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Hlabi Dunstan Morudu

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*Corresponding author: Hlabi Dunstan Morudu, Research and Policy Analysis Unit, Statistics South Africa, Isibalo House, Kock Street, Pretoria 0001, South Africa
E-mail: Hlabim@statssa.gov.za

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Service delivery protests in South African municipalities: An exploration using principal component regression and 2013 data

Hlabi Dunstan Morudu^{1*}

Abstract: The proliferation of service delivery protests in South Africa, as regularly seen in the media, makes it necessary to explore the underlying relationship between the level of services delivered by local municipalities and the number of protests in the country. Can the relationship be used by policy-makers to minimise the number of protests? This paper is exploratory given data challenges, and uses principal component regression to assess the relationship between protests and available service delivery data at local municipality level. The paper finds that, to minimise the number of protests, local municipalities need to further increase the provision of basic services (e.g. housing, electricity, sewerage and sanitation, refuse removal, the number of schools, nurseries, crèches and hospitals) particularly in high population density areas. With regard to water services, focus should be placed more on actual water supply to communities rather than on the number of water accounts registered with municipalities.

Subjects: Area Studies; Development Studies, Environment, Social Work, Urban Studies; Social Sciences; Urban Studies; Development Studies

Keywords: service delivery; protests; South Africa; principal components regression



Hlabi Dunstan Morudu

ABOUT THE AUTHOR

Hlabi Dunstan Morudu (PhD) is a Chief Director at the Policy Analysis and Research Unit of Statistics South Africa, i.e. South Africa's National Statistics Office. He has extensive experience in the collection and interpretation of statistics in South Africa: initially for monetary policy formulation at the South African Reserve Bank (1994–2004); and subsequently for Statistics South Africa on various socio-economic development issues (2006–2017). Given severe scarcity of official data in South Africa for development planning at local municipality levels, he recently published a paper on the possible use of Zipf's rule in generating pertinent statistical estimates to fill the statistics gap. He has made several presentations in various intergovernmental forums on statistics research and socio-economic planning.

PUBLIC INTEREST STATEMENT

The increase in service delivery protests in South African local municipalities, as regularly seen in the media, makes it necessary for policy-makers to know the underlying behaviour between basic services and protests. The paper looks at protests throughout South Africa's 234 local municipalities. It isolates only those protests that were attributed to service delivery. The paper then contrast the number of identified protests with what local authorities have delivered on housing, water, electricity, sewerage, sanitation and refuse removal. Despite some challenges with available statistics, the paper establishes that protests generally occur in crowded local municipalities (mostly metropolitan municipalities) and in municipalities that experience decreases in the provision of basic services. To resolve most service delivery protests, the findings suggest more resources be channelled toward crowded areas with signs of decreases in the provision of basic services.

1. Introduction

The proliferation of service delivery protests in South African local municipalities, as regularly seen in the media, make it necessary to explore the underlying relationship between the level of services delivered by local municipalities and the number of protests in the country. Can the relationship be used by policy-makers to minimise the number of protests? This paper looks at the relationship between protests and available service delivery data, e.g. housing, water, electricity, sewerage and sanitation, and refuse removal at local municipality (including metropolitan areas) level. The objective is to assist policy-makers anticipate the occurrence of service delivery based protests, and enhance overall proactive efforts in averting protests.

The paper uses principal component regression to: (a) explore possible underlying components (i.e. combinations of variables) that possibly account for service delivery protests at local municipality level, and (b) to resolve problems of collinearity that pervade service delivery data, i.e. multicollinearity. The relationship between the underlying core components and the number of protests is then assessed to conclude on pertinent forecasting properties.

This paper is an exploration given challenges with available data. Firstly, there is a general lack of usable basic services data collected at lower geographical levels than local municipalities. For instance, one local municipality like the City of Johannesburg Metropolitan area has some 130 Wards where protest might take place, but available service delivery data is at local municipality level. The study is thus limited to aggregated basic services data at local municipality level released annually by Statistics South Africa. Secondly, Statistics South Africa releases local municipality population estimates only once every 5 years through Censuses and Community Surveys. There are no regular, official, annual population estimates at local municipality level. Thus simulated annual local municipality population sizes (i.e. for non-Census or Community Survey years), using Statistics South Africa's highly aggregated annual mid-year population estimates, are drawn from Morudu (2015).

Thirdly, the South African Police Services' Incident Registration Information System (IRIS), potentially a very useful source of data on the number of protests in the country, does not employ useful classification and reporting systems. That is, it conflates various types of protests and hence grossly misleads. In the absence of other authoritative sources of protest data, this study compiled the number of service delivery protests from all media reports captured in the world wide website. Despite potential news media coverage biases, the resulting protest numbers are found to be roughly consistent with those compiled by the Social Change Unit (University of Johannesburg), the Institute for Security Studies, and Municipal IQ (Alexander, Runciman, & Maruping, 2015; Lancaster, 2016).

Irrespective of the data challenges, the results (presented in Section 5) provide some useful insights on the relationship between protests and basic services. Section 2 sketches the nature of the problem in more detail. Section 3 explores discussions in the literature on the contribution of basic services to protests. Section 4 outlines the approach adopted in this paper. The results are presented in Section 5, while conclusions and recommendations are presented in Sections 6 and 7 respectively.

2. The problem and its parameters

The problem entails capturing the quantitative role of basic service delivery in stirring protests in South African local municipalities. The objective is not only to quantify the role of basic services in invoking protests, but to develop a possible mechanism through which policy makers can quantitatively assess and prospectively avert protests.

The paper treats protests as the dependent variable. That is, service delivery protests arise due to changes in a number of service delivery indicators. The independent variables, e.g. service delivery variables, that are seen to account for the occurrence of protests are regarded as follows. Firstly, the population size in local municipalities is included in the study as an independent variable mainly

because service delivery protests tend to be more frequent in densely populated municipalities (e.g. metropolitan areas) and least frequent in sparsely populated municipalities.

Secondly, protests are understood to be linked to an inadequate provision of basic services at local municipality level. Basic services in this paper are captured through statistics collected from local municipality accounts on water, electricity, sewerage, sanitation and refuse removal. Expenditures on new construction works by local municipalities in water, electricity, sewerage, sanitation and refuse removal, as an expression of local municipality efforts to expand on basic services, are also included as independent variables. In general, one would expect more protests in areas where there are severe shortages of one or more of the basic services water, electricity, sewerage, sanitation and refuse removal.

Thirdly, although local municipalities are not mandated with the provision of housing, housing has generally been interpreted as a basic service at least since the adoption of the Reconstruction and Development Programme in 1994. Protests tend to be more frequent in areas where there are severe housing shortages. Due to data limitations, this paper incorporates formal housing as a whole, provided mostly through the private sector but including the most basic housing (i.e. called RDP houses) provided by national government. Available data provides residential buildings certified as complete and ready for occupation by local authorities, and also provides certified extensions to residential buildings that are completed in the year.

Lastly and guided by available data, the provision of communal utilities such as schools, crèches, hospitals, churches, sport and recreation facilities are included as independent variables. The category also includes expenditures by local municipalities on new construction works of roads, streets and bridges. It is envisaged that lack of communal facilities increases the likelihood of protest.

The challenge is to assess which of the available independent variables are significant, which are insignificant, and whether useful relationships with protests can be established to guide policy in tackling protests. Section 3 follows with a review of the literature on the relationship between protests and basic service delivery.

3. Literature review and data issues

There has been very little quantitative research on the relationship between service delivery and protest in South Africa. Most studies on South Africa have tended to provide more qualitative insights on the relationship between basic service delivery and protest. They provide useful insights on the environment under which policy-makers operate.

One category of the qualitative studies identifies a number of service delivery obstacles (e.g. cumbersome legislative environment, weak intergovernmental fiscal relations, low managerial capacity in municipalities, poor public participation in development forums, political infighting, migration, corruption, a culture of rates boycott) that account for poor service delivery and the proliferation of service delivery protests (e.g. Asendorpf, 2000; Shaidi, 2013; Twala, 2014). Such obstacles do indeed have to be addressed to facilitate quicker service delivery and a reduction of service delivery protests.

Another category of available qualitative research presents the overall transition from Apartheid to democracy as being shallow. From independence in 1994, more concrete transition benefits took place between capital and the new elite, largely side-lined the poor, and invoked the resurgence of resistance from the poor manifest through service delivery protests (e.g. Alexander, 2010; Bond, 2006; Madlingozi, 2007; Naidoo, 2007; Siwisa, 2008). A much deeper transition, through a more thorough realignment of resources towards the poor, would have averted most service delivery strikes.

Perhaps due to data challenges, quantitative research on the problem is limited. Empowerdex, an economic empowerment rating agency (Empowerdex, 2009), presents quantitative research on

basic services (viz. housing, water, electricity, sanitation and refuse removal) that are actually provided by local municipalities (i.e. current status index), improvements made over time (i.e. improvement index) and an overall score based on Census 2001 and Community Survey 2007 data. Due to lack of usable protest data, the study simply ranks local municipalities based on performance indices. It would be difficult for the study to explain why most service delivery protests occur in metropolitan areas where overall service delivery indices are high, e.g. City of Cape Town (73.4) and City of Johannesburg (70.8) (Empowerdex, 2009, p. 21). There are least service delivery protests in some of the local municipalities with the least overall indices, like Msinga local municipality (18.55) (Empowerdex, 2009, p. 5).

By introducing statistically useful protest data, this paper makes it possible to quantitatively explore a more explicit relationship between protests and service delivery. The paper is aimed more at guiding policy formulation quantitatively under the institutional environment discussed in the outlined qualitative studies. The paper adds more insights on currently available quantitative research through use of principal components regression, outlined in Section 4.

4. Approach

The study adopts principal components regression, illustrated in detail in Fekedulegn, Colbert, Hicks, and Schuckers (2002), as a useful approach to identify possible components that relate the provision of basic services to resultant protests. Principal components regression as an approach, typically enables an assessment of the effects of a large number of possible independent variables by reducing them into fewer more comprehensible components (i.e. combination of variables) and usable results. Significantly, the reduction into components (or usable variables) is done without undermining the statistical properties of the entire set of variables.

For an outline of principal components regression, consider a typical multiple regression equation of the form:

$$y = X\beta + \varepsilon \tag{1}$$

where:

$$y = \begin{pmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{pmatrix} (n \times 1) \quad X = \begin{pmatrix} x_{11} & x_{21} & \dots & x_{p1} \\ x_{12} & x_{22} & \dots & x_{p2} \\ \vdots & \vdots & & \vdots \\ x_{1n} & x_{2n} & \dots & x_{pn} \end{pmatrix} (n \times p) \quad \beta = \begin{pmatrix} \beta_1 \\ \beta_2 \\ \vdots \\ \beta_p \end{pmatrix} (p \times 1) \quad \varepsilon = \begin{pmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_n \end{pmatrix} (n \times 1)$$

with the number of protests (i.e. the dependent variable) in matrix y for each local municipality 1 to n ; p independent variables in matrix X (i.e. different basic services x_1, x_2, \dots, x_n) for each of the n local municipalities; and matrix β with coefficients $\beta_1, \beta_2, \dots, \beta_p$ that are to be estimated for respective basic services. The error term matrix ε , with error terms for each local municipality i , is normally distributed with a zero mean and a constant variance, i.e. $\varepsilon_i \sim N(0, \sigma^2)$.

Ordinary least squares estimates of β (denoted $\hat{\beta}$) are provided by:

$$\hat{\beta} = (X'X)^{-1}X'y \tag{2}$$

and the variance-covariance matrix of $\hat{\beta}$ is depicted as:

$$\text{Var}(\hat{\beta}) = \sigma^2(X'X)^{-1} \tag{3}$$

The observations in matrices X and y can be standardised through:

$$\dot{X}_{ij} = (x_{ij} - \bar{x}_i) / s_{xi} \quad (4)$$

where \dot{X}_{ij} denotes each standardised observation in column i and row j of matrix X ; \bar{X}_i is the mean of column i ; and s_{xi} is the standard deviation of observations in column i . The y matrix is similarly standardised. Standardisation retains the essential properties of Equation (1).

For the development of principal components (see Fekedulegn et al., 2002, pp. 3–8), note that $X'X$ in Equation (2) is the correlation matrix among the different types of basic services. Find eigenvalues ($\lambda_1, \lambda_2, \dots, \lambda_p$) through the determinant:

$$|X'X - \lambda I| = 0 \quad (5)$$

where I is an identity matrix. Each eigenvalue λ_i is associated with an eigenvector v_i that satisfies the equation:

$$(X'X - \lambda I)v_i = 0 \quad (6)$$

The vectors $v_i = (v_{1i}, v_{2i}, \dots, v_{pi})'$ provide normalised eigenvectors such that $v_i'v_i = 1$ and $v_i'v_j \neq 1$ for all $i \neq j$. The eigenvector matrix V is orthogonal and normal with $VV' = I$. Equation (1) can thus be written as $y = XVV'\beta + \varepsilon$, or $y = XZ\alpha + \varepsilon$ when $Z = XV$ and $\alpha = V'\beta$. The matrix Z consists of uncorrelated principal components z_1, z_2, \dots, z_p with z_1 accounting for the largest variance, z_2 accounting for the second largest variance in the remainder of the total variance, and so on. The matrix α provides pertinent coefficients, viz:

$$\hat{\alpha} = (Z'Z)^{-1}Z'y \text{ with } \text{Var}(\hat{\alpha}) = \hat{\alpha}^2(Z'Z)^{-1} \quad (7)$$

The matrix Z retains the same statistical information as the standardised X matrix though the data are reconstituted into uncorrelated variables. Even more remarkable, the statistical information is retained even when less useful principal components are discarded. That is, one can discard principal components with: (a) the least eigenvalues, (b) with eigenvalues less than 1, or (c) the least t -values. The approach adopted in this paper entails discarding principal components with the least t -values. The results of $\hat{\alpha}$ in Equation (7), after discarding insignificant principal components, are then scaled back to the original values of basic services variables.

4.1. Data issues

This paper is an exploration given challenges with available data. There is a general lack of usable data defined at lower geographical levels than local municipalities. The study is thus limited to aggregated basic service indicators compiled and annually released by Statistics South Africa at local municipality level.

Data on basic services for local municipalities, i.e. supplies in water, electricity, refuse removal, sewerage and sanitation services, is drawn from the 2013 Non-Financial Census of Municipalities (P9115) (Statistics South Africa, 2014a). The annual census provides the total number of consumer units (e.g. household units, household blocks as in flats) registered by local municipalities in their accounts for water, electricity, refuse removal, sewerage and sanitation. A major limitation of using the number of accounts registered by local municipalities is that there might, in some instances, not be actual service delivery in households as may occur with prolonged electricity blackouts or water supply closures.

Residential building data (which includes government sponsored residential units) and communal buildings (e.g. schools, hospitals, churches) data is drawn from the 2013 Selected Building Statistics of the Private Sector as Reported by Local Government Institutions (P5041.1) (Statistics South Africa, 2014c). The selected data refer to new formal buildings that have been officially declared as

completed in the year by local municipality authorities. The population census provides more detailed categories of residential buildings, including informal dwellings where much service protest takes place, but the population census occurs only once in ten years. The annual General Household Survey, which also offers detailed household categories, provides highly aggregated national and provincial estimates that are inadequate for the study.

Expenditure on new construction works by local municipalities in residential buildings, water, electricity, sewerage, sanitation, refuse land sites, community assets, roads, streets and bridges is drawn from Capital Expenditure by the Public Sector (P9101) (Statistics South Africa, 2014b). Population estimates at local municipality level, deduced from the Mid-year Population Estimates (P0302) (Statistics South Africa, 2014d), are drawn from Morudu (2015).

There is no usable official data on protests. The paper generated South African protest data, strictly those associated with the provision of basic services (i.e. housing, water supply, electricity supply, refuse removal, sewerage and sanitation), from all media reports in the worldwide web. The data provides estimates similar to those cited elsewhere (Alexander et al., 2015; Lancaster, 2016; Municipal IQ, n.d.). It excludes protests based on other factors like health, education, security, employment, transport, demarcation, political representation, corruption, xenophobia and witch-hunts. Out of a sample of 67 recorded service delivery protests in 2013, the majority took place in provinces Gauteng (28), Western Cape (12), Eastern Cape (11) and Kwa Zulu-Natal (10).

Of all the annual independent variables considered in this study, none has a usable stable time series. That is, the forecasting of protests cannot be based on time series (e.g. from today to tomorrow) as would have been desired, but on where it happens most. Thus the study focuses on 2013 cross-sectional data, a year following major improvement in the reporting of basic services data, and a year where all surveys used in this study had published. In total, the study has one dependent variable (i.e. protests) and 16 independent variables. Table 1 presents all the selected variables and their respective summary statistics. Section 5 presents the main results of this study.

Table 1. Summary statistics of selected data on service delivery and protests at local municipalities

Variable	Observations	Minimum	Maximum	Mean
Protests2013	233	0.000	18.000	0.288
Pop2013	233	7,170.000	4,609,667.000	225,781.506
WS2013	233	0.000	963,906.000	39,500.725
ES2013	233	700.000	822,397.000	42,633.227
SSS2013	233	0.000	793,272.000	34,611.292
SWS2013	233	0.000	973,455.000	36,295.438
RBC2013	233	0.000	12,434.000	334.056
ARBC2013	233	0.000	11,668.000	123.880
SNCHC2013	233	0.000	18.000	0.326
CSRBC2013	233	0.000	24.000	0.597
ENCWRB2013	233	0.000	166,806.000	1,158.056
ENCWRSB2013	233	0.000	870,290.000	14,216.609
ENCWW2013	233	0.000	370,828.000	8,410.172
ENCWE2013	233	0.000	758,493.000	8,583.614
ENCWSS2013	233	0.000	416,090.000	6,004.923
ENCWRLS2013	233	0.000	75,562.000	989.764
ENCWCA2013	233	0.000	461,197.000	8,702.455

Variable definitions

ARBC2013—Additions to existing residential buildings completed in 2013
CSRBC2013—Churches, sports and recreation buildings completed in 2013
ENCWCA2013—Expenditure on new construction works: community assets in 2013
ENCWE2013—Expenditure on new construction works: electricity in 2013
ENCWRB2013—Expenditure on new construction works: residential buildings in 2013
ENCWRLS2013—Expenditure on new construction works: refuse land sites in 2013
ENCWRSB—Expenditure on new construction works: roads, streets and bridges in 2013
ENCWSS2013—Expenditure on new construction works: sewerage and sanitation in 2013
ENCWW2013—Expenditure on new construction works: water in 2013
ES—Number of consumer units receiving electricity in 2013
Pop2013—Estimated populations size in 2013
Protests2013—Number of service delivery protests in 2013
RBC2013—Residential buildings completed in 2013
SNCHC2013—Schools, nursery schools, crèches and hospital buildings completed in 2013
SSS2013—Number of consumer units receiving sewerage and sanitation services in 2013
SWS2013—Number of consumer units receiving solid waste services in 2013
WS2013—Number of consumer units receiving water in 2013

5. Results

Table 2 presents the correlation matrix (i.e. matrix $X'X$) and reveals some broad patterns. There are very high correlations among basic services water (WS2013), electricity (ES2013), solid waste (SWS2013), sewerage and sanitation (SSS2013). There are also very high correlations among all the selected buildings. Basic service variables and building variables are in turn highly correlated with population size, an aspect that highlights the significance of population size on both sets of indicators.

There are generally weak correlations among expenditure variables on new construction works by local governments, probably an indication of unsynchronised expenditure patterns. A few expenditures have relatively strong correlations, viz. (a) residential buildings (ENCWRB2013) with community assets (ENCWCA2013); (b) sewerage and sanitation (ENCWSS2013) with roads streets and bridges (ENCWRSB2013), water (ENCWW2013) and electricity (ENCWE2013); and (c) community assets (ENCWCA2013) with electricity (ENCWE2013), sewerage and sanitation (ENCWSS2013).

Protests are most correlated with population size (Pop2013), water supply (WS2013), electricity supply (ES2013), sewerage and sanitation (SSS2013), solid waste (SWS2013), residential buildings completed (RBC2013) and additions to residential buildings (ARBC2013) among others. They are least correlated with expenditure in new construction works of residential buildings (ENCWRB2013), refuse land sites (ENCWRLS2013), roads, streets and bridges (ENCWRBS2013).

The eigenvalues of the correlation matrix are presented in Table 3. The first three principal components, i.e. those with an eigenvalue of 1 or greater, account for 83.05 per cent of the total variation (Figure 1 presents a Scee Plot of the eigenvalues). Subsequent principal components could be discarded or included for analysis depending on their usefulness. Table 4 presents eigenvectors of all 16 principal components.

The initial set of regression results on the 16 principal components are presented in Table 5. Using t-statistic values to select the number of useful components, all components with $|t| < 2$ are discarded and the process culminates into Table 6 with 8 statistically significant and standardised service delivery protest variables.

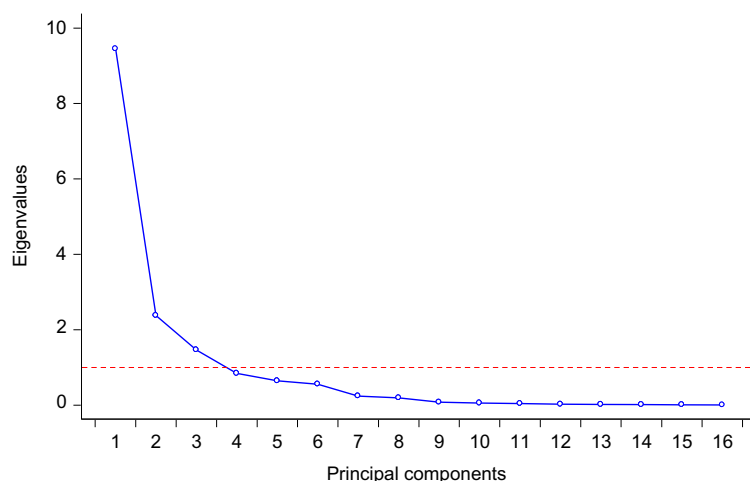
Table 2. Coefficients of correlation among the variables

Variables	Pop 2013	WS 2013	ES 2013	SSS 2013	SWS 2013	RBC 2013	ARBC 2013	SNCHC 2013	CSRBC 2013	ENCWRB 2013	ENCWRSB 2013	ENCWW 2013	ENCWE 2013	ENCWSS 2013	ENCWRLS 2013	ENCWCA 2013	Protests 2013
Pop2013	1.000	0.966	0.969	0.961	0.964	0.766	0.658	0.518	0.521	0.482	0.422	0.356	0.568	0.495	0.260	0.715	0.821
WS2013	0.966	1.000	0.973	0.994	0.964	0.728	0.621	0.463	0.502	0.497	0.501	0.402	0.561	0.559	0.237	0.734	0.797
ES2013	0.969	0.973	1.000	0.968	0.943	0.804	0.703	0.585	0.592	0.557	0.478	0.426	0.655	0.554	0.303	0.796	0.758
SSS2013	0.961	0.994	0.968	1.000	0.973	0.718	0.612	0.453	0.484	0.454	0.503	0.418	0.557	0.562	0.234	0.700	0.776
SWS2013	0.964	0.964	0.943	0.973	1.000	0.696	0.616	0.435	0.478	0.353	0.498	0.371	0.556	0.567	0.232	0.644	0.787
RBC2013	0.766	0.728	0.804	0.718	0.696	1.000	0.862	0.788	0.718	0.665	0.083	0.330	0.748	0.242	0.477	0.758	0.636
ARBC2013	0.658	0.621	0.703	0.612	0.616	0.862	1.000	0.804	0.785	0.395	0.164	0.382	0.933	0.355	0.585	0.666	0.684
SNCHC2013	0.518	0.463	0.585	0.453	0.435	0.788	0.804	1.000	0.751	0.549	0.007	0.288	0.740	0.160	0.491	0.640	0.406
CSRBC2013	0.521	0.502	0.592	0.484	0.478	0.718	0.785	0.751	1.000	0.447	0.166	0.224	0.764	0.312	0.452	0.652	0.458
ENC- WRB2013	0.482	0.497	0.557	0.454	0.353	0.665	0.395	0.549	0.447	1.000	-0.020	0.108	0.333	0.062	0.226	0.803	0.242
ENC- WRSB2013	0.422	0.501	0.478	0.503	0.498	0.083	0.164	0.007	0.166	-0.020	1.000	0.487	0.380	0.925	-0.004	0.440	0.289
ENC- WW2013	0.356	0.402	0.426	0.418	0.371	0.330	0.382	0.288	0.224	0.108	0.487	1.000	0.447	0.546	0.184	0.284	0.307
ENC- WE2013	0.568	0.561	0.655	0.557	0.556	0.748	0.933	0.740	0.764	0.333	0.380	0.447	1.000	0.554	0.563	0.707	0.545
ENC- WSS2013	0.495	0.559	0.554	0.562	0.567	0.242	0.355	0.160	0.312	0.062	0.925	0.546	0.554	1.000	0.114	0.545	0.389
ENC- WRLS2013	0.260	0.237	0.303	0.234	0.232	0.477	0.585	0.491	0.452	0.226	-0.004	0.184	0.563	0.114	1.000	0.354	0.276
ENCW- CA2013	0.715	0.734	0.796	0.700	0.644	0.758	0.666	0.640	0.652	0.803	0.440	0.284	0.707	0.545	0.354	1.000	0.502
Pro- tests2013	0.821	0.797	0.758	0.776	0.787	0.636	0.684	0.406	0.458	0.242	0.289	0.307	0.545	0.389	0.276	0.502	1.000

Table 3. Eigenvalues of the correlation matrix

	Component 1	Component 2	Component 3	Component 4	Component 5	Component 6	Component 7	Component 8
Eigenvalue	9.451	2.375	1.463	0.843	0.644	0.553	0.237	0.191
Variability (%)	59.072	14.842	9.141	5.270	4.027	3.459	1.479	1.196
Cumulative (%)	59.072	73.913	83.054	88.324	92.351	95.809	97.288	98.484
	Component 9	Component 10	Component 11	Component 12	Component 13	Component 14	Component 15	Component 16
Eigenvalue	0.075	0.056	0.040	0.024	0.021	0.016	0.009	0.003
Variability (%)	0.469	0.350	0.249	0.149	0.129	0.098	0.056	0.017
Cumulative (%)	98.954	99.303	99.552	99.701	99.830	99.928	99.983	100.000

Figure 1. Scree plot (ordered eigenvalues).



As expected, protests are negatively related to the number of consumer units supplied with electricity (ES2013), sewerage and sanitation services (SSS2013), the number of schools, nurseries, crèches and hospitals completed (SNCHC2013), expenditure on new construction works of residential buildings (ENCWRB2013) and electricity (ENCWE2013). For instance, an increase in the number of consumer units supplied with electricity is expected to decrease the likelihood of protests. Protests are most sensitive to sewerage and sanitation services (SSS2013) with a coefficient of -2.008 while protests are least responsive to expenditure on new construction works in residential building with a coefficient of -0.261 .

Also as expected, protests are positively related with population size (Pop2013) and additions to residential buildings completed (ARBC2013). That is, the higher the population size, the higher the likelihood of protest. Further, an increase of completed extensions in residential buildings (particularly in crowded areas) is an indicator of potential protest. Extensions completed on residential buildings, suggesting overcrowding, account for a high responsiveness to protests with a coefficient of 0.915 .

The positive relationship between protest and the number of consumer units connected to water supply (WS2013) is least expected. It may suggest the number of registered consumer units at local municipalities does not necessarily translate into actual water supply. For instance, in Letlhabile consumer units (like households) that were duly registered in the local municipality's accounts engaged in protest due to protracted unavailability of water.

Table 4. Eigenvectors (loadings) of all the components

	Component 1	Component 2	Component 3	Component 4	Component 5	Component 6	Component 7	Component 8	Component 9	Component 10	Component 11	Component 12	Component 13	Component 14	Component 15	Component 16
Pop2013	0.294	0.113	-0.251	-0.203	-0.015	0.001	0.009	0.080	0.009	0.101	0.712	-0.146	0.163	-0.022	-0.462	0.102
WS2013	0.295	0.166	-0.237	-0.133	0.001	0.051	0.071	-0.034	-0.204	-0.066	-0.303	-0.313	-0.164	0.219	-0.194	-0.674
ES2013	0.310	0.096	-0.180	-0.077	0.018	0.014	0.042	0.061	-0.089	-0.161	0.061	0.039	0.647	0.083	0.617	-0.070
SSS2013	0.292	0.179	-0.226	-0.184	0.018	0.042	0.066	-0.003	-0.158	-0.035	-0.466	-0.044	-0.045	0.193	-0.152	0.696
SWS2013	0.285	0.188	-0.205	-0.284	-0.075	-0.016	0.024	0.050	0.070	0.210	-0.019	0.546	-0.361	-0.474	0.192	-0.110
RBC2013	0.285	-0.233	-0.093	-0.053	0.140	-0.055	-0.206	-0.217	0.822	-0.157	-0.113	0.017	0.011	0.148	-0.056	-0.034
ARBC2013	0.275	-0.228	0.209	-0.190	-0.031	-0.171	-0.341	-0.225	-0.201	-0.003	0.147	-0.503	-0.321	-0.193	0.350	0.134
SNHC2013	0.235	-0.341	0.113	0.061	0.126	-0.245	-0.007	0.848	0.013	0.050	-0.093	-0.027	-0.054	0.029	-0.029	-0.019
CSRBC2013	0.239	-0.247	0.174	0.082	-0.245	-0.373	0.759	-0.258	0.016	0.014	0.024	0.016	-0.002	-0.002	-0.025	0.013
ENC-WRB2013	0.190	-0.230	-0.336	0.597	0.204	0.247	0.034	-0.101	-0.080	0.072	-0.116	-0.154	0.097	-0.510	-0.088	0.031
ENC-WRSB2013	0.153	0.486	0.264	0.246	-0.204	0.059	0.055	0.185	0.166	-0.634	0.058	-0.121	-0.131	-0.243	-0.026	0.048
ENC-WW2013	0.158	0.205	0.357	-0.010	0.851	0.026	0.180	-0.118	-0.081	0.011	0.097	0.102	-0.069	0.052	0.006	-0.011
ENC-WFE2013	0.268	-0.130	0.371	-0.006	-0.128	-0.142	-0.390	-0.185	-0.289	-0.119	-0.162	0.368	0.341	-0.122	-0.388	-0.097
ENC-WSS2013	0.195	0.404	0.325	0.227	-0.187	0.015	-0.080	0.027	0.229	0.682	-0.121	-0.200	0.155	0.037	0.037	-0.008
ENC-WRLS2013	0.147	-0.292	0.320	-0.259	-0.145	0.812	0.191	0.075	0.035	0.013	0.005	-0.006	0.006	0.003	-0.001	-0.003
ENCW-CA2013	0.281	-0.050	-0.065	0.485	-0.132	0.135	-0.146	-0.059	-0.159	0.000	0.263	0.318	-0.342	0.533	0.145	0.033

Table 5. Component coefficients

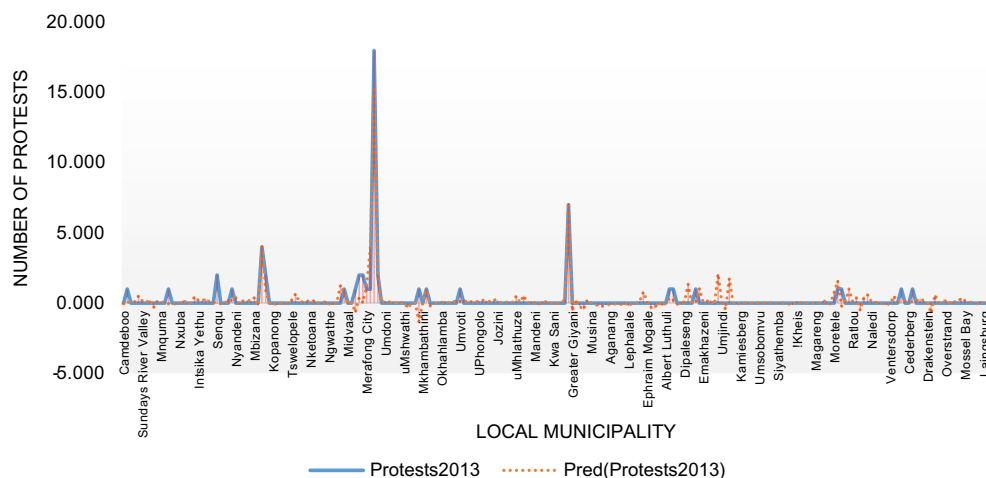
Source	Value	t	Pr > t
Intercept	0.288	8.391	<0.0001
Component 1	0.363	32.555	<0.0001
Component 2	0.100	4.514	<0.0001
Component 3	-0.173	-6.096	<0.0001
Component 4	-0.586	-15.695	<0.0001
Component 5	-0.079	-1.856	0.065
Component 6	-0.123	-2.678	0.008
Component 7	-0.245	-3.481	0.001
Component 8	-0.401	-5.115	<0.0001
Component 9	-0.540	-4.322	<0.0001
Component 10	0.334	2.308	0.022
Component 11	1.233	7.177	<0.0001
Component 12	-2.597	-11.703	<0.0001
Component 13	-1.493	-6.259	<0.0001
Component 14	0.747	2.727	0.007
Component 15	-0.808	-2.223	0.027
Component 16	-3.959	-6.002	<0.0001

Table 6. Reduced standardised protests coefficients

Source	Value	t-statistic	Pr > t
ARBC2013	0.915	10.260	<0.0001
WS2013	2.651	9.706	<0.0001
Pop2013	0.607	4.728	<0.0001
SNCHC2013	-0.157	-3.221	0.001
ES2013	-0.583	-3.256	0.001
ENCWE2013	-0.435	-5.308	<0.0001
ENCWRB2013	-0.261	-6.590	<0.0001
SSS2013	-2.008	-7.666	<0.0001

Figure 2 shows the forecast capability of the regression results at 95 per cent confidence interval. The Figure shows protest predictions (Pred(Protests2013)) emanating from protests registered in 2013 (Protests2013). All major protests areas (Johannesburg, Ethekwini and Cape Town) could be adequately predicted. There would have been an insignificant number of upward misses as in Mbombela and Bushbuckridge where more protests were predicted than registered, and underestimates in places like Matlosana and Cedeberg. More robust estimation could however be developed through use of time series data, if it were available.

Figure 2. Protests2013 vs. predicted Protests2013.



6. Conclusions

Given the increasing number of protests in the country as a challenge, this study sought to quantitatively explore the relationship between the number of protests and basic services that are provided at local municipality level in an effort to explore possible policy actions towards the reduction of protests. The study highlighted a gap in currently available literature, viz. (a) most research (whilst useful) has been qualitative rather than quantitative; and (b) quantitative research has been limited in terms of policy formulation due to lack of useful protest data.

Despite major data challenges, the study looked at all usable data on basic services and protests, and used principal components regression as a reduction technique aimed at capturing a few useful components/variables that policy-makers can focus on in minimising service delivery protests. The study yields useful results on the relationship between protests and basic services. Mainly that protests tend to increase with declining provisions of basic services like housing, electricity, sewerage and sanitation, refuse removal, schools and hospitals. That is, local municipalities need to largely accelerate on the provision of basic services so as to minimise on the occurrence of protests.

The reduction of service delivery protests is however not limited to the quantitative findings of this study. The environment under which policy-making takes place, as suggested in the immense qualitative literature on South African protests, needs to undergo significant changes.

The study offer some key policy recommendations in Section 7 both in terms of what needs to be done for the reduction of protests, and for improvements on South African data. The final scope of the paper, its results and predictive abilities can indeed be greatly enhanced through significant improvements in data.

7. Recommendations

To alleviate service delivery protests, the findings suggest more needs to be done in increasing the rate of providing electricity, sewerage and sanitation, the number of schools, nurseries, crèches and hospitals. Expenditures on new construction works in residential buildings and electricity infrastructure also need to be accelerated to significantly contribute towards reducing the number of service delivery protests. These findings and recommendation bear some consistence with conclusions reached in qualitative studies that call for a more thorough realignment of resources towards the poor (e.g. Alexander, 2010; Bond, 2006; Madlingozi, 2007; Naidoo, 2007; Siwisa, 2008).

Further, protests occur more in crowded areas. It is untenable to engage in programs of decreasing population sizes (e.g. as witnessed under Apartheid's influx control measures). Thus, it would be most beneficial to further intensify the provision of basic services (i.e. housing, water, electricity, sanitation, refuse removal and communal facilities) with modern proxemics in highly populated areas.

The results of the study suggest some challenges with currently available data. In particular, the behaviour of water services with regard to protests imply that more attention needs to be accorded to the actual provision of water in communities than the number of connections or accounts registered in local municipalities. That is, the provision of water infrastructure is necessary but not sufficient. Alternate, more useful data sources than municipal accounts need to be developed for water, and possibly other basic services.

Other important data issues also need to be addressed. Most service delivery protests occur at geographical levels that are lower than local municipality boundaries. It would be more beneficial for policy-makers that Statistics South Africa collect service delivery data (e.g. housing, water, electricity, sanitation and refuse removal) at levels lower than municipal boundaries. Aggregated data at municipal boundary levels limits much richer analysis. For instance, raw data suggests most service delivery protests occur in informal settlements around established cities.

Further, and more significantly, it would be useful to generate/collect more frequent data (e.g. quarterly or monthly depending on budgets) on basic services and protests. Time series data, unlike the cross-sectional data used in this study, would enable more forward looking forecasting and promote more proactive policy interventions on anticipated protests.

For the development of official, reliable protest data, a more useful classification system needs to be invoked with the South African Police Service in its IRIS. There is currently no other authoritative source of protests in the country. Given the proliferation of service delivery protests, policy formulation cannot be limited to data gathered from media reports.

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Author details

Hlabi Dunstan Morudu¹

E-mail: Hlabim@statssa.gov.za

¹ Research and Policy Analysis Unit, Statistics South Africa, Isibalo House, Kock Street, Pretoria 0001, South Africa.

[†] Postal address: Private Bag X44, Pretoria 0001, South Africa.

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