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Translation of insights from Rotterdam into design-led patterns

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DOI
10.1007/s10901-024-10170-1

Publication date
2025

Document Version
Final published version

Published in
Journal of Housing and the Built Environment

Citation (APA)
Çobanoğlu, N. O. M., & Van Dorst, M. (2025). Towards vital neighbourhoods: Translation of insights from Rotterdam into design-led patterns. *Journal of Housing and the Built Environment*, *40*(1), 283-307. https://doi.org/10.1007/s10901-024-10170-1

Journal of Housing and the Built Environment
https://doi.org/10.1007/s10901-024-10170-1

ARTICLE

Towards vital neighbourhoods: translation of insights from Rotterdam into design-led patterns

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Received: 25 March 2024 / Accepted: 28 November 2024

Abstract
The provision of vitality in neighbourhoods has become a prominent issue on the urban agenda, particularly in the aftermath of the COVID-19 pandemic, due to its profound impact on the well-being of urban residents. While the foundational principles of vitality are well covered in the literature, with a growing number of empirical studies measuring it in different contexts, neighbourhoods are not always designed accordingly. The mass housing areas from the previous century are even on the verge of demolition due to a lack of vitality. This highlights a gap between the theory and the methods for translating it into practice. Although practical interventions to sustain or enhance neighbourhood vitality exist, a comprehensive toolkit addressing the foundational principles is needed. In this regard, this research examines exemplary projects and strategies aimed at promoting neighbourhood vitality, focusing on Rotterdam. It employs the pattern language methodology to translate these novel and practical tools from specific cases into generic design patterns. The retrieved list of design patterns for promoting vitality, varying in scale and temporality, serves as a framework for both design and communication during the future revitalisation of neighbourhoods.

Keywords Vitality · Vital neighbourhoods · Pattern language · Resident wellbeing · Rotterdam neighbourhoods

1 Introduction

The vitality of neighbourhoods has become a prominent issue on the urban agenda, as it profoundly impacts the well-being of urban residents. While urbanites are less reliant on their neighbourhoods today, the urbanisation rate, climate change, and the COVID-19

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pandemic urged us to rethink the way we build our neighbourhoods. Vital neighbourhoods are reasserted as a social-ecological plea (Hajer et al., 2020) and a vision for the post-pandemic future (Moreno et al., 2021). Vitality promotes natural surveillance (Montgomery, 1995) through the presence of people appearing at different times, 'eyes on the street' (Jacobs, 1961), creating a sense of safety and security. It also promotes natural animation in space, which is the everyday flow of successful urban places (Montgomery, 1995). According to Jalaladdini and Oktay (2012), vitality helps to reduce crime, support local commercial interests, and increase the chances of passive enjoyment of the environment while simultaneously encouraging social interaction. However, neighbourhoods built over the last century are often anonymous high-rise urban enclaves or low-density, low-rise suburban developments that lack vitality. Modernist mass housing areas from the previous century are even on the verge of demolition due to their monotonicity, lack of vitality, struggling with the issues of alienation, social conflict, crime, and perceived safety.

Nonetheless, neighbourhoods are not static entities; their vitality levels change throughout their life cycle. Neighbourhoods lacking vitality face two main trajectories: the pessimistic scenario of demolishment and the optimistic path of revitalisation (Wiesel, 2012). The rising awareness of the sustainable use of resources and social capital puts revitalisation at the forefront (Van Gameren et al., 2018). Numerous projects have been realised, especially around Europe, to revitalise and retrofit these areas to the contemporary needs and environmental requirements (Löschke & Easthope, 2017; Publica, 2017). The lessons to be learned need to be extracted from these projects. The Netherlands is one of the foremost countries focused on revitalising its neighbourhoods. Novel design tools and strategies have been developed and adopted, especially for pre- and post-war mass housing areas in Rotterdam lacking vitality.

The literature outlines the foundational principles of vitality, and there is a growing body of empirical research on measuring them. However, neighbourhoods are not always designed accordingly, highlighting a gap between the theoretical framework and the methods for translating it into practice. Although practical interventions to sustain or enhance neighbourhood vitality exist, a comprehensive toolkit addressing the foundational principles is needed. Accordingly, this research addresses two main questions: What are the foundational principles of vitality at the neighbourhood scale, and how can these be translated into practical design patterns based on experiences from Rotterdam? To this end, exemplary projects and strategies aimed at revitalising neighbourhoods in Rotterdam are examined and translated into generic design-led patterns. The resulting list of design patterns for promoting vitality will serve as a framework for both design and communication, fostering a more optimistic scenario for the future of neighbourhoods lacking vitality.

2 The foundations of urban vitality

The term vitality was coined by Jacobs (1961, p. 408), who defined the term as the capacity of a place to 'stimulate and catalyze the greatest possible range and quantity of diversity among uses and among people.' The principles for attaining vitality are set by Jacobs (1961) as serving more than one primary function for enabling the presence of people at different times for different reasons, shorter blocks for increasing chances of encounters, incorporating buildings of varying ages and conditions to provide for a range of housing

types and prices, and a certain density of people.[1] Gehl (1987) claims that such frameworks, as the vitality of Jacobs, outsets the necessities so that possibilities for vibrant public life can be facilitated by design. After nearly 60 years, the framework continues to guide a growing body of exploratory research measuring and validating the principles of vitality (Table 1).

Maas (1984), who put forth the most comprehensive explanatory model on vitality, defines vitality as the synergy in urban places arising from a variety of commercial and entertainment opportunities, a continuous density of socially heterogeneous pedestrian population, and the physical environment enabling these activities. Similarly, Montgomery (1995, p. 105) defines it as the combination of 'animation, people on the streets at different times, human variety.' It can be enhanced by promoting mixed-use by a diversity of primary uses generating secondary uses marked by small-medium sized businesses, density and diversity of people (different tastes and proclivities) with different time schedules, creating an active street life (Montgomery, 1998).

The foundations of the notion are still subject to ongoing discussions. March et al. (2012) identify vitality as an urban design principle for successful places directly related to the qualities of the physical environment. Meanwhile, Talen (2006) underlines that urban form alone cannot create diversity or vitality, but it can thrive or be sustained better under specific configurations. Bosselmann (2008) states that vitality relies on the qualities of the mixture of activities, density, and public life. Lu et al. (2019) identify the main principles promoting vitality as public transport accessibility, diversity of urban functions, and an appropriate building density (land occupation rate). Netto et al., (2022, p. 318) set the proxies as the 'people's co-presence in public spaces' and 'diversity in local activities.' Zhou (2012, p. 70, 387) adds the human dimension and re-defines it as both the 'presence of rich choices of interesting things and places for people to experience over different times and seasons' and the level at which 'the city inspires people to take their own initiatives and to be part of city-making.'

Based on these theoretical discussions and affirmative empirical studies, it can be claimed that vitality is founded on the principles of diversity of activities (functional mix) and people (social mix)[2] that foster and sustain socio-economic transactions (public life) in neighbourhoods and the presence of pedestrian-oriented spaces where these transactions could occur. Despite the broad literature on the foundational principles supported by empirical studies, there is a lack of a comprehensive framework regarding the tools to apply in neighbourhoods lacking vitality. This research aims to bridge this gap between theory and practice by presenting a set of novel and practical design patterns for vitality at the neighbourhood scale.

[1] Jacobs (1961) argues that density is more of a performance measure than a number, whereas suggesting approximately 200 dwellings/acre (250-500 dwellings/hectare).

[2] Diversity of activities is defined by Talen (2006, p. 243) as '*nonresidential uses—services, facilities, amenities, and the whole range of public and quasi-public resources'* and diversity of people as *'varying incomes, races, genders, ethnicities, household sizes, lifestyles'.*

Table 1 Contemporary exploratory research on the foundational principles of vitality in different contexts

Author	Case	Validated principles of vitality
Huang et al. (2023)	Hong Kong	Short blocks, building density, mixed use, and aged buildings
Gómez-Varo et al. (2022)	Barcelona	Density (population, commercial uses, public facilities), functional diversity, contact opportunity (intersections and distance to public spaces), aged buildings, accessibility (public transport and walkability measures), and distance to border vacuums (large scale single-uses)
Li et al. (2022)	Wuhan	Population density, functional diversity, aged buildings, street network integration, the sidewalk ratio and proximity to public transportation
Wu and Niu (2019)	Shanghai	Density (population); mixed-use and diversity (commercial and public facilities, industrial, manufacturing, and warehouse uses); frequent streets (porosity); variety of building ages; avoiding border vacuums
Lu et al. (2019)	Chengdu	Building density and functional diversity, FAR (floor area ratio)
Zumelzu and Barrientos-Trinanes (2019)	Valdivia	Population density and land use mix, variety of block and plot sizes, adaptability of building use
Sung and Lee (2015)	Seoul	Land use mix, density, block size, building age, accessibility, avoiding border vacuums
Jalaladdini and Oktay (2012)	Famagusta & Kyrenia	Commercial functions supported by pleasant pedestrian corners/facilities
Zhou (2012)	Almere & Tongzhou	Small-scale economic activities, public and commercial facilities, and socio-cultural events, as well as urban governance

3 Methodology

The 'pattern language' by Alexander et al. (1977) presents a set of principles -patterns- to guide urban design and planning processes. Every pattern 'describes a problem which occurs over and over again in our environment and then describes the core of the solution to that problem in such a way that you can use this solution a million times over without ever doing it the same way twice' (Alexander et al., 1977, p. x). Patterns are hypothetical, general, and abstract properties and processes (De Jong & Van Der Voordt, 2002) that present the bare minimums to safeguard the necessities in a physical environment (Dovey, 1990).

Rooij and van Dorst (2020) refer to the use of patterns as a method for organising the complex and dynamic nature of design by partitioning it into simpler and understandable parts. The patterns could be used as a tool for communication, design, assessment, and learning by all stakeholders (Rooij & van Dorst, 2020) through the stages of visioning, analysing, designing, and monitoring (Croxford et al., 2020).

The pattern methodology has been applied to translate local interventions into generic design solutions in the form of patterns. It has been used recently to extract patterns that foster resilience in the urban environment (Sant, 2022) through nature-based solutions (Barron et al., 2019; Zhou et al., 2024) and play (Donoff & Bridgman, 2017). Regarding the neighbourhood environments, this methodology was used by Marcus and Sarkissian (1986) for the planning of medium-density housing, by Mehaffy et al. (2020) for regenerating declining neighbourhoods, and by Lepratto (2018), who compiled patterns for neighbourhood revitalisation based on architectural and urban interventions in post-war mass housing areas around Europe.

This research employs the pattern methodology to extract design patterns that enhance neighbourhood vitality[3] based on experiences in Rotterdam. Initially, the foundational principles of vitality are revisited from the literature. Subsequently, contemporary strategies and design-led interventions from the last decade aimed at fostering neighbourhood vitality in Rotterdam are reviewed through published documents by the municipality, academic articles, and news reports. Afterwards, theory-based sampling (Patton, 2002) is used to select the cases to be included based on two criteria: (i) the intervention is an operational example representing one of the principles set in the literature, and (ii) there is sufficient accessible information on the intervention. Data for the selected cases is collected from secondary sources (journal articles, theses, policy documents, and relevant websites), personal communications with the residents and design professionals, and multiple on-site observations. In the final stage, the novel strategies and interventions from the case studies are translated into generic design patterns and compiled into an overall framework.

A dynamic feedback mechanism is employed during the examination of the selected cases (Fig. 1). A case is sought to translate -decode- a principle defined in the literature into a practical design pattern, and conversely, novel design interventions from the case are translated -encoded- into a pattern and added to the set of principles. The final set of patterns is also cross-validated by a workshop and several feedback sessions with design professionals from Rotterdam.

[3] The patterns are applicable for centrally located, medium-high density urban neighborhoods.

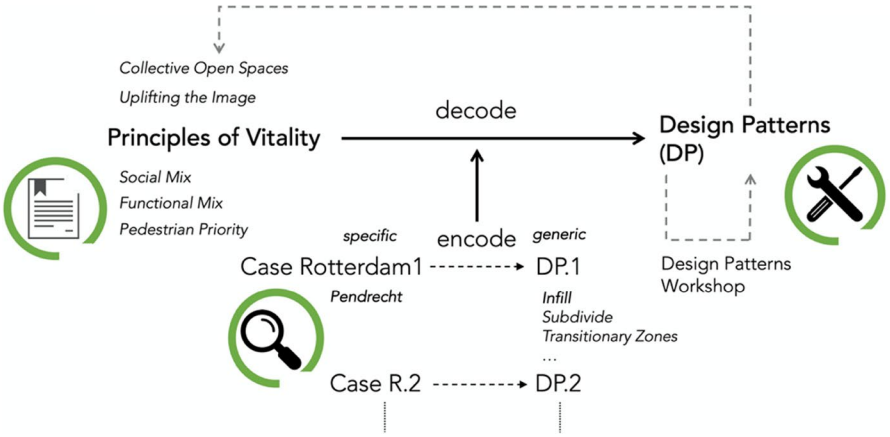

Fig. 1 Extraction of design patterns (DP) from the case study strategies and design-led interventions in Rotterdam

4 Design-led patterns for vital neighbourhoods: insights from Rotterdam

In the Netherlands, revitalisation policies have been adopted since the 1970s, and their scope has been expanded since to include social and economic strategies with more area-based solutions (Mak & Stouten, 2014). The target has been mainly post-World War II neighbourhoods composed of low-cost social rented apartments hosting low-income tenants (Kleinhans et al., 2007) to improve their living conditions and reduce spatial segregation (Priemus, 2005). Rotterdam, as the second largest city in the Netherlands, hosting large pre- and post-war housing areas, needed such policies triggered by the transition to a post-industrial urban economy (Stouten, 2017).

Recently, the approach towards neighbourhood revitalisation in Rotterdam has shifted towards bottom-up, collaborative approaches and smaller-scale, gradual strategies, including experimental methods (Boonstra & Lofvers, 2017). Such strategies from Rotterdam aimed to foster neighbourhood vitality are examined and translated into generic design patterns in the following sections aligned with the foundational principles of vitality.

4.1 Design patterns for a functional mix

The diversity of functions is one of the main foundations of vitality at the neighbourhood scale. Vitality is even used interchangeably with the level of activities in a place since vital places are associated with conviviality and liveliness (Adams & Tiesdell, 2007). The conventional approach to achieving a functional mix is the introduction of commercial land uses to the neighbourhoods. Alternative patterns emerged from Rotterdam, including the incorporation of production spaces, the reuse of leftover spaces for diverse functions, and the attainment of a vertical mix of functions through multifunctional buildings and active plinths.

4.1.1 Incorporating production spaces

The incorporation of production spaces, such as co-working and maker spaces, into neighbourhoods has increased with the transition to knowledge-based economies and hybrid working. Such spaces provide an alternative to commercial spaces for attaining a functional mix by not only fostering economic development but also stimulating social engagement in the neighbourhood (Nakano et al., 2020).

A unique example from Rotterdam is the adaptive reuse of an existing building located in the courtyard of a residential block in the Oude Noorden neighbourhood (Fig. 2). The building that used to be the old laundry facility of the former Bergweg hospital was transformed into an incubator space for the fashion industry in 2019 (Stipo, 2020). Today, this facility called 'De Wasserij' (meaning the laundry due to its former function) hosts studios and maker spaces for fashion designers and small firms. Introducing this production space promoted vitality in the neighbourhood while providing a space for young creatives.

4.1.2 Reuse of leftover spaces

Leftover or residual spaces, defined by Trancik (1986) as 'lost spaces' and Solà-Morales (1995) as 'terrain vague', refer to spaces with ambiguous functions that do not contribute to their surroundings. Leftover spaces pose challenges to vitality by affecting perceived safety and walkability, whereas both authors emphasise the latent potential of such spaces for redevelopment and creative infill. The redevelopment of 'Hofbogen' in Rotterdam is an explicit example of how such reuse patterns can enhance neighbourhood vitality.

The Hofbogen is a 1.9-km viaduct built in 1907 that runs through the Bergpolder, Liskwartier, and Agniesebuurt neighbourhoods which became a leftover space after losing its railway function. In 2008, Crimson Architects, commissioned by the housing association Hofbogen BV, prepared a redevelopment vision proposing transforming the upper level into a public space as a 'high line' and renovating the spaces under the arches to be repurposed. The project aimed to preserve the site while repurposing it and establishing good connections with the surrounding neighbourhoods (Crimson Architectural Historians, 2008; Wesselman, 2017). Ultimately, 150 spaces underneath the viaduct were repurposed, and a rooftop park (Luchtpark Hofbogen) and public spaces to connect the neighbourhoods were created along the viaduct. In 2020, a new master plan was developed that envisions the upper level as a green backbone, a recreational space, for the surrounding neighbourhoods (Holmes, 2021). So far, the reuse of the viaduct has created a vibrant zone, serving

Fig. 2 De Wasserij located in a residential courtyard in the Oude Noorden neighbourhood (Authors, 2023; Google Earth, 2023), and the building plan showing the allocation of production spaces, including ateliers and maker spaces

Fig. 3 Reuse of the Hofbogen viaduct with newly introduced functions, including retail and play areas (Authors, 2023)

Fig. 4 The multi-functional neighbourhood centre 'De Hillevliet' in the Feijenoord district (Authors, 2023)

diverse functions, including commerce and recreation, for the nearby residents while connecting the adjacent neighbourhoods (Fig. 3).

4.1.3 Multi-functional buildings

In addition to the functional mix, the importance of the vertical distribution of these functions is emphasised by Montgomery (1998) and Sim (2019) for attaining vitality. One of the patterns to achieve vertical mix is through multi-functional buildings encompassing educational, socio-cultural, housing, and retail purposes. In Rotterdam, neighbourhood centres ('huis van de wijk') exemplify this pattern by combining multiple functions.

The neighbourhood centre 'De Hillevliet', located at the intersection of the Hillesluis and Bloemhof neighbourhoods, stands as a successful example. Since its opening in 2021, the building hosted a variety of social and cultural initiatives that develop educational and cultural programs for the residents of the nearby neighbourhoods and the city. Examples of such initiatives include 'De Makkerij', which is a social enterprise that organises workshops for creative craftsmanship, 'The Boijmans Van Beuningen Museum South branch' that acts as an exhibition and activity space, and the 'SKVR', organising cultural activities accessible for all. The building also hosts some offices of the Rotterdam municipality and

has a library, sports halls, and coworking spaces ('Over De Hillevliet', n.d). The centre adds significantly to the diversity of activities and the overall vitality of the neighbourhoods.

During a meeting with the location leader of SKVR, it was mentioned that the building fits well with the diverse program of the initiatives, as it requires ample space. Yet, the residents perceived the building as unwelcoming and akin to a fortress (Fig. 4). To overcome this issue, they started organising on-site programs, pop-up activities, meetings in schools and public squares, and free courses targeting groups such as youth and women (Location lead of SKVR, personal communication, April 19, 2023). This highlights the importance of connecting multi-functional buildings with neighbourhood public spaces to leverage their potential in enhancing neighbourhood vitality.

4.1.4 Active plinths

Another commonly implemented pattern to attain vertical mix is through active plinths. It is regarded as one of the most influential factors in urban form affecting vitality (Atak, 2020). While retail functions are often utilised for this, a broader range of functions can be incorporated at the ground level, including the new trends of small-scale shopping, co-working spaces, temporary functions, pop-up stores, and social functions such as schools or residences to increase functional diversity (Karssenberg & Laven, 2016).

In this regard, a 'plinth transformation strategy' was developed to respond to the shop vacancy and the growing housing shortage in the Feijenoord, Oude Noorden, Crooswijk and Charlois neighbourhoods of Rotterdam in 2018. The strategy aimed at transforming vacant plinths into retail or housing functions. In the Oude Noorden neighbourhood, architectural firms commissioned by the municipality acted as transformation managers, encouraging property owners to convert their vacant ground floors into shops or sell them for transformation (De Stadmaker, 2018; Stipo, 2020). The project resulted in the rise of the number of active plinths promoting vibrant street life in the neighbourhood (Fig. 5).

An active plinth strategy was also employed in the Ommoord neighbourhood, a post-World War II mass housing area in Rotterdam designed by the modernist Dutch urbanist Lotte Stam-Beese. The neighbourhood consisted of a core area of high-rises situated on open plinths within a park-like continuous landscape (Rijksdienst voor het cultureel Erfgoed, 2016). During the renovation in the 2010s by BIQ architects commissioned by the

Fig. 5 An active plinth attained by retail function in the Oude Noorden neighbourhood, and through the incorporation of housing in the Ommoord neighbourhood (Authors, 2023)

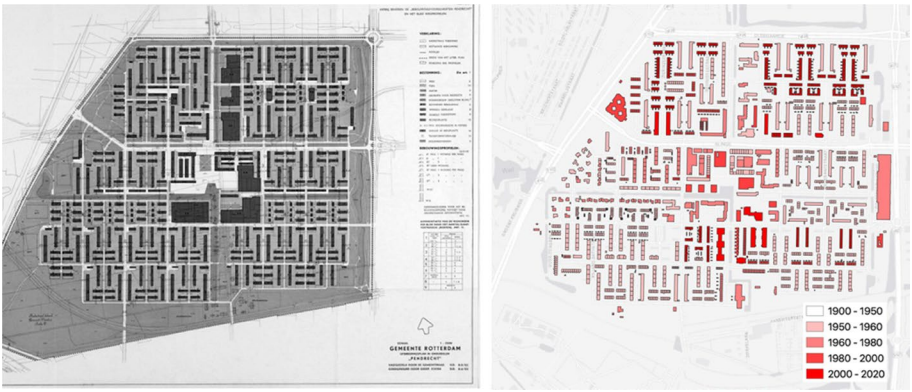

Fig. 6 The original design of the 'stempels' (Stadarchief Rotterdam, 1952–1954) and the building ages in the Pendrecht neighbourhood demonstrating infill developments preserving the 'stempels' (Esri Netherlands, 2016; OpenStreetMap, 2016)

housing association, the ground floors were transformed into residences to accommodate the ageing population in the neighbourhood (Löschke & Easthope, 2017). This strategy, which addressed the needs of the ageing residents, also created a safer and more vibrant environment at eye level (Fig. 5). As the aging population grows, this approach demonstrates the importance of considering local needs when transforming vacant plinths.

4.2 Design patterns for social mix

Alexander et al. (1977) put forth social mix as an essential foundation for neighbourhood vitality. To achieve this goal, Jacobs (1961) proposed incorporating a variety of buildings of different ages and layouts to accommodate different households. In Rotterdam, the main shortcoming of the pre- and post-war neighbourhoods is the limited variety of housing in terms of size and layout. Instead of total 'bulldozer renewal,' patterns such as the incremental introduction of new blocks, renovation, and architectural modifications on the existing blocks are implemented to address this issue. These interventions extend to the transformation of the open spaces near the housing blocks to create active transitional zones between the public and private realms to facilitate encounters and interaction between different social groups within the neighbourhood.

4.2.1 Infill development

To accommodate diverse social groups within the neighbourhoods, a variety of housing types should be provided. Infill development is used as a pattern to diversify the options in residential areas characterised by uniform units, such as detached single-family houses or high-rise apartment blocks. It is also seen as a tool to enhance the livability of the neighbourhoods by adapting to the changing needs and diversity of residents (McGreevy et al., 2023). Infill development involves the construction of new buildings on already urbanised land or the adaptive reuse of existing buildings or underutilised sites ('Infill Development', 2010). This pattern is frequently employed in Rotterdam to expand housing choices; a notable example is the Pendrecht neighbourhood.

Pendrecht is a post-World War II neighbourhood renowned for its trademark design, composed of 'stemples' (repetition of housing groups like a stamp) by Lotte Stam Beese. The neighbourhood faced significant impoverishment from the 1990s onwards and was listed as one of the most deprived neighbourhoods of Rotterdam in 2009. In response, revitalisation efforts began in the early 2000s, focusing primarily on diversifying the housing stock and transforming the collective open spaces (Gemeente Rotterdam, 2008). A range of infill strategies were implemented synchronously and incrementally, including the construction of new high-rise buildings, demolish-rebuild projects, and the renovation of the former buildings. These strategies yielded diverse housing choices and retrofitted the former blocks to meet contemporary standards and needs. Maintaining the original 'stempels' layout to preserve the neighbourhood's historical identity and sustaining the balance between built-up and open spaces was integral to the process (Fig. 6). Incorporating underutilised spaces and providing new housing choices promoted the neighbourhood's vitality. Pendrecht case demonstrates how the incremental use of diverse infill patterns contributes to preserving the site's historic identity while enabling long-term residents to stay in place.

4.2.2 Architectural subdivision

Expanding housing typologies to accommodate different households can also be achieved through architectural modifications. Such interventions update and increase the type of dwellings in the housing blocks while creating a new urban image (Herrera-Limones et al., 2023) and, in return, contribute to a lower residential mobility rate (Mariotti and Hess, 2023). One such pattern is architectural subdivision, which is the reallocation of the inner layout of the existing buildings to acquire a variety of units. This pattern has been used from the 2000s onwards, especially in the pre- and post-war mass housing areas in Rotterdam under the Klushuizen (Do-It-Yourself Renovation Houses) strategy. The strategy allows the residents to modify the inner layout of their buildings. Klushuizen strategy was initially implemented on the Wallisblock (Fig. 7) as part of revitalisation efforts in the Spangen neighbourhood (Boonstra & Lofvers, 2017).

The housing block was on the verge of demolition due to rising maintenance costs, outdated living conditions, and rising social problems. The transformation was secured by the innovative economic model. Most of the houses were bought by the municipality and sold for 1 euro on the condition that they be renovated by future residents (Książek, 2018). There was intensive cooperation between the buyers, who formed their association, commissioned architects, the housing association of the former residents, and the municipality

Fig. 7 The preserved outer brick facade and the replaced inner courtyard façade of the reallocated Wallisblok in the Spangen neighbourhood (Authors, 2023)

Fig. 8 The absence of transitionary zones in the former allocation of the common open spaces (above) and the introduction of transitionary zones on the new infill blocks (below) in the Pendrecht neighbourhood (Authors, 2023)

(Hulshof Architecten, 2012). The block's inner layout was reallocated to yield various housing typologies (vertical allocation for 4-story row houses and horizontal allocation for large apartments). The project resulted in attracting new resourceful households, an increase in homeowner occupancy, improved safety, and the emergence of civic initiatives in the neighbourhood; however, it was criticised for leading to gentrification. Despite this, the pattern had a favourable impact on the level of social mix in the neighbourhood, leading to its subsequent application in other places and adoption as a standard policy instrument (Boonstra & Lofvers, 2017). Although the pattern positively influences the social mix in the neighbourhood, promoting vitality, the case underscores its impact on property values and resident mobility. To prevent the displacement of long-term residents, the process should be monitored carefully, and strategies should be adopted to support them remain in place.

4.2.3 Transitionary zones

In addition to providing housing for diverse social groups, places of encounter are essential for fostering social mix. Gehl (1986) demonstrated that proximity and visually permeable boundary mechanisms -soft edges- in the front yards positively contribute to the level of active street life, social encounters, and neighbourhood vitality. Besides, the legibility of public, private, and semi-private zones, along with the gradual transition between them, is crucial for maintaining privacy and safety, which in return enhances overall vitality (Habraken, 2000; Madanipour, 2003; Newman, 1972; Van Dorst, 2005). Reorganising previously ambiguous shared common spaces into clearly defined private, semi-public, and public zones also motivates residents to take ownership of their immediate surroundings (Pirrus & Leetmaa, 2023).

During the infill developments in Pendrecht, open green spaces were reallocated to create such transitionary zones (Gemeente Rotterdam, 2008). The former large common areas between housing blocks were reallocated into public and semi-public zones by adding multiple entrances and pedestrian paths in front of the new blocks. Private gardens were added in front of the new low-rise housing blocks delineated with soft boundary elements (such

as bushes or visually permeable fencing) (Fig. 8). Creating legible transitionary zones with soft boundary mechanisms resulted in higher personalisation and maintenance of front yards in the neighbourhood. These clearly defined transition zones, coupled with soft boundary elements, led to greater personalisation and maintenance of front yards throughout the neighbourhood, creating an active zone for social encounters and fostering neighbourhood vitality.

4.3 Design patterns for pedestrian orientation

A pedestrian-oriented environment is another key foundation of neighbourhood vitality. Gehl (1987, p. 77) illustrates the correlation between pedestrian-oriented design and vitality by stating, 'if the speed of movement is reduced from 60 to 6 kms per hour, the number of people on the streets will appear to be ten times greater'. Similarly, Appleyard (1981) highlights the inverse relation between traffic volume and residents' perception of their home territory and their neighbouring patterns, both of which have direct implications on neighbourhood vitality.

To enhance pedestrian orientation, the Rotterdam Mobility Approach (2020) outlines several strategies, including the provision of better-quality infrastructure for pedestrians and cyclists, redirecting heavy traffic to the main streets, classifying streets based on speed rather than modality, enhancing mobility options through public transport hubs, and introducing vehicle sharing systems (Gemeente Rotterdam, 2020). At the neighbourhood scale, patterns employed under these strategies include the reallocation of streets to afford more durable pedestrian activities, spilling out towards the spaces designated for cars and conducting temporary street experiments.

4.3.1 Reallocating the street

The Netherlands has a long tradition of pedestrian orientation dating back to the 1970s 'woonerf' (living yard) concept of the street as a living space (Nio, 2010). Following this tradition, the Schepenstraat located in the Blijdorp neighbourhood is a novel example of the pedestrian-oriented reallocation of the street.

As a reaction to a redevelopment proposal by the municipality in 2014 that envisioned a typically car-oriented street, the residents of Schepenstraat formed their association kernTEAM and applied for the municipality's 'Right to Challenge' program. The program provided residents who formed associations with the necessary resources to transform their environments based on their needs and preferences. The kernTEAM had a core group that included architects and urban planners who volunteered their professional expertise. Between 2015 and 2017, the group organised meetings and workshops with the residents. Based on these, they prepared a master plan that envisioned a 'park-like street'. The plan preserved all the existing trees, provided balanced car and bike parking spaces, and introduced the idea of zelf-beheer (self-managed green spaces).[4] The plan was implemented between 2018 and 2019, resulting in a high-quality, pedestrian-oriented, green street ('Schepenstraat', 2018) (Fig. 9). During a meeting with one of the core group professionals (L. Geerling, personal communication, May 10, 2023), it was mentioned that 'the project

[4] A co-management structure in which resident groups voluntarily maintain allocated pocket green areas along the street.

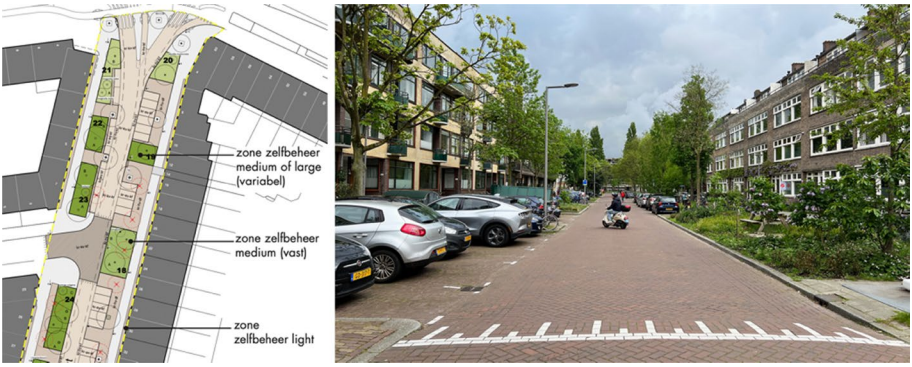

Fig. 9 Part of the Schepenstraat masterplan indicating the allocation of the zelf-beheer areas (kernTEAM Schepenstraat, 2017, p. 20) and the view from the street after transformation (Authors, 2023)

not only resulted in a high-quality physical design but also brought the residents together'. The reallocation of the street has become a flagship project for Rotterdam in terms of its positive outcomes on physical as well as on social and governance levels and a key pattern for neighbourhood revitalisation.

4.3.2 Spilling out towards the street

Pedestrian spaces spilling out towards the street, occupying the spaces allocated for cars, enable durable and informal activities that promote vitality (Llewelyn-Davies, 2000). This pattern became widely spread, especially during the coronavirus pandemic, in the form of parklets used by cafes and restaurants. However, Jalaladdini and Oktay (2012) stress the importance of providing spaces where people are not obliged to consume food or beverages to ensure their durable presence. Otherwise, the pattern presents the risk of being used as a tool for the privatisation of public space. In the Netherlands, Steinberg (2022) identifies five forms of spilling out: public parklets, 'fiets vlonders' (bicycle platforms), 'terras vlonders' (parklets used by cafes and restaurants) (Fig. 10), parklets functioning as tiny playgrounds, and new bike lanes (occupation of a series of parking spaces).

Fig. 10 'Terras vlonders' from Hoogstraat and the transformed median on Groene Hilledijk in the Feijenoord neighbourhood (Authors, 2023)

There are many cases in which this pattern has been implemented in the Rotterdam neighbourhoods. For instance, in 2017, the firm Humankind, commissioned by the municipality, transformed the median of the Groene Hilledijk boulevard in the Feijenoord neighbourhood, which was often used for car parking, temporarily into a seating place that later became permanent (Humankind, 2017) (Fig. 10). Similarly, in 2021, Studio Klinkenberg introduced the 'Rotterdam Place Maker' project, a modular parklet design that allows customised applications in Rotterdam ('Rotterdamse Ruimte Makers', n.d.). Spilling out patterns usually start as temporary occupations of car parking spaces to create pedestrian areas, and due to their positive impact on neighbourhood vitality, they often become permanent interventions. The cases from Rotterdam also demonstrate the importance of creating spaces not only as extensions of the ground-floor commercial uses but also for broader public use.

4.3.3 Temporary experiments

Temporary experiments enable co-creating and testing the interventions for pedestrian-oriented transformations. Temporary street experiments are a pattern utilised to strike a balance between traffic and public space functions through 'an intentional, temporary change of the street use, regulation and/or form, aimed at exploring systemic change in urban mobility" (Bertolini, 2020, p. 735).

An example is the 'Mobility Challenge Hoogkwartier' in Rotterdam, a two-month experiment conducted in 2019 that challenged the residents of the neighbourhood to rely only on the provided shared mobility options. The experiment enabled the conversion of car parking spaces into small public spaces and the reorganisation of the traffic to create a safer pedestrian environment. The primary objectives of the experiment were to demonstrate how mobility choices impact the quality of public spaces and neighbourhood vitality and to encourage residents to shift toward active and shared mobility options. The monitoring process yielded positive results, and the findings were used to develop a roadmap for future experiments (Stadslab Hoogkwartier, 2020). While certain changes made during the experiment, like the green parklets, can still be observed in the neighbourhood (Fig. 11), the long-term adoption of shared mobility options was less successful.

Similar experiments have been implemented in Rotterdam neighbourhoods based on temporary pedestrianisation of residential streets and transformation into public spaces

Fig. 11 The green parklets that became permanent after the Mobility Challenge Hoogkwartier experiment (Authors, 2023)

Fig. 12 The 'Groene Oase op Zuid' Community Garden in the Carnisse neighbourhood (Authors, 2023)

together with the residents ('Happy Streets Wilhelminapier', 2018), such as the 'Holiday Streets' which transformed streets into recreational areas as a response to mobility restrictions during the COVID-19 pandemic ('Vakantiestraat', 2020). Temporary experiments create convivial streets that promote neighbourhood vitality and allow testing and evaluating different interventions. Key to their success is the employment of co-creation methods and systematic monitoring. The Hoogkwartier case demonstrates how temporary experiments help residents envision the long-term impact of such transformations on vitality, with accepted interventions by the residents often becoming permanent.

4.4 Design patterns for collective open spaces

The COVID-19 pandemic underscored the role of collective open spaces in the neighbourhood for social interaction, recreation, and community cohesion, promoting mental and social well-being (Agarwal et al., 2024). Although not explicitly set as a foundational principle in theory, the introduction and reprogramming of collective open spaces also emerged as a key strategy for revitalising neighbourhoods in Rotterdam. These spaces promote neighbourhood vitality and foster a sense of community through the collective appropriation of a shared space. The most common patterns for creating collective open spaces in Rotterdam include community gardens and play areas.

4.4.1 Community Gardens

Community gardens are collectively cultivated lands maintained by the voluntary members of a community, often neighbourhood residents. Beyond their intrinsic environmental and well-being benefits, community gardens foster social cohesion by providing an inclusive gathering place where residents can interact informally and build connections (Firth et al., 2011), enhancing neighbourhood vitality. 'Carnisse Tuin' (Carnisse Garden) is one of the numerous examples of this pattern implemented in Rotterdam.

'Veerkracht Carnisse' (Resilient Carnisse) urban living lab was formed in the Carnisse neighbourhood between 2011 and 2015 to empower the local community and enhance their self-organising capacity in addressing the issues related to urban sustainability and resilience. One of its key initiatives was supporting residents in creating the community garden 'Carnisse Tuin.' After its opening, the garden became a hub for various activities, including seed exchange events, educational programs for schools, and visits from elderly

homes. Although the garden was closed in 2015, a substitute garden was opened in another location in the neighbourhood under the name 'The Groene Oase op Zuid' (green oasis of the south) (Frantzeskaki et al., 2018). Currently, this garden thrives with many volunteers and a dedicated gardener, hosting various programs for the residents (Fig. 12). The garden strives to promote the health and well-being of the residents, foster community cohesion, and offer a high-quality green space for the neighbourhood ('De Groene Oase', 2018). As seen in this case, community gardens serve as vibrant spaces for social engagement and collaboration among residents, fostering a sense of community and significantly enhancing the overall vitality of the neighbourhood.

4.4.2 Play spaces

In terms of collective open spaces, another pattern implemented in Rotterdam neighbourhoods to promote vitality is the introduction of play spaces. Play spaces have a crucial role since the neighbourhood's affordances or constraints in terms of play can deprive the children of the fundamental right to 'explore and experience' (Berg & Medrich, 1980). Play spaces were introduced as a pattern during the revitalisation efforts in the Bloemhof neighbourhood in Rotterdam.

The Bloemhof neighbourhood, constructed in the 1920s, faced significant deprivation and was designated as one of the most deprived neighbourhoods of Rotterdam in 2009. As a part of revitalisation endeavours, it was selected as a target neighbourhood under the greening strategy of the municipality between 2016 and 2018. The implementation of the strategy included greening the main street Lange Hilleweg and several other streets, and revitalising the squares like Groenewegplein and Ericaplein (Gemeente Rotterdam, 2017). During the revitalisation of the squares, play spaces for different age groups were incorporated into the design (Fig. 13). Establishing play spaces on the square created a vibrant and lively atmosphere, enhancing neighbourhood vitality.

4.5 Design patterns for uplifting the image

Although the physical image is not included among the foundational principles of vitality or considered a parameter in exploratory research on neighbourhood vitality, uplifting the image remains one of the most used strategies in neighbourhood revitalisation. The

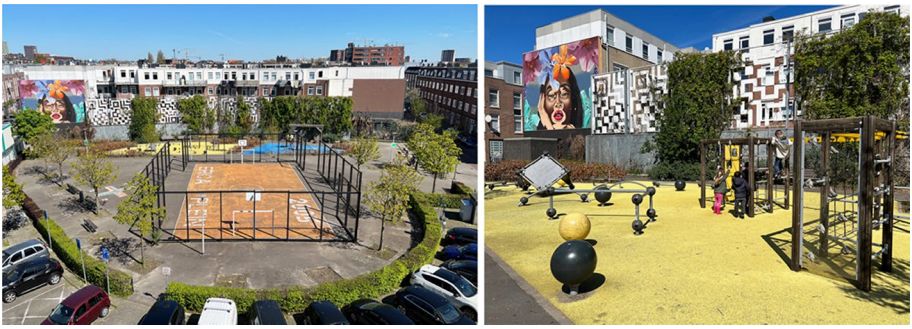

Fig. 13 The play space for different age groups introduced on Ericaplein in the Bloemhof neighbourhood (Authors, 2023)

primary strategy has been integrating contemporary architectural designs into the aged housing blocks (Lepratto, 2018). In Rotterdam, patterns like installing artworks and refurbishing building facades have been employed to achieve this goal.

4.5.1 Artworks

Installing artworks as a pattern helps transform the perceived image of stigmatised areas and improves wayfinding. As a visual and symbolic intervention, artworks effectively emphasise the distinctive physical characteristics and reflect the social and ethnic diversity of places (Reinders, 2005). Artworks were introduced in the Pendrecht neighbourhood as part of urban revitalisation efforts in the 2000s.

While renovating some of the blocks in the neighbourhood, the firm Van Schagen Architecten approached The Centre for Visual Arts Rotterdam to incorporate visual arts into the process. Artists coordinated by the centre designed glass appliqué windows under the project 'Raamvertelingen' (Window Tales) in 2009 and 2013. In their designs, they reflected the characteristic aspects of Stam-Beese's -the designer of the neighbourhood- modernist philosophy, such as large-scale landscaping, stamps (stempels), community, and abstract aesthetics. More than fifty windows were placed in the porches of the housing blocks ('Window Tales I', n.d.). Recently, in 2022, murals have been commissioned for the blind walls along Slinge, the main street of the neighbourhood. These murals by artist Ricardo van Zwol are inspired by the neighbourhood residents ('Ricardo van Zwol', 2022). Both cases illustrate the use of art installations as a pattern to transform the stigmatised perception of the neighbourhood, uplifting the image by emphasising its unique socio-spatial characteristics and identity (Fig. 14).

4.5.2 Facade refurbishment

Facade refurbishment is often employed as a complementary pattern in neighbourhood revitalisation. Regarding facades, Netto et al. (2022) found a positive correlation between continuous frontages with a high density of windows and doors and increased pedestrian activity. As a result, facades with rhythmic qualities and permeable surfaces enhance active street life and contribute to neighbourhood vitality.

The facades of some of the housing blocks in the Ommoord neighbourhood in Rotterdam were refurbished during the renovation. New permeable frames were added to the facades in a rhythmic order, and stairways enclosed by permeable surfaces were introduced

Fig. 14 Examples of the glass appliqué windows and the murals in the Pendrecht neighbourhood (Authors, 2023)

to increase the visibility of the circulation areas and enhance safety ('Knikflats', 2009) (Fig. 15). The refurbishment not only updated the physical appearance of the housing blocks but also improved perceived safety and attractiveness for pedestrians, thereby promoting vitality.

5 Discussion and conclusion

The concept of vitality, coined by Jacobs (1961), has been extensively explored in the literature, with broad consensus on its foundational principles of functional mix, social mix, and pedestrian orientation. Exploratory studies have assessed these principles, and their shortcomings have been targeted through design and planning strategies, especially during the revitalisation of decaying neighbourhoods. Recurring patterns in this process include enhancing the functional and social mix, refurbishing the aged housing blocks, and incorporating artworks and play spaces (Marin et al., 2023; Vila-Vázquez & Petsimeris, 2023). Despite their recurrence, a comprehensive framework to guide practice has been lacking. Recently, UN-Habitat (2024) published the report 'My Neighborhood', a checklist outlining the key principles for resilient neighbourhoods, with vitality as a central strategy. The key strategies for achieving vitality are identified as promoting a functional mix of land uses (with an emphasis on vertical mix and active plinths), enhancing walkability and proximity to essential services, establishing a fine-grain urban fabric that reinforces local identity and ensuring an appropriate density, integrating multi-modal transportation options, enhancing connection with nature, and fostering active streets and public spaces. Building on this, this research decodes the foundational principles of vitality into actionable design patterns that promote neighbourhood vitality. In this regard, pattern methodology facilitated the organisation and documentation of the novel and practical design solutions and strategies implemented in Rotterdam. Furthermore, each pattern is discussed in relation to potential outcomes, providing additional insights for implementation.

The extracted patterns present design-led interventions that had direct implications on the foundational principles of vitality based on published evidence, observational inquiries, and expert insights. However, they are not a final prescription for achieving vitality, a complex phenomenon that cannot be translated into a few design-led patterns. These patterns are also limited to the cases investigated in Rotterdam within the scope of this research. They instead serve as generative building blocks, catalysts, for promoting vitality. Furthermore, two new principles emerged from the extracted patterns: the incorporation

Fig. 15 Refurbished facades of the housing blocks in the Ommoord neighbourhood (Authors, 2023)

of 'collective open spaces' and 'uplifting the image' of the neighbourhood, offering additional dimensions which have not been extensively explored in previous studies.

The patterns vary with respect to their scale (from building to neighbourhood) and temporality (from daily experiments to permanent infill developments) (Fig. 16). Based on the cases, it can be claimed that the higher the scale of the pattern, the larger its influence is. For instance, architectural subdivisions, although promoting social mix at the neighbourhood level, are often limited to the scale of the residential block, while temporary experiments resonate with the entire neighbourhood and even the district. There are exceptional cases, such as multifunctional buildings, with an extensive range of impact regardless of their scale. However, as the case demonstrated, their activities had to be extended to public spaces to reach the residents. On the other hand, temporality does not impact the reach-out scale, whereas temporary patterns enable testing the interventions and promote community engagement. The spatial distribution of the implemented patterns should be balanced within neighbourhoods to avoid the risk of creating stagnated or over-vital nodes.

Translating case-specific interventions into more abstract, practical, and generic patterns allows them to be communicated as a road map for participatory design processes or an assessment tool to guide revitalisation efforts in neighbourhoods. For implementation in other neighbourhoods, a context-specific approach is essential. Subsets of patterns can be formed with patterns added or subtracted depending on the specific needs of each neighbourhood. This flexible use of the patterns facilitates the development of temporary, co-created solutions that can quickly respond to changing needs in the living environments, as seen during the pandemic.

According to Alexander et al., (1977, p. xiii), 'No pattern is an isolated entity. Each pattern can exist in the world only to the extent that is supported by other patterns…' Similarly, Adams and Tiesdell (2007) argue that vitality arises not from individual components of cities but rather from their relationships. The case studies also illustrate that the patterns are often used together (Fig. 17), and their impact is amplified when clustered. The clustering of the patterns highlights the importance of a holistic approach to neighbourhood revitalisation. Moreover, the patterns are not always in line with each other; for example, infill developments might conflict with creating collective

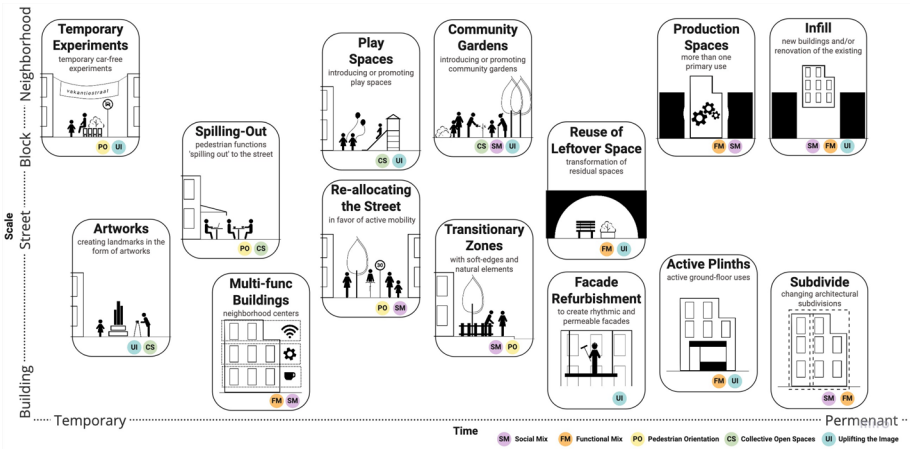

Fig. 16 Design-led patterns extracted from Rotterdam, with respect to their scale, temporality, and relation to foundational principles of vitality (Authors, 2023)

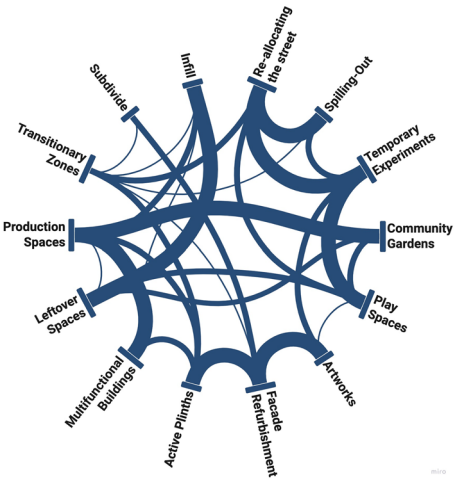

Fig. 17 Clustering between the extracted patterns based on their concurrencies among the examined cases in Rotterdam (Authors, 2023)

open spaces. In such cases, bottom-up co-creation methods for selecting the set of patterns and experimentation enabling trial-and-error can be employed as strategies during decision-making.

The assessed cases also revealed insights into potential risks, such as displacement of long-term residents due to increasing land values, privatisation of streets through parklets, the necessity of securing residents' approval to ensure long-term success, and the importance of embedding socio-spatial characteristics and local identity into these interventions. These insights highlight the importance of socio-economic strategies and participatory processes that support these design-led patterns to attain vital neighbourhoods. These aspects are crucial for ensuring the permanence and inclusivity of such interventions, particularly in the revitalisation of deprived neighbourhoods. Without complementary policies, patterns that enhance neighbourhood vitality can inadvertently lead to gentrification over time, as seen in certain neighbourhoods in Rotterdam. Therefore, the set of patterns should always function both as a design and a communication tool. Another risk is that when self-sufficient and isolated, vital neighbourhoods may promote spatial segregation. To avoid this, vital neighbourhoods must be locally tweaked and well-connected with the rest of the city.

In conclusion, as cities worldwide face the challenges posed by the global housing and climate crisis, along with the enduring impacts of COVID-19, the urgency for design and planning strategies that foster healthy, resilient, and vital neighbourhoods has become increasingly critical. This research not only contributes to the theoretical understanding of neighbourhood vitality but also provides a practical framework to guide neighbourhood revitalisation. Integrating both theory and insights from multiple case studies, this framework serves as an adaptable toolset that can be tailored to specific contexts. It can be used as a communication tool to guide the design processes by urban planners, NGOs, local policymakers, and residents.

Finally, vitality refers to 'a capacity not only for being alive but also to grow and develop' (Adams & Tiesdell, 2007, p. 671). As a dynamic force that evolves, the concept of vitality and the patterns that promote it must be continuously revisited. By continuously reviewing and refining these patterns, urban revitalisation efforts can promote neighbourhoods that thrive.

Acknowledgements This article stems from the research conducted during the post-doctoral fellowship of Nihan Oya Memlük Çobanoğlu supervised by Machiel Van Dorst at TU Delft, Faculty of Architecture and Built Environment, Department of Urbanism which was funded by TUBITAK (The Scientific and Technological Research Council of Türkiye) under the 2219-International Postdoctoral Research Fellowship Program.

Declarations

Conflict of interest The authors have no competing interests to declare that are relevant to the content of this article.

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