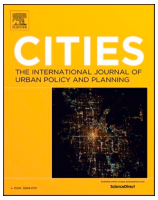
Cities 134 (2023) 104179

Contents lists available at ScienceDirect

Cities

journal homepage: www.elsevier.com/locate/cities



Community vitality and frugal practices in informal settlements in Nairobi: Towards a typology

Jan Fransen [a,*], Beatrice Hati [b], Rosebella Nyumba [b], Erwin van Tuijl [c]

[a] IHS Erasmus University Rotterdam, P.O. Box 1935, 3000 BX Rotterdam, the Netherlands
[b] The International Centre for Frugal Innovation, Kenya Hub, Kenya
[c] The International Centre for Frugal Innovation, Institute of Social Studies, Erasmus University Rotterdam, the Netherlands

ARTICLE INFO

Keywords:
Urban vitality
Frugal innovation
Community development
Informal settlements
Kenya
Africa

ABSTRACT

While community vitality is of increasing importance, it remains understudied. This study explores community vitality in informal settlements by turning to the concept of frugal practices, defined as activities to develop and implement low-cost robust solutions that address communities' needs within resource-constrained contexts. Based on literature and case study analysis in Nairobi, we define community vitality as dynamic relationships between residents and other local actors to cope with uncertainty and to meet community goals. The study finds that community vitality in informal settlements is indicated by strong bonding among community actors searching for affordable practices to overcome resource constraints. The study introduces three types of community vitality. *Poverty-driven community vitality* plays a crucial role in survival but is likely to offer low levels of community control and poor-quality services. *Robust community vitality* offers informal settlers more control, but opportunities remain isolated within the confines of informality. *Dynamic community vitality* enables the improvement of living and working conditions in strong and open partnerships. We recommend upgrading practitioners to acknowledge and support robust and dynamic community vitality. The challenge lies in dealing with poverty-driven community vitality, which requires addressing power abuse and poor-quality services while maintaining frugal functionalities.

1. Introduction

A key theme in urban studies is community development in informal settlements (Seeliger & Turok, 2014; Simone & Pieterse, 2017). Community development refers to processes within which community members take collective action to find solutions for common problems (UN, 2014), including climate change, poverty, and poor-quality infrastructure (Conway et al., 2017; Dale et al., 2010; Wainaina et al., 2022). Community development in informal settlements is severely hindered by extreme resource constraints and the marginal and at times oppressive role that governments adopt when faced with illegal housing, employment, and services (Seeliger & Turok, 2014; Satterthwaite et al., 2020; Wainaina et al., 2022). In this constrained context, residents, community-based organisations (CBOs), non-governmental organisations (NGOs) and firms take initiative to knit a community together, overcome shocks and meet common goals (Gilchrist & Taylor, 2011).

A wide variety of perspectives and concepts are used to understand how communities develop, including community resilience (Folke, 2006; Fransen et al., 2022), CBOs (Igalla et al., 2019) and community activism (Larner & Craig, 2005). We apply the concept of community vitality which encompasses the ability of communities to collectively solve problems (Scott, 2009) in the face of uncertainty and change (Montgomery, 1998; Nederhand et al., 2021). Community vitality is set apart by its focus on dynamic relationships between local actors (Dale et al., 2010). It approaches community development as a relational endeavour, with strong bonding among local actors at its core (Fraser et al., 2005; Putnam, 1993). This approach identifies a specific and arguable narrow unit of analysis (i.e., relations), while at the same time adopting a broad scope. Its scope is broader than that of community resilience, which focuses on shocks and stresses as catalyst for community development (Folke, 2006; Fransen et al., 2022), broader than CBOs, which zooms in on one actor (Igalla et al., 2019), and broader

Abbreviations: FSQCA, Fuzzy Set Qualitative Comparative Analysis; NGO, Non Governmental Organisation; CBO, Community Based Organisation; CHV, Community Health Volunteers.

* Corresponding author.
E-mail address: j.fransen@ihs.nl (J. Fransen).

https://doi.org/10.1016/j.cities.2022.104179
Received 18 February 2022; Received in revised form 26 October 2022; Accepted 31 December 2022
Available online 10 January 2023

than community activism with its focus on capacity for engagement (Head, 2007; Larner & Craig, 2005). Community vitality is concerned with all relations within a community for the good and for the bad as what is good for one sub-community may turn out to be bad for another (Nederhand et al., 2021). The relational processes are nonlinear and full of thrive (Simone, 2004). As Scott (2009: 4) argues: "Vital urban communities are those that are able to cultivate and marshal these relationships in order to create, adapt and thrive in the changing world". Accordingly, community vitality has been studied in various contexts of a changing world, including environmental challenges (Dale et al., 2010), urban regeneration (Hui et al., 2021), happiness (Conway et al., 2017), suburban communities (Debord, 1983), health (Hughes et al., 2016), adult learning (Cherrstrom et al., 2018), and urban design (Montgomery, 1998).

In this study we focus on community vitality in informal settlements. Its constrained context amplifies the importance of social relations as a resource to tackle common problems. Moreover, the marginal role of government, a key player in community development (Head, 2007), may alleviate roles of other actors. Despite this arguably distinctness of community vitality in informal settlements it is to our best knowledge not yet studied.

To address this research gap, we link urban vitality with the concept of frugality, a resource-constrained innovation type (Agarwal et al., 2016) based on the principle of "doing more with less" (Radjou et al., 2012). Its rationale is to develop affordable, adaptable, appropriate, and accessible solutions for users in resource constrained contexts (Bhatti et al., 2018). For instance, Tata and Mitticool offer low-cost and robust water purifiers and clay-based fridges respectively, which work in environments with uncertain electricity connection (Radjou et al., 2012). Likewise, GE's handheld ECG machine can be used in remote communities without a hospital, M-Pesa offers a digital payment platform for the unbanked (Hossain et al., 2016; Rosca et al., 2017) and WhatsApp is used by women in refugee camps to establish networks and business (Ritchie, 2022). Frugality has been conceptualised as a product or service, a mindset or process of innovation (Soni & Krishnan, 2014). These perspectives interrelate, as a frugal product is not possible without a frugal mindset to save resources in innovation and production processes (Chakravarty, 2022:3). Accordingly, we define frugality as *practices* to develop and implement low-cost robust solutions that address communities' needs within resource-constrained contexts.

Within this context, our first objective is to *analyze how frugal practices contribute to our understanding of community vitality in informal settlements*. As relationships in a community are plural and multilevel (Nederhand et al., 2021), our second objective is to *identify different types of community vitality in informal settlements applying different frugal practices*. To do so, we deploy a comparative study of seven frugal practices in informal settlement in Nairobi. We use a Fuzzy-Set Qualitative Comparative Analysis (FSQCA) to analyze effects of the mutual dependencies and collective interactions between indicators of frugal practices and community vitality which configurate into types of community vitality (Chang & Gerrits, 2022; Ruhlandt et al., 2020).

Our main contribution to literature is the introduction of three types of community vitality (poverty-driven, robust, and dynamic) that share high levels of affordability and relationality but differ on other variables. Moreover, by using FSQCA, we do not only show further evidence of the relevance of FSQCA in urban studies (Chang & Gerrits, 2022; Ruhlandt et al., 2020; Wainaina et al., 2022), but also provide new insights into methodological discussions in frugality literature (Bhatti et al., 2018). Finally, we contribute to frugality literature by offering a rare application in urban and regional studies, following Busch (2021) and Van Tuijl et al. (2022).

The paper is structured as follows. It first brings together theory on vitality, informal settlements, and frugality, which culminates in a working definition and operationalisation of community vitality in informal settlements. The theory section is followed by methods, results, debate, conclusions and recommendations.

2. Theory

2.1. Community vitality

The concept of community vitality dates to community psychology literature in the 1960s, which defined it as the ability of communities to collectively solve problems (Scott, 2009). Ever since, the core of a vital community are social relations between people, firms, communities, and institutions (Fraser et al., 2005; Hui et al., 2021; Nederhand et al., 2021). Social relations offer a sense of belonging and enable local actors to develop their living and working environment within the context of the material, institutional and cultural structure of a community (Fraser et al., 2005). More recently, community vitality literature stresses the importance of dealing with uncertainty. Dale et al. (2010) therefore argues that vitality not only aims to meet common goals, but also to cope with shocks. In that sense, community vitality overlaps with community resilience (Magis, 2010). It is a subset of urban vitality, which also includes city-wide systems beyond and outside the realm of community development, such as urban economic or transport development.

We define a community as an organic entity which has developed a systemic social network and sub-networks (Dale et al., 2010), whereby sub-networks have different and sometimes conflicting functions (Simone, 2004). Within these subcommunities, residents negotiate the allocation of scarce resources within dense networks of space, institutions, and organisations (Dale et al., 2010). A community has therefore not one but many identities, dreams, and goals (Head, 2007).

Taking these definitions of 'vitality' and 'community' on board, we define community vitality as dynamic relationships between residents and other local actors to cope with uncertainty and plot towards improved wellbeing, by constantly renegotiating the allocation of scarce resources within cultural, institutional, and material community structures. A vital community is relational, dynamic, multilevel, and plural, with a diverse set of residents and other actors, who act and interact in ever changing settings (Nederhand et al., 2021).

2.2. Informal settlements

Informal settlements are unplanned and poorly serviced neighbourhoods with tenure uncertainty and precarious housing, services, and employment (Seeliger & Turok, 2014). Their illegality makes government agencies unable or unwilling to work within them (Satterthwaite et al., 2020). In this paper, we look at community vitality within the material, institutional and cultural structure of an informal settlement.

The material structure is characterized by extreme resource constraints and uncertainty, related to precarious services, infrastructure, housing, and income. Informal settlements are diverse, and residents may therefore be constrained on one, a few or all these resources (Fransen & Kassahun, 2011). The uncertainty of income, services, infrastructure and/or housing leads to constant alertness to renegotiate even the most basic needs (Simone, 2004; Thieme et al., 2021).

The institutional structure is defined by the informal status and relative absence of government rules and regulations. The informal status creates a formal-informal dichotomy within a city, which reduces the access of informal dwellers to new ideas, partnerships, and other resources and thus functions as a barrier towards community vitality (Dale et al., 2010). The relative absence of formal rules and laws creates uncertainty, which is filled by a complex and incomplete myriad of informal rules, which informal settlers struggle to comprehend and within which they improvise and hustle for scarce resources (Simone, 2004; Thieme et al., 2021). However, the relative absence of formal laws and regulations may also unleash creativity and collective action, whereby local actors innovate and experiment outside bureaucratic rules (De Soto, 1989; Fransen & Kassahun, 2011).

The cultural structure of a community conditions the actions and interactions of local actors. Its unwritten and implicit rules inform people how they are supposed to behave and relate to each other

(Braden & Mayo, 1999). It is a broad concept, which influences community vitality in multiple ways, ranging from trust and respect which enable reciprocal relationships to a learning culture which enables adaptations and transformations, to a culture of wellness and community activism (Braden & Mayo, 1999; Hui et al., 2021). The material, institutional and cultural context of informal settlements informs our operationalization of community vitality.

2.3. Vital communities in informal settlements

We operationalise community vitality in informal settlement based on three variables, which are "inherent to any city due to the presence of human beings from different walks of life, who relate with each other, despite or irrespective of their differences" (Nederhand et al., 2021, p. 1).

The first variable is *relationality* (Nederhand et al., 2021). Relations are at the core of a vital community and enable informal settlers to give meaning and form to life. The interactions may look disorderly and fragmented (Bakhtin, 1981), but together they form the intricate patchwork of a vital community. A vital community has dense and diverse sets of social networks (Dale et al., 2010). Informality creates uncertainty, which requires people to constantly renegotiate access to scarce resources in diverse, fluctuating and power-laden compositions across space and time (Simone, 2004; Simone & Pieterse, 2017). While bonding networks within the informal settlements tend to be strong, linking networks to external knowledge and actors are likely to be hampered by the formal-informal boundary (Putnam, 1993; Thieme et al., 2021). We therefore operationalise relationality as bonding and linking networks.

The second variable, drawn from literature on community resilience in informal settlements, is *adaptive capacity*, defined as the capacity of local actors to deal with the inherent material, institutional and cultural uncertainty of informal settlements by adjusting resources and networks to changing contexts. Adaptive capacities range from being unable to cope with shocks and stresses to being able to adapt and transform living and working conditions (Satterthwaite et al., 2020; Seeliger & Turok, 2014).

The third variable, a key theme in community activism literature (Head, 2007; Larner & Craig, 2005), is the *level of citizen control*. Community vitality can be enabled or obstructed at specific moments in time and place when residents interact with those in power, be it service providers, employers, criminals, or police officers (Nederhand et al., 2021). These power imbalances determine who has the right to the city (Lefebvre, 1996). The 'right to the city' debate is contentious, as informal settlers at best have a partial right, being excluded from formal services, infrastructure, and networks. The question is to what extent and how informal settlers can self-organise their living and working environment within this constrained context (Simone, 2004). Institutions, including culture, may oppress community vitality, when its rules and power structures stifle local initiative, or when the urban poor are forced to use their scarce resources for overly expensive basic services. Service providers, gangs and corrupt police officers may exploit the vulnerable positions of informal settlers (Simone, 2004). Alongside this misuse of power, various forms of community engagement (Head, 2007) and participation (Arnstein, 1969) arise. Community participation may be at the level of tokenism, when citizens are informed and consulted but other actors make decisions influencing their living environment, or it may be a high level of citizen control when collective action and/or partnerships lead to community empowerment (Arnstein, 1969). These varying levels of citizen control reflect the plurality of power positions within informal settlements.

2.4. Frugality

Frugality is underpinned by notions of thrift and resource saving to achieve goals that could be religious, cultural, economic, or environmental (Onsongo & Knorringa, 2020). In informal settlements, frugality fills the gaps left by state and market neglect by drawing on local knowledge and skills. Frugality can create break-through performance (Gibbert et al., 2007), trigger local entrepreneurship (Linna, 2013), and introduce innovative activities (Radjou et al., 2012; Rao, 2013).

Frugality is a resource-constrained innovation concept seen as a philosophy, process or product (Soni & Krishnan, 2014) that we jointly label as 'frugal practice'. It has been theorised in literature on entrepreneurial bricolage that examines how actors incrementally solve problems by applying combinations of resources at their disposal (Linna, 2013), and in literature on *jugaad* in India (Radjou et al., 2012) and *jua kali* in Kenya (Holm et al., 2019), where actors use their ingenuity and flexible thinking to improvise solutions to local problems. It is exemplified in practices to alter, repurpose, refurbish or repair goods to suit prescribed functions or to prolong their life (Gerasimova & Chuikina, 2009).

To operationalise frugal practices, we use four interrelated variables that aim to overcome resource constraints and address users' (in our case informal settlers') needs by complexity reduction of goods/services processes and business models (Rosca et al., 2017). The first variable is *affordability*, whereby the level of frugality indicates relatively lower cost solutions (Bhatti et al., 2018) more suitable for resource-constrained contexts (Agarwal et al., 2016), including financial, time, skills, networks and material resources (Hossain et al., 2016). The second variable is *quality*, whereby the level of frugality indicates to what extent practices offer "good enough" solutions by combining basic functionality and robust quality with user friendliness (Rao, 2013). The third variable is that frugal practices address *communities' needs* (Bhatti et al., 2018), such as water, food, and energy supplies (Radjou et al., 2012). We operationalise this variable by exploring to what extent frugal practices contribute to basic needs, advanced needs and/or community goals in informal settlements. The last variable is the extent to which informal settlers have *access to local and external resources* (Bhatti et al., 2018), considering the availability of resources and communities' capabilities to mobilise these (Busch, 2021) within and between resource-scarce and -abundant contexts (Sarkar & Mateus, 2022). Taken together, the variables measure the different levels of frugality of practices in informal settlements.

2.5. Concluding remarks

We define community vitality in informal settlements as dynamic relationships between residents, and public, civil, and private actors to cope with uncertainty and plot towards improved wellbeing, by constantly renegotiating the allocation of scarce resources within the cultural, institutional, and material structures of an informal settlement. Table 1 operationalises community vitality and frugal practices, using the material, institutional and cultural structures as contextual and sensitizing. We operationalise community vitality based on relationality, adaptive capacity, and citizen control. We treat relationality as the bonding and linking interactions between actors; adaptive capacity as the ability to adapt or transform, and citizen control as the level of participation. Frugal practices are activities to develop and implement low-cost robust solutions that address communities' needs within resource-constrained contexts. We measure frugal practices as their perceived affordability, access to resources, quality, and community needs. Table 1 also indicates scores for each indicator, as explained in the method section.

3. Methods

We apply FSQCA as a research approach to identify how frugality and vitality lead to vitality outcomes. FSQCA enables the comparison of a medium number of qualitative case studies (Fiss, 2011). It hinges on the notion of multiple causation, whereby a combination of factors, here

Table 1
Indicators.

Variable	Sub-variable	Indicators	Scores
Frugal practices	Affordability	Affordable price	Low: unaffordable Medium: affordable High: perceived as low costs
	Access	Access to resources	Low: access to local resources Medium: basic access to external resources High: access to local and external resources
	Quality	Robustness	Low: not robust nor applicable Medium: not robust but applicable High: robust and applicable
	Community needs	Common goals met	Low: struggle to address basic needs Medium: addresses basic needs High: community goals met
Community vitality	Relationality	Bonding	Low, medium, and high intensity of interactions within community
		Linking	Low, medium, and high intensity of interactions outside community
	Adaptability	Adaptive capacity	Low: insufficient capacity Medium: adaptive capacity High: transformative capacity
	Level of citizen control	Level of participation	Low: power abuse Medium: information and consultation High: partnerships and community decision

Source: authors.

vitality and frugal practices, form configurations which are associated with specific outcomes, here community vitality (Gerrits & Verweij, 2018).

Our sample is drawn from two large informal settlements in Nairobi: Mathare and Mukuru. The settlements offer different contexts: self-organisation in Mathare and community-based upgrading in Mukuru. We have mapped 32 frugal practices from transcribed research data on basic services in Mathare (16 cases), Mukuru biocentres (10) and the Mukuru Spatial Planning Area (SPA) upgrading programme (6). For Mathare, we did so by analyzing data from 47 semi-structured interviews and focus group discussions with households, community-based organisations, community health volunteers and community leaders, collected in a study on community resilience and development in 2020/21. For Mukuru, we analyzed 56 semi-structured interviews and focus group discussions with frugal innovators, CBOs, and community members compiling short-term innovation ethnographies of frugal practices, collected in 2002/21. The authors were involved in both studies. For Mukuru slum upgrading, we used personal experience, as one of the authors was involved in the process, combined with observation, and analyzing project reports and working papers. Out of the 32 frugal practices, we selected seven for deeper analysis and comparison by maximizing variety on vitality and frugality. For those seven, we conducted follow-up interviews, site visits with recorded field notes, and validation meetings to improve internal validity. Fig. 1 lists the selected cases.

The analytical process comprised three steps. First, we axially (re) coded data in Atlas-ti to trace the multiple forms through which frugality and vitality manifest themselves. Second, we scored each indicator into a three-point ordinal fuzzy set i.e., low, medium, high, reflecting that each can be in or (partially) out a specific set (Smithson, 2012). Scoring reflects a process of minimization and calibration (assigning values), which enables comparison (Chang & Gerrits, 2022). This process is potentially subjective and has therefore been accompanied by validation sessions among the researchers. Scoring led to a data matrix with all scores of the seven frugal practices. Third, we reduced the number of rows by grouping frugal practices with similar scores. We calculated the strength of the emerging types of community resilience based on group membership, which measures the percentage to which indicators of frugal practices fit into a type, and external variety, which measures to what extent scores vary between types. While FSQCA is a powerful tool to explore typologies based on large qualitative datasets, it does not enable empirical generalization due to the medium number of cases.

4. Results

4.1. Case descriptions

4.1.1. Service cartels and gangs

Cartels and gangs offer a wide range of basic services in Mathare. We define gangs as organised groups of criminals and cartels as a collection of informal firms who collude to manipulate and commercialize government-provided services. Both are illegal but socially accepted. We focus on illegal electricity and water provision by cartels and security

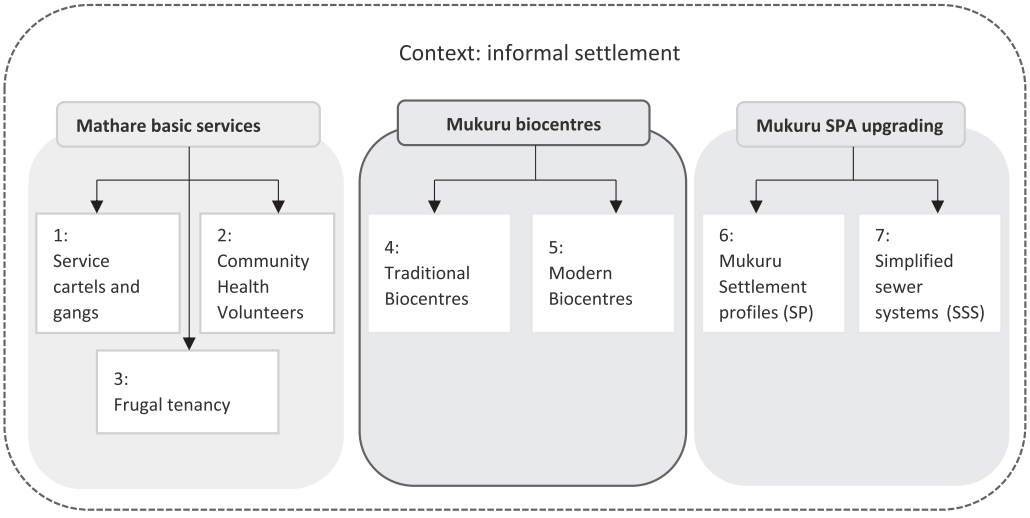


Fig. 1. Data sources and selected frugal practices.
Source: Authors.

services by gangs.

Service cartels and gangs offer services which are frugal in the sense of being affordable. Respondent M50 observes that "*Community members prefer illegal connections and services because they are cheaper*". The actual price however depends on the context. Prices go up when electricity and water are repackaged in small quantities to favour informal settlers who can only purchase products for immediate daily needs. Security services are affordable, if compared to private and corrupt public alternatives. The services mainly use local entrepreneurship, labour, tools, equipment and material to prepare and maintain "spaghetti connections" for water, "sambaza" for electricity and protection against crime. These practices aim to satisfy immediate needs by offering last mile connectivity. However, electricity and water services are of low quality and unreliable (M53), while security services of gangs are violent, manipulative, and create no-go zones for the police and other security service providers. Territorial conflicts arise when gangs fight over their monopolies (M9 and M11).

Community vitality is indicated by strong local networks, within which informal settlers constantly negotiate with cartels and gangs. The relationship of gangs and cartels with government is controversial, as they illegally set prices in unregulated monopolies, vandalize trunk infrastructure, and discourage new entrants and government interventions. Cartels and gangs bribe and/or collude with each other and at times with police and government officials:

> "…organised gang group would start terrorizing community members after the police patrol passes. These organised groups or criminal groups knew the police patrol routine."
>
> (M10)

These relationships are not very adaptive, as they are full of conflict and tension, but can temporarily become adaptive when gangs and cartels jointly revolt against (police) interference. Even in such a context, however, citizens experience a low level of control and adaptability as they depend on the goodwill of cartels and gangs.

4.1.2. Community health volunteers (CHVs)

The government launched the CHV programme in 2006 to offer basic community health awareness, practice home care, and offer basic emergency and health services. The programme is frugal in that it is highly affordable, whereby volunteers offer free medical assistance to low-income groups:

> "We are not paid but we are sometimes given 500 shillings in a training (…). NGOs (…) appreciate what we do when we work with them. There was a time when we were doing a polio campaign and for that we were being paid 500 shillings per day."
>
> (M45)

CHVs mainly employ local resources whereby volunteers are drawn from the community. They receive three months of training from the government on a 13-module curriculum, which is sufficient to respond to emergencies, create awareness, provide first aid and other basic health needs. Patients with serious illnesses are referred to hospitals. CHVs are appreciated within the community and offer qualitative basic health services (M45).

Community vitality is characterized by strong links with local and external actors. CHVs operate in well-organised local networks and build ties of trust with about 100 households each offering home care services and awareness creation. CHVs partner with CBOs, churches, and NGOs:

> "I was picked by SHOFCO (Shining Hope For Communities) as a gender champion…. some of these families have gender-based violence cases. (…) I am also a facilitator at Dream Girl, my job is to train school students and pupils on how the world is, I train them about drugs."
>
> (M45)

CHVs also network extensively with external actors, such as the disease surveillance office, nutrition office and health coordinators (M44). When needed, CHVs adapt their services. They have for instance devised novel strategies to raise awareness and improve hygiene during the COVID-19 lockdowns (M46). CHVs offer a medium level of citizen control, as citizens are informed and consulted, while the government maintains firm control of the CHV service.

4.1.3. Frugal tenancy

Frugal tenancy is the practice of tenants to partition rooms and sublet the partitioned space. The practice emerged when Mathare became dense and rents increased. The practice is partially frugal. Subletting of partitioned living spaces reduces the cost of housing for sub-tenants and supplements the tenant's income. The partitioning uses local cheap resources:

> "Sometimes partitions within the room are done with a cloth in order to separate common areas for cooking and visitors from the more private spaces for sleeping."
>
> (M19)

The partitioned units offer a basic living/commercial space at a relatively low cost. They often offer low quality and unreliable housing as the rooms are noisy, offer little privacy and are uncertain because there is no formal agreement between landlords, structure owners, tenants, and sub-letting tenants.

Community vitality of frugal tenancy is indicated by strong local networks. As partitions are highly visible, it requires the silent consent of the landlord, who appreciates that it is needed to pay rents. Also, finding a place to stay within someone else's house depends on who you know and trust. The process of subletting requires multilevel and adaptive negotiations, whereby house owners may exploit their position of power. Complex and adaptive chains of subletting emerge, where rooms are subdivided when needed. Structure owners ask (sub)tenants who are unable to pay rents to leave or hire goons to kick out stubborn tenants. Landlords may evict structure owners from their land without notice, sometimes through 'hot demolitions' (landlords setting structures on fires to evict tenants and structure owners). Frugal tenancy thus offers subletters low level of control.

4.1.4. Traditional biocentres

The external NGO Umande Trust has set up biocentres in Mukuru to improve water and sanitation, empower the community and improve the environment. The biocentres are managed by community groups and consist of toilets, bathrooms, biodigesters, cooking areas and multipurpose halls. The bio digester uses the faecal sludge from toilets to generate biogas for cooking. This promotes the use of clean energy and contributes to waste management, reducing flying toilets and open defecation.

The frugality of traditional biocentres is indicated first by the affordability of services and products. The fees for services only cover operation and maintenance costs. Biogas is more affordable than charcoal, which has sharply increased in price (MK2). Affordability also improves by combining sanitation and social functions, including micro credit and savings (MK1). The biocentres use local resources such as labour, building materials and human waste for biogas generation. They address basic needs related to water and sanitation services. The quality is medium, with basic functionality and durable materials which eases maintenance and operation. The use of human waste for cooking and limited privacy during cooking are however perceived to be substandard (MK2). MK3 narrates:

> "You find that most of the residents will not want to come to a communal cooking point because of issues of privacy issues, the distance issues. There are also issues of just basically where the location of the cooking point was put."

Community vitality is indicated by a high level of bonding and

linking. Umande Trust took the initiative and partnered with government officials, NGO's, structural engineers and architects, Kenyatta University, Equity Bank and Kenya Water for Health Organization. Later, management and ownership were transferred to community groups. Most interactions are local, with community groups operating and maintaining the biocentres. During Covid-19, the biocentres adapted by collaborating with schools to upgrade toilets, install hand washing stations and train children on how to wash their hands. They piloted mobile payment systems, which however did not work within the local context. To cater for the increasing population, more biocentres have been established. Umande Trust continues to play a large role in employing new staff, offering technical advice, and adapting and initiating activities. Citizen control is therefore at a medium level: informal settlers are informed, consulted, and manage operation and maintenance, but Umande Trust holds control.

4.1.5. Modern biocentres

Modern biocentres offer more varied services than traditional biocentres, such as a piped biogas to neighbouring houses, tiled floors, flushable toilets, spacious meeting rooms and offices for hire. They also have a different association with community vitality.

Frugality can be indicated by their affordability and use of resources. Though still frugal, cost of construction is slightly higher than that of traditional biocentres, as the services have a higher standard. However, the prices remain the same, as construction is subsidized. Compared to traditional biocentres, modern biocentres offer more advanced services and options. They have flushable squatting toilets tiled floors and spacious rooms for hire. Piped biogas to houses is available for those households that value privacy when cooking. Modern biocentres are therefore also of a higher quality. The materials furthermore reduce maintenance costs, e.g.:

> "So maintenance are just little things because their doors don't break every day, there are just different checks and balances they just have to put in place but they are one off major cost, not continuous cost." (MK2)

Community vitality is indicated by strong bonding and linking. The practices are transformative, because community engagement is designed to draw active and meaningful participation from residents. Transformation is also visible in the new technologies used, the response to market needs, as visible in offering piped biogas connections and working spaces, and the upscaling and constant improvements. This slowly transforms sanitation, cooking and waste management systems within Mukuru. Community members furthermore operate as partners, which amounts to a relatively high level of control. They engage in discussions with trustees and participate in making strategic development partnership. Unlike the traditional biocentres, communities are trained on different capacities such as financial management in the new biocentres model.

4.1.6. Mukuru settlement profiles

The settlement profiles constitute a community information base on the settlement, which serves as the backbone of the Mukuru community-based upgrading programme.

It is a frugal practice, first, because of its affordability. The strategy applied low-cost methods to collect data on settlement's history, spatial layout, social and physical infrastructure, household characteristics, sociocultural aspects and community life. NGO's trained voluntary community members and availed mapping and planning tools. Community profiling turned out to be significantly cheaper than contractor-based mapping and enumeration (Slum Dwellers International, 2018). The settlement profiles were mainly prepared with local resources, knowledge, and people. The community mappers were trained and tech-enabled, and the data gathered was screened through a two-stage verification and vetted in community meetings. As a result, the profiling approach attained a precision and contextualization that external agents cannot easily accomplish. The profiles open-up the possibility of empowerment and settlement upgrading. They became a tool for advocacy, being used by community members to initiate dialogue with governments, civil societies and private sector organisations on better planning, decent shelter, and better access to basic services (Horn et al., 2020).

Community vitality is indicated by strong bonding and linking. Being initiated by an external NGO, the profiles have been prepared by about 450 community mappers, with around 70 % representing women and youth (Horn et al., 2020). A network of actors consulted with government authorities such as municipal and city council officials (Slum Dwellers International, 2018). External NGOs provided the requisite resources including mapping tools, technical capacities and compensation for the volunteers. Government authorities subsequently used the profiles as a decision-making tool to guide upgrading. By and large, the multilevel relations were adaptive, with actors acting together towards a common goal; to co-produce evidence-grounded data for settlement upgrading. The process aims for transformation in the sense of community empowerment and settlement upgrading (Sverdlik et al., 2020). Towards the end of the process, citizens controlled the process and data, as indicated in the community brand "Tujuane Tujengane" (know each other, build each other) (Horn et al., 2020).

4.1.7. Simplified sewer systems (SSS)

SSS are designed as an alternative to the centralized space- and resource-intensive sewer systems. Their design is adapted from the condominium sewers in Brazil and Tanzania (Tilley, 2014).

It is a frugal practice, which offers an affordable and flexible design for an off-site sewerage network, with smaller diameter pipes, shallower depths, and flatter gradients than conventional sewer systems (Sverdlik et al., 2020). The installation, operation and maintenance are decentralised to the community and use locally available materials, thus incurring 20 to 50 % less costs than centralized sewer systems (Tilley, 2014). Their design and development combine external engineering and planning skills with local construction and maintenance skills, and external materials and tools with local ones. The sewer systems are of high quality, suitable to the informal settlement due to their flexibility and easy maintenance. The system eliminates non-essential design features and saves on the use of space, thus preventing resettlements. They address advanced needs of Mukuru residents: they not only respond to the sanitation needs but also ensure that minimal space is required and enable community maintenance (Sverdlik et al., 2020).

Community vitality is indicated by strong bonding and bridging. The design was selected and adapted in co-production with interested community members, firms, local governments, and NGOs. These actors formed a coalition (the WASH consortium) and drew experiences from Tanzania through benchmarking visits (Slum Dwellers International, 2019). The interactions were adaptive to common needs and responsive to the contextual realities of resource- and space-scarcity. It demonstrates transformative capacities as it is a system-changing practice, specifically designed to fit local resource- and space-demands and enable community management and maintenance. The process capacitated local communities, treating community groups as partners. Through community contracting, community members provided skilled labour which created jobs, facilitated community ownership, and built skills for maintenance.

4.2. Grouping cases

Table 2 scores the indicators of cases based on the descriptions offered in the previous subsection. Table 3 subsequently groups the cases into three types of community vitality: poverty-driven, robust, and dynamic. For each type, Table 3 refers to frugal practices and their modal indicator scores. Group membership, which measure internal coherence, ranges from 94 % to 96 %. Within groups, we furthermore find that indicators of frugal practices associate for over 90 % with

Table 2
Modal scores of cases.

Indicators	Cases						
	1 Service cartels/gangs	2 Frugal tenancies	3 CHVs	4 Traditional biocentre	5 Modern biocentre	6 Settlement profiles	7 Simplified sewer system
Frugality							
Affordability	High	High	High	High	High	High	High
Resources	Low	Low	Medium	High	High	High	High
Needs	Low	Low	Medium	Medium	Medium	High	Medium
Quality	Low	Low	Medium	Medium	High	High	High
Vitality							
Bonding	High	High	High	High	High	High	High
Linking	Medium	Medium	Medium	High	High	High	High
Adaptability	Low	Medium	Medium	Medium	High	High	High
Participation	Low	Low	Medium	Medium	High	High	High

Source: authors.

Table 3
Types of community vitality.

Indicators	Types		
	Poverty-driven [1]Service cartels/ gangs [3]Frugal tenancies	Robust [2]CHVs [4]Traditional biocentres	Dynamic [5]Modern biocentres [6]Settlement profiles [7]Simplified sewer system
Frugality			
Affordability	High[1,3]	High[2,4]	High[5,6,7]
Resources	Low[1,3]	Medium[2]	High[4,5,6,7]
Quality	Low[1,3]	Medium[2,4]	High[5,6,7]
Users' needs	Low[1,3]	Medium[2,4]	Medium[5,7]
Vitality			
Bonding	High[1,3]	High[2,4]	High[5,6,7]
Linking	Medium[1,3]	Medium[2,4]	High[5,6,7]
Adaptability	Low[1]	Medium[2,3,4]	High[5,7]
Participation	Low[1,3]	Medium[2,4]	High[5,6,7]
Group membership score[a]	94 %	94 %	96 %

Superscript numbers relate to the number of the frugal practice.
[a] Percentage to which the embedded cases fall within the group.
Source: authors.

vitality indicators. The internal coherence of the groups is therefore high. Variety between groups is measured as the extent to which indicators differ between groups. Table 3 shows a sufficient external variety score of 67 % (16 of the 24 possible different scores). All types of community vitality overlap on high affordability and bonding, while they partially overlap on user needs addressed and linking, and differ fully on access to resources, quality of frugal practices, adaptive capacities, and level of citizen control. As the types of community vitality are internally coherent and differ sufficiently, we conclude that they are distinct.

5. Typology of community vitality

This section introduces three distinct types of community vitality based on research findings and literature. The three types share two characteristics: strong bonding within the community and affordable practices. As this finding is in line with theory on frugality (Radjou et al., 2012) and community vitality (Fraser et al., 2005; Nederhand et al., 2021), we deduce that community vitality in informal settlements is likely to be indicated by bonding in affordable practices.

5.1. Poverty-driven community vitality

Our findings reveal that informal settlers are likely to engage in local relations with service cartels, gangsters, and frugal tenants to access basic services in situations where formal service providers are inaccessible. These illicit service providers tailor services to the needs of the urban poor. However, the quality of localised services tends to be low and unreliable, offering limited opportunity for informal settlers to control and improve their quality of life (see also Thieme et al., 2021). As the income of the urban poor tends to be uncertain, they cannot afford regular services and constantly change gears, look for alternatives, renegotiate, accept poor quality, and improvise (see also Simone, 2004; Simone & Pieterse, 2017). This type of community vitality enables survival but also has a negative connotation because of the potential misuse of power and poor quality of services. The configuration of factors may well reinforce urban poverty traps, especially if informal settlers spend most of their resources and energy to survive (Dasgupta, 2007). Our findings show that it is a distinct form of community vitality, characterized by the illicit use of public resources, low quality and irregular basic services. It is associated with a low level of community resilience due to limited capacity to cope (Folke, 2006) and of community activism due to low levels of citizen control (Larner & Craig, 2005).

5.2. Robust community vitality

Robust and poverty-driven community vitality partially overlap as both are affordable, with strong bonding and a medium level of linking to external actors. However, robust community vitality comprises stronger bonding and linking, whereby households have medium control over their living environment. Informal settlers engage in systemic and cordial negotiations, which lead to frugal practices and offer medium quality with basic functionalities. Frugal practices provide an innovative and creative fix, which offer a viable alternative to (in)formal practices (Radjou et al., 2012). In line with theory on CBOs, we find that informal settlers engage in collective action to meet community needs (Igalla et al., 2019), but these are likely to remain isolated and within the confines of informality. Examples are CHVs and basic biocentres, which offer relevant services of medium quality, but do not create new opportunities to improve quality of life. Robust frugal practices thereby systemically reinforce community vitality. Bahadur and Doczi (2016) therefore argue that frugal practices can enable adaption but are unable to transform social systems. Folke (2006) similarly argues that community resilience often results in adaptive instead of transformative change. The aimed level of community activism, system change, is thus unlikely to be achieved.

5.3. Dynamic community vitality

Dynamic community vitality is set apart by a high level of citizen control, whereby informal settlers organise themselves and partner with actors inside and outside the informal settlement. This brings in new resources and ideas, resulting in improved biocentres, settlement profiles, and simplified sewer systems. In all three, citizen control is institutionalised within CBOs (see also Igalla et al., 2019). We add to theory that collective action configurates with strong bonding and linking networks, adaptive capacities, and a high level of frugality. These frugal practices are of high quality and offer constant innovations and improvements.

Dynamic community vitality enables system transformation, thus living up to the ideal of community activism and engagement (Head, 2007), but this finding needs to be qualified: two of the three cases transform subsystems, limiting change to sociotechnical sewer and energy systems. Community profiling is the only one which enables the community to meet goals and transform systems underlying community development, as it maps cultural, material, and institutional root causes of uncertainty and poverty. This finding confirms that transformation is rare but not impossible if a community undertakes deliberate collection action to transform (Bahadur & Doczi, 2016; Folke, 2006).

In dynamic community vitality, informality and scarcity become opportunities to innovate out-of-the-box (De Soto, 1989; Fransen & Kassahun, 2011; Radjou et al., 2012). Similar examples are half London in Kampala, where a bustling night life emerged in an informal settlement, and Kampung Cyber in Yogyakarta, where informal firms jointly developed an IT network to boost innovation, branding, and e-marketing (Fransen & Gaol, 2016). The combination of weak rules, strong networks, citizen power and frugal innovation enabled sub-communities to adapt and transform their living and working environment (see also Dale et al., 2010).

6. Conclusions and recommendations

A vital community is one whereby dynamic relationality enables the community to cope with shocks and meet common goals in the face of uncertainty and change. It relates to other concepts of community development but is set apart by its focus on relations among actors. Vitality is of key importance in informal settlements where governments are relatively absent, and resources are scarce. At the same time, scholarly work on community vitality in informal settlements remains behind.

The first objective of the paper is to describe community vitality in informal settlements, by turning to the concept of frugal practices. Based on seven frugal practices in Nairobi, we show that their community vitality is defined by strong bonding among local actors. They constantly negotiate affordable solutions, conditioned by the cultural, institutional, and material context. We therefore conclude that community vitality in informal settlements is indicated by strong bonding in affordable practices (Bhatti et al., 2018; Radjou et al., 2012). Whereas affordability enables communities to deal with resources constraints, bonding creates an environment of trust for frugal practices to emerge and sustain.

Our second objective is to identify different types of community vitality in informal settlements. We have applied FSQCA to analyze effects of the mutual dependencies and collective interactions between variables of frugal practices and community vitality. The variables are based on literature of community vitality and frugality, complemented with insights from community resilience (Folke, 2006), community activism (Head, 2007; Larner & Craig, 2005) and CBOs (Igalla et al., 2019). Our study introduces three distinct types. *Poverty-driven community vitality* describes the variety of practices which enable informal settlers to survive but tend to offer a low level of citizen control and poor-quality services. In *robust community vitality*, collective action offers alternatives to (in)formal services, but the community remains isolated within the confines of informality. *Dynamic community vitality* on the other hand enables the improvements of living and working conditions in strong and open partnerships, whereby informality becomes an enabling environment for new, path breaking forms of community vitality.

The definition and typology show that community vitality is a concept on its own, which is distinct from other concepts on community development and can be applied in informal settlements. We recommend more research to see how the various concepts on community development relate in different contexts.

Our main contribution to literature is the introduction of three types of community vitality in informal settlements. As our study is based on a medium number of cases, we recommend quantitative or FSQCA studies with more cases to test our findings and further develop our proposed typology. Moreover, we show initial evidence on the importance of multilevel interaction for vital communities (Nederhand et al., 2021), but could not explore how and why actors in informal settlements form networks across spatial scales. This forms another suggestion for further research, especially studied through the lenses of CBOs and community activism. We also recommend exploring more deeply how culture and institutions affect community vitality in informal settlements. Finally, we recommend upgrading practitioners to acknowledge and support robust and dynamic community vitality. The challenge however lies in dealing with poverty-driven community vitality. This requires addressing power abuse while maintaining frugal functionalities and recognizing and supporting positive attributes of poverty-driven community vitality.

Funding

This work was supported by Vital Cities and Citizens of Erasmus University Rotterdam and the International Centre for Frugal Innovation of Leiden, Delft and Erasmus University.

CRediT authorship contribution statement

Jan Fransen: Supervision, Funding acquisition, Conceptualization, Formal analysis, Methodology, Project administration, Resources, Writing – original draft, Writing – review & editing, Validation. **Beatrice Hati:** Data curation, Investigation, Writing – original draft, Writing – review & editing, Validation. **Rosebella Nyumba:** Data curation, Investigation, Writing – original draft, Writing – review & editing, Validation. **Erwin van Tuijl:** Conceptualization, Writing – original draft, Writing – review & editing, Validation.

Declaration of competing interest

None.

Data availability

Data will be made available on request.

Acknowledgement

We would like to thank Ghetto Foundation and in particular Samuel Kiriro for the pleasant collaboration in data collection. For feedback on the paper, we would like to thank Peter Knorringa, Jurian Edelenbos, the organisers and participants of the writers' workshop organised by Vital Cities and Citizens and the reviewers of the article.

References

Agarwal, N., Grottke, M., Mishra, S., & Brem, A. (2016). A systematic literature review of constraint-based innovations: State of the art and future perspectives. *Transactions on Engineering Management, 64*(1), 3–15.

Arnstein, S. R. (1969). A ladder of citizen participation. *Journal of the American Institute of Planners, 35*(4), 216–224.

Bahadur, A., & Doczi, J. (2016). *Unlocking resilience through autonomous innovation*. London: Overseas Development Institute.

Bakhtin, M. M. (1981). *The Dialogic Imagination: Four Essays*. In C. Emerson, & M. Holquist (Eds.). Austin: University of Texas Press.

Bhatti, Y., Basu, R., Barron, D., & Ventresca, M. (2018). *Frugal innovation: Models, means, methods*. Cambridge: Cambridge Univ. Press.

Braden, S., & Mayo, M. (1999). Culture, community development and representaion. *Community Development Journal, 34*(3), 191–204.

Busch, H. C. (2021). Frugal innovation in energy transitions: Insights from solar energy cases in Brazil. *Cambridge Journal of Regions, Economy and Society, 14*(2), 321–340.

Chakravarty, S. (2022). Resource constrained innovation in a technology intensive sector: Frugal medical devices from manufacturing firms in South Africa. *Technovation, 112*, Article 102397.

Chang, R. A., & Gerrits, L. (2022). What spatially stabilises temporary use? A qualitative comparative analysis of 40 temporary use cases along synchronised trajectories of stabilisation. *Cities, 130*, Article 103868.

Cherrstrom, C. A., Zarestky, J., & Deer, S. (2018). "This group is vital": Adult peers in community for support and learning. *Adult Learning, 29*(2), 43–52.

Conway, R., Boniwell, I., & Metz, T. (2017). Community vitality. *Happiness, 347*.

Dale, A., Ling, C., & Newman, L. (2010). Community vitality: The role of community-level resilience adaptation and innovation in sustainable development. *Sustainability, 2*(1), 215–231.

Dasgupta, P. (2007). Poverty traps: exploring the complexity of causation. In *Twenty twenty (2020) focus brief on the world's poor and hungry people*. International Food Policy Research Institute (IFPRI).

De Soto, H. (1989). The other path. In *The invisible revolution in the Third World*. London: IB Tauris and Co.

Debord, G. (1983). *Society of the spectacle*. Detroit, MI, USA: Black and Red Publishing.

Fiss, P. C. (2011). Building better causal theories: A fuzzy set approach to typologies in organization research. *Academy of Management Journal, 54*(2), 393–420.

Folke, C. (2006). Resilience: The emergence of a perspective for social–ecological systems analyses. *Global Environmental Change, 16*(3), 253–267.

Fransen, J., & Gaol, P. H. (2016). Absorptive capacity and local networking of home-based enterprises in 'Kampong Cyber', Yogyakarta, Indonesia. In G. M. Gomez, & P. Knorringa (Eds.), *Local governance, economic development and institutions* (pp. 292–312). London: Palgrave Macmillan.

Fransen, J., & Kassahun, S. (2011). Incorporating informal settlements in Addis Ababa: from centralized urban planning to local planning. In A. Bongwa, S. Kassahun, & M. P. van Dijk (Eds.), *Decentralization and service delivery in Ethiopia* (pp. 104–116). Maastricht: Shaker Publishing.

Fransen, J., Peralta, D. O., Vanelli, F., Edelenbos, J., & Olvera, B. C. (2022). The emergence of urban community resilience initiatives during the COVID-19 pandemic: An international exploratory study. *The European Journal of Development Research, 34*(1), 432–454.

Fraser, M., Kember, S., & Lury, C. (2005). Inventive life: Approaches to the new vitalism. *Theory, Culture and Society, 22*, 1–14.

Gerasimova, E., & Chuikina, S. (2009). The repair society. *Russian Studies in History, 48*(1), 58–74.

Gerrits, L., & Verweij, S. (2018). *The evaluation of complex infrastructure projects: A guide to qualitative comparative analysis*. Edward Elgar Publishing.

Gibbert, M., Hoegl, M., & Välikangas, L. (2007). In praise of resource constraints. *MIT Sloan Management Review, 48*(3), 15.

Gilchrist, A., & Taylor, M. (2011). *The short guide to community development*. Policy Press. pp. 2+. ISBN 978-1-84742-689-5.

Head, B. W. (2007). Community engagement: Participation on whose terms? *Australian Journal of Political Science, 42*(3), 441–454.

Holm, L. S., Reuterswärd, M. N., & Nyotumba, G. (2019). Design thinking for entrepreneurship in frugal contexts. *The Design Journal, 22*(sup1), 295–307.

Horn, P., Kimani, J., Makau, J., & Njoroge, P. (2020). *Scaling participation in informal settlement upgrading: A documentation of community mobilisation and consultation processes in the Mukuru Special Planning Area, Nairobi, Kenya*.

Hossain, M., Simula, H., & Halme, M. (2016). Can frugal go global? Diffusion patterns of frugal innovations. *Technology in Society, 46*, 132–139.

Hughes, L. S., Phillips, R. L., DeVoe, J. E., & Bazemore, A. W. (2016). Community vital signs: Taking the pulse of the community while caring for patients. *The Journal of the American Board of Family Medicine, 29*(3), 419–422.

Hui, E. C. M., Chen, T., Lang, W., & Ou, Y. (2021). Urban community regeneration and community vitality revitalization through participatory planning in China. *Cities, 110*, Article 103072.

Igalla, M., Edelenbos, J., & van Meerkerk, I. (2019). Citizens in action, what do they accomplish? A systematic literature review of citizen initiatives, their main characteristics, outcomes, and factors. *VOLUNTAS: International Journal of Voluntary and Nonprofit Organizations, 30*(5), 1176–1194.

Larner, W., & Craig, D. (2005). After neoliberalism? Community activism and local partnerships in aotearoa New Zealand. *Antipode, 37*(3), 402–424.

Lefebvre, H. (1996). The right to the city. In *Writings on cities* (pp. 147–159). Cambridge, MA: Blackwell Publishers.

Linna, P. (2013). Bricolage as a means of innovating in a resource-scarce environment: A study of innovator-entrepreneurs at the bop. *Journal of Developmental Entrepreneurship, 18*(3), 1–23.

Magis, K. (2010). Community resilience: An indicator of social sustainability. *Society and Natural Resources, 23*(5), 401–416.

Montgomery, J. (1998). Making a city: Urbanity, vitality and urban design. *Journal of Urban Design, 3*(1), 93–116.

Nederhand, J., Avelino, F., Awad, A., Duijn, M., Edelenbos, J., Engelbert, J., Fransen, J., Godor, B., Schiller, M., & Van Stapele, N. (2021). *Reclaiming the city from an urban vitalism perspective, Rotterdam, vital cities and citizens, EUR*.

Onsongo, E., & Knorringa, P. (2020). Comparing frugality and inclusion in innovation for development: Logic, process and outcome. *Innovation and Development*, 1–21.

Putnam, R. (1993). The prosperous community: Social capital and public life. Vol. 4. Available online. In *, 13. The american prospect* http://www.prospect.org/print/vol/13. (Accessed 4 July 2003).

Radjou, N., Prabhu, J., & Ahuja, S. (2012). *Jugaad innovation: Think frugal, be flexible, generate breakthrough growth*. London: John Wiley and Sons.

Rao, B. C. (2013). How disruptive is frugal? *Technology in Society, 35*(1), 65–73.

Ritchie, H. A. (2022). An institutional perspective to bridging the divide: The case of Somali women refugees fostering digital inclusion in the volatile context of urban Kenya. *New Media and Society, 24*(2), 345–364.

Rosca, E., Arnold, M., & Bendul, J. C. (2017). Business models for sustainable innovation - An empirical analysis of frugal products and services. *Journal of Cleaner Production, 162*, 133–145.

Ruhlandt, R. W. S., Levitt, R., Jain, R., & Hall, D. (2020). One approach does not fit all (smart) cities: Causal recipes for cities' use of "data and analytics". *Cities, 104*, Article 102800.

Sarkar, S., & Mateus, S. (2022). Value creation using minimal resources–A meta-synthesis of frugal innovation. *Technological Forecasting and Social Change, 179*, Article 121612.

Satterthwaite, D., Archer, D., Colenbrander, S., Dodman, D., Hardoy, J., Mitlin, D., & Patel, S. (2020). Building resilience to climate change in informal settlements. *One Earth, 2*(2), 143–156.

Scott, K. (2009). Community vitality: Measuring what matters. *The Vanier Institute of the Family*, 1–4.

Seeliger, L., & Turok, I. (2014). Averting a downward spiral: Building resilience in informal urban settlements through adaptive governance. *Environment and Urbanization, 26*(1), 184–199.

Simone, A. (2004). People as infrastructure: Intersecting fragments in Johannesburg. *Public Culture, 16*(3), 407–429.

Simone, A., & Pieterse, E. (2017). *New urban worlds: Inhabiting dissonant times*. Polity Press.

Slum Dwellers International. (2018). Know your city : Slum dwellers count. In *We don't need others to collect information on our settlements . We can do it ourselves!*.

Slum Dwellers International. (2019). Sanitation learning exchange visit to simplified and decentralised sanitation Systems in Tanzania. Available at: https://sdinet.org/2019/02/sanitation-learning-exchange-visit-simplified-decentralised-sanitation-systems-tanzania/.

Smithson. (2012). *Fuzzy set analysis for behavioral and social sciences*. Springer Science and Business Media.

Soni, P., & Krishnan, R. T. (2014). Frugal innovation: Aligning theory, practice, and public policy. *Journal of Indian Business Research, 6*(1), 29–47.

Sverdlik, A., Makau, J., Kimani, J., Mumbi, C., Njoroge, P., Otibine, E., Nyambuga, K., & Wairutu, J. (2020). *Achieving scale, social inclusion, and multifaceted shelter solutions lessons from the special planning area (SPA) in Mukuru, Nairobi: City briefing*. Available at www.iied.org.

Thieme, T., Ference, M. E., & van Stapele, N. (2021). Harnessing the 'hustle': Struggle, solidarities and narratives of work in Nairobi and beyond introduction. *Africa, 91*(1), 1–15.

Tilley, E. (2014). *Compendium of sanitation systems and technologies*. Eawag. doi: ISBN: 978-3-906484-57-0.

UN. (2014). *Community development* Accessed from. UNTERM. on 10 October 2022 web.archive.org.

Van Tuijl, E., Dittrich, K., Rossi Doria, D., & van de Berg, L. (2022). Frugal Innovation in the 1.5-metre-society: Analysis of restaurants in The Hague. forthcoming. In Kresl (Ed.), *The impact of COVID on cities and regions: Policy responses of local leaders*. Cheltenham: Edward Elgar.

Wainaina, G. K., Truffer, B., & Lüthi, C. (2022). The role of institutional logics during participation in urban processes and projects: Insights from a comparative analysis of upgrading fifteen informal settlements in Kenya. *Cities, 128*, Article 103799.