Research articles

Barriers and opportunities for participatory environmental upgrading: Case study of Havelock informal settlement, Durban

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ABSTRACT

Urbanisation is one of the key challenges of this decade with 68% of the global population likely to be living in urban areas by 2050. This challenge is particularly acute in sub-Saharan Africa where future towns and cities will see an influx of residents living in spontaneous human settlements. As cities struggle to keep up with the speed of growth and spread of informal settlements, associated environmental challenges such as air and water pollution and waste management have been significantly increasing posing a health risk in high density settings. Using the case of Havelock informal settlement in Durban, the authors identified key challenges associated with poor environmental conditions, lack of basic infrastructure, and the implications for settlement upgrading. The study uses mixed methods combining transect walks, priority mapping, seasonal calendar, focus group discussions and household interviews to explore the households' most challenging environmental issues faced daily by informal dwellers. This paper seeks to make the case for targeted participatory environmental infrastructure and management delivery in urban settlements in South Africa. The research also highlights the value of adopting a holistic approach to infrastructure provision to effectively enhance the living conditions of communities. Targeted participatory processes are vital to ensure that holistic infrastructure interventions are acceptable, appropriate and embedded in local communities to create sustainable habitats.

1. Introduction

Urbanisation is one of the key challenges of the 21st century with 68% of the global population likely to be living in urban areas by 2050 [1]. Inclusive strategies will be required for urban planning and management. As a consequence of rapid urbanisation and population growth, informal settlements form a major part of the urban landscape globally. While proving to be a housing alternative for the poor, they constitute a major challenge for local authorities [2,3]. Informal settlements are home to over half of the urban poor in developing nations, circa 61.7% of the urban population in the African cities [3]. Despite the global proliferation of informal settlements, UN-Habitat [4] acknowledges that the phenomenon remains inadequately addressed.

As cities struggle to keep up with the pace of development, growth and spread of informal settlements, the associated challenges, including environmental impacts (air and water pollution, and waste) have increased. In the meanwhile, the notion of housing has now been expanded beyond the house structure to include the socio-cultural home environment, the physical characteristics of the neighbourhood and the social environment and services within communities [5], resulting in a policy shift from housing to human settlements in South Africa. The lack of resilient and adequate infrastructure in informal settlements coupled with poor housing stock in high density settings greatly increases the risk of illness and injury [6]. With rapid growth rates projected in Sub-Saharan African cities, sustainable development and overall well-being of city dwellers will be dependent on environmental management of urban growth in low-income settlements.

According to recent estimates, there are approximately 2.2 million informal dwellings in South Africa [7], which accounts for 13% of all households. Given the nature of land tenure arrangements and high mobility of residents in those settings it is likely that the number could potentially be significantly higher [8]. Urban migration, access to social and economic opportunities and poverty are major causes of informal settlements, as dwellers cannot afford to access formal housing schemes [9,10]. Informal settlements in South Africa are characterised by inequalities in access to services such as energy, water and sanitation with limited access to statistics and data on the gaps [8]. Also, the limited data on infrastructural services

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in such settings does not always capture the (in)adequacy in terms of the quality and quantity of access and hence the associated day-to-day experiences and challenges. Using an adapted sustainable habitat conceptual framework [11] and participatory techniques, the authors assess the environmental factors in an informal settlement, which faces multiple hazards and chronic environmental challenges.

This work forms part of the interdisciplinary project ISULabaNtu[1] funded by the Economic and Social Research Council (ESRC, in UK), through the Newton Fund and the National Research Foundation in South Africa. ISULabaNtu has the goal of co-producing sustainable and integrated approaches for community-led upgrading, exploring construction, environmental management and urban governance in informal settlements in Durban. This paper seeks to make the case for targeted participatory environmental infrastructure and management delivery in urban settlements in South Africa using the case study of partially serviced Havelock informal settlement. This settlement, like many others, has been subject to a multitude of natural and manmade disasters in the last decade including flooding and fires. Using mixed methods, the authors demonstrate challenges faced by the community due to inadequate infrastructure provision and environmental conditions providing evidence required to advocate for more explicit participatory and inclusive upgrading processes for environmental improvements.

2. Background and literature review

2.1. History of South African housing

The housing terrain in South Africa has been one of separate development, based on racial grounds [12]. The Group Areas Act of 1950 and the Promotion of Bantu Self-Government (1959) demanded that different racial groups had to inhabit separate areas [13]. The South African Constitution (1996) guarantees the right of the individual to access adequate housing. Nevertheless, defining adequate housing is quite difficult as it depends on the specific context and circumstances of households and individuals, together with their needs and priorities. The housing challenges can be traced back to the apartheid era, when backyard shacks were erected in formal residential areas. The first post-apartheid policy was based on the Reconstruction and Development Program (RDP), within which subsidised housing was considered a major sector to redress the past policies [71]. The RDP main aim was to address the triple challenges of poverty, inequality and unemployment. Some other key housing policies are the White Paper on Housing (1994) and the Breaking New Ground (BNG): a Comprehensive Plan for the Development of Sustainable Human Settlements (2004). After many years of delivering 'housing' without associated human settlement land uses, there was a shift to a more holistic and inclusive model for housing delivery [14]. The shift from RDP to the BNG policies aided the establishment of human settlements that could grow into sustainable nodes for development.

In 1998, the People's Housing Process (PHP) approach to housing provision was approved as a self-help housing scheme inspired by the work of the homeless people's federation and saving and housing schemes from around the globe. The PHP has been a feature of the national policy; however, most provinces refused it in favour of private sector delivery [15]. The Breaking New Ground (BNG) policy set out to address the quality loophole in the RDP policy and moved from delivery of fully subsidised serviced housing units to the delivery of integrated human settlements with emphasis on access to social services and employment opportunities. The BNG proposed a new approach focused on poverty eradication, reduction of vulnerability and promotion of social inclusion through participatory layout planning [16]. A revised policy called Enhanced People's Housing Process (ePHP)

was adopted in 2008 to integrate more explicitly beneficiaries into housing upgrading. The ePHP model has been applied as a step-by-step process of in-situ, incremental upgrading in self-organised communities able to make minimum contributions in terms of time, savings, labour and materials [17]. Through ePHP, local communities were able to participate in decision-making over the housing process, create partnerships, mobilise and retain social capital, promote local economic development, foster empowerment, involve women and youth, and create sustainable and inclusive human settlements in response to community needs [18].

A critique of the formal housing policy had to do with the allocation to beneficiaries who were often relocated far from their existing settlements, in a bid to eradicate informal settlements. As a result, the Prevention of Illegal Eviction and the Unlawful Occupation of Land Act (1998) aimed at addressing the challenges of relocation in informal settlement upgrading [8]. Another important change introduced by the BNG policy was the shift in focus from informal settlement eradication to in-situ upgrading through the Upgrading of Informal Settlements Program (UISP), which focused on formalising households in-situ, by providing incremental services and regularising tenure.

2.2. Participatory upgrading

Physical upgrading of informal settlements typically uses the approaches of demolition and relocation or in-situ development. Demolition and relocation is the process of moving inhabitants from their settlements to another 'greenfield' site. In-situ upgrading is generally preferred by the residents as this involves the formalisation of informal settlements in their original location, limiting socio-economic disruptions [16,19,20].

The South African government, since 1994, has applied different strategies. They range from the roll-over upgrading, which involves the removal of residents from their informal settlement shelter into temporary accommodation (transit camp). Lastly, the most effective strategy is the in-situ upgrading, which aims to preserve social and economic networks by decreasing the number of households relocated to another site or elsewhere on the site [19].

There is a growing body of literature which encourages participatory techniques as a key method to enhance a sense of local ownership within an upgrading project [21–24]. Community perceptions, alignment with needs and aspirations are key to leveraging sustained community participation and investment in upgrading projects [25]. Groups such as the SDI Alliance are calling for partnerships rather than participation [26]. It is important to actively involve dwellers at the outset so that service delivery caters to their needs and ensures ownership of the upgraded infrastructure.

Self-help activities and co-design strategies interrelated to community self-reliance are not new to South Africa, as since the 1950s incremental self-building approaches on serviced sites were considered the cheapest and most efficient solution for slum upgrading [27]. Self-building can range between site-and-services (the original translation of Turner's [28] model) to self-help approaches with individuals involved in dwelling design, construction, project management and mutual help activities, as local communities hold the necessary local knowledge [27,29–33]. Community participation derives from co-design activities and refers to grassroots planning processes where the local populations decide themselves about the future of their own settlement [34]. In practice, there is often lack of social and physical resources, as well as conflicting interests in individual and community expectations from the involvement in development projects [35].

As seen in the case of Zwelisha settlement in Durban, the establishment of a Community Development Committee (CDC) increased the impact of community leadership, assisted in mediating between the city and the residents and made the upgrade process smoother to operate [36]. It has been argued that the issue of infrastructure upgrading and provision does not lie in the lack of funding, but in the lack of human capital. There is often a lack of knowledge within the public sector on how best to engage with informal settlement dwellers to not only understand their needs, but also get their buy-in and ensure sustained participation in upgrading efforts.

2.3. Infrastructure provision

Infrastructure provision has been identified as one of the means to dealing with the triple challenge of poverty, inequality and unemployment. Post-Apartheid South Africa is dealing with updating and providing infrastructure to meet the demands of a growing population that has increased by 15 million since 1994 [37]. The state's commitment to improving infrastructure is clearly spelt out in the National Infrastructure Plan [38] with a commitment of R827billion [39]. The plan sets out the state's approach to building new and upgrading existing infrastructure which includes health care facilities, schools, water, sanitation, housing and electrification. This forms part of the National Development Plan 2030 which aims to systematically tackle the triple challenge mainly resulting from the apartheid segregation policies [38].

The debate on citizens 'right to the city' is still ongoing with the argument that all citizens have a right to stay in the city as enshrined in the South African constitution [40]. However, post-apartheid, the economic segregation continues to define human settlements. The urban poor have been able to access health care, education, and other social infrastructure, but access to housing has been limited and slow despite various governmental departments' drive to meet the ever-increasing housing demand [41].

Many urban poor find themselves locating on vacant land, often susceptible to flooding, or other hazards, erecting makeshift shelters close to existing water and sanitation services. For example, in Durban the Quarry Road settlement is partly located on a road reserve and flood plain, while the Havelock informal settlement is located on private property and a portion within the Durban Metro Open Space System. Other settlements are located on state owned or privately-owned land [42]. The dwellings are increasingly more vulnerable to flooding due to climate change and poor waste management systems [43].

Breaking the cycle of poverty in urban settings requires an understanding of how multiple deprivations compound on each other, with a need to broaden the framework for measuring poverty. Essentially, this means spreading indicators of poverty beyond income measures [44] to include quality of housing stock, access to infrastructure and basic services, costs of basic goods and the ability to participate in political systems. The provision of appropriate integrated infrastructure services in urban informal settlements has a knock-on impact on socio-economic indicators such as health, education, income and housing [45,46]. A qualitative study on informal settlements in India and South Africa during initial stages of upgrading shows that residents value and perceive water and sanitation infrastructure to be a critical need [47]. More recently, Ntema et al. [48] have examined perceptions of residents in Freedom Square (Bloemfontein) and identified urban management, which includes physical infrastructure, as an important component for informal settlement upgrading.

There has also been a tendency of providing infrastructure services in a random and haphazard manner in informal settlements with a lack of integration of services [49]. Holistic infrastructure interventions, which focus on improving environmental conditions and cover a wider range of infrastructure services, are likely to result in long-lasting benefits [50]. Van Noorloos et al. [51] also argue that integration should be viewed from a lens of community-led incremental participatory practices at both individual (household) and neighbourhood (community) levels. A comparative study of two settlements where environmental assessments and broader interventions were implemented in one of the settlements demonstrated better outcomes in terms of improved infrastructure in the community [52]. Projects driven by environmental assessments in informal settlements are more likely to effectively improve conditions. The integration of services is not just a design challenge but requires harmonisation between policies and governmental departments for upgrading projects [53] which aligns with a more integrated settlements approach. Therefore, there is a case to be made for integrating service provisions for water, sanitation, waste management, electricity and roads within the upgrading processes.

2.4. Informal settlement upgrading policies in South Africa

The current approach to informal settlement upgrading in South Africa is focused on incremental upgrading as a step-by-step process where municipality provides communal services [17]. Networked services are provided in the case of a full upgrade which includes subsidised housing and services though often this approach has been proven to be financially unsustainable (ibid.). Depending on the suitability of the land, informal settlement upgrading can include in-situ upgrading and interim services programme (prefabricated ablution blocks with toilets and water points). Though experiences of using communal facilities is significantly different from using household-level services. Previous studies have shown the social risks associated with reliance on communal services especially for the most vulnerable [8].

The prioritisation of infrastructure services is reflected in the shift in policies with the revision of housing policy in the early 2000s to spark more inclusive and holistic informal settlement upgrading with emphasized inclusion and participation through the UISP [16]. The upgrading process includes in-situ upgrading, keeping as many structures as possible in their original position with a focus on a broad range of infrastructure services through interim or permanent engineering solutions to address environmental vulnerability and offering social inclusion [16]. The National Housing Code (2009) provides for the UISP, which includes incremental upgrading and encourages participation in the upgrading process [54].

The South African Housing Development Agency [55] identified four main categories of developmental response to address basic infrastructure and housing needs:

1. *Full upgrading* which includes full services, top-structures and formal tenure (i.e. formalisation) where appropriate, affordable and viable (category 'A').
2. *Interim basic services* (leading to eventual formalisation), where informal settlements are located in viable and appropriate areas but where such formalisation/full upgrading is not imminent (a situation which often prevails) (category 'B1').
3. *Emergency basic services* for informal settlement where the full upgrading is considered not viable but relocation is not urgent or possible (a situation which also often prevails) (category 'B2').
4. *Relocations* as a last resort for settlements affected by urgent health or safety threats, which cannot be mitigated, and an alternative relocations destination is readily available (category 'C').

Overall, the government is moving away from housing delivery as the main upgrading response (given the financial and temporal unsustainability of the process) and shifting towards a more rapid, participative and incremental approach based on the in-situ provision of basic services to informal settlements along with basic, functional tenure [55].

2.5. Infrastructure policies in Durban

South Africa comprises of eight metropolitan municipalities, the eThekwini metro is the only one in KwaZulu-Natal east of South Africa. eThekwini municipality comprises of five regions with a combination of rural and urban communities. The city of Durban, which is predominantly urban, is administered by the eThekwini municipality and has a population of 3.8 million [56]. There is a clear spatial separation of residential areas and economic activities as people do not generally live in the area where they work [57]. Generally, the urban poor in Durban maintain strong connections to the rural areas of South Africa, where they might have emigrated from, which means that they often regard their 'urban' home as transient (ibid.). This affects the willingness to invest in their communities and local/community politics have come into play at grassroots with instances of resistance to new development projects when those projects are presented in a technical language.

eThekwini Water and Sanitation unit (EWS) is responsible for the provision of water and sanitation services. The unit has over the years shown a concerted effort to include public participation in decision-making [57].

The Department of Water Affairs (DWA) is responsible for forming and implementing policies to protect water resources, ensure equitable provision of water services, water licensing and sanitation. Provision of water in informal communities is achieved through a water storage tank or a standpipe within 200 m of every household as prescribed by DWA to be the basic level of potable water. The water storage tank or standpipe is located at the boundary of the settlement or along an established path for operational reasons. Similarly, ablution blocks for sanitation are also to be located within 200 m of every household, in line with the DWA recommendations. In informal settlements where incremental services are provided, a Community Ablution Block (CAB) is connected to municipal waterborne reticulation. Each CAB consists of toilets, showers, and clothes washing facilities. Where no connection to waterborne reticulation is available, chemical ventilated improved pit (VIP) toilets are provided and are emptied as and when required by the municipality at no cost to the settlement inhabitants.

Attempts to introduce low-water and environmentally friendly sanitation initiatives to achieve sustainability and minimise natural resource consumption is challenging when the affluent parts of Durban city use water intensive solutions such as water flush toilets. The disparity is evident in the overall quality of infrastructure and housing rather than just in sanitation between the two groups, but often 'sustainable' solutions have made lower income neighbourhoods feel as though they are saving resources for wealthier communities to use. One of the solutions to address this issue are CABs, but questions have been raised about women's and children's safety in using the system, indicating that the latrines are not accessible to all members of the community equally. Perception of risk by itself influences how women use such public facilities as demonstrated by a qualitative study of users in India [58]. Hence, there are trade-offs between social aspirations and environmental resources that eThekwini will need to broker as they install sanitation services to meet the growing urban demand. Examples such as Cape Town's "Day Zero" campaign in 2018, where the Mayor declared severe restrictions in light of the water level in major dams lowering and countrywide drought, demonstrated to the public that water is a scarce resource and emphasized the urgent need to design and implement water and sanitation technologies to conserve water.

Durban Solid Waste (DSW), the cleansing and solid waste department of eThekwini municipality is responsible for solid waste management in Durban City. The Municipality Integrated Waste Management Plan (2016) of DSW stipulates the need for households weekly waste collection. The report specifies that in formal residential areas this collection should be done by DSW-owned vehicles, but in informal settlement areas the collection is done by private contractors hired by the DSW. These private contractors are known as Community Based Contractors (CBCs). The utilisation of CBCs is useful, as they are familiar with their collection area, and the collection method creates employment within low-income communities. However, there is little evidence of ongoing monitoring and evaluation with this method. For domestic waste, the DSW provides different colour bags for waste storage. Currently, garden refuse and other organic material goes into landfill in Durban [59]. Within informal communities, recycling usually occurs at an individual level as a way of generating income, mostly through plastic and cardboard collection and selling.

eThekwini Electricity, the licensed electricity distributor of eThekwini municipality with its policies determined by the National Energy Regulator of South Africa (NERSA), has also embraced the government's Free Basic Electricity programme, first introduced in 2003, which provides first 65kWh free and the balance of up to 150kWh at a reduced tariff to indigent customers [72]. According to a Durban government representative, due to the nature of informal settlements, being compact and irregular in construction, the municipality is required to ensure that electrical infrastructure has a higher standard of safety with one of the biggest barriers being the accessibility in terms of both landowners' approval and the residents' participation. In reality, electrical connections tend to be makeshift and precarious, with the responsibility of power cuts falling on the residents.

3. Case study: Havelock

Havelock is an informal settlement located 8 km from Durban city centre, with an estimated 200 households and more than 400 residents (Fig. 1). The settlement, originally established more than 30 years ago (1986), sits on privately owned and municipality owned land (see Table 1).

A detailed enumeration of the settlement was planned to commence from December 2019 but was postponed due to a fire which destroyed the entire settlement. This demonstrates the high level of vulnerability of Havelock, which is characterised by several hazards, such as illegal electrical connections, dangerous electrical cables sprawled across paths, fire hazards and flooding.

This is also typical of most informal settlements in Durban which face barriers such as the topography with steep terrain (Fig. 2), as well as the conflictive nature of the settlement with its neighbours and the location on partly public, partly private land, which impacts on the ability for long-term planning.

The EWS installed two CABs on the Sanderson and Havelock access routes (Fig. 1) for both male and female residents in response to the number of households in the settlements. These blocks are supposed to be regularly cleaned and managed by members of the community with the support of the municipality. However, their conditions are not always adequate. One ablution block is situated across the stream, which floods frequently and has a makeshift bridge going over it. There is a clothes washing facility and a drying area near the second ablution block, which is also close to the stream. Despite weekly waste collection, rubbish is dumped into the stream with items such as dirty diapers posing risk of spreading diseases. A pile of solid waste is also frequently seen above the sewer line. Hardly any vegetation grows between the dwellings other than bushes near the ablution block and a food garden at the lower end of the site near Sanderson Road. One bush used to be a vegetable garden, but now is highly dangerous due to the electrical wiring going through it. Similarly, access routes and paths within the settlement are narrow, steep, slippery and with electric cables posing a hazard of electrocution and raising risk of sparking fires. Scrap tyres are used to improve pathways, especially during rainy season, which is when they become slippery and often unpassable.

Havelock revealed some signals of community participatory initiatives and community leadership, which were among the critical factors for the choice of the settlement as a case study for this research. In 2012, with the assistance of the Informal Settlements Network (ISN), the settlement conducted an in-depth enumeration[2] of the shacks. Willingness to engage in participatory processes has been demonstrated by the residents who were able to mobilise with the assistance of ISN and Community Organisation Resource Centre (CORC) through the South Africa SDI Alliance, to develop a community savings scheme and other service related community projects, such as the nursery and recycling of glass bottles.

Havelock has been subject to several minor episodes of fires since 1999, further exacerbating its vulnerabilities. The last major incident in December 2019, which burned down the whole settlement. There was an enumeration exercise planned for December 2019 to update the previous one which has now been postponed.

4. Methods

Mixed methods were used for data collection to enable a strong understanding of both the socio-cultural systems and environmental challenges and impact on day-to-day life. The overall project data collection covered three communities in Durban (see [62]) out of which the informal settlement of Havelock is covered in this paper. For selecting the case studies, the authors looked at factors such as community leadership, presence of an active Non-Governmental Organisation (NGO), nature of historical

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[2] The community self-enumeration and settlement profiling encourages a common understanding and dialogue between community members which goes beyond data collection. The survey includes door to door surveys, GIS co-ordinates of dwellings, identification of skills, existing amenities and condition of infrastructure services.

Fig. 1. Drone map of Havelock informal settlement.
Source: Loggia & Govender [60].

Table 1
Havelock facts.
Source [61] adopted from eThekwini municipality records (2017).

Havelock facts	
Ward	34
Planning unit	Greenwood Park
Region	Northern
No of structures	227 (2012), 294 (2017)
Landowner	Private
Zoning	Duplex 900
Zoning	Existing residential/DMOSS
Time established	15–20 years
First settler	1986

development and community willingness to participate in upgrading projects. Through discussions with eThekwini municipality, a long list of settlements was developed from which Havelock was selected as one of the non-serviced settlements which not only fulfilled the criteria of selection but where SASDI Alliance had a presence and active engagement with the residents.

Stakeholder interviews were conducted with nine representatives from eThekwini municipality, leading academics and technical experts through face-to-face meetings at their offices in June 2018 (Table 2).

A range of tools[3] such as focus group discussions, priority mapping and seasonal calendars were targeted specifically to women. Ten women participated in a focus group to discuss environmental challenges and opportunities. This discussion was held within the settlement in a community building and led by local community researchers who were trained by the project team. Out of those ten participants, six women also participated in a priority mapping exercise to identify community priorities and filled out a tabular seasonal calendar to identify seasonal challenges. Time was a barrier so all ten participants of the focus group discussion were unable to complete the priority mapping exercise. The strategy of including local community researchers enabled the team to work closely with the community and clearly communicated the purpose of the research. The tools were translated in Isizulu to ensure wider participation from all with the community researchers well versed in the language. The team carried out a series

of transect walks to visually observe environmental features and changes, and finally 50 household (HH) interviews were conducted. The participating households were selected randomly through convenience sampling. In addition to exploring the demographic profile of the participants (gender, age, occupation, income, HH size), survey questions covered the following areas: solid waste management, recycling activities, farming, water and grey water use, flooding, access to sanitation and access to electricity.[4] The fieldwork was carried out in three phases between May 2017 to June 2018 and ethical clearance was obtained both at the University of Westminster in the UK and at the University of KwaZulu-Natal in Durban, South Africa.

5. Conceptual framework

For the purposes of our case study's analysis, we adapted the sustainable – affordable habitat framework developed by Nair et al. [11] which consists of four components making up a sustainable habitat: socio-cultural, economic, technological and environmental factors. The framework offers an opportunity for a comprehensive examination of the critical factors required for the development and preservation of sustainable habitats. We focused predominantly on the environmental factors and mapped out the interlinkages between those and the factors under the other three domains. As our study's focal point is sustainability in environmental upgrading and management in ISU, we did not consider sustainability and affordability equally. Nevertheless, we recognized the critical role affordability plays in ISU, particularly given the low-income profile of informal settlement dwellers, such as is the case in Havelock. In our study, we grouped socio-cultural factors into adaptability, equality, integration of services, self-help housing and community participation; economic factors into pre-requisites, shelter needs and affordability, resources (as pre-requisites), and procurement of building materials; technological factors into feasibility, functionality, strength and durability; and three groups of environmental factors which lie at the centre of our analysis: proper planning, healthy environment and infrastructure. Given the scope of the study, we simplified and adjusted this domain to the three broad categories by eliminating renewable and non-renewable resources and material efficiency as no data

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[3] Templates available from the authors upon request.

[4] Interview schedule available from the authors upon request.

Fig. 2. The challenging terrain in Havelock (May 2018).
Source: authors.

was collected on those components deeming their inclusion in the analysis infeasible.

Fig. 3 below demonstrates the final adaptation of the proposed framework.

6. Results

6.1. Demographic profile

The average age group of the respondents who participated in the household interviews (*n* = 50) was 33 years with 76% of respondents having secondary education. The average household comprised of two adults and 0.5 children with 24% of respondents renting their shacks, confirming the migratory nature of the community. Circa, 40% of the residents were employed in a range of informal and temporary jobs. Other studies in Havelock suggests that residents are engaged in entrepreneurial activities such as petty trading selling cigarettes, cool drinks and other household items, while others are engaged in providing needed services, such as child

Table 2
Stakeholder informant interviews conducted.

Interview code	Role/title	Organisation
I-A	Project Manager of Green Corridor	eThekwini municipality
I-B	Manager for Catchment Management	eThekwini municipality Coastal, Stormwater and Catchment Management (CSCM)
I-C	Strategic Executive Water and Sanitation	eThekwini municipality
I-D	Senior Lecturer	School of Built Environment and Development Studies, UKZN
I-E	Head	Khanyisa Projects and Aqualima Trust
I-F	Senior Manager: Strategic Support	Umgeni Water
I-G	Senior Planning Officer	eThekwini Water and Sanitation
I-H	Professor	School of Architecture, Planning and Geomatics, University of Cape Town
I-I	Project Coordinator	Durban City Council for Bridge City KwaMashu Open Space Project

minding [61]. Over 50% of respondents felt very connected to their community, with an overall positive feeling about the community spirit and connectedness.

In terms of income generation, five respondents did not declare their range of income and only one respondent fell into the highest R4001–5000 (approx. £212–265) bracket. No respondents declared incomes higher than R5000 (£265) per month implying that most residents fall in the low-income bracket (Figs. 4 and 5).

6.2. Environmental hazards

Transect walks highlighted the risk and adequacy challenges with regard to water and sanitation, solid waste management, electrical connections and flooding. Among the top issues in Havelock are health and safety hazards, referring to day-to-day living conditions, illegal electric wiring and high risk of fire (see Section 6.3.3). The shacks are built densely from unconventional materials, some of which are easily flammable, e.g. untreated timber, clothing materials, plastics and cardboard, and often share roofs and walls [61]. Storm water runs between the dwellings from Havelock road towards the stream at the lower end of the settlement, threatening the already unstable structures. Unpassable paths and contaminated areas, particularly around the stream, can cause accidents, as can the unpassable bridge during heavy rains. Fieldwork showed that there was a strong interest in developing opportunities for urban farming though access to water and availability of land were noted among key barriers [62].

Periodical heavy rains pose flooding risk in Havelock due to the poor quality of the settlement, which is built close to the stream and has clogged drains. Flooding has been reported to occur in 86% of the sampled houses in Havelock affecting households in different ways (Figs. 6 and 7).

Houses across the whole settlement frequently get flooded during the rainy season, with the houses near the stream being the most affected. Used tyres and other scrap materials are used on pathways to improve accessibility during rains and to avoid stepping on the electricity cables, which pose a serious threat of electrocution and fires. Additionally, residents also wear plastic boots or slippers to ensure safety from the cables lying on the ground. The stream cleaning efforts have been carried out in Havelock in order to improve the flow of water after heavy rains. What is more, at times of particularly heavy rains the water goes over the makeshift
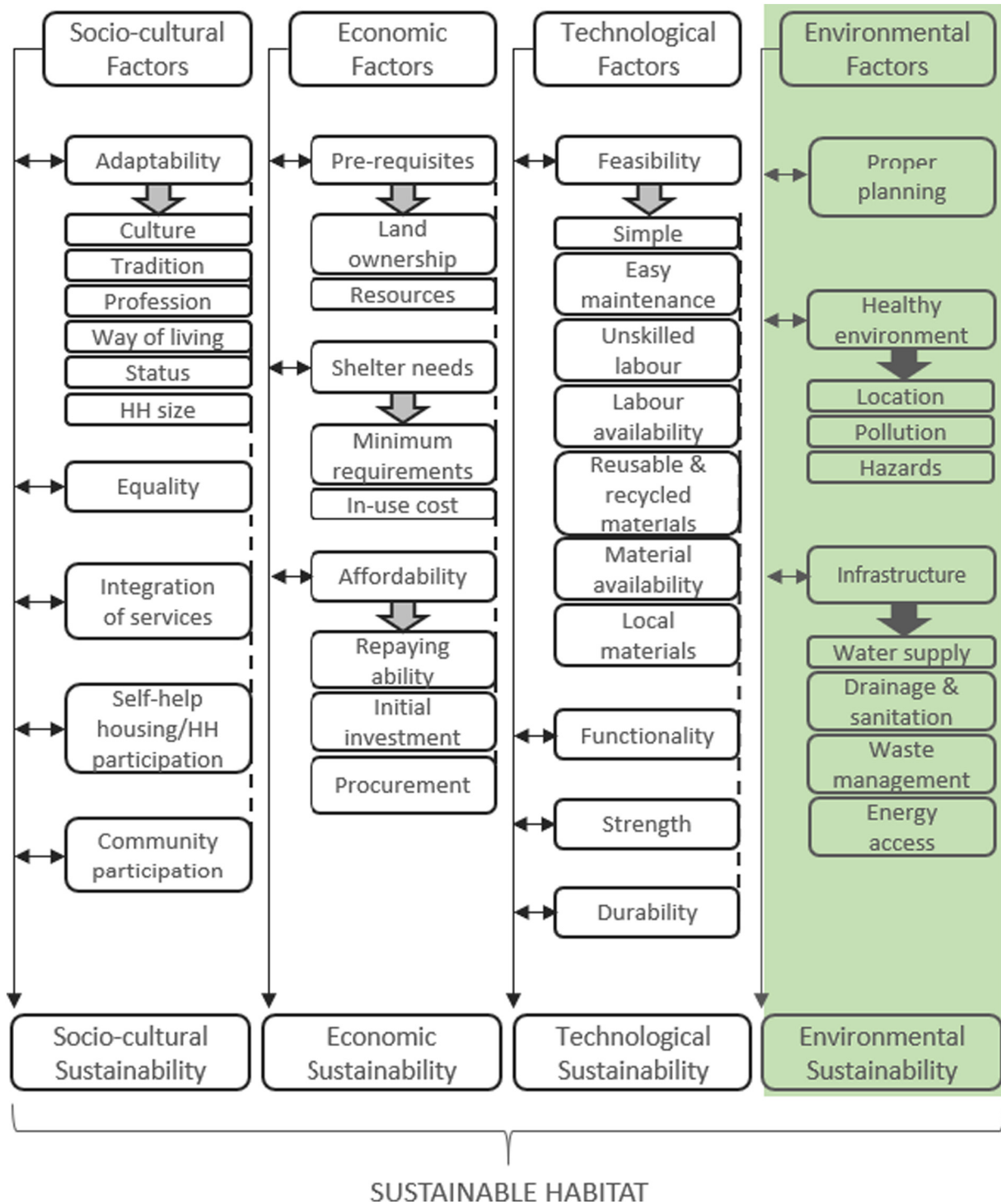
Fig. 3. The sustainable – affordable habitat framework (adapted from [11]). The focal point of the study (environmental factors) is marked in green and has been adjusted according to the scope of the study. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

bridge, posing a serious challenge for access into the settlement. The stream catchment area also suffers from the presence of unsecured cables. Flooding damages are typically severe with furniture getting wet, forcing the residents to store it outside, blocking the pathways; clothing getting destroyed; mud covering the floors and making it difficult to clean up, effectively making the living conditions perilous. In worst cases, roofs or walls collapse, and personal possessions are washed away. Residents experience additional challenges caused by flooding, namely the inability to walk to the CABs as

the stream overflows, covering the bridge and making it impossible to cross it to reach the facilities. Affected houses spend anything between R80-R3000 (£4–£160) to recover, however, often they do not have any expenditure associated with the fixing of damages as they either do it themselves, get help from the community or from the municipality. Those who are able to pay get help from contracted workers and source material from the local hardware stores, or find scrap materials around the settlement or nearby areas. Price, quality, durability (in terms of water tightness),
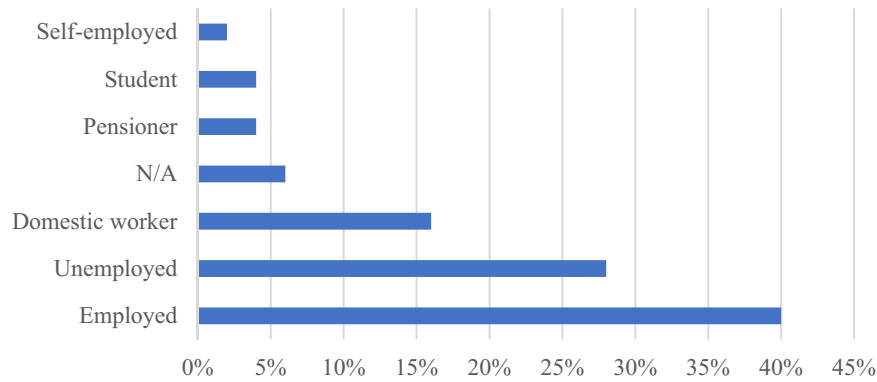
Occupation

Fig. 4. Occupation patterns in Havelock.
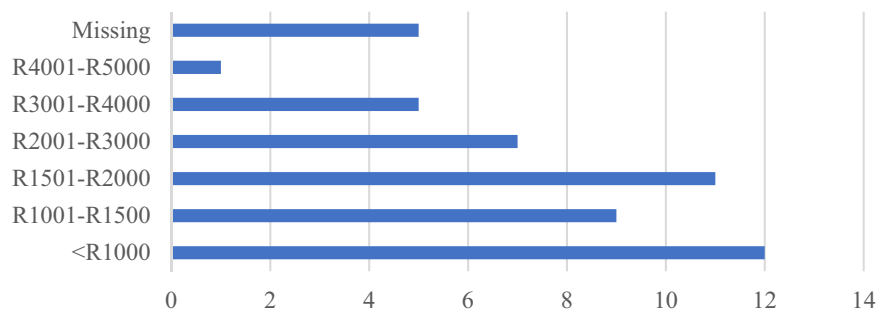
Income

Fig. 5. Household income in Havelock.

cost (affordability), and safety are key attributes when sourcing external building materials. Overall, there is a need for both flood adaptation measures, such as early warning systems, resilient housing and infrastructure, and mitigation measures, including cleaning of local streams and water resource management at basin level.

6.3. Infrastructure priorities

Priority ranking conducted with women's groups exposed that water, housing (top structures) and energy were identified as the top three high priority issues among the residents, with water ranked number 1 and

Impact of flooding on Havelock's residents

Fig. 6. Flood risk and its impact on the residents.

Fig. 7. Flood in Havelock (April 2019).
Source: authors.

Fig. 8. Priority mapping in Havelock.

housing ranked number 2, reflecting the poor housing stock and living conditions in the settlement (Fig. 8). Water supply and toilets within the dwelling were highly desirable. Energy access was identified as the third priority as electricity connections in the settlement are illegal and unreliable, and the erratic nature of supply means that electrical appliances get damaged during power surges. Regarding seasonal challenges, the residents noted instances of water shortages in June and July due to no rains. The same months were also identified as months with high-electricity consumption due to the need for heating which is mostly provided through electric heaters.

6.3.1. Water and sanitation

There are no household toilets in Havelock and water has to be fetched from the ablution blocks, which have a 24-hour water supply. Families typically use 20 L buckets, or recycled paint containers, and collect water from the CABs, making as many as 2–5 trips per day. The location of the CABs at the top and the bottom of the hill makes it challenging to collect water. Both men and women are involved in the collection though women are the ones making sure there is always enough water in the house. Water is heated in electric kettles or on paraffin stoves for cooking and bathing purposes. The water supply at the CABs is regular and generally reliable, and focus group respondents felt that they had enough water to satisfy their household needs. However, some women expressed a desire to have hot water baths in their houses rather than having to use the municipal showers, particularly during the cold winter months, indicating aspirations higher than what the current level of service provision is.

Regarding sanitation, residents use the CABs that are open between 5 am and 10 pm. If residents want to use the blocks after hours, they

need to find the caretaker to open the locks. There is currently more than one caretaker in the settlement. The eThekwini municipality built the CABs in April 2016 to replace dated toilet containers. Current CABs also use a containerised structure and come with a public tap in the middle with 12 taps. The female toilets contain four WC cubicles and two shower cubicles, along with a washbasin with two taps. Generally, no issues with the units have been reported by the focus groups participants, however, no cleaning products and no toilet paper were noticed during the transect walk and the streetlight behind the toilet had been disconnected by the municipal corporation as it was illegal, leaving no lighting near the ablution block. Residents are willing to pay for toilets in their houses, which they would prefer for reasons of convenience and safety at night. This mirrors the results from the household interviews where safety was seen as the top challenge followed by CABs' servicing and cleanliness (Fig. 9).

The perceived advantages and disadvantages of public toilets is highlighted in Fig. 10. In Havelock, where reliance on public toilets is the most prevalent, public toilets' most important advantages are good servicing and free use. The lack of privacy and long queues are seen as disadvantages of public toilets. The community appeared to be divided on the issue of cleanliness with nearly 80% of residents highlighting the frequent cleaning of toilets as an advantage but then circa 30% of residents citing cleanliness as a disadvantage. There is a need to work closely with the community to discuss the potential for individual water and sanitation services or further improved services that will boost safety and comfort.

6.3.2. Solid waste management

Nearly 82% of the household interviews respondents expressed satisfaction with the municipal solid waste management systems. However,

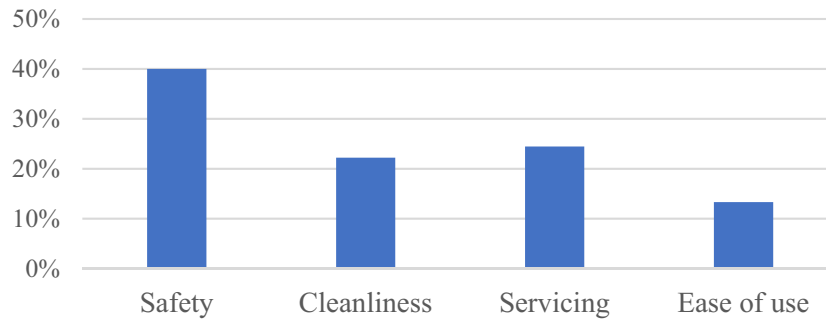## Sanitation facilities: challenges

Fig. 9. Challenges with sanitation facilities in Havelock.

transect walks and focus group discussions revealed challenges. With organic waste being dumped near the ablution blocks by the stream when bins are full, rats have become a problem, posing a significant health risk. Solid waste is also disposed of in the stream including diapers and other items, which pose risk of contamination. The accumulating waste further exacerbates flood risk. Residents living in nearby houses have to clean up the stream themselves (Fig. 11).

Only 20% of respondents acknowledged that they segregated waste and only 18% recycled waste. While there is awareness of recycling, the lack of such behaviour could be attributed to the fact that recycling facilities are not adequate. The settlement has been experiencing problems with recycling of bottles with private recyclers not always coming to pick them up which results in piles of glass bottles being accumulated near the stream. Recycling is mostly done by waste pickers who earn a living from segregating solid waste (bottles, plastic, cardboards, cans etc.), collecting it either from designated places where community members dispose of those recyclables, or picking it up from around the settlements, and selling it to private dealers. There is an informal disposal area for waste and construction material at the entrance of the settlement. Discussions with the residents highlighted the need for more frequent collection of waste,

support for recycling activities on site and improved links with local businesses to provide livelihood opportunities linked to waste management.

However, in the construction of the dwellings 80% of material supply follows a free material flow to the community through Havelock road (e.g. wood panels, clothing and mud). These are cheap, reclaimed materials from dumps and from the local networks of contacts and are used for building the shacks and making any improvements. Only 15% of primary source materials are purchased externally, mainly obtained as by-products of the nearby construction, manufacturing and waste industry. This lifecycle thinking about building materials and ways of improving the physical conditions of the houses was in contrast to the status quo of a temporary settlement, as a community leader claimed, "we know that we will not be [in] here for the rest of our lives".

6.3.3. Electricity

There is no legal electricity provision in Havelock; however, the community members have drawn illegal connections from neighbouring formal housing or streetlights. This represents one of the biggest challenges, putting dwellers at high risk of electrocution and fire. The eThekwini municipality was preparing to electrify Havelock as part of their developmental
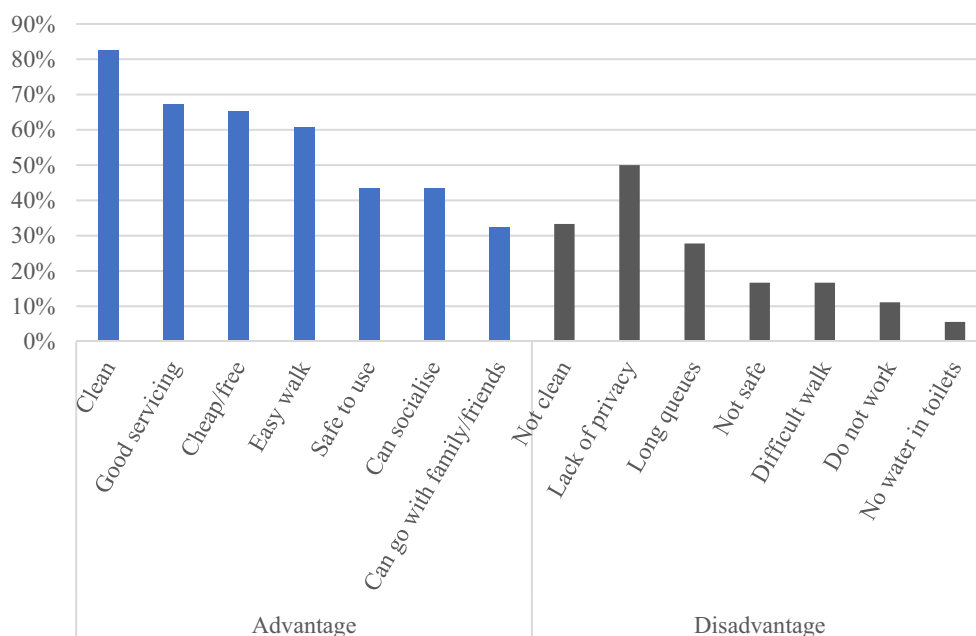
Perception of public toilets

Fig. 10. Advantages and disadvantages of public toilets in Havelock.

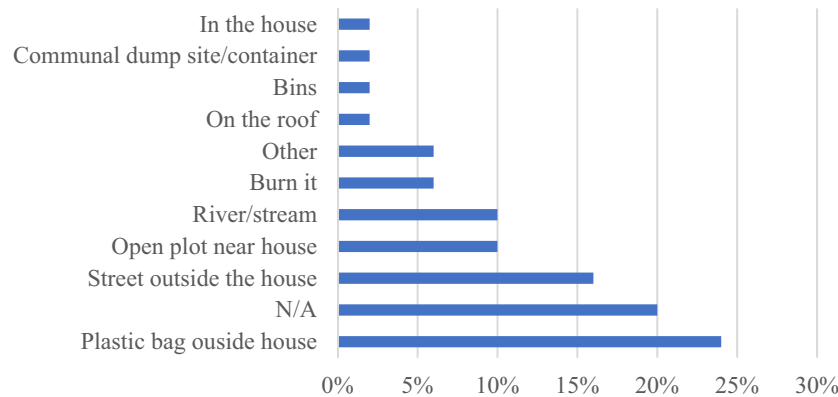## Disposal of uncollected waste

Fig. 11. Solid waste disposal in Havelock.

plan but the fire in December 2019 has delayed the work and now electrification will need to follow the new housing layout.

Circa 74% of respondents in Havelock reported having electricity access in their household. Other major source of energy is paraffin, which is used for cooking and heating [63]. Illegal wiring results in casualties and presents a large monthly cost as municipality cuts connections up to twice a month, forcing settlement dwellers to pay large amounts every time disconnections occur (Fig. 12).

Households predominantly rely on illegal connections for which they do not pay, other than for the (informal) connection fee to the person who provides it, which often is expensive and ranges R250-R800 (£13–42). Additionally, if there are issues with the power lines or any damages, the residents are also responsible for paying for those, which they tend to do as a group (collect money and purchase necessary parts together). Such incidents happen frequently during the rainy season. Electrical cables can be found spread on the ground around the settlement, which has caused electrocutions and deaths in the past, and poses a serious risk not only for the residents (many of whom are concerned about the safety of their children) and the added risk of fires.

Electricity is used to power fridges, TVs, kettles, irons, microwaves, stoves, cell phones, lights, radios, hair dryers, toasters, fans, mosquito killers, etc. A large proportion of the sampled houses own a mobile phone (86%), televisions (72%), lamps (62%) and radio (52%). Very few houses use electric heaters (~10%). The electricity supply is unreliable with power cuts sometimes lasting as long as three days. Fluctuation in voltage causes damage to appliances and residents then need to get them repaired which usually costs around R20 (~£1) per appliance. When asked about getting a legal connection to the grid network, focus group participants

expressed willingness to pay for prepaid cards but not for metered connections, as they were worried about high bills. The participants also expressed interest in underground cables to be provided by eThekwini municipality to reduce the risk of fires and electrocution. If the housing consolidation were tied into a statutory upgrading process and formal upgrading plans, formal electrification would potentially materialise.

6.4. Mapping the linkages

Through the application of the sustainable-affordable habitat framework and the mapping of interlinkages between the four domains that make up its building blocks, the study demonstrates that there is a case to be made for environmental upgrading to improve living conditions and address the residents' challenges faced in their day-to-day lives.

The results show strong direct links between environmental factors and the socio-cultural, economic and technological domains of a sustainable habitat. The two-way relationship between proper planning, healthy environment and infrastructure- all which are faced with challenges in the case of Havelock, and the other building blocks of the framework, points towards the existence of several interdependencies which can either facilitate or hinder sustainable habitat creation and maintenance. They are mapped out in Fig. 13 below. It is important to note that the framework is process (rather than product) driven; hence, it can offer solutions to different communities through diversified responses. Depending on the type of habitat and its dynamics, the relationships and linkages can be more or less pronounced, or non-existent.

Proper planning, which can entail both co-design with residents and formal municipal planning, can easily occur if land ownership is clear and
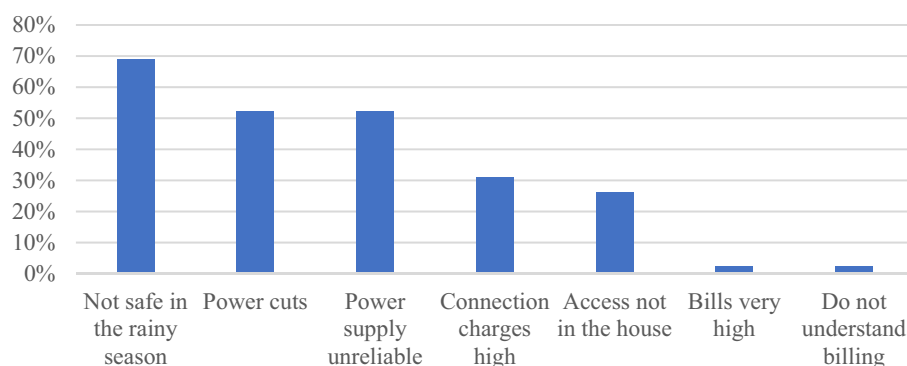
Electricity challenges

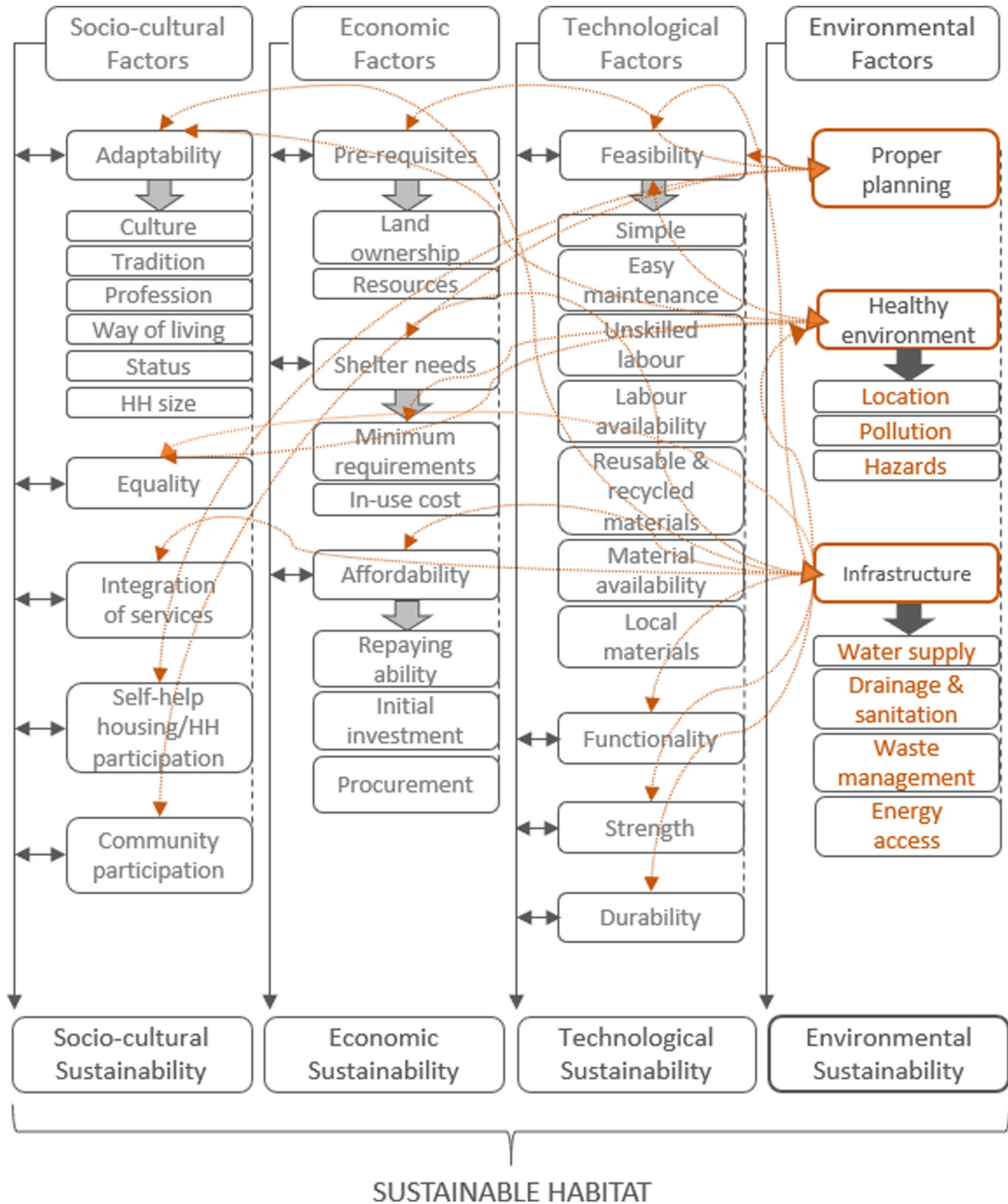

Fig. 12. Challenges with electricity in Havelock.

Fig. 13. Mapping the linkages through sustainability factors – an adaptation of the sustainable – affordable habitat framework. (Adapted from [11].)

legally regulated, and when well-defined resource allocations are committed. The residents of Havelock have experienced land ownership issues and conflicts with residents of adjoining formal sites, which have limited the ability to move forward with re-blocking schemes. Due to municipality's scarce resources, given the number of informal settlements they have to consider and support, and the associated backlog of informal settlement upgrading, availability of economic resources has been insufficient to meet the needs of the settlement and all of its residents.

While progress has been impeded by factors such as land rights and ownership, community efforts to conduct in-situ, participatory upgrading has shown prominence and resulted in incremental improvements across the settlement, including in terms of the state of housing and the successful negotiation for the provision of services. However, as affordability remains a challenge, given the low-income profile of the households in Havelock, not all community members have been able to benefit equally, with some relying solely on reclaimed materials of poorer quality than those able to procure from external providers. In future upgrading scenarios, potential building materials in Havelock would have to be simple, easy to procure and ideally available locally, while also fire- and water-proof so as to protect from fire hazards. Additionally, issues of access to water and sanitation

facilities, which depend on where in the settlement the household is located, aggravate existing inequalities, disproportionately impacting the vulnerable groups, such as children and the disabled. While there has been provision of CABs, existing challenges also include safety, especially for women at night given the poor lighting around the facilities. Location also dictates exposure to susceptibilities such as flooding as dwellings closer to the stream have a higher probability of being affected while those towards the top of the settlement suffer less overall. These factors associated with inadequate planning result in perilous living conditions posing health and safety risks. The informal electricity network further exacerbates them as the existing electrical connections are not safe to use especially during the rainy season and flooding which occurs frequently due to the lack of clear storm water paths and poor solid waste management systems. Ongoing environmental challenges are also impacted by events such as the recent fire (December 2019) which damaged nearly all structures in Havelock. The lack of easy access to water during that incident and hence a rapid spread of fire throughout the settlement brought to the forefront the critical role of appropriate services.

Integrated environmental improvements which bring together improved flood risk and solid waste management combined with provision of underground electricity cables and improved, individual water and sanitation services could significantly ameliorate the overall state of the settlement and the living conditions of its inhabitants. When basic infrastructure needs are met, residents are then able to shift their focus to higher order aspirations, such as education and employment [50]. Adequate, quality and integrated infrastructure plays a crucial role in building healthy environments and communities. It can positively impact on both the socio-cultural domain of a sustainable habitat, boosting adaptability and equality, as well as economic and technological factors, particularly the meeting of (at least basic) shelter needs and strength and durability, which are important in building household resilience to hazards. Most informal settlements are subject to multiplicity of hazards which will require both mitigation and localised adaptation measures to further enhance community resilience.

Aside environmental challenges, Havelock faces other issues which hinder the upgrading process and therefore the status of infrastructure. These include lack of community cohesion and mutual trust, resulting in antagonistic attitudes within the settlement; and lack of continuity of capacity and skills building, especially in younger generations. Training on areas such as construction, urban farming and waste disposal should be offered to leverage the participation of residents. In return, community members could be better equipped to more efficiently participate in the upgrading process and assume more leadership in decision making regarding housing needs, service integration and the overall feasibility of any undertaking [64–66]. Even though low-skilled labour is available in the settlement, co-design which incorporates skills that are more technical could contribute to faster and context-appropriate design of infrastructure solutions, which could better match the residents' needs, while also building long-term sustainability and buy-in [67]. The lack of skills, however, does not apply solely to the communities involved. Patel [36] has discussed the lack of skills and capacity also at the municipality level, which reinforces unequal power relations that may not serve or be relevant to all community groups and individuals.

There are also socio-cultural attitudes of the inhabitants, many of whom see Havelock as a temporary home rather than a permanent one, which refers to the traditional ways of living and makes it difficult to exert long-term commitment and planning in participatory design activities, and to maintain continued engagement. Despite this, there is a clear (expressed) need to improve the living conditions in the settlement which, if achieved, could shift community members' perceptions towards seeing it as a more permanent habitat option. The links between environmental, socio-cultural, and technological factors thus highlight how crucial acceptance and co-design processes are to achieve desired sustainability outcomes and to ensure feasibility of proposed solutions. Issues such as accessibility, in terms of the location – distance from dwellings, safety- accessibility at night, and consideration of different groups- accessibility for disabled people and children, are among critical factors that will ensure the efficacy of selected solutions, all of which should be adapted to residents' specific needs and circumstances [68]. This, in turn, will warrant a satisfactory maintenance of the facilities, which has been a challenge in Havelock and other informal settlements [69,70]. This is also where participatory digital solutions, such as community led GIS-based data collection and drone collaborative mapping techniques, could be utilised to conduct participatory planning, and monitor and evaluate the performance of existing services.

Overall, the mapping exercise demonstrates the wide-ranging impact of environmental factors on socio-cultural, technological and economic factors illustrating the potential for substantial gains if interventions included holistic environmental improvements.

7. Conclusions

This study highlights the need for environmental upgrading through community-led-processes for the achievement of sustainable habitats where residents' needs and aspirations are prioritised and mainstreamed in the decision-making. This requires local communities to fully participate, engage and co-lead decisions on the provision of infrastructure services. Our study also highlights gaps in operation and maintenance of facilities resulting in sub-standard service delivery, health and safety risks and daily challenges, which can compromise the fulfilment of basic needs of settlement residents. Gaps in various services in Havelock demonstrate the need and value in harmonising infrastructure interventions across multiple departments. Municipalities will need to work closely with local communities and groups to improve the quality of services installed and subsequent maintenance of services. There is a lack of understanding about the dynamics of informal settlements and there is a need for integrating and coordinating all the interventions from the different departments of the municipality, with a recognition of the role healthy environments and functioning infrastructure play in building socio-economic well-being of low-income households. As infrastructure shows the highest number of interconnections between and within the four sustainable habitat pillars, it can be an effective enabler for unlocking the potential of communities.

In conclusion, rapid urbanisation has led to high growth of informal settlements with inadequate services. Municipalities such as eThekwini face the challenge of rapidly scaling up infrastructure provision in informal settlements to meet the increase in demand and the need to conserve environmental resources. Moving forward, municipalities need to be enablers working closely with local communities to co-develop and jointly drive the process of in-situ upgrading. Given the scale of the challenge, partner stakeholders, such as academia and community-based organisations can act as a bridge between local communities and local authorities by mapping the condition of infrastructure, assessing needs and aspirations of communities and using this evidence to leverage support for future interventions. NGOs and community-based organisations also have a valuable contribution to make in supporting community-led processes for enumeration and advocacy. To ensure a successful upgrading project, strong multi-stakeholder partnerships and interdisciplinary collaborations will play a critical role in order to overcome the current backlog in municipal upgrading activities and help speed up the process. Within in-situ upgrading there is an opportunity to integrate housing and infrastructure needs to offer opportunities for the development of social fabric, such as access to job opportunities, livelihood development, health facilities, schools and public transport.

The lack of political will can affect all domains of a sustainable and affordable habitat, and is a key factor, and a pre-requisite, in driving citywide incremental participatory upgrading. The application of the conceptual framework and the mapping of interlinkages among the four pillar domains show that there is a need for greater integration and coordination between infrastructure provision, social development and government departments for successful service delivery and housing upgrades. Alignment of interventions with community priorities is essential to ensure uptake and sustenance of services in the long term.

CRediT authorship contribution statement

Priti Parikh: Conceptualization, Methodology, Validation, Writing - original draft, Writing - review & editing, Supervision. **Iwona Bisaga:** Methodology, Validation, Data curation, Formal analysis, Writing - review & editing. **Claudia Loggia:** Conceptualization, Methodology, Writing - review & editing, Supervision. **Maria Christina Georgiadou:** Conceptualization, Writing - review & editing, Supervision, Project administration, Funding acquisition. **Judith Ojo-Aromokudu:** Writing - review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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