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MONITORING THE CONDITION OF PUBLIC SECTOR FIXED INFRASTRUCTURE IN SOUTH AFRICA

REVIEW ARTICLE[1]

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ABSTRACT

Infrastructure is designed and built to deliver a service, but how well the infrastructure is operated and maintained is a major determinant of how effectively it is able to deliver that service. Despite this, much of the South African infrastructure owned by the public sector is not kept in a good condition. The article describes 25 years of high-level effort – including the conducting of research, the compilation of guidelines, and the passing of legislation – to improve the condition of public sector infrastructure. *Inter alia*, it introduces and describes the 'infrastructure report card' concept and how that has been applied in South Africa. It also highlights current texts on infrastructure asset management and suggests some examples of infrastructure asset management planning.

ABSTRAK

Infrastruktuur is ontwerp en gebou om 'n diens te lewer, maar hoe goed die infrastruktuur bedryf en onderhou word, is 'n groot bepaler van hoe effektief dit in staat is om daardie diens te lewer. Ten spyte hiervan word baie Suid-Afrikaanse infrastruktuur wat deur die openbare sektor besit word, nie in 'n goeie toestand gehou nie. Die artikel beskryf 25 jaar se

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hoëvlakpoging – insluitend die uitvoer van navorsing, die samestelling van riglyne en die aanneming van wetgewing – om die toestand van openbare sektor-infrastruktuur te verbeter. Dit stel onder andere die konsep "infrastruktuurverslagkaart" bekend en beskryf hoe dit in Suid-Afrika toegepas is. Dit beklemtoon ook huidige tekste oor infrastruktuur-batebestuur en stel 'n paar voorbeelde van infrastruktuur-batebestuurbeplanning voor.

1. INTRODUCTION

Infrastructure such as pipes, roads, bridges, water-treatment works, power stations, and many more is designed and built to deliver a service. However, the simple fact of the commissioning of that infrastructure, even if appropriately designed and built, is no guarantee of service delivery over the intended lifetime of the infrastructure (Public Works *et al*., 2007: 3-5). It must also be operated correctly as well as maintained and repaired whenever necessary.[2]

This infrastructure, while providing essential services, incurs ongoing operation and maintenance costs. In the meantime, as the infrastructure ages, it physically deteriorates. Moreover, its environment might change in innumerable ways (including that the infrastructure might be subject to overuse or abuse[3]). All these factors affect the condition of the infrastructure and thus its ability to continue to provide its intended service. Hence, the need for an owner of infrastructure to be well informed of the condition of that infrastructure (Public Works *et al*., 2007: 3-5).

Whether public or private sector, delivery of a service or a product is heavily dependent on the condition of the infrastructure. For example, if the business is to move goods from place to place, it helps (to say the least) to be assured that the delivery van is not likely to break down on the way. Granted, reliable delivery may be crucially affected by factors other than the physical condition of the infrastructure, but, in any conceivable circumstances, it would always be heavily dependent on that physical condition.

The topic of keeping infrastructure in a satisfactory condition and able to continue delivering the required service is generally known as "infrastructure asset management" (IPWEA, 2006; DPLG, 2007; ISO, 2014). A key part of effective asset management is budgetary planning (DPLG, 2007[4]).

2 It needs to be added that service delivery on the part of that infrastructure might also be unsatisfactory for reasons other than the standards of its operation and maintenance. For example, it might have been under-designed (*i.e*., inadequate capacity), inappropriately designed or constructed (*i.e.*, incorrect choice of technology or materials), poorly constructed, or constructed in the wrong place. Or, subsequent to its commissioning, it might have been damaged, or become loaded beyond its design capacity, or subjected to unanticipated forms of use, among other factors.

3 And that it might become obsolete or be rendered redundant.

4 This 131-page document contains no less than 59 usages of the word 'budget'.

Essential to that is knowledge of the condition of the infrastructure because, without that knowledge, how can priorities for repair, rehabilitation, or eventual replacement be determined?

This article is planned to be the first of a series of four to be published in this journal. They will describe investigations of the condition of South Africa's public sector[5] fixed infrastructure (and what trends there might be), reasons for/contributory factors to that condition, and the consequences of this condition for service delivery and quality of life. The final article of the series is planned to review how the nation got itself to the point where the condition of infrastructure is seriously harming the economy,[6] and how South Africa might (or could) find its way to better infrastructure condition and, hence, improved service delivery.

These articles will not discourse on infrastructure asset management principles and/or practice. That is, they will not cover the topic and techniques of the assessment of condition of specific components or sectors of infrastructure. Instead, they will highlight the monitoring/reporting of infrastructure conditions.[7]

2. METHODS AND REVIEW

Many South African public sector institutions, mandated to provide specific services, are failing to do so for a myriad of reasons, including insufficient skills and funding, as well as poor governance (SAICE, 2022). The review focuses on one of the reasons – albeit a major reason – for the failure, namely the inadequate management (*i.e.*, operation and particularly maintenance) of the fixed infrastructure on which the service delivery is dependent.

First, the review describes 25 years of public sector infrastructure monitoring (and, it must be noted, neglect of monitoring) in South Africa. Secondly, it emphasises the need for the independence of reporting the infrastructure condition in South Africa. Thirdly, it introduces the 'report card' concept as a handy measure of infrastructure condition. The article also descrtibes what the American and UK report cards comprise of and how the South African report cards have been compiled. Fourthly, in the

5 While this review does not discuss infrastructure asset management and condition monitoring in the South African private sector, it is important to note that this is highly varied, ranging from non-existent to world class, the dominant factors determining this being the sophistication of the infrastructure and the extent to which the owner of the infrastructure is concerned about possible infrastructure failure and its consequences.

6 For example, "IMF says SA could grow by 3% if Eskom, Transnet are fixed" (News 24, 2023).

7 See Section 6 for suggestions as to where this kind of information can be found, and also some examples of infrastructure asset management plans.

discussion section (Section 4), where examples are presented of useful public sector reports, legislation, frameworks, and strategies with respect to monitoring public infrastructure conditions, the review highlights that the implementation thereof is generally lagging far behind.

Qualitative research methods are employed for the study, primarily through the application of desktop research and data analysis of grey literature (information produced outside of traditional publishing and distribution channels) (Schöpfel & Prost, 2021: 80). Relevant grey literature used in this review consisted of articles, reports, the Internet, and other documents obtained from the author's extensive personal database of relevant material (Schöpfel & Prost, 2021: 81).

Three types of publications were used, namely government publications, including guidelines and legislation; other report cards, from which SAICE drew its inspiration, and contemporary reports of the condition of infrastructure in South Africa. The selection criteria for each were: whatever was most relevant; whatever, in English, that the author could get hold of, and that seemed credible, and whatever the author could get hold of and which, also, seemed credible.

The following sources were particularly useful. The reports of the South African National Department of Public Works, the Council for Scientific and Industrial Research (CSIR), and the Construction Industry Development Board (CIDB), as well as the infrastructure condition report cards of the American Society of Civil Engineers (ASCE), the (British) Institution of Civil Engineers (ICE), and the South African Institution of Civil Engineering (SAICE).

Content analysis was used in analysing the publications (Mayring, 2022: 85). Specific themes include infrastructure monitoring, independent reporting of infrastructure condition, as well as report-card inclusions, refinements, limitations, and ambitions.

3. KEY ISSUES

3.1 Twenty-five years of public sector infrastructure monitoring

An understanding of the principles and practices of infrastructure asset management – together with refinement of its techniques and understanding of its strategic importance – has evolved over many decades overseas (Ugarelli & Saegrov, 2022) and in South Africa. Undoubtedly, however, interest in the topic in South Africa has increased rapidly over the past 25 years. This is partly because of circumstances attendant on the growth of the public sector infrastructure portfolio in this country, together with the

greater visibility of its condition and the effect of that condition on service delivery, and partly because of the rapid advance of infrastructure asset management techniques, greatly aided by advances in ICT. This paper's focus on the past 25 years does not deny previous achievements.

In 1994, once it had won the first national elections, in which all adults, without racial exclusions, could participate, the new majority rule government of South Africa set to work with a will to implement what it termed the "Reconstruction and Development Programme" ("RDP"). Improving the engineering infrastructure – especially basic services such as water, sanitation, roads, and electricity – and extending its coverage formed an appreciable part of this programme.

> The RDP integrates growth, development, reconstruction, redistribution and reconciliation into a unified programme. The key to this link is an infrastructural programme that will provide access to modern and effective services such as electricity, water, telecommunications, transport, health, education and training for all our people. This programme will both meet basic needs and open up previously suppressed economic and human potential in urban and rural areas (Parliament of the Republic of South Africa, 1994: Clause 1.3.6).

Investment in new infrastructure was steeply ramped up and, within a few years, the proportion of the population within reach of infrastructure for each of those basic services increased significantly.

However, attention paid to the operation and, particularly, maintenance of infrastructure, new and old, did not rise at the same pace. Indeed, it soon became apparent to some observers that maintenance was being neglected in the rush to build new infrastructure (Public Works *et al*., 2007: 3), often to fulfil the many electoral promises that services would be provided to specific constituencies within specified time frames.

The Council for Scientific and Industrial Research (CSIR), a statutory research and development authority reporting to, and largely funded by the National Department of Science and Technology, was sufficiently concerned to commission a number of studies (all for internal use only by the CSIR and not published) of the condition of infrastructure and the factors that had led to it being in this condition. It found that these factors prominently included institutional weaknesses, skills shortages, and insufficient budgets (CSIR, 2005). Another important factor was an often-skewed understanding, much favoured by many politicians (including Ministers), of "delivery" to mean only the construction and commissioning of infrastructure – that is, with hardly any appreciation of the need for the infrastructure to be carefully operated and maintained so that the intended service, be it water, or electricity, or whatever, would continue to be provided into the future.

Initially, when trying to draw attention to operation and maintenance, the CSIR encountered strong resistance from some senior government officials, who opposed efforts to "distract" them (as they saw it) from their mandate to build new infrastructure. The CSIR responded to this by redoubling its efforts to find and document, and present to decision makers, evidence of service-delivery breakdown and examples of both good and bad practice in infrastructure asset management. This work included identifying contributory factors, including systemic strengths or weaknesses, in a selection of institutions such as specific municipalities and government departments.

The ensuing publication *Towards a framework for the maintenance of municipal infrastructure: In support of government growth objectives*, released by the CSIR in 2005, described the threat to service delivery posed by deteriorating infrastructure owned by the public sector. Using examples in municipal infrastructure, this report set out the argument that service delivery is the result of a process that can be viewed as a chain of factors. This chain is only as strong as its weakest link – thus any effort to improve service delivery would be futile if only some of the inhibiting factors were addressed. It suggested that these factors should include the following:

- Improving the financial sustainability of the infrastructure owners.
- Awareness raising and stakeholder consultations.
- Prioritising strategic infrastructure.
- Capacity audits and skills development.
- Building the maintenance sector.
- Introducing new delivery models.
- Establishing norms and standards, and appropriate practice guidelines.
- Legislation enhancement.
- Conditional infrastructure investment.
- Performance management.
- Monitoring and evaluation.
- Linking infrastructure and maintenance budgets (CSIR, 2005).

The CSIR report went on to say that government needed to draw up a 'business plan' for performance improvement.

The Construction Industry Development Board (CIDB) was an early convert to the CSIR point of view, and several of the seminal documents thereafter were released under the auspices of both the CSIR and the CIDB. For example: “The state of municipal infrastructure in South Africa and its operation and maintenance: An overview” (CIDB & CSIR, 2007).

Meanwhile, other bodies were also starting to show alarm at the deterioration of infrastructure. The Institute of Municipal Engineering of Southern Africa (IMESA) determined that its contribution would be to comprehensively set out what it viewed as “best practice” infrastructure asset management. To this end, it partnered with the Association of Local Government Engineering New Zealand and the Institute of Public Works Engineering Australia (IPWEA). In 2006, the three institutes published a “South Africa edition” of the previously published *International Infrastructure Management Manual*. This excellent manual and its subsequent updated editions (all of them aligned with “Asset Management Standard PAS 55” (British Standards Institution, 2008) and, subsequently, ISO 55000:2014 (ISO, 2014), and their later editions have, however, not been as widely read and used in South Africa as they deserve to be, primarily for the reason that many of the examples to which they refer represent high-end practices which, regrettably, can be understood and applied by few in the South African public sector.

A promising breakthrough of sorts came when the CSIR was appointed to draft what became the “National Infrastructure Maintenance Strategy”, a document subsequently approved by Cabinet in 2007. This Strategy document was careful to state the following:

> The fact that government has focused on new infrastructure to address backlogs from the past is not the problem, and government should not change its focus in this regard. The challenge is to supplement this by also focusing on the maintenance of both new and old infrastructure at the same time as providing the new infrastructure needed to address backlogs (Public Works *et al*., 2007: 3).

It was also careful to draw a distinction between “some public sector institutions which maintain their infrastructure at a high standard – budgets are adequate (even if barely so), skilled staff are in place, leadership is committed, and policies support sound infrastructure maintenance practices”, and others which do not (Public Works *et al*., 2007: 3). To back this assertion, it named some of the institutions that were managing their assets well, and those that, as evidenced by deteriorating infrastructure, were not.

Another issue to which the Strategy drew attention was the common tendency for decisions on procurement of public sector infrastructure to be made on the basis of lowest construction or acquisition cost. In

these instances, hardly any, if any, attention was paid to the long-term consequences such as the significant possibility that the "lowest initial cost" infrastructure could prove to be less robust when in use and would, therefore, incur higher maintenance costs or need earlier replacement.

The "National Infrastructure Maintenance Strategy" set out an "action plan" for

> improving infrastructure asset management planning, budgeting and implementation, [whereby] public infrastructure will be maintained in such a way as to enable sustainable service delivery, increased economic growth, and increased access to services and economic opportunities for the poor. In addition … since there will be an ongoing need for maintenance, and since most maintenance activities are repetitive, expansion of the maintenance industry will provide increased opportunities for long-term employment (Public Works *et al*., 2007: 13).[8]

Unfortunately, it would not be unfair to say that, despite its approval by Cabinet, the Strategy has since been paid not much more than lip service by government.

Recognising that reports to, and meetings with government were having hardly any effect, the CSIR sought ways to more innovatively and imaginatively present its findings and to argue the case for more emphasis on maintenance and for life-cycle planning to be part of infrastructure investment decisions.

In 1998, the ASCE published its first "Report Card on America's Infrastructure" (ASCE, 1998). This report card (and its successors in 2001 and every four years after that through to, most recently, 2021) depicted the condition and performance of American infrastructure in the familiar form of a school report card – assigning letter grades based on the physical condition and needed investments for improvement.

In 2003, the ICE, the London-based "mother" of learned society voluntary associations for civil engineering professionals, published its first "State of the Nation" report, giving "an assessment of the state of the industry … and highlight [of] the actions the ICE believes are necessary to improve UK infrastructure" (ICE, 2022: 3).

8 The CSIR subsequently estimated that anything between one quarter and one half of a million permanent jobs in routine maintenance could be created, if the budgets were forthcoming. These jobs would be across the entire country – wherever there is infrastructure to be maintained, and best of all, the vast majority of the jobs could be undertaken by people with low levels of skill, thus alleviating to a small but significant extent the high unemployment rate among South Africans who were unable to complete formal schooling.

The CSIR had, for some years, expressed its intention to, in due course, follow the leads of the ASCE and the ICE in preparing a South African equivalent of the above "report cards" or "state of the nation" reports. However, it was only when, in 2006, the incoming President of the South African Institution of Civil Engineering (SAICE), the South African counterpart of the ASCE and ICE, declared his ambition that the SAICE should follow their lead, that the SAICE and the CSIR agreed to join forces, in order to research, write, and publish the first nationwide infrastructure condition report card for South Africa.[9]

Thanks largely to the extensive database on the condition of public sector infrastructure in South Africa that the CSIR had already built, this ambition was realised within the same year (SAICE, 2006a).

3.2 The need for independent reporting on infrastructure condition

While it is clearly desirable that any assessment of infrastructure condition should be undertaken by a body independent of the owners of the infrastructure or parties paid by them (for example, consultants) to undertake such work, why would the SAICE wish to do the reporting and consider that it is best placed, or at least very well placed, to assess the condition of public sector infrastructure in South Africa?

As noted earlier, in 2006, the SAICE, greatly assisted by the CSIR, released its first report on the condition of a broad spectrum of engineering infrastructure in South Africa. The purpose was to draw the attention of government and the public at large to factors underlying the condition of public sector infrastructure, and to the importance of maintenance.

To the best of the SAICE's knowledge, and the CSIR and others consulted, this was the first time that a comprehensive all-sector review had been undertaken, by anyone, of the condition of South Africa's infrastructure.

As stated in the opening paragraph of the 2022 report card:

> More than any other set of professionals, civil engineers are entrusted by society to conceive, design, build and maintain the nation's portfolio of infrastructure assets. They are the custodians of the built environment. It is appropriate, then, for the institution (SAICE) to prepare this assessment of the condition of public infrastructure [and to do this] as a public service (SAICE, 2022: 3, emphasis added).

9 That this agreement was so readily reached was no doubt at least in part due to the CSIR lead researcher and his line manager having both also served as Presidents of SAICE!

Accepting that SAICE is well placed to do this assessment, there are two, complementary views as to why the SAICE should want to do it. The one, admittedly, contains an element of self-interest: addressing infrastructure backlogs, whether they be of absence of infrastructure or because of the need to operate, maintain or rehabilitate existing infrastructure, creates work for civil engineering professionals and the industry. But the other view goes way beyond that.

Civil engineers take pride in their work. They plan, design, build, operate, and maintain infrastructure with the intention that it provides a service, and when that infrastructure is neglected, it is disappointing not only professionally, but also emotionally. "I" had a hand in building that road, or hospital, or railway line, as "my" contribution to the economy and to raising the quality of life of my fellow citizens – but now it has been broken!

As taxpayers, too, engineers (and other citizens) have a right to be aggrieved that the investment, to which they contributed financially, is no longer serving its purpose.

Beyond that, still, is a feeling that raising concerns about infrastructure condition is a professional obligation. The 2009 ASCE report card put it particularly well:

> Civil engineers are stewards of the nation's infrastructure, charged with the design, construction, operation, and maintenance of our vital public works. Inherent in that responsibility is the obligation to periodically assess the state of the infrastructure, report on its condition and performance, and advise on the steps necessary for its improvement (ASCE, 2009: iii, emphasis added).

The following year, the ICE went a step further, (justly) laying a claim to be a body excellently equipped to assess the state of UK infrastructure.

> The State of the Nation report is produced by one of the world's most senior and respected professional institutions. The Institution of Civil Engineers (ICE) exists to serve society by developing the knowledge, skills and advice to provide the right infrastructure. It also offers independent opinion on the actions we should take (ICE, 2010: 3).

Note that the SAICE's goal not only to be independent but also to be seen to be independent extends to its refusal to accept sponsorship of any kind, despite offers being made over the years.[10] Given that these offers have thus far all been from owners of infrastructure, the SAICE has each time turned them down on the grounds that any gradings of the condition of those sponsors' infrastructure might as a consequence of the sponsorship be thought to be biased.

10 The acceptance of research input from the CSIR and others does not compromise that independence.

3.3 Report card concept

3.3.1 Purpose of a report card

The ICE warned:

> The nation that neglects its infrastructure neglects its future. But the nation that respects its infrastructure respects its people, and provides for their sustainable future (ICE, 2010: 6).

The media release accompanying the launch of the first SAICE infrastructure report card succinctly captured the SAICE's reasoning behind it and the CSIR going to the enormous trouble of preparing a report card on infrastructure condition in South Africa.

> Infrastructure and its maintenance underpin quality of life and economic development. If these are inadequate it will impede social and economic growth in South Africa – something our country just cannot afford.
>
> SAICE feels that if government is aware of the profession's opinion on where maintenance or replacement is most needed, such as where infrastructure is ageing or approaching obsolescence, better-informed decisions can be made (SAICE, 2006b: 4).

The release closed by quoting the then SAICE President, Sam Amod:

> To measure is to know! The report card will, we hope, be of interest and value to all tiers of government, business, industry and the general public (SAICE, 2006b: 4).

By contrast, the ASCE, at least in respect of the early report cards, was nothing like as restrained as to use phrasing such as "we hope will be of interest and value"! Rather, the report cards have urged citizens to lobby government to address infrastructure issues. For example, its 1998 report proclaimed on the cover page that it was "[a] voter's guide to renewing America's infrastructure". In addition, inside could be found a map of the USA with a facility for said voters to click on their places of residence and discover the names of their public representatives, and pro forma draft letters concerning infrastructure matters that could be used to lobby these representatives (ASCE, 1998).

This activist tradition continued. In 2001, the cover page proclaimed a not dissimilar title: "Renewing America's Infrastructure: A Citizen's Guide" (ASCE, 2001).

The ICE wrote more modestly:

> Their aim [the State of the Nation reports] is to stimulate debate and to highlight the actions that we believe are needed to improve the state of the nation's infrastructure and associated services (ICE, 2010: 2).

The ICE nonetheless is very active in promoting the reports, not least among decision makers at national level.[11] The 2010 report made specific mention of the establishment of Infrastructure UK, "the government body tasked with developing a 5-to-50-year view of our strategic infrastructure priorities and establishing a clear delivery plan" (ICE, 2010: 3). The ICE has since built up a close relationship with this body.

3.3.2 The American and UK report cards

The ICE reports have not been explicit as to numbers of contributors, describing them only as "numerous". Generally, the reports refer to the work of various committees, some of which seem to be standing and others *ad hoc*. Seeing that the themes of the state of the nation reports have varied significantly from year to year (for example, the 2022 report focused on improving infrastructure productivity), key participants have varied from year to year. Given the focus of the 2022 report and its subtitle "Improving Infrastructure Productivity", not too unexpectedly they were members of the ICE Productivity Community Advisory Board, "a group of 23 industry experts who advise the Institution's Engineering Knowledge programme on the speciality areas" (ICE, 2022: 4).

The ASCE has, for each report card, identified how the core team of volunteers involved has been growing. To illustrate:

For the 1998 report card:

> An 11person volunteer (with strong staff support) essentially reviewed federal reports and data to form a basis to develop the grades (Dinges, 2001: email).

Whereas the 2021 report card refers to

> [t]he ASCE Committee on America's Infrastructure, made up of 31 dedicated civil engineers from across the country with decades of expertise in all categories, volunteers their time to work with ASCE Infrastructure Initiatives staff to prepare the Report Card. The Committee assesses all relevant data and reports, consults with technical and industry experts, and assigns grades using the following criteria: capacity, condition, funding, future need, operation and maintenance, public safety, resilience and innovation (ASCE, 2021: 3).

When the time to release each report card approaches, "[l]ocal data and anecdotes [are] gathered from local members to help us launch the 'national' report card in local media markets across the US" (Dinges, 2001: email).

11 It helps that the Houses of Parliament are merely a few blocks away from the ICE headquarters in London, and that the ICE building itself is a splendid venue for the launch events.

In addition to the national publications, both the ICE and the ASCE compile sub-national reports, the latter more regularly. For example, in 2013 and 2015, the ICE issued reports specifically on infrastructure in Scotland (ICE, 2013; ICE, 2015). Thanks largely to volunteer members at local level, the ASCE has, over the years, been compiling report cards specific to each of the states – there is now an infrastructure report card of some vintage or another for every one of the states and also the District of Columbia.

In the years between national reports on infrastructure condition, the ICE published,

> State of the Nation reports each focused on a specific issue which will affect the delivery of effective infrastructure for the UK. Since 2008, ICE has published thematic reports focused on topics such as defending critical infrastructure, low carbon infrastructure, transport and capacity and skills (ICE, 2010: 1).

As noted earlier, the most recent State of the Nation report, that of 2022, focused on "improving infrastructure productivity", whereas the focus of the previous year was clearly enough expressed in the subtitle, "State of the Nation 2021: Six ways for civil engineers to act on climate change" (ICE, 2022; ICE, 2021).

Both the ASCE and the ICE devote considerable resources to publicising and disseminating the reports and claim that widespread coverage is achieved. For example, that the message of the 1998 report card "reached 80 million people in the US" (Dinges, 2001: email).

Note that national or regional infrastructure condition report cards, or similar documents with the same intention, have been or are regularly being published over and above those by the ASCE and the ICE. For example, that by Infrastructure Australia (Infrastructure Australia, 2019).

Some of these are not researched and written by the combinations of volunteers and contractors or paid staff that characterise the report cards of the ASCE, the ICE, and the SAICE, and/or the coverage and/or the type of analysis is different. Infrastructure Australia, for example, is not part of a voluntary or learned society, but was established by government "in 2008 to advise governments, industry and the community on the investments and reforms needed to deliver better infrastructure for all Australians".[12]

12 https://www.infrastructureaustralia.gov.au/about-us

3.3.3 The SAICE report cards

With the ASCE report cards as its primary role model, and taking advantage of the information supplied or elicited by the CSIR,[13] the first SAICE report card covered the infrastructure condition of the following sectors:

- water and waste water (in respect of waste water, all waterborne systems on a reticulated network, and including treatment – but not on-site systems);
- solid waste management;
- roads;
- airports;
- ports;
- rail;
- electricity (generation, high-voltage transmission, local distribution);
- healthcare infrastructure (hospitals and clinics).

The CSIR's experts in each of these sectors assembled and packaged the necessary information, drawing from their own knowledge and that of their colleagues, and from reports they could obtain from public sector sources (for example, from the pavement management information systems of a selection of roads authorities). No attempt was made to cover all authorities responsible for infrastructure of a particular type – for two reasons. First, it was known beforehand that only a minority of these authorities would have reliable and up-to-date information. Secondly, it was judged to be sufficient that only a sample, together with the extensive overall understanding that the CSIR experts possessed of each sector, would provide a credible enough snapshot of the infrastructure condition.

For example, whereas the vast majority of hospitals in the public sector are the responsibility of the provincial governments, the CSIR had, in previous years, been appointed to undertake infrastructure assessments of hospitals in no less than four of the nine provinces. For another example, the authority responsible for the nation's nine commercial ports had regularly appointed the CSIR to inspect selected aspects of their infrastructure.

Bear in mind that the intention was (and still is) to grade the <u>average</u> condition of infrastructure within each sector (and also nationally overall). That is, infrastructure (for example, roads) in the care of some authorities

13 The CSIR lacked expertise in water resources infrastructure such as dams and major pipelines and canals, and solid waste management. The contribution to the 2006 report card by, respectively, South African National Commission on Large Dams (SANCOLD) and the Institute of Waste Management of South Africa, is acknowledged with thanks.

could be in superb condition, whereas that belonging to others could be literally falling apart – but it is the "average" grade that would appear in the report card. As a consequence, the assigned grade hides huge variations in the condition and performance of the infrastructure in each sector. For another example, water quality is, with the occasional exception, excellent in the metropolitan areas, although there are invariably problems of ensuring reliable water supply at all times, and water losses are often very high. However, water quality in many of the more rural areas, including small towns, too often does not meet the minimum drinking water quality standards laid down by the World Health Organization and the South African Bureau of Standards (SABS, 2015).

It must be noted that the condition of only fixed infrastructure in each sector is assessed. Thus, for example, in the rail sector, railtrack, structures such as bridges, signalling and communication are taken into account, but rolling stock is not.

The report cards make the effort to explain that the current condition of existing infrastructure is being adjudicated. Thus, they have not mentioned, other than in passing, any owner's apparent intentions to improve infrastructure in the future, even when these are accompanied by plans with budgets. These intentions would instead be reflected through improved grades in future report cards. The focus of the report cards has always been entirely on the contemporary condition of infrastructure.

Following the ASCE lead, the SAICE adopted a five-point grading scale, although the nomenclature and the criteria are not exactly similar. The SAICE scale was (and has remained):

- A: "World class".
- B: "Fit for the future".
- C: "Satisfactory for now".
- D: "At risk of failure".
- E: "Unfit for purpose".

3.3.3.i Subsequent inclusions and refinements

The public infrastructure sectors assessed in 2006 have been covered by all subsequent report cards, and in addition:

- fishing harbours featured in 2011 and 2022 (but not in 2017, as in that year, no new information could be obtained);
- the public ordinary schools sector debuted in 2011 and has appeared in both subsequent report cards;

- universities and colleges for technical and vocational education and training appeared in 2017 and again in 2022;
- debuting in 2022 were oil and gas bulk pipelines, and ICT fixed infrastructure (the latter an anomaly in that it is almost entirely owned by the private sector). A note on fire safety considerations appeared in 2022.

When the time for preparing the second report card was approaching, the SAICE team assessed the risk of the gradings being challenged – for example, that an entity responsible for infrastructure in one of the sectors, dissatisfied with the grading it had been allocated, might not unreasonably demand to see the SAICE's documentation. This precaution had not been taken the first-time round, for two reasons. First, the time allocated to complete the work was far too short. Secondly, the CSIR's experts had indicated that, if necessary, they would be on hand to defend their findings.

Thus for the second report card, it was decided that the sector experts would write formal reports, which should cover, at minimum, some dimensions of the infrastructure (for example, how many treatment works, what size distribution, and what total capacity); who owns the infrastructure; what legislation governs service delivery as well as service quality standards and infrastructure condition, and what monitoring may be in place, and what can be gleaned about the condition of the infrastructure.

These reports were duly written to a length of anything between 30 and 70 pages. The same procedure was followed in 2017 and 2022.

The second report card established a mechanism for moderation of the grades. This mechanism was also adopted for the third and fourth report cards. This commenced once the sector reports were available – these were circulated to a group of specialists usually drawn from the SAICE's technical divisions and comprising members who had not been involved in the report card up to that point. The ensuing process culminated in a half-day meeting of these specialists, at which the merits of gradings for each of the sectors would be determined. The kind of decision that would have to be made could simplistically be expressed as "does excellence, or mediocrity, in road condition warrant the same grading as excellent or mediocrity in electricity generation, or in healthcare facilities – and what should the grading be?"

In 2011, a mechanism for oversight was also established. The SAICE invited experts, not necessarily SAICE members nor necessarily engineers, to constitute a small panel providing independent advice on the entire report card process: Is the process fair? Is it sufficiently comprehensive? Is it robust enough to support its conclusions?

Once draft sector reports were coming through, a small team would start to assemble ideas for a commentary on cross-cutting themes. This was continually revised and supplemented, aiming to be available as a coherent full draft around the same time as the moderation would take place. Whereas it has, from the first instance, included some description of the public asset, and comments about skills and finances, the commentary evolved over the years until, in 2022, the following topics were covered:

- responsibility for infrastructure;
- investment, and preservation of the public asset;
- the opportunities offered by maintenance;
- climate change and environmental factors;
- user behaviour and crime impacts, and
- a set of "matters of critical importance", being people and relationships, institutional robustness, data management and infrastructure monitoring, and "reasons for optimism".

The author highlights only one of these. The SAICE pointed to the "significant extent" to which infrastructure deterioration and service delivery failure "are attributable to institutional failures in capacity and governance that extend beyond the realm of asset management" (SAICE, 2022: 18).

The SAICE also deplored the paucity of data on the condition of public sector infrastructure assets:

> Consistent and accurate data collection is essential to understanding the current stock, performance and reliability of infrastructure assets. Moreover, such information is vital to scheduling maintenance and renewal of existing facilities, and to predicting future needs. … Most municipalities as well as many provincial and national departments and State-Owned Companies do not collect or analyse data that is crucial to their core functions (SAICE, 2022: 20).

Publication, the launch, and report dissemination, all undertaken by the SAICE, followed.

3.3.3.ii CSIR/SAICE co-operation

At no stage was there a formal contract between the CSIR and the SAICE. Rather, their successful cooperation was built on trust. Thus, preparation for the 2017 publication was proceeded with on the basis of a simple memorandum of understanding, whereas the first two were even more informal – in each case, letters of agreement, no longer than two pages, were exchanged. Apart from defining the responsibilities of each party, these three agreements made clear:

- that each party would carry its own costs (for the CSIR, the cost of personnel undertaking research and writing the sector reports; for the SAICE, all costs thereafter, right up to and including the cost of publishing a report card, the launch, and dissemination – also marketing and any follow-up, for example, with government);
- timelines;
- any matters of copyright.

There was no mention of penalties such as, for example, penalties for delivery later than scheduled. After all, what penalties could be imposed, if the relationship was built on trust and there was no contract, with payment on deliverables, so how could penalties take the form of, say, withholding of payment?

Each of the first three report cards were published by and branded "SAICE", with hefty acknowledgement of the very substantial contributions by the CSIR.

When the time came to prepare the fourth, the CSIR was once more approached, asking it to again provide the excellent research support of previous years. However, this time the approach was unsuccessful, the CSIR citing financial constraints, and stating that it had, to a large extent, lost the sector expertise it had contributed previously.

The SAICE thus turned to its own membership, asking its technical divisions to research and write the reports on each of the infrastructure sectors that the CSIR had previously undertaken. This approach generally worked out very well indeed, the outputs produced by some of the technical divisions proving to be of the highest quality, which speaks volumes for the commitment of the volunteers who undertook the task. Outstanding performers included the Water Engineering and Transportation divisions, and also the contributions by the South African Institute of Electrical Engineers and the Energy Expert Group of the South African Academy of Engineers. Unfortunately, the SAICE does not have technical divisions corresponding to only a few of the infrastructure sectors (for example, basic education infrastructure). Therefore, in respect of these, it proved more difficult to cobble together the range and quality of the information required. The 2022 findings for these sectors are consequently not as comprehensive or credible as in previous years.

3.3.3.iii Ambitions and limitations

Unlike its American and British counterparts, the SAICE has not become more ambitious, such as in terms of producing regional (in South Africa's case, provincial) infrastructure condition reports, or the substantial "specific issue" focus reports such as those by the ICE. This is primarily because it is a much smaller institution with less resources. The SAICE has in the order of less than 8,000 members (personal communication, SAICE CFO, 20 June 2023), whereas its sister institutions in the United States and the UK have, according to their websites, respectively, "more than 150,000" (ASCE, 2022) and nearly 93,000 (ICE, 2020) members.

To give sister institutions in other countries that could be considering undertaking the compilation of infrastructure condition report cards along the same lines as the SAICE, some idea of the effort involved by the volunteers: whereas records of time were not kept, any estimate would simply be an educated guess – the author suggests that the effort would have been something between 1,000 and 1,200 person-days.

Counting from the start of the process to launch of the publication, the 2022 report card took the longest, close on three years. The first third of that was spent in (unsuccessfully) negotiating with the CSIR, and internally, within the SAICE, defining scope and responsibilities, finally obtaining formal approval by SAICE structures. The next step was persuading the technical divisions to source members who would be prepared to write the sector reports, a process which they invariably began by calling for volunteers. The writing then proceeded – some divisions were in a position to table credible reports within a few months, whereas others struggled to such an extent that the report card leadership team had to find substitutes. That left the last few months for editing, moderation, review, writing sector summaries, and writing those initial chapters about cross-sector matters of importance, followed by publication and launch.

The second and third report cards were slightly quicker. A major reason why they were not much quicker was that the CSIR, for budgeting reasons, could deliver only half of the sector reports each year.

The first was by far the quickest, taking less than a year. This can readily be explained in terms of the informality and complete absence of bureaucracy, and that the great majority of the condition information had already been assembled by the CSIR for its own purposes.

Given how long the preparation of each report card has taken, the data presented in the report cards would be of varying vintage and never absolutely up-to-date, even on the day that the publications are launched. To illustrate simply: if the report about a sector is being written in Year X,

the probability is that the most recent information in the public domain is of Year X minus 1 – if the researcher is lucky (it is more likely to be on average already two years old). Between the time that the sector reports are received, and bearing in mind that some arrive behind schedule, much later than others, and also that publication, as outlined above, takes up further time, by the time the report card appears the condition information presented in it is already on average between two and three years old.

Neither the CSIR nor the SAICE has the resources to do much if any in the way of primary research, and thus they depend almost entirely on information already in the public domain or which infrastructure owners can be persuaded to release from their files. This would only be as complete as the owners of the infrastructure, or regulators if there are any, have compiled. If no condition assessments have been done, then the researchers have either to do without, or attempt to infer (maybe by using proxy information, which is sometimes quite effective), or undertake the primary research themselves, an expensive and time-consuming exercise. The only significant, but limited, instances of the latter were undertaken by the CSIR at its cost, and then only a very few times. For example, in 2011, to supplement the public health infrastructure data it already had, the CSIR undertook a limited high-level condition survey of hospitals in a couple of provinces.

The SAICE has within its membership a very large number, if not the majority, of the professionals who plan, design, build, operate, maintain, and refurbish infrastructure of South Africa. Their collective opinion on the condition of this infrastructure would, therefore, constitute a considerable body of credible evidence. The SAICE would have liked, each time a report card has been prepared, to survey its membership for views on infrastructure condition. Unfortunately, it has been possible to undertake this survey only once – in 2017 – and only thanks to the considerable statistical analysis assistance of the CSIR (Rust *et al*., 2021).

It was comforting to note that the opinion survey findings strongly supported the findings of the 2017 publication.

4. DISCUSSION

4.1 Useful public sector reports

As noted earlier, the SAICE report card processes have drawn, *inter alia*, from “reports they could obtain from public sector sources”. Pertinent to the report cards, these reports exist for each of the sectors covered by the report cards, although with huge variations from sector to sector, and from infrastructure owner to infrastructure owner, in factors such as

completeness, reliability, and age of the information significantly affecting their usefulness. Moreover, these reports, even if they contain information on infrastructure condition, have usually been prepared for purposes other than condition monitoring.

Some examples may serve as illustration:

The several “Green Drop”, “Blue Drop”, and “No Drop” reports, which first appeared roughly a dozen years ago, and were not seen for some years thereafter, but which resumed relatively recently, have taken pains to point out that they are key instruments of “incentive-based regulation programmes”, seeking “to identify and develop the core competencies required”, and clarifying “the requirements and obligations placed on water services institutions, thereby protecting customers from a potentially unsustainable and unsafe service” (DWA, 2011: 1). Thus, they assess the overall performance of infrastructure (for example, in the case of the Green Drop, the waste water treatment facilities), measuring a mix of skills, monitoring activity, sample analyses, water quality compliance, water quality failures response, and reporting (*i.e.*, transparency). While these reports reveal much about the condition of the treatment facilities sampled – some of it by inference, from performance, rather than by direct measurement – they are not primarily about the condition.

It would be good practice and much to their advantage if all road authorities (state-owned companies, provincial governments, and municipalities) were to do regular condition monitoring, but few do. A great deal can, however, be learned from those whose reports can be accessed.

Provincial government departments of basic education have established and maintained (or ought to maintain) databases of all basic educational facilities. These databases should include a prescribed set of information on learners, educators, and curricula, as well as the size and location of every school, the extent of infrastructure (for example, numbers of toilets), and the condition of that infrastructure. In practice, the reliability of this information varies widely, and also how up-to-date it is.

Other public sector institutions that keep databases of infrastructure, usually including key information about the condition of that infrastructure, include the National Energy Regulator of South Africa (NERSA, most pertinently in respect of municipal distribution networks), provincial and national Department of Public Works and Infrastructure (of public buildings and other facilities such as water and waste water treatment works belonging to departments such as the national Department of Correctional Services), among others. The reliability and completeness of this information, and also how current it is, also varies widely. Moreover, gaining access to this information has at times proven to be very difficult, if not impossible, even for the CSIR and the SAICE.

4.2 MFMA, PFMA, NIMS, GRAP 17, NSWSIAM, NIAMM and GIAMA

The Local Government: Municipal Finance Management Act 56 of 2003, known as the MFMA, is the principal (but not the only) legislation that requires municipalities to responsibly take care of their infrastructure assets (and of other forms of assets) (South Africa, 2003). It places an obligation on municipal accounting officers "for the management of the assets of the entity, including the safeguarding and maintenance of those assets" (MFMA Clause 96(1)(a)). A similar requirement, applicable to the other spheres of governance, appears in the Public Finance Management Act 1 of 1999, known as the PFMA, in Clause 38(1)(d) (South Africa, 1999).

Earlier, it was stated that "it would not be unfair" to say that the National Infrastructure Maintenance Strategy (NIMS), despite its 2006 approval by Cabinet, "has since been paid not much more than lip service by government". That statement did not, however, recognise that, within the following couple of years, government would take a number of other steps, not in any way the consequence of the Strategy, but with the same goal in mind, namely to improve the management of public sector infrastructure.

Four of these measures are noteworthy:

To financially account for infrastructure assets, the so-called "GRAP 17" was published. Periodically modified, it is still very current (Accounting Standards Board, 2021).

The National Department of Water Affairs (DWA), as it was then called, commissioned the formulation of a National Strategy for Water Services Infrastructure Asset Management (NSWSIAM). This appeared in 2008 (DWA, 2008), but, regrettably, has never been applied to the extent intended.

Approximately 10 years ago, the CIDB, on behalf of the National Department of Public Works (DPW), began development of a National Immovable Asset Maintenance Management Framework (NIAMM). This eventually became a set of six documents that appeared in 2015, to be applied "for immovable assets under the custodianship of National and Provincial Departments of Works":

- Maintenance Management Standard.
- Maintenance Accounting Framework.
- Monitoring and Evaluation Protocol.
- Maintenance Planning Guidelines.
- Competency Framework.
- Contractor Development in the Maintenance Industry.

Support for this key framework, in terms of its ratification and formal adoption, has waxed and waned over the years. During 2017, it was endorsed by Public Works MinMEC (*i.e.*, the grouping of provincial public works ministers under the chairmanship of the national Minister of Public Works), and was to be signed off by the Minister, whereafter it would, through regulations to be introduced in terms of GIAMA, become mandatory in all national and provincial public works departments. At the time, under discussion were:

- DPW exploring how to make it mandatory on local government;
- a support programme being devised and implemented, and
- establishment of a dedicated unit to oversee and manage its adoption across state-owned companies, national, provincial and local government (Anon, 2017: Personal communication).

The author has, over the years, attempted to track progress of the NIAMM. In June 2019, he was advised by the CIDB that it was intending to put out a tender for that dedicated unit, but this did not go ahead. In December 2021, he was told that they (the CIDB) are "trying to resuscitate it", which could be interpreted to mean that hardly anything had really happened. Finally, a more recent enquiry of the CIDB elicited only that the NIAMM is "[s]omething that is sitting on a shelf somewhere, as a resource" (Anon, 2023a: Personal communication).

Finally, the Government Immovable Asset Management *Act 19 of 2007 (GIAMA)* aimed to provide for a uniform framework for the management of any immovable asset belonging to the national and provincial spheres of governance (South Africa, 2007). It, too, has never been applied to the extent intended, despite the careful design of the following set of principles:

- The Minister of the Department of Public Works and Infrastructure[14] (DPWI) is appointed as custodian of immovable assets which vest in the national sphere of government. The Minister acts as the caretaker of immovable assets and is given the powers to acquire, manage, or dispose of these assets.
- GIAMA regulates immovable asset management by means of contractual relationships between the custodian and national user departments.
- The custodian is required to annually prepare a custodian immovable asset management plan, whereas the user department is required to annually prepare a user immovable asset management plan.

14 Previously, the Department of Public Works.

- The preparation of these asset management plans represents the backbone of the immovable asset planning and budgeting process.

However, while many of these immovable asset management plans, both custodian and user, have been prepared, "[t]he implementation of GIAMA has proven to be difficult particularly the development and budgeting of credible asset management planning on an annual basis" (Parliamentary Monitoring Group, 2019). Moreover,

> Members noted the maintenance backlog amounted to R74 Billion and said that if the infrastructure had been maintained correctly this amount would not be as high. They asked what the Department was going to do to decrease this amount and prevent it from increasing year in and year out. Members asked if the services of the DPWI were improving over the years or not; on '*D rating: at risk of failure'*, if there were any time frames to handle the problem and why was the necessary attention not given to infrastructure for the past 25 years;… (Parliamentary Monitoring Group, 2019, emphasis in the original.)

From the above it will be understood that, while the planning of the infrastructure asset management of public sector assets has made much progress, its implementation is generally lagging far behind. Coupling that with inadequate levels of skill in many institutions responsible for infrastructure, and often woefully inadequate budgets for operation, maintenance and repair, it should not be too surprising that the condition of much of the public sector infrastructure leaves a lot to be desired.

5. CONCLUSION

This paper outlined some aspects of the monitoring of infrastructure condition in the South African public sector and introduced the "report card" concept as a means of presenting the findings of independent reporting on infrastructure conditions. It has not reported the findings of any of that monitoring – this will be covered in the second paper of the series.

6. SUGGESTIONS FOR FURTHER READING

Despite it having been around a long time, the best introductory text to infrastructure asset management written specifically for the South African public sector is still the Department of Provincial and Local Government's *Guidelines for Infrastructure Asset Management in Local Government 2006-2009*, which appeared 15 years ago (DPLG, 2007). This text spells out the basics in adequate detail but without getting over-complicated.

Of equal value, but not as readily available, are the notes which were made available to attendees on one or another of the courses on infrastructure asset management presented over the period 2014-2021 by the Institute of Municipal Engineering of Southern Africa (IMESA) on behalf of the Municipal Infrastructure Support Agent.

Many institutions, public and private, offer training in infrastructure asset management. Among them is IMESA, which, despite no longer offering courses, allows free use of the Asset Management Program Learning Environment (AMPLE) online learning system (IMESA, 2018), a web-based tool (knowledge management system) that has an intuitive and user-friendly set of online process and practice guidelines, templates, and decision support. This "is dated now but a useful resource" (Anon, 2023b: Personal communication).

Over the years, the Western Cape has set a high standard for infrastructure asset management planning. For two recent examples:

- Western Cape Government: Transport and Works. User Immovable Asset Management Plan 2021/2022 (Western Cape, 2021).
- Western Cape Government: Department of Health: User Asset Management Plan 2022/2023 (Western Cape, 2022).

For a clear explanation of the logic and purpose of identifying a hierarchy of components, and how best to do this identifying, see Western Cape Provincial Government (2006: 3-4), specifically Chapter 2: Standardised Asset Hierarchy, in particular, the need to provide a minimum level of detail that is accurate enough for the owner of the infrastructure to effectively monitor trends in infrastructure condition; and that is accurate enough to provide a foundation for the owner to make informed strategic and tactical decisions and to promote the establishment of maintenance and rehabilitation programmes to control and safeguard their infrastructure assets.

Of more than passing interest is how, from relatively early on, the Western Cape supported the implementation of infrastructure asset management principles, especially at municipal level (Von Holdt & Du Plessis, 2007).

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