

# AN ASSESSMENT OF THE CONDITION OF SOUTH AFRICA'S TRANSPORT FIXED INFRASTRUCTURE

K WALL\* and C RUST\*\*

\*Department of Construction Economics, University of Pretoria, Hatfield 0028; 082-459-3618; [kevin.wall@up.ac.za](mailto:kevin.wall@up.ac.za) or [kevinwall468@gmail.com](mailto:kevinwall468@gmail.com)

\*\*CSIR Built Environment

## ABSTRACT

The purpose of the “report cards” of the condition of engineering infrastructure in South Africa, the product of cooperation between the CSIR and SAICE, have been to draw the attention of government, and of the public at large, to the importance of maintenance, and to factors underlying the state of repair of infrastructure. The success of these report cards, published in 2006 and 2011, has been such that the CSIR and SAICE are again working together to prepare a new report card, to appear later this year.

Of the 10 infrastructure sectors assessed in the previous report cards (and which are again being assessed in the third), no less than four concern public transport fixed infrastructure, viz roads, airports, ports and rail.

Whereas completion of the third report card will not take place until mid-2017, the objective of this paper is, after a brief description of the background to and purpose of infrastructure report cards and the process by which the South African report cards are compiled, to discuss key findings of the previous report cards – and also preliminary findings of the current work on the third report card – all with a particular focus on the transport sector.

## BACKGROUND

In 2006 the South African Institution of Civil Engineering (SAICE), in partnership with the Council for Scientific and Industrial Research (CSIR), released the first ever “report card” assessment rating of the condition of public sector engineering infrastructure in South Africa (SAICE 2006). The purpose of the report card was to draw the attention of government, and of the public at large, to the importance of maintenance, and to factors underlying the condition (state of repair) of infrastructure. Its success was such that the CSIR and SAICE brought the second report card out in 2011 (SAICE 2011), and are again working together to prepare a third, scheduled to appear mid-2017. (A paper presented at SATC 2016 described the nature and purpose of infrastructure report cards, the historical background of the previous two report cards, and the key cross-sector findings of the 2006 and 2011 report cards. (Wall, Rust and Kistan 2016.)

It is anticipated that the findings of this next report card will be widely debated because, in the last few years, service delivery problems, particularly those attributable to operation and maintenance of infrastructure, have received heightened attention across the country – and have manifested in the so-called “service delivery protests”.

Whereas publication of the new report card will only take place some months after this conference paper has been written, in the paper may be found:

- the background to and purpose of infrastructure report cards and the process by which the South African report cards are compiled;
- key findings of the previous report cards, with a particular focus on public transport fixed infrastructure; and
- a preview of some of the findings of the forthcoming transport-related sector reports.

## **INFRASTRUCTURE REPORT CARDS**

Infrastructure report cards are a reflection at a point in time on the condition of built environment infrastructure, i.e. that part of the nation’s public sector capital stock that produces services that are consumed by households, such as hospital services, drinking water, sanitation, electricity, or facilitates economic activity, such as electricity, public transport, roads and ports. This infrastructure is a public asset. All in a nation have a stake in its upkeep and operation, and all, directly or indirectly, share in the consequences of its neglect.

The SAICE/CSIR work has been modelled on the report cards published from time to time by the American Society of Civil Engineers (ASCE) and the British Institution of Civil Engineers (ICE). The ASCE was in 1998 first in the field with its initial “Report Card on America’s Infrastructure”, and have since settled into a regular pattern of publishing these every four years (the last was in 2013 (ASCE 2013), and the next is due for later this year.) However, both they and the British have brought out specialist reports, of various types, in the intervening years. For example, the most recent ICE report focused on Scotland’s infrastructure (ICE 2016). A recurrent theme in the American reports has been the cost which the perceived deficiencies in the infrastructure condition are imposing on the American economy, businesses and households. The most recent report focusing on this theme was “Failure to Act: Closing the Infrastructure Investment Gap for America’s Economic Future”, which appeared in 2016. (ASCE 2016<sup>1</sup>)

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<sup>1</sup> This report states that “... deteriorating infrastructure, long known to be a public safety issue, has a cascading impact on our nation’s economy, impacting business productivity, gross domestic product (GDP), employment, personal income, and international competitiveness” (ASCE 2016, page 3) It further calculates that about half of the needed funding is indeed provided, but the shortfall, which accumulates each year, has grown to the trillions of dollars.

These infrastructure report cards are intended to draw the attention of both government and the public at large to the importance of maintenance, and to factors underlying the condition of infrastructure – factors such as skills and finance, for example. Whereas they have little technical value to infrastructure professionals, the intention is that they be put to good use in macro level planning, lobbying for infrastructure funding, stimulating debate and highlighting the actions that engineers believe are needed to improve the condition of a nation’s infrastructure. By publishing them, learned societies and institutions provide more than information – they commit to a role of advocacy.

## **THE SOUTH AFRICAN INFRASTRUCTURE REPORT CARDS**

Massive strides have been made by all spheres of government in the last 22 years to correct infrastructural imbalances. Drinking water, sanitation, energy and transportation access have received focused attention, and, acting on its mandate, the government is continuing to invest at rapid pace in infrastructure for disadvantaged communities. However the combination of limited resources for the demands of existing infrastructure, priority provision for the previously disenfranchised, public sector restructuring, and shortages of key skills has led to extreme pressure on the condition of the public infrastructure asset base.

SAICE decided about a dozen years ago that the widely-reported condition of engineering infrastructure, and the negative effect which the poor condition of infrastructure was having on quality of life and economic development, was of sufficient concern that it should compile a "report card" of the condition of infrastructure. It approached the CSIR for assistance with the research component – which assistance was readily given – and, in 2006, the first "National Infrastructure Report Card" was published. (SAICE 2006)

This, the first ever report card of the condition of engineering infrastructure in South Africa, highlighted “the observations of the professionals responsible for the planning, construction, operation and maintenance of our nation’s life-support system”. It graded infrastructure (water, sanitation, solid waste, roads, airports, ports, rail, electricity and hospitals and clinics) on a scale from "A+" ("in excellent condition"), through to "E-" ("infrastructure has failed or is on the verge of failure, exposing the public to health and safety hazards"). Overall, it gave the infrastructure a D+ grade.

The second report card, again a CSIR/SAICE partnership, was launched in April 2011. (SAICE 2011) This covered ten sectors<sup>2</sup>, one more than in 2006. These were further

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- Water and sanitation services infrastructure.
- Solid waste management.
- Roads.
- Airports Company of South Africa airports.
- Commercial ports.
- Rail permanent way and structures.
- Electricity generation infrastructure.
- Health care infrastructure.
- Public ordinary schools infrastructure.

divided into 27 sub-sectors, six more than the previous time. It was found that, in comparison to 2006, nine of the sub-sectors showed improvement, twelve remained unchanged and four had deteriorated. The Public Schools sector and the Fishing Harbours sub-sector were new and were therefore not given trend indicators. Overall, a grade of C- was awarded.

This overall improvement from a grade of D+ in 2006 reflected marginal improvement in the average condition of South Africa's infrastructure over the previous five years, influenced by the heavy investment in, especially, national assets such as stadiums, ports, rail, airports and national roads, much of this in preparation for the 2010 FIFA Soccer World Cup. However the downside of the attention given to these national assets was that, on the evidence, it too-often diverted attention of the authorities from their core business of maintenance and upgrading of other infrastructure – with predictable consequences. Thus the authors of the second report card strongly cautioned against a perception that the rise to C- represented a blanket improvement. On the contrary, “the quality and reliability of basic infrastructure serving the majority of our citizens is poor and, in many places, getting worse. Urgent attention is required to stabilise and improve these”. (SAICE 2011)

Note that the South African report cards have not commented on backlogs as expressed in the absence of infrastructure to serve certain areas and communities. It is the condition of existing infrastructure which is the focus, together with the effect of that condition on service delivery (e.g. that a badly operated and maintained water treatment works is sometimes unable to supply the town for days at a time). Also important is consideration of the factors which lead directly to infrastructure being in this condition.

## **RESEARCH METHODOLOGY 2006, 2011 and 2017**

The process towards the 2011 report card had the comfort of a formal agreement between SAICE and the CSIR and a formal process of peer review. The 2017 report card has gone a step further, with a memorandum of understanding having been signed between the parties.

The third report card is at the time of writing (early 2017) well underway. As in previous years, the key roles of the two parties are:

- The CSIR takes responsibility (including carrying its costs) for compilation of the basic research reports, and also the authors of each infrastructure sector report give their view on possible gradings; whereas
- SAICE takes responsibility (including carrying its costs) for moderating the sector reports (including reviewing alternative evidence, and bringing that into account if

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• The large-scale water resources infrastructure owned by Department of Water and Forestry.

advisable), and then taking an all-sector view of the recommended gradings, followed by determination of the final gradings to be published, and for everything to do with writing of the report card itself, its launch, and any following up.

In summary, the following research methodology was previously followed by the CSIR – and is again being followed currently:

- Drafting sector reports (mostly desk top work) for infrastructure sectors which have been identified and for which it has the required in-house expertise;
- Arranging for the drafting of reports for selected sectors where it does not have sufficient expertise itself; and
- Contributing to the process of grading and, particularly, to the drafting of the report card itself.

For the purposes of reviewing the CSIR output, SAICE has – and will again – call together a number of peer review groups, selected for their knowledge and expertise in each sector, to review the CSIR output and reach consensus on grading of the condition of infrastructure in each of the sectors as mentioned above. It will then, and taking into account the difficulty of comparing “apples” (e.g. airport infrastructure) with “oranges” (e.g. roads in municipal areas) with “plums” (e.g. public sector schools infrastructure), and so on, attempt to reach agreement on an average grading for all public sector infrastructure in the country.

The same research questions are being posed to the current report card team as were posed to the earlier teams. These questions are simply stated:

- What is the condition of key elements of South Africa's infrastructure in public (i.e. as opposed to private) ownership?
- How does this compare with the 2006 and 2011 assessments? What is the overall trend, and what are the trends by sectors?
- What contributes to the condition and its trends? What recommendations can be made?

The methodology used in 2006 and 2011 has worked well, and therefore the new report card is being prepared along more or less the same principles.

A new feature in 2017, still being developed, will be an opinion survey, the objective of which is to collect data on the views of professionals and members of the public who are not involved in the report card process, in order to augment the report card's assessments. The timing of this is still being considered. One proposal is that its findings are incorporated in the 2017 report card. An alternative proposal is that the survey is sent out

round about the same time as the report card is released. This would assist publicity for the survey, and would presumably lead to a better respondent rate than might otherwise be the case. Also, the results should be available, and could be released, sometime after release of the report card, thereby extending the period of government and public interest in the topic of infrastructure condition and what should be done about it.

## **KEY FINDINGS OF THE REPORT CARDS**

As emphasised earlier, the focus of these report cards is on the condition of the infrastructure. However increasing importance has over the years been accorded to recognising the factors which lead directly to this infrastructure being in the condition that it is.

In both 2006 and 2011, two key themes (or “drivers” or constraints) ran as a thread through all the grades. The first was the shortage of skills and the impact of this on planning, procurement, design, construction and care of infrastructure. The second was that grossly insufficient funding is allocated to maintenance of the existing asset base and the new assets that come on-stream each day.

South Africa suffers an acute skills shortage in the public-sector infrastructure sector. Whereas this is understood in certain circles of government (e.g. Dlamini 2016<sup>3</sup>), any measures which might have been taken to address it, seem to have had little effect. Just two illustrations should highlight how serious this shortage is. First, a survey undertaken by SAICE some years ago showed that more than one-third of all 231 local municipalities did not have a single civil engineer, technologist or technician. (Lawless 2007) Lawless has since repeated the survey, and found that the situation has, if anything worsened. Whereas the number of civil engineering staff had increased, the amount of engineering infrastructure for which they were responsible had increased by a greater amount. Furthermore, the experience of the staff had on average fallen, and the number of engineers had reduced, many engineers having been replaced by technicians or technologists. (Lawless 2016)<sup>4</sup>

Second, the low skills base of so many in the public sector who are responsible for infrastructure manifests in many ways other than operation and maintenance of this infrastructure. One of the most important of these is the frequent underspending of the capital budgets of many public sector institutions – particularly municipalities, some of

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<sup>3</sup> Gordhan went on to say that South Africa faced "no shortage of money in the system, but there is a shortage of implementation capacity to get things done".

<sup>4</sup> The 2016 SATC paper reported the findings of a detailed and thorough Water Research Commission (WRC) study on the skills shortages encountered in a small sample of water services institutions. The report of this study, still embargoed at the time of writing the 2016 paper, has since been released. (Vienings and Lima 2016)

The authors of the current paper have not been able to get hold of any equivalent studies available in the public domain for any part of the transport sector, at least in respect of fixed infrastructure.

which grossly underspend every year. For example, in financial year 2014/2015, no less than 241 municipalities (of a total of 278) underspent on their adjusted budgets<sup>5</sup> by more than 5% – of these, 172 underspent by more than 15%. Furthermore, “A comparison of 2013/14 and 2014/15 indicate that the total municipal spending performance shows a slight deterioration”. (National Treasury 2015, pp3-4).

After skills, the second key constraint was the lack of adequate funding for the maintenance of the existing asset base and the new assets that come on-stream each day. An annual maintenance budget allocation of 4% of replacement cost is commonly regarded as the minimum needed to keep assets in good condition. However, such allocation is rare. Moreover, 4% would certainly be too low if – as is usually the case – the budget is expected to cater for a maintenance backlog which requires rehabilitation or refurbishment in addition to routine maintenance.

National government acknowledges that the background to the lack of adequate funding for infrastructure maintenance – and a number of other financial ills which beset municipalities – is that a very large number of municipalities are “in financial distress”. This is despite the substantial financial transfers which are annually made to municipalities. Government has, correctly in our view, identified a number of major contributory factors to this distress, including that “operational expenditure plans exceed realistically collectable revenues” (ibid, page 6), “weak multi-year budgeting”, “limited planning and project management” and “supply chain management inefficiencies” (ibid, page 8).

One symptom of this municipal financial distress which causes difficulties for the owners of bulk engineering services is that “municipalities debt to Eskom and water boards is on the increase” – e.g. in August 2016, the Eskom CEO told Parliament that the outstanding debt from municipalities totalled R 10.8 billion. (Peyper 2016)<sup>6</sup>

The debt has climbed to such an extent that some bulk suppliers are taking drastic steps in attempts to enforce payment by the municipalities. For example, Eskom has taken steps to cut power supplies to municipalities which regularly violate repayment agreements. Most recently, the national Department of Water and Sanitation (DWS) has obtained a court ruling against the O R Tambo District Municipality, in terms of which the municipality must pay the R 73 million owed to the Department, plus interest – failing which, the Sheriff of the High Court will on 10 February 2017 oversee the sale of the municipality’s movable assets. (Nini 2017.) (Unless there is a political intervention – not unlikely under the circumstances.)

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<sup>5</sup> Note: “on their adjusted budgets”, not on their budgets as first approved! Such a comparison would have looked even worse.

<sup>6</sup> Government departments and parastatals have not themselves necessarily been practising responsible financial management at all times. For example, “Irregular expenditure by government departments and the entities under their control ballooned almost 80% to R 46.36 billion in the 2015-2016 financial year, as they failed to adhere to supply chain management guidelines, auditor-general Kimi Makwetu said”. (That is R 46.36 billion of a budget of R 1.2 trillion.) (Magubane 2016.)

In 2011, a third key theme, viz the need for systems and a systematic approach, also ran as a thread across all the grades. Such an approach would enhance the integration of services and maximise the use of scarce human and infrastructural resources. It will also reduce the incidence of failure as constant data collection on condition allows early identification of acute and chronic weak points in the delivery chain. Neglect is also costly in financial terms - the old English saying “a stitch in time saves nine” is apposite.

The shortage of critical data pertaining to infrastructure condition was identified in 2011, and it was also identified that this shortage had for a number of reasons worsened since 2006. Reliable, consistent data is a prerequisite for the urgently required shift from reactive "repair" to planned "maintenance". Data which is systematically captured and analysed enables planning, prioritisation of targets and adequate budgeting for maintenance. However it is pleasing to report that, with most of the 2017 sector reports to hand at the time of writing, there has been some improvement in respect of public transport fixed infrastructure. For example:

- Four of the nine provinces have released “visual condition index summaries of road condition per percentage of network” more or less consistently for each of the years 2010 or 2011 through 2014 or 2015. (The other provinces have released summaries only intermittently.)
- The rail sector report for the first time reproduces “condition of infrastructure” tables which in colour-coding summarise the condition of each of the 18 “sections” of Transnet Freight Rail’s core network – for example the Ermelo to Richards Bay section of the Coal Network System.

The allocation of maintenance funding by owners of public sector infrastructure is generally way insufficient, especially in circumstances where it is expected to also cater for a maintenance regime that has led to neglect. As an exception in the transport sector, the early returns for the 2017 report card show that ACSA (Airports Company of South Africa) and SANRAL have been able to keep up their already good reputation for consistently finding funding for maintenance of their infrastructural assets, reducing the need for expensive refurbishment at a later stage.

The importance of life-cycle costing cannot be overemphasised. Although departmental-specific policies or legislation often support this idea, this does not translate to implementation, especially in early stages such as procurement, which so often makes no attempt to optimize life-cycle costing. That is, the bid with the lowest capital price is favoured, although accepting this bid usually means significantly more expensive maintenance and repair costs in the long term. While the practice continues unabated in many areas, some infrastructure-owning institutions show greater awareness. In particular, it is gratifying to notice that, in some proposal calls for appointments for consulting work, at least, a higher weighting is being given by them to “functionality” (as opposed to price and other evaluation criteria). A toehold has even been gained by the school of thought which takes into account, when evaluating price, by how much each

tenderer has exceeded the minimum threshold for functionality. That is, in these instances it is no longer that all tenderers who achieve the minimum functionality level are thereafter, when price is evaluated, treated the same – rather, a higher functionality score of a tender is able to an extent to discount the higher price of that same tender.

## THE TRANSPORT SECTOR

As noted earlier, of the 10 infrastructure sectors assessed by the report cards, no less than four concern transport, viz:

- roads;
- airports;
- ports; and
- rail.

The two earlier report cards are available on the SAICE website ([www.civils.org.za](http://www.civils.org.za)) or (2011 report only) on CSIR research space (<http://researchspace.csir.co.za/dspace/handle/10204/5807>), so all that is incorporated in this paper is a very brief explanation of only the transport-related grades from 2011, noting in particular the trends from 2006 to 2011.<sup>7</sup>

As follows (all quotations from SAICE 2011, pages 7 and 8):

- The highest grading in the transport sector, viz B+, was given to Airports Company (ACSA), which was described as "... a model of excellent maintenance and operational practice. It is strongly driven not only by the need to meet statutory requirements, but also by its own high standards", and also (i.e. B+) to the heavy haul rail lines (i.e. ore and coal).
- The next highest grading, viz B, went to national roads.
- The next highest grading, viz B-, went to commercial ports.
- The lowest grading, viz E, was received by "provincial, metropolitan and municipal gravel roads", where the comment was inter alia that "Condition data is scarce. Few municipalities make use of pavement management systems to prioritise their needs".
- With respect to trends 2006-2011, no subsectors showed a downward trend, whereas seven of the 12 showed an upward trend.

At the time of writing, of the four transport sectors, the first drafts of the report on both road and rail are available, with airports and commercial harbours still awaited. Preliminary findings of all of these will be available by and will be summarised at the SATC conference. Meantime, the following can be shared:

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<sup>7</sup> The relevant table from the 2011 report card is reproduced in the 2016 SATC paper. (Wall et al 2016.)

- Whereas the average condition of the SANRAL network has deteriorated, with a larger percentage of roads categorised as “very poor”, “poor” and “fair”, this is largely due to SANRAL taking over from the provinces the remainder of the strategic road network, trebling 1994-2014 the length of road for which it is responsible.
- The visual condition index statistics for paved roads which are the responsibility of Gauteng provincial government show that between 2010 and 2015 there has been a distinct shift away from “very poor” and “poor” categories towards “good”.
- Some of the data frankly looks suspicious, and if there is a rational explanation, this is not provided. In particular that from a province which after several years of reporting of the order of 20% “fair” to “very good” for its gravel road network, in 2013 reported that this had fallen to zero.
- With some exceptions, the condition of the 18 sections of the Freight Rail core network is deemed “acceptable”. One of the exceptions is the De Aar to Port Elizabeth section, which is deemed no more than “adequate”.
- In contrast, the average condition of branch lines is “poor to very poor”.

## **IMPACT OF TRANSPORT INFRASTRUCTURE CONDITION**

The impact of the condition of transport infrastructure is largely self-evident – the impact on the safety of travellers and transporters of goods of eroded road edges, of worn and/or misaligned rail permanent way, of defective harbour navigation lights, or of airport runways where grease, rubber and other substances have accumulated – to choose a few examples.

More insidious are the impacts which do not make headlines such as “Motorist sues for pothole accident”. A good example is the impact of road infrastructure condition on logistics costs. “Road roughness”, is a measurable parameter, and widely-used proxy for the less visible (i.e. as opposed to eroded road edges) elements of road condition.

“The most important cost components [of vehicle operating costs] affected by road roughness are fuel consumption, vehicle repair and maintenance, and tyre wear”. The CSIR measured the 2009 through 2013 change in vehicle operating costs of road roughness over those portions of the main freight corridors which are the responsibility of provincial governments. Fuel consumption increased by 2%, tyre costs by just over 2%, and repair and maintenance costs by 10.6%. (CSIR 2013 pp52-56.)

Needless to say, the owners and operators of the transport vehicles would seek to pass the greatest proportion of these additional costs on to the end users of the freight carried. For example, a portion of the costs of foodstuffs sold in supermarkets would in effect be compensation to the transporter of those foodstuffs for the cost of bad roads.

## **FINDINGS**

It is sufficient to simply reproduce the following paragraph, taken from the text of the 2016 SATC paper. The sentiments expressed here are as valid as they were when written a year ago.

“.... while government should not change its drive to provide new infrastructure to address backlogs, the challenge is to supplement this by at the same time also focusing on the maintenance of both new and old infrastructure. If this is not done, the already considerable legacy of that infrastructure which is dysfunctional for want of sound operation and adequate maintenance in the past, and which therefore needs rehabilitation or replacement at considerable cost, will increase rapidly. Infrastructure, once created, is unrelenting in its demand for maintenance, and this demand will escalate increasingly the longer it is ignored” (Wall et al 2016, pp9-10).

## **CONCLUSIONS**

The process by which the third South African national infrastructure report card is being compiled has been well tested. The two co-operating organisations, viz the CSIR and SAICE, are well resourced, and have 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.

Whereas there is a wealth of information on infrastructure condition in the public domain for some sectors, for other sectors this is not the case. Often, what is available, is incomplete and/or so dated that it cannot be used for report card purposes other than as a limited contribution to understanding the condition. The research team is well positioned to compile a balanced view across all sectors, to identify trends, to identify key issues, and to make sound recommendations.

It is anticipated that, by the time of the 2017 SATC conference, all of the sector reports would have been completed, checked, edited and peer-reviewed (by reviewers to be arranged by the CSIR), and the process of evaluation by SAICE will be well advanced. It is also probable that the grading by the SAICE expert panels will have commenced, even if not completed. The text of the report card, together with short summaries of the sector reports, would hopefully be well advanced.

There is also an outside chance that the report card will have been completed and released to the public – but only an outside chance. However if the report card has been released, then the presentation at SATC will probably constitute the first public event, subsequent to the launch of the report by SAICE and CSIR, at which the findings of the report card will be revealed.

## REFERENCES

American Society of Civil Engineers, 2013. "2013 Report Card for America's Infrastructure".

American Society of Civil Engineers, 2016. "Failure to Act: Closing the Infrastructure Investment Gap for America's Economic Future".

CSIR, 2013. "10th state of logistics survey".

Dlamini, P, 2016. "Service delivery hampered by 'shortage of engineers and financial managers', says Gordhan". "Business Day", 12 July 2016.

Institution of Civil Engineers, 2015. "The State of the Nation: Infrastructure 2015: Scotland".

Lawless, A, 2007. "Numbers and needs in local government – civil engineering, the critical profession for service delivery". SAICE.

Lawless, A, 2016. "Numbers and needs in local government – update 2015". Proceedings: annual conference of the Institute of Municipal Engineering of Southern Africa. East London. (October 2016)

Magubane, K, 2016. "Irregular spending balloons by 80% as departments and state entities ignore guidelines". "Business Day", 16 November 2016.

National Treasury, 2015. "Report to Parliament: over- and underspending of municipalities as at 30 June 2015". (September 2015.)

Nina, A, 2017. "ORT assets to go under the hammer". "Daily Dispatch", 31 January 2017.

Peyper, L, 2016. "Treasury concerned that one-third of municipalities need help". Fin24, 11 November 2016.

SAICE, 2006. "The SAICE infrastructure report card for South Africa: 2006". The South African Institution of Civil Engineering. (November 2006).

SAICE, 2011. "The SAICE infrastructure report card for South Africa: 2011", the South African Institution of Civil Engineering. (April 2011).

Vienings, A and Lima, M, 2016. "Integrated water sector skills intervention map based on a sector skills gap analysis", Report of Water Research Commission Project K5/2113. Water Research Commission, Pretoria.

Wall, K, Rust, C, and Kistan, K, 2016. "Assessing the condition of South Africa's transport fixed infrastructure". Southern African Transportation Conference. Pretoria, July 2016.