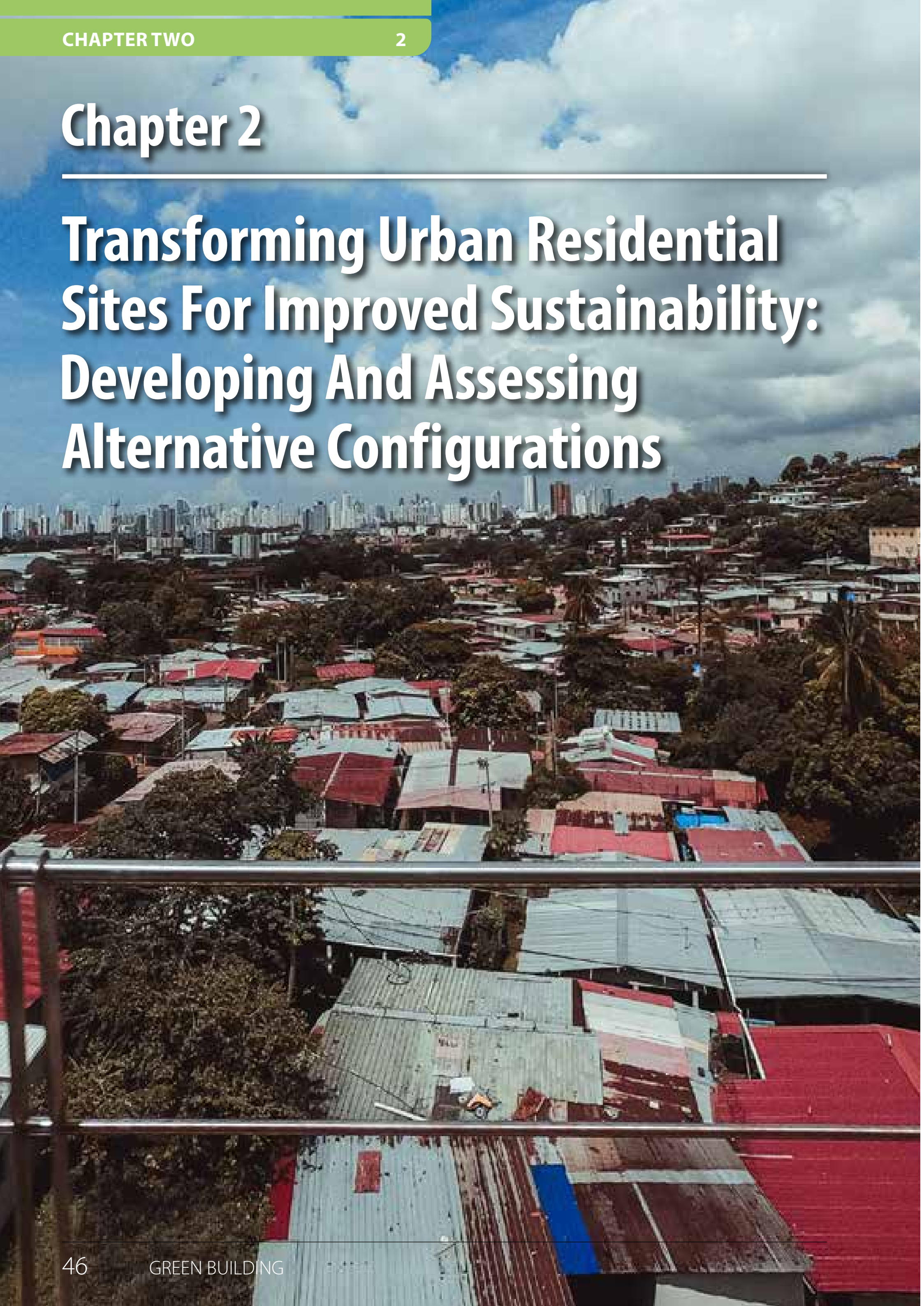


Chapter 2

Transforming Urban Residential Sites For Improved Sustainability: Developing And Assessing Alternative Configurations

1.0 Introduction

Africa is urbanizing rapidly. In 1960, 20% of the population lived in urban areas. By 2010, 40% of the population lived in urban areas and annual urban growth rates of 4 to 5% are projected (United Nations Environment Programme, 1999; United Nations Centre for Human Settlements, 2002). Housing programmes have not been able to keep up with this growth, resulting in large informal settlements, which are estimated to accommodate 62% of the urban population (UNHabitat, 2014).

Rapid urbanisation is evident in South Africa where housing backlogs are estimated to be 2.2 million households (Department of Human Settlements, 2019). Projections indicate that demand for housing in cities will continue to grow and that there is a particular need for affordable rental accommodation close to work (Department of Human Settlements, 2019).

South Africa has committed to achieving the Sustainable Development Goals (SDGs) by 2030. The SDGs consist of 17 developmental goals covering areas such as climate change, water, energy, housing, health and education. South Africa's progress in terms of the Sustainable Development Goals is being tracked by Statistics South Africa (Statistics South Africa, 2019). A selection of the SDG targets and progress relevant to urban and built environments are presented in Table 1.

Table 1 shows that South Africa experiences high levels of poverty and youth unemployment and a significant proportion of the population live in informal settlements. It also indicates that while the provision of water, electricity and sanitation has improved, backlogs still exist and that the use of renewable energy is low.

Achieving the Sustainable Development Goals (SDGs) in South Africa will require a concerted effort and for all sectors of the economy to play their part. The construction and building industry can support the achievement of the SDGs by increasing employment and self-employment opportunities, addressing housing backlogs and developing mixed-use settlements with sustainable energy, water, waste and sanitation systems. Achieving these objectives in existing urban residential sites is explored in this study. The study has the following parts. First, a methodology for the study is provided. Second, results from the study are presented. Third, results from the study are discussed. Finally, conclusions and recommendations are drawn.

2.0 Methodology

The study explores how sustainability performance can be improved in existing urban residential sites in South African cities. It does this by describing an existing case study site and assessing its sustainability performance. Alternative arrangements for the site are proposed and described and their sustainability performance assessed. Comparing and analysing the results of the two assessments is then used to evaluate and comment on the value of the different built environment configurations and elements. These steps and the assessment methodology is described in more detail below.

SDG Target	Current progress
1.1.1: Proportion of population below the international poverty line, by sex, age, employment status and geographical location (urban/rural)	25.4% (2006), 26.3% (2009), 16.4% (2011), 18.8% (2015)
6.1.1: Percentage of population using safely managed drinking water services (percentage of population)	Safely managed: 77% (2015), 75% (2016), 80% (2017)
6.2.1: Percentage of population using safely managed sanitation services, including a hand-washing facility with soap and water	Basic service: 67% (2015), 68% (2016), 70% (2017)
7.1.1: Proportion of population with access to electricity	93.12% (2014), 92.89% (2015), 94.12% (2016), 95.27% (2017)
7.1.2D: Percentage of the population that uses solar energy as their main source of energy (domesticated indicator)	Cooking: 0.1% (2014), 0.1% (2016) Lighting: 0.3% (2014), 0.5% (2016) Heating water: 0.8% (2014), 0.6% (2017) Heating space: 0.2% (2014), 0.1% (2017)
7.2.1: Renewable energy share in the total final energy consumption	14.56% (2013), 15.16% (2014), 26.2% (2015)
8.5.2A: Youth (15–34 years) unemployment rate	35.7% (2010), 35.9% (2014), 35.8 % (2015) ,37.6% (2016), 38.7% (2017)
11.1.1D1: Percentage of urban population living in informal dwellings	11.3% (2014), 12.7% (2016), 12.2% (2017)

Table 1. South Africa's performance in terms of Sustainable Development Goals (Statistics South Africa, 2019).

2.1 Identification and description of the case study area

This step presents the case study site and the neighbouring area and describes characteristics relevant to sustainability performance.

2.2 Sustainability assessment of the case study site

An assessment of the case study area is carried out using the Sustainable Building Assessment Tool (SBAT) (Gibberd, 2001). The Sustainable Building Assessment Tool (SBAT) aims to assess the sustainability performance of buildings by measuring the extent to which built environment characteristics required to support sustainable living and working patterns exist in a building or a design of a building.

Built environment characteristics measured in the SBAT are based on a definition of sustainability that includes both minimum quality of life (defined using the Human Development Index developed by the United Nations) and environmental limitations (defined with reference to the Ecological Footprints and the earth's carrying capacity) (Loh, 2000; Gibberd, 2017). SBAT indicators used to measure performance are derived from environmental, economic and social sustainability objectives shown in Table 2 (Gibberd, 2017). Under the Criteria heading, codes such as EN1 are the references used in the SBAT Excel tool. [See Table 2]

SBAT assessments are carried out by evaluating the site and building using criteria shown in Table 2. Assessment data captured in the tool generates scores and the graphic reports shown in Figures 5 and 9, with a '5' indicating very high potential sustainability performance and '0', very low performance (Gibberd, 2017).

1. Proposed interventions to improve the sustainability performance of the case study site

The results of the assessment are used to propose interventions to improve sustainability performance. These interventions are presented and described.

2. Sustainability assessment of case study site with proposed interventions

An assessment of the case study area (proposed) with proposed interventions is carried out using the Sustainable Building Assessment Tool and the performance presented in terms of the 15 sustainability areas from the tool.

3. Discussion

The results of the two assessments (existing and proposed) are reviewed and analysed to ascertain the value of the proposed interventions in terms of sustainability performance and support for the achievement of the Sustainable Development Goals. This discussion leads to the Conclusions and Recommendation of the study.

Category	Area	Objective	Criteria
Environmental	Energy	The building is energy efficient and uses renewable energy.	EN1 Orientation, EN2 Building Depth, EN3 Roof Construction, EN4 Wall Construction, EN5 Floor Construction, EN6 Window to Wall Ratio, EN7 Ventilation openings, EN8 Daylight, EN9 Internal Lighting, EN10 External Lighting, EN11 Installed Equipment Power Density, EN12 Food Cooking, EN13 Water Heating, EN14 Renewable Energy Generation
	Water	The building minimises the consumption of mains potable water.	WA1 Toilets, WA2 Wash Hand Basins, WA4 Showers, WA5 Hot Water, WA6 Landscape, WA7 Rainwater harvesting
	Waste	The building minimises emissions and waste directed to landfill.	WE1 Recycling Area, WE2 Recycling Collection, WE3 Organic Waste, WE4 Sewage, WE5 Construction Waste
	Materials	Construction impacts of building materials are minimised.	MA1 Building Reuse, MA2 Timber Doors and Windows, MA3 Timber Structure, MA4 Refrigerants, MA5 Volatile Organic Compounds, MA6 Formaldehyde, MA7 Locally Sourced Materials
	Biodiversity	The building supports biodiversity.	BI1 Brownfield Site, B14 Municipal Boundary, BI3 Vegetation B14 Ecosystems
Economic	Transport	The building supports energy-efficient transportation.	TR1 Pedestrian Routes, TR3 Cycling, TR3 Public Transport
	Resources	The building makes efficient use of resources.	RE1 Site Density, RE2 Area per occupant RE3, Renewable Energy Generation, RE4 Food Production
	Management	The building is managed to support sustainability.	MN1 Manual, MN2 Energy Metering, MN3 Water Metering, MN4 Recording, MN5 Residents Association
	Local Economy	The building supports the local economy.	LE1 Locally Sourced Materials and Products, LE2 Small Enterprise, LE3 Construction Workers Support
	Services and Products	The building supports the use of sustainable products and services.	SP1 Fruit and Vegetables, SP2 Bakery Products, SP3 Beans and pulses, SP4 Milk and Eggs, SP5 Clothing, SP6 Furniture, SP7 Equipment Hire, SP8 Notice Board
Social	Access	The building supports access to facilities.	AC1 Internet Access, AC2 Banking, AC3 Groceries, AC4 Post Office, AC5 Creche, AC6 Primary Schools
	Health	The building supports a healthy and productive	HE1 Exercise, HE2 Health facility, HE3 Fruit and Vegetables, HE4 Bean and Pulses, HE5 Milk and Eggs, HE6

Table 2. Sustainable Building Assessment Tool Categories, Areas, Objectives (Gibberd, 2017).

Figure 1. Location of the case study area in Pretoria, South Africa (Google Earth, 2021)

Figure 2. Aerial photograph of the case study area in Pretoria (Google Earth, 2021)

3.0 Identification and description of the case study area

The case study area is a centrally-located suburb in Pretoria. This is shown as the red rectangle in Figure 1 and is South East of the city's CBD. [See Figure 1]

The site area is shown in more detail in Figure 2. This shows that the sites are generally between 800 and 1,400m2 and have large free-standing houses, outbuildings, garages and some have swimming pools. [See Figure 2]

The area is largely residential, although some commercial properties face onto the main road to the North of the site, as shown in Figure 3. [See Figure 3]

Figure 4 shows a plan and section of the case study site. The numbers in the drawings are referenced in brackets in the text. This shows the 753m2 site (3), a 153m2 free-standing house (2) and a garage and out-buildings of 37m2 (4). The site has a swimming pool (1) and frontage onto a neighbourhood road that runs North-South (5). The site is sloping and is terraced with lawns and shrubs as shown in the section in Figure 4. The house is occupied by 2 people. [See Figure 4]

4.0 Sustainability assessment of the existing case study site

Sustainable Building Assessment Tool (SBAT) assessments of the existing and proposed

Figure 3. Maps of the case study area showing the buildings (on the right) and zoning (on the left) (City of Tshwane, 2021).

arrangements can be used to understand the significance and value of different built configurations and elements in terms of sustainability. In the reviews below, SBAT areas are referred to in capital letters, for instance, "Local Economy", with the detailed criteria for each area being available in Table 2. SBAT scores for the different arrangements are read off the SBAT reports shown in Figures 5 and 9 with a '5' indicating very high potential sustainability performance and '0', very low performance (Gibberd, 2017).

A sustainability assessment of the case study site was carried out using the Sustainable Building Assessment Tool (SBAT). The results of the assessment are shown in Figure 5. This shows a score of 1.7 is achieved. [See Figure 5]

Figure 5. Sustainable Building Assessment Tool results for the existing house and site.

A score of 1.7 indicates low performance and a review of Figure 5 indicates that the existing buildings perform poorly in terms of Energy, Water, Waste and Materials. However, the large garden with indigenous trees results in an improved score for Biocapacity. The site is well provided for with side-walks and has bus stops and a railway station within a walking distance of 400m, resulting in a good Transport score. The low density of the site (between 20 and 30 persons/ha) and the space use of the building (above 70m2 per person) results in it achieving a poor performance in the Resource area.

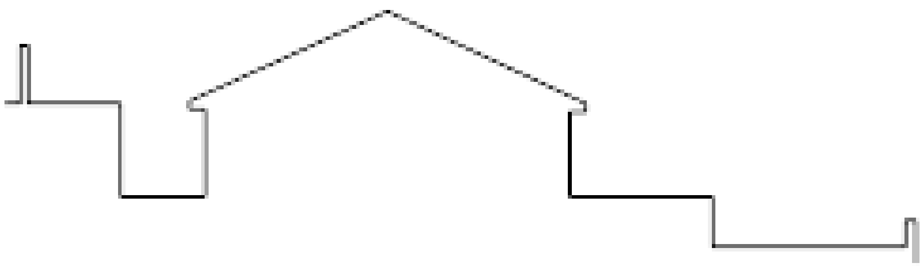
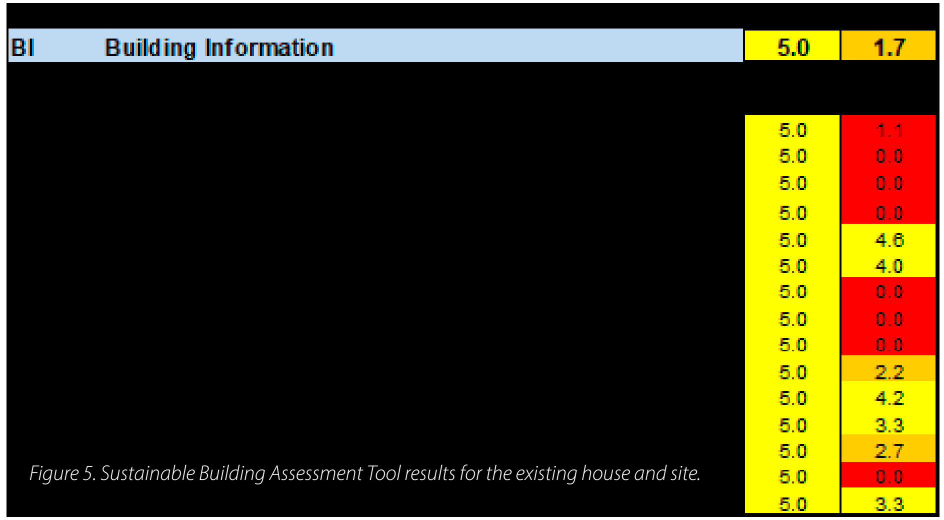


Figure 4. Plan and section of an existing situation showing a freestanding house, swimming pool, double garage and road.



BI	Building Information	5.0	1.7
		5.0	1.1
		5.0	0.0
		5.0	0.0
		5.0	0.0
		5.0	4.6
		5.0	4.0
		5.0	0.0
		5.0	0.0
		5.0	0.0
		5.0	2.2
		5.0	4.2
		5.0	3.3
		5.0	2.7
		5.0	0.0
		5.0	3.3

Figure 5. Sustainable Building Assessment Tool results for the existing house and site.

A lack of support for efficient management of the building and a lack of provision for local enterprises leads to low scores in the Management and Local Economy areas. The site is within walking distance of a small shopping centre, parks, clinics, schools, creches and post offices leading to higher scores with the Services and Products and Access SBAT areas.

5.0 Proposed interventions to improve the sustainability performance of the site

A review of the SBAT performance of the existing site and building in Figure 5 show that performance is low in nearly all of the SBAT areas. Therefore, a new built environment configuration and elements are proposed for the same site. Outline plans and sections of this are shown in Figure 6 and items referenced in brackets in the text. This shows vegetable and fruit gardens in the centre of the site (1), overlooked by apartments (2), behind the apartments is a service area for energy, water and recycling systems (3), facing the road (5) are commercial units (4). [See Figure 6]

The approach is based on a 24m2 modular unit that can accommodate commercial use or a range of different accommodation types. This is shown in Figure 7. From the left, the examples show a retail unit or fast food outlet, a cycle repair or hire shop, a retail unit (for instance for fruit and vegetables) and an internet café. To the right of this are accommodation

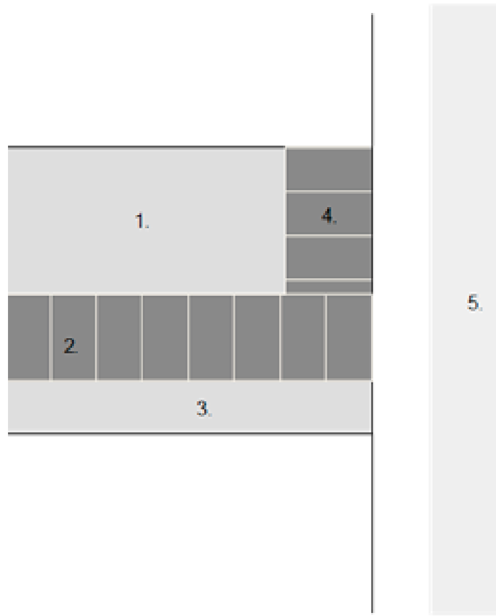


Figure 6. Plan and section of the proposed development showing commercial units opening on to the road and apartments above these and to the interior of the site.

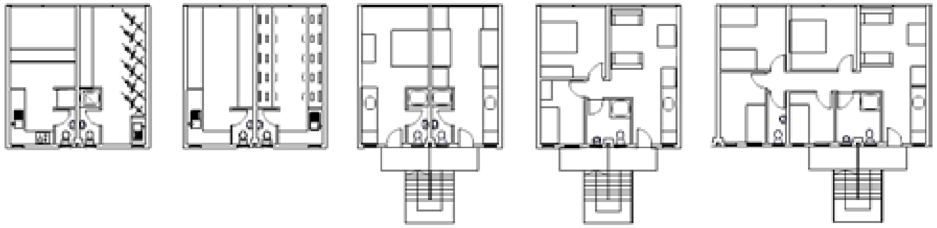


Figure 7. Modular plans showing commercial units and different apartment layouts.

options consisting of 1-bed, 2-bed and 4-bed units. [See Figure 7]

The buildings are designed to be energy efficient and have passive cooling and heating systems as well as LED lighting and equipment as shown in Figure 8. A photovoltaic system with panels on the roof (5) and batteries in the service area provides power to the accommodation (2).

Solar hot water systems provide hot water to the accommodation (4). A greywater system captures water from showers and reuses this to flush toilets. Rainwater is captured from hard surfaces and stored in underground tanks (1). These systems are installed and operated by small enterprises. Metered connections for each of these services provide sustainable funding for the installation, maintenance and upgrading of these systems (6) (Gibberd, 2019). Gardens in the centre of the site can be used to grow vegetables, herbs and fruit for the commercial units (greengrocer, or fast food unit) or the apartments (8). Functions accommodated in the commercial units are deliberately selected to support sustainability performance and therefore include the following types of activity: greengrocer, a small food retailer and bakery, a cycle repair and hire shop, an internet café with courier, post and business services, a tailor and furniture and maintenance enterprises. [See Figure 8]

6.0 Sustainability assessment of case study site with proposed interventions

An assessment of the proposed building and site was undertaken using the SBAT. The results are shown in Figure 9. This shows that a score of 4.2 has been achieved. [See Figure 9]

A score of 4.2 indicates that the proposed built environment configuration and elements have the potential for strong sustainability performance. A review of Figure 9 shows that performance in all areas is around 4.0 or above this except for Inclusion. The interventions enable an improvement from 1.7 for

Figure 8. Section of the apartment block and service systems.

BI	Building Information	5.0	4.2
[redacted]			
		5.0	4.2
		5.0	4.5
		5.0	4.0
		5.0	4.5
		5.0	4.2
		5.0	4.0
		5.0	5.0
		5.0	5.0
		5.0	5.0
		5.0	3.9
		5.0	4.2
		5.0	5.0
		5.0	4.1
		5.0	2.5
		5.0	3.3

Figure 9. Sustainable Building Assessment of the Proposed Arrangements

	Existing	Proposed
Environmental	1.1	4.3
Economic	1.2	4.6
Social	1.9	3.0
SBAT Rating	1.7	4.2

Table 3. SBAT Performance of the Existing site and Proposed site.

the existing buildings and site to 4.2 in the proposed new site arrangements and buildings, as shown in Table 3.

Environmental sustainability performance has improved from a score of 1.1 to a score of 4.3. This has been achieved through renewable energy, greywater and rainwater harvesting and waste recycling systems in the building. Indigenous and vegetable planting on 40-50% of the site has been used to maintain biocapacity performance.

Economic sustainability performance improves from a score of 1.2 to a score of 4.6. This has been achieved through higher densities, with over 150 persons/ha and accommodation of 10-19m2 per person being achieved. Efficient resource and land use including vegetable gardens and renewable energy plants also contribute to performance. Effective management systems and submetering systems further increase performance in this area. Finally, the inclusion of commercial units, onsite service enterprises and the specification of locally sourced materials and products support the Local Economy objective and enhance economic sustainability performance.

Social sustainability performance improves from 1.9 to 3.0. This has been supported through specifications and design that include high levels of daylighting, natural ventilation and healthy material specifications. However, aspects of the proposed development related to the multiple-storey design, modules with limited space and the sloping site result in it not achieving some Inclusion criteria. Similarly, a lack of local facilities in the neighbourhood reduces Social Cohesion scores. This results in a lower social sustainability score compared to the environmental and economic sustainability scores.

7.0 Discussion

A review of the results indicates that the approach appears to offer significant potential for improving the sustainability performance of the site and creating positive impacts. The new arrangement can accommodate around 40 people, support 5 small enterprises and employ 10 people, compared to the existing situation which accommodates 2 people and does not support onsite employment or small enterprises. Proposed urban density exceeds minimum sustainability minimums defined by the UNHabitat of 150person/ha and are higher than densities for Barcelona (171persons/ha), Ho Cho Minh City (150person/ha), Cape Town (32 person/ha) and Johannesburg (53person/ha) but lower than some Asian cities (UNHabitat, 2014a; Malpezzi, 2013).

Sustainable energy, water and waste systems have been integrated into buildings on the site and are installed and maintained by small enterprises. This creates local jobs, enables carbon emissions and waste to be reduced, and enhances resilience and business continuity as they are largely off-grid.

The inclusion of small commercial units on the site which provide energy, water, recycling, mobility, communication and health services as well as products such as healthy affordable low-ecological footprint food significantly enhance sustainability performance of the site as they create small enterprises and employment while enabling more sustainable living and working patterns (Gibberd, 2019).

The methodology however does not support high performance in the Inclusion area, and it appears that the approach needs to be adjusted for this. This could include reviewing designs to ensure accommodation was more inclusive.

More space and lifts where these are required.

The methodology could also be refined to include a greater emphasis on neighbourhood interventions. This could support the establishment of community organizations and facilities to improve performance in the Social Cohesion area. Neighbourhood interventions could also include energy micro-grids and neighbourhood rainwater harvesting and waste recycling schemes that could improve sustainability performance more cost-effectively than site-only systems.

The SBAT assessment results can also be reviewed in terms of the SDG goals as shown in Table 4. This shows that the approach appears to be effective in addressing all of the SDG targets identified. It successfully addresses both environmental targets, such as the generation of renewable energy as well as social and economic targets such as poverty, unemployment and improved access to housing, clean water and electricity. [See Table 4]

8.0 Scaling up the application of the methodology

Given that the methodology appears to show promise as a means of improving sustainability performance and achieving the Sustainable Development Goals, how easy would it be to implement and undertake at scale? How would the proposed systems work, and be maintained in practice?

First, the methodology is applied to a single residential site. This enables rapid implementation as there is a single owner and there would not be a need to purchase and develop multiple sites. However, the density and the functions proposed for the site may require changes in local zoning and planning regulations which could be justified by demonstrating improved efficiencies and social and economic impacts, such as increased access to housing and work opportunities. An interesting aspect of the proposed approach is the lack of provision for car parking which is replaced by local access to services and products and local mobility enterprises that provide transportation services in the form of ride-hailing services and rentable bicycles/ebikes. Again, this would be a distinct departure from current practice but could be justified by demonstrating beneficial impacts such as reduced congestion and increased local employment, walking and cycling.

Second, the approach demolishes the existing buildings and would generate construction waste. However, landfill impacts could be minimized by reusing masonry waste in the foundations of the new building. The design approach also retains the site terracing and avoids major cut and fill of the site. This reduces site disruption and provides the potential to retain mature indigenous vegetation and trees. Existing neighbourhood roads, pavements, electricity, water and sewer systems would all be retained, reducing costs and disruption.

Third, the modular design of accommodation lends itself to prefabrication, enabling low-waste, rapid construction processes. If carried out at scale, this can be a fast, cost-effective method of constructing significant numbers of apartments and commercial units, enabling housing backlogs to be addressed and employment opportunities to be created (Shahzad et al., 2015). The use of bio-based materials for prefabricated units could be used to stimulate agricultural industries and avoid carbon

SDG Target	Current progress	Aspects of proposed built environment configuration that support this SDG
1.1.1: Proportion of population below the international poverty line, by sex, age, employment status and geographical location (urban/rural)	25.4% (2006), 26.3% (2009), 16.4% (2011), 18.8% (2015)	Increased employment and self-employment opportunities, increased availability of affordable accommodation and food
6.1.1: Percentage of population using safely managed drinking water services (percentage of population)	Safely managed: 77% (2015), 75% (2016), 80% (2017)	Reduced consumption of mains potable water, increased use of rainwater harvesting, onsite water storage in case of shortages.
6.2.1: Percentage of population using safely managed sanitation services, including a hand-washing facility with soap and water	Basic service: 67% (2015), 68% (2016), 70% (2017)	Sanitation services available to large numbers of people.
7.1.1: Proportion of population with access to electricity	93.12% (2014), 92.89% (2015). 94.12% (2016), 95.27% (2017)	Onsite electricity generation through PV system, onsite energy storage in batteries.
7.1.2D: Percentage of the population that uses solar energy as their main source of energy (domesticated indicator)	Cooking: 0.1% (2014), 0.1% (2016)	Systems can be designed to enable 100% cooking energy needs to be met from renewable systems.
	Lighting: 0.3% (2014), 0.5% (2016)	Lighting energy requirements can be met from PV systems.
	Heating water: 0.8% (2014), 0.6% (2017)	All hot water requirements can be met from solar water heaters.
	Heating space: 0.2% (2014), 0.1% (2017)	Passive environmental control systems aim to achieve comfort through the year without mechanical means.
7.2.1: Renewable energy share in the total final energy consumption	14.56% (2013), 15.16% (2014), 26.2% (2015)	Systems can be designed to support 100% renewable energy share of final consumption.
8.5.2A: Youth (15–34 years) unemployment rate	35.7% (2010), 35.9% (2014), 35.8 % (2015) ,37.6% (2016), 38.7% (2017)	Increased employment and self-employment opportunities, increased support for education and learning.
11.1.1D1: Percentage of urban population living in informal dwellings (domesticated indicator)	11.3% (2014), 12.7% (2016), 12.2% (2017)	Increased availability of affordable housing in well-located sites which can be used to reduce informal dwellings.

Table 4. A review of the Site Sustainability Transformation methodology in relation to the Sustainable Development Goals

emission and mining impacts associated with steel and cement-based construction (Amziane and Sonebi, 2016; Martinez, 2017; Chippagiri et al., 2021).

Fourth, renewable energy systems, greywater, rainwater harvesting, and recycling systems can be operated by onsite service enterprises and installed at their expense. This reduces the capital cost of the development. It also supports the development of highly efficient systems which are well maintained by small enterprises who depend on these for their income. As systems are not owned by the building owner but are owned by onsite service enterprises there is an incentive to invest in these as better technology becomes available, enabling sustainability performance to be improved over time (Gibberd, 2019).

Fifth, the approach includes small commercial units that can accommodate small enterprises that contribute directly to improved sustainability operational performance. This can be illustrated by the following examples. Having a small greengrocer that has fresh, locally produced, affordable, vegetables, fruit eggs and milk close to accommodation would encourage occupants to buy this instead of travelling by car or public transport and purchasing processed food from supermarkets. This would provide the following benefits; lower carbon emissions associated with food, reduced obesity and better health because of better diets and exercise, local employment and enterprises created by producing and selling food, reduced carbon emissions and pollution by avoiding car travel, a reduced requirement for cars and car parking freeing land for other uses and reduced farming input costs, landfill impacts and carbon emissions from using compost created from organic site waste rather than artificial fertilisers. The multiple benefits of the approach illustrated above could be calculated and factored into the business case for the approach (Gibberd, 2020).

2 CHAPTER TWO

Finally, the study highlights where the approach is not effective at improving sustainability performance. These are in areas associated with Inclusion, Social Cohesion and Access which include criteria that relate to the design and space allowed in buildings and to the location and neighbourhood within which the site is located. Shortcomings in Inclusion performance could be dealt with a design that had a focus on universal design and an increased space provision. The current module area of 24m2 keeps capital and ongoing cost low, are aligned with Tiny House standards and achieve SBAT Resource Use criteria (International Code Council, 2021). However, it may be valuable to carry out design exercises to ascertain whether slightly more generous space provision and design innovations could improve Inclusion performance.

Access and Social Cohesion performance could be improved through programmes that transformed the local neighbourhood at the same time as sites and buildings. These programmes would focus on ensuring that all of the facilities that supported healthy living and working patterns were within easy walking distance of the accommodation. Also, neighbourhood interventions should focus on developing programmes and shared facilities that support increased social cohesion. Kyttä et al. (2016) confirm that there is a link between social sustainability and higher urban densities as increased density shortens distances to everyday services and contributes to higher perceived environmental quality. However, Bramley et al. (2009) make the point that while residential satisfaction, stability, neighbourhood environment, and safety are shown to improve with higher densities, this is also dependent on social and demographic factors.

9.0 Conclusions and Recommendations

The study aimed to address the urgent need to find methodologies and solutions that can be used to improve the sustainability performance of urban areas and contribute to the achievement of the Sustainable Development Goals. The proposing Site Sustainability Transformation methodology provides a structured way of assessing existing sites and buildings, developing sustainable options and testing and evaluating these. Its application in a case study to an urban residential site in Pretoria indicates that there appears substantial potential to improve the sustainability performance of sites by changing the configuration of built form, introducing off-grid technologies and diversifying the activities accommodated on the site. Proposed changes appear to contribute to the achievement of the Sustainable Development Goals. As an exploratory investigation, the study provides a useful methodology and proposals on how the sustainability performance of an urban residential site in South African cities can be improved. Further, detailed investigations of the methodology and proposed solutions are recommended.

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