Union bei, darunter *Kreislaufwirtschaft*, *Klimaneutralität* und die Bekämpfung des städtischen Wohnungsmangels. Während bisherige Forschung *Community*- oder *Developer-Ansätze* isoliert betrachtet, ist deren effektive Kombination noch wenig erforscht. Die vorliegende Studie untersucht, wie die Integration verschiedener Stakeholdergruppen in *Adaptive Reuse* die *gemeinwohlorientierte* städtische Transformation voranbringt.

Dafür folgt die Methodik einem *semi-quantitativen* Ansatz. Dieser umfasst eine eingehende funktionale Analyse erfolgreicher *Adaptive-Reuse-Fallstudien* der letzten zehn Jahre in Europa. Darüber hinaus evaluiert ein Workshop mit Expertinnen und Experten Integrationsstrategien aus verschiedenen Stakeholder-Perspektiven für die *Neuperlach-Fallstudie*. Diese befasst sich mit der Umnutzung von zwei großen Bürogebäuden im Südosten Münchens aus den 1970er und 1990er Jahren. Abschließend fasst ein *Gebäudekonzept* weitere Ergebnisse unter den *drei Integrationssäulen* von nachhaltigem *Adaptive Reuse* zusammen.

Die Ergebnisse zeigen Unterschiede zwischen beiden Ansätzen: Während *Community-Projekte bezahlbares Wohnen*, *Gemeinschaftsflächen* und *Nachbarschaftsräume* priorisieren, konzentrieren sich *Developer-Projekte* auf Wohnungen mit höherem Standard sowie rentable Büro- und Einzelhandelsflächen. Die Forschungsergebnisse empfehlen eine *hybride Governance* im Rahmen einer *Public-Private-People Partnership*, bei der *Developer* von Fördermitteln profitieren und die *Community* querfinanzieren. Pionierprojekte erfordern jedoch *finanzielle Risikominderung* und beschleunigte Anpassungen von *Flächennutzungs-* und *Bebauungsplänen*.

Diese Studie basiert auf der *New European Bauhaus Initiative* und verbindet akademisches Wissen mit praktischen Fallstudien zu *Adaptive Reuse*.

Stichwörter:

Adaptive reuse, Residential, Stakeholder, Governance, Collaborat, Circular**

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List of abbreviations

Abbreviation	Definition
AR	Adaptive Reuse
BCR	Building Coverage Ratio
BE	Built Environment
BIM	Building Information Modeling
BSO	Building Stock Observatory
CBS	Circular Building Strategy
CE	Circular Economy
CEAP	Circular Economy Action Plan
CEN	European Committee for Standardization
CLT	Community Land Trust
CU	Circular Use
EC	European Commission
EGD	European Green Deal
EN	Eurocode Standard
EP	European Parliament
ESG	Environmental, Social, Governance
EU	European Union
FAR	Floor Area Ratio
GFA	Gross Floor Area
IEA	International Energy Agency
IHRK	Integrated Action Area Concept *(Integriertes Handlungsraumkonzept)*
ISEK	Integrated District Development Concept *(Integriertes Stadtentwicklungskonzept)*
JoCP	Journal of Cleaner Production
LBK	Local Building Commission *(Lokalbaukommission)*
LHM	City of Munich *(Landeshauptstadt München)*
NEB	New European Bauhaus
NPO	Non-Profit Organization
PPPP	Public-Private-People Partnership
SLR	Systematic Literature Review
SoBoN	Socially Responsible Land Use *(Sozialgerechte Bodennutzung)*
UN	United Nations
WGBC	World Green Building Council

Glossary

Adaptive reuse

Functional and, consequently, physical changes to a building (Own definition).

Adapt

Conversions or additions that go beyond maintenance and change the capacity or function of a building (Douglas, 2006).

Architectural program

Planning the use of a building by defining the required spaces, their users, spatial relationships, and size to ensure an efficient and functional layout (Wong, 2016).

Conversion

Adaptation of abandoned or obsolete buildings that no longer satisfy users by changing their function (Wilkinson et al., 2014).

Community adaptive reuse

A bottom-up approach to adaptive reuse based on grassroots efforts (Own definition).

Cooperatives

Member-driven organizations that acquire and manage democratically owned buildings with a focus on collective decision-making and long-term community empowerment (Oevermann et al., 2023).

Developer adaptive reuse

A top-down approach to adaptive reuse based on authoritative decisions (Own definition).

Integrated adaptive reuse

A middle-out approach to adaptive reuse that effectively combines grassroots efforts and authoritative decisions (Own definition).

Municipal ownership

Public sector bodies that manage and refurbish buildings within a strategic urban framework, balancing commercial viability with broader public interest objectives (Oevermann et al., 2023).

Non-profit organizations

Organizations that acquire and manage buildings focus on social inclusion and fund projects through grants and donations to create purpose-built spaces that preserve cultural assets (Oevermann et al., 2023).

Private investors

Profit-oriented companies that acquire and refurbish buildings, focusing on financial returns and operational efficiency. They are often guided by market strategies and legal frameworks (Oevermann et al., 2023).

Renovation

Modernization or restoration of an old building to an acceptable condition, including replacing building components or redesigning interior spaces (Douglas, 2006).

Transformation

Converting unused or underutilized buildings into new uses, reusing structures and materials, and preserving cultural and spatial connections (Wong, 2016).

1. Introduction

1.1. Context: The EU sustainability agenda

Scarce resources, an escalating climate crisis, and an alienating society are the main drivers of the *European Union's* (*EU's*) ambitious sustainability goals for the *built environment* (*BE*).

A fundamental target of the *European Union* is the integration of *circular economy* (*CE*) in the construction sector by 2050 (EC, 2020a). Therefore, the *European Commission* (*EC*) set up the *Circular Economy Action Plan* (*CEAP*) with the following three principles: "eliminate waste and pollution," "circulate products and materials (at their highest value)," and "regenerate nature" (Ellen MacArthur Foundation, n.d.).

Another central goal of the *EU* is climate neutrality by 2050. The *European Green Deal* (*EGD*) applies climate mitigation and adaptation measures (EC, 2019). As buildings comprise 36% of the *EU's* greenhouse gas emissions, they significantly contribute to the climate crisis (European Defence Agency, n.d.).

Besides implementing *CE* measures, climate mitigation, and adaptation, the *EU* aims for sustainable urban transformation. This involves the *Renovation Wave*, which seeks to increase annual energy renovation rates by 2030 to improve the condition of the existing building stock (EC, 2020b). Moreover, the *European Parliament* (*EP*) emphasizes addressing urban housing shortages through sustainable solutions (EP, 2021).

The *New European Bauhaus* (*NEB*) initiative addresses these transformation goals. Led by the *EC*, the *NEB* initiative bridges the gap between science, technology, and art and culture. At its core are shared values and societal benefits, aligning with the *EGD* (EC, n.d.): *Aesthetics*, *Sustainability*, and *Inclusion*.

A pioneering project contributing to the *NEB* and *EGD* is the *Circular Neuperlach Action*. Located southeast of Munich, it is part of the *Creating NEBouhoods Together* initiative. It develops a sustainable vision for the district, converting underutilized offices (see *Figure 1*, p. 11) into regenerative, climate-friendly, and community-centered spaces (Circular Neuperlach, n.d.).

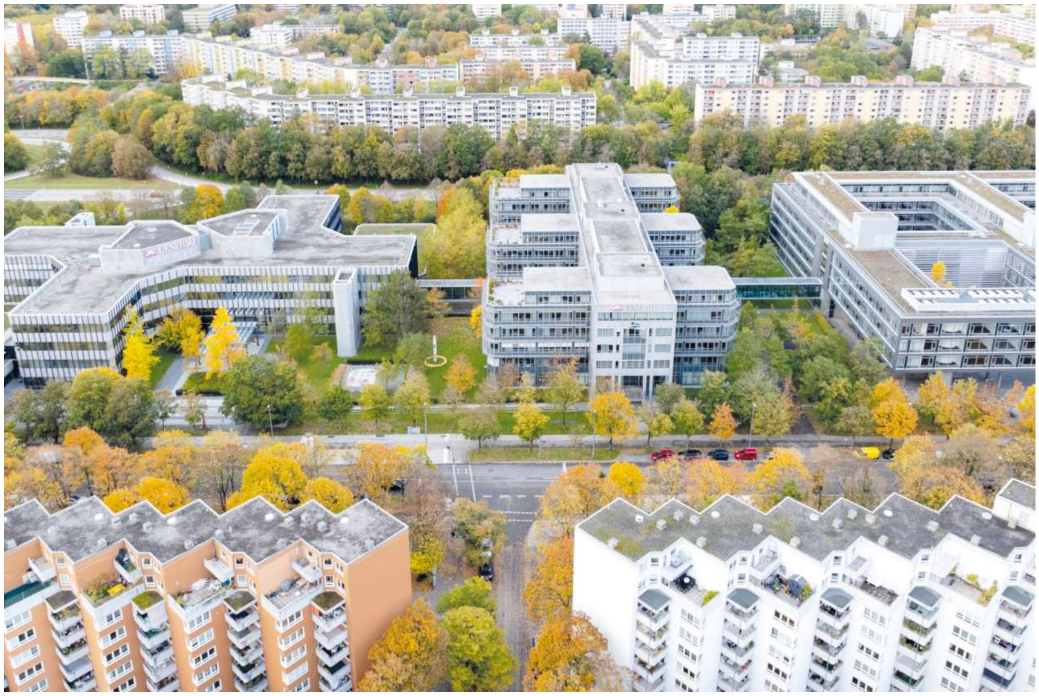


Figure 1: Neuperlach building case study. Image courtesy of © Patrik Thomas.

Adaptive reuse (*AR*) is key in achieving the *European* goals for sustainable urban transformation, specifically in the *Circular Neuperlach Action* project, which aligns with *NEB* and *EGD*.

AR of existing buildings applies *CE* principles to extend the useful lifespan of buildings through functional updates. Regarding climate neutrality, embodied carbon emissions can be preserved, offering an environmentally sustainable approach to the existing building stock. Moreover, *AR* comprises the energy retrofit of existing structures with outdated operational energy performance, increasing the annual renovation rates to 3%, especially the currently low annual deep renovation rates of 0.2% (Buildings Performance Institute Europe, 2021).

In more detail, *AR* of common building typologies prone to obsolescence allows new housing opportunities in underutilized spaces and contributes to urban densification. By addressing the core values of the *NEB* initiative, *AR* projects not only protect the environment but also have the potential to preserve local culture and strengthen the social fabric.

1.2. Problem: Underrepresentation of local communities

Grassroots efforts are of great value in *AR* projects and sustainable transformation. The completed *OpenHeritage EU* initiative demonstrated the potential of several community-driven *AR* projects, emphasizing the role of local communities in strengthening attachment to place and long-term engagement (Oevermann et al., 2023).

Over four years, the broad study tested 16 *AR* projects across 11 *European* countries. One successful example of neighborhood revitalization is a cooperative-run cultural hub supporting social inclusion in Lisbon’s Intendente neighborhood (see *Figure 2*).

Figure 2: OpenHeritage EU initiative for community-driven adaptive reuse. Source: Silva (2023).

While community efforts are decisive for long-term success, the *OpenHeritage EU* initiative is limited to heterogeneous heritage projects of a smaller size. In contrast, large-scale projects are typically the domain of developers with substantial experience in project management. Although some private developers operate under a social agenda, the local community must actively participate in conversion processes from the early project stages to increase success. This underlines the need for further *AR* case studies that explore the effective combination of both approaches.

1.3. Research aim: Integrated adaptive reuse

While full circularity and climate neutrality lie in the future, tackling affordable housing shortages and promoting the common good-oriented urban transformation are pushing for quick solutions now. The *NEB* initiative and, more precisely, the *Circular Neuperlach Action* project contribute to sustainable urban transformation through several building case studies. *AR* of *Neuperlach's* obsolete and vacant building typologies holds great potential for addressing the *EU* goals. However, community *AR* projects are vital in promoting sustainable and vibrant neighborhoods with strong community engagement. Therefore, further case studies must integrate local communities into large-scale *AR* projects.

The present study addresses this gap with the following research question:

How can large-scale projects integrate community approaches into residential adaptive reuse for sustainable urban transformation?

In the context of the *Circular Neuperlach* project, the study examines two monofunctional office buildings in Neuperlach from the 1970s and 1990s. Their common typology, building size, and construction year make them an ideal theoretical case study for mixed-use residential *AR*. For detailed analysis, the study examines the role of different stakeholder groups, evaluates innovative hybrid governance and collaborative financing models, and explores the functional capacity of the *Neuperlach* case study.

To answer the research question, the study tests three hypotheses:

- H1: The community and developer approach lead to different outcomes.
- H2: Collaboration between stakeholder groups generates shared benefits.
- H3: Integration combines social cohesion with financial viability.

The findings serve as a model adaptable to other *European* cities.

1.4. Relevance: The potential of existing buildings

Residential *AR* of obsolete building typologies addresses several *EU* sustainability goals. *Europe* is facing a far-reaching housing shortage, aggravated by rising construction costs. In *Germany*, the supply of social housing has fallen sharply, with only 1.1 million units available as of 2023 compared to 2.1 million units in 2006 (Statista, 2024e). The social housing deficit is over 830,000 units (Statista, 2024f). This concerns, above all, urban areas, where low offer and high demand contribute to gentrification. While efforts to build new homes fall short of expectations, the construction industry must focus on quick solutions for the existing building stock.

In *Europe*, the existing non-residential building stock consists of over a quarter of office buildings (see *Figure 3*). A recent study by the *Technical University of Darmstadt* and the *Pestel-Institut* (2019) estimates that converting office buildings and adding floors to existing structures could create 1.3 million apartments only in *Germany*. According to Vafaie et al. (2023), *AR* leads to cost savings ranging from 10 to 12 percent compared to new construction. This underscores the vast potential of existing buildings to immediately address the *EU's* urban housing shortage.

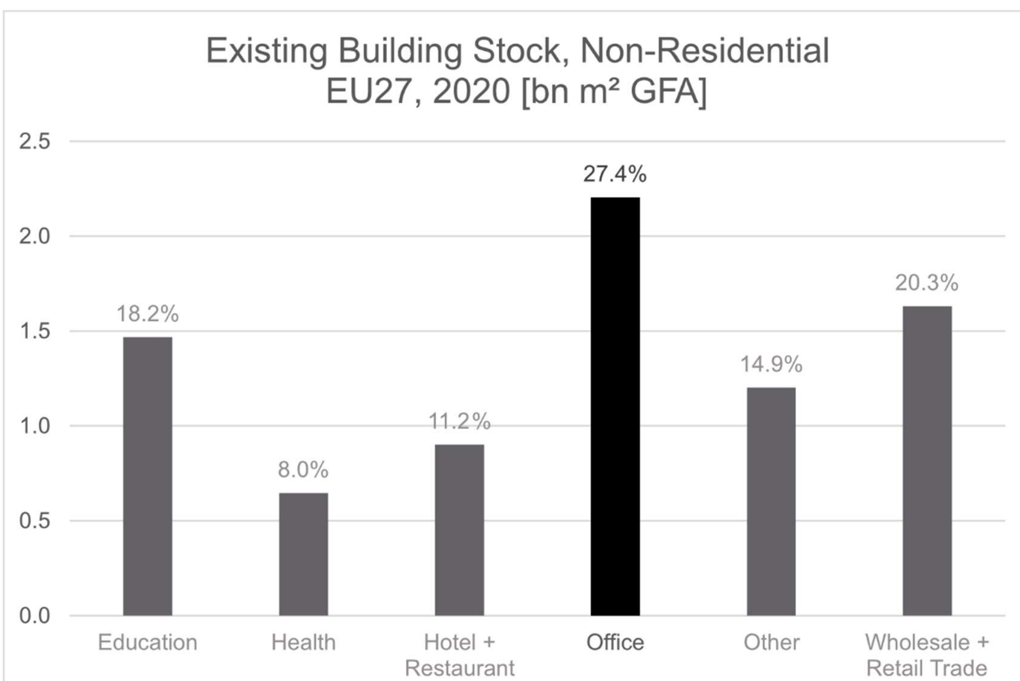


Figure 3: Existing building stock of non-residential buildings in the EU27, 2020. Source: Own figure based on data from the European Commission Building Stock Observatory (EC, 2020c).

1.5. Thesis structure

The present study is structured into *six chapters*, building upon each other to explore community, developer, and integrated approaches to residential *AR* (see *Figure 4*).

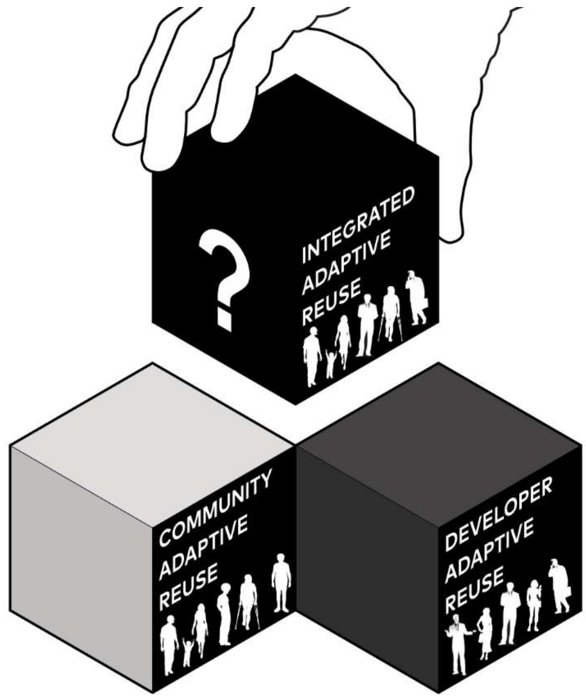


Figure 4: Community, developer, and integrated adaptive reuse. Source: Own illustration.

- *Chapter 1* introduces the overarching *EU* goals and the contribution of residential *AR*.
- *Chapter 2* sheds light on the current scientific literature on *AR*, provides a theoretical framework, definition, and success factors, gives an example of community, developer, and integrated approaches to *AR*, and highlights the research gaps.
- *Chapter 3* explains the methodology for integrated *AR*: the building database, the expert workshop, and the building concept.

- *Chapter 4* presents the results, highlighting strengths in community and developer approaches to residential *AR* and their effective combination for an integrated approach.
- *Chapter 5* discusses the findings, placing them in the current scientific discourse and linking them to practical residential *AR* case studies.
- *Chapter 6* answers the research question on integrated *AR*.

This structure offers a holistic view from scientific knowledge to practical experiences, pointing to sustainable urban transformation (see *Figure 5*).

Figure 5: Integrating community initiatives in adaptive reuse. Source: Oevermann et al. (2023).

2. Literature review

2.1. Introduction to literature review

The ambitious *EU* sustainability goals require transformative actions. While traditional construction methods fail to reach these goals, *AR* represents a promising solution as part of the *CE*. Bocken et al. (2016) popularized the three circular principles: *narrowing* (fewer materials), *slowing* (extended use), and *closing* (material recycling) resource loops. Nußholz et al. (2023) implemented the *regenerating* (ecosystem recovery) principle, while Çetin et al. (2021) added the supportive *collaborating* (shared action) principle. These circular principles can be applied to every scale. Munaro et al. (2020) found through a systematic literature review (*SLR*) that 39% of *CE* research focuses on material recycling or component reuse. Pomponi and Moncaster (2017) argue that "current *CE* research tends to focus either on the macro-scale, such as eco-parks, or the micro-scale, such as manufactured products, with the risk of ignoring the additional impacts and potentials at the meso-scale of individual buildings (p. 710)." This highlights the need for deepened building-scale investigations (see *Figure 6*).

Figure 6: Research scale of the study. Source: Own figure based on concepts from Ossio et al. (2023).

The research comprises a literature review using academic databases (*Scopus Academic Database*, *Web of Science*, *ResearchGate*), complemented by extensive books on *AR*. These are the keywords:

- Circular economy
- Circular built environment
- Circular construction
- Circular building
- Adaptive reuse

The publication year is preferentially from 2015 onward, when the *CE* concept experienced rapidly increasing interest (Munaro et al., 2020; Benachio et al., 2020; Mhatre et al., 2021; Cruz Rios et al., 2022; Ossio et al., 2023).

The subsequent literature review sections on *AR* provide the theoretical framework, key definitions, success factors, ownership models, examples of community, developer, and integrated approaches to *AR*, and identified research gaps.

2.2. The three pillars of sustainable adaptive reuse

The theoretical framework of the present study is derived from the *OpenHeritage EU* project by Oevermann et al. (2023) and is explained in the following (see *Figure 7*).

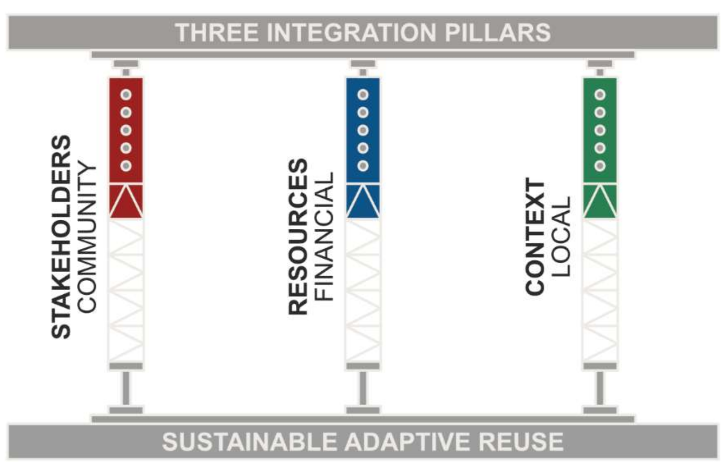


Figure 7: OpenHeritage's three integration pillars of sustainable adaptive reuse. Source: Own illustration based on concepts from Oevermann et al., 2023.

Integrating communities and stakeholders

The first pillar of sustainable *AR* highlights the importance of community engagement. Participatory governance models empower stakeholder collaboration. For instance, *Cascina Roccafranca* in *Turin* exemplifies co-governance between the municipality and local organizations, fostering social inclusion and innovation. The first pillar focuses on:

- Promoting local ownership and engagement
- Establishing governance structures at eye level
- Creating community capacity through participatory forums

Integrating financial, materialistic, and human resources

The second pillar of sustainable *AR* advocates for efficient resource use. Leveraging existing finances, materials, and labor reduces costs, raw material demand, and carbon emissions. For example, the *Sunderland High Street Lab* utilized crowdfunding and supported local craftsmanship and construction skills. The second pillar includes:

- Securing diverse funding sources
- Ensuring access to traditional financial institutions
- Decreasing dependency on voluntary work and in-kind donations

Integrating territorial and regional contexts

The third pillar of sustainable *AR* aligns with territorial and regional contexts. Policies adapted to local geography and culture are key to effective collaboration. The *Praga Lab* in *Warsaw* exemplifies this by integrating urban policies while preserving the district’s cultural identity and industrial heritage. The third pillar emphasizes:

- Encouraging collaboration across different governance levels
- Supporting the economy of local communities
- Addressing disparities between territories

The three integration pillars for sustainable *AR* empower local communities, gather financial resources, and respect the local context.

2.3. Adaptive reuse definitions

In the last decades, scientific literature has recorded various definitions of *AR*. According to Vafaie et al. (2023), *AR* encompasses "the change of function on a small or large scale" (p. 2). This definition addresses Ossio et al. (2023), who note that all buildings face inevitable "economic, technical, or functional" (p. 11) obsolescence.

Wilkinson et al. (2014) describe *AR* as "any work to a building over and above maintenance to change its capacity, function or performance" (p. 4). Similarly, the *Office for Design and Architecture South Australia* (2014) defines *AR* as "to re-use a building or structure for the purpose of giving it new life through a new function" (p. 1). Wong (2016) notes that *AR*, "as the renovation and reuse of pre-existing structures for new purposes, requires the introduction of the new within the established order of the existing" (p. 124).

Plevoets and Cleempoel (2019) emphasize fundamental or minor "changes that involve a functional and a physical component […] and may vary from almost completely changing a building's structure and appearance to a few minor changes to an interior" (p. 23). This aligns with the concept of *shearing layers* from Brand (1994), which explains how buildings evolve through distinct layers—site, structure, skin, services, space plan, and stuff—each with different rates of change. Brand recognizes the dynamic relationship between function and form, saying that "function reforms form, perpetually" (p. 18).

Berger et al. (2009, as cited in Wong, 2016) refer to *AR* as "transforming an unused or underused building into one that serves a new use," including "not only the reuse of existing structures but also the reuse of materials, transformative interventions, continuation of cultural phenomena through built infrastructure, connections across the fabric of time and space and preservation of memory" (Wong, 2016, pp. 30–32). This comprehensive definition reflects the inherent nature of *AR*, promoting sustainability by repurposing existing structures, reducing the need for primary raw materials, and maintaining cultural continuity.

Despite their differences, the various definitions share a common theme: They all refer to *AR* as a functional update. This implies extending the life of the building and averting its immediate physical end due to functional obsolescence.

Historical background

As Plevoets and Van Cleempoel (2019) documented, the practice of *AR* has existed for centuries under different names. For instance, *Michelangelo* converted the *Imperial Roman Baths of Diocletian* in *Rome* into *Santa Maria degli Angeli* during the *Renaissance*, giving them a new religious function. *AR* was recognized in the *1964 Venice Charter* as a strategy for monument conservation with societal benefits.

Notable proponents of *AR* include the *Italian* architect *Carlo Scarpa*, the *Spanish* architect *Rafaël Moneo*, the *Norwegian* architect *Sverre Fehn*, and the *Brazilian* architect *Lina Bo Bardi*, all of whom integrated historic buildings into their design approaches.

The *Renaissance* principles of *translatio, imitatio,* and *aemulatio* require a deep understanding of adaptation. *Translatio* means "clinging to a model's footsteps and aims at similarity," while *imitatio* seeks "equality rather than similarity." *Aemulatio* "aims to improve upon the model itself" (p. 32), demonstrating creative freedom (Plevoets & Van Cleempoel, 2019). Each philosophy represents an increased degree of functional and physical change:

- *Translatio* preserves (e.g., *Reconstruction of Notre Dame Cathedral, Paris*).
- *Imitatio* reinterprets (e.g., *Tate Modern, London*).
- *Aemulatio* transforms and surpasses (e.g., *Fondazione Prada, Milan*).

Contemporary *AR* projects exemplify a nuanced architectural approach that balances preservation, reinterpretation, and transformation.

Merriam-Webster (1973) defines *AR* as "the renovation and reuse of pre-existing structures (such as warehouses) for new purposes." Nowadays, *AR* practices aim at resource conservation and carbon emission reduction: "Within today's context of climate change, the term 'adaptive reuse' is re-defined, and in a significant manner" (Wong, 2016, p. 30). According to Oevermann et al. (2023), *AR* ideally contributes "to broader policy aims such as sustainability or regeneration" (p. 16).

The longstanding tradition of converting buildings to meet evolving societal needs has shifted from a primary focus on heritage preservation to a broader emphasis on environmental sustainability.

2.4. Adaptive reuse success factors

The success of *AR* projects depends on different factors. Therefore, Vafaie et al. (2023) highlight *AR* success factors predominating in scientific literature, separated into ten categories (see *Table 1*).

Table 1: Literature's most cited adaptive reuse success factors. Source: Own table adapted from Vafaie et al., 2023.

Category	Success factor	Citations
Architectural	Structural analysis	[24]
Structural	Building lifespan extension	[21]
Socio-cultural	Community participation	[25]
Economic	Job creation	[23]
Environmental	Accessibility	[23]
Energy	Condition assessment	[12]
Authenticity	Architectural history	[21]
Legal	Building regulations	[16]
Management	Stakeholder collaboration	[14]
Functional	Functional compatibility	[20]

Community participation is the most frequently cited success factor, underscoring the importance of effective *stakeholder collaboration*. Other important factors are *job creation* and *accessibility*. Literature also emphasizes *structural analysis*, *building lifespan extension*, and *functional compatibility*, three core characteristics of *AR*. *Architectural history* and *building regulations* are decisive success factors in cultural heritage preservation. *Condition assessment* is of increasing importance for energy retrofits.

Vafaie et al. (2024) confirm these theoretical *AR* success factors through a recently added practical case study on *Fenix I* in *Rotterdam*—this *AR* project was also included in the building database (see *Appendix A* and *Appendix B*). The findings underscore the decisive role of early *stakeholder collaboration* despite the project falling short of expected profit and developers barely breaking even. However, *Fenix I* is widely considered successful due to its social, architectural, and urban impact.

The theoretical and practical insights into *AR* success factors emphasize the need for active *community participation* and early *stakeholder collaboration*.

2.5. Adaptive reuse ownership models

Based on Oevermann et al. (2023), the following ownership models are standard in *AR*. They range from models that emerged from community initiatives to those increasingly shaped by institutional and regulatory frameworks, representing a gradual transition from bottom-up to top-down.

- *Community land trusts* are developments under community governance, in which local non-profit organizations own property and create and manage assets vital to their communities.
- *Cooperatives* are owned by their democratic members with autonomous structures and self-organization.
- *Non-profit organizations* own and rent a property that is not solely profit-oriented.
- *Private investors*, potentially pursuing social goals, offer a property they own or have purchased.
- *Municipal ownership* plays a role in strategic urban land planning with varying site management based on the specific property, its surroundings, and the involved stakeholders.
- *Regulation of the commons* is founded on constitutionally allowed access to publicly accessible resources.

Each stakeholder group brings different strengths to *AR* projects, ranging from regulatory oversight from *municipalities* to financial support from *private investors* and social engagement from *NPOs*. The challenge lies in the careful coordination of the different interests.

The following chapters present three practical case studies of *community*, *developer*, and *integrated AR* projects.

2.6. Community adaptive reuse

The present study defines *community AR* as a bottom-up approach based on grassroots efforts. Local communities are actively involved in decision-making, respecting individual people's needs.

In *Umbaukultur*, Grafe and Rieniets (2022) featured the *Alte Samtweberei* in *Krefeld* (see *Figure 8*). In 2014, the *NPO Montag Stiftung Urbane Räume* started the initiative to transform an expired textile factory in the historic *Samtweberviertel* district into a vibrant cultural hub. The conversion introduced rental apartments, including socially subsidized units. Artists, architects, and artisans repurposed the *Pioneer House*, while the *Gatehouse* now includes co-working spaces. The *Neighborhood Room* at the heart of the *Alte Samtweberei* adapts to evolving community needs. The final project phase started in 2018, inaugurating a community garden, workshop spaces, and a sports area. Rental income from residential and commercial uses generated surplus funds, which a local foundation reinvested into social initiatives.

The *Alte Samtweberei* contributes to a thriving neighborhood through the *NPO's* high community engagement.

Figure 8: Alte Samtweberei in Krefeld, Germany. Source: Nachbarschaft Stiftung (n.d.).

2.7. Developer adaptive reuse

Developer AR is regarded as a top-down approach based on authoritative decisions. Developers typically incorporate private investment and market-oriented goals capable of generating high urban impact.

The Cosmopolitan in *Brussels* is a good example (see *Figure 9*). In 2014, the real estate developer *Besix RED* converted a 1960s office tower into a mixed-use development with residential units and two office levels. The physical adjustments not only preserved the existing concrete structure with its unique ceiling heights of more than three meters but also added three floors, accentuating the proportions of the building's slim silhouette. The west and east façades offer generously sized balconies with panoramic city views to those residents who can afford them. The double-height entrance hall strengthens the connection between the building and the urban surroundings, enhancing the quality of life in the densely populated urban environment (Grafe & Rieniets, 2022).

The Cosmopolitan exemplifies urban revitalization through the real estate developer's strategic decision-making involving *private investors*.

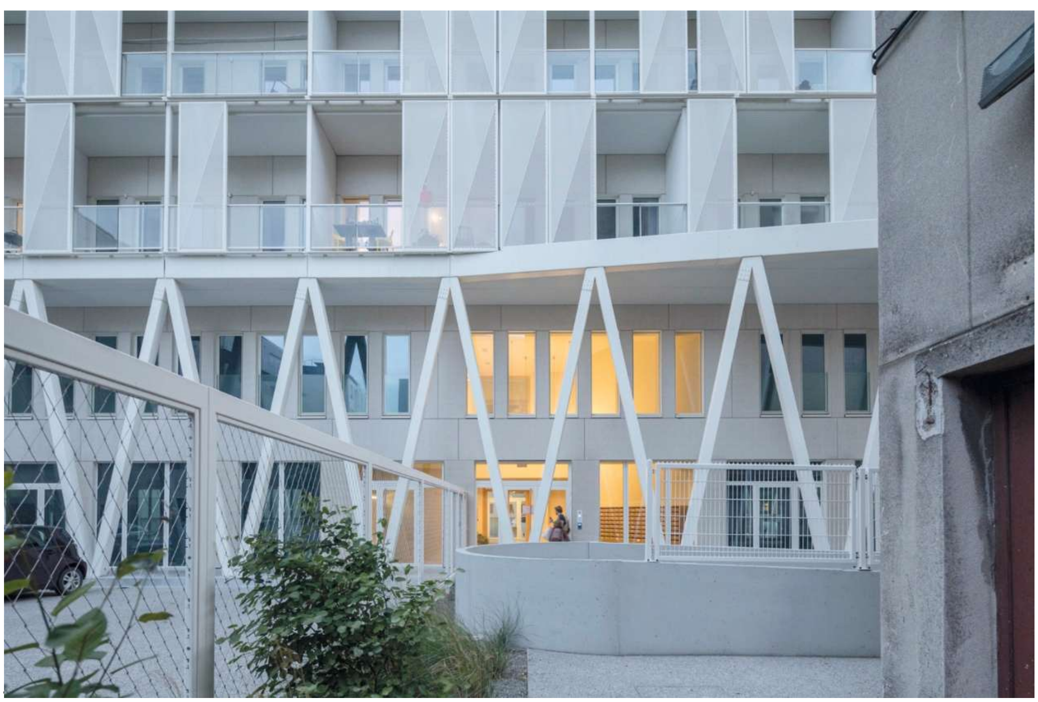


Figure 9: The Cosmopolitan in Brussels. Source: ArchDaily (2021). Image courtesy of © Laurian Ghinitoiu.

2.8. Integrated adaptive reuse

Integrated AR is considered a middle-out approach that effectively combines grassroots efforts and authoritative decisions. Integrating individual perspectives bridges the gap between different stakeholder groups.

De Flat Kleiburg in *Amsterdam* showed close stakeholder collaboration (see *Figure 10*). The consortium *DeFlat* proposed a participatory renovation model in 2013, giving in to the pressure of people who believed in preservation and the local government. The modernist residential ideal was saved, allowing future residents to purchase the apartments in raw condition and complete the interior in self-renovation. In return, the consortium renovated the main structure, elevators, and galleries, leaving the apartments empty shells. This strategy significantly reduced costs while increasing community engagement to finish their kitchens, bathrooms, and heating systems. The reduction in the provision of essential infrastructure promoted the adaptability of people's personalized living spaces (Grafe & Rieniets, 2022).

De Flat Kleiburg demonstrates effective stakeholder collaboration with shared benefits within a public-private-people partnership (*PPPP*).

Figure 10: De Flat Kleiburg in Amsterdam. Source: Arkitekten (n.d.). Image courtesy of © Stijn Brakkee.

2.8. Adaptive reuse research gaps

Several research gaps in *AR* remain unaddressed. Despite the increased attention over the past decade, hybrid governance models are still underexplored. This is reflected in the widely recognized research dimensions of circularity in the *BE* from Pomponi and Moncaster (2017), with the neglected governmental dimension, as Cruz Rios et al. (2022) later validated (see *Figure 11*).

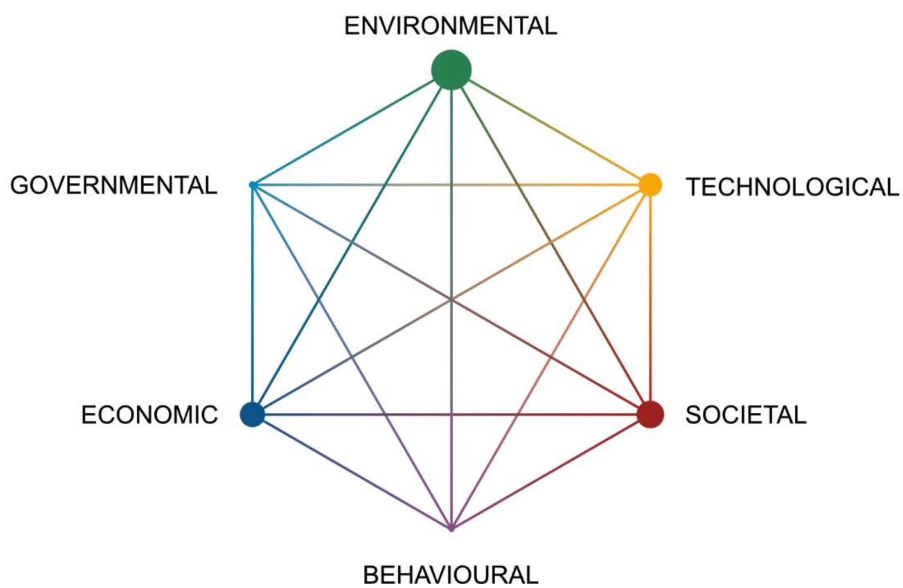


Figure 11: Research dimensions and priorities of circularity in the built environment. Source: Own figure adapted from Pomponi and Moncaster (2017).

To address the gap in hybrid governance models, the *OpenHeritage EU* initiative advocates for "co-creation with locals and externals" (Oevermann et al., 2023, p. 167). Regulatory frameworks often hinder stakeholder collaboration, as existing regulations span heritage conservation and urban development to property laws, housing regulations, and broader societal and cultural frameworks (Oevermann et al., 2023). Notably, Kip and Oevermann (2022) found a selective bias in community-driven *AR* projects towards educated initiators over working-class residents, hindering equal participation and causing gentrification. This represents an entry barrier for individual citizens, discouraging social inclusion.

While Rettich and Tastel (2023) argue that the *Federal Building Code* provides sufficient tools for urban transformation in theory, practical modifications to zoning laws and land-use plans often end in slow and controversial processes. Staudt et al. (2025) call for flexible planning methods, enabling *AR* projects to adapt to changing circumstances. However, addressing local concerns in regional planning remains difficult.

Another gap closely connected to hybrid governance models is innovative financing, as local communities are struggling with access to stable funding. Oevermann et al. (2023) propose "inclusive business models," "self-restoration," and "public-private-people partnerships" (p. 167) as practical solutions. Kip and Oevermann (2022) also successfully tested commoning instruments in *AR* for non-commercial uses, yet these are financially fragile. Remarkably, Rettich and Tastel (2023) emphasize the increased willingness of different stakeholders to cross-finance community buildings or neighborhoods, investing in social services, cultural institutions, and supply networks.

A third gap is the scarcity and scalability of pioneering *AR* projects. Nußholz et al. (2023) identified the general absence of circular building case studies in academic literature. They emphasize the need for gray literature to complement peer-reviewed research to bridge the gap between theory and practice. Furthermore, the promising community-driven *AR* projects of the *OpenHeritage EU* initiative are limited to individual heritage projects in peripheral urban areas (Oevermann et al., 2023). Foster (2020) also remarks that all *AR* projects "are unique, place-based, and community-based, meaning that a universal solution is impossible" (p. 11). However, Hild and Farnoudi (2020) see the vast potential of commercial building typologies in residential *AR* when focusing on the suitable structural grid. This means that the scalability of *AR* projects results from a compromise between common building typologies and the individual context.

The present study addresses these research gaps with numerous practical case studies in residential *AR,* providing real-world insights. It also discusses integration models for the *Neuperlach* case study, hybrid governance models, and collaborative financing and funding possibilities.

3. Methodology

3.1. Introduction to methodology

The methodology applied a semi-quantitative study and was structured in three integral components (see *Figure 12*). The building database, the expert workshop, and the building concept contributed to a comprehensive understanding of residential *AR*.

Figure 12: Research design of the master's thesis. Source: Own figure.

3.2. Building database

The building database established many *AR* projects in *Europe*, as Gallego-Schmidt et al. (2020) recommended. Practical case studies emphasizing circularity were in focus. The scope and parameters were:

- **Geographical:** Projects located in *Europe*
- **Temporal:** Buildings repurposed since 2015
- **Building size:** Medium-scale (≥ 1,000 m² GFA)
Large-scale (≥10,000 m² GFA)
- **Building use:** Pure residential
Mixed-use residential

The used data sources were:

- **Professional journals:** *Journal of Cleaner Production* (*JoCP*)
- **Books on adaptive reuse:** Various publishers
- **Architecture magazines:** *Detail* (all issues since 2020)
- **Building databases:** *ARUP* (2022); *Delft University of Technology* (n.d.)
- **Architecture websites:** *BauNetz*

The outcome represented a curated database of 20 highly relevant projects in pure and mixed-use residential *AR*. The analysis compared circular building strategies (*CBSs*) patterns in community and developer approaches.

The 30 *CBSs*, of which 17 were relevant for *AR*, originated from Nußholz et al. (2023), who conducted a systematic literature review (*SLR*). Çetin et al. (2021) supplemented the supportive collaboration strategy to include the governmental circular dimension, leading to a maximum of 18 *CBSs* per *AR* project (see *Appendix A*).

Reference building analysis

For in-depth analysis, the reference building selection ensured an even distribution of six community and six developer projects (see *Appendix C* and *Appendix D*). In the case of multiple stakeholders, they were assigned based on who was decisive for the project start to ensure sample size. Architectural plans, spatial modeling, and standardized calculations served this purpose.

The reference building analysis assessed the representation of community projects in medium-scale (≥ 1,000 m² *GFA*) and large-scale buildings (≥ 10,000 m² *GFA*). The residential use analysis compared the sufficiency of apartment sizes and affordability of pricing segments. These ranged from subsidized and affordable to market-rate, premium, and luxury apartments.

The functional analysis of the reference buildings highlighted different use proportions in community and developer *AR* projects. Based on concepts from Staudt et al. (2025), a further analysis examined the vertical use distributions more closely across the typical floor, ground floor, and top floor. The basement was excluded due to the lack of floor plans. The use classes were categorized by *Eurocode EN 1991-1-1* of the *European Committee for Standardization* (CEN, 2002) (see *Table 2*, p. 31).

Table 2: Use classes by EN 1991-1-1. Source: Own table adapted from CEN, 2002.

Category	Specific use	Example
A	Residential areas	Residential apartments, hospital wards
B	Office areas	Office spaces, administrative buildings
C	Gathering areas	Community meetings, public events
D	Retail areas	General retail shops, department stores
E	Storage areas	Storage rooms, archives
F	Vehicle areas	Parking garages, vehicle traffic areas

Project publications served for data collection and preparation, including floor plans, sections, and axonometries explaining the functional programming. First, the *BIM* software *ArchiCAD* helped to scale all necessary plans according to the column grids from project descriptions. Next, the 3D modeling software *Rhinoceros 3D* created the room volumes and assigned them to their specific use class layers, which the visual programming language *Grasshopper* utilized to automatically calculate room volumes and floor areas by use class. Finally, the equal weighting of all reference buildings, varying significantly in size, ensured consistent, unbiased average values.

The precise information on conversion, ownership models, and stakeholders was included in the appendix (see *Appendix B*).

3.3. Expert workshop

The *Circular Neuperlach Action* project group of the *Technical University of Munich* considered different expert perspectives during the expert workshop. These included a municipal expert with extensive experience at the *Local Building Commission* (*LBK*) *Munich*, a cooperative expert specializing in architecture and urban planning, and a private expert focused on sustainable project development. The workshop consisted of:

- Evaluation of integration models for the *Neuperlach* case study
- Use allocation of community needs in 1:100 model sections
- Creation of a feasible stakeholder network with shared benefits

First, the experts evaluated the proposed integration models for the *Neuperlach* case study based on their expertise (see *Figure 13*, p. 32).

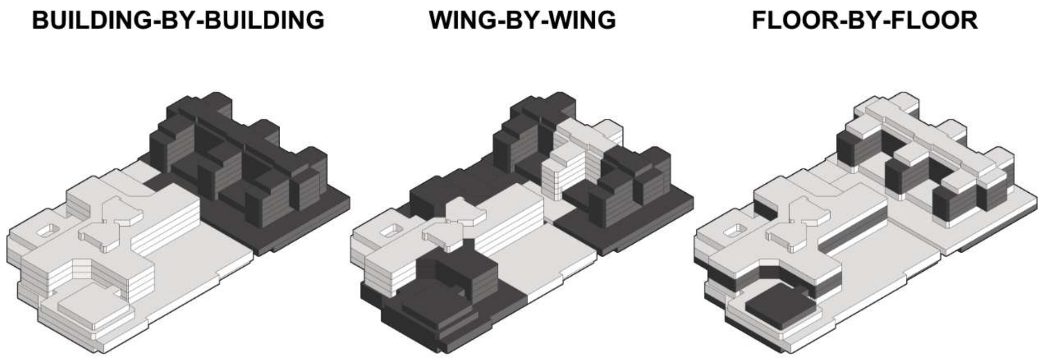


Figure 13: Integration models in the Neuperlach case study. Source: Own illustration.

The *integration by building* entirely separated the community from developers. Similarly, the *integration by wing* forced a vertical separation of community and developer responsibilities. This included minor interventions like physically decoupled areas with individual vertical access and major interventions like partial demolition into several smaller buildings. In contrast, the *integration by floor* separated both stakeholder groups horizontally. Here, the governance of ground floors, with increased room heights for public access, and the top floors, with rooftop access, were separated from the governance of regular floors.

Next, the participants allocated community needs, originating from the *Integrated Action Area Concept* (*IHRK*) and the *Integrated District Development Concept* (*ISEK*) (Landeshauptstadt München [*LHM*], 2021a, 2021b). Therefore, 1:100 scale model sections of the two office buildings' shell structures were prepared in advance. The community needs, such as affordable housing, co-working, and cultural offers, were spatially distributed in the models to test the potential use allocation of the favored integration model.

Ultimately, the professionals created a stakeholder network for the *Neuperlach* case study. A pinboard served the purpose of intuitively weaving a feasible network of stakeholders involved in building conversion. Low hierarchies, collaborative decisions, and attractive financing were central to the discussion. Also, the scope of existing legal frameworks was highlighted.

The experts received detailed preparatory materials in advance. These comprised the land use, development, and site plans, which are publicly accessible through the official municipal geoportal (LHM, n.d.-a). Additionally, they had early access to the *IHRK* (LHM, 2021a). Detailed plans of the *Neuperlach* case study facilitated the elaboration of workshop results (see *Appendices E–G*). Overall, a robust foundation for the building concept stood firm.

3.4. Building concept

The building concept was based on the research framework of the three integration pillars of sustainable *AR* (Oevermann et al., 2023):

- Integrating community-oriented uses
- Integrating profitable uses
- Integrating uses into the local context

Integrating community-oriented uses

Circular uses (*CUs*), as introduced in Staudt et al. (2025), increase functional density for the *Neuperlach* case study through space sharing and space intensification (see *Figure 14*). This leads to the so-called "vibe" and "tribe" (p. 12) effect, which strengthens the social fabric with potential economic and environmental benefits (Lundgren, 2023).

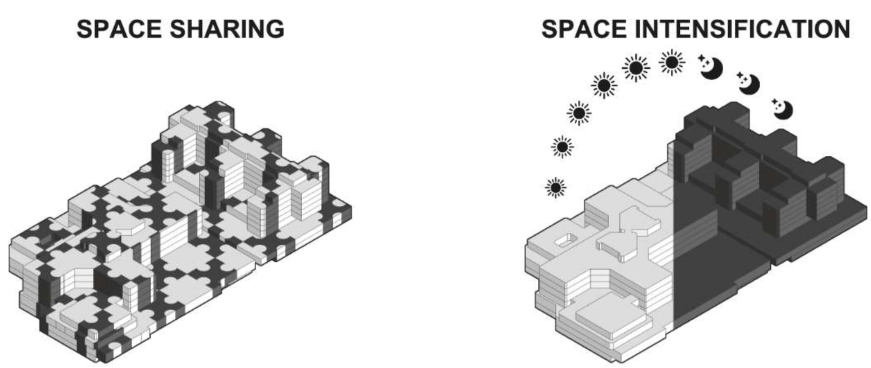


Figure 14: Circular uses in the Neuperlach case study. Source: Own illustration based on concepts from Staudt et al. (2025).

Therefore, a *pairwise comparison matrix* (Ramík, 2020) determined the most compatible uses. The matrix effectively filtered the core uses, positioning them at the heart of the architectural programming, with supportive uses around them and autonomous uses placed offside. Use combinations were identified, which enhanced space and time efficiency, leading to functional occupancy. The three steps were:

- Combinations through space sharing.
- Combinations through space intensification.
- Cross-comparison of space sharing and space intensification.

Space sharing determined parallel use combinations, where the same space can allocate multiple functions. This requires flexible space, as in the *LocHal Library* in *Tilburg, Netherlands*, which spatially combines a public library and co-working facilities. *Space intensification* identified sequential uses, where the same space could accommodate distinct functions over time, whether throughout the day or on different days of the week. This requires adaptable space, as in the *LocHal Library*, which temporally changes between quiet study areas during the morning and vibrant event spaces in the evening (ARUP, 2022).

Integrating profitable uses

Detailed cost calculations determined the profitable uses to establish a balanced use mix for the *Neuperlach* case study. For residential uses, the special focus was on a realistic share of affordable housing.

The amortization period was calculated with the following formula:

$$t \cdot Monthly\ Revenues > Initial\ Costs + t \cdot Monthly\ Costs$$

Solved for t:

$$t > \frac{Initial\ Costs}{Monthly\ Revenues - Monthly\ Costs}$$

The condition was that monthly revenues exceed monthly costs:

$$Monthly\ Revenues > Monthly\ Costs$$

To ensure reliable calculations, financial input data were sourced from reputable industry benchmarks:

- **Construction costs** originate from the *Baukostenindex* (*Construction Cost Index* [*BKI*]), which includes standardized cost estimates for constructing and converting different building typologies in *Germany* (BKI, 2023 & 2024).
- **Revenue streams** are based on current market data from *Statista*, which offers insights into rental income (Statista, 2024a, 2024b, 2024c, 2024d).
- **Variable costs** comply with the *German federal law's ImmoWertV 2022* (*Anhang 3*), which provides guidelines for assessing operating expenses (Bundesministerium der Justiz und für Verbraucherschutz [*BMJ*], 2022).
- **The number of parking spaces** results from the *Stellplatzverordnung* (*parking space regulation*) of the *City of Munich*, which defines requirements for parking facilities (LHM, 2007).

The analysis compared the profitability of different use categories regarding their initial construction costs, annual variable costs, and revenue streams. The *construction cost index* accounted for inflation in older values as of December 2024 (BKI, n.d.). The *Construction Cost Index for Existing Buildings*, *Baukosten Gebäude Altbau*, provided reliable data for the office conversion to use categories *A-Residential, B-Office, C-Gathering,* and *D-Retail* (BKI, 2023).

However, the *Construction Cost Index for New Buildings*, *Baukosten Gebäude Neubau*, included the previously missing use categories *E-Storage* and *F-Vehicles*, applying a conservatively estimated factor of 50% of new construction costs, as no major interventions were needed. The *Construction Cost Index for New Buildings* also provided ratios for housing pricing segments, which were applied proportionally to the construction costs of an office-to-residential conversion (BKI, 2024).

The available data provided realistic ranges for construction costs, including average data and minimum and maximum boundaries. For future price developments, a higher 3% annual inflation rate was assumed for construction costs compared to 2% for revenue streams. This assumption reflects higher construction sector uncertainties, such as labor shortages, resource scarcity, and fluctuating market conditions.

The profitability rates were determined by calculating the annual profit relative to construction costs, ideally falling within the 5–10% range (or higher). This indicated that the project achieved financial amortization within 10–20 years, generally considered an attractive timespan for investors. Low-risk projects typically prefer quicker amortization times, around 10 years, ensuring a faster return on investment and reduced financial exposure. All cost calculations included a risk factor of 15% of the planned construction budget, often necessary as a risk buffer (Bundesinstitut für Bau-, Stadt- und Raumforschung [*BBSR*], 2015).

The building concept aimed for a faster financial amortization than the examined community projects and a higher share of affordable housing and community spaces than the developer projects.

Integrating uses into the local context

The seven building wings of the *Neuperlach* case study offered different qualities for conversion. A comprehensive analysis assessed the functional capacity of the two existing office buildings, comprising quantitative building parameters from Eisele et al. (2020) and qualitative context-specific parameters. These parameters determined the building wings most suitable for the local community with high spatial requirements.

The building database, expert workshop, and building concept formed a cohesive methodology for exploring integrated *AR*.

4. Results

4.1. Results from the building database

The building database highlighted patterns of *CBSs* in community and developer approaches to *AR* (see *Figure 15*, p. 38).

The *collaboration* strategy emerged as a distinguishing factor. This was due to half of the projects incorporating strategies like participatory workshops, co-decision-making processes, or shared governance with the local community. Most community projects (88.9%) were collaborative, compared to only a few developer projects (18.2%). Notably, none of the five privately owned buildings (0.0%) showed collaborative efforts.

Apart from *collaboration*, community approaches applied 7.0 *CBSs*, slightly more than the 6.5 *CBSs* in developer approaches, showing higher community efforts in circularity. While pure residential *AR* applied 6.5 *CBSs*, mixed-use residential *AR* achieved 7.0 *CBSs*, suggesting a higher degree of circularity in polyfunctional buildings.

Due to the inherent nature of *AR*, all buildings applied the three *CBSs*:

- *Building adaptation* (100.0%)
- *Refurbishment* (100.0%)
- *Clean energy* (100.0%)

Furthermore, three *CBSs* were identified as above-average:

- *Durability* (70.0%)
- *Space sharing* (65.0%)
- *Space intensification* (65.0%)

Therefore, *CUs* were highly present in residential *AR*. The corresponding *CBSs* are *durability, building adaptation, space sharing,* and *space intensification*. Community projects applied 3.2 *CUs* compared to 2.8 *CUs* in developer projects.

This underscored the importance of the *building use phase* in *AR*.

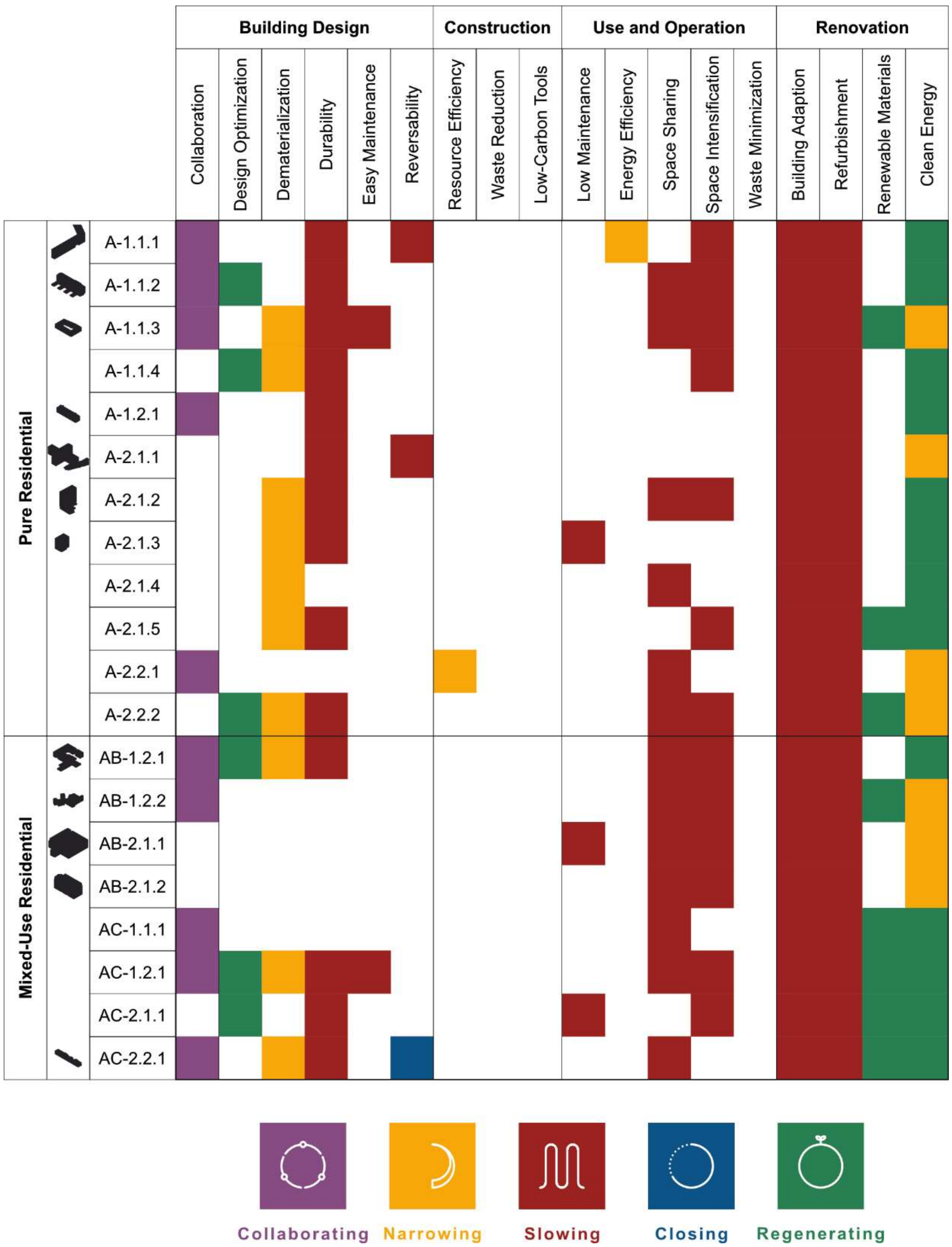


Figure 15: Circular building strategies in residential adaptive reuse. Source: Own figure based on principles from Nußholz et al. (2023), Çetin et al. (2021), and Bocken et al. (2016).

The analysis of *CE* principles revealed a strong emphasis on *slowing* (87 instances), followed by *regenerating* (27), *narrowing* (19), and *collaborating* (10), while *closing* (1) was almost absent, indicating a strong tendency toward extending the building's functional and physical lifespan.

For comparison, an additional analysis of *CBSs* in 10 office *AR* projects showing similar patterns was included in *Appendix A*.

Ownership models by building size

The building database compared *AR* ownership models from Oevermann et al. (2023) by building size (see *Figure 16*).

It strengthened the assumption that community approaches were underrepresented in large-scale projects. While the three smallest buildings comprised *cooperatives* and *NPOs*, the four largest buildings heavily relied on *private investors*. Notably, the latter comprise most of the total area of all projects.

However, community involvement in large-scale buildings was possible in combination with *municipalities*, while community leadership was the absolute exception.

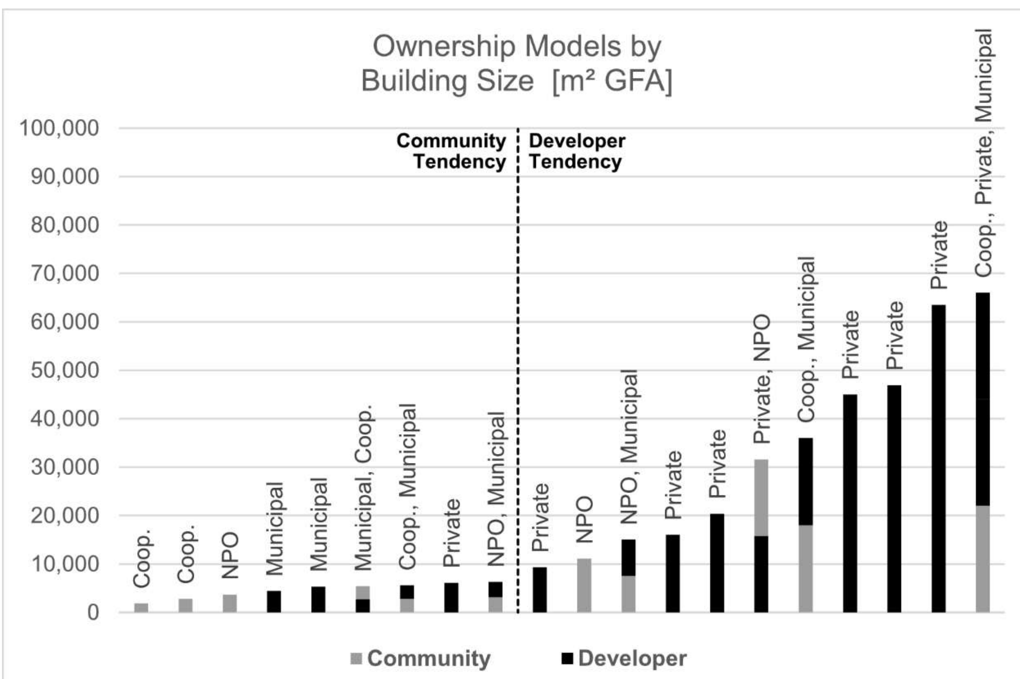


Figure 16: Ownership models in residential adaptive reuse by building size. Source: Own figure.

Average apartment sizes

The reference building analysis also compared average apartment sizes (see *Figure 17*). Generally, this indicated sufficient use of space in residential *AR*. However, the 4-room apartments showed a notable difference between community and developer projects, providing an additional area of more than 20 m² on average. This suggested a slight tendency in developers toward larger apartments.

Besides, the community projects included more than twice as many residential common areas (6.4%) as developer projects (3.0%).

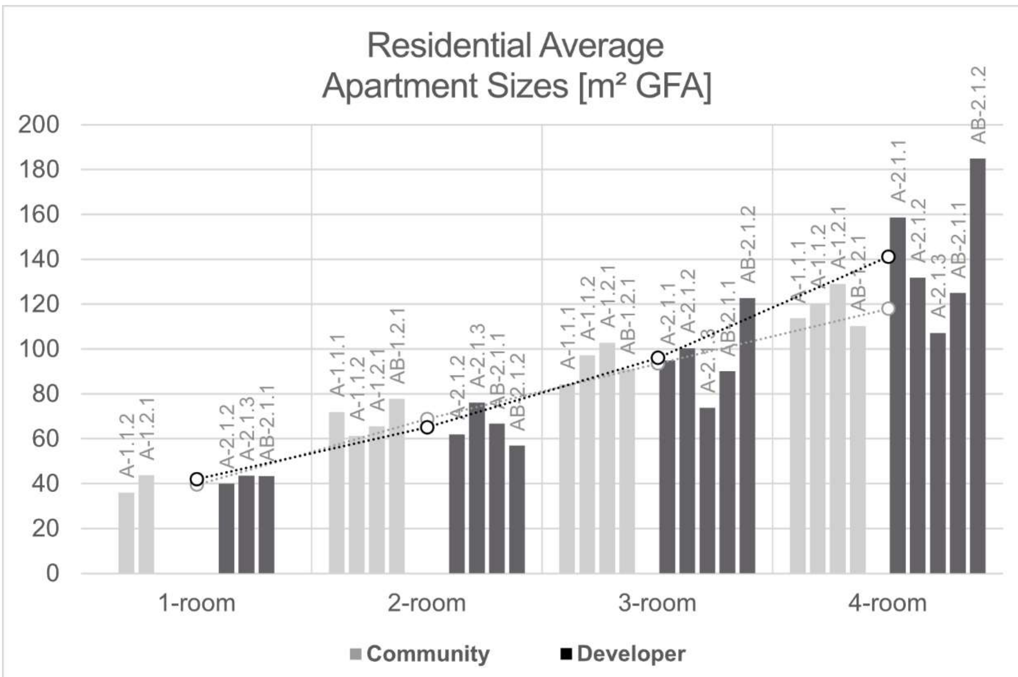


Figure 17: Average apartment sizes in residential adaptive reuse. Source: Own figure.

Residential units by pricing segment

The previous analysis of apartment sizes must not be seen without the share of different pricing segments (see *Figure 18*, p. 41). Community projects emphasized prices below market rate, with a significant share of *subsidized* and *affordable* housing. On the contrary, developer projects focused on *market-rate* residential units, with a decent share of *premium* and few *luxury* penthouse apartments.

Notably, collaborative developer projects incorporated higher shares of social housing.

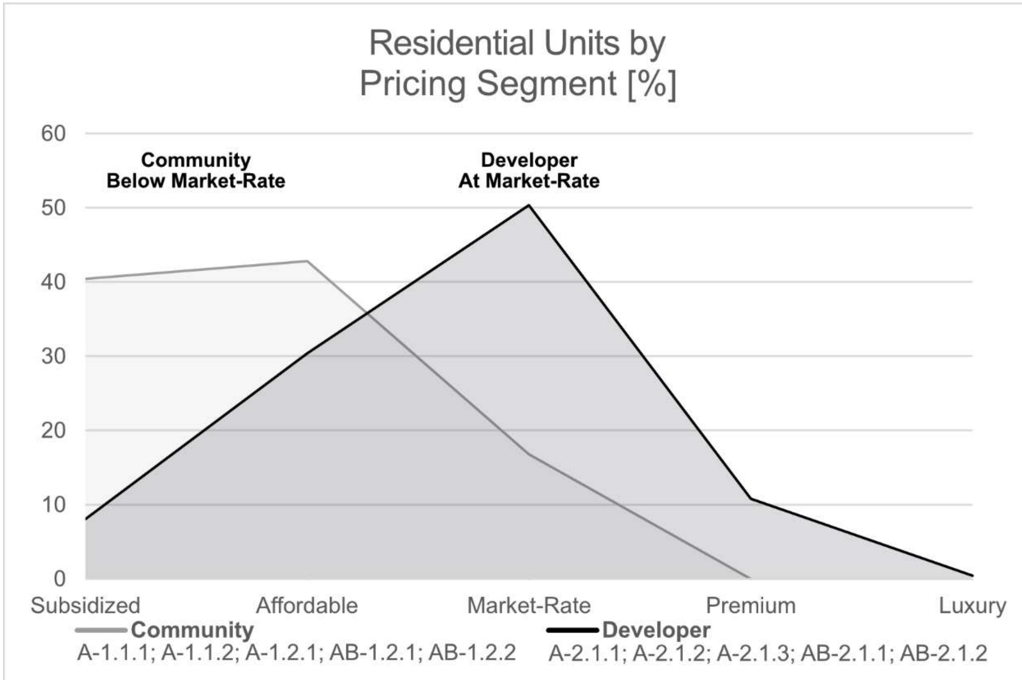


Figure 18: Approximate calculations of residential units by pricing segment. Source: Own figure.

One encouraging example of a private investor with a social agenda was the *Morland Mixité Capitale* in *Paris*, with 80 social housing units, 84 intermediate units, and 35 market-rate units demonstrating mixed-income housing (*CALQ*, n.d.).

Mixed-use residential use class analysis

The use class analysis of the 3D-modeled reference buildings revealed divergent tendencies in mixed-use residential *AR* (see *Figure 19*, p. 42). The community (31.3%) and developers (30.5%) allocated roughly one-third to residential space. While the former showed a significantly higher share of gathering space (+22.8%), the latter invested in additional office space (+6.1%), retail space (+5.5%), and above-ground vehicle space (+13.3%).

The analysis also brought areas with the *CUs building adaptation, space sharing,* and *space intensification* to light:

- Retrofittable parking spaces in the *Veemgebouw* in *Eindhoven*
- A neighborhood room in the *Alte Samtweberei* in *Krefeld*
- Alternating uses in the evening at *BOB Campus* in *Wuppertal*

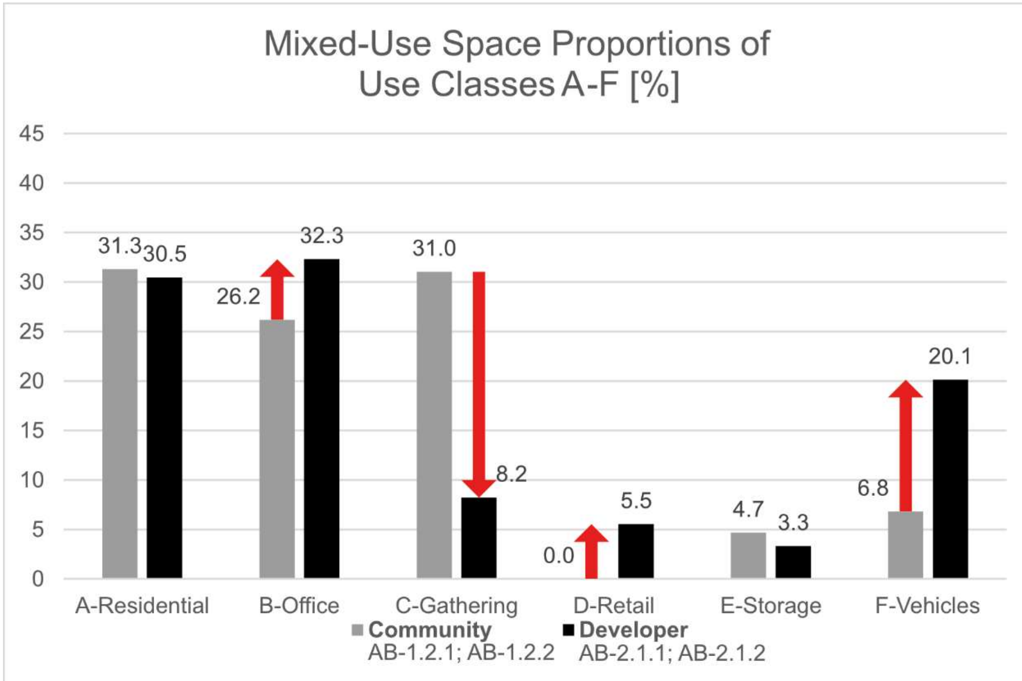


Figure 19: Differences in mixed-use residential space proportions. Source: Own figure.

An in-depth analysis of mixed-use residential *AR* projects examined the vertical space distribution (see *Figure 20*, p. 44).

- **Typical floors**
  The typical floors mainly consisted of half *residential* and half *office space*. An individual project also assigned lots of *vehicle space*.
- **Ground floor**
  The ground floor in community projects included much *gathering space*, while developer projects assigned a comparable amount of *retail space*.
- **Top floor**
  The community reserved most of the top floor for *gathering space*. On the contrary, developers sacrificed significant *gathering space* for more *residential* and *office space*.

Pure residential vertical space distribution

The in-depth analysis of pure residential *AR* projects revealed similar tendencies in vertical space distribution (see *Figure 21*, p. 45).

- **Typical floors**
  The typical floors incorporated *residential space* in line with their purpose.
- **Ground floor**
  The ground floor showed significant differences. While community projects comprised half *residential* and little less than half *gathering space*, the developer projects showed a relatively even ratio of all uses, including *office*, *retail*, and above-ground *vehicle space*.
- **Top floor**
  The top floor of the community included much *residential space*, supplemented with some *gathering space*. The developers also allocated significant *storage space* in a prime rooftop location.

Summary of key findings

The three most important findings from the building database were:

- Community projects were more committed to collaboration and circularity, especially *CUs* in the *building use phase*.
- Developers provided apartments with a *higher standard*, whereas the community emphasized *affordability* and included more *common areas*.
- The ground and top floors highlighted different priorities in space allocation between *gathering space* in community approaches and *office* and *retail space* in developer approaches.

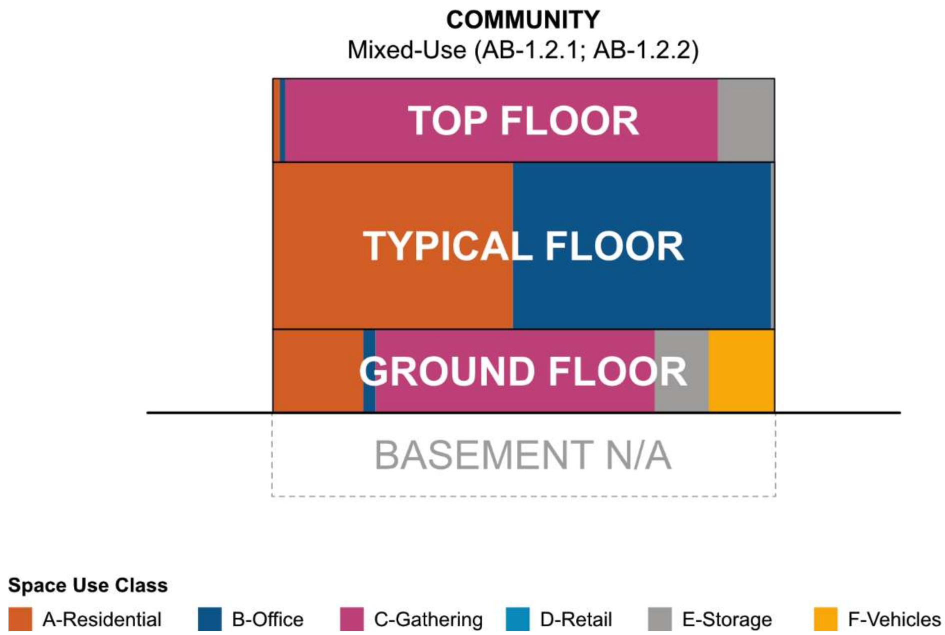
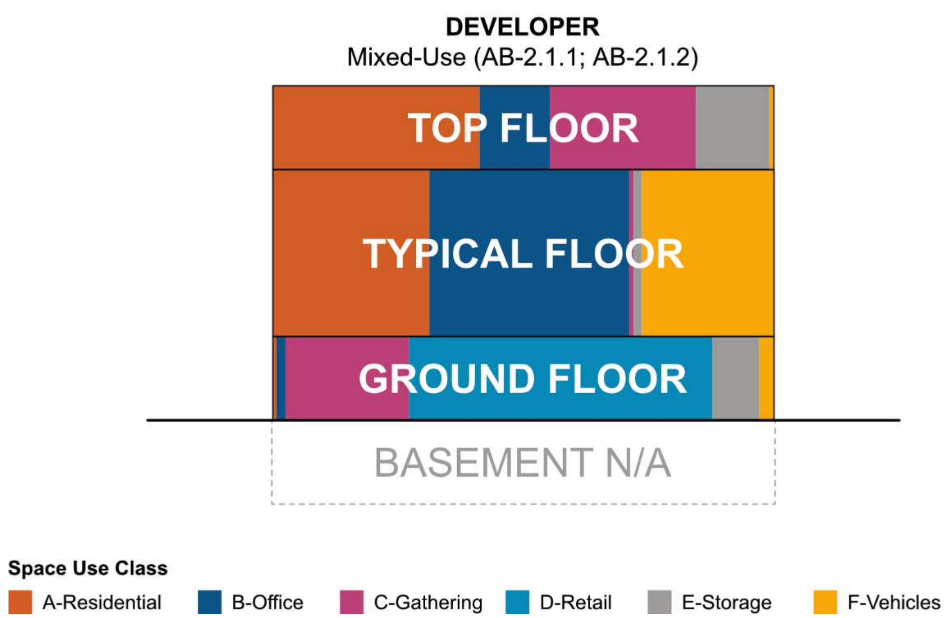


Figure 20: Mixed-use residential vertical space distribution. Source: Own illustration based on concepts from Staudt et al. (2025).



(**Figure 20** continued)

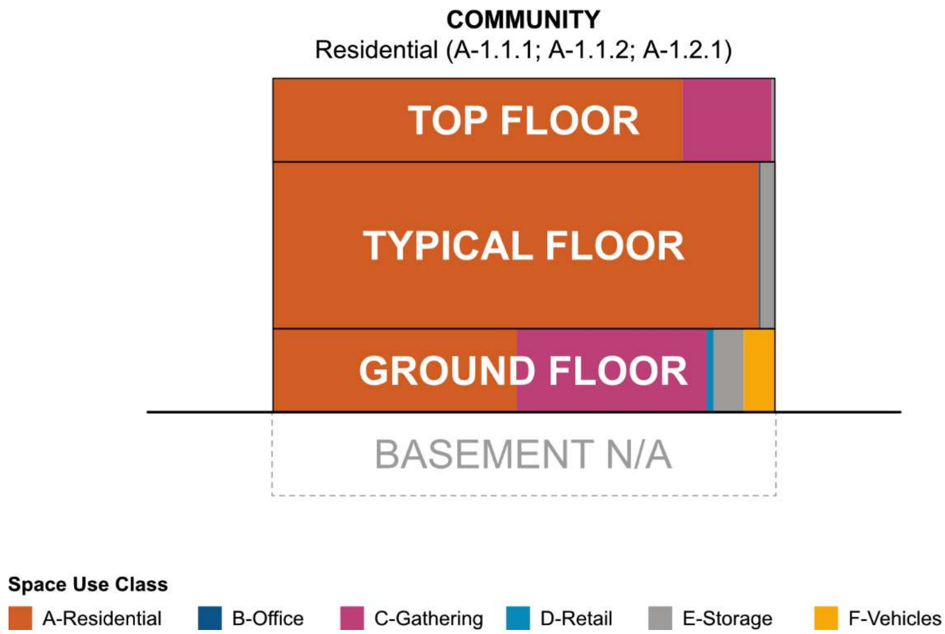
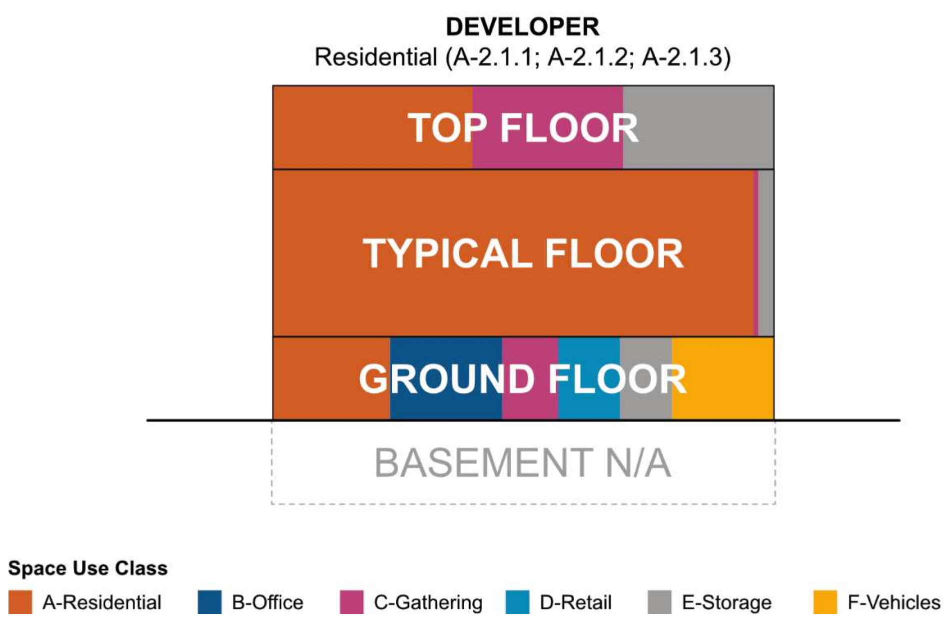


Figure 21: Pure residential vertical space distribution. Source: Own illustration based on concepts from Staudt et al. (2025).



(**Figure 21** continued)

4.2. Results from the expert workshop

The expert workshop on integrated *AR* provided valuable perspectives. The experts are described based on their respective roles:

- Municipal expert
- Cooperative expert
- Private expert

Integration model

In the first task, experts evaluated the strengths (+) and weaknesses (-) of three integration models for the *Neuperlach* case (see *Table 3*):

- *Building-by-building*
- *Wing-by-wing*
- *Floor-by-floor*

Table 3: Expert views on the proposed variants for integrated adaptive reuse. Source: Own table.

Integration	Municipal expert	Cooperative expert	Private expert
Building-by-building	+ + Clear governance structure + + Separate ownership + + Distribution of operational responsibilities	+ + Independence + + Separate governance + + Reduced conflicts + + Less complex - Individual bld. qualities	+ + Clarity + + Separate responsibilities - Cross-financing needed
Wing-by-wing	+ + Flexible solution + + Qualities of existing building + Some level of separate governance	+ + Combination potential + Some independence - Clear agreements needed	+ Middle-ground - Overlapping responsibilities - Operational challenges - Contractual clarity needed
Floor-by-floor	- - Overly complex - - Significant difficulties in governance - - Distribution of operational responsibilities unclear	- - High degree of operational governance interdependency - - Hindered long-term management - - Difficult collaboration	- - High costs - - Lack of planning security - - Excessive coordination - - Unviable

The experts unanimously agreed on *integration by building* due to the reduced governance complexity and the distributed operational responsibilities. The discussion also identified *integration by wing* as a viable middle ground. However, concerns about operational challenges remained, expressing the need for clear contracts to prevent overlapping responsibilities. Lastly, the experts considered *integration by floor* unviable due to increased governance complexity, high operational interdependence, and impracticality for cost coordination.

Use allocation

In the second task, experts focused on use allocation for the previously selected *integration by building* based on the community needs of *Neuperlach*. While *Office Building 1* required a creative community approach due to its increased room heights and depths, *Office Building 2* was assigned to a serial developer approach (see *Figures 22* and *23*, pp. 48–49).

First, the participants assessed the space qualities of the two existing office buildings of the *Neuperlach* case study. The panel followed the municipal expert's initiative to convert *Office Building 2* into a pure residential building, with the ground floor dedicated to childcare facilities and local supply, enhancing urban vibrancy and promoting a pedestrian-friendly street level.

Next, the participants envisioned *Office Building 1* as a neighborhood hub, prioritizing affordable and inclusive space. This included co-working spaces on the typical floors to encourage local entrepreneurship, cultural and community spaces on the ground floor, and affordable housing on the top floors to settle future residents.

On the ground floor, the participants provided cafés and restaurants as gathering points for residents and visitors. Creative trades, such as workshops, were located within the projecting podiums. Public sports facilities were conceivable on the ground or top floor. A room for neighborhood management helped with coordination.

On the top floors, the participants allocated significant residential space. The municipal expert referred to the development plan, which permitted both buildings to be extended to a cornice height of 26 meters (LHM, n.d.-b). To address the inadequate daylight supply, the extension included inner courtyards. However, the conversion required an amendment to the land use plan, which allowed for only one in five residential stories (20%) in the core area of *Neuperlach*.

Both buildings pursued high sustainability goals to receive funding, including green roofs for urban gardening and photovoltaic modules for renewable energy generation. A mobility hub freed many parking areas, and a circularity hub featured a bike repair workshop. According to the municipal expert, the existing vertical development cores provided easy access to the converted buildings.

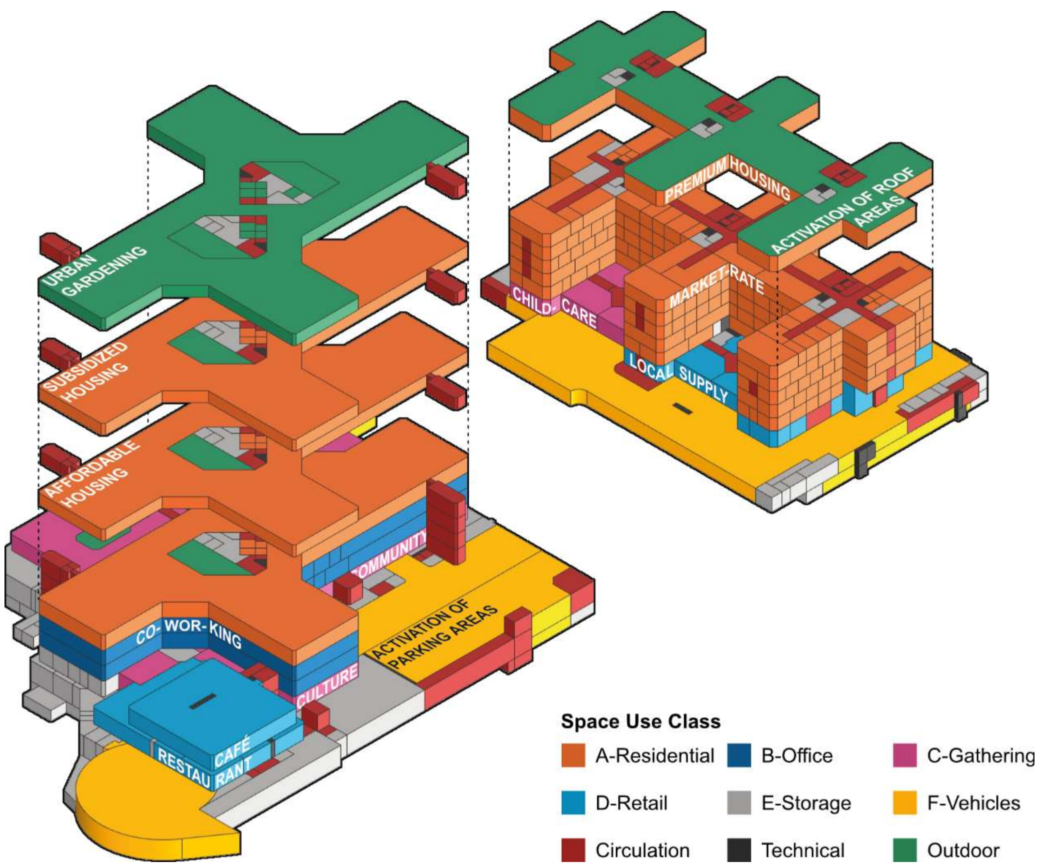


Figure 22: Experts use allocation for the integration by building. Source: Own illustration.

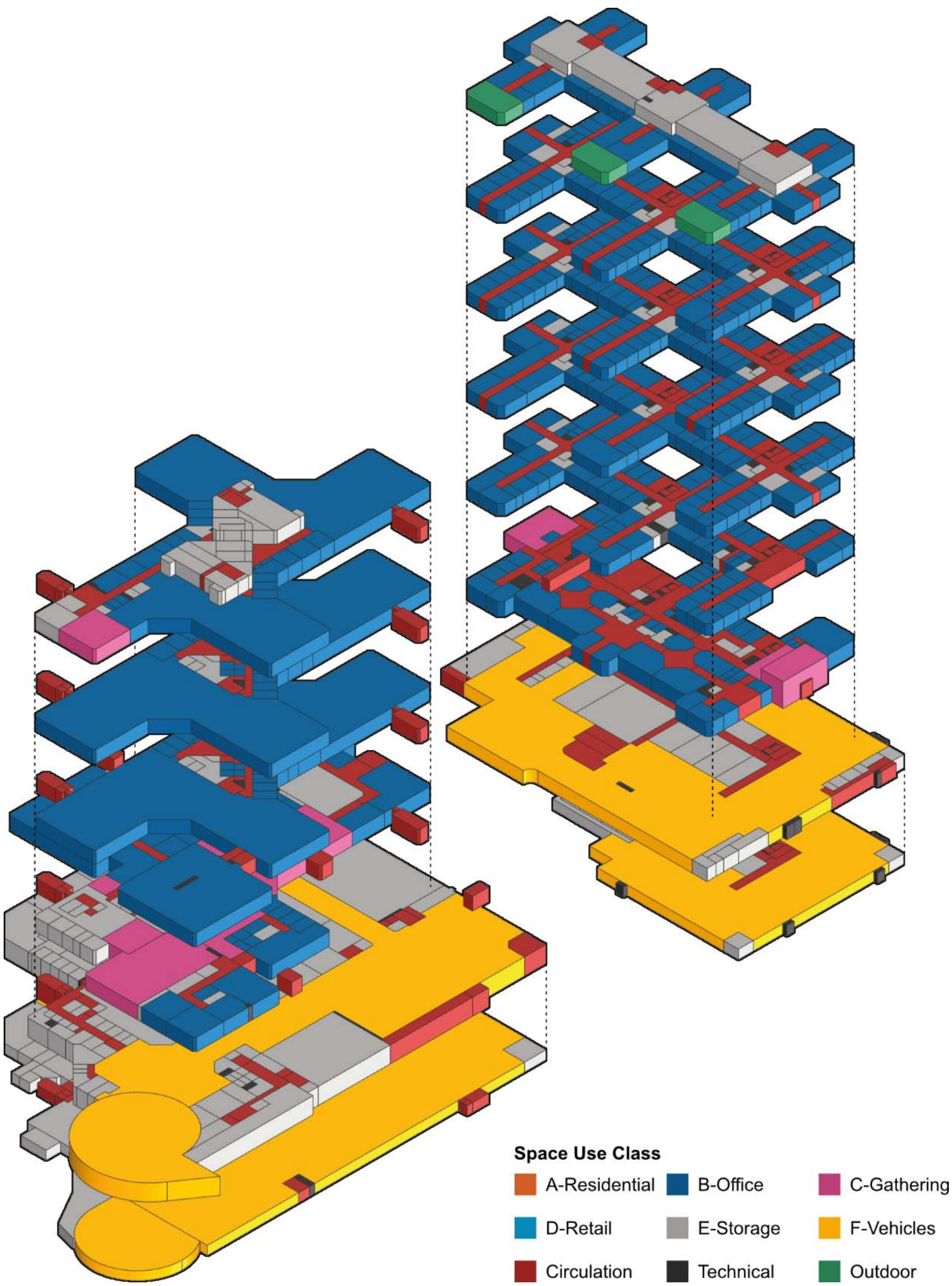


Figure 23: Existing office buildings 1 (left) and 2 (right) of the Neuperlach case study. Source: Own illustration.

Stakeholder network

In the third task, experts created a feasible stakeholder network for the *integration by building* (see *Figure 24*, p. 52). The discussion highlighted relevant actors, their roles, and relationships. Based on Oevermann et al. (2023), the experts distinguished between public, private, and civic stakeholders, providing regulatory, financial, and operational management support.

The stakeholder network primarily consisted of:

- *City of Munich*
- *Private investors*
- *Community stakeholders*

The experts also mentioned *private users*, *neighborhood management*, *external consultants*, *banks*, and *funding institutions*. Together, they created a comprehensive stakeholder network, highlighting the shared benefits of close stakeholder collaboration. The *City of Munich* was the keystone for synergy between *private investors* and *community stakeholders* under a *public-private-people partnership* (*PPPP*).

Other important aspects of the stakeholder network were:

- *Leasehold agreements* increase the influence of the community.
- A *concept tender process* can assign areas for community initiatives.
- *Affordable housing* is based on *Socially Responsible Land Use* (*SoBoN*).
- *Cross-financing* from developers to the community ensures long-term financing.
- *Shared operational responsibilities*, like public infrastructure and outdoor areas, require clear regulations.

Community stakeholders

Housing cooperatives (*wagnis eG, WOGENO München eG*), the *apartment syndicate*, or local cultural associations assign a contract to fully take over operational responsibilities, ensuring long-term social cohesion.

Private users

Small businesses, artists, and residents revitalize the building and surrounding neighborhood, respecting diverse user needs.

Neighborhood management

The neighborhood management coordinates and administrates shared spaces for community and culture, facilitating dialogue between user groups.

The City of Munich

The *City of Munich* initiates the project through pre-emptive rights or concept-based tendering. As a regulator, it manages zoning changes, grants exemptions, and ensures compliance with the city's *Socially Responsible Land Use* (*SoBoN*) policy.

Funding institutions

The *EU*, foundations, and city programs provide grants for community initiatives from potential funding sources like the *EGD*.

Private investors

Major private real estate firms act as contractual partners for cross-financing community stakeholders. Long-term lease agreements or alternative tenancy models lead to shared financial benefits in collaboration.

External consultants

Architects, urban planners, and legal and financial advisors provide strategic guidance and help navigate extensive requirements for the project's success.

Banks

Financial institutions offer favorable financing terms for projects that meet *Environmental, Social, and Governance* (*ESG*) criteria, aligning with urban sustainability goals.

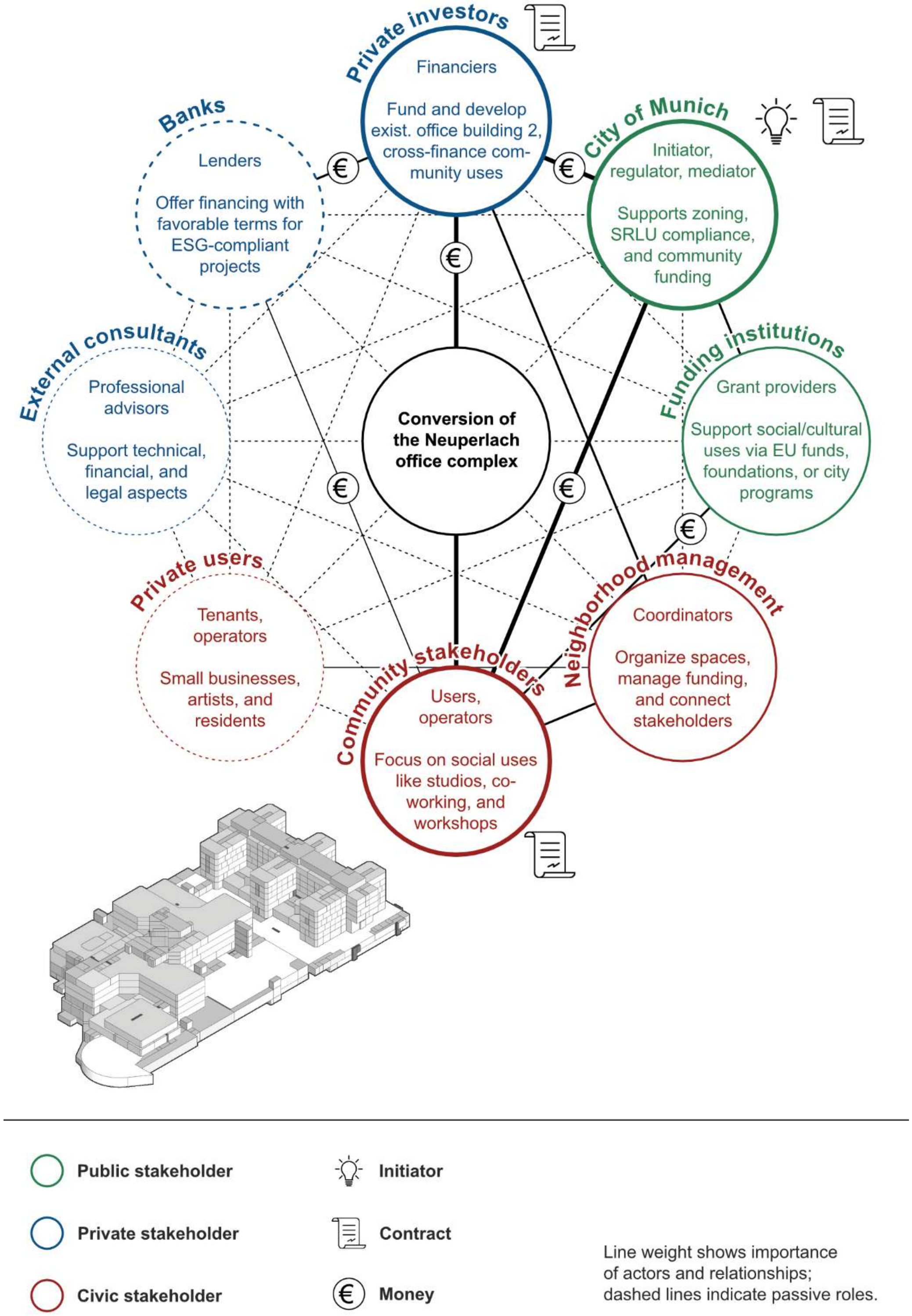


Figure 24: Stakeholder network of building-by-building integration variant. Source: Own illustration based on Oevermann et al. (2023).

4.3. Results from the building concept

The building concept examined the functional capacity of the two existing office buildings of the *Neuperlach* case study. It is embedded within the research framework of the three integration pillars of sustainable *AR*, integrating community-oriented and profitable uses into the local context.

Integrating community-oriented uses

The *pairwise comparison matrix* identified core, supporting, and independent uses, allowing for the strategic spatial arrangement of community-oriented uses (see *Figure 25*).

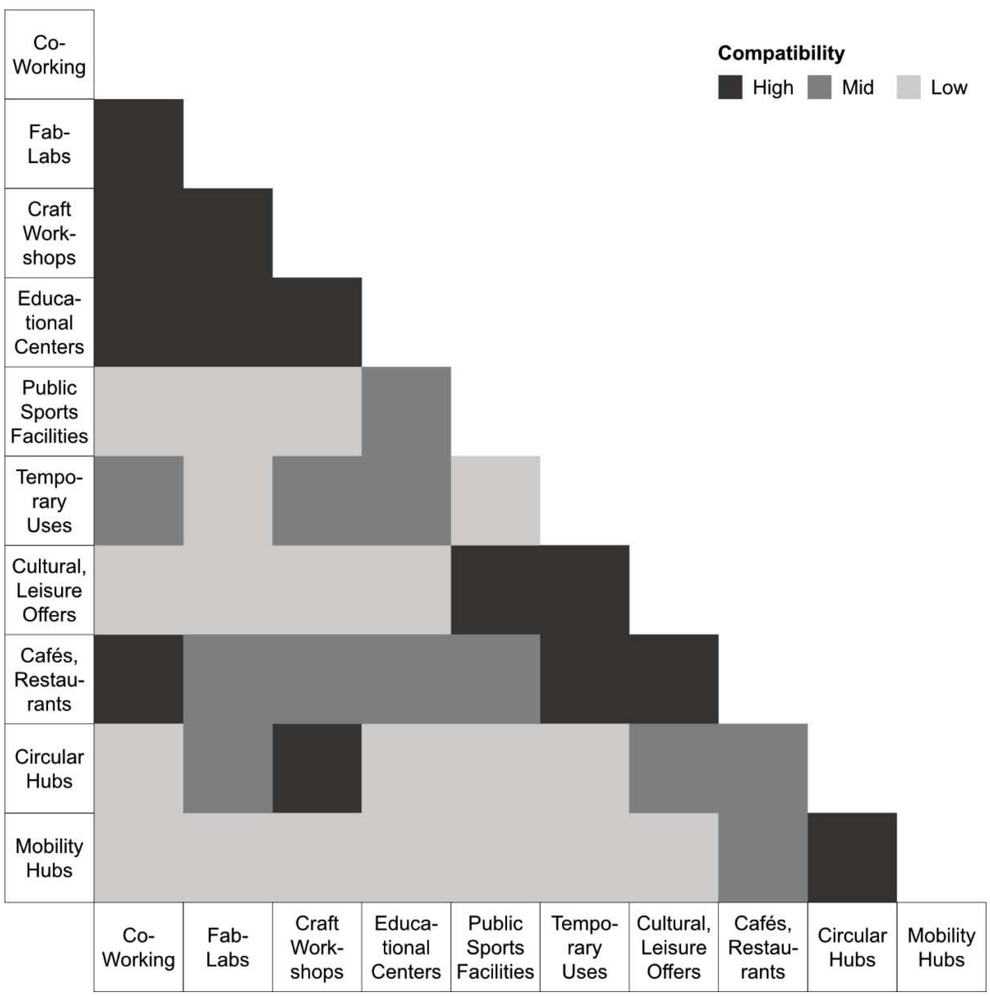


Figure 25: Pairwise comparison matrix of community-oriented uses. Source: Own figure based on community needs from LHM (2021a, b).

The findings from the *pairwise comparison matrix* analysis were:

Core uses

- Cafés and restaurants
- Craft workshops
- Co-working
- Educational centers

Supporting uses

- Fab-labs
- Cultural and leisure offers
- Temporary uses

Autonomous uses

- Circular hubs
- Public sports facilities
- Mobility hubs

Cafés and restaurants emerged as the most compatible uses due to their strong connectivity with multiple functions such as *co-working*, *temporary uses*, and *cultural and leisure offers*. *Craft workshops* had strong connections to creative and learning environments like *co-working*, *fab-labs*, and *educational centers*. Thus, *educational centers* and *co-working* were also highly compatible, promoting knowledge-sharing and productivity.

Fab-labs, *cultural and leisure offers*, and *temporary uses* played a supporting role. There were also autonomous uses with few connections, like *public sports facilities*. *Mobility hubs*, possibly combined with *circular hubs*, were suitable for remotely located areas.

The *pairwise comparison matrix* brought valuable insights for community-oriented architectural programming, suggesting spatial arrangement based on functional hierarchy.

The matrix resulted in thematic axes, including *CUs space sharing* for spatial efficiency and *space intensification* for temporal efficiency (see *Figure 26*, p. 56). Community-oriented uses spanned the following themes:

- *Greening* includes gardens, food production, and renewable energy generation on rooftop outdoor areas. Ecological awareness, self-sufficiency, and renewable energy generation create a strong sense of environmental responsibility.
- *Learning and making* combines productive and educational uses, fostering innovation and skill development. The spaces allow professional use during the day and are open to the community in the evening or on weekends.
- *Cultural and social* is the centerpiece of the building, including the most compatible uses, connecting and holding the whole community together. Granting public access encourages social interactions and cultural exchange.
- *Sports* enables structured and informal recreational activities, attracting diverse user groups from the local surroundings. The wide range of facilities contributes to the health and well-being of the community.
- *Circularity and mobility* reduces car dependency and promotes *CE*, a culture of reuse and repair. Temporary uses can fill the volatile number of freed-up parking spaces with exceptional room heights, sound insulation requirements, and no daylight.

As suggested in the expert workshop, a central neighborhood room can facilitate the coordination and management of community-oriented uses.

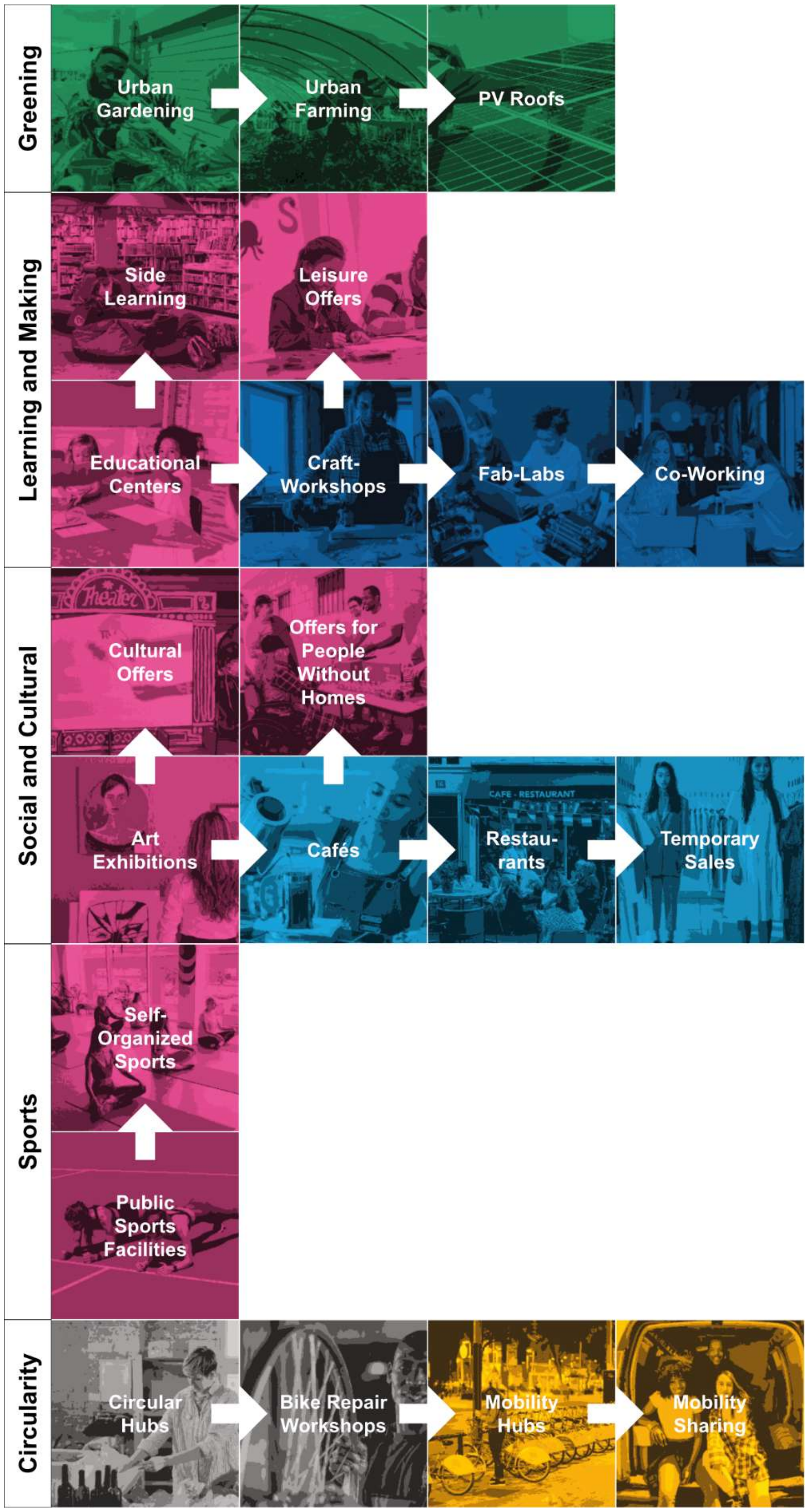


Figure 26: Thematic axes with space sharing (→) and space intensification (↑) strategies. Source: Own figure.

Integrating profitable uses

Based on the previous use class analysis of community and developer projects, the cost calculations revealed significant differences in amortization periods between the community-oriented and profitable use mix.

Due to a higher share of affordable housing and non-commercial space, the community-oriented use mix achieved financial amortization after 14.3 years (see *Figure 27*, p. 58). Depending on construction costs, a range from 9.3 years early amortization to 21.0 years late amortization was possible. This meant a broad range of roughly 12 years, which led to higher financial risk and uncertainty.

On the contrary, the profitable use mix incorporating higher-priced housing segments and increased office and retail space was financially amortized after 9.3 years (see *Figure 28*, p. 58). Early amortization with low construction costs was achieved after 6.4 years, and late amortization with high construction costs after 13.5 years. This represented a much narrower timespan of roughly 7 years, which meant a quicker return on investment and reduced exposure to unpredictable market developments.

Overall, the profitable use mix of developer projects amortized 5 years faster than the community-oriented use mix. This could be decisive for the financial viability of *AR* projects.

The calculations left little financial leeway for the increase of community-oriented uses. However, the building concept reached a balanced use mix, which was financially amortized within 10.0 years (see *Figure 29*, p. 59). The most profitable uses—small retail space (34.5% profitability) and office space (10.8% profitability)—cross-financed the non-commercial community space (4.1% profitability) (see *Table 4*, p. 59). The determined use mix reduced approximately 100 parking spaces in the existing office buildings. This equaled 2,500 m² freed-up underground area, 12.5 m² per parking space, plus an additional 12.5 m² for circulation areas.

After all, the detailed cost calculations ensured the long-term financing of the building concept.

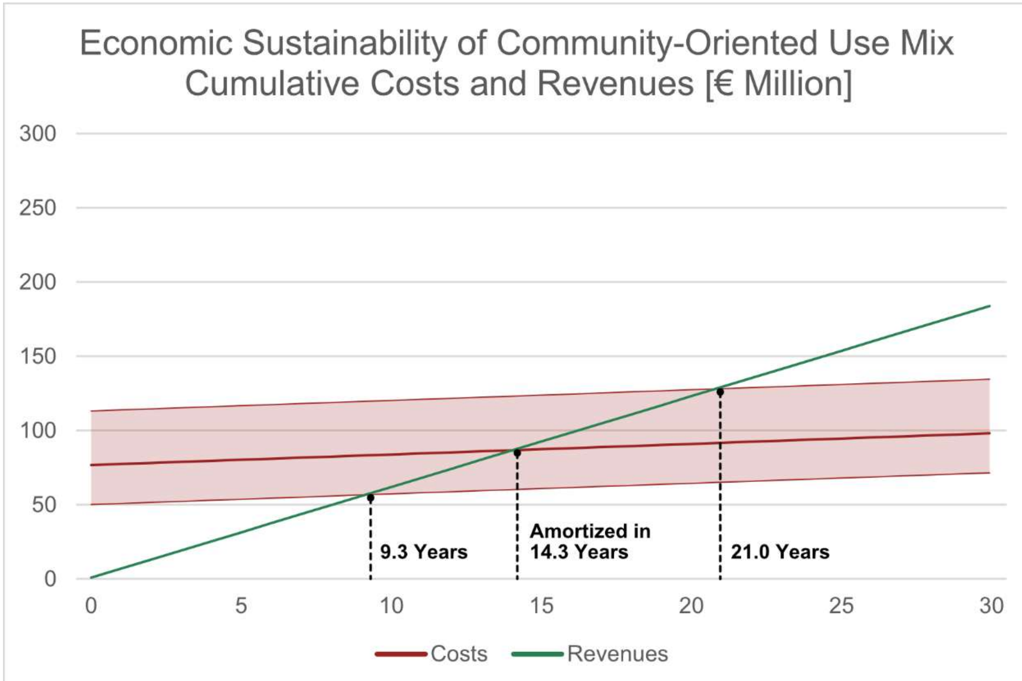


Figure 27: Economic sustainability of community-oriented use mix. Source: Own figure.

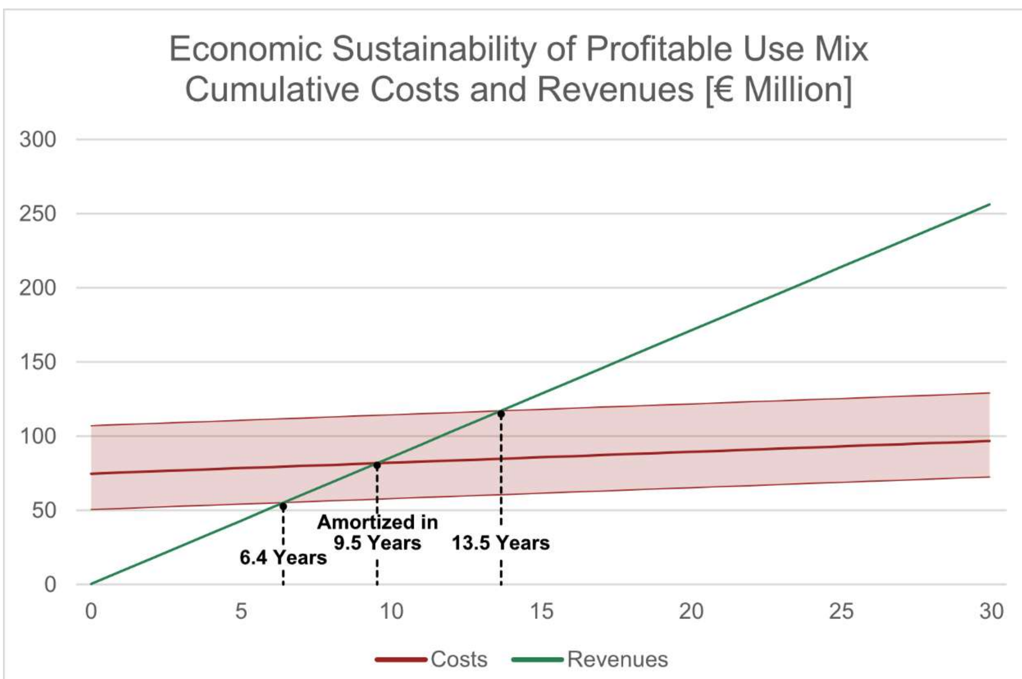


Figure 28: Economic sustainability of profitable use mix. Source: Own figure.

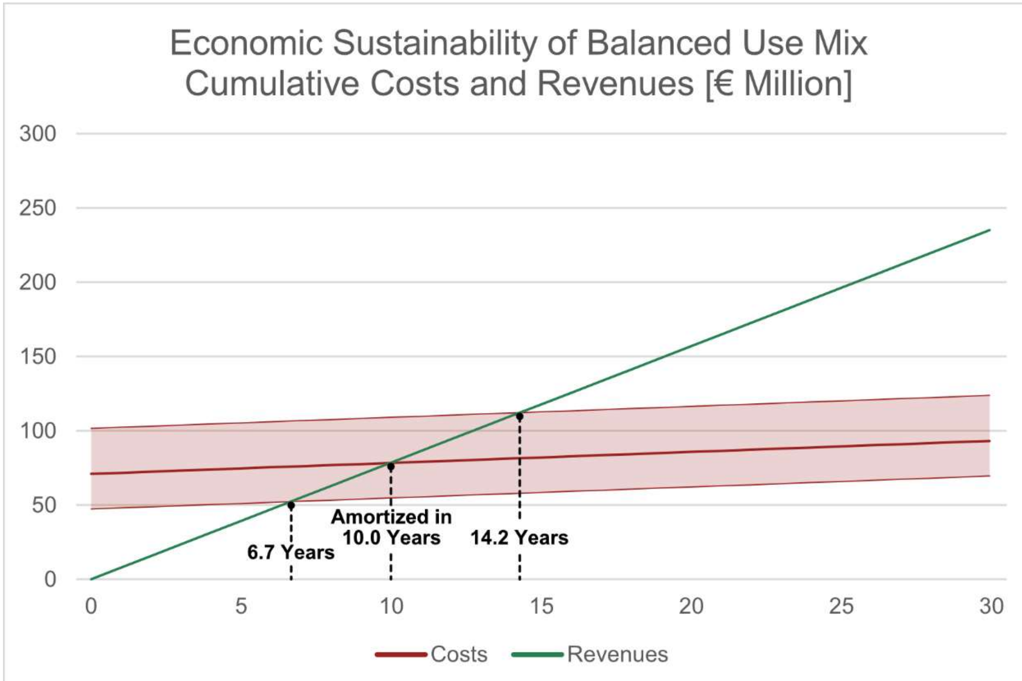


Figure 29: Economic sustainability of balanced use mix. Source: Own figure.

Table 4: Breakdown of costs and revenues by use category. Source: Own table.

Use	Share	[m²] NFA	[€ (net)] Constr. Costs	[€/a (net)] Var. costs	[€/a (net)] Revenues	[%] Profitability
Subsidized housing	2.5%	790	1,176,770	17,303	68,118	4.3%
Affordable housing	15%	4,741	7,060,621	99,163	653,935	7.9%
Market-rate housing	20%	6,321	10,556,207	125,730	1,089,891	9.1%
Premium housing	5%	1,580	3,040,311	29,105	319,836	9.6%
Luxury housing	2.5%	790	1,321,874	17,665	208,525	14.4%
Office spaces	30%	9,482	21,570,515	207,809	2,544,401	10.8%
Community spaces	12.5%	3,951	11,303,109	70,685	530,084	4.1%
Small retail spaces	7.5%	2,370	3,943,640	59,034	1,419,994	34.5%
Storage spaces	5%	1,580	2,114,757	11,094	150,676	6.6%
Residential parking sp.	174	4,350	3,594,233	26,189	202,784	4.9%
Office parking spaces	238	5,950	4,916,250	37,303	416,058	7.7%
Community parking sp.	14	350	289,191	2,047	19,579	6.1%
Retail parking spaces	48	1,200	991,513	8,362	111,881	10.4%
Storage parking sp.	20	500	413,130	2,645	18,647	3.9%
	LHM (2007)		BKI (2024) BKI (2023)	BMJ (2022)	Statista (2024a, b, c, d) Statista (2020)	

Integrating the local context

The *Neuperlach* case study included quantitative building parameters and qualitative context-specific parameters (see *Tables 5* and *6*, pp. 61–62). *Structural system*, *clear floor height*, *maximum wing depth*, and *vertical extension potential* were important building parameters, while avoiding noise from *car traffic* and generating the required *foot traffic* were decisive context-specific parameters. Most importantly, the existing *pedestrian bridge* turned out to be the linchpin, as it could divert the required pedestrian flow into the building.

For residential use, the *frame structure with cores* of *Office Building 1* was more suitable for serial developers; on the contrary, the *load-bearing wall system* of *Office Building 2* was for flexible community solutions. Without the top floor, currently used for technical office equipment, the *vertical extension potential* of up to three stories of *Office Building 1* offered the developers ample space to cross-finance the community. Also, the existing stories of *Office Building 1* required major interventions like cutting out floor slabs due to their *maximum wing depth*, which led to insufficient daylight supply. Additionally, the typical 3.20 m *clear floor height* of *Office Building 2* allowed for space-efficient split-level solutions on the upper stories (see *Appendix I*).

For community spaces, preferentially located on the ground floor, both buildings offered generous *clear floor heights* of approximately 4 meters. Overall, both office buildings included *projecting podiums* on the ground floor, allowing the local community to use them more creatively. However, these spaces remained unused without the required *foot traffic*. This was why the culturally significant *pedestrian bridge* was the deciding factor. While *car traffic* isolated *Office Building 1* to the north and west, *Office Building 2* was more strategically integrated into the urban fabric, benefiting from *foot traffic* from the *Wohnring* in the south and the *pedestrian bridge* in the north. This offered vast potential for community spaces in the north wing and the rest of the building—under community or developer governance—to provide affordable housing.

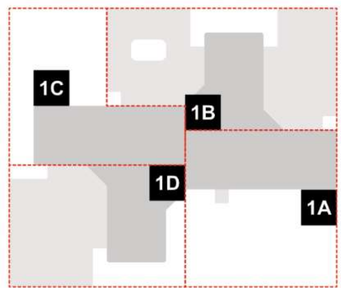
Additional architectural plans and visualizations were included in the appendix:

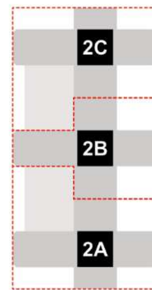
- *Appendices E–G*: *Neuperlach* case study (*existing*)
- *Appendices H–J*: *Neuperlach* case study (*conversion*)

Table 5: Quantitative building parameters of the Neuperlach case study. Source: Own table based on categories from Eisele et al. (2020).

		
Building parameter	**Office Building 1**	**Office Building 2**
Construction year	1977	1994
Building coverage ratio	0.6 (LHM, n.d.-b)	0.6 (LHM, n.d.-b)
Floor area ratio	1.5 (LHM, n.d.-b)	1.5 (LHM, n.d.-b)
Gross floor area	22,720	17,140
Number of stories	4	6
Building height	20.65 m	25.35 m
Vert. extension potential	26.00 m (LHM, n.d.-b)	26.00 m (LHM, n.d.-b)
Number of basements	2	2
Number of podiums	3	2
Typical fl. clear height	3.75 m	3.20 m
Ground fl. clear height	3.90 m	4.05 m
Basement clear height	5.15 m (B1); 2.55 m (B2)	3.55 m (B1); 2.55 m (B2)
Floor slab thickness	35 cm	30 cm
Structural system	Frame structure with cores	Load-bearing wall system
Structural grid spacing	8.40 m × 8.40 m	7.50 m × 7.50 m
Max. wing depth	20.40 m	12.50 m
Daylight depth 21.6.	1.70 m	1.45 m
Daylight depth 21.3.	4.20 m	3.55 m
Daylight depth 21.12.	11.20 m	9.55 m
Parking spaces	46 (B1); 286 (B2)	120 (B1); 141 (B2)
Development cores	4	3
Roof surface area	3,713.76 m²	2,765.63 m²

Table 6: Qualitative context-specific parameters of the building wings of the Neuperlach case study. Source: Own table.





Context param.	**1A**	**1B**	**1C**	**1D**	**2A**	**2B**	**2C**
Housing	✓ Quiet location	✗ Car traffic	✗ Car traffic	✓ Quiet location	✓ Quiet location	✓ Quiet location	✗ Car traffic
Greening	✓ Roof	✓ Roof, Podium	✓ Roof	✓ Roof, Podium	✓ Roof, Podium	✓ Roof	✓ Roof, Podium
Learning and making	✓ Access	✗ Limited access	✗ Limited access	✓ Access, Podium	✓ Access, Podium	**?** With 2A/2C	✓ Access, Podium
Social and cultural	✓ Foot traffic	✗ Foot traffic	✗ Foot traffic	✓ Foot traffic	★ Ped. bridge	★ Ped. bridge	★ Ped. bridge
Sports	✓ Roof	✓ Roof, Podium	✓ Roof	✓ Roof, Podium	✓ Roof, Podium	**?** With 2A/2C	✓ Roof, Podium
Circularity and mobility	✓ Direct access	✓ Direct access	✓ Direct access	✓ Direct access	**?** Indirect access	**?** Indirect access	**?** Indirect access

5. Discussion

5.1. Summary of findings

The following summarizes the most important findings from the building database, the expert workshop, and the building concept.

The building database showed different patterns when comparing *CBSs* between community and developer projects. Despite potential legal and financial constraints, the community projects were more committed to collaboration and circularity regarding the applied *CBSs*. *CUs* also showed higher community engagement during the *building use phase*.

The analysis of ownership models by building size identified that *cooperatives* and *NPOs* were underrepresented in large-scale projects, where *private investors* (with a social agenda) dominated. Moreover, developers tended to larger apartments with higher standards, while the community prioritized affordability and twice as many common areas. However, few pioneering projects, particularly those involving *municipalities*, exemplified effective stakeholder collaboration with shared benefits.

The use class analysis reinforced the prevailing tendency of community projects to focus on affordability and social inclusion, while developer projects prioritized rentability and risk mitigation. Moreover, the vertical space distribution analysis highlighted community approaches that allocated significantly more gathering space and developer approaches that incorporated increased office and retail space. This was particularly evident on the ground and top floors, with public and semi-public access. Both community and developer approaches demonstrated the demand for additional mobility infrastructure through a significant share of above-ground vehicle space.

Overall, the building database highlighted numerous practical case studies in *AR*, which can be considered variably successful depending on the specific sustainability aspect. Their respective governance models significantly influenced community projects, promoting social cohesion and developer projects that ensured financial viability.

The expert workshop investigated *hybrid governance models* for the *Neuperlach* case study. Among the three proposed integration models, a clear favorite emerged:

- *Integration by building* convinced all experts due to clear governance structures and minimal conflict potential.
- *Integration by wing* was seen as a middle ground but required clear contractual agreements to mitigate operational challenges, especially in shared public infrastructure and outdoor areas.
- *Integration by floor* offered no alternative due to high governance complexity, overlapping responsibilities, and impractical cost coordination.

For the *Neuperlach* case study, experts converted *Office Building 1* into a *mixed-use residential* building under *community governance* and *Office Building 2* into a *pure residential* building under *developer governance*. The latter was intended to cross-finance the community, and the experts brought up further financing and funding options that aligned with sustainability criteria. As a result, the stakeholder network led to a *hybrid governance model* involving the *City of Munich, private investors,* and *community stakeholders* representing a *PPPP*.

Based on realized projects, the cost calculations of construction costs for conversions were significantly lower than those for new buildings, allowing for a risk factor of 15%. *Community projects* required an average of 14.3 years for financial amortization, with high uncertainty due to a broad amortization range. *Developer projects* amortized significantly faster, averaging 9.3 years, with a narrower range, indicating lower financial risk. The *balanced use mix* achieved amortization after 10.0 years, ensuring financial attractiveness while increasing social impact.

A *pairwise comparison matrix* analyzed community needs, revealing *core, supporting,* and *autonomous uses*. This resulted in *thematic axes* with *CUs*, forming the base for a vibrant social fabric. Ultimately, the *quantitative building* and *qualitative context parameters* of the *Neuperlach* case study allowed for a strategic allocation of the community adjacent to the existing *pedestrian bridge*, which generated the required foot traffic.

Overall, the study contributes to a holistic perspective on *AR*, promoting public sector initiation, private sector collaboration, and civic sector participation.

5.2. Comparison with existing literature

The research findings build upon existing literature on *AR*.

The higher number of *CBSs* in community projects reflects Vafaie et al. (2023), who found that "active community participation in the planning of reuse projects" (p. 13) is the most frequently cited success factor. All buildings applied *CBSs building adaptation* and *refurbishment*, which were based on *AR's* inherent nature, defined by functional and physical change (Plevoets & Cleempoel, 2019). *Clean energy*, also present in all projects, confirmed *AR's* current shift toward sustainability, as Oevermann (2023) and Wong (2016) noticed.

The higher application of *CUs*, as in Staudt et al. (2025), underscores various independent sources that *AR* projects with active community participation have a significantly higher chance of long-term success as people stay engaged and invested in maintaining the initiative over time (Harrison, 2013; Macdonald, 2013; Oevermann et al., 2023; Perkin, 2010).

The underrepresentation of large-scale community projects is possibly due to existing legal hurdles and financial constraints. Oevermann et al. (2023) emphasized communities' difficulties in overcoming complex regulations without external support. Friedmann (2021) stressed the importance of "municipal leadership" (p. 19) for community involvement, providing regulatory assistance, and setting up long-term plans.

To counter adverse financial conditions, Rettich and Tastel (2023) suggested regional regulations for the financial support of communities and confirmed the willingness among financially strong stakeholders. The analysis also noticed a few combined approaches, which were in line with Cruz Rios et al. (2022), who advocated for governance models that effectively "blend top-down and bottom-up approaches" (p. 10).

Developer projects tended to feature larger apartments with higher standards, whereas community projects emphasized space sufficiency and affordability. This difference may be linked to the financial uncertainties of *AR*, causing developers typically to set aside a risk contingency, which experience shows is often necessary (BBSR, 2015).

The expert workshop confirmed in the person of the municipal expert, in line with Rettich and Tastel (2023), that existing building regulations provide a sufficient legal framework for integrated approaches, with zoning plan amendments and their alignment playing a central role in ensuring legal certainty. The resulting stakeholder network for the *Neuperlach* case study aligned with the *PPPP* model, embodying *hybrid governance* and *collaborative financing*, as Oevermann et al. (2023) advocated for in their *OpenHeritage EU* initiative.

The building concept utilized a *pairwise comparison matrix* (Ramík, 2020) to determine *core uses*. As a result, a strategic arrangement of community-oriented uses in *thematic axes* with *CUs* emerged, further increasing functional occupancy. This possibly generates the "vibe" and "tribe" (Lundgren, 2023, p. 12), enhancing multi-dimensional sustainability.

The cost calculations combined *community-oriented* and *profitable uses* in a *balanced use mix* for *integrated AR*. While developers achieved a lucrative amortization period within 10 years, the community amortized 5 years later. The amortization range, tied to construction costs, was narrower in developer projects, emphasizing their need for cost control. Profitability rates aligned with case studies from *BBSR* (2015).

The iterative reflection of the expert workshop results addressed the local conditions for the individual wings of the *Neuperlach* case study. This ensured that the conversion sufficiently considered the existing *building-specific* (Eisele et al., 2020) and *context-specific* qualities. Rettich and Tastel (2023) emphasized the importance of fundamental infrastructural decisions for the *use mix* outcomes in their *common-wealth* and *market-oriented* transformation scenarios.

5.3. Explanation of unexpected results

The study revealed few unexpected results, though some required brief discussion.

Community projects from the building database applied more *CBSs* than developers. This demonstrates creative potential despite possible legal or financial deficits. Remarkably, the *closing CE* principle was the absolute exception. In contrast, the highly present *slowing CE* principle reflects a sensitive approach to *AR* that prioritizes preservation over demolition at different scales. The expert workshop rejected the *integration by floor*. *Integration by building* and *integration by wing* complied with the vertical logic of *zoning* and *land-use plans*, facilitating boundary adjustments. The *building concept* contradicted the *expert workshop's community* and *developer governance* allocation. This underscored the importance of considering all relevant *building* and *context parameters* at the early stages of *building conversion*.

Overall, the study aligned with the previously mentioned research trends.

5.4. Relevance to the field

The research findings contributed in several ways to the scientific debate on *AR*.

While *CE principles, CBSs,* and *CUs* are theoretically sound, empirical studies on their application in successful *AR* projects are missing (Nußholz et al., 2023). Besides, stakeholders require pioneering projects for testing innovative governance models (Oevermann et al., 2023). Also, the local community needs co-financing mechanisms to capitalize on the commitment of financially strong stakeholders (Rettich & Tastel, 2023). The present study gave detailed insights into practical case studies, highlighting how *governance models* affect *circularity*. Moreover, it explored the potential of three *integration models* for the *Neuperlach* case study and provided a feasible *stakeholder network* representing a *PPPP* under *hybrid governance*. Ultimately, it included *cross-financing* and *ESG-funding strategies* from the expert discussion, demonstrating the vast potential for residential space in the core area of *Neuperlach* and proposing an inherently profitable *balanced use mix*.

These findings extended the scientific boundaries to successful case studies, shifting the *circularity discourse* from *material recycling* to *stakeholder collaboration*.

5.5. Contribution to theory and practice

The study contributed to theoretical and practical case studies in *AR*.

Existing studies support the implementation of innovative *governance models* in *AR* (Cruz Rios et al., 2022). The present study proposed a *hybrid governance model* under *PPPP* for the *Neuperlach* case study, effectively combining the strengths of bottom-up and top-down approaches. Also, practical case studies are required to supplement scientific literature on *circularity* (Nußholz et al., 2023). The research findings highlighted numerous real-world projects in residential *AR* and proposed a detailed *building concept* for the *Neuperlach* case study. Experts also saw *financing* and *funding opportunities* that complied with sustainability goals. The proximity to practice can support policymakers, project developers, and architectural and urban planners in integrating the local community into large-scale projects.

These theoretical findings based on practical case studies and broad expert perspectives opened the gate to *pilot-testing integrated AR*.

5.6. Potential applications

The research findings offer applications within the broad *EU sustainability agenda*.

Insights from successful residential *AR* projects can inform *EU* and municipal policies addressing the current urban housing shortage. The identified *hybrid governance models* may require further legal support and financial incentives from municipalities to go beyond individual pioneering projects. *Private investors* expecting higher regulations can negotiate concessions with the city to comply with *ESG* criteria. This enables a *self-sustaining financial model* and a more *inclusive social fabric*, aligning with the *NEB* initiative. The ever-changing *societal needs* are pressing for further *building conversions* to avoid vacancy due to *functional obsolescence*. The common typology of the *Neuperlach* case study opens the discourse on *scalable solutions* in other *European cities*, fulfilling the *EGD's* ambitious *Renovation Wave* goal, including *deep renovation rates*.

This contributes to the *EU's sustainability agenda*, addressing multiple goals simultaneously through *integrated AR*.

5.7. Methodological constraints

The study's *semi-quantitative approach* included several methodological constraints.

The building database indicated tendencies, not general statements. This was due to the limited number of case studies, which were further subdivided into pure and mixed-use residential *AR* projects. For the latter, a heterogeneous use mix was characteristic, which made comparability even more difficult.

Besides, the study excluded *non-European projects*, as well as projects that were realized before the *circularity concept* became popular. Earlier projects that unknowingly practiced *AR* were missing, potentially overlooking relevant lessons from the past. However, these limitations did not affect the intended number of case studies. The lack of available basement floor plans affected the interpretation of use class distributions, which could have explained the high above-ground vehicle space.

The expert workshop did not fully represent the diversity of stakeholders involved in *AR*, potentially missing important perspectives. However, the careful selection of experts, the provision of preparatory material, and their many years of experience formed a strong discussion round. Although no community representatives attended the workshop, participants had been in close contact with locals before, which meant that the community was at least indirectly represented. Additionally, a comprehensive list reflected the context-specific community needs, which the experts sufficiently addressed during the workshop.

The cost calculations depended on stable market conditions. For future uncertainties, especially relevant for longer amortization periods, cost calculations included generous risk factors and higher annual inflation rates for construction costs. However, amortization periods can significantly differ depending on city and location. Therefore, all calculations considered recent average values of the largest *German* cities according to *Statista* and excluded significantly higher revenues from *1A prime locations*, ensuring reliable and representative figures.

5.8. Future research directions

The present study takes a holistic view of residential *AR*, yet several open questions remain, guiding future research directions.

The next step is the realization of research-accompanied prototypical building conversions featuring hybrid governance models. While the expert workshop confirmed that zoning changes are theoretically possible, rigid land-use policies may cause project-endangering delays. Prototypes promote stakeholder collaboration, remove legal barriers, and negotiate regionally flexible policies.

Moreover, the frequent occurrence of *CUs* highlights the importance of the building use phase. However, conventional materialistic metrics failed to appropriately credit functional occupancy in sustainability calculations. This also concerned *ESG* criteria, which were highly relevant for funding access and could be decisive for project feasibility.

Ultimately, the building concept's building and context parameters showed a promising strategy for scalable yet context-sensitive solutions in *AR*. However, comprehensive databases and specialized tools are required to support conventional planning processes, where quick decisions are key.

These future research directions will lead to sustainable urban transformation.

6. Conclusion

Investigating different *governance models* in residential *AR* resulted in an *integrated approach*. The present study addressed the research question:

How can large-scale projects integrate community approaches into residential adaptive reuse for sustainable urban transformation?

The research findings confirmed that *hybrid governance models, strategic cross-financing,* and *ESG funding* were conceivable for the *Neuperlach* case study.

This provided evidence for the three hypotheses:

H1: Confirmed (✓) → Community and developer projects allocate space differently.

- The community emphasizes *affordability* and *shared spaces*.
- Developers tend to *larger apartments* with a *higher standard*.
- They allocate increased amounts of profitable *office* and *retail spaces*.

H2: Partially confirmed (✓~) → Hybrid governance models are feasible but face legal challenges.

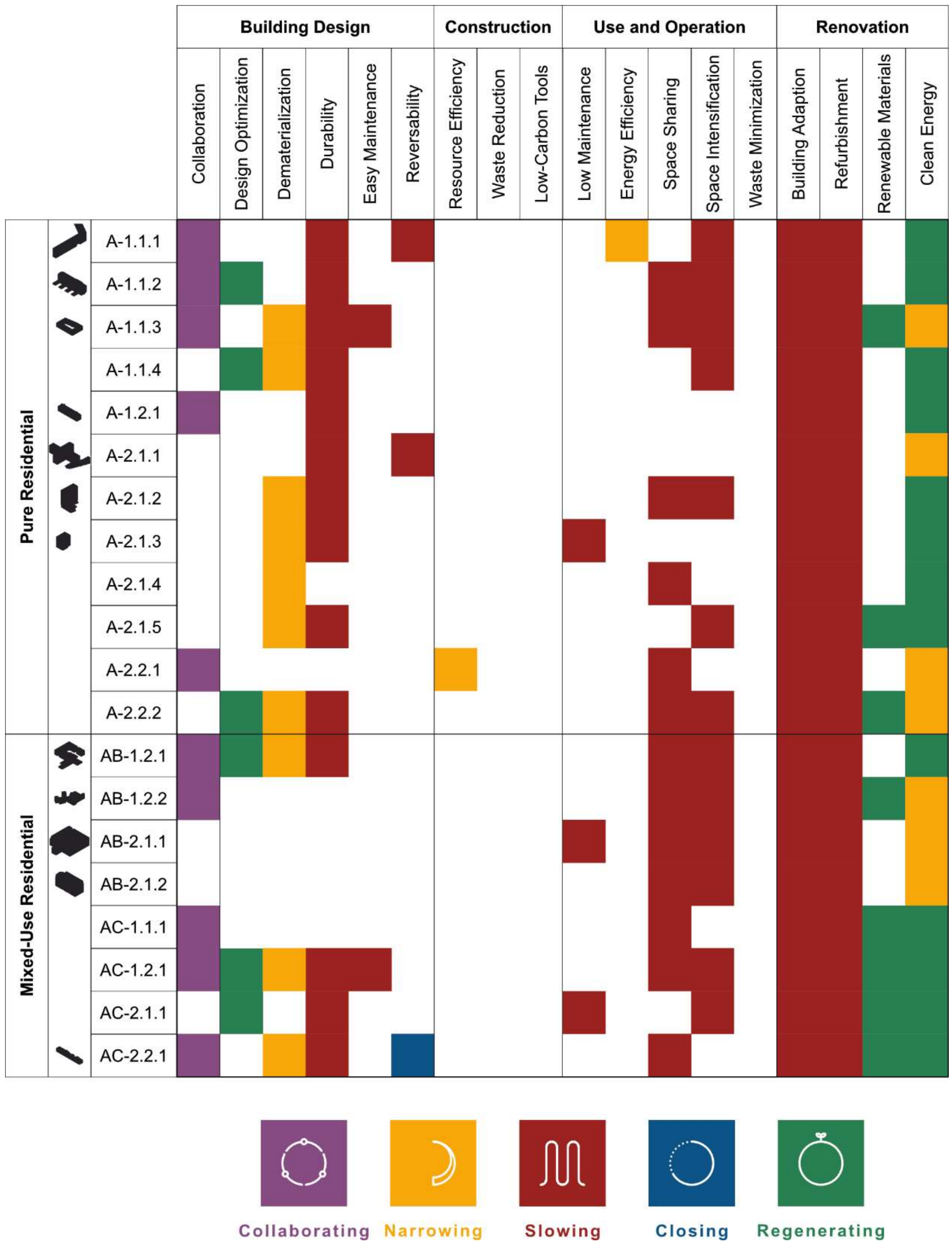
- *Integration by building* or *wing* is possible, clearly separating operational responsibilities.
- *Strategic cross-financing* from the developers supports the community.
- *Zoning amendments* and *leasehold agreements* require case-by-case negotiation.

H3: Confirmed (✓) → Combining community-oriented and profitable uses in conversion aligns with social goals and achieves fast amortization.

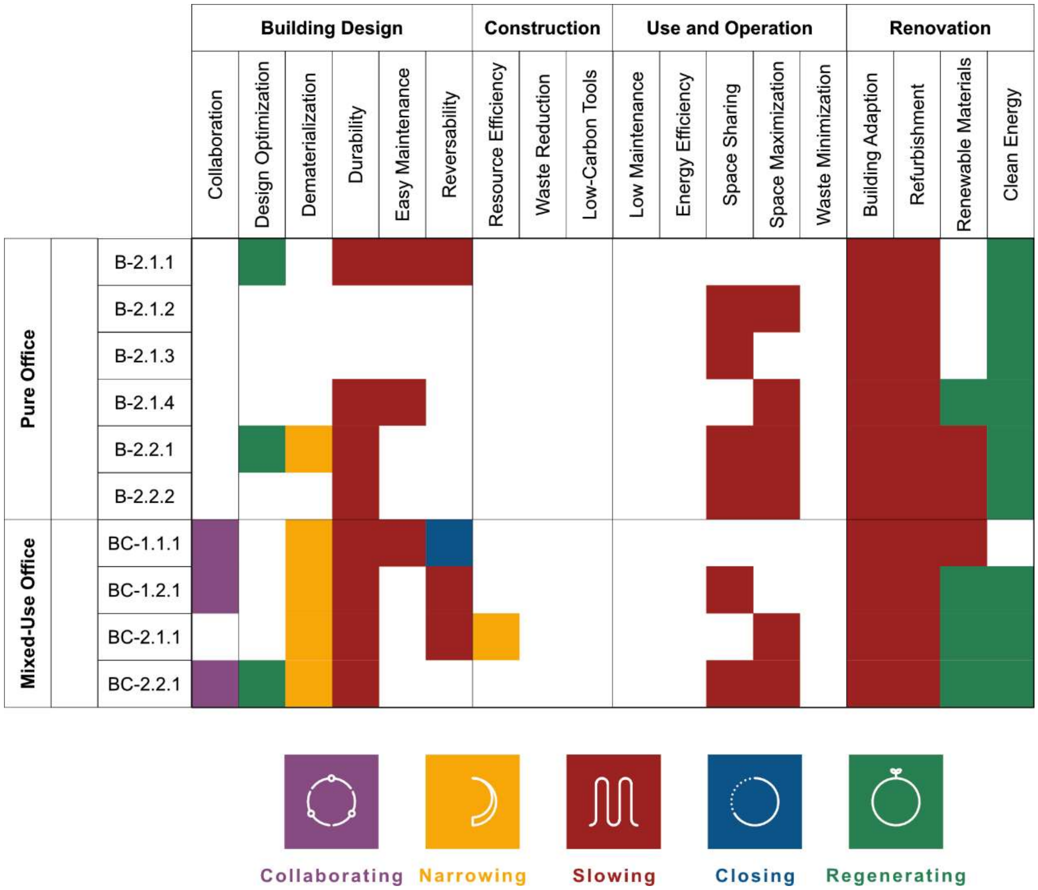
- *Conversion costs* of realized projects are lower than *new build costs*, according to documented costs and scientific literature.
- Alignment with *ESG criteria* improves access to *municipal* and *EU funding*.
- *Financial amortization* of a *balanced use mix* within *10-15 years*, including generous risk factors, is realistic.

The findings demonstrated the readiness for *practical case studies* in *AR*, testing *hybrid governance models* and *strategic cross-financing*.

7. Appendices



Appendix A: Circular building strategies in residential and office adaptive reuse. Source: Own figure, based on principles from Nußholz et al. (2023), Çetin et al. (2021), and Bocken et al. (2016).



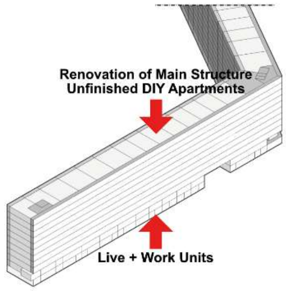
(**Appendix A** continued)

Code	Building	Conversion	Ownership	Stakeholder	Location	Year	GFA [m²]	Source
 A-1.1.1	Revitalization of De Flat Kleiburg	Residential (outdated social housing) to DIY apartments	Cooperative, Private, Municipal	Tenants, Consortium DeFlat, City of Amsterdam	Amsterdam, Netherlands	2017, built 1971	66,000	BauNetz, 2021
 A-1.1.2	Conversion of the Felix Platter Hospital	Hospital to cooperative housing	Cooperative, Municipal	Housing cooperative wohnen&mehr, City of Basel	Basel, Switzerland	2022, built 1967	36,000	Zettel, B., 2024, p. 40–49
 A-1.1.3	Conversion of the Lysbüchel Area (Abakus)	Industrial to cooperative housing	Cooperative (Apartment syndicate)	Apartment Syndicate Basel	Basel, Switzerland	2021, new build	1,850	Grafe & Rieniets, 2022
A-1.1.4	Conversion of Hertie-Kaufhaus	Dept. store to residential, commercial, public	Cooperative, Municipal	Bauverein zu Lünen eG, City of Lünen	Lünen, Germany	2017, built 1969	5,600	Grafe & Rieniets, 2022
 A-1.2.1	Conversion of a Wine Warehouse	Industrial to cooperative housing	Non-profit organization	Stiftung Habitat	Basel, Switzerland	2023, built 1955	11,100	Schoof, J., 2024, p. 22–31
 A-2.1.1	Schönburg	Office to residential, hotel, retail	Private	Swiss Prime Site AG	Berne, Switzerland	2020, built 1970	46,892	Schoof, J., 2021, p. 60–67
 A-2.1.2	Conversion of The Cosmopolitan	Office to residential, commercial	Private	BESIX RED	Brussels, Belgium	2019, built in the 1960s	16,000	Grafe & Rieniets, 2022
 A-2.1.3	De Voortuinen Tower	Office to residential	Private	Pinnacle	Amsterdam, Netherlands	2021, built 1971	9,300	Schoof, J., 2024, p. 58–65
A-2.1.4	Conversion of Gasholders London	Industrial to luxury apartments	Private	King's Cross Central Limited Partnership	London, UK	2016, built 1867	20,394	Arup, 2022
A-2.1.5	Neuwiesen New Living	Commercial to urban apartments	Private	SISKA Immobilien AG	Winterthur, Switzerland	2018, built 1982	6,100	BauNetz, 2021
A-2.2.1	Conversion of Fittja People's Palace	Residential to affordable housing	Municipal, Cooperative	Botkyrka-byggen AB, Residents/ Tenants	Stockholm, Sweden	2016, built 1970	5,320	Grafe & Rieniets, 2022
A-2.2.2	Paris Student Housing	Office to student housing	Municipal	Paris Habitat	Paris, France	2021, built 1972	4,400	Schoof, J., 2022, p. 96–103
 AB-1.2.1	Conversion of Alte Samtweberei	Textile factory to residential, commercial, community	Non-profit organization, Municipal	Urbane Nachb. Samtweberei gGmbH, City of Krefeld	Krefeld, Germany	2017, built ~1890	15,000	Grafe & Rieniets, 2022
 AB-1.2.2	BOB-Campus	Textile factory to residential, educational, community	Non-profit organization, Municipal	Montag Stiftung Urbane Räume, City of Wuppertal	Wuppertal, Germany	2022, built in the 1970s	6,300	Wessely, H., 2024, p. 36–45
 AB-2.1.1	Morland Mixité Capitale	Administrative to residential, hotel, office, retail, culture	Private	Emerige SA	Paris, France	2022, built in the 1960s	63,500	Kalten-bach, F., 2023, p. 54–69

Appendix B: Building conversions, governance models, and stakeholders. Source: Own figure.

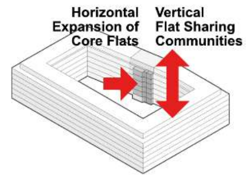
Code	Building	Conversion	Ownership	Stakeholder	Location	Year	GFA [m²]	Source
 AB-2.1.2	Conversion of Veemgebouw	Warehouse to residential, commercial, parking	Private, Non-profit organization	Stam + De Koning, Trudo	Eindhoven, Netherlands	2022, built 1943	31,600	Drey, S., 2023, p. 70–83
AC-1.1.1	Bellevue di Monaco	Residential to housing, culture, community	Cooperative	Social Cooperative Bellevue di Monaco	Munich, Germany	2019, built 19th-20th century	2,800	BauNetz, 2021
AC-1.2.1	Conversion of Silo Erlenmatt	Industrial storage to hostel, culture, community	Non-Profit organization	Stiftung Habitat, Verein Talent	Basel, Switzerland	2020, built 1912	3,691	Schoof, J., 2023, p. 60–69
AC-2.1.1	Fenix I	Warehouse to residential, cultural, commercial	Private	Heijmans Vastgoed B.V.	Rotterdam, Netherlands	2019, built 1922	45,000	Zettel, B., 2021, p. 28–33
 AC-2.2.1	Conversion of Fabra i Coats	Industrial to social housing and culture	Municipal	Barcelona City Council	Barcelona, Spain	2019, built 1900	5,392	Kalten-bach, F., 2021, p. 68–75
BC-1.1.1	CRCLR House	Warehouse to coworking, community, event spaces	Cooperative, Private	Impact Hub Berlin, Private Contractors	Berlin, Germany	2022, built 1905	6,600	Popp, P., 2023, p. 72–79
BC-1.2.1	Kopfbau K.118	Industrial to studios, think tanks, workshop	Non-profit organization	Abendrot Foundation	Winterthur, Switzerland	2021, built 1900	1,266	Nußholz et al., 2023
BC-2.1.1	Conversion of Gare Maritime	Railway station to offices, retail, public	Private	Extensa Group	Brussels, Belgium	2020, built 1907	45,000	Kalten-bach, F., 2021, p. 56–71
BC-2.2.1	Conversion of LocHal	Locomotive hall to library, office, public	Municipal	Municipality of Tilburg	Tilburg, Netherlands	2019, built 1932	11,200	Arup, 2022
B-2.1.1	Up! Berlin	Department store to office	Private	SIGNA Holding GmbH	Berlin, Germany	2021, built 1979	62,700	Pfanner, D., 2021, p. 82–91
B-2.1.2	Conversion of Tripolis	Office to office, public amenities	Private	Flow Development	Amsterdam, Netherlands	2022, built 1994	47,443	Wong, 2023
B-2.1.3	Conversion of 90 Long Acre	Office to office, retail	Private	Northwood Investors	London, UK	2024, built in the 1980s	22,300	Arup, 2022
B-2.1.4	Jacoby Studios	Hospital to company headquarters	Private	Tap Holding	Paderborn, Germany	2020, built 17th century	12,500	Kalten-bach, F., 2021, p. 30–41
B-2.2.1	Conversion of Rijnstraat 8	Office to government offices, public	Municipal	Rijksvastgoed-bedrijf	Den Haag, Netherlands	2017, built 1992	100,000	BauNetz, 2021
B-2.2.2	Uccle Town Hall	Office to administrative center	Municipal	Municipality of Uccle	Brussels, Belgium	2021, built in the 1970s	14,000	Schoof, J., 2022, p. 54–63

(**Appendix B** continued)

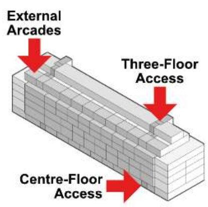


A-1.1.1: Revitalization of De Flat Kleiburg
Amsterdam, 2017
NL Architects, XVW Architectuur

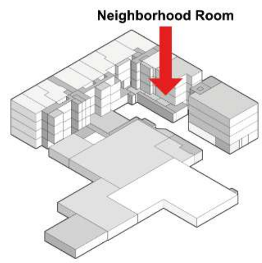
A-1.1.2: Conversion of the Felix Platter Hospital
Basel, 2022
Müller Sigrist Architekten, Rapp Architekten



A-1.1.3: Conversion of Lysbüchel Area (Abakus)
Basel, 2021
Stereo Architektur

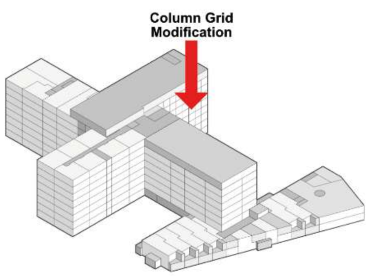


A-1.2.1: Conversion of a Wine Warehouse
Basel, 2023
Esch Sintzel Architekten

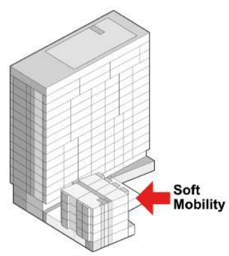


AB-1.2.1: Conversion of Alte Samtweberei
Krefeld, 2017
Böll Architekten

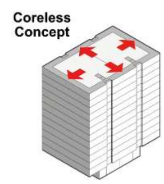
AB-1.2.2: BOB-Campus
Wuppertal, 2022
raumwerk.architekten



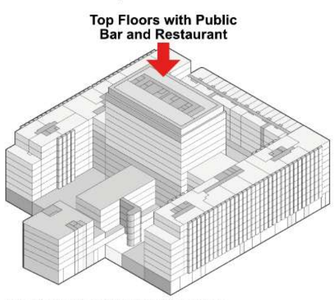
A-2.1.1: Schönburg
Bern, 2021
Theo Hotz Partner, Marazzi + Paul



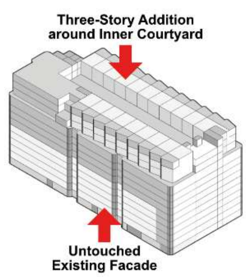
A-2.1.2: Conversion of The Cosmopolitan
Brussels, 2019
Bogdan & Van Broeck



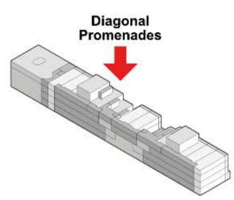
A-2.1.3: De Voortuinen Tower
Amsterdam, 2021
Elephant



AB-2.1.1: Morland Mixité Capitale
Paris, 2022
David Chipperfield Architects

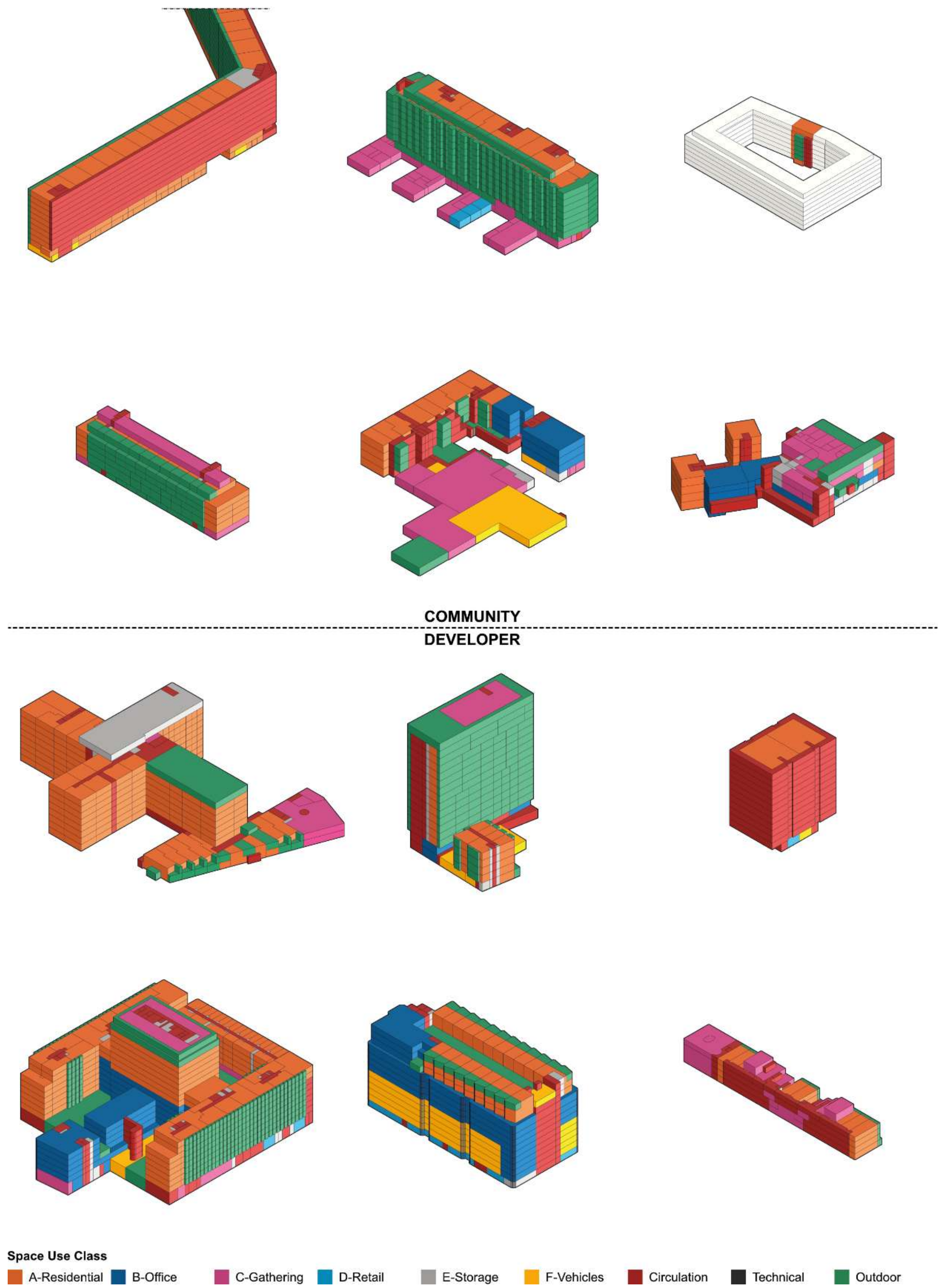


AB-2.1.2: Conversion of Veemgebouw
Eindhoven, 2022
Caruso St John Architects

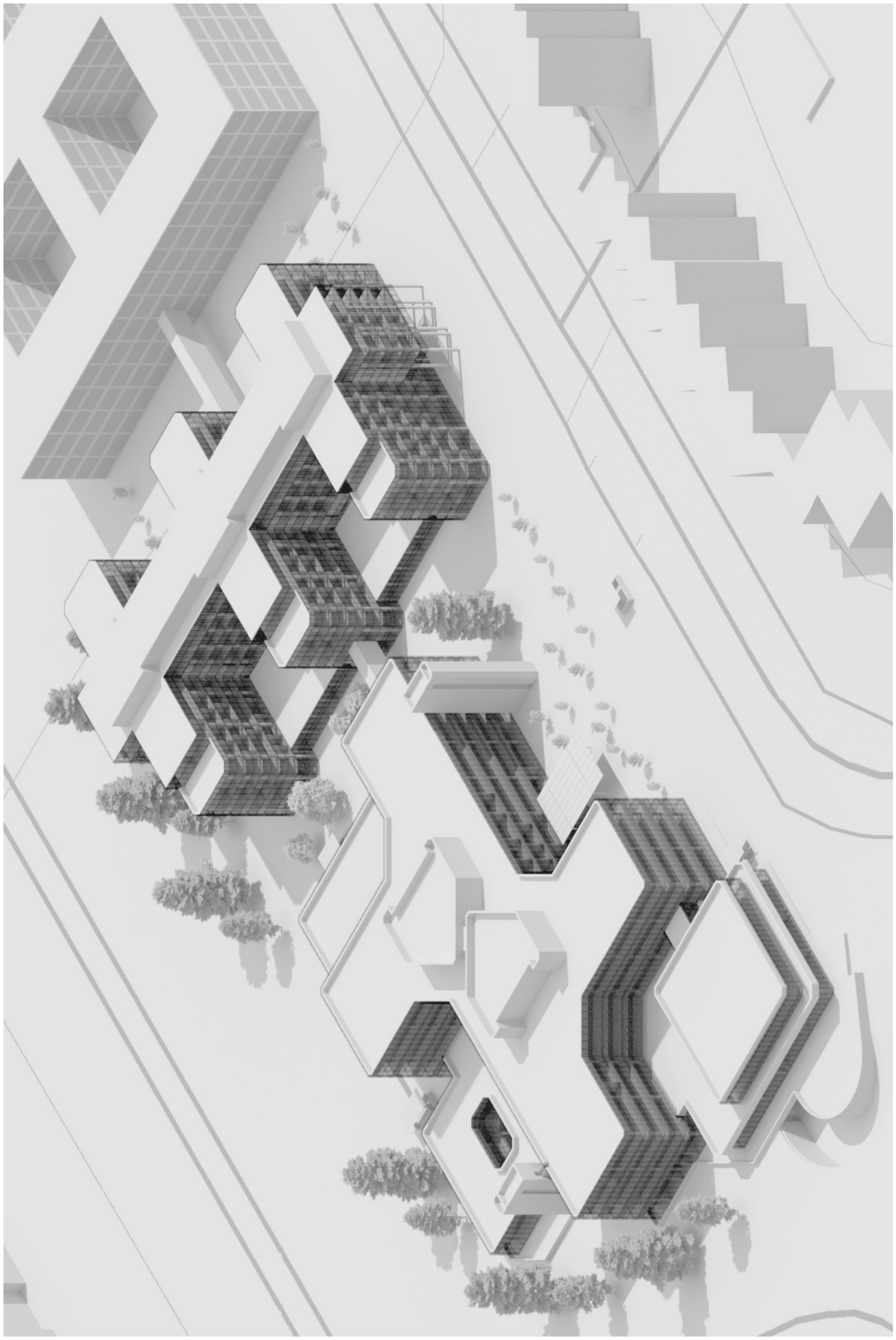


AC-2.2.1: Conversion of Fabra i Coats
Barcelona, 2019
Roldán + Berengué Arquitectos

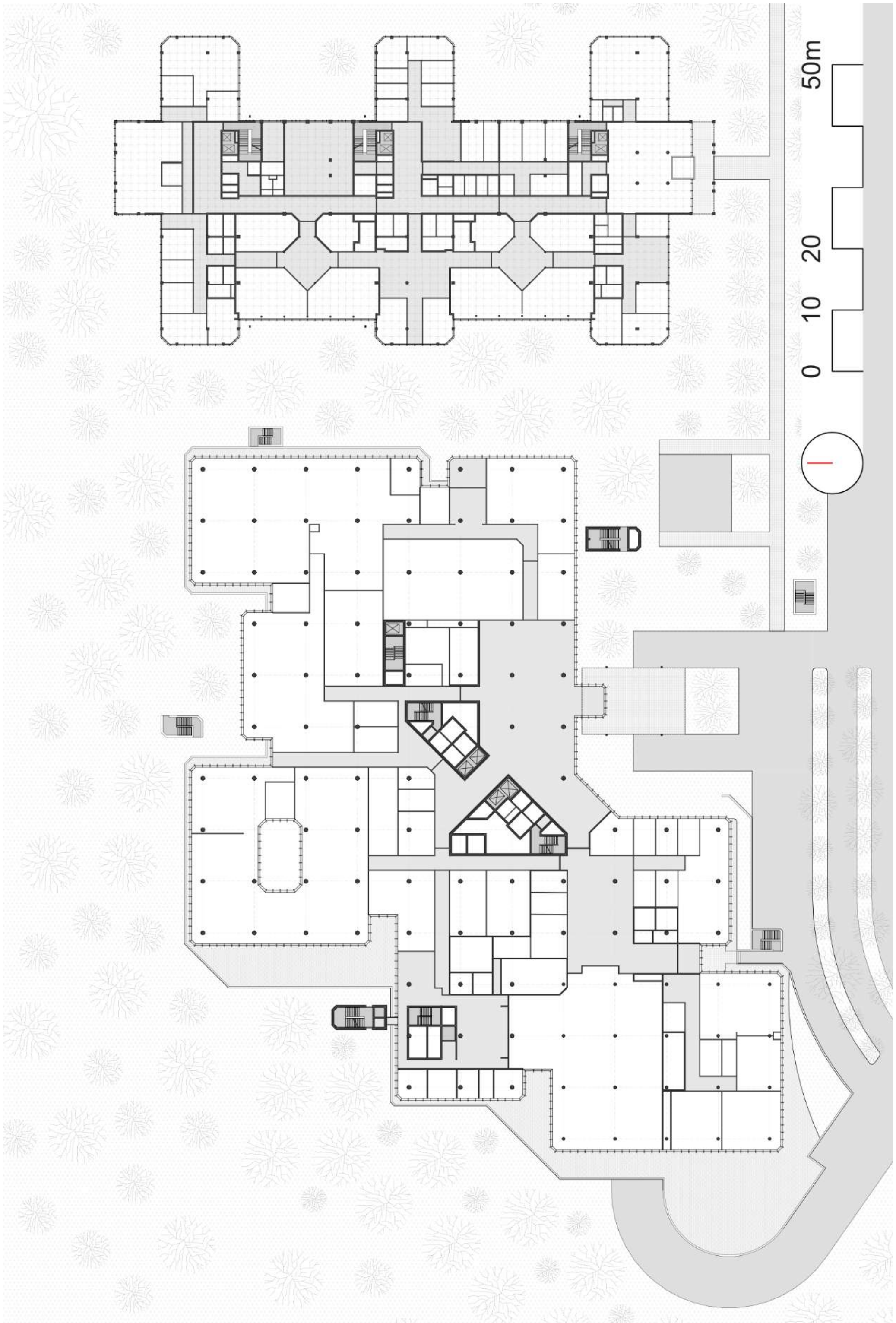
Appendix C: Reference building concepts. Source: Own figure.



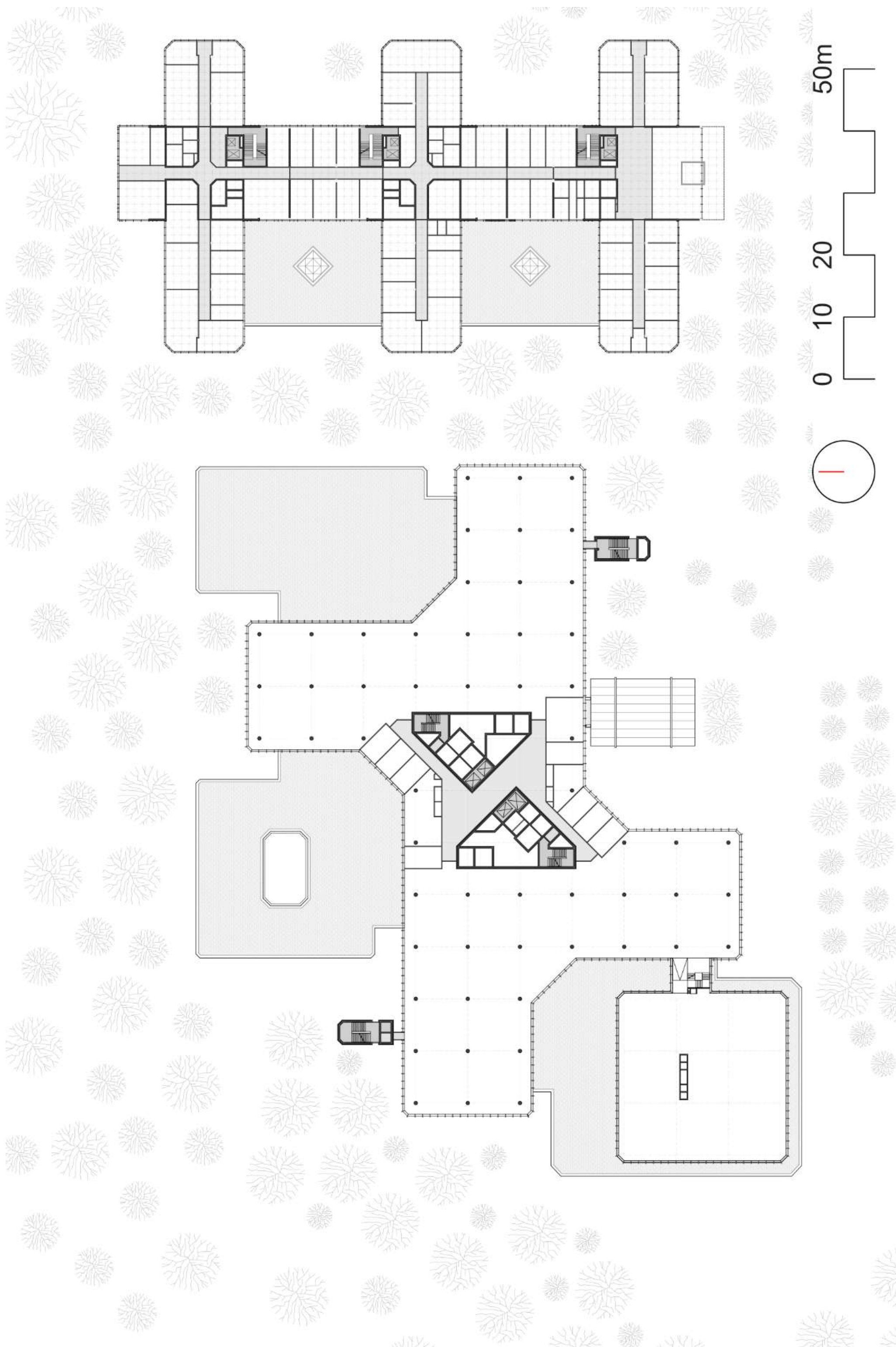
Appendix D: Reference building space use classes. Source: Own figure.



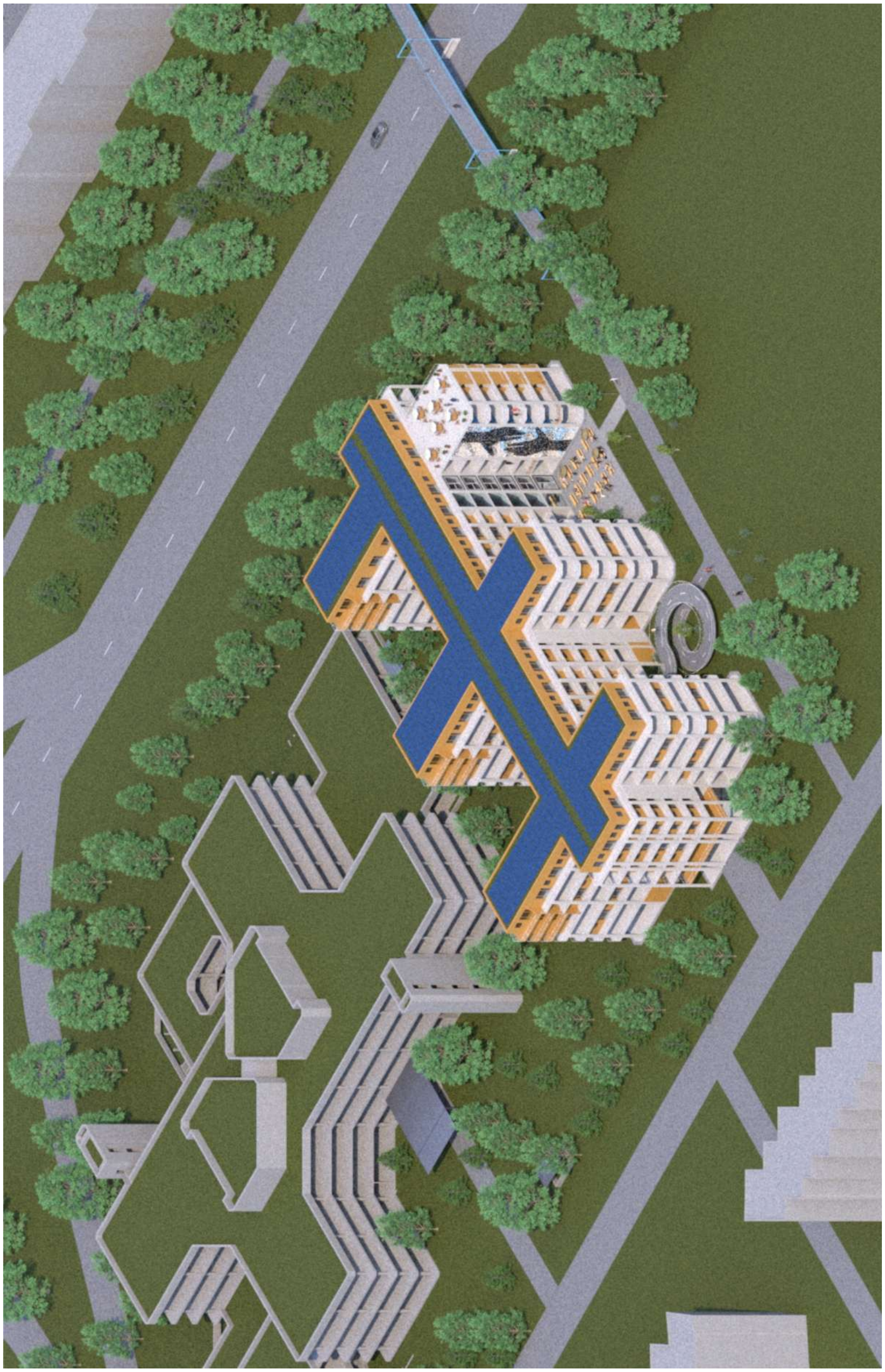
Appendix E: Axonometric view of the Neuperlach case study (existing). Source: Own figure.



Appendix F: Ground floors of the Neuperlach case study (existing). Source: Own figure.



Appendix G: Typical floors of the Neuperlach case study (existing). Source: Own figure.



Appendix H: Axonometric view of the Neuperlach case study (conversion). Source: Own figure.

Appendix I: Exploded axonometry of the Neuperlach case study (conversion). Source: Own figure.

Appendix J: Perspective of the Neuperlach case study (conversion). Source: Own figure.

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