Sustainable Rural Development Through Generative Design

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Abstract:

South African apartheid laws between the 1940s to the late 1980s kept black families in poor rural areas, formally known as Bantustans, which weren't considered part of South Africa. Only young men were allowed to move to cities, where they were used as valuable labor. After the end of apartheid in the mid-1990s urbanization increased rapidly. This led to further poverty in rural areas as very little development took place, limiting economic opportunity. We will look at how this lack of action impacted the Rural Eastern Cape and what sustainable development solutions can be applied to provide more inclusive development solutions.

We analyze the current development conditions in the rural Eastern Cape and learn from them, we look at the current sustainable development conditions in urban areas and how design interventions can be extrapolated for improved development methods in rural areas, using existing data to provide generative design solutions in the long term. Generative design is an iterative design process involving a program that will generate a certain number of outputs that meet certain constraints. It will assist in refining feasible solutions that are contextually relevant and achieve the following: Provide sustainable design solutions to reduce a need for retrofitting in the future developments, improve quality of life and minimize rural migration by providing a comprehensive method of producing easily interpreted sustainability guidelines that can be applied in various conditions for the best possible design development strategy.

1. INTRODUCTION

When looking at the rural Eastern Cape in South Africa, the current approach to development is reactive instead of proactive and presents little opportunity for purpose-driven intervention. This results in superimposing conventional development practices that have been seen to be ineffective in urban areas; the introduction of the RDP model is an example of how a traditional solution that has been applied in cities but has not managed to address the housing crisis fully, has been used in rural areas to combat increasing population (Makgetla 2010). The rural eastern Cape presents a unique opportunity to redefine urban spatial planning as rural areas develop and more people seek to leave the cities.

This paper will investigate the possibility of implementing generative design solutions in the rural context and identify how well-considered development practices could improve people's lives and reduce migration in these areas.

The concept of generative design is to use an iterative design process that involves a program that will generate a certain number of outputs that meet certain constraints and a designer that fine-tunes the feasible region by selecting specific results or changing input values, ranges, and distribution. This process is predominantly used as an efficient method of exploring design possibilities used in various design fields to reach design goals that are better defined over time.

Generative design is a design exploration process; the process is focused on identifying the end goals and setting parameters, limitations, and spatial requirements that will result in the best outcome or design solution. Using a generative design approach in Urban Planning would focus on identifying and considering the local conditions, building typologies, existing codes, and regulations and focus less on the specifications of the final project or intervention. The outcome is a result of the non-linear design process, which responds to a series of contextual urban factors instead of schematic intentions that can be superimposed in any context.

A generative design approach tells us that we cannot know in advance what the best solution might be or what the outcome might look like and challenges designers to focus on a critical analysis of the area, its people, their needs, the contextual shortcomings, and opportunities to develop a solution and ultimately a proposal.

With the above understanding in mind, we have identified a need to explore how this process can be used to create data-driven design solutions at a high level by using easily accessible data to drive sustainable solutions by selecting contextually relevant interventions. The interventions can, over time, become a matrix of guidelines that can be used across governing bodies within rural areas in the Eastern Cape for a more directed development approach.

The data which can be deemed easily accessible as a test bed to start building algorithmic parameters that may assist in identifying which interventions are more likely to be successful in developing a sustainability masterplan can be categorized into the following:

Social:

Employment Rate, Crime statistics, population density, Level of Education in the region, teenage pregnancy, the mortality rate

Natural:

Rainfall data, Solar data, wind data, relative humidity, dry-bulb temperate

Physical:

Landscape, landmarks, building typology, infrastructure (sanitation, power, roads)

The designer/ end user can modify the above parameters to best pick from a sitting database of sustainability interventions which assists the designer in shortening time in identifying a relevant design approach to start solving the problem, and it will equally eliminate unnecessary interventions from the onset, saving time.

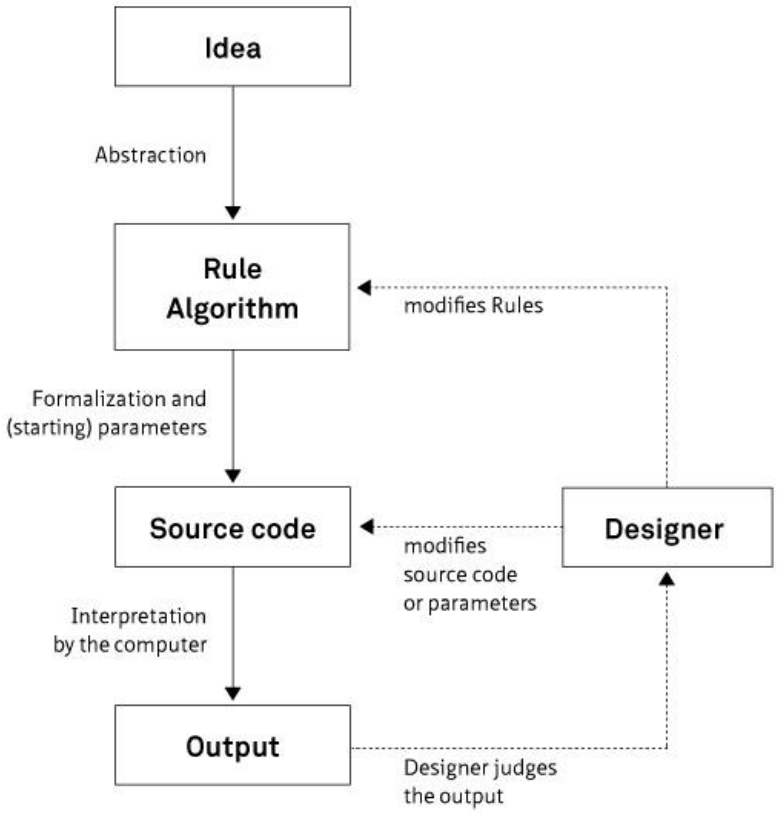


Figure 1: Schema of Generative Design as an iterative process

2. IMPACT OF HISTORY AND URBANISATION TRENDS ON THE RURAL LANDSCAPE OF SOUTH AFRICA

As the world develops, it is looking more at inclusive and sustainable solutions to increase the earth's life span, and Africa is no different. However, it faces unique challenges. It is said that While Africa is one of the least urbanized regions in the world, it is also the region where towns and urban cities grow the fastest. By 2001, 57% of the South African population was urbanized. This percentage has risen during the last decade, with the United Nations estimating that 67.9% of the South African population will live in cities by 2025.

This has several effects on the Urban Cities that experience the influx, and the rural areas lose critical human resources. The downside to this phenomenon includes physical, social, and environmental issues (Makgetla 2010). The unplanned nature of urban, peri-urban, and rural development creates sprawling development and poor utilization of ecological resources. Most metropolitan areas in South Africa, like most parts of the global south, are dealing with deteriorating environmental conditions and a weak public sector struggling to provide adequate services. (Yankson 1999)

The urban areas experience a shortage of employment and housing due to the influx, increasing poverty, and causing unpleasant social environments, including urban environmental concerns. Health risks associated with overpopulation, all while rural areas are left drained and peri-urban areas experience mixed land uses where rural activities and modes of life are in rapid retreat. Many forms of urban land use are being established. (Yankson 1999)

These issues are all linked to rapid urbanization, and understanding the cause is necessary. Why are people leaving rural areas at such a rapid rate, and how do we reduce the urbanization curve to slow down, better prepare cities for growth, and better equip rural areas for population retention?

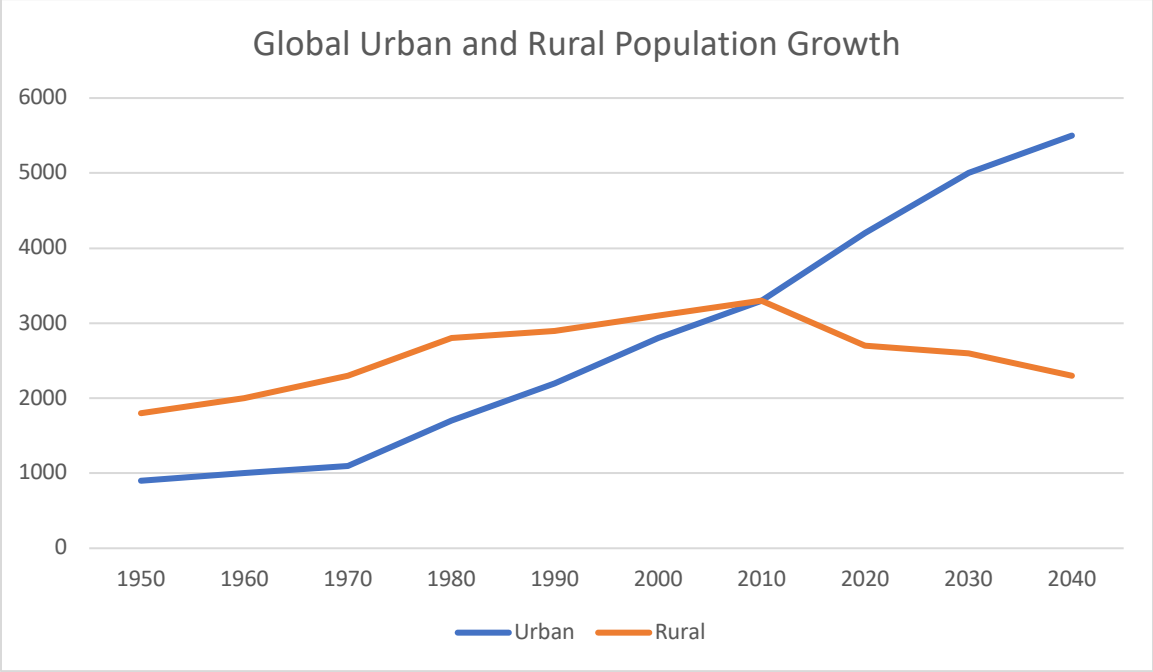


Figure 2: Urban and Rural Population of the World

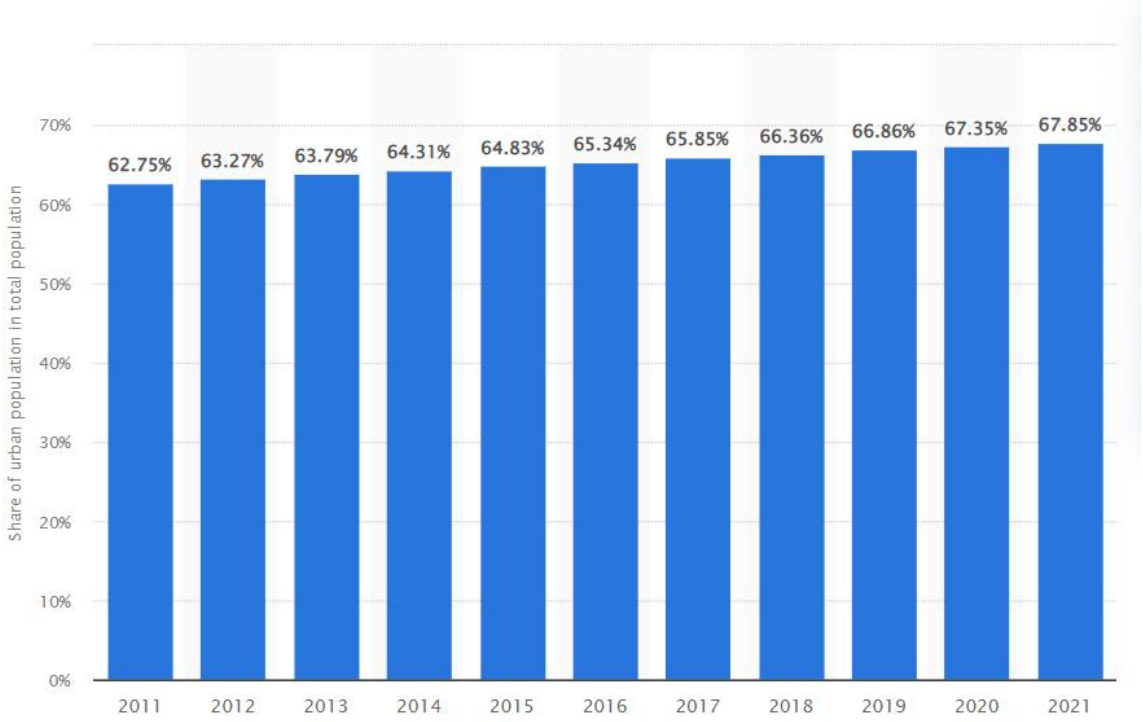


Figure 3: Urbanization Rate in South Africa(Source: Stats SA)

There are various reasons for this which are historical, cultural as well as economic. Historically, the rural areas of South Africa were characterized by unusually high levels of poverty and joblessness, combined with minimal employment in agriculture (Van Schalkwyk 2015). This situation primarily reflected economic structures shaped by colonialism and apartheid. In particular, the apartheid system established in 1948 aimed to force much of the African population into rural reserves, which the state called “homelands” or “Bantustans” (Van Schalkwyk 2015). The result was a dualized system on the land. Based on poorly paid farm labor, an advanced and diversified commercial farming sector stretched around impoverished, often densely populated communities with limited natural resources and government services.

After the transition to democracy in 1994, the main challenge for rural development was to end the marginalisation of the rural poor, the impoverished in the former Bantustans, and farm workers. That, in turn, required significant changes in access to resources, including land and water; significant improvements in the provision of education and skills; transformation of market institutions to make them serve smaller producers; and improvements in rural infrastructure and other government services (Makgetla 2010).

According to the South African Government information, the challenges in rural areas in South Africa include unsustainable use of natural resources, inadequate access to socio-economic and cultural infrastructure and services, lack of access to water for both households and agricultural developments, a low literacy rate and skills levels, migratory labor practices, a decay of the social fabric, and an abundance of unexploited opportunities in many economic sectors.

The facts above make quality sustainable development critical for the rural Eastern Cape as it forms an inclusive environment for its citizens to participate equally in the financial and social economy. Inclusivity becomes essential in this sector as it

presents new opportunities to people who need access to further knowledge, technology, and infrastructure. They can provide improved quality of life regarding jobs, food security, and safety, potentially reducing diseases and improving life expectancy. So, these regions must be counted in the global movement of sustainability as they can play a critical role in the development of our society.

3. DEFINING SUSTAINABLE DEVELOPMENT

To understand what good sustainable urban development looks like and what principles should underpin it, we looked at understanding sustainable communities. Defining sustainability has always been a broad topic; we need to understand the key drivers that help facilitate sustainable communities on a micro and macro level to create a truly circular economy maintained over time. Portney states that "a sustainable community can be anything from a small neighbourhood to a group of people who share some interest, to a program operated by a governmental or nongovernmental organization, to a rather localised ecosystem, to a multistate region encompassing numerous ecosystems" (Portney 2003). In the case of our study, we will look at sustainability around urban planning communities and then touch on neighbourhood-making in a geographically bounded area that can be influenced by residents meeting their diverse needs while making use of natural resources, enhancing the environment while supported by governmental organisations.

Van Schalkwyk sees the ideal sustainable community being defined along five typical dimensions (Van Schalkwyk 2015), as shown in the Table below Figure 3. All five of these dimensions articulate the three spheres of sustainability: society and environment economy. On a broader scale, these speak to local and international standards like the UN Sustainable Development Goals. South Africa is one of the member states, making the government a key stakeholder in developing Rural communities in South Africa.

Table 1. Five dimensions of sustainable community development.

Dimension	Description
Increased local economic diversity	Economic development strategies should place an emphasis on increasing the local economic diversity.
Self-reliance	This includes the development of local markets and local productions. Products that were previously imported should be locally produced. Cooperation among local economic entities should be encouraged.
Reduced energy consumption and management and recycling of waste.	Ideally the use of energy and materials would be in balance with the earth's ability to absorb waste. The recycling of waste can also be used as an economic gain if managed correctly.
Protection of biodiversity and careful stewardship of natural resources.	The community should protect and enhance the biological biodiversity of the area in which they function. The careful stewardship of natural resources can also aid in the reduction of energy consumption and management of waste.
Social justice	A sustainable community is a community that provides for the housing and living needs of all its residents without any prejudice. There isn't any class and race-based spatial separation of households or neighborhoods and everyone enjoys equality of access to services.

Figure 4: Five dimensions of sustainable community development

4. METHODOLOGY

The method of study for the paper was based on a precedent case study and qualitative observation analysis; the reason for precedence was to look at how can the implementation of good sustainability and design interventions improved and rejuvenate an area that was previously run down and to make it a hub of activity and present economic opportunity and improve quality for life of people. This was most relevant because it draws similarities in environmental decay, like lack of employment, safety, and the need for collaboration between municipalities, professionals, and the end user. Our area of interest needs to solve similar challenges by defining helpful interventions that will be successful. Although the site is urban, we think that the notion of creating a community an environ with footpaths and public spaces resonates with that of the rural eastern cape as there are vast areas of the open plan which can be used for public space, and people walk long distances, so walkability to resources is critical. The site also had existing infrastructure that needed to be redeveloped and reused to empower its immediate community. In rural Eastern Cape, there is a need for energy production and water scarcity; we looked at the precedence as a way of having insight in terms of how alternative methods for producing energy and water management can be strategically used while having the ability to research our own contextually relevant interventions.

5. PROJECT CASE STUDY

HAMMARBY SJOSTAD, STOCKHOLM

Hammarby Sjostad was known for being an industrial and residential area that was unsafe, had high pollution levels, and was generally run down and unpleasant. Now Hammarby is one of the most successful urban renewal districts. Upon completion in 2016, the project became home to 25000 people and offers work opportunities to a further 10000 people.

Sustainability

Sustainability was a key design driver in the design and development of this district. The water-focused story had very ambitious sustainability goals stitched into the planning process. Sustainable alternatives have been implemented for water management, energy, and waste.

The district is a result of an integrated collaborative process between municipal authorities, urban planners, developers, architects, landscape architects, engineers at eco-tech businesses, energy company Fortum and the Stockholm Water Company. It incorporates a few principles from traditional Stockholm's 19th-century urban planning principles, blending modern architecture. Based on the strategy of a compact green town, a favorable balance has been found between construction and public spaces. The absence of fences and the presence of public spaces with footpaths yield a district with various atmospheres that offer a high quality of life (Iveroth 2013).

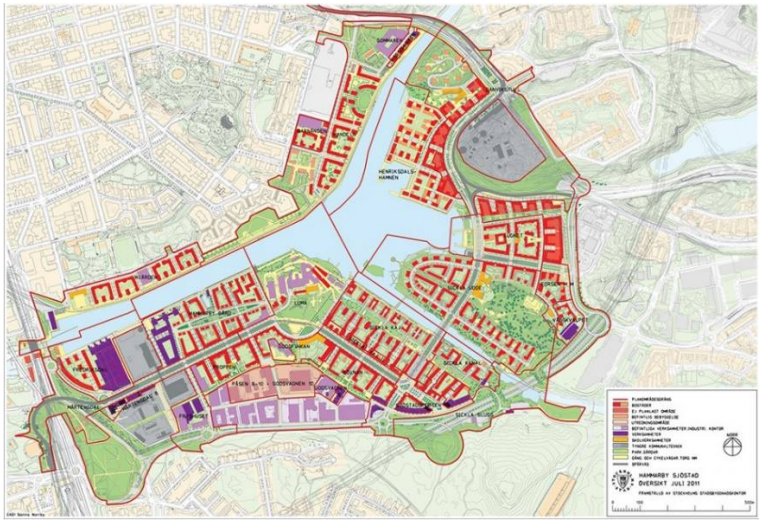


Figure 5: Hammarby Sjostad (Source:Stockhom City Planning Administration)

Energy

The primary source of heating in Hammarby Sjöstad is district heating. Thirty-four percent of this heat comes from purified wastewater, 47% from combustible household waste, and 16% from biofuel (2002 figures). When the heat has been extracted from the warm, purified wastewater, the remaining cold water can be used for district cooling, which is used for cold storage refrigeration in grocery stores and office buildings as a replacement for energy-guzzling air conditioning systems.

Hammarby Sjöstad is experimenting with different energy supply solutions, including integrated solar power solutions that partially provide power to the building and community services like street lighting. Over 900 of the flats in Hammarby use biogas cookers; the biogas comes from the residents themselves. Using biogas reduces electricity consumption by 20% (Iveroth 2013).

The town has several environmental goals, mainly focused on public buildings. These include:

- District heating connection with exhaust air systems: 100, of which 20 kWh electricity/m2 UFA.
- District heating connection with heat extraction systems: 80, 25 kWh electricity/m2 UFA.
- The entire heating supply shall be based on waste or renewable energy sources.

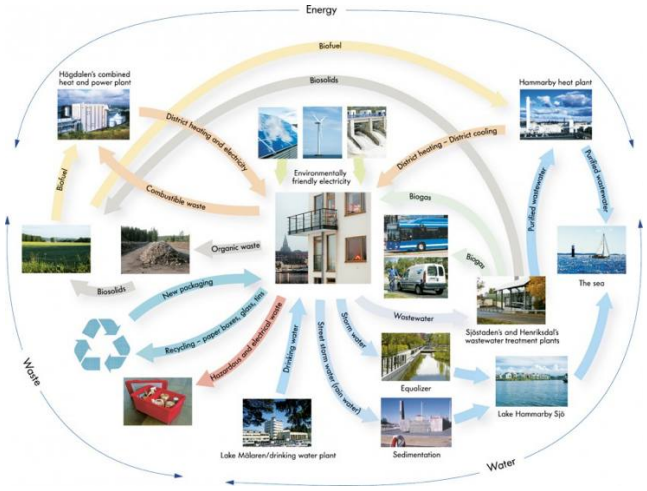


Figure 6: Internal Energy, Waste, and Water Systems (Source: Bumpling AB)

Water

The first step in sustainable water management was a proper participation and education model for the district's residents, ensuring that residents could reduce daily water consumption by half. The additional focus of the education process and strategy was on reducing pollutants present in wastewater by 50%, by raising residents' awareness of the impact of detergents and other household activities. The residents also have access to a water metering and monitoring system to increase awareness and the chance of habit change.

Wastewater

Wastewater is treated locally. The sludge produced by the treatment process is recycled and used for fertilizing farmland and forestry land. The waste releases biogas during processing. That biogas is used as fuel for vehicles such as buses, taxis, and waste collection trucks, and to heat 1000 homes in the area. Heat is extracted from the treated water in the treatment plant, which is then used for district heating. With a spread in temperatures ranging between 10°C and 20°Cover the whole year, the wastewater is highly suitable for heat and cold extraction. In summer the,cold water can be used for cooling.

Rainwater

Rainwater infiltrates the ground directly or is drained off through canals. The many small channels are part of the design of the urban landscape. Some roofs have been designed as green roofs that buffer much rainwater. Runoff from roads is captured separately and drained to treatment pools before infiltrating the ground. The Hammarby model shows that wastewater can be used in multiple ways and that rainwater can be returned to the natural cycle. Hammarby has become an example of sustainable urban planning. For instance, it inspired Toronto's Waterfront (Canada), London's New Wembley, and many cities in China and Thailand.

The sustainability interventions brought into this area create several benefits, the most obvious being the reduced environmental impact. However, they also add value in other tangible and non-tangible ways. The most valuable is the economic, and social value brought into the area by this development, which together provides a high quality of life. This is an example of how well-considered and place-specific interventions can create a different lived experience for the residents.

The people in this community have access to heat and energy, reducing the cost of living from an economic standpoint. New economic and social nodes have converted this industrial into a residential and commercial property. The development provides opportunities for residents to live, work and play within the district, further a well-being component that may increase the residents' quality of life.

This case study presents us with practical examples of how sustainability-focused initiatives can create opportunities for designers, developers, and governments to create spaces/places that improve affordability, better access to amenities, and economic opportunities without compromising on the quality of the design of buildings and outdoor spaces.

Taking our precedence into consideration, we focus on our identified Rural Town of Tsolo in the Eastern Cape of South Africa, a small, poorly planned, and highly congested rural town serving multiple villages. The challenges faced by the community living in this region can be addressed with similar interventions should they be tailored to the local context.

The interventions should address accessibility and mobility, creating circular economies, access to potable water and sustainable energy sources, better quality sanitation that prioritizes sustainable water uses, and capitalising on the existing infrastructure—utilizing Hammerby as a reference to develop guidelines for the rural town of Tsolo, identifying challenges that may need similar interventions to create place-specific solutions that are sensitive to the cultures and preferred lifestyles existing in this community. We will examine if our interventions can be applied in other parts of the Eastern through generative design initiatives.

DEVELOPMENT GUIDELINES

Fundamental principles to take out of our precedence project are the good use of interventions related to water and energy and then educating residents about the importance of sustainability and how to use the systems that have been put in place optimally. To be contextually relevant, these interventions need to be reviewed against our needs, and additional interventions can be added. A sustainability matrix needs to be established to set our goals for the Eastern Cape Rural Development and our site location.

The SDGs have been considered as part of the development of good practice guidelines for developing projects that are socially conscience and are in line to be building sustainable communities. We believe they can serve as a strong driver in rural development. When developing the guideline matrix, ensure that each strategy and approach aligns to an SDG. This creates a design process that will ensure that any new development and its interventions are considered and developed with the UN Sustainable Development principles embedded in the process and implementation.

Category	Sustainability Feature	Aim	SDG
Energy	Energy Efficiency	To minimize energy requirements and greenhouse gas emissions through the energy hierarchy.	SDG07: Affordable and Clean Energy
Energy	Renewable Energy Production	To reduce the environmental and economic harms associated with fossil fuel energy.	
Water	Indoor potable water use reduction	To encourage and recognize design that minimises extreme reliance on indoor potable water use	SDG06: Clean Water and Sanitation
Water	Drinking water quality	Provide access to drinking water without unpleasant taste and odor and appearance that complies with health-based limits	SDG06: Clean Water and Sanitation

Category	Sustainability Feature	Aim	SDG
Water	Basic water quality management	Implement protocols to reduce the risk of water quality and legionella colonization.	SDG06: Clean Water and Sanitation
Health and Well Being	Local Food Environment	Encourage a local food environment that increases the availability of plant-based food options, promotes humane livestock practices, limits environmental degradation, and reduces dietary exposure to pesticides.	SDG02: Zero Hunger
Health and Well-Being	Nourishment	To encourage the creation of food environments where the healthiest choice is the easiest choice.	SDG03: Good Health and Well-Being
Health and Well-Being	Nutrition Education	Encourage the selection and consumption of healthier food choices through advertising and massaging.	SDG03: Good Health and Well-Being
Health and Well Being	Places of Respite and connection to nature	To encourage and recognize developments that create appropriately designed areas where people can relax in a place of respite and connect to nature.	SDG03: Good Health and Well-Being
Ecology, Land Use, and Biodiversity	Urban Consolidation	To encourage and recognize integrated planning and shared land use in developments by providing on-site outdoor facilities for use by the local community.	SDG11: Sustainable Cities and Communities

Category	Sustainability Feature	Aim	SDG
Materials and Embodied Carbon	Building Life Cycle Impact Reduction	To encourage adaptive reuse and optimize the environmental performance of products and materials.	SDG13: Climate Action
Material and Embodied Carbon	Storage and Collection of Recyclables	To reduce the waste generated by building occupants and hauled to and disposed of in landfills.	SDG13: Climate Action
Emissions and Pollutions Prevention	Discharge to Sewer	To encourage and recognize developments that minimize discharge to the municipality sewerage system.	SDG06: Clean Water and Sanitation
Transport, Mobility, and Universal Access	Access to Quality Transit	To encourage development in locations shown to have sites that has limited to no form of integrated transport systems.	SDG11: Sustainable Cities and Communities
Transport, Mobility, and Universal Access	Neighbourhood Development Location	To avoid rural development on inappropriate sites. To reduce traveling long distances, improve liveability, and improve human health by encouraging daily activity.	SDG11: Sustainable Cities and Communities
Socio-Economic Aspects	Employment creation	To encourage and recognize developments that create employment opportunities through design decisions that include facilities for micro-enterprises and targeted employment for priority groups.	SDG08: Decent Work and Economic Groth
Socio-Economic Aspects	Empowerment	To encourage and recognize projects committed to and have made achievements in implementing the principles of local Economic Empowerment.	SDG08: Decent Work and Economic Groth

Category	Sustainability Feature	Aim	SDG
Community and Placemaking	Integrative Design	Facilitate a collaborative project process and support adherence to collective well-being and sustainability goals.	SDG11: Sustainable Cities and Communities
Community and Placemaking	Housing Equity	Promote housing equity through the allocation of healthy, affordable housing units.	SDG11: Sustainable Cities and Communities
Community and Place Making	Diversity and Inclusion	Promote an equitable culture by implementing and disclosing diversity and inclusion policies and initiatives.	SDG11: Sustainable Cities and Communities
Community and Placemaking	Support for Victims of Domestic Violence	Increase availability and access to support services, resources, and care for victims of domestic violence.	SDG05: Gender Equality

Implementation

With the overall understanding, a matrix can be used as a guide for Rural development. We want to explore different cases in the rural Eastern Cape to map out our thinking and how something of this nature can be implemented, looking at a typical conventional approach of having the insight into an area to start developing interventions and using data as a way of selecting interventions.

This is to beta test our theory of extracting comparative data and match it to helpful interventions from the same data set of interventions pre-developed across the sustainability profession over the years. However, what will be different here is that each intervention will only act as a driver to design thinking as it will enable the designer/end-user to ask the right question based on data-driven knowledge, and from this point onwards, they can apply contextually relevant answers. The idea is to create a user-friendly tool that can be used by non-specialists who are not necessarily industry professionals but policymakers in government to have an early test bed for their planning policies for each area in question to ensure that the correct information is used upfront. Some areas in the rural Eastern Cape are fairly remote to do a site survey, and research technology like this can be used as a starting point by simply extracting data to have an overview of how the sustainability master plan for the area in question can be achieved.

Example 1 - Tsolo: Qualitative knowledge based on the experience of the area

Example 2 - Libode: Quantitative knowledge based on data

AREA TSOLO "CBD," EASTERN CAPE, SOUTH AFRICA

Challenge: *Sustainable densification to prevent sprawl:*

The CBD has a single main road overburdened by public transport, making it impossible to navigate around at peak density times of the month when the local community and people from surrounding villages do their grocery shopping which is the most anticipated activity in this area due to government grant pay-out. This location can be densified and pedestrianized to make it safer and easier to navigate during peak times and increase its economic value. An alternative route can be mapped, which aligns with town planning regulations. It can be linked to feeding into neighbouring villages, creating more accessible avenues to access the town.

This would also be ideal for preventing unnecessary development outside the existing town, preventing sprawl, and lowering embodied energy.

Interventions:

Land use: Urban consolidation

Socio-Economic Aspects – Empowerment

Transport, Mobility, and Universal access - Neighbourhood Development Location

Health and Well-Being – Places of Respite and connection to nature

Energy – Renewable Energy Production

Mock-up Intervention proposal below 1:



Figure 6: Pedestrian streets, Ease of access

Food Security:

Agriculture can be a driving force in ensuring food scarcity for the community in this region can be a thing of the past. There is also a strong history and tradition of subsistence farming with evidence of fields that used to be regularly worked, evidently in aerial footage.



Figure 7: Formerly used subsistence land (Image Source: Google Maps)

We see a unique opportunity on the land around the wastewater treatment plan. Its positioning could prove strategic as it is positioned 1km from the CBD and 2 km from the Agricultural college. The water from the treatment plant can be used to start various farming activities for the community, and the product can travel to the CBD, which is closer. At the same time, the students can use the area as a training ground and prototyping for new farming methods. This presents efficient use of land within the local community and creates a form of circular Economy with low embodied energy.

To support further economic activity around the Agricultural School, introducing a program that helps the students and the homes that are currently subsistence farming to commercialize potentially introducing a program to assist families in identifying the correct product to farm and establishing a farmers' market that can occur once a month at the Agricultural School or an identified location near the town. This would allow families to generate income and reduce dependence on social grants and government intervention. This initiative would also give students access to markets.

Interventions:

Health and Wellbeing: Local Food Environment

Health and Wellbeing: Nutrition Education

Socio-Economic Aspects: Employment creation

Mock Intervention proposal below 2:



Figure 8: Roadmap to Circular Economy and Food Security (Image Source: Google Maps)

The above gives us insight into how these interventions can be integrated into existing and new spaces should they be well thought out and what potential challenges they can solve or prevent. This is a snapshot of the application as many goals can be listed under these measures and their applicability in different scenarios.

Generative Design

With the world becoming more technologically driven and quick turnaround, data-driven solutions are becoming mandatory for answering design questions. One of the questions we had was, can green design interventions be easily applied using algorithmic process drive solutions like generative design methodologies? How can we start having iterative design processes to deliver flexible output using data? What data is most valuable, and how does each intervention find its applicability? This, of course, will be done with an understanding that each area needs contextually relevant solutions that can impact its immediate environment.

How do we then achieve this iterative data-driven process? What we are proposing for this process is using already existing information to carve out a path to drive policymaking and design thinking. We see a close relationship between design interventions that are already existing and generally publicly accessible data. The interventions have been living and have been tried and tested in the professional space on various projects like Hammarby Sjostad.

We see these interventions being collated into a data bank where they can be pulled and aligned according to our starting parameters. Our starting parameters in this instance would be statistic data of the region or area where we can deduce what in the intervention is most valuable. Once this desktop process is complete, further in-depth studies can be done using the extracted interventions as they would be aligned with researched information. This system can also assist in reducing the focus on unnecessary interventions by filtering them out and saving more time.

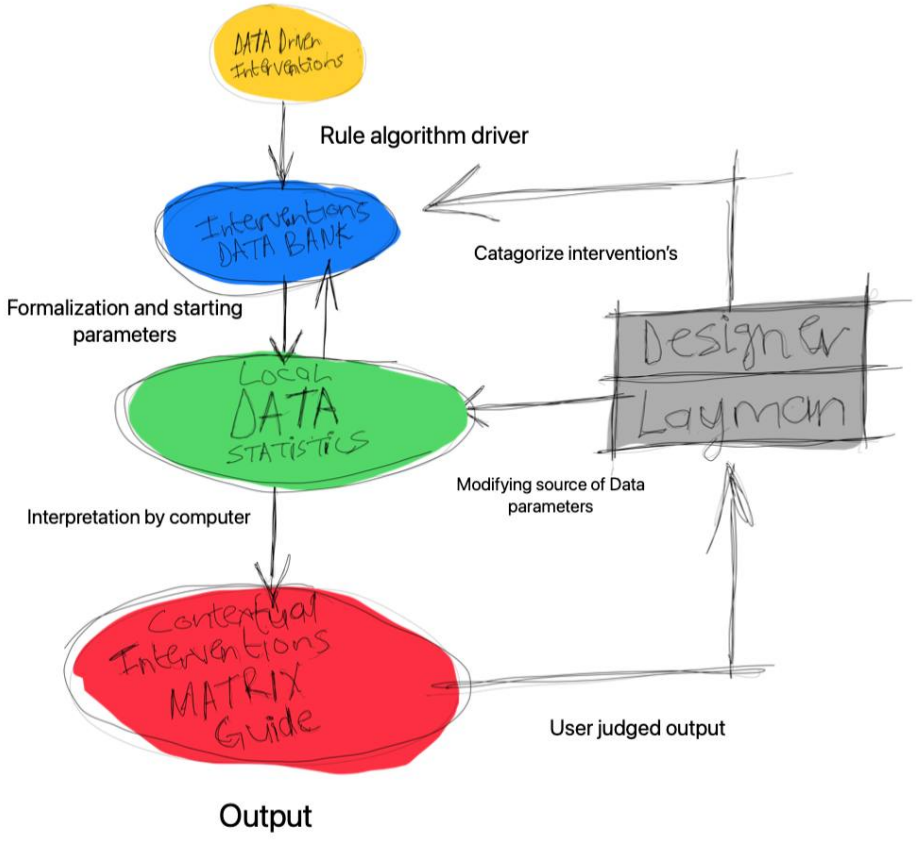
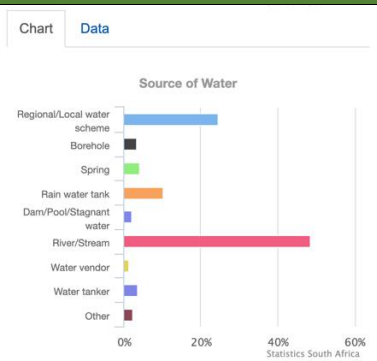
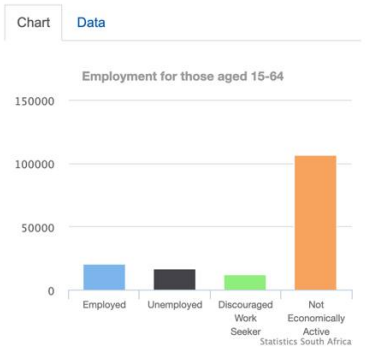
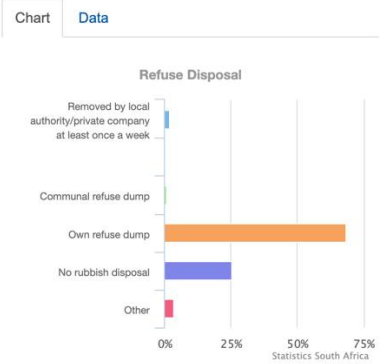


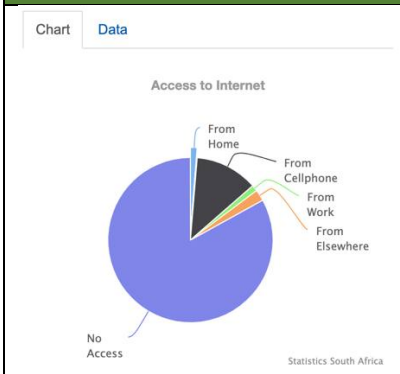
Figure 9: Proposed Schema of Generative Design

The below data is an example of what type of data can be used to start driving the process:

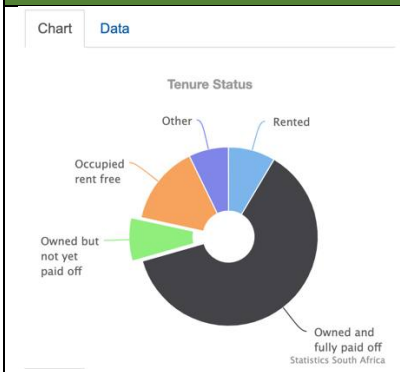
We used Nyandeni Municipality as a test bed for data collection to try to inform our interventions, for Libode since it falls under this municipality.

Using the data matrix, we start looking at what interventions can apply only using data for our assumption. This process can be automated in the future using different data banks and can be integrated with rural municipalities as a tool for early-stage development. For our paper's sake, we can do a desktop exercise on the various interventions needed.

Data	Category	Sustainability feature	Aim
 *Chart 1: Water Sources in Nyandeni Municipality(Source: StatsSA)*	Water – 48% of the water source comes from streams and rivers	Water quality management	Implement protocols to reduce the risk of water quality and legionella colonization.
 *Chart 2: Employment rate in Nyandeni Municipality(Source: StatsSA)*	Socio Economic Aspect	Employment Creation	To encourage and recognize developments that create employment opportunities through design decisions that include facilities for micro-enterprises and targeted employment for priority groups.
 *Chart 3: Refuse Disposal in Nyandeni Municipality(Source: StatsSA)*	Material and Embodied Carbon	Storage and Collection of Recyclables	To reduce the waste generated by building occupants and hauled to and disposed of in landfills.

Data	Category	Sustainability feature	Aim
 *Chart 4: Access to Internet in Nyandeni Municipality(Source: StatsSA)*	Socio-Economic Aspects	Empowerment	To encourage and recognize projects committed to and have made achievements in implementing the principles of local Economic Empowerment.

Interventions that can be pushed further out or excluded due to being low priority

Data	Category	Sustainability Feature	Aim	Reason for Exclusion
 *Chart 5: Tenure Status in Nyandeni Municipality(Source: StatsSA)*	Community and Placemaking	Housing Equity	Promote housing equity through the allocation of healthy, affordable housing units.	62% of the population in this region owns their properties. This intervention is not a high priority and can be pushed further down the line or excluded.

- **LIBODE, EASTERN CAPE, SOUTH AFRICA**

The metrics can be used and adapted to address the different challenges faced in other rural towns. We will look at Libode, a rural village that is about 50km away from Tsolo. Libode had a population of about 5000 in 2011 and is situated between Port St Johns and Mthatha and serves as the administrative location for Nyandeni Municipality. This town has some similarities but has its own set of challenges and opportunities for intervention. Using the data from Nyandeni Municipality and developing the intervention metrics, we can apply these findings to identify place-specific interventions for Libode. (reference)

Libode has one main road that runs through the town, and the location of the main economic activity is located on the far edge of the town. The matrix has given us multiple challenges that Libode and other towns in Nyandeni Municipality face.

These include high levels of unemployment, with a high percentage of people who could be more economically active. The absence of economic activity increases the number of households living below the poverty line and economically excludes a large portion of the population of Libode. Financial inclusion is a high priority in Post-Apartheid South Africa as the demographic of Libode is almost entirely black. Other challenges and interventions include the need for a waste disposal system and the collection and sorting of recyclables. Introducing a waste disposal system focused on recycling is itself an opportunity to increase economic activity, create jobs and educate residents in Libode about waste management.

Below we will extract one of the challenges and interventions highlighted in the matrix and unpack it to make it place-specific and to understand how it can be developed.

Challenge:

- High unemployment and economic exclusion

Intervention

Livestock Agricultural Development

The Marubeni Piggery Project is located towards the east of Libode. It is a small-scale project that could catalyze the community to develop an agricultural livestock center—the creation of an enterprise that will provide employment opportunities and food security. The existing Piggery Project is adjacent to vacant land, allowing for gradual expansion. The current piggery project and vacant land face the R61, the main road to access Libode from the N2 and the town'.



Figure 10: Location of Land for Livestock Farming

The challenge with agricultural enterprising in this region is the earning potential. Data extracted from Stats SA shows that within the Nyandeni municipality, only 40.5% of households with agricultural activity on their land make a profitable living. This is because some of the household's farm for subsistence purposes; however, those that farm for commercial purposes struggle to increase turnover and profit because of limited access to markets. The development of Livestock Enterprise would need to be supported by the creation of a supply chain to access markets.

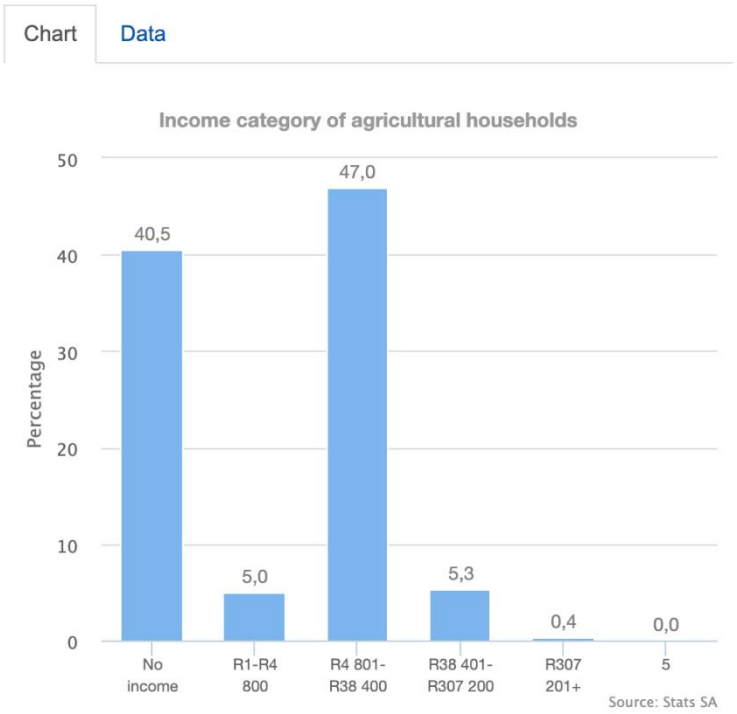


Chart 6: Location of Land for Livestock Farming

Of the agriculturally active households in Libode, 29% are involved in livestock farming. This means that many homes have the resources and skills to maintain livestock. This presents an opportunity for a historically, economically, and systematically excluded community to develop a self-sufficient industry based on existing skill sets and resources. External intervention for development would still be necessary for building infrastructure that will support the growth and scaling of the opportunity.

CLOSING ARGUMENT.

Much needed foresight is required to be at the forefront of developing and integrating technology or the ways we can tackle this challenge. Rural environments should be included in these advancements with the world moving into AI technology and other mediums to create practical and quantitative design solutions. Creating methodologies that help foster new and different ways in these regions is critical hence progressive ideation methodologies like generative design can make a springboard for such. Its iterative design process way and multiple output solutions can bring variety and creativity to how development policies are created, and design solutions are implemented.

Rural South Africa can potentially reduce the rate at which people are exiting the rural community, and skills are developed if they are set into places where people can live comfortably, have access to services, and access opportunities to make a living. Creating development tools can be a starting point to change how we respond to development in our rural and peri-urban towns.

The SDGs have been put in place to help not only the state but private entities to move towards sustainability and building the sustainable development goals into development guidelines assists in making better to rural towns that can provide better quality lives to the villages and communities they serve.

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