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Local development policy effects on environmental quality: the case of Amathole District Municipality

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Abstract. Sustainability is a global problem which is practically difficult to implement. Pressure from Constitutional developmental obligations present enormous problems in South Africa, hampering the transitioning to sustainability at sub-national levels, where increased resources are required to compliment expertise amid negative effects of incoherent efforts and disaggregated planning that complicates the attainment of minimum sustainability levels. Data gathering is haphazard, making it impossible to get meaningful knowledge of baseline environmental conditions. This study galvanized professionals and academics to develop environmental quality indicators, gather data and conducted an assessment using Multi Criteria Analysis (MCA) to stimulate municipalities to implement sustainable policies and comply with national objectives. 6 municipalities were assessed for environmental quality using 25 locally relevant indicators. Information about the district levels of sustainability was provided by the results. The aim being transparency, objective self-assessment and reporting providing the basis for implementing corrective policy decisions in line with Local Agenda 21 and NFES recommendations.

Keywords. Environmental quality, Amathole District, local sustainability, local development, spatial development, multi criteria analysis

Introduction

Under pressure from Constitutional obligations, local government in South Africa (SA) plan and implement infrastructure projects that exert pressure on natural resources. As a result, a raft of municipal services (housing, electricity, water, sanitation, roads) are demanded on unprecedented scales. SA is following world trends in urban rural migration which is heading to be in excess of 70 percent of the population living in urban settings. The situation is compounded in by the need for universal access to basic services covering both rural and urban areas. The need for resources and capacity development in SA municipalities is well documented and the struggle with competing development and sustainability agendas remains a contentious issue (UN 2013).

Development efforts in local municipalities in pursuit of compliancy with the Constitution[i], other legislation[ii] and policy directives[iii;iv] affects the local environment in conflicting ways. In rural places, problems of public health, sanitation, solid waste management, reliable public transport and energy consistently worry both residents and administrations. As

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Gross *et al*. 2007 noted, municipalities, have been under perpetual pressure from the increasing demand for improved public infrastructure, employment opportunities, reduced pollution and low risk of exposure to natural disasters. Concurrently, the greenhouse gas (GHG) emissions has immerged as another issue with global adverse effects caused by towns and cities expanding exponentially, lifestyles with propensity for excessive consumption and economic activities in urban areas that are intensive in carbon emissions. Consequently, acute environmental problems are emanating in the forms of increased local and global pollution that result from raw materials and energy flowing and being used from distant resource locations in the process of production of goods and services. The phenomenon of Global warming which currently besieges the planet is a culmination of GHG emissions, that intensifies the risk to climate induced natural disasters. Clear evidence to local development being obstructed by climate induced risks whose impacts render municipalities extremely vulnerable, and places them under additional stress on their adaptive capacity especially the urban poor and rural communities.

The National Development Plan 2030 (NDP) reflects local environmental quality as a critical concern in SA, certainly, from the widely canvased problems of segregation, dereliction and degradation of neighbourhoods, traffic congestion, accessibility of well-being and health-care and socio-economic deprivation that have taken centre stage in political issues not only in SA but throughout Sub-Saharan Africa (DPME 2012). The solution for addressing these issues comes in the form of a comprehensive framework integrated with other policies, which is missing from the scientific domain. It is a requirement for it to compliment the methodology and to facilitate evaluation of physical, spatial, economic and social indicators. A measurement system that is coherent and capable for proper evaluation of components and trends in, environmental quality has been fully developed either.

International organisations like Communitas, Sustainable Development Solutions Network (SDSN), World Urban Campaign, UN-Habitat, International Council for Local Environmental Initiatives (ICLEI) and United Cities and Local Governments (UCLG)'s advocacy programmes help to accelerate the proliferation of sustainability best practices succeeding in various countries (Yildirim 2017). Municipalities in SA are confronted by numerous issues, such as perennial urban planning, regulated participation, social responses, infrastructure, health, cultural services, water and transportation. Most of which have a direct bearing on the environment (McDonald 2017:2).

Globally, most countries incorporate sustainability and environmental problems in their long-term political visions that electorates buy into. National priorities from such political visions culminate in authentic public participation practises for environmental concerns that overlap with ecosystem management and environmental policies. McDonald (2017) noticed a trend in most countries of accelerated moves in recent years to decentralize the management of resources by environmental policy communities, encouraging stakeholders to collaborate through ecosystem-management approaches. Empirical evidence points to municipalities globally creating innovative projects and prototypes for environmental management (Campbell and Corley 2012), and in SA, the functional area of such political decisions is domain of municipal autonomy (RSA 1996).

Problem statement

Strategies, policies and local projects are applied as sustainability approaches in SA municipalities. National strategies from the department of Environmental Affairs and Tourism (DEAT), SA Local Government Association (SALGA), LA21, International Municipal Organisations for sustainability, COP19 emissions reduction strategies and Integrated

Technium Social Sciences Journal
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Development strategies (IDP) form the basis of tools for sustainability. Various municipal projects, i.e.: water and energy efficiency, waste management and recycling, sustainable spatial development planning, renewable energy and urban transformation projects form the other part of local sustainability approaches. According to Local Government: Municipal Systems Act 2000, the IDP is the main strategic management document for municipalities, directing them to act collaboratively in decision-making processes particularly with communities and relevant stakeholders to engender democratic and participatory management. Attention to holistic integrated comprehensive development, particularly at local level, is a precondition for the success of national development.

All stakeholders are supposed to work in a co-ordinated fashion in operationalising sustainability, however, such integration is still at a disintegrated stage with stakeholders having different, often conflicting, priorities. The smallest administrative units (local municipalities) are the first level where integration begins. An elaborate scheme of collaboration needs concise clarification of converging objectives, whose coordination is aimed at district level, with full participation of local municipalities that require policy alignment. Collaboration requires accurate information on each municipality's current sustainability condition in the district, the information of which must be used to reflect common facets and variances on how municipalities have progressed towards their sustainability pursuit. To facilitate the crafting of achievable targets and uniform minimum standards, this approach must be adopted to facilitate full municipal participation in pursuing LA21 implementation.

Objectives

This study conducted a survey on the district-wide environmental conditions, applied a multiple criteria decision analysis to select indicators and used the results as the basis for recommending sustainable environmental action plans. The study further intended to make use of the indicators identified to assess local sustainability and identify target areas in local municipalities for remedial action.

Theoretical framework

Two aspects can be identified in the concept of quality. When certain specifications are set as standard for a product (physical or service), the exact replication of that standard or closeness thereto, defines the quality being sought. While the concept of quality can be viewed as ambiguous or vague, it has connotations of being clear. After an assessment, quality depicts the main features and characteristics of an entity on a scale of achievement relative to the expected standard. According to Pakzad (2006:78), a thing or entity is created as an assemble of components of sub-qualities which, when aggregated, becomes its quality. Confronted with the phenomenon of sustainability, researchers must consider clarifying the concept of quality together with the concept of the environment. Attfield (2003) proposed a good three-part classification for the methods of defining this concept coherently as:

- Commonly, the environment is defined as the periphery, where people or whole communities in their short existence are surrounded with;
- Naturally occurring features such as rivers, mountains, wildernesses, coral reefs, oceans and gouges scattered around habitations are objective systems of nature that are older and more durable than humanity;
- Where, human beings and animals have a sense of belonging and regards as home, is perceived as their environment.

Technium Social Sciences Journal
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It can thus be deduced from this definition that environment can be viewed as a real thing that has an independent entity or that the human mind can interpret it as such (Holden 2015:37). The complexity in quality of the environment emanates from embracing abstract perceptions, views, attitudes, and values among heterogenous institutions, groups and individuals (Ronizi and Biglou 2015:436).

Environmental quality is a multidimensional concept that is associated with several sub-qualities i.e.: quality of life, and place, perception, satisfaction and liveability. These component concepts are often similar, hence, mental perceptions, characteristics and values that exist among individuals, groups and communities, all combined, make up this quality (Qeidari 2014:153). In 1995, researcher Khan stated a trio of dimensions for sustainable development as: "economic sustainability (growth, productivity, development), social (equity, accessibility, participation), environment (recovery capacity, biodiversity)" (Roşu 2012:25). It is obvious that theoretical frameworks are lacking in a comprehensive, precise, and a consensus definition for the concept of quality of environment. This concept is connected and overlaps with other obscure and complex concepts, specifically, quality of life, liveability and sustainability; having been identified as component parts of the broader concept of quality of life. In literature is limited to only implicit definition of concepts. Context or indicator choices informs the conclusions on what meaning has been ascribed to the concepts. In the literature perused, the concepts of liveability, environmental quality, ecological footprint, quality of life and sustainable development quality were assigned extremely wide range of definitions.

Research methodology

Geographical Scope of the Research

The Amathole District Municipality (ADM) is a combination of local municipalities nestled in the central part of the Eastern Cape (EC). Stretching adjacent the Sunshine Coast north, from the Fish River mouth, further down traversing the Eastern Seaboard until south of Hole in the Wall along the Wild Coast. To the north, it borders the Amathole Mountain Range. As a district, it has concurrent legislative and administrative functions with six local municipalities (LMs): Raymond Mhlaba, Mbhashe, Amahlathi, Mnquma, Ngqushwa and Great Kei. Four of the local municipalities (coastal municipalities) borders the Indian ocean to the east while two (inland) are landlocked to the west. Each local municipality administers small towns or urban centres (kleindorpies)[v], 18 of which are the study sample.

Great Kei (EC123) has cattle production and tourism as the main economic activities, with film industry showing keen interest in the area. It is historically famous for its agricultural sector and cultural heritage. Mngquma (EC122) is nestled between Mbhashe to the north east, Great Kei to its south and Amahlathi to the west with an economy dominated by: social services (41%), wholesale and retail trade (18.5%) and manufacturing (15.5%). The fourth local municipality to have a coastline as its boundary is Ngqushwa (EC126), at the southern tip of the district is mainly rural in nature and its main economic activities are agriculture and tourism. Raymond Mhlaba (EC129) to the west of the district has the biggest surface area and greatest number of kleindorpies. Coined the Winterland of the EC, this countryside municipality has its topography dominated by the Winterberg mountain range (IiNtabazeNkonkobe) that imposes itself to the north. With a rural hinterland forming a major part of the municipality, farming activities dominate the economy. Social services, wholesale and retail trade; personal services; finance and insurance; construction and manufacturing also form part of this economy. In the hinterland, at the centre of the district lays Amahlathi (EC124) landlocked between Buffalo City Metro to the south and Chris Hani district. It covers a surface area that is second largest in

Technium Social Sciences Journal
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the district. Forests and thickets are land marks characteristic to this area with social services, finance, manufacturing, retail trade, agriculture, construction and transport as economic activities.

Method

Elsewhere, multi-criteria decision analysis methods were key tools in the evaluation of environmental quality in municipality (Kumar *et al.* 2017., Ferrarini *et al*. 2001: Teixeira 2020), This study, places MCDA favourably ahead of other methods of distinct quantitative methods. When a study requires information on the capability of different options to get to the objectives with indicator representation in an analysis at the same time (Boggia and Cortina 2010). According to Voogd (1983), Multiple Criteria Decision Analysis (MCDA), is suited for comparing different options in consideration of a defined criteria, assessing facets by which dimensions of several probable outcomes being investigated can be defined. By its nature, environmental problems are intrinsically multi-objective, which makes researchers more inclined to use MCDA (Navarro *et al*. 2019; Bodini *et al*. 2000; Janssen and Ritveld 1990; Ambrasaitea *et al*. 2011). Analysis in this study was carried out using DE FINITE (DEcisions on a FINITE set of alternatives) 3.0 for Windows, a software program equipped with four methodological modules each representing analytical methods for MCDA as follows:

i. Weighted Summation
ii. REGIME
iii. Expected Value (EV)
iv. Evaluation of Mixed Data (EVAMIX)

According to Janssen (2012), DEFINITE system can be used on a variety of problems and rejects political dependency by bringing rational, responsible and justifiable decisions that are legitimised by external review to improve the quality of decisions made in environmental management.

The methodology proposed enables the researcher to rank alternatives from best to worst when making a decision. It has the capacity analyse numerous attributes and options by systematic mathematical steps (VU 2020). MCDA follows two simple steps in the analytical process.

The iterative simple steps of a multi-criteria decision analysis are limited to:

- Development of an effects table ***X,*** with dimensions ***JxI***, considering ***i (i=1.... I)*** options and ***j (j =1….J)*** indicators (criteria). E.g., the value assumed by criterion *j* for each of the *I* alternatives is represented by z_{ji}, z_{ji} ***0, ., $z_j I$***.
- Running of a system of weights ***wj (j=1,…..,J)***, which is the source of information on the importance attributed to a variety of criteria, stated as (1).

Equation (1)

$$W = (w_1, \ldots\ldots, w_j)$$

Lawn (2006) set the precedent, with a sustainability assessment model, to use a trio of economic, social and environmental indicators as criteria for assessment; with municipalities as the different options. The ADM analysis can be replicated on local, provincial or national levels.

The model allows for weights' sensitivity to be analysed internally. Typically, if various views (political, professional or scientific) of an issue of sustainability, are represented by an array of weighing profiles, decisions are made with the full knowledge on the ramifications of such decisions and, also, the relevant criteria attributed to the end results is identified. Data was

Technium Social Sciences Journal
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manipulated via the weighted sum methodology which resulted in a classification of available alternatives. Every criterion must have a weight unit, or importance value attributed to it. Equation 2 is the formula that orders alternatives in Weighted Summation:

Equation (2)

$$\underset{I=1,2,\ldots,I}{\text{maximise}} \sum_{j-1}^{J} (w_j x'_{ji}$$

wj is the symbol for the weight which criterion ***j*** is applied. The impact that alternative i exerts on criterion j is standardised by a score of ***x'ji***. Equation 3 is the statistical formula DEFINITE uses as a standard formula to Weighted Summation:

Equation (3)

$$x'_{ji} = \frac{x_{ji} - \min_i x_{ji}}{\max_i x_{ji} - \min_i x_{ji}}$$

Therefore, for every option, ***i*** scores are ordered per their relative order position starting at the lowest, ascending to the greatest value.

Dealing with mixed (quantitative and qualitative data) is an earned novelty of 'EVAMIX'. Its purpose is to perform evaluations in a table with two subsets of scores. All subsets are comprised of alternatives that are examined between pairs to get a series of coefficients that are dominant. This study limited analysis to qualitative coefficients only and simplified the procedure by calculating dominance coefficients using the formula stated in equation 4:

Equation (4)

$$\beta_{ii'} = \left[\sum_{j \in Q} \{ w_j (x_{ji}^j - x_{ji}^j) \} p \right] \frac{1}{p}$$

where *Q* signifies the set of quantitative criteria and *i* and i0 are two generic options. By following the precedent of Voogd (1983) and Jansen and van Herwijnen (1994), ***p***, is the scaling parameter which must be a positive integer value set selected in terms of a criteria to result in a value equal to 1. The outcome of the analysed pairwise comparisons results in a matrix of dominance scores. Matrix rows are added up to get the final scores to assign to the respective alternatives before replicating the Weighted Summation standardisation process.

Regime and Expected Value methods have a similar approach in using a set of feasible weights (S). Values that meet a predetermined group of qualitative priorities acquired by arraning the criteria according to importance are grouped together. A number of weight vectors are applied in the face of numerous values that might meet the set criteria. According to Rietveld (1984), the vector is determined as the expected value of the feasible set in Regime, then applied to Weighted Summation method.

The 'concordance index' in Regime, which is applicable for the validation of the predictive ability of a surviving model marks the starting point. Being a fraction of pairs in a set of data, a high probability of survival prediction by the MCD model is signified by very high survival times observed as stated in equation 5 (van Delft and Nijkamp, 1977):

Equation (5)

$$c_{ii`} = \sum_{j \in c_{ii`}} wj$$

Technium Social Sciences Journal
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www.techniumscience.com

Cii`*** represents the subset of criteria, when alternative ***i*** *is* dominant over ***I`; as previously, ***wj*** again, is the weight relevant to criterion ***j***. With this method, a set of concordance indices is extrapolated by comparing all available pairs of options, focusing on the difference stated in equation 6:

Equation (6)

$$C_{ii`} - C_{i`i}$$

Option ***i*** is preferred over option ***I`*** if the result is a positive sign or the other way if the result is negative. Calculation of the concordance indices considers all vectors in ***S***. A consistent positive result obtained for two indices within the entire vectors of weights signifies conclusive dominance of option I over ***i`***, therefore a likelihood of dominance equal to 1 is allocated to option ***i***. It is also possible to get a mixture of both positive and negative cases in different parts of the set ***S***. In that case, the probability of dominance of plan ***i***, dominating over that of plan ***i`*** is indicated by the sum of positive cases. A structured probability table is used to present the results in which the final score for each option is the average obtained in the row of relative success (probability) coefficients that comprises the table. Score standardisation is not required in this method.

Research findings

Indicators and data collection

UN Sustainable Development Goals (SDG) encourage countries to develop frameworks of indicators for local sustainability and resilience. At the second Urban Sustainable Development Goal Campaign Consultation on Targets (SUSDGCCTI 2015), a preliminary set of SDG indicators that fit universal acceptability were proposed for use at various government levels including municipalities (Simon *et al.* 2016). Data can still be collected and distributed based on these indicators to support SDG implementation and monitoring regardless of them not being final. Open data for decision making is supported by both the World Council on City data (WCCD) and the Global Partnership for Sustainable Development Data.

According to (Pope *et al*. 2004; Todorescu 2015; Sengupta and Sarkar 2017), "sustainability is a multidimensional concept" that takes consideration of economics, social context and environmental aspects, coordinating them as a single public policy. The multidimensional attribute is represented appropriately by several indicators with context relevance in the examination methodology applied to measure local sustainability (Ness *et al*. 2007; Moffat *et al*. 2001). Researchers are gradually working on improving methods to determine and apply indicators with keen interest (Munda and Nardo 2009).

Rees (2003), in interpreting and assessing its complex elements, singled out ecological economics as the more appropriate approach to take. This approach has complexity connotations that (Venkatachalam 2007; Christensen 1991; Costanza *et al*. 1991) found to be advanced in complexity than the neoclassical model. With this in mind, methods of assessing sustainability must be capable of interpreting and examining a variety of dimensions. Complex Social Value (CSV), when assessing a public good, connects economic and social evaluations with biological and ecological evaluations. This approach is replicated in sustainability because of the reputational efficacy. CSV which seldom used is a paradigm shift from the extensively used Total Economic Value (TEV.

NASEM (2011) advances the idea in the USA of starting the process of assessing conditions of the environment with indicator determination as a critical prerequisite if sustainability is the goal. This approach has been prevalent earlier in New Zealand, Canada, Denmark, the Netherlands (Ward, 1990; Holten-Andersen *et al*. 1998; Environment Canada

Technium Social Sciences Journal
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1991; Alberti and Parker 1991). Local Agenda 21 and the OECD[b] (1993) provide generic lists of indicators as a default; however, most deal with global problems, with very few local, regional and national indicators being found on the lists. The nature of an area (either, urban, rural, city, farming, coastal or nature conservation) represents the specific context that must guide the relevance of indicators for sustainability evaluation from a pool of generic globally determined indicators that are not appropriate on every environmental scale.

There is a limited range of categories for environmental indicators to choose from. Generally, commonly used indicators are concerned with the atmosphere, air, climate, biodiversity, natural resources, settlement problems, waste, water, population and health (OECD[a] 1991. According to Eurostat (1999), these categories, together with individual measures within them, can change when specific (local conditions) are taken into consideration. In the Environmental Resource Program (ERP) for example, the Carolina Environmental Program resorted to the qualities of both air and, exposed water in dams or rivers, solid waste, hazardous waste, vehicle usage in miles and licenced bulk marine fish caught as appropriate indicators for environmental quality (UNC 2008). The indicators that were appropriate for the city of Coventry's environmental assessment system were: waste accumulated and recycled, wetlands, wildlife reserves, household water usage, electricity usage, surface and impurified water quality, and air quality (City of Coventry 2008). In Seattle, the forward thinking of Sustainable Seattle (S2), saw appropriateness in: refuse accumulation and disposal, recycling, energy conservation, material balances, nature parks, protected wildernesses and ecological footprint, as indicators (CIC 2016). The Community Indicators programme has become a recognised prototype for sustainability evaluation (Holden 2006; Palmer and Conlin 1997; Anderson, 2010). In the National Framework for Sustainable Development (NFSD), under the auspices of SA Department Environmental Affairs and Tourism (DEAT) within the framework of LA21, national experts and stakeholders working on a system of indicators for local environments proposed the following categories: public health, toxic materials, air quality, water consumption, efficacy of depuration, waste output, waste recycling, vehicle usage, urban greenhouse gas emissions, and electricity usage (de Souza *et al*. 2017). That framework provides guidance to this study's choice of indicators appropriate for use in ADM as listed in Table 1 with the meanings thereof explained briefly in the following paragraph.

The general pressure exerted on any inhabited environment is indicated by population density (number of people per km^2) which is the number of people that make up a population. The usage of resources endowed to an area of a selected magnitude quantifies resource depletion. These resources include, household water consumption (per capita m^3), electricity (per capita kWh), soil and gravel excavated from quarries (m^3 displaced), road construction (network of roads per km^2 of land area), and reservation of dump sites for solid waste (volume in m^3). The quality of portable water is affected by chemicals including: heavy metals, phosphates, nitrates, chlorine, ammonia, organic compounds herbicides, pesticides, and acid rain and the indicators thereof inform many parameters included. The measurement instruments for the quality of water only detects measurements from a certain minimum level, which also determined inclusion of such indicators. Only nitrates and chlorine made it on the list according to this criterion, measured in mean values (mg $lt^{-}1$) per annum.

Port Alfred LM was the only site with a monitoring station for the quality of air and this left 95 percent of ADM without information about air pollution. The per capita number of cars serve a dual purpose, i.e. to estimate air pollution and the pressure from traffic congestion that reduces mobility. Air pollution is also caused by a significant number of industries that discharge CO^2 emissions. Environmental degradation is also impacted on by road development

Technium Social Sciences Journal
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which an additional indicator included in table 2 for land consumption and alteration. Clarity is required in the meaning of this indicator to avoid ambiguity since it has both cost and benefit implications. If a cost criterion is intended, a lower cost measurement is desirable, otherwise as criteria measuring benefits, the higher on the scale, means better. In most localities, traffic congestion is persistently a source of problems that flow from insufficient road development; therefore, the indicator was used to measure costs. The effects of public transport are twofold; i.e. it reduces the number of cars and therefore air pollution, and increases mobility at the same time. To measure this effect on the environment, the percentage of the population that often use public transport was included as an indicator.

It has been documented that international organisations (World Bank (WB), United Nations Development Programme (UNDP), United Nations Environmental Commission (UNEC), International Council for Local Environmental Initiatives (ICLEI) and the OECD) have long amassed generic environmental and socioeconomic indicators which have proliferated within the scientific literature. These generics have proved to be relevant mostly on a national scale, with limited application when filtered down to a widely granular sub-national special reference needed for local level sustainability analysis. This weakness is a valid motivation for separate local municipalities to vote with their feet and use their autonomy in selecting indicators with relevance to local conditions. According to Streimikiene (2015), indicators first evaluate all areas and then identify both aspects and with substandard performance that concerns management. If such indicators are applied with sensitivity to management decisions, critical local issues must therefore influence them for adequate representation local particular environmental and prevailing socioeconomic conditions. This clarifies why there should be a focus on identifying indicators locally where they should include the three minimum conditions prescribed by LA21 programme and commonly applied internationally: i.e., "policy relevance, analytical soundness, measurability" (OECD[b] 1993).

The selection process of indicators need not be a wholesale sourcing information for all indicators, instead, it must be contextual, i.e., selectively analysing the only those which are more fundamental in essence and the best suited to provide the most reliable information about the status of sustainability for a particular locality (Nathan and Reddy 2010; Farinha *et al.* 2019). In Mega and Pedersen (1998)'s view, selection must aim at indicators that are, simple, clear, scientifically sound, valid, verifiable reliable and replicable with same effect. In this study, the following set of indicators (table 2) that meet multiple criteria of measurability, simplicity, availability, cost-effectiveness, acceptability and relevance (Belton and Stewart 2002) was determined as applicable at municipality level for ADM. These indicators were developed to measure the local sustainability performance according to EC priorities in general and ADM in particular.

The researcher is appreciative of the fact purpose and importance of using common indicators for monitoring, evaluating and comparing the process of environmental sustainability for the purpose of developing 'sustainability' from just being an abstract concept to an empirical concept. The comparability of ADM indicators is important, for it will allow municipalities in SA to have a standardised and single pool to share and apply successful tools and measures from. The major function of sustainability indicators is to assess environmental quality performance, which brings the importance of ability to compare performance between similar municipal areas to the fore. Yigitcanlar and Lönnqvist (2013) opined that comparability serves to validate and improve indicators, bringing clarity to complex and theorical policy issues. Standardisation is an important contributor in enhancing cooperation and knowledge sharing within and between municipalities (Pires *et al*. 2014).

Technium Social Sciences Journal
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Agriculture is a significant contributor to the EC economy (ECDC 2020; Global Africa Network 2019) with serious ramifications on the quality of water. Estimation of non-point pollution in ADM was via the population of livestock, (tonnes per km^2) reared on every farm in the local municipality. According to Cestii *et al.* (2003:16) sub-national level authorities are confronted by the enormous challenge of nontreated wastewater in pursuit of sustainability initiatives. Nontreated wastewater discharge, enormously impacts negatively on both people and water reservoirs. Scientists estimate that severe pathogenic pollution, ostensibly due to lack of sanitation treatment, contaminates almost one third of rivers in developing countries, with direct consequences on health (UNEP 2019). The indicator for this condition expressed as a percentage of households dependent on secondary and tertiary sewage treatment plants is found on the list for estimation. Waste production is monitored by a twin set of indicators to determine the total output per capita, and the tonnage of waste collected after separation (plastic, paper, combustible fraction, glass, residual inert, and organic material). The former truly measures environmental pressure, while the later, is important for compliance with regulations from DEAT which encourages the collection of waste in separate forms, facilitating recycling, which is an important component of sustainability strategies. Municipal recycling efficiency was not part of the assessment, excluded because recycling in EC has over 70 percent private operations with centralised operations at a provincial scale, however, on the list appears waste collected after separation locally, which is an assessment for waste recycling potential.

Both kleindorpies and rural villages treat green areas with some local environmental value. Greening provide numerous services: air purification, noise levels reduction and recreational opportunities. Urban green areas coverage was exclusively considered in kleindorpies; excluding conservation areas found away from the vicinity of developed areas within the urban sprawl, since they are found in only two of the sample local municipalities. The annual budget that is allocated by each municipality on environmental protection, and the administrative units or programmes focusing on solving environmental issues or environmental awareness advocacy are also vital indicators for each municipality's priorities towards the environment, and were included in ADM.

Rank and file indicators are complimented by socioeconomic indicators showing usage of PHC facilities by communities. Adverse environmental conditions are known to be the cause of numerous human health ailments. Prevention of all forms of pollution (air, noise, water) is a formidable strategy of health problems avoidance in a sustainable society. However, the current practise has relegated the normal absolute prevention to an acceptable degree with enormous costs of cure that could have been avoided by prevention. Based on this analysis, it is incumbent on municipalities, with their close proximity to communities, to lead in public health monitoring through data compiled by PHC facilities. In ADM, at least one PHC clinic is allocated to every kleindorpie, while hospitals are a provincial function that allocates in fewer larger cities; accordingly, PHC clinics operate as centres of first referral, limiting services to only primary care. One of the objectives of this study was to come with a description of baseline environmental conditions, however, it was found necessary to include microeconomic indicators, specifically social housing, disposable income (wages and social grants) and banking facilities. Municipal own revenue in ADM is derived from service charges (water, electricity, sanitation, refuse removal), rates and taxes. The SA fiscal system significantly finances local government with financial grants which makes ADM financially viable to afford resources to its local municipalities, with financial benefits spilling over to environmental protection policies. Economic indicators are considered for ADM in this perspective bearing in mind the district's constitutional functions.

Technium Social Sciences Journal
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The list is completed by two other social indicators: rate of unemployment and an age index that stratifies local population demographics. The extent of unemployment presents enormous socioeconomic problems for all municipalities: the higher the rate, the bigger the budget allocated to job creation initiatives which withdraws public funds subjectively from other functions and often, the highest risk is on environmental initiatives. Health ethics legislation protecting privacy, prohibits institutions from releasing statistics on disease and links to deaths registered in all PHC facility of municipalities, thus, only analysed district level summaries were publicly available. Fossil fuel usage was considered inappropriate because of its multiple purposes in transport, commercial and domestic energy. In those kleindorpies where not more than two fuel filling stations are found, measuring fuel consumption would readily allow calculations for earnings per household; the cost of computing this would be prohibitive. The study list of indicators covers indicators that are empirically common for sustainability studies, although compounding problems are encountered (Hardi and Pinter 1994; Hammond *et al*. 1995).

Popular indicators i.e. deforestation or biodiversity loss were inappropriate for the study since all land in ADM's kleindorpies is urbanised and agriculture is intensive in commercial farms. Forests are confined to commercial plantations and protected areas. Consensus is seldom in the choice of indicators, therefore constant elimination and substitution is required, informed by relevance. Research is yet to come up with models to determine optimal solutions for selecting appropriate indicators. Each country is bound to have its own priorities for data collection and analysis, reflecting local needs for resource management and environmental regulation.

Data collection with the aid of municipal officials followed the completion of the list of indicators in form of a structured questionnaire. Validity and reliability of information was tested concurrently with filling some informational gaps with the aid of other agencies invited to provide independent information for cross-comparison. They were the Statistics South Africa (StatsSA), SALGA, Water Research Commission.

Application of MCA to environmental performance

Three stages are involved in multi criteria decision making approach i.e. conceptual framework development, followed by the assignment of weights by a panel (usually subject matter experts, professionals, academics) and finally the application of the model (Egilmez *et al*. 2015:8). This study's model is composed of 25 sustainability indicators grouped into several thematic impact areas. The measurable aspects (standards and criteria) applied in the comparison of local environment conditions to acceptable standards are 25 sustainability indicators (table 2) grouped into several impact areas, including socio, economic, air, energy, soil, water, buildings, transportation, health and waste. The values collected by the survey instruments were validated and presented as an effect table for MCDA, as shown in Table 3. Columns represent a kliendorpie by its code while rows relate to an assigned indicator. This table contain scores that calibrate performance. The lower value of a negative cost indicator is equivalent to better performance with reference to the aims and wishes of a community that is environmentally sustainable oriented. A quantitative (ratio) scale is applied in the measurement the entire list of criteria. Applying MCDA techniques in the evaluation, aggregation algorithms to the set of values were stored in the analysis metrics (AM) and in the criteria-weight vector were applied to evaluate the performance of alternative options. In line with MCDA requirements with regard to weight representing value of importance, the qualitative statements indicating the relative importance of criteria formed the basis of quantitative weight assignment.

Technium Social Sciences Journal
Vol. 38, 833-856, December, 2022
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It is advisable that such a framework is designed by a team made of groups and professional individuals, such as regulatory entities, non-governmental organisations (NGO) academic institutions, and government officials (Sébastien and Bauler 2013). The production of qualitative statements involved a purposefully selected group of officials with sustainability expertise who ranked the criteria in according to importance guided by their professional perceptions, using a generic 1 to 7 ranking (listing starting at the least ascending to the greatest) point Likert scale (Sauro and Lewis 2016). These experts provided a variety of views; supplementing the researcher, who stood for scientific community view-points, environmental regulatory entities (provincial DEAT official) and sector regulatory agencies (WRC scientist), seven officials from each local municipality and ADM were requested to participate. 15 officials, representing a variety of economic sectors and other experts from allied subjects were invited to participate, but only four academics from Nelson Mandela Metropolitan, Fort Hare, Rhodes and Walter Sisulu universities participated.

Eighteen municipal respondents submitted their vectors of 25 values which were averaged to obtain only one vector sufficient to represent their expert view. It is necessary for every point of view to have only one representative of vector of preferences, regardless of the number of panellists with a common view point. To get a distinct vector of priority values for all the study criteria (an average for 25 vector preferences), the panel vector was averaged with the researcher's; the resultant values forming this vector being used in the expression of the relative importance of the 25 criteria.

Evaluation of individual alternatives is strictly required, thus, in this method of pair-wise comparison, characteristics and options are presented in sets of two. A value of 1 is consistently assigned a characteristic when compared to its mate, hence, in the table, the anchor diagonal values of the pair-wise comparison matrix are all 1. Odd numbers 3, 5, 7, and 9 indicate verbal judgements in the order of importance, ranging from 'moderate to', 'strong', 'very strong', and 'absolute' respectively. Even numbers 2, 4, 6, and 8 have a mitigating effect between the odd values. The judgments are derived using fundamental scale of analytical hierarchal process (AHP) (Darji and Rao 2013). A comparison was made between each coefficient to the rest, maintain pairs for obtaining quantitative weights within the vector. Replicating scale Kok and Lootsma (1985) and Janssen (1994), the difference obtained from each comparison was expressed on the base of the nine-point Likert scale.

Table 4, illustrates that X8 (mean concentration of nitrates) as the indicator which was assigned the greatest value in the vector of averaged preferences. The last position was shared by four indicators in terms of preference—X20, X22, X23 and X25, index of per capita bank facility, home ownership, age and unemployment, respectively. X8 compared with the least important indicators produced the widest observed difference from all possible pairs, elevating X8 to a class that is considered very much more important than indicators X20, X22, X23 and X25, and these differences assigned the highest value (9).

An analysis matrix (AM), was constructed with coefficients ultimately quantifying the importance variances by comparing the indicator in the row to the column, guided by values displayed by vector of the averaged preferences. Coefficients of the eigenvector with the largest eigenvalue of matrix AM are the source of weights applied in MCDA (Ross 1998; Schmidt *et al*. 2015; Saaty, 1990). Table 4 is an array of vector of weights and values of averaged preferences used in ADM. DEFINITE generated the various sets of weights required in Regime and Expected Value methods, systematically starting from the point of vector of averaged preferences. Fulfilling the relative priorities expressed in the vector of the averaged preferences was the only condition that qualified all vector of weights to be included as part of the so-called

Technium Social Sciences Journal
Vol. 38, 833-856, December, 2022
ISSN: 2668-7798
www.techniumscience.com

feasible set. The four DEFINITE analytical sub-systems determined a variety of rankings that were subjected to evaluation using a simple Spearman's correlation analysis and applied to the rankings obtained at the stage of multiple-criteria evaluation by various algorithms (Statistics Solutions 2019). Table 5 is the summary of the results obtained using this method.

Although rankings obtained by 'Regime' marginally differ from the others, the insignificant difference is indicative of a strong concurrence from the observation. Regime correlation coefficients does not surpass 0.9, while other three methods display correlations bound within the range of 0.9 and 1 but above Regime result. Specifically, 'Weighted Summation' and 'Expected Value' revealed remarkably similar ranking. Overall ranking was calculated with utmost certainty, emanating from the high correlation between the four methods. Iteratively assigning an option a higher ranking in a pairwise comparison having ascertained that it has a better score than another for more than 70 percent of the methods utilised, results in this overall ranking (Janssen and van Herwijnen 1994). Table 6 below shows the overall rankings.

Discussion and conclusions

Discussion

In the broader scheme of sustainable development, the sustainability of the environment in which all development takes place, takes the centre stage. The responsibility of this centre stage falls on sub-national level units. Local governments which are closest to communities, must pay extra attention on the protection aspect of environmental management. The LA21 program, encourages authentic participation and wide collaboration by municipalities pursuing sustainability implementations for their jurisdictions over the long-term, for the benefit of future generations. Empirical evidence contains numerous examples of investigations on sustainability performance of environments on municipalities being conducted due to their high priority on strategic plans. Systematic and consistent determination of municipal environmental sustainability is a critical tool and strategy for good progress towards the achievement of sustainability.

Upon analysing the results, the picture that emerges is of a district subdivided with municipalities in two categories due to their rankings. Figures 2 and 3 plots the kleindorpie ranking considering two variables: population density and average height above the sea level; the results clearly separating kleindorpies belonging to coastal (blue bars) region and those that are situated inland in the landlocked region (brown bars) can be observed. With only two exceptions (Fort Beaufort and Adelaide), all the kleindorpies from the coastal (brown bars) category of municipalities occupy the first seven positions of the ranking. In the middle section of rankings (8-13), occupation of rankings is 50 percent distributed. The worst performing section of the rankings (14-18) is occupied by only kleindorpies from inland municipalities.

Certain indicators displayed remarkable variations that influenced the patterns that emerged. Water treated with nitrates and chlorine show significant increases of the two chemical compounds when it passes from inland to coastal areas. Results displayed by the nonpoint pollution of agriculture, display a similar trend. Motor vehicle population, road network establishment, solid waste accumulation and natural resource utilisation, has a propensity to increase along with population density, thus, environmental quality has an inverse relationship to population density, as portrayed in figure 2a. Population density does not follow any regional pattern. In terms of oversight and intergovernmental support, a provincial plan for sustainability requires remedial action to focus on categories differently. Aspirations to reach the same level of environmental quality for competing kleindorpies of the same region might

Technium Social Sciences Journal
Vol. 38, 833-856, December, 2022
ISSN: 2668-7798
www.techniumscience.com

be easier to achieve in the context where the municipalities they belong to reveal performance outcomes that are similar, because the administration will be confronted by smaller changes in their objectives. Sustainability strategies and programmes for inland municipalities have to pay a great deal of attention to their environment.

Adelaide was an exception from the inland category with good performance, indicating suggesting that emulation of its performance by peers is not insurmountable provided impediments in structures governance and funding, do not operate in hindrance to corrective action initiatives (i.e. ineffective regulation, population explosion, agricultural intensity, industrial and commercial activity). Quality improvement in environments with sectors with minimal economic hurdles is easier. Inland municipalities can turn around faster, even if presenting with worse performance compared to coastal municipalities in terms of agro-nonpoint pollution, secondary waste treatment, quality of portable water and the intensity of CO^2 discharging industries (Cestii *et al*. 2016). Any strategy to curtail activities of sectors currently regarded as critical to the local economy such as tourism, farming, logging or industry might be a futile exercise that can end up causing protracted conflicts.

Coastal municipalities (blue bars) generally show better environmental performance with some exceptions as the final ranking indicate. If the objective is to force local environmental quality homogeneity, poorly performing municipalities which is an anomaly in comparison with peers, must devise programmes for remedying environmental degradation.

An example from the results is ADM03, ADM04 and ADM08 ranked 11, 13 and 14 respectively, in contrast with the peers that occupy the first 7 positions. Poor performance in ADM, is contributed mainly by secondary and tertiary waste water treatment, the highest district age index and above provincial average unemployment. Of all the kleidorpies in coastal municipalities, ADM03, ADM04 and ADM08 rank very low in comparison with the others. ADM, demographically has categorised certain areas as having exceptionally high population densities, of which Butterworth ADM03 is one of them. ADM03's informal economic sector (retail trade and manufacturing) is sustainable, its CO^2 emission are quite significant, the ecological footprint supplement by green areas is negligible and the quality of portable water is very low. However, vehicle population is at par with those ranked 1-7. Kentani ADM04 has some environment performance characteristic of kleindorpies ranked 1-7, such as low nitrates and phosphates in portable water and low CO^2 emissions. ADM04's performance is compromised by a lower index of depuration. The rest of kleindorpies, achieve a higher place on the ranks (i.e. Stutterheim ADM16), while scoring worse in the same indicator. ADM04 scores very high electricity and water usage: only ADM09 and ADM14 in the district surpass that level of consumption. There is no extensive greening in ADM04 areas, while the skewed index on age index, leaning towards older people (+45) is an indication of population imbalance. With unusually three PHC clinics, this number does not correlate positively with the very low index for public health.

Akin to results based monitoring and evaluation (RBME) and management by objectives (MBO), rankings apportioned show the levels of each municipality's performance on environmental quality. Spurred by this information, municipalities put interventions in place to remedy deteriorating environmental conditions by worst performing municipalities. Poor environmental performance on any criteria of assessment required high priority in corrective action plans. Values assumed by the indicators must not monotonously influence the types of interventions as this requires multicriteria decision analysis (MCDA) techniques to be applied in the processes of crafting remedies. It will be useful to firstly identify and understand the processes that directly cause poor performance, since the process context may differ, requiring

Technium Social Sciences Journal
Vol. 38, 833-856, December, 2022
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www.techniumscience.com

context specific remedies. Careful consideration should also be made for particular boundary conditions (economic and social) as a further step to develop feasible remedial strategies. For these reasons, lessons from this research should not viewed as an attempt to strictly prescribe environmental policy actions. Nonetheless, the outcome of ADM outcomes as revealed by this study can be a vital stage to in environmental strategic planning where the local sphere of government can emulate or tailor-make indicators, targets, objectives, methodologies, scope or trends to benchmark environmental aspects.

Conclusions

Guided by NFSD and NDDS1, EC is transitioning toward sustainability and this research summarises contributions of ADM. A preliminary provincial database is now in place to tabulate baseline data on environmental conditions pertaining to ADM's six local municipalities in granular format according to 18 kleindorpies (purposeful sample). Consolidation of all available databases can prevent information asymmetry and close gaps of critical data being missed. The provincial database, although still work in progress, is significantly assisting in closing the information gap that has adversely affected the capacity to implement sustainable development policies in the province.

Environmental quality or sustainability being a multidimensional concept, required an analytical tool like MCA to identify patterns of environmental conditions. Accordingly, the study indicates that ADM is divided into two regions, each with distinct characteristics whose environmental conditions display similarities on the local municipalities within them. The patches correspond to the coastal region (municipalities bordering the Indian Ocean) and the central and western region (inland and landlocked) of the district.

Social and economic constraints have been documented as impediments to the actioning of sustainability strategic planning in the inland region where environmental quality is worse. The quality of the environment in the coastal region comparatively to inland region even though areas of concern exit. In view of the socio-economic constraint context, important aspects of a holistic scheme(s) to revitalise environmental sustainability must focus on reduced consumption of both surface and ground water, harnessing of ocean bound river water, alternative energy, reducing solid waste accumulation, improved sewage treatment and improving recycling output. Increased use of public transportation is recommended since communities seem not to be keen on it. ADM inherited a better public transport system in more kleindorpies that were not part of the homeland system in the EC province. Public road transport system for commuters is beset with poor levels of service emanating from issues of unreliable vehicles, safety of commuters, and escalating fares. Commuters are generally disgruntled by the level of service provided by transport operators. Government policy which currently targets the lowest part of the income hierarchy for subsidies, is the cause of in low private operator profitability and impacts negatively on commuter transport system. Conflicts, from self-interests, often surface when major economic sectors (tourism, manufacturing, commerce, industrial and agricultural) get obliged to curtail production activities to contain high rates of environmental decline in the absents of the above interventions. The MCDA concurrently revealed that the levels of environmental performance is heterogenous even if the municipalities were resident in same regional category. The coastal region has, two municipalities (Mnquma LM, Mbashe LM^{0}**)** perform much worse than the remainder (Ngqushwa LM; Great Kei LM^{0}); in these cases, particular areas must be targeted with relevant interventions. As with the central and western region, by contrast, two municipalities (Raymond Mhlaba LM, Amahlathi LM^{0}**)**

perform relatively well environmentally, with performance precedence eligible for emulation by those lagging behind.

A hypothetical environmental performance model that is ideal for all the municipalities could not be defined in the absents of an acceptable benchmark for the majority of indicators adopted. With that weakness being pervasive, the determination of a scale that ranks environmental sustainability has resourced ADM and its local municipalities with a guide to what they have achieved short of what they still have to do to reach acceptable standards of environmental sustainability. Experience in Melbourne is a good example where extensive participation is vital (Shen *et al*. 2011:19) and in Calgary (The Cities Alliance 2007:102). In this respect, The MCDA technique demonstrates particular appropriateness when it is explicit on the requirement that values of importance must be assigned. Consistency with this requirement, makes the evaluation process inclusive of perceptions which stretches the participatory democracy consistent with Agenda 21.

In this, study both quantitative and qualitative methods are applied using structured questionnaire-based interviews as data collection tools. The results indicate that municipalities generally succeed only as far as the first stage of planning but significantly lacks in the critical management stages of environmental sustainability implementations. This finding is coherent with the purpose and objectives for the formation of ICLEI and UCLG-MEWA (Kates *et al*. 2012:). South African municipalities participate in the LA21 program and they have embraced emerging environmentally sustainable management approach since 2008[vi]. Notwithstanding this achievement, there is overwhelming evidence that at the same time, municipalities still significantly lacking, practically, in implementations of environmental sustainability strategies with common weaknesses in innovative green buildings projects, ground-breaking renewable energy, and municipality-wide sustainable buildings.

Local municipalities are capable of adopting pro-sustainability initiatives for their environments targeting buildings, spaces and the workforce with relative ease, difficulties are confronted in adapting these environmental implementations for business entities and all communities in the municipalities. This failure purses enormous problems for the future of sustainability because municipalities in South Africa should imperatively adapt their communities to the sustainable development that their administration is pursuing. Bearing in mind that empirically, implementation of LA21 programs has been difficult (Azam and Osman 2012; Mehta 1996:315), in the long run, municipalities need guidance in finding best ways to vigorously adapt to systematically sustainability implementation. Overall, ICLEI is a formidable resource with its regularly revised guidance tools on lessons and best practices of LA21 programmes implementation (Mehta, 1996:310). Through SALGA, SA municipalities still keep ICLEI's guidance for sustainable development, however, the local administrative units still lag behind in living standards with sustainability.

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[i] Constitution of the Republic, Act 108, 1996 as amended.
[ii] Local Government: Municipal Systems Act 32, 2000.
[iii] National Development Plan, chapter 5.
[iv] National Framework for Sustainable Development (NFSD).
[v] This is a direct translation into Afrikaans and is popularly used as an English term by communities.
[vi] In 2008, Cabinet approved the South Africa National Framework for Sustainable Development (NFSD). The approval signalled a new wave of thinking aimed at promoting the effective stewardship of South Africa's natural, social and economic resources.