VERSATILE AND AFFORDABLE HOUSING THROUGH OPEN BUILDING AND COOPERATIVE COMMISSIONING

Florian Holtbernd

Faculty of Architecture & the Built Environment, Delft University of Technology Julianalaan 134, 2628BL Delft

ABSTRACT

In the context of sustainable housing design the ambition arises to realize dwellings resilient towards the ever changing multiplicity of society and its demands towards a home. Realizing accessibility to affordable and suitable housing for various household constellations as well as programmatic, spatial and social versatility are key principles to achieve this aspiration.

A case study analysis of Holunderhof, Kalkbreite and WagnisART leads to the conclusion that a combination between architecturally influenced floor-space efficiency with a high level of spatial quality and cooperative ownership can achieve programmatic and social versatility while guaranteeing long-term affordability for low-and average income households.

Evaluating the characteristics concerning versatility and affordability of Balance Uster, Patch22 and San Riemo, which can be categorized as Open Building concepts, portrays how this approach successfully provides the possibility to subdivide and adapt initially large apartments into various dwelling types also allowing for future different non-housing functions. Since this concept relays largely on individual personalization and private ownership, long-term affordability is unlikely.

Combining the advantages of modular adaptability with affordable cooperative housing for lower income groups as realized at San Riemo is a possible hybrid approach, but shows disadvantages in unfortunate floorplan layouts with dark and inefficient spaces.

KEYWORDS: Housing Design, Open Building, Adaptability, Versatility, Affordable housing, Cooperative housing

I. INTRODUCTION

In the light of the undeniable responsibility of the building industry to reduce its impact on carbon emissions since the construction sector is responsible for 40% of Europe's energy consumption (United Nations Environment Programme, 2022) we keep looking for innovative design solutions to construct sustainable buildings. At the same time the statement by Carl Elefante, former president of the American institute of Architects, might be sobering to such honourable ambitions as he states: "The greenest building is the one that already exists" (Adam, 2021). With this profound understanding in mind another layer of a sustainable building future becomes apparent: The need for transformation of the existing building stock.

Combined with the persistent critical housing shortage in the Netherlands (van Bokkum, 2023) the task rises to transform buildings that face demolition into housing. KAW (2020) shows how especially postwar neighbourhoods have a great, but yet unused, potential to create housing opportunities within the existing urban fabric. The modernist efficiency of such tabula-rasa urban plans reveals a vast repetition of the typical dwelling for the 1950's Dutch nuclear family paired with a separation of functions. These post-war ideologies clash with the current residential use and liveability of such neighbourhoods, since area's like Boerhavewijk are increasingly multicultural with a large variety of household constellations (Allecijfers.nl, 2022). This multiplicity of demands towards 1-2 person households, home-office requirements, the absence of a mid-century stay-at-home-mom, upfront elderly proof design etc. results in a mismatch of supply and demand of the housing stock. This mismatch of supply and demand especially concerns households with limited financial resources (below modal income) since they are neither in the position to build a house according to their needs nor do they have access to the full spectrum of the private housing market (Schneider & Till, 2005). Yet, social housing has mostly been approached through large scale top-down developments (Dömer et al., 2014) lacking space for personalization, diversity and adaptability to the earlier described complexity and multiplicity of housing demands.

Solutions to establish a new-found durable quality and appreciation of now vacant buildings should be motivated by the potential to re-use existing building structures in a socially sustainable way by designing resilient dwellings concerning the ever changing diversity of housing demands.

Based on studies by Lengkeek and Kuenzli (2022), Dömer et al. (2014) and the NICIS (Netherlands Institute for City Innovations Studies) the principles of versatility and affordability can be deducted as crucial elements to achieve the overarching goal of socially sustainable housing in the sense of dwellings resilient towards the ever changing multiplicity of society and its demands towards a home.

By examining innovative housing projects explicitly aimed at achieving socially sustainable housing through affordability and versatility, two primary design approaches emerge as particularly: Open Building, notably established by Habraken (Kendall & Dale, 2023), and the concept of "designed diversity," prevalent in recent projects commissioned by housing cooperatives. Both offer a distinct answer to the same question.

The overarching aim of this research is therefore to evaluate the effectiveness of these two approaches in achieving versatility and affordability to inform a nuanced position towards the design process of projects with a similar agenda. Thus the research question is posed as follows:

To which extend can the principles of programmatic versatility and affordability be achieved through unconventional housing design distinguishing between two differing approaches: the open building concept and cooperative housing projects with deliberately designed diversity?

The sub-questions further narrowing down the matters of interest concerning affordability and versatility of the case study analysis will be discussed in chapters 2.2.3. and 2.2.4.

After having stated the relevance and objective of this research, the broad terminology of affordable and versatile housing will be elaborated in chapter II. After defining the distinction between what will be considered as *open building* and what as *designed diversity* in the context of this paper, the choice and categorization of case studies will be justified. Following a one-by-one evaluation of the casestudies in chapter III, similarities and patterns concerning their eligibility to realize versatility and affordability will be extrapolated in chapter IV. To which extend the results are influenced by one of the two overarching design approaches will be of special interest.

II. METHOD

2.1. Comparative Analysis

The research will be evolving around a case study analysis of six housing estates. Previous defined specific criteria of versatility and affordability will establish the framing the relevant aspects of each project. Isolated one by one claims about design objectives and ambitions of a project provided by the developer and architect will be mirrored to the realized outcome as discussed in the architectural discourse in books, journals, magazines and newspapers. Thus, it is not the objective to perform a plan analysis because it is the aim to evaluate already existing claims, experiences and descriptions within the context of comparable projects to distinguish the nuances of differing approaches towards the same principles. The project specific characteristics concerning structures, lay-outs, business models, legal structures, construction methods etc. to achieve versatility and respectively affordability will be compared afterwards.

This comparison will not be in a direct sense of measurable values on which one performs better than the other but a relative assessment of successful, effective and desirable implementation of claims and objectives concerning versatility and affordability.

2.2. Definitions of Terminology

The two categories of overarching architectural concepts that will be mutually assessed are Open Building and Designed Diversity, as defined in chapter 2.2.1. and respectively 2.2.2.

Chapters 2.2.3. and 2.2.4. will narrow down the aspects of the broad terms Versatility and Affordability relevant to this research and further distinguish according to which factors the subdivided housing estates will be evaluated.

2.2.1. Open Building

Open Building is a well-established term, most prominently defined by John Habraken (Dale, 2023) It describes the concept of establishing a general superstructure to provide the possibility for convenient adaptability and rearrangements of spatial planning. In the context of this research especially the Open Building aspect of adaptable housing conditions will be relevant. Projects which explicitly formulate the objective to achieve long-term adjustability of various dwelling types to meet changing demands. The aspired flexibility of those projects has to go beyond interior design alterations towards an overall reconfiguration of dwelling types, and programmatic infill. These criteria also exclude projects that primarily focus on flexible infill of an open floorplan, as seen in the Grundbau & Siedler initiative. Despite BeL Architects' radical application of Le Corbusier's open floorplan concept 'Maison Dom-Ino', the objective was cost-efficient self-building methods to meet individual housing demands without considering future adaptation after completion (Friedrich, 2013).

2.2.2. Designed Diversity

Defining the second category of Designed Diversity does not rely on an established style or concept. It is rather a collection of contemporary architectural designs distinguishing themselves from modular, repeatable and standardized designs. Typical elements making a project eligible for this lable are design briefs demanding various dwelling types for a socially, culturally and financially diverse target group combined with several public, commercial and collective functions all in one housing estate. Another aspect is that this programmatic versatility also becomes apparent in the architectural expression. Not per se through materialization but mainly by composition of volumes, circulation and floorplan layouts.

Projects matching this tailor-made hyper-diversity to accommodate various types of program and dwelling types upfront will be considered as "Designed Diversity".

2.2.3. Versatility

According to the Oxford Advanced American Dictionary versatility means to be "able to change easily from one activity to another or able to be used for many different purposes [and] to adjust to new conditions, or (of things) able to be used for many different purposes" (2024). Combining this common understanding of the term with its application in architectural literature will lead to a definition framing the scope of versatility relevant to this research. Next to the aesthetic versatility achieved through brick construction as formulated by Torija (2022) steel is described also as a versatile construction material by Blanc et al. (1993) allowing the architect to realize pretty much any desired shapes and spans for various functions. Friedman (2021) refers to prefabricated homes as "extremely versatile" in the sense of being adaptable do different circumstances and demands. Knapp (2005) describes the quality of traditional Chinese country homes to adapt their layout to the household constellation over several generations as versatile architecture, thus formulating an understanding of versatility very close to the one implemented in this research: A versatile architectural design can adapt to different uses and meet the diverse needs of its occupants over time and thus allows buildings to be more resilient and responsive to changing requirements and user preferences. This concerns programmatic, spatial and functional versatility. The term "versatility" is preferred, since by adding the layers of variety, adaptability, diversity and multiplicity it does not inherently imply the requirement of physical change of the building structure to achieve this objective like the term "flexibility", a more common term in the architectural discourse, does. Flexibility as part of versatility will be further evaluated through the indicators Adaptability, Multifunctionality, Variability, Structure&Construction as proposed by Hatipoğlu and İsmail (2020).

Since five out of six projects are located in German-speaking cities, the following German terms to incorporate the language-specific nuances will be considered as buzzwords categorizing a project as versatile: *Vielseitigkeit, Vielfalt, Flexibilität, Aneignungsmöglichkeiten, freie Programmierung, Gewerbemix, Vielseitiges Raumprogramm, unterschiedliche Wohnformen, soziale Durchmischung.*

The following sub-questions will guide the scope of versatility according to which the projects will be evaluated:

What kind of and how many different typologies and functions could be accommodated by each of the selected housing projects?

Are there interventions or procedures ensuring versatility of programme and/or users after the initial occupants have moved out?

Is there a relation between the level of versatility and interior spatial quality?

Are spatial, programmatic and social versatility addressed as separate objectives or as mutually reinforcing principles?

2.2.4. Affordability

Based on findings by Dömer, Drexler and Schultz-Granberg (2014) affordability in housing design can be distinguished as cost-per-area efficiency and the more qualitative relation between costs and benefits of residential qualities. Therefore concepts to achieve cost-efficiency on the areas of construction methods providing future adaptability will be equally regarded as affordable projects as the mere objective to lower rental/ purchasing costs per tenant.

To further add the layer of long-term affordability the structure of financial ties between development, ownership, rent and increase in value will be assessed. By researching the differing accessibility towards various income groups at the moment of completion and after a change of residents will further support the evaluation of long-term affordability.

In between the criteria of versatility and affordability lies the analysis about access to shared facilities, to private/semiprivate/shared outdoor space and the personal gain connected to integrated public/commercial space within a project. This last indicator will provide a stronger context on the relation between costs and benefits per dwelling.

To further frame the level of affordability the following sub-question will be posed:

How do the costs per tenant/owner relative to their income relate to comparable housing projects in the same area?

In which way are the total costs of ownership distributed amongst the dwellers and/or developer?

To which extend is the construction process part of the concept to achieve lower costs for the inhabitant?

Are measures beyond the actual mortgage/rent addressed to lower monthly costs for the inhabitants?

To which extend is the commissioning party involved in maintaining the long term affordability of their project?

Which effect does the architectural design have on maintaining such a long term affordability or are external factors like the underlying business model decisive?

2.3. Choice of Case Studies

The case studies will be selected based on two main indicators: Their comparability in terms of scale, urban and environmental context and program and second a comparable level of commitment towards the general design objective of versatile, affordable and overall socially sustainable housing.

Criteria to determine relevance to the design location are: They must be situated in a urban context. The housing project should be constructed as a whole on one defined plot and accommodate around 50-250 inhabitants and facilitate non-residential functions. The projects must have been completed between 2000 and 2020 in central Europe to ensure similar climate conditions and building standards.

Versatility and affordability in a mutually endorsing relationship should be distinguishable as the core characteristic of a chosen project. Meaning, Social relevance for future generations, affordability concepts and accessibility for a large variety of household constellations and housing demands have to be addressed specifically in the initial project description provided by the architect or the developer.

In addition the chosen projects have to be well documented and discussed, since doing a plan analysis is not the objective as mentioned in chapter 2.1.

Holunderhof has been selected because of the statement by the managing director of the housing cooperative Röntgenhof that it is their core value to respond to the needs of families, elderly and disabled in equal measure (*Interview Tatjana Horvath*, n.d., para. 2) and fitting the objective of this research by striving to pass their values to the coming generations matching the changes of society and its demands.

Kalkbreite fits this study based on the explicit statements in their own project documentation describing the ambition to accommodate a large variety of households with built-in flexibility towards changing circumstances by providing so-called joker-rooms. On top of that low rents are specifically mentioned as a main tool to achieve the aspired diversity of users (Genossenschaft Kalkbreite, 2014, pp. 4-5).

The relevance of various public functions located in the plinth combined with the unique constellation of several floorplan layouts and unconventional dwelling types expressed through a bold design of polygonal volumes and protruding bridges makes WagnisART a suitable project for this research. The statement by the cooperative Wagnis to establish housing estates with versatile uses for future generitons by connecting living, working, culture, social interaction and inclusion further highlights the eligibility for this study.

Balance Uster can be regarded as a prime example of the open building approach, based on the description of the "Konzept Balance" by the architects and the constructor as a concept without defined target group because of its adaptability. Responding to the dynamic changes of society and household structures is a clearly defined goal of the Balance concept (Leb, 2013). Furer (2008) and Leb (2013) even regard the Balance concept as a contemporary quite literal interpretation of John Habrakens Open Building Concept who has even visited the pilot project in Walliseben.

Patch 22 will match the open building category based on the way the architect promotes flexibility and diversity of space and functions as means to the end of sustainability, matching overarching objective of this study. The ambition to prove sustainable and future adaptive housing to be financially feasible by taking on the initiative to develop personally as an architect without depending on external investors further makes this project applicable concerning affordability and versatility.

San Riemo also fits the research objective in the open building category due to the inherent commitment of the commissioning "Kooperatieve Grossstadt" to realize various conceptual dwelling types to welcome conventional households just as much as progressive co-living concepts.

It is noteworthy that projects are concentrated in Zürich. As several authors have pointed out before (see Lengkeek & Kuenzli, 2020. Totté, 2019. Kockelkorn & Schindler, 2024. Banz et al., 2018), the city's notable density of cooperative and innovative housing initiatives is attributed to historical cooperative influence and current legislation mandating one-third non-profit housing within Zürich. As an illustration, the city currently hosts 250 housing cooperatives, each with multiple estates, and this trend is on the rise (Gosen, 2019).

III. RESULTS

Project	Location	Architect	Commissioner	Dwellings	Program
Holunderhof	Zürich 2018	Schneider Studer Primas Architekten GmbH	Gemeinnützige Bau- genossenschaft Röntgenhof Zürich	95 dwellings +- 230 inhabitants	392 m² collective parking &storage 115 m² nursery
				2 × Studio 36 m ² 15 × 2-room apartments 63 m ² 38 × 3 ^x .a. 92 m ² 32 × 4 ^x .a. 104 m ² 8 × 5 ^x .a. 118 m ²	4476 H- Collective garden
Kalkbreite	Zürich 2014	Müller Sigrist	Genossenschaft Kalkbreite	<pre>97 housing units, 55 dwellings +- 250 inhabitants 30 x studios of 29-56 m² throughout 3 cluster apartments 2 x studio's 38-45 m² • 18 × 2-room apartments 50-103 m² • 13 × 4r.a. 95-133 m² • 8 × 5r.a. 123-127 m² • 6 × 6r.a. 142-152 m² • 2 × 7-9r.a. 142-215 m²</pre>	816 m ⁷ retail 489 m ² gastronomy 1617 m ² office/atelier 654 m ² culture 312 m ² nursery 285m ⁷ guest house 330 m ² interior communal space 301 m ² additive rental space 2500 m ² public courtyard collective roof terrace
wagnisART	München 2016	SHAG Schindler Hable Architekten GoR, bogevischs buero architekten & stadtplaner GmbH	Wohnbaugenossen- schaft Wagnis eG	138 dwellings +- 250 inhabitants 57 2-room apartments throughout 9 cluster apartments 48 × 2r.a. 39-61 m ² 38 × 3r.a. 73-91 m ² 25 × 4r.a.108-131 m ² 10 × 5r.a. 112-161 m ² 15 × studio 44-50m ²	Gastronomy, olices,meeting rooms, car- park, guest rooms, event room, workshops, laundry hall, rehearsal room All public, rental, communal and inter- active spaces are located on the ground floor. No dimensions provided. 5187 m ² public courtyard collective roof terrace/bridges

Table 1. Factsheet of selected case studies in the Designed Diversity category.

Table 2. Factsheet of selected case studies in the Open Building category.

Project	Location	Architect	Commissioner	Dwellings	Program
Balance Uster	Zürich 2001	Haerle Hubacher Ar- chitekten	Streich AG Gener- alunternehmung	35 dwellings	100m² private terrace per floor
				35 - 245 possible inhabitants	+- 6500 m² semi public outdoor space
				35 × 190 m² apartments	1 private parking spot per dwelling
				possible as loft or 1 - 6 bedrooms	
				or + max 35 × sublet apartments	
Patch 22	Amsterdam 2016	FRANTZEN et al	Lemniskade Projects	Currently 29 dwellings	600 m² commercial space
				16 - 217 possible inhabitants	37 exterior parking spots.
				5 × row houses 115 m ²	
				min 6 max 48 apartments	
				minimal units:	
				24 × 42 m ²	
				12 × 66 m²	
				$12 \times 87 m^2$	
				max: 6 × lofts 532m ²	
San Riemo	München	SUMMACUMFEMMER & Büro Juliane Greb	Kooperntive Grossstadt eG	Currently 29 dwellings	1 guest room
	2020			currently 100 inhabitants	205m ² collective space (workshop,laundry)
				max 24 × 14 m² bedrooms on 5 floors	320m² commercial space (gastronomy)
				6 wetcell+kitchen cores on 5 floors	267m ² collective roof terrace
				smallest unit: 2r.a. 52 m²	
				largest private unit: 5r.a. 117.5 m ²	
				cluster apartment: 11r.a. 144 m²	

3.1. Holunderhof

Holunderhof is a 5-story apartment block with 73% 3- to 4-bedroom dwellings (Lengkeek & Kuenzli, 2022) along a noisy street to the north and a neighbourhood park to the south side where it replaces a previous apartment block occupied by the same cooperative. It has been commissioned by Baugenossenschaft Röntgenhof, a cooperative founded in 1925 with currently 20 housing estates in the region of Zürich (*Siedlung 8: Holunderhof*, n.d.). Six entrance porches grant access to four dwellings per floor.

Genossenschaft Röntgenhof gloats about the many young families living at Holunderhof. On top of that only two studio's and no collective or commercial facilities have been incorporated into the project. Gosen (2019) states that a clearly defined audience valuating qualitative private space above

collectively appears to be a typical approach by the Röntgenhof cooperative. However, two aspects of versatility reveal themselves behind this seemingly monotonous programme: It is an explicitly essential core-value of the Baugenossenschaft Röntgenhof to establish a diversity of inhabitants within one building concerning age, household constellation and income (*Siedlung 8: Holunderhof*, n.d.). This is realized through designing lifecycle-friendly dwellings and different apartment sizes even within the same category of family-friendly homes reaching from 63m² two-bedroom flats up to 118m² five-bedroom apartments.

Second: Different floorplans with unconventional oval shapes and room layouts, like creating enfilades by opening sliding doors along the curved terrace even within minimalistic two-bedroom apartments, as highlighted in figure 1. At the same time all of the apartments share the same fundamental spatial qualities of at least double-sided orientation and direct access to private outdoor space as well as the earlier mentioned enfilades (Lengkeek & Kuenzli, 2021)

This tailor-made layout does have a weak spot: The previous building accommodating a similar program with the same values has been demolished, because renovation was to costly and the floorplans did not match contemporary demands (Bachmann, 2017), thus questioning why these apartments optimized for the current ideals should be fit to accommodate future demands.

As seen in most cooperatives in Zürich, affordable housing is regarded as a tool to make social diversity within a building possible. Gosen (2019) describes how the rent of a three-bedroom apartment owned by a cooperative varies between 1.800 and 2.500swiss francs per month compared to the average of 2.800CHF/month. However the obligatory share of 80 up to 260CHF/m² to become a member of a cooperative creates a significant financial hurdle. In case of Holunderhof the feasibility of a maximum rent of 200CHF/m² per year, half the price of similar apartments in the neighbourhood, has been a strict criteria for the selection of the winning architecture firm in the design competition (Bachmann, 2017) even though cost-efficiency is the last thought that comes to mind when confronted with the curved and irregular façade with its protruding terraces around the courtyards.

Additionally Minimizing floor space usage per tenant is another key characteristic of the Röntgenhof cooperative to maximise cost efficiency, since rent and contribution fee depend on the amount of square meters per tenant. By additionally reinforcing the rule that a tenant can only rent a place with the amount of rooms equal to the amount of family members plus one, dwellings are sought to be occupied as efficiently as possible also effecting lower energy consumption as has been pointed out by De Beun (2023).

Figure 1. Enfilades at Holunderhof. Own work based on drawings by Schneider Studer Primas retrieved from https://www.swiss-architects.com/de/schneider-studer-primaszurich/project/ersatzneubau-wohnsiedlung-holunderhof#image-9.



3.2. Kalkbreite

Kalkbreite is a housing estate which stands out due to its complex location on top of tram depot on the axis of three central neighbourhoods within the inner city of Zürich. The striking complex program of various public, commercial and collective functions (table 1) is distributed over generic spaces as well as multi-story unique designs on the lower three levels of the building. A just as versatile collection of dwelling types is added on top of this multi-purpose plinth around a 2500m² courtyard.

This spatial versatility is the architectural implementation of the values and objectives of the commissioning Genossenschaft Kalkbreite which aims to ensure social diversity by actively assigning apartments based on sex, age, origin and income (Genossenschaft Kalkbreite, 2014).

The most striking approach to ensure versatility in the sense of accommodating changing household constellations as spatially efficient as possible, ten "joker rooms" are added that can be rented additionally for three years to bridge the gap until a suitable bigger apartment within Kalkbreite becomes available. This is also reflected by the objective of the Genossenschaft Kalkbreite to accommodate operational, professional and private changes spatially as long as it is beneficial for the members of the cooperative.

This measure also reflects the multiple attempts to minimize floor-space-usage lowering rent also by actively promoting low energy consumption (De Beun, 2023). The same affordability principles mentioned about Holunderhof are applicable for Kalkbreite with the unique addition of an own internal procedure to subsidies members with low income through collective membership fees, which lowers the typical hurdle of purchasing a share ensuring long-term affordability for low-income households (Lengkeek & Kuenzli, 2022). The importance of a mutual relation between low rents and social diversity is also highlighted by the cooperative themselves.

Another measure to ensure financial feasibility of this ambitious project is the generated income through the high density of commercial spaces benefiting from the central location within the city.

3.3. WagnisART

The housing estate WagnisART is composed out of five polygonal blocks connected by underground parking and storage and grand bridges, which span between the building blocks on the third floor defining a sequence of public courtyards. With 138 dwellings it is the largest out of currently seven housing estates commissioned and owned by the cooperative Wagnis in Munich.

Educational functions, guest houses, music studios and office spaces for rent (also without cooperative membership) and collective facilities located in the plinth of all five blocks establishes a high level of various encounters between people from the entire neighbourhood and beyond (*WagnisART*, 2021).

The large variety of equally distributed dwelling types from studios to family homes and cluster apartments is translated in the architectural design of unique and different floorplan layouts fitted into the polygonal volumes prolonged by grand bridges creating a private, yet collective outdoor space inbetween roof terrace and necessary circulation.

Again the same cooperative principles of non-profit rent combined with purchasing a personal share as described for Holunderhof are also applicable for this German cooperative.

Especially the nine cluster apartments accommodating 57 housing units covering almost one third of all available dwellings realize affordability through efficient space-usage and collective facilities.

3.4. Balance Uster

Three projects have been realized inbetween 1997 and 2003 in the greater region of Zürich with the same *Balance* concept by Haerle Hubacher.

Realizing programmatic and spatial versatility through the paradox simplicity of the initial floorplan layout which can be converted into dozens of different housing types reaching from lofts to eight-room family houses, a separate office extension or even into two separate dwellings of various sizes as shown in figure 2. This adaptation is facilitated by three main interventions: A patented cabinet element which is the spatial and constructive backbone of potential subdivision walls and respective door-placement. A concrete core containing all vertical shafts provides two possible bathroom locations and several points to install a kitchen in different layouts. Lastly the circulation is essential especially to the possibility of a separate office/commercial function or one extra sublet apartment. The external staircase and elevator core grants access to a spacious terrace functioning as outdoor space and entrance hall with two front doors. To design dwellings that are equally suitable for living and working, various household constellations and intergenerationally appropriate has been an overarching design objective for Haerle Hubacher as well as the commissioning Streich AG (*Neue Züricher Zeitung*, 2021).

The construction process is an essential part of this concept to achieve cost efficient and participatory housing. Semi-finished products are refined on site in a separately installed "Bauhütte"/ Construction lodge. Modular application of façade elements and the stacking of one basic dwelling type distributed over seven cubic volumes results in a cost-efficient repetition on 30.000m² over all three projects of one and the same housing unit. Costs increase afterwards depending on individual adaptation. The first project in Walliseben was sold under a loss, thus achieving the initially desired social diversity of inhabitants as stated by the architect Sabine Hubacher herself (Leb, 2013). This diversity lacks in Uster and Fällanden since more than 90% of the average Swiss income had to be spend on monthly mortgage payments for the apartments that were sold for around €600.000 in 2001 (Dömer et al., 2014).

Even though separation of one floor into two independent units is facilitated and proven to be successful according to several inhabitants (Beyeler, 2010) it may strengthen the objective to create a more diversified use but does not effectively lower the financial hurdle to own an apartment in the Balance concept, because the owner always has to buy and adapt one entire floor of $190 \text{ m}^2 + 100\text{m}^2$ terrace first. Being able to sublet part of your house, lowering rental costs of an otherwise external office or realizing elderly friendly apartments to anticipate on care-expenses are opportunities to lower personal expenses only accessible to people who can afford to buy an apartment of currently way above 1.000.000CHF.





3.5. Patch 22

Patch22 has been developed and constructed by the architect Tom Frantzen himself through his company Lemniskade Projecten BV to ensure the freedom to design truly sustainable housing through innovative climate installations, a mostly wooden structure and a concept of constructional and legal framework allowing future adaptability of layouts and functions. Located in Amsterdam north at a former harbour the building contains 5 row houses attached to six open floorplan stories on top of a double-height commercial space on the ground floor. The wooden structure is stabilized by a concrete core functioning as central vertical shaft for installations and as circulation element granting access to a maximum of eight dwellings per floor.

Programmatic diversity is not given initially but is objected to be possible through spatial flexibility.

Hollow floors allow installations, ducts and pipes to be located at any given position on the story around the central core. The complete lack of constructional partition walls or internal columns and dry installation techniques even allows for vertical combinations of subdivided housing units.

According to Frantzen himself their biggest achievement has been the legal framework which makes it possible to change housenumbers, dwelling types and functions over time. The above average floor-to-ceiling height of 4m and a higher load-bearing capacity of 4kN further makes the switch between housing and offices possible within building code restrictions.

The radical open floorplan concept also has its negative effects on spatial quality: Unusual deep spaces lead to several rooms with very distant- or even without any direct window connection – a phenomenon also known to occur in office transformations.

Next to the initially of over-sized apartments and high floor-space-usage per person of up to $148m^2$ per person in some of the currently occupied dwellings, also unavoidable furnishing costs of $\notin 800$ -

 $\in 1500/m^2$ according to estimations by the developer himself (Lemniskade Projecten BV, 2021) substantially raise the financial bar to purchase an apartment at Patch22.

But as stated by the architect Frantzen himself, this project is considered a pilot to sell sustainable future oriented housing to "the ones who can afford to pay for it" (Here comes the sun, 2019, 04:30).

But even though the aspect of financial feasibility for low-incomes is not part of his affordability concept, Frantzen still achieves to guarantee future alterations to be way more realistic and financially feasible. In the context of current discussions about the lacking cost-efficiency of office transformations this concept of affordability becomes a significant contribution to the long-term development of the real estate market.

3.6. San Riemo

San Riemo is the pilot project of Kooperative Grossstadt located in Riem, an outskirt of Munich. It is the only project of this study which combines a cooperative ownership with an open building approach.

Adaptability and co-existence of various dwelling concepts is the key characteristic of San Riemo. This objective is realized through two circulation cores, which grant access to an initially open floorplan with a central zone providing seven possible locations for bathrooms and kitchens and two façade zones subdividable into 12 rooms of 14m² per side. The ground floor offers one zone to commercial users and a grand hall over the remaining two zones of for collective use like workshops, laundry and cultural events.

Three divergent dwelling type concepts are realized: 'Basic Living' provides a conventional private apartment to lower the hurdle for cooperative members who value a more traditional sense of a private home to take part in this overall collective initiative. 'Nuclear Living' describes households which stick to one private core with kitchen and bathroom but share flexible living rooms with their neighbours. Filial Living is a more radical form of the cluster apartments as can be found in Kalkbreite and WagnisART since private space is limited to one bedroom opening up the possibility of large collective kitchens and living rooms.

Central zone with nucli: Advantage of rearrangeable layouts comes at the expense of highly variable spatial quality. If the kitchen is connected to a non-private space (as it is the case in more than half of the current dwellings) the access to daylight is only granted if the front door is left open. Towards the side of the bedrooms three doors/windows have to opened to allow an unrestricted view outside due to the translucent, but not fully transparent corrugated windows along the balcony.

3.7. Results in context

Based on their manifesto to make architecture competitions more transparent and democratic, the progressive Kooperative Grossstandt stands out in sharing near everything of the participatory planning and construction process. The more than a century old cooperative Röntgenhof on the other hand presents itself as a more top-down authority mentioning architects and contractors as crucial consultants. For example, the decision to demolish and replace the previous housing estate at the exact same location of the current Holunderhof has merely been based on reports declaring renovation as not financially feasible (Bachmann, 2017).

The developers of Balance Uster are very open about the low construction costs and the participation process with a variety of initial owners but never mentions the price development of 190m² apartments and its possible effect on the long-term affordability of this open-minded concept of *balance* sold into private ownership. Patch 22 could lead to a similar remark at first glance but distinguishes itself in this very issue by advertising the effort and cost put into a legal framework, which allows future fragmentation of the initial *one owner per floor* system.

IV. CONCLUSIONS

4.1. Comparing Versatile Qualities

While both approaches address the topic of versatility by offering a solution for the multiplicity of society, projects labelled as Designed Diversity propose an initial level of diversity and versatility of users and functions while Open Building concepts start with similar users aiming to establish a solid foundation to anticipate evolving demands and changes of programme over time.

Balance Uster and Patch22 both regard the stacked version of a traditional detached single-family home as their point of departure. This floor-by-floor subdivision limits horizontal interaction. The personalized layout fitting the initial users creates a linear dependency towards future developments. Diversity and adaptiveness to changing needs and effective use of space is never guaranteed. Hypothetically these projects could just as well remain clusters of a few wealthy owners of oversized apartments. Since both projects are up to the free market after the initial stage of participation, square meter prices are more likely to evoke a next generation of wealthy buyers looking for luxury loft-like housing with home-office extensions instead of the described objective of a diversity of users and functions.

The San Riemo concept of adaptability evolving around a nucleus used as kitchen and living room rather instead of a merely functional core promotes small-scale and more accessible alterations but leads to unfortunate floorplan layouts with dark and inefficient spaces.

The flexibility realized in Patch22 could be interpreted as a more radical upgrade of the Balance concept, since the core is reduced to installations and circulation only granting maximum flexibility to install wet-cells and kitchens at any given spot and angle thanks to the hollow floor construction. This freedom on the other hand raises the bar to modify an apartment without professional support of interior designers, plumbers and electricians, whereas the more rigid subdivision in Uster provides easier accessible pre-installed systems for interior wall and kitchen placement.

In case of the Designed Diversity category promises for a long-term social diversity are more likely to hold up but are mostly backed by values and bylaws of housing cooperatives. The architectural concept comes second but is a vital element in making these objectives feasible through smart floor-space-usage, collective spaces and multipurpose rooms or by community oriented co-housing apartments. How tailor-made dwelling designs without participation or flexibility can result in a upfront provided high level of spatial quality becomes apparent in the unique enfilade's along curved protruding terraces seen at Holunderhof. Such a quality could be achieved but never guaranteed in an Open Building concept. This planned out versatility also becomes apparent in the exterior architecture: Volumes and façade organization communicate the interior diversity, whereas all three Open Building concepts feature repetitive facades in a cubic volume respectively communicating the blank page that awaits adaptation.

The apparent difference in initial programmatic versatility, which stands out in table 1 and 2, must not be interpreted as evident difference between the two approaches since it is in the defined nature of the Designed Diversity category to provide this initial range of functions and respectively in the nature of Open Building designs to evolve their programmatic infill and adaptation over time.

4.2. Comparing Affordability

Analysing three Open Building concepts reveals two main factors impacting affordability: Merging desired functions or dwelling types into one cost-efficient cluster for the initial owner of an entire story, making a business connected to home or intergenerational constellations more feasible. And optimizing construction costs through semi-finished prefab elements and repetitive stacking of one unfurnished basic floorplan type allowing fast construction and adaptive, cost-efficient personalization. Because of the concept to start big und subdivide later, these concepts are fully dependent of initial owners with above-average income. Social mix and affordability projected for the future, might work but will remain in control of initial home-owners.

The same overall conclusion concerning versatility of projects in the Designed Diversity category is applicable for their approach to achieve affordability: The cooperative values and bylaws set the

idealistic and legal framework guaranteeing non-profit rent and the life-long right to remain a tenant supported by the architectural implementation to design dwellings that keep rents as low as possible due to efficient floor-space usage. Considering San Riemo as an open building commissioned by a cooperative aiming at low to average income households further highlights the influence of the business case on affordability rather than the architecture.

To which extend a project is affordable will always rely on the context and perspective. Being part of the Balance concept in Uster makes homeownership more feasible towards a middle class wealthy household looking for future-proof flexibility like subletting, having your own business next door or providing an independent apartment for grown-up children, therefore fitting the aim of this research paper to investigate unconventional versatile housing. From the point of view of a less financially stable household with similar aspirations this system would never be feasible despite this cost-efficient concept. Changing the perspective again towards a cooperative housing unit with below average rent, shifting personal demands towards the floorplan layout decreases affordability because of the need to move or even leave the cooperative system if certain spatial requests exceed the assigned dwelling type.

V. DISCUSSION

This research establishes a point of departure to map and evaluate the multiplicity of contemporary methods to achieve the same goal of social sustainable housing through versatility and affordability. However, it lacks quantitative data to support the conclusions and to objectively come to justified recommendations based on comparable statistics. The qualitative nature of this analysis on the other hand illustrates in a transparent way the different but valuable advantages and disadvantages of certain overarching design approaches.

The six case studies presented in this research have also shown that a successful realization of an architectural design objective of versatility and affordability can only thrive within the context of a strong business model. The four projects achieving affordability through independence from a speculative housing market are commissioned by housing cooperatives, a business model fairly unknown in The Netherlands. From my own recent experience in partaking in a project with the initial ambition to become a cooperative, I can affirm that municipal support, expertise and trust from collaborative banks are essential. Where in the case of projects in Zürich the municipal policies to realize a minimum amount of non-profit housing, this foundation lacks in The Netherlands. In the end, the financial risks arising due to the lack of tolerant land-lease agreements and an obliging mortgage forced the project in Delft to give up on its cooperative ambitions (the involved architect remained the same) versatility and affordability could not be achieved to the same level without the backbone of this cooperative business model.

The lessons learned provide new inspirational perspectives for the design ambition which motivates this research even though the process of a deeper understanding how mutual consolidation of business model and architecture can be realized is far from finished. The case study analysis leads to more realistic and specific inspiration on the possibilities to design unconventional versatile and affordable housing and has led to discover more and even more suitable reference projects which are still under construction. The very recent developments in this topic also affirmed the contemporary relevance of this research and design objective. Through elaborating on the weak points of other projects I also challenge some of my own ideas, which helps to formulate more effective and specific design ambitions.

REFERENCES

Adam, R. (2021, August 13). 'The greenest building is the one that already exists.' The Architects' Journal. https://www.architectsjournal.co.uk/news/opinion/the-greenest-building-is-the-one-that-already-exists

Analyse Platform woonopgave. (2023, May 30). Platform Woonopgave.

https://platformwoonopgave.nl/sdm downloads/analyse-platform-woonopgave/

Bachmann, T. (2017). Ersatzneubauten - Das Beispiel Holunderhof. WOHNEN, 4, 12-13.

Banz, C., & Krohn, M. (2018). Social design: Participation and Empowerment. Companyédition Museum für Gestaltung Zürich/Lars Müller.

Berg, J. (2008). Houses in transformation. Nai010 Publishers.

Beyeler, M. (2010). Weiterbauen: Wohneigentum im Alter neu nutzen. Christoph Merian Verlag.

- Beyeler, M. (2022, July 5). *Siedlung balance*. flexible-grundrisse.de. https://flexible-grundrisse.de/2021/06/25/p-069-balance/
- Bogevischs buero architektur & stadtplanung GmbH. (n.d.). *Genossenschaftliche Wohnanlage wagnisART*. bogevisch.de. https://www.bogevisch.de/projekte/genossenschaftliche-wohnanlage-wagnisart
- Bolhuis, J. (2023, October 17). Living Lab Boerhavewijk (By AP+E & Studio dmau) [Slide show Presentation].
- Boudet, D. (2017). New housing in Zurich: Typologies for a Changing Society. Park Publishing (WI).

Brand, S. (1997). How buildings Learn: What happens after they're built. Viking.

http://ci.nii.ac.jp/ncid/BA23638003

- Cities for Adequate Housing. (2018). Cities for Adequate Housing. https://citiesforhousing.org/#section--0
- CO2 emissions from buildings and construction hit new high, leaving sector off track to decarbonize by 2050:
 - UN. (n.d.). UN Environment. https://www.unep.org/news-and-stories/press-release/co2-emissionsbuildings-and-construction-hit-new-high-leaving-sector
- De Beun, M. (2023). Densification of Dutch postwar neighbourhoods through application of spatially efficient cooperative housing principles on gallery flats as a strategy towards enabling a sustainable and circular 2000-watt-society [Masterscriptie]. TU Delft.
- De Nederlandse Duurzaam Bouwen Awards. (2018, February 1). *final Patch22* [Video]. YouTube. https://www.youtube.com/watch?v=5KBn5fLSd40
- Dömer, K., Drexler, H., & Schultz-Granberg, J. (2014). *Affordable living: Housing for Everyone*. Jovis Verlag. Drooghmans, L. (2019, May). Holunderhof architectuurwijzer. *architectuurwijzer*.

https://architectuurwijzer.be/holunderhof/

Elser, O., Rieper, M., & Nägele, C. (2008). *Housing models: experimentation and everyday life*. Folio Verlag. *Ersatzneubau Wohnsiedlung Holunderhof Schneider Studer Primas*. (n.d.). Swiss-Architects.

https://www.swiss-architects.com/de/schneider-studer-primas-zurich/project/ersatzneubauwohnsiedlung-holunderhof

ForrerGerber AG: Wohnbauten. (n.d.). http://www.forrergerber.ch/wohnen.html#exhibeo115

- Forrest, R., & Kearns, A. (2001). Social cohesion, social capital and the neighbourhood. Urban Studies, 38(12), 2125–2143. https://doi.org/10.1080/00420980120087081
- Friedrich, J. (2013). Learning from Wilhelmsburg: Das Wohnbauprojekt "Grundbau-und-Siedler." *Bauwelt*, 35, 16–21. https://www.bauwelt.de/themen/bauten/Learning-from-Wilhelmsburg-2153141.html

Furer, R. (2008). Haerle Hubacher: Eigenheim-Stapel (Vol. 6). René Furer.

Gemeente Haarlem. (2012). Gebiedsvisie Boerhavewijk. Gemeente Haarlem.

Genossenschaft Kalkbreite. (2014, August). Projektdokumentation Wohn- und Gewerbebau Kalkbreite. https://www.kalkbreite.net/wp-content/uploads/2018/12/Projektdoku_2014.pdf

Genossenschaft Kalkbreite. (2019, October 29). *Mieten | Genossenschaft Kalkbreite.* https://www.kalkbreite.net/kalkbreite/mieten/

Ghisleni, C. (2023, August 1). Social Sustainability: Participatory design in collective space creation. ArchDaily. https://www.archdaily.com/1004448/social-sustainability-participatory-design-incollective-space-

creation#:~:text=Social%20sustainability%20in%20architecture%20aims,%2C%20inclusion%2C%20a nd%20community%20cohesion.

- Gosen, J. (2021, May 16). Hoe werkt het coöperatieve woonmodel in Zürich? *architectuurwijzer*. https://architectuurwijzer.be/hoe-werkt-het-cooperatieve-woonmodel-in-zurich/
- Grosswohnungen zu moderaten Preisen. (2001, June 28). Neue Zürcher Zeitung. Retrieved December 10, 2023, from https://www.nzz.ch/article7G3VG-ld.176387
- Hatipoğlu, H. K., & İsmail, S. H. (2020). Housing Flexibility: A Framework for a Quantitative Evaluation Method due to Turkish Designers. *Iconarp International Journal Architecture and Planning*, 8(2), 545–566. https://doi.org/10.15320/iconarp.2020.126
- here comes the sun. (2019, February 1). Patch 22 Amsterdam Gouden Piramide 2018 [Video]. YouTube. https://www.youtube.com/watch?v=I7R9f-oBUSk

- Hoben, A. (2020, October 18). München-Riem: Flexibles Wohnen im Genossenschafts-Bau. *Süddeutsche.de*. https://www.sueddeutsche.de/muenchen/muenchen-riem-flexibles-wohnen-1.5075452
- Hubacher, S. (2021, January 10). *Balance Uster Haerle Hubacher partner*. Haerle Hubacher Partner. https://haerlehubacher.ch/balance-uster/
- Interview Tatjana Horvath: Holunderhof Zürich. (n.d.). Gross Generalunternehmung AG. https://www.grossag.ch/de/konversation/interview-tatjana-horvath-holunderhof-zuerich.html
- KAW. (2020, June). Ruimte zat in de stad: onderzoek naar beter gebruik van de ruimte die we hebben. www.kaw.nl.
- Kendall, S. H., & Dale, J. R. (2023). The short works of John Habraken: Ways of Seeing / Ways of Doing. Routledge.
- Knapp, R. G. (2005). Chinese houses: the architectural heritage of a nation. Tuttle.
- Kockelkorn, A., & Schindler, S. (2023). *Cooperative Conditions: A Primer on Architecture, Finance and Regulation in Zurich*. Cooperativeconditions. https://www.cooperativeconditions.net/#
- Kooperative Grossstadt eG. (n.d.). Konzept San Riemo. kooperative-grossstadt.de. https://kooperative-grossstadt.de/konzept-san-riemo/
- Kromhout, J. M. (2018). De extramuralisering: De effecten op zorgvastgoed bij woningcorporaties in Nederland [Masterscriptie]. Rijksuniversiteit Groningen.
- Leb, J. (2013, July 8). Die Rückkehr der Mitbestimmung Teil2. *gat.news*. https://gat.news/nachrichten/dierueckkehr-der-mitbestimmung-teil2
- Lemniskade Projecten B.V. (2021, October 20). *Inbouw: Verwachting kosten*. Top-Up Amsterdam. https://www.top-up.amsterdam/inbouw/#afwerking
- Lengkeek, A., & Kuenzli, P. (2022). Operatie wooncoöperatie: uit de wooncrisis door gemeenschappelijk bezit. trancity x valiz.
- Müller Sigrist Architekten. (n.d.). *Wohn- und Gewerbesiedlung Kalkbreite, Zürich*. muellersigrist.ch. https://www.muellersigrist.ch/arbeiten/bauten/wohn-und-gewerbesiedlung-kalkbreite-zuerich/

Müller Sigrist Architekten (Ed.). (2021). Müller sigrist : bauten und projekte: 2001-2021. Quart Architektur.

Patch22: Sustainability (By Lemniskade Projecten B.V. & FRANTZEN et al architecten). (2017). Patch22. https://patch22.nl/sustainability/

- Remøy, H., & Van Der Voordt, D. (2014). Adaptive reuse of office buildings into housing: opportunities and risks. *Building Research and Information*, 42(3), 381–390. https://doi.org/10.1080/09613218.2014.865922
- Schneider, T., & Till, J. (2005). Flexible housing: opportunities and limits. *Arq-architectural Research Quarterly*, 9(2), 157–166. https://doi.org/10.1017/s1359135505000199
- Schweizerischer Ingenieur- und Architektenverein (Ed.). (2003). Wohnsiedlung Balance in Uster. *Tec21*, *26*(3), 19–21. https://doi.org/10.5169/seals-108772
- Siedlung 8: Holunderhof. (n.d.). Röntgenhof. https://www.roentgenhof.ch/wohnen/siedlungen/
- Simon, A. (2008, October). Wohnueberbauung Balance Uster. Wohnmodelle.at.

https://wohnmodelle.at/index06a3.html?id=46,0,0,1,0,0

- StreichAG. (2005). Konzept Balance. ForrerGerber AG. http://www.forrergerber.ch/wohnen.html#exhibeo111
- SUMMACUMFEMMER, Büro Juliane Greb · San Riemo. (2021, June). Divisare. https://divisare.com/projects/445152-summacumfemmer-buro-juliane-greb-san-riemo
- Till, J., & Schneider, T. (2005). Flexible housing: the means to the end. *Arq-architectural Research Quarterly*, 9(3–4), 287. https://doi.org/10.1017/s1359135505000345
- Totté, P. (2018, July 17). Patch22, maximale flexibiliteit binnen één gebouw. *architectuurwijzer*. https://architectuurwijzer.be/patch22-maximale-flexibiliteit-binnen-een-gebouw/
- Totté, P. (2019, May 16). Het belang van de Genossenschaften in Zürich. *architectuurwijzer*. https://architectuurwijzer.be/het-belang-van-de-genossenschaften-in-zurich/
- UN Global Impact. (n.d.). *Social Sustainability*. Retrieved November 5, 2023, from https://unglobalcompact.org/what-is-gc/our-work/social
- Van Bokkum, M. (2023, July 12). Onderzoek: het woningtekort houdt nog jaren aan. NRC. https://www.nrc.nl/nieuws/2023/07/12/onderzoek-het-woningtekort-houdt-nog-jaren-aan-a4169571
- Van Den Elsen, W. (2016, May 17). 'Veel Nederlandse zorg nog niet klaar voor grote veranderingen' -Zorgvisie. Zorgvisie. https://www.zorgvisie.nl/veel-nederlandse-zorg-nog-niet-klaar-voor-groteveranderingen/
- WagnisArt. (2021, June 1). flexible-grundrisse.de. https://flexible-grundrisse.de/2021/06/01/p-028-wagnisart/
- Wassenberg, F., & Van Dijken, K. (2011). A Practitioner's view on neighbourhood regeneration: Issues, Approaches and Experiences in European Cities (By Nicis Institute).

Wijk Boerhaavewijk (gemeente Haarlem) in cijfers en grafieken. (2023). AlleCijfers.nl. Retrieved November 5,

2023, from https://allecijfers.nl/wijk/boerhaavewijk-haarlem/

Wohnbaugenossenschaft Wagnis eG. (n.d.). WagnisART. wagnis.org.

https://www.wagnis.org/projekte/realisierte-projekte/wagnisart.html