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REPORT CARDS, AND OTHER TRACKING OF SOUTH AFRICA'S PUBLIC SECTOR FIXED INFRASTRUCTURE CONDITION

REVIEW ARTICLE¹

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ABSTRACT

This article is the second of a planned series being published in this *Journal* describing investigations of the condition of South Africa's infrastructure, reasons for/contributory factors to this condition, and the consequences of this condition for service delivery and quality of life. The purpose of the article is not to critique any of the infrastructure condition measurements, but to convey to the reader a general impression of the direction in which the condition of public sector infrastructure in South Africa is heading, and to make inferences from that. The article introduces surveys which have been undertaken by credible institutions, including a number of national, provincial, and local government departments, state-owned companies, as well as the Auditor General to track South Africa's public sector fixed infrastructure condition. Over the years, a number of these surveys, some of them tracking the condition of this infrastructure and others tracking various performance criteria which allow inferences of the infrastructure condition to be made, have shown that the infrastructure is, on average, not in a good state – thus hampering service delivery

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and, as a consequence, harming the economy and the quality of life of the population. However, the South African Institution of Civil Engineering, with its four “infrastructure report cards”, approximately five years apart, has provided the clearest picture of trends in infrastructure condition nationwide.

ABSTRAK

Hierdie artikel is die tweede van 'n beplande reeks wat in hierdie tydskrif gepubliseer word en beskryf ondersoeke na die toestand van Suid-Afrika se infrastruktuur, redes vir/bydraende faktore tot hierdie toestand, en die gevolge van hierdie toestand vir dienslewering en lewenskwaliteit. Die doel van die artikel is nie om kritiek te lewer op enige van die infrastruktuurtoestandmetings nie, maar om aan die leser 'n algemene indruk oor te dra van die rigting waarin die toestand van openbare sektor-infrastruktuur in Suid-Afrika inslaan, en daaruit afleidings te maak. Die artikel stel opnames bekend wat deur geloofwaardige instellings onderneem is, insluitend 'n aantal nasionale, provinsiale en plaaslike regeringsdepartemente, maatskappye in staatsbesit, en ook die Ouditeur-generaal om Suid-Afrika se vaste infrastruktuurtoestand in die openbare sektor na te spoor. Oor die jare, het 'n aantal van hierdie opnames, sommige van hulle wat die toestand van hierdie infrastruktuur naspour en ander wat verskeie prestasiekriteria naspour wat dit moontlik maak om afleidings van die infrastruktuurtoestand te maak, getoon dat die infrastruktuur gemiddeld nie in 'n goeie toestand is nie – dus dienslewering belemmer en, as gevolg daarvan, die ekonomie en die lewensgehalte van die bevolking benadeel. Die Suid-Afrikaanse Instelling vir Siviele Ingenieurswese, met sy vier “infrastruktuurverslagkaarte”, ongeveer vyf jaar uitmekaar, het egter die duidelikste beeld van tendense in infrastruktuurtoestand landwyd verskaf.

1. INTRODUCTION

Even by 2006, only 12 years into majority rule, the South African Institution of Civil Engineering (SAICE) and the Council for Scientific and Industrial Research (CSIR) were able to discern that significant strides had been made to correct infrastructural imbalances. Drinking water, sanitation, education, energy, and health infrastructure had received focused attention, and government was continuing to invest at a rapid pace in infrastructure for disadvantaged communities. However, worryingly, the combination of limited resources, public sector restructuring, inefficiency, shortages of key skills and less than optimum governance had placed great pressure on the condition of the public infrastructure asset base. It was then already possible to perceive that South Africa had failed to invest sufficiently in maintaining and renewing its infrastructure. Moreover, “we have for too long suffered from a ‘patch and make good’ culture” (SAICE, 2006: 4).

The first article, “Monitoring the condition of public sector fixed infrastructure in South Africa” (Wall, 2023), of a planned series being published in this *Journal* describing investigations of the condition of South Africa’s infrastructure, reasons for/contributory factors to this condition, and the consequences of this condition for service delivery and quality of life summarised how, over 20 years ago, the CSIR and others were concerned that investment in new infrastructure was not matched by concomitant

investment in operation and maintenance – and what they variously did about it. The article introduced the ‘report card’ concept adopted by the CSIR and the SAICE and described how it has been used to present their findings on the resultant condition of infrastructure. However, the article did not disclose the findings of these report cards.

The main function of this article, the second in the series,² is to present and discuss the principal studies of infrastructure condition, including the ‘Drop’ reports of the national Department of Water and Sanitation (DWS), reports of road authorities’ monitoring of pavement quality, and the annual reports of the Auditor General who annually audits state-owned companies and government institutions across all three spheres – the comments of the latter invariably containing commentaries on service delivery performance and underlying reasons for the level of this performance.

However, this article on tracking South Africa’s public sector fixed infrastructure condition mainly draws on findings of the tetralogy (SAICE, 2006; SAICE, 2011; SAICE, 2017; SAICE, 2022) of SAICE report cards. Giving its main attention to the SAICE report cards is justifiable on the grounds that:

- As distinct from other national surveys of infrastructure condition or related matters, all of which focused on only one infrastructure sector (e.g., wastewater treatment, or roads), the report cards have attempted to cover a broad range of infrastructure sectors, including most if not all of those of primary concern to the economy and quality of life of South Africans.
- The report cards are the only series of assessments of the condition of public sector fixed infrastructure which:
 - have been published at regular intervals over a considerable period of time;³
 - have throughout used the same method of information gathering, and
 - have throughout assessed condition in the same way, using the same scale/measuring stick, thereby making it possible to infer trends in condition.

The author agrees that all the various processes to measure infrastructure condition have flaws and difficulties, some more than others, but the purpose of the article is not to critique the indicators or the method whereby

2 The subject matter of the further articles has not yet been finalised, but, provisionally, they will, *inter alia*, describe and discuss the principal factors affecting infrastructure condition and what could possibly be done to improve infrastructure condition and, hence, service delivery.

3 16 years, 2006-2022.

they are collected and aggregated. It is solely to use the information generated and to summarise the main efforts to track the condition of South Africa's public sector fixed infrastructure, and to infer from that if the condition is, generally and (not the same thing) on average, improving, staying static, or deteriorating.

2. METHODS AND REVIEW

The extent to which public sector owners of infrastructure do not assess the condition of infrastructure in their care is alarming. For, without knowledge of this condition, how can the owners plan and prioritise, and budget, for infrastructure improvement?

This article uses the writing process of, and findings from the report cards (SAICE, 2006; SAICE, 2011; SAICE, 2017; SAICE, 2022) by the CSIR and the SAICE to show how it can be used by public sector owners to track the condition of public sector infrastructure.

First, the review describes the grading convention adopted by SAICE (and why it was adopted) and summarises the instructions to the writers of the sector reports on how the reports should be written. Secondly, it describes the validity of the process, and the availability and credibility of data, and dismisses comparability of grades with American and United Kingdom grading systems. Thirdly, the discussion section presents the average grades for the years 2006, 2011, 2017, and 2022 and discusses trends. This section also describes how the average condition of infrastructure has declined. Findings on the infrastructure conditions for the year 2022 are presented, with some detail of the evidence of decline of three of the largest infrastructure sectors, electricity, water, and roads. What the SAICE would like to do but has not yet felt it has the resources to do, is also summarised. Lastly, the conclusion emphasises the guidelines to start compiling report cards, but to implement this, 'leadership and action' are recommended.

3. KEY ISSUES

3.1 The grading convention

The American Society of Civil Engineers (ASCE) convention for rating of infrastructure condition, assigning letter grades 'in the familiar form of a school report card', is simple in concept and clear in meaning (ASCE, 2024). Adapted by the SAICE, it proved excellent for the purpose of grading infrastructure condition – audiences seemed to understand it without difficulty.

Table 1 presents an abbreviated description of the meanings assigned by the SAICE:

Table 1: Grading definitions

A	World class – this infrastructure is in excellent condition and well maintained.
B	Fit for the future – in good condition and properly maintained.
C	Satisfactory for now – infrastructure condition is acceptable although stressed at peak periods.
D	At risk of failure – not coping with normal demand and poorly maintained.
E	Unfit for purpose – this infrastructure has failed or is on the verge of failure, exposing the public to health and safety hazards.

Source: SAICE 2022: 6

3.2 Brief to the writers of the sector reports

The first article (Wall, 2023) summarised the minimum requirements, for the second and third SAICE infrastructure report cards, for the formal reports for each sector, which were written by the chosen experts. Essentially these were: some dimensions of the infrastructure; who owns the infrastructure; legislation governing service delivery and also service quality standards and infrastructure condition, plus what monitoring if any, and what can be gleaned about the condition of the infrastructure.

By the time the preparation of the fourth (*i.e.*, that which eventually appeared in 2022) report card was commenced, the “ground rules” laid for these sector reports had become somewhat more formalised. In summary:⁴

- These report cards would be a reflection at a point in time on the condition of public infrastructure in the built environment,⁵ and would not directly comment on backlogs or the absence of infrastructure to serve certain areas and communities, nor on inappropriate levels of service or on inappropriate technologies. The focus was on the condition of existing infrastructure, together with the effect of that condition on service delivery (*e.g.*, that a badly operated and maintained water-treatment works might be unable to supply its town for weeks at a time). Highly pertinent to this would be the factors that have led directly to the infrastructure being in the condition that it was.
- The report cards would not describe the stated intentions of many agencies to improve infrastructure in the future, even when these are accompanied by plans with budgets. These intentions (if these are eventually realised) would instead be reflected in improved grades in future report cards.

4 The following, to a great extent, paraphrases Wall & Amod, 2021: “The SAICE IRC: Research brief for sector reports” (Unpublished).

5 Emphasis in the original.

- In the interests of saving time and cost, and in order to avoid pointless duplication of effort, the necessary information should, in the first instance, be sought and will most likely be gleaned from desktop research. The extent to which this would be practical would naturally depend on the existence (even if not readily available) of suitable documentation which, to some extent, at least covered the required areas and was sufficiently recent.
 - SAICE would honour the need for confidentiality where necessary and acknowledge references and sources where appropriate.
 - Notwithstanding the existence or availability of suitable reports, sector experts (particularly those in the employ of the owners of the infrastructure in question) could (and might be willing to) provide specific supplementary information.
- It was likely that, in many instances, the report card would have to make do with information that covered infrastructure condition in only limited areas. For example, it was unlikely that all nine provincial road condition reports would be available to similar levels of detail and accuracy. So, if only say three could be obtained, a judgement call would have to be made as to what extent this could be regarded as representative of that infrastructure sub-sector in the whole country.
- For a number of reasons, including that a full set of the required documentation would highly likely be incomplete, outdated or unreliable, a need might be found for primary research. How much primary research, and in respect of what, would need to be assessed. At minimum, it might simply be the combined expert opinion of the professionals in direct contact with the infrastructure in question.
- The length of the sector reports was of less concern than the comprehensiveness and reliability of the information. Was the field adequately covered? If some parts of the field were not satisfactorily covered, what effect would this have on the credibility of the sector report? What could be done about the shortfall? Was the report authoritative – were the most reliable sources of information used? Were all sources referenced? Where “off the record” information was used, had the best effort been made to verify this information? Was the information as up-to-date as possible, even if not necessarily comprehensive, included in the mix? To what extent had the considered opinion of experts in the field been used to supplement and verify the available data?

The experts responsible for each sector report were also asked to record anything they discovered that might have driven better operation and maintenance practices, including, in particular:

- standards – including whose standards, how valid and/or useful it was for those standards to be applied, and why and in what way these standards influenced then-current operation and maintenance practices;
- measuring and monitoring, whether internal, or external (e.g., Green Drop and Blue Drop, citizen monitoring, media);
- legal and/or regulatory compliance requirements (e.g., in respect of airports, the International Civil Aviation Organisation standards; the standards for drinking water quality).

Finally, the sector experts were told that a very experienced engineer would be dedicated⁶ to coordinate their work, and to edit (and overwrite, where necessary) the draft reports from each sector.

3.3 Process validity

In 2022, each of the SAICE technical divisions has, as long as the infrastructure sector allocated to it was within its area of competence (e.g., water and waste water infrastructure to Water Engineering Division, fishing harbours to Marine Division, the rail system and commercial ports to Railway and Harbour Engineering Division, and the roads to Transportation Division), demonstrated a depth of understanding of the infrastructure sector and the circumstances in which infrastructure is well looked after, and delivers reliable services – or is not well looked after, as the case may be – and what, in particular, can lead to a deterioration of the condition of the infrastructure, and consequent falling reliability of the services. The same sentiments about depth of understanding could be expressed of other professional institutions or learned societies, of whom the SAICE has, over the years, requested assistance – most recently, the South African Institute of Electrical Engineers⁷ and the South African Academy of Engineering.⁸

3.4 Data availability and credibility

All the infrastructure condition measurement in South Africa is determined by the availability of information. The SAICE has no budget to undertake primary research, and it must, therefore, make do with whatever information, good and bad, it can gather. However, underlying all of this is the problem of lack of data because what is going on in different sectors can very seldom be measured in the same way. But the compilers of the measures have several good defences available, an important one being that they

6 This author was appointed 'Research Leader'.

7 saiee.org.za

8 saae.co.za

could point out that they are following international best practice (e.g., with respect to the report cards, the ASCE) to the best of their ability, allowing for the acknowledged major problem of data availability and credibility.

Systematically captured and analysed data enables planning, prioritisation of targets, and adequate budgeting for maintenance, but the data must be credible and sufficiently comprehensive and up-to-date. However, both data availability and credibility have, on average across all infrastructure sectors (although there are some notable exceptions), declined from report card to report card. Thus, for example, there are no reliable national databases of the condition of public housing, electricity distribution infrastructure in the care of municipalities, or municipal roads.

Aside of national databases, it seems that many public sector owners of infrastructure (with municipalities apparently the worst offenders) are not sufficiently knowledgeable of the condition of their infrastructure. While this has presented a problem to the researchers, it is, or should be, of even greater concern to the municipalities and other public sector infrastructure owners, as infrastructure condition monitoring is required to enable the all-important shift from reactive 'repair' to planned 'maintenance'.

3.5 Comparability of grades

The author has, on a number of occasions, been asked if the SAICE's criteria for the allocation of grades are comparable with those of ASCE and the (UK) Institute of Civil Engineers (ICE).⁹ The short answer is that no, they are related but by no means exactly comparable¹⁰ – one cannot say that if British, American, and South African roads are all rated D, this places them on a par.

Grades are allocated subjectively on the basis of incomplete evidence and of sufficient consensus (not necessarily unanimity) on the part of professionals knowledgeable in the field who have volunteered to do the grading. 'Condition' of infrastructure is a highly important if not the main parameter in the measurement by all of the agencies. At times, it is the central determinant of grading – at other times, direct measurement of condition is not available, and proxies are sought that would assist in determining a grading. Therefore, what constitutes 'fitness', for example, or 'at risk of failure' cannot be measured with objective absolute accuracy. What even professionals understand by these terms is coloured by their own experience.

9 As used in, for example, ICE 2003.

10 This opinion is not shared by some of the other SAICE colleagues associated with the report-card process.

For a simple analogy: say that the outdoors temperature is 10°C. Then ask people from different climatic zones if they consider this to be hot or cold. Someone who is used to arctic temperatures will say that it is warm, whereas someone who has only lived in the tropics will say that it is cold. How the temperature is felt depends on the observers' context and lived experience. Similarly, how different people would view infrastructure condition would inevitably depend on their context and lived experience.

Without question, however, it is highly desirable that any adoption of a five-step report card-format of grading of infrastructure condition uses criteria for grading allocation that are at least very roughly comparable to those of the ASCE (or apparently so). If the criteria are not comparable, this must be made absolutely clear in their description.

4. DISCUSSION

4.1 Trends and perceptions in gradings 2006–2022

The first infrastructure condition report card (IRC), that of 2006, set the pattern for grading each of a number of public owned infrastructure sectors (initially, water, sanitation, roads, airports, commercial ports, rail, solid waste, electricity, hospitals, and clinics) on a scale from A+ (in excellent condition), through to E- (unfit for purpose). Overall, *i.e.*, averaging across all infrastructure sectors, it gave infrastructure condition a D+ grade.¹¹

The second report card, released in April 2011 (SAICE, 2011) concluded that, again 'on average', there had been improvement, and awarded the overall grade of C-. Nonetheless, it highlighted that this 'marginal improvement in the average condition of South Africa's infrastructure over the previous five years' had been influenced by the major investment in 'national assets' (stadiums, harbours, rail, national roads, and airports) in preparation for the FIFA Soccer World Cup which was very successfully held in South Africa in 2010. The downside of the focus on these national assets was that it had diverted the attention of the authorities from maintenance and upgrading of their core infrastructure – with predictable consequences. The authors of the IRC concluded that "the quality and reliability of basic infrastructure serving the majority of our citizens is poor and, in many places, getting worse" (SAICE, 2011: 5).

11 The plus (and minus) indicators reference that the grade is 'a little better' (or a little worse) than the average for the grade given. Thus, for example, C- indicates 'satisfactory for now', but deteriorating – however, by no means yet at 'at risk of failure', which is the definition of D.

The 2017 report card lowered the overall average back to D+ and noted that the 'apparent improvement' between 2006 and 2011 'was not a cause for complacency', as "it is evident that the poor attitude to maintenance continues and is reflected in the downturn on the current overall grade" (SAICE, 2017: 5).

In 2022, the overall grading, across all report card sectors, dropped to a straightforward D, the lowest overall grading yet.

In its commentary on the 2022 grades, the report card team again directed attention to:

"the further degradation of social infrastructure [which] paints a dismal picture of the plight that ordinary people face to access basic services of water, sanitation, health, education, public transport and electricity. Altogether, the situation cries out for urgent and sustained attention" (SAICE, 2022: 7).¹²

The team also noted that:

"no single sector of infrastructure operates in isolation – all of them are interconnected. Energy generation requires water for cooling and ports require roads and rail connectivity to serve the economy. So, while we grade sectors separately, there is a tightly woven interdependency between all these facilities. When rail services are inadequate, commerce shifts to the roads, even at a cost premium. When taps run dry, entrepreneurs will supply water in tankers. And some will resist a return to the previous modes of operation, even though the replacement modes are inefficient or inappropriate. Consequently, when public infrastructure is inadequate or unreliable, the resulting disruptions occur at a net cost to the fiscus and weaken the developmental role of the State" (SAICE, 2022: 7).

In 2022 it was found that only nine of the 32 subsectors¹³ received an A or a B. While this is gratifying for the nine, that the great majority of the subsectors were deemed, at best, C: Satisfactory for now, should be of national concern.

The grades assigned by the report cards over the years for the main infrastructure sectors have trended as follows (for the sake of simplicity, only 2006 and 2022 grades are shown).

12 The Auditor General mentioned something very similar on a number of occasions – for example, Auditor General 2022.

13 For example, whereas 'roads' was a 'sector', each of its 'subsectors' was also graded – *i.e.*, national roads, paved provincial roads, paved roads in the major urban areas, other municipalities' paved roads, provincial and municipal unpaved roads.

Table 2: Grades 2006 and 2022 by infrastructure sectors, and overall average

<i>Infrastructure sector</i>	2006	2022
<i>Water and sanitation</i>		
National water resources (bulk water) infrastructure	D+	D-
Water supply in the major urban areas	C+	C+
Water supply to all other areas	D-	D-
Waste water and sanitation for major urban areas	C-	C-
Waste water and sanitation for all other areas	E	E
<i>Roads</i>		
National roads	B	B+
Paved provincial roads	D-	D
Paved roads in the major urban/metropolitan areas	X	D
Other municipalities' paved roads	X	D-
Provincial and municipal unpaved roads	X	E
<i>Airports, harbours, and rail</i>		
Airports (the nine major airports)	B	B-
Commercial harbours	C+	B-
Heavy haul freight railway lines	B	B-
General freight railway lines	C	C-
Branch railway lines	E	E
PRASA passenger lines	D+	E
<i>Electricity</i>		
Eskom electricity-generating infrastructure	C+	D-
Eskom high-voltage electricity transmission network	C+	B
Local electricity distribution	X	D
<i>Health and schooling</i>		
Public sector hospitals	C	D+
Public sector clinics	D+	D
Public ordinary schools	X	D
South Africa overall average – all infrastructure sectors	D+	D

X indicates that subsector categories in 2006 were not the same as for subsequent report cards

Source: SAICE 2006; SAICE 2022

The public sector fixed infrastructure of the country appears to be stuck in a condition that is on average, with some exceptions (SANRAL roads, airports, commercial harbours, the heavy haul freight railway lines, and high-voltage transmission, all of which are in a better shape), at best:

“Satisfactory for now: infrastructure condition is acceptable, although stressed at peak periods. It will need investment in the [medium term] to avoid serious deficiencies' developing” (the definition of Grade C, SAICE, 2022: 6).

Much is, however:

“[a]t risk of failure: infrastructure is not coping with demand and is poorly maintained. It is likely that the public will be subjected to severe inconvenience and even danger without prompt action” (the definition of Grade D, SAICE, 2022: 6) – or worse.

Although “with the notable exception of energy generation, South Africa’s economic infrastructure remains in a satisfactory (or better) condition”, of the greatest concern is that:

“social infrastructure continues to deteriorate. Crime and non-payment for services as well as weak institutions lacking appropriate skills and accurate data have contributed towards a further decline in the overall condition of infrastructure since the last SAICE Infrastructure Report Card” (SAICE, 2022: 11).

The ruling party, the African National Congress (ANC), is openly worried about the often poor performance of state-owned companies and municipalities, usually closely related to their dysfunctionality – a concern no doubt linked to fear of the likely effect of this dysfunctionality on its electoral performance in 2024. President Ramaphosa is under no illusions:

“The poor performance of many local governments remains an area of concern. Too many of our municipalities, 163 out of 257, are dysfunctional or in distress due to poor governance, ineffective and sometimes corrupt financial and administrative management and poor service delivery” (Ramaphosa, 2023a: 18-19).

Sadly, according to the Auditor General’s June 2023 published report on municipal financial management, *i.e.*, that for the 2021-2022 financial year, only 33 of the 257 municipalities received a clean audit¹⁴ (Auditor General, 2023: 14).

A major factor in the condition of all of public sector fixed infrastructure is undoubtedly the generally very insufficient expenditure on maintenance and repairs. Municipalities as a group are the worst offenders. A major factor in this is the financially constrained situation in which most of the municipalities find themselves – they do not generate enough income to budget sufficiently, even for essentials. The Auditor General commented:

14 “A financially unqualified opinion with no findings (clean audit) means the municipality:

- produced quality financial statements free of material misstatements;
- produced quality performance reports that measure and report on performance in a manner that is useful and reliable, and
- complied with key legislation relating to financial and performance management” (Auditor General, 2023: 138).

“The financial health of municipalities continued to deteriorate, partly because increased economic pressures¹⁵ meant that consumers were not paying the bills, but also because of poor financial management. Municipalities are losing money because they are not billing and collecting revenue, are using unfair and uncompetitive procurement practices, and are paying for goods and services that they either do not receive or do not use. Poorly managed local government finances directly affect municipalities’ ability to deliver the promised services to their communities” (Auditor General, 2023: 6).

4.2 Selected infrastructure sectors – The 2022 findings

By way of background on the responsibility for public sector infrastructure in South Africa:

- The owners and operators include state-owned companies (SOCs), national government departments, provincial government departments (there are nine provinces), municipalities (257 of these, including eight metropolitan municipalities), a number of water boards that supply treated water in bulk to the majority of the population in urban areas, and a number of entities belonging to some of the above (e.g., Johannesburg Roads Agency and Ekurhuleni Water Care Company).
- Generation of the vast majority of electricity is the responsibility of the SOC Eskom, which is also responsible for the bulk transmission of this electricity nationally and, in certain areas, also its local distribution.
- The major dams and bulk water distribution infrastructure: The national Department of Water and Sanitation (DWS).
- The inter-city roads system: South African National Roads Agency Ltd (SANRAL), another SOC.
- The nine commercial ports and the inter-city rail infrastructure and rail services: Transnet (another SOC) or one of its subsidiaries (e.g., Transnet Freight Rail).
- The nine principal airports: Airports Company of South Africa (a SOC).
- The nine provincial governments are, each in its own province, responsible for, among others, infrastructure, all state-owned schools (approximately 25,000 in total), hospitals and clinics, and all roads, paved and unpaved, that are not the responsibility of either SANRAL or a municipality.

¹⁵ *I.e.*, the poor state of the national economy, and extremely high unemployment. (The official unemployment rate was 32,1% in the fourth quarter of 2023) (Statistics South Africa, 2024: online).

- The municipalities are, each within its own area, responsible for water supply and treatment (unless this is the responsibility of a water board, in which case the municipality takes care of local distribution only), all waste water and sanitation infrastructure (including treatment), and roads other than SANRAL or provincial roads. In addition, where Eskom does not undertake it, the municipality is responsible for local electricity distribution.
- Some of the infrastructure sectors have independent regulators such as the Rail Safety Regulator. For others, the regulatory function is performed by the same institution as is responsible for many aspects of infrastructure delivery (e.g., Department of Water and Sanitation).

The above is not an all-inclusive list but does embrace the great majority of the infrastructure of interest to the report cards.

For the purposes of this article, three of the sectors serve as representative not necessarily of the overall condition of infrastructure in South Africa from report card to report card, but to illustrate, very much summarised, the findings of the report card tetralogy. Whereas the first sector, electricity generation, is mainly in the hands of one institution, the other two sectors, waste water and roads, have in common that, as noted in the bullet-pointed list above, they each have a very large number of owners – particularly that every municipality has within its area the stewardship of a very large stock of both of these types of infrastructure.

4.2.1 Electricity generation

Electricity generation in South Africa provides a graphic illustration of the consequences of neglect of maintenance. Sadly, also, all South Africans still live with these consequences, even though the bulk of the damage was caused by decisions taken over a decade ago.

South Africa's electricity infrastructure consists of bulk electricity generation, national transmission, regional interconnection, provincial distribution, urban municipal distribution and reticulation to rural towns, farms, and communities. The state-owned company Eskom¹⁶ provides the bulk electricity generation, national transmission, regional interconnection, provincial distribution, and much of the local reticulation (mostly the rural areas, but also to mines and many industries).¹⁷ The National Energy Regulator (NERSA) has the mandate to regulate the electricity supply and

¹⁶ <https://www.eskom.co.za/>

¹⁷ The mandate for urban distribution vests with municipal electricity undertakings, historically organised as the Association of Municipal Electricity Undertakings of Southern Africa.

distribution industry – regulations define product pricing, product quality, and services as delivered to customers.¹⁸

Eskom generates by far the greatest proportion of the electricity used in South Africa, although this is starting to drop quite rapidly as more renewables are commissioned.

The South African electricity sector is characterised by:

- Demand slowly falling over the past 12 years (Figure 1).
- Rising prices.
- Increasing unavailability and unreliability of the Eskom generation capacity (Figure 2).
- Infrastructure increasingly under threat from vandalism and theft (South Africa, 2022; De Ruyter 2023)

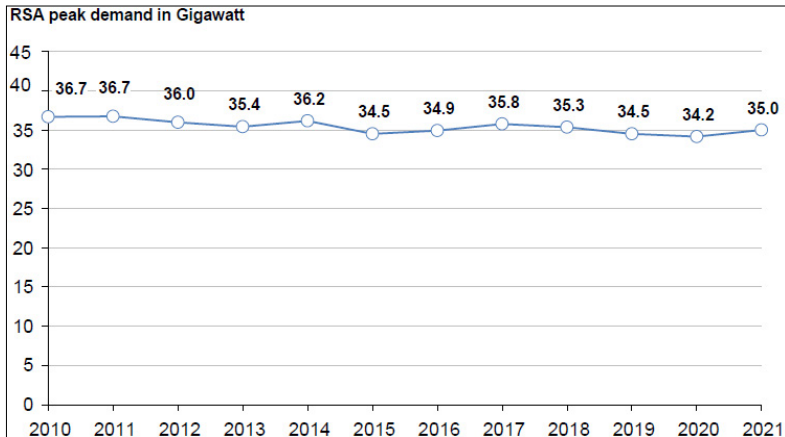


Figure 1: Slowly declining peak electricity demand 2010 to 2021

Source: Pierce & Ferreira, 2022: 21

Some decades ago, Eskom’s generation strategy, driven primarily by a core of large thermal coal-fired power stations, was to develop an extra high voltage national grid that traversed the country, penetrated deeply into the rural and agricultural community, and interconnected with Southern Africa.

18 <https://www.nersa.org.za/>

The strategy is still dominated by coal,¹⁹ which is projected to remain the principal energy source to at least year 2030. After that, and up to 2050, it is planned that all the existing coal-fired power stations will be decommissioned. For a transition to cleaner energy sources to proceed smoothly, and at the same time to allow adequate downtime for maintenance and selective refurbishment of existing plants (some of them already over 50 years old), additional generation capacity has been required. However, commissioning this additional capacity has taken far longer than planned. In particular:

- Medupi and Kusile power stations, which should have come into full operation between 2015 and 2017 with 6GW of capacity, at which time Eskom could decommission older plants reaching the end of their planned lifespan, were commissioned years late, and have since been plagued by breakdowns.
- Procurement of non-thermal generation capacity took a long time to get off the ground – only in the last couple of years did independent power producers contribute significantly to the nation's energy requirements.

This slow acquisition of new generation capacity, together with extended spells of under-maintenance of the Eskom coal-fired power stations, has led to a growing maintenance backlog, increasingly leading to unplanned outages (*i.e.*, planned or unplanned temporary failure of supply). Exacerbated by significant losses of key staff, the energy-availability factor (EAF) of the national grid has declined steeply (Figure 2). The consequences of poor EAF are increased use of emergency high-cost diesel generation and increased frequency and severity of forced national load-shedding, all of it contributing to Eskom's rapidly increasing electricity operating costs²⁰.

19 Coal still dominates the South African energy mix, providing 80% of the total system load. The contribution of renewable energy technologies (wind, solar PV, and CSP) increased in 2022 to a total of 6.2 GW installed capacity and provided 7.3% of the total energy mix (Pierce & Le Roux, 2023).

20 Thus, pushing up tariffs. Adjustment for the 2023/24 Financial Year: "average tariff increase of 18,65% for Eskom's standard tariff customers and an increase of 18,49% for municipalities" (NERSA, 2023).

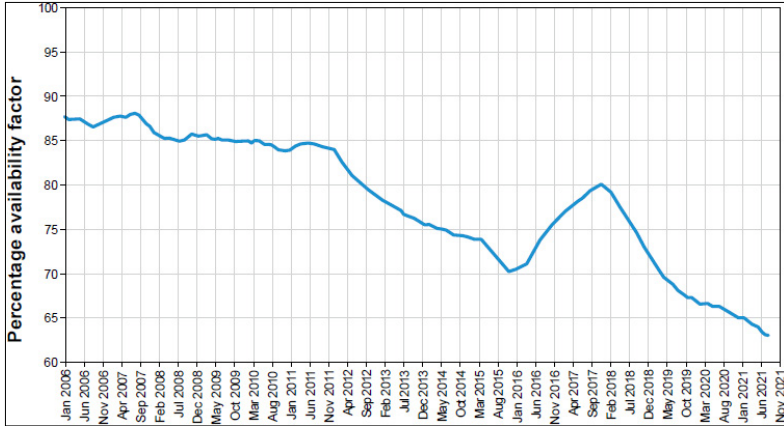


Figure 2: Declining national grid generation availability factor for the period start 2006 to end 2021^{21,22}

Source: ESKOM – reproduced in SAICE, 2022: 44

A more telling example than the following of the direct effects of maintenance neglect in any sector would be difficult to find. Breakdowns of Eskom generation capacity was increasingly reported in the media from roughly the end of 2010. Eskom was slow to advance plausible reasons for this, but it became increasingly apparent that Eskom had departed from its programme of planned maintenance. The problem was compounded by the outages – because of the consequent loss of generation capacity, that part of the generation infrastructure which continued to function was often kept in service, even though its time for scheduled maintenance had arrived, further exacerbating the backlog in maintenance, and leading directly to breakdowns.

However, the extent of this neglect of maintenance was only revealed in 2015, when the then Eskom CEO for the first time described the scope – and consequences for generation capacity – of this neglect. The following extracts from his media presentation on 15 January 2015 refer:

- “Eskom has an elaborate maintenance regime that should maintain the health of our generation fleet.
- Our philosophy of keeping the lights on at all costs superseded the maintenance philosophy and has put us into a very difficult position – Keeping the lights on programme has avoided load-shedding in the past 7 years against all the odds managing an

21 For clarity, the vertical axis is a 'percentage availability factor'.

22 The figure depicts the '12-month moving average'.

extremely low operating margin – There is a severe maintenance backlog – Increasingly leading to unplanned outages (load losses) – Some of our running plants have partial load losses, because parts are worn out, and we do not have a time window to replace/fix – Keep the lights on philosophy has created a culture where proactive maintenance is less important.

- We have arrived at a point that does not allow us to ignore the health of our plants. (Matona, 2015 – reproduced in SAICE 2017: 36).

A graph from his presentation further illustrates the point. This graph (Figure 3) shows the increasing UCLF (unplanned capability loss factor) percentages which Eskom experienced between 2005 and 2015, when ‘keeping the lights on’ trumped the planned maintenance regime.

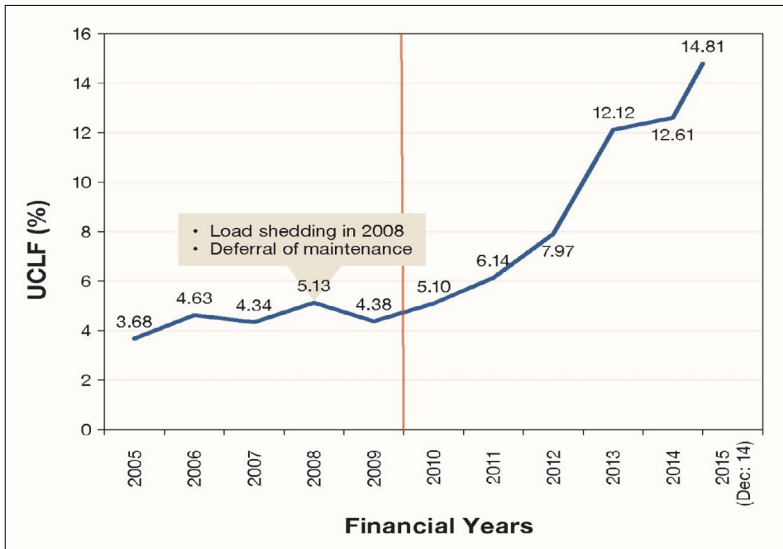


Figure 3: Eskom unplanned capability loss factor 2005-2015

Source: Matona, 2015 – reproduced in SAICE, 2017: 36²³

23 The red line indicates the start of the period when UCLF started to climb at a significant rate.

4.2.2 Waste water

As mentioned earlier, in 2008, DWS (then the Department of Water Affairs) introduced the Green Drop certification programme, the goal of which was (and still is) compliance of waste water treatment works with the national Wastewater Discharge Standards (DWS, 2022). The Department simultaneously introduced the Blue Drop programme, aimed to ensure compliance of water-supply systems with the national Drinking Water Quality Standards (DWS, 2023). Between them, they measure the most important indicators for sustainable and safe water and waste water service delivery, such as management commitment; safety and risk planning and mitigation; process management; quality compliance; staff qualifications, and adequate budgets.

These incentive-based programmes, apart from raising the awareness of municipalities of good practice in water supply and waste water treatment, led directly to many (regrettably, not all) municipalities investing more into their water and sanitation staff and infrastructure, thereby improving their performance. Moreover, they also generated a wealth of data which allowed the Department and the water and sanitation sector at large to plan and manage the water value chain more effectively.

Unfortunately, the programme was discontinued after 2013, and was not resumed until 2021. A new Green Drop report (DWS, 2022) appeared the following year (and Blue Drop the year after that (DWS, 2023), while this article was being finalised).

Bearing in mind that the performance of a waste water service is a function of the loading on the system (e.g., quantity and quality of influent) and the combination of infrastructure and its condition, on the one hand, and the skill with which this infrastructure is operated, on the other, the performance of waste water systems varies widely across the country. Some systems give excellent results, but others fail in many critical respects.²⁴

The Green Drop Report 2022, released by DWS in April 2022 (DWS, 2022) describes the results of the assessment, in 2021, of every waste water system, public or private, of any consequence (995 waste water networks and treatment works, the vast majority of which are owned by municipalities), and provided a cumulative risk rating for each waste water treatment works.

24 Note that a treatment works is only part of the system. A reticulation system collects from the sewered area, and in many instances this reticulation is heavily infiltrated by rain and groundwater. While almost always flowing under gravity, in some specific instances, pumping of low points and hence pump stations, is also required. The Green Drop audits "cover the sewer network, sewer pump stations and treatment systems ... not on-site sanitation" (DWS, 2022: x).

The map of South African administrative boundaries relevant to waste water (see Figure 4) is colour-coded from turquoise: 'Excellent: need to maintain via continued improvement' through to dark pink: 'Critical: need urgent intervention for all aspects of waste water services', with grey being 'Average: ample room for improvement'.

Figure 4 illustrates that, perhaps to be expected, the Green Drop scores are on average higher around major urban areas.

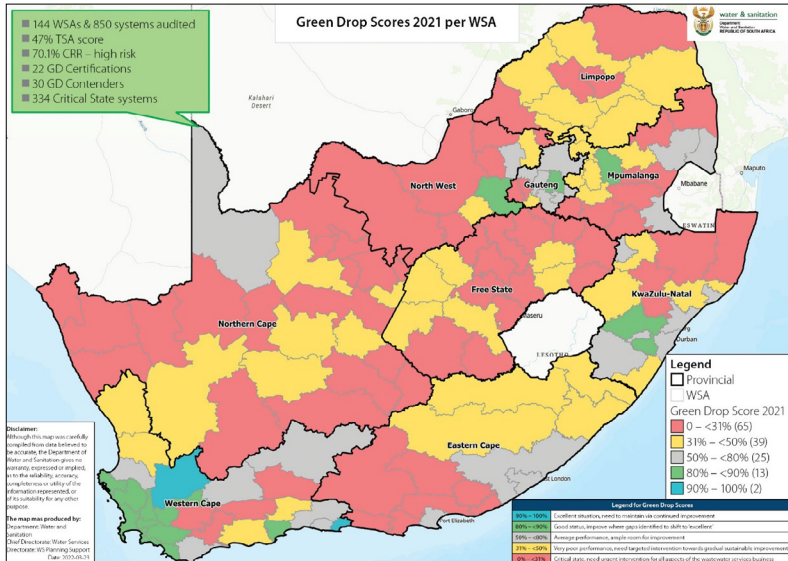


Figure 4: Green Drop scores 2022

Source: DWS, 2022: 10

Only 22 public sector waste water systems achieved Green Drop Status. A further 30 received high scores except in that microbiological and chemical effluent quality did not meet the Green Drop standard (DWS, 2022)

When comparing the Green Drop reports, it is clear that performance gradually improved in the period 2009 to 2013, but it has since declined back to 2009 levels or worse. In 2009, 33 Green Drops were awarded, 40 in 2011, and 60 in 2013 (DWS, 2022: 10), but only 22 in 2022. Even more cause for concern, the 2022 report identified that a total of 334 (39%) of municipal waste water systems were in a critical state, compared to 248 (29%) in 2013, confirming that performance dropped in the years during which regulatory supervision slackened.

4.2.3 Roads

The South African circa 750,000km road network is managed at three levels, namely primary intercity, with roads of national economic importance managed by SANRAL on behalf of the national Department of Transport; the secondary and tertiary intercity network, primary access and mobility roads largely managed by the nine provincial departments, and the mostly urban and rural roads managed by municipalities.

The condition of this road network varies greatly with category, type of road, sphere of government, and geographical location. At one end of the spectrum, the condition of the 21,000km managed by SANRAL is generally very good, no doubt mainly because it has managed to retain its high level of professional engineering expertise. On the other hand, the nine provinces have, for two decades, lost experienced road professional expertise. Of the municipalities, some of the larger metropolises have, to a great extent, retained their levels of professional expertise, and consequently the condition of their road networks, while very few other municipalities have been as prudent (Personal communication, SANRAL anonymous employee, 2023.)

How much infrastructure condition monitoring is undertaken varies widely, depending mostly on the zeal and resources of the authority that owns the infrastructure. For example, whereas the general state or condition of a road is customarily described in terms of a visual condition index (VCI) using a five-point scale, *i.e.*, 'very good', 'good', 'fair', 'poor', and 'very poor', in practice few South African road authorities undertake regular condition assessments. Acceptable information for the 2022 SAICE report card was received only from SANRAL, two of the nine provincial roads authorities, and half of the metropolitan municipalities. Information from other provinces and municipalities was comparatively scarce and too incomplete to enable firm general conclusions to be reached. It can be inferred that authorities, which are not sufficiently informed of the condition of the roads, would very likely also not be able to manage these assets in a satisfactory manner.

A positive move has been that, in 2018, the national Department of Transport initiated a programme to force provincial road authorities to develop, maintain, and operate pavement management systems. However, the process was interrupted by COVID-19 'and since staff changes'. Progress is, therefore, not where it was planned to have been (Personal communication, SANRAL anonymous employee, 2023).

5. ASPIRATIONS

The SAICE, with its limited resources, has been doing very well to produce the four report cards. The credibility of the SAICE and of its process to put the IRCs together has been recognised at the highest levels of the land – the President himself has referred to it, for example, in one of his weekly ‘Dear Fellow South African’ online letters to all:

“We have good quality infrastructure, but in far too many instances it is not being properly maintained and upgraded. Last year, the South African Institution of Civil Engineering gave the country’s social infrastructure a D rating, with E being failed or failing. Passenger rail scored particularly low, achieving an E.” (Ramaphosa, Presidency, 24 July 2023.)

The SAICE has established the IRC ‘brand’ as a reliable and credible barometer of infrastructure condition. It has taken much effort over many years to get there. But in the absence of any kind of ‘proof’ that this effort has led to improved infrastructure condition in South Africa, is SAICE doing ‘enough’?

An expanded effort – if the SAICE had the resources – could, of several possibilities, involve initiatives such as estimating the costs of repair and rehabilitation of entire infrastructure sectors or parts thereof, or putting effort into a programme to keep the condition of infrastructure in the eye of government and the public between report cards, instead of only once every four or five years, *i.e.*, when IRC is launched.

Those who care about public sector infrastructure should at intervals – such as each time a new administration takes over after a general election – be able to ask for estimates of the cost of repair and rehabilitation of this infrastructure, preferably by sector, if not in more detail. In 2021, the ASCE estimated that “the nation’s backlog of bridge repair needs \$125 billion”, and that the nation needs to “increase spending on bridge rehabilitation from \$14.4 billion annually to \$22.7 billion annually, or by 58%” (ASCE, 2021: 9). While the ASCE did not make estimates for all sectors, another for which it did was rail, where “a current state of good repair backlog [is] \$45.2 billion” (ASCE, 2021: 14).

Calculations of this sort, especially at local sector level, enable at least ballpark estimates to be made of the funding requirements year by year that would enable restoration of infrastructure condition over a period of, say, 10 years. A political case could then be made, *e.g.*, by a service provider in a critical area, for financial assistance from national government, or for funds to be raised externally.

The case for funding would be immensely strengthened if the estimate of the cost to bring infrastructure from its present condition up to scratch would be accompanied by an estimate of the cost of not having infrastructure, or having infrastructure which is not functioning. That is, the cost to service delivery and thereby to the economy and to individuals. Over 15 years ago, it was said:

“It is self-evident that failure of infrastructure services has consequences for human development, poverty alleviation and economic growth”
(Department of Public Works *et al.* 2007: 5).

The SAICE has recognised the need for at least national-level estimates, but has thus far lacked resources to calculate these.²⁵

Another matter of concern to the SAICE has been the stop-start nature of its own forefronting of concern at the condition of infrastructure and the effect of this on service delivery. That is to say, a report card appears every five years, attracting publicity, and also sometimes eliciting promises (usually quickly forgotten) by government that action will be taken. Following the release of the 2022 report, however, in an attempt to continuously inform the public and keep the pressure on government, the SAICE set up an Infrastructure Panel. This is still work in progress, but the intention is that the panel will adopt a programme of action that would include periodically issuing short commentaries or policy documents. These could cover infrastructure condition, service-delivery matters, and related topics such as snapshots of what public sector infrastructure owners are spending on maintenance and repair, as opposed to what they ought to be spending.

While details of this, including resources to be allocated to the programme, have still to be resolved, the SAICE would attempt, on a completely different scale, to emulate the ASCE and ICE which, as noted earlier, between the periodic main report cards of infrastructure condition nationally, release reports on thematic issues affecting civil engineering and service delivery and/or reports on infrastructure condition in regions rather than only nationally.

25 The author is currently working with another professional institution in South Africa, exploring the possibility of their assisting with suitable estimates in a pilot area.

6. CONCLUSION

To convey to the reader a general impression of the direction in which the condition of public sector infrastructure in South Africa is heading, this article uses measurements available – while pointing out flaws in these measurements.

It is trusted that this description of methods and levels of the effort that go into compiling a national infrastructure condition report card would be useful to asset-management practitioners and professional societies in countries that might be considering compiling a snapshot of public sector infrastructure condition in their countries. Especially this might be so if, like the SAICE, they could not call on resources of the scale and quality available to their counterparts in the United States or a major European or Asian nation.

Compiling a national infrastructure condition report card is not a task to be lightly undertaken. If the report card is to be credible, its compilation must be undertaken by experienced professionals who are prepared to devote considerable amounts of time. In South Africa, a great deal of that time went to finding suitable condition data – not an easy task in a country where the majority of public sector institutions place no great importance on monitoring the condition of their fixed infrastructure, let alone looking after it, keeping it in a good condition. Moreover, at the cost of generalising, the SAICE IRC research teams have found these institutions to be much less willing to share information about the infrastructure they own than, it is reported by the ASCE and ICE, their counterparts in the United States and the United Kingdom have been.

Sometimes, the compilers of a report card would need to exercise considerable ingenuity to deal with one or both of the following: (i) credible data is available, but on a variety of different databases, the knitting together of which can be very time-consuming, and, (ii) while infrastructure condition data might not be readily available, the condition of specific infrastructure can within limits be inferred from other information which is available. An example of the former, in respect of the 2017 report card, in the health infrastructure sector, has been described (De Jager & Wall, 2022). An example of the latter, actually resorted to by the compilers of a few of the 2022 sector reports, would be where, although no engineering assessment of the condition of water infrastructure has been done, the condition of that infrastructure, and of its operation and maintenance, can be inferred from records of the water-supply interruptions that are due to infrastructure faults (*i.e.*, infrastructure failings, as opposed to, for example, a drought).

The author agrees that it would be preferred if the report cards had 'any shortcomings, inconsistencies and other errors' ironed out. But this could

only be done, at least to any significant level, if the SAICE were able to apply even more resources to the report card effort than up to now (unlikely), if public sector infrastructure condition monitoring in South Africa were to improve (also unlikely), and if the results of this monitoring were to be placed in the public domain (that would be helpful).

Ideally the report cards should be improved as described earlier, but it would even be better if more public sector agencies did their own 'report cards', and, of course, released them to the public.

7. RECOMMENDATIONS

The first of the author's two recommendations (paraphrasing the ASCE 2021 report card recommendations for the United States) is:

South Africa needs a strategic and holistic plan to renew, modernise, and invest in our infrastructure. This plan should make basic maintenance a centrepiece as we improve our legacy systems.

The second recommendation also draws inspiration from the ASCE 2021 report card:

ASCE listed a series of "Recommendations to Raise the Grade". It is noteworthy that the very first on the list²⁶ is:

"Leadership and action

Smart investment will only be possible with strong leadership, decisive action, and a clear vision for our nation's infrastructure"
(ASCE, 2021: 8; emphasis added).

In the author's opinion, South Africa regrettably falls far short in respect of all of these: clear vision, strategic and holistic plan, strong leadership, and decisive action. Little wonder that the condition of public sector infrastructure has been trending downwards over the years. Nonetheless, it is with this same set of priorities that a turnaround must be achieved.

DEDICATION

This article is dedicated to Dr Rodney Milford, now long retired from the CSIR but the author's line manager for most of the first decade of the current century. Once the author had identified the looming crisis that would be caused by infrastructure neglect and deteriorating condition, Dr Milford encouraged the author to research this area, and thereafter successfully defended the author from those in senior government circles at the time who wished the CSIR to stop this research as it was "embarrassing the government".

²⁶ The other two are 'investment' and 'resilience'.

ACKNOWLEDGEMENTS

As noted earlier, the IRC 2022 was almost entirely the work of volunteers, most of them from the technical divisions of the SAICE. For the data which they were able to make use of, they in turn were dependent on a multitude of willing officials in both the public and private sectors. In the context of this article, particular thanks go to the sterling contributors to the report card of two SAICE technical divisions, viz. Water Engineering and Transportation, and the South African Institute of Electrical Engineers and the South African Academy of Engineers.

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