

SAICE's report cards on the state of infrastructure

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In 2006 the South African Institution of Civil Engineering (SAICE) released the first ever 'report card' of the state of engineering infrastructure in South Africa. This report highlighted 'the observations of the professionals responsible for the planning, construction, operation and maintenance of our nation's life-support system'. It graded infrastructure on a scale from A+ to E-. Overall, it gave South Africa's infrastructure a D+ grade. 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 state of repair of infrastructure – factors such as skills and finance, for example. The report card was a great success, and received media coverage exceeding the Institution's highest expectations. The SAICE 2011 Infrastructure Report Card was launched in April 2011. It covers ten sectors, further divided into 27 subsectors. These have been graded and the trend since 2006 is indicated. An overall grade of C- was awarded. It is anticipated that the 2011 report card will be widely disseminated and debated. Even more so because, since 2006, service delivery problems, and in particular those problems attributable to inadequacies of operation and maintenance of infrastructure, have received heightened attention.

1. Introduction

The importance of well-maintained infrastructure to the economic health of nations is clear. Indeed the positive relationship between gross fixed capital formation (GFCF) and economic growth, is well documented (Investec, 2005), and is the basis for sustained economic and social development. If maintenance is inadequate, social and economic growth will be impeded – something that just cannot be afforded.

Many countries publish infrastructure reports, but these are mostly in relation to the commercial activity in the construction sector or on the general condition of infrastructure to the extent that it supports commercial activity. They do not attempt to grade the condition of the infrastructure or to comment on the trends in condition, or the constraints preventing improvement. They are also not prepared by the professionals intimately involved with the design, construction and maintenance of these assets.

Infrastructure report cards (IRC) are only published (at least in the English-speaking world) by three institutions apart from the

South African Institution of Civil Engineering (SAICE). Since the late 1990s, the American Society of Civil Engineers (ASCE) has produced the *Report Card on America's Infrastructure*, the Institution of Civil Engineers (ICE) (UK) the *State of the Nation* reports and Engineers Australia a national *Infrastructure Report Card*. All have since been published at regular intervals and at increasing levels of detail. They are intended to draw the attention of both government and the public at large to the importance of maintenance, and to factors underlying the state of repair of infrastructure – factors such as skills and finance, for example. In themselves, these reports have little technical value to infrastructure professionals, but they may be put to good use in macro-level planning, lobbying for infrastructure funding, stimulating debate and highlighting the actions that civil engineers believe are needed to improve the state of a nation's infrastructure. By publishing them, learned societies and institutions provide more than information – they commit to a role of advocacy.

However, all of these countries are classed as 'developed'. By contrast, South Africa is a developing country (IMF, 2010),

albeit with the status of 'newly industrialised'. It also has a unique development history which was pertinent in articulating the purpose of the SAICE IRC.

2. South African infrastructure report card

South Africa is recovering from the extended ravages of an iniquitous system that formalised the economic and social deprivation of the majority of its population in the interest of the minority. South Africa's long history of apartheid resulted in economic and social infrastructure that remains terribly imbalanced both in extent and condition between the previous 'white' and 'non-white' settlements. That legacy extends to every aspect of infrastructure from transportation to water and sanitation.

Moreover, South Africa ranks poorly in terms of both income inequality and human development. The United Nations Development Programme (UNDP, 2009) ranks the country among the 10 most unequal countries, for which data are available, with a Gini index – defined such that 1 represents total equality (all citizens own the same) and 100 total inequality (1 citizen owns all) of the wealth – of 57.8 whereas scores for Australia, the UK and USA range from 35.2 to 40.8. The human development index (HDI) is a standard measure of human well-being (incorporating life expectancy, literacy, education and standards of living). South Africa ranks a dismal 129th of 182 countries, compared with Australia (2), USA (13) and UK (21).

The size of South Africa's economy, at just under US\$300 billion, is smaller than several corporations (Forbes, 2009) and ranks 31st among countries (World Bank, 2010), although it is a member of the G20 – primarily because of its significance in Africa. It is frequently mentioned as the powerhouse of Africa and has been a consistently improving industrial nation since democracy in 1994.

Despite this, before embarking on the first IRC in 2006, SAICE took the view that the IRC will be a reflection at a point in time on the condition of public infrastructure in the built environment, and will not comment on the legacy of apartheid. This was not a decision made lightly. The inherited backlogs are large, but the past cannot be managed. Only the present can be managed in the hope and with the objective of creating an even brighter future. The reports would also not highlight the stated intentions of many agencies to improve infrastructure in the future, even when these are accompanied by plans with budgets. These would instead be reflected through improved grades in future report cards. The focus would be entirely on the contemporaneous condition of infrastructure.

Since democracy in 1994, massive strides have been made by the government to correct this infrastructural imbalance. Con-

struction has also been promoted as a vehicle for job creation and poverty alleviation, a role for which it is well suited (CICA, 2002). South Africa, uniquely, entrenches the requirements for public procurement in its constitution (Republic of South Africa, 1996: Chapter 217: Procurement), and requires that it should be 'in accordance with a system which is fair, equitable, transparent, competitive and cost-effective'. However, it also does not prevent affirmative action or structured preferences in procurement that favour the racial groups disadvantaged under apartheid. The combination of limited resources for the demands of existing infrastructure, priority provision for the previously disenfranchised, public sector restructuring and migration of skills due to political uncertainty, led to extreme pressure on the condition of the existing public infrastructure asset base.

3. The SAICE 2006 infrastructure report card

In 2006, SAICE released the first ever report card of the state of engineering infrastructure in South Africa (SAICE, 2006). This report 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+ to E-. Overall, it gave the infrastructure a D+ grade. (Refer to the Appendix for an abbreviated report card, and to the SAICE website (www.civils.org.za) for the full report.)

The initiative was, by any measure, very successful, exceeding all expectations. The report card received widespread media coverage and, in addition, invitations were received from government departments and other decision-makers for SAICE to engage with them in order to address the issues raised in the report card. SAICE succeeded spectacularly in the twin objectives of opening a public dialogue on the condition of public infrastructure and highlighting the importance of maintenance.

3.1 Key findings: skills and funding constraints

South Africa suffers from an extreme shortage of skills and the impact of this on planning, procurement, design, construction and care of infrastructure is severe. The following two examples illustrate this.

- (a) A 2005 survey by SAICE showed that more than one-third of all 231 local municipalities then did not have a single civil engineer, technologist or technician (Lawless, 2007). Vacancies in local government for engineering practitioners exceeded 1000. This is not simply a result of shortages – the imperative to transform the public service to be more demographically representative of the population was sometimes unwisely implemented. The situation has not improved much since.

- (b) The ratio of population to engineer in South Africa is of the order of 3200 to 1, 20 times less than some of the countries earlier mentioned. Furthermore, while the ratio among the South African white population is approximately 300 to 1, which is similar to America and Western Europe, the ratio in the black population is in the order of 50 000 to 1, among the worst in Africa and the world. The case for transformation cannot be clearer.

The links between technology professionals, infrastructure provision and quality of life must be recognised. The provision and maintenance of infrastructure that performs well and is sustainable into the future also depends on the quality of human capital and technological capacity in a country. Thus the technology achievement index (TAI) in South Africa, as defined by the United Nations (UN), plays an important role in infrastructure provision. The UN indicated that a direct positive relationship exists between the TAI and both gross domestic product and the HDI (Roux, 2007).

The construction industry is notorious for low levels of innovation and often lags behind in technological development (Rust *et al.*, 2009) with the consequent low TAI in this sector. This is confirmed by SAICE research (Lawless, 2005) which indicated that South Africa suffers from a tenfold disadvantage in terms of the number of engineers per capita when compared with the developed world or other developing and newly industrialised nations such as India or China. In general, it is also found that developing countries have more doctors than engineers, whereas the opposite is true in developed countries. South Africa has only half as many engineers as doctors. By comparison, Australia, USA, Western Europe and even China or India, have a similar number of engineers to doctors, or more engineers than doctors.

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 in order to keep assets in good condition. However, such allocation is rare. Moreover, it is simply not sufficient, especially when it is expected to cater for a maintenance debt that usually requires upgrading, repair or refurbishment rather than routine maintenance.

There is an old saying that somebody pays for maintenance, whether it is done or not. For example, on roads, maintenance that is delayed for 1 year could cost three to six times more. The consequences of neglect are severe, impairing both quality and, sometimes, length of life, through outbreaks of water-borne disease, reduced safety on roads and rail, inconvenience and inefficient commercial activity.

3.2 Impact of the SAICE report card

In brief, the following might be regarded as primary positive achievements.

- (a) The first ever publication in South Africa (or Africa) of a consolidated report on the state of a broad range of infrastructure by a credible institution, drawing attention to its condition and importance by headlining issues in a manner understandable to technical, decision-making and lay persons. It provides the headline issues requiring attention and a benchmark for further monitoring.
- (b) The primary objectives of informing the public and decision makers were achieved through the numerous live interviews and presentations, print, visual and audio media exposure and discussions with client and sector organisations.
- (c) The exposure received by SAICE was the greatest for many years, if not ever – all of it overwhelmingly positive. The credibility of the institution as a learned society with the authority, indeed the duty, to comment broadly on engineering infrastructure has been enhanced.
- (d) The role of civil (and all) engineering professionals as creators and custodians of all aspects of infrastructure was placed centre stage. The impact has been to raise the awareness of the public, parents, learners, educators and government to the urgency of the infrastructural crisis in South Africa.

However, subsequent to the publication of the 2006 IRC (SAICE, 2006), some sector infrastructure owners have shown themselves to be very sensitive to criticism, irrespective of whether they perceive it to be fair or unfair. One of their 'defence mechanisms', it seems, has been to restrict access to information. The 2011 IRC research team has consequently found that there has been reluctance on the part of professionals in certain areas to share information with the team.

Another disappointment and concern – but it must be made clear that this is with respect to a minority of infrastructure sectors – has been the discovery that less monitoring of the state of infrastructure is taking place than was the case a few years ago. On the other hand, it is pleasing to report that condition monitoring has greatly improved, both in breadth and in quality of coverage, in at least one sector – namely the water services sector.

4. The SAICE 2011 infrastructure report card

In 2009 the decision was taken that, whereas so much construction had been taking place in preparation for the soccer World Cup, the next edition of the IRC should be published late in 2010 or early in 2011. This would allow a reasonable period for the new infrastructure to be used before being graded.

The acceleration of projects required for the soccer World Cup – highways, mass transit, airports and the many stadiums – provided South Africa with a welcome buffer from the negative consequences of the global financial crisis since 2008. The downside is that this appears to have distracted authorities from the core business of maintenance and upgrading of other infrastructure – with predictable consequences. Given that resources are limited, the diversion has caused a delay in the provision of basic services to the poorer sections of society.

In the evolution of the report card, SAICE envisaged gradually expanding the scope similar to the progress achieved by colleagues in other countries. The USA, UK and Australia have achieved state, county and territory elaboration over time. SAICE has in 2011 expanded the infrastructure areas from the previous nine to include fishing harbours and public schools. In future, more detailed analyses of one or more province, or of a sector, such as all municipalities, are contemplated. Also possible, because of South Africa's pre-eminence in the region, is an extension of the process to Southern African Development Community (SADC) neighbours. However, as has been acknowledged, 'Clearly, these are ambitious objectives and some, if undertaken, go beyond the mandate of SAICE and will require external authority and especially substantial funding' (Amod and Wall, 2007).

Deliberately left undefined was the publishing interval. Infrastructure condition does not in general alter significantly in the space of a year, so it might not be cost-beneficial to publish detailed IRCs annually, but rather issue subject-specific bulletins between the IRCs.

The modest resources available to a learned society such as SAICE also motivated the development of a partnership for the research component of the process. As in 2006, SAICE recognised the Council for Scientific and Industrial Research (CSIR) as the organisation best placed to assemble and analyse the body of data required. Thus in 2009 an understanding was reached between SAICE and CSIR to the effect that CSIR would draw up the research reports across all sectors (and cover the costs of its staff working on the research reports). SAICE reserved the right to disagree with the findings of the research. It would refine and interpret these findings through the input of its network of engineering professionals and technical divisions, perform the grading, and publish and publicise the report.

The new report card was launched in April 2011, weeks before local government elections. Once again, skill shortages and lack of maintenance across all sectors are highlighted. Two new key themes have also emerged, namely holistic systems and sustainability.

The 2011 IRC covers ten sectors, one more than in 2006. These are further divided into 27 subsectors, six more than the last time. These have been graded and the trend since 2006 is indicated (refer to the appendix). Nine show improvement, 12 remain unchanged and a further four have deteriorated. The public schools sector and the fishing harbours subsector are new and therefore do not have trend indicators. Overall, a grade of C– has been awarded.

The improvement from a grade of D+ in 2006 reflects marginal improvement in the overall condition of South Africa's infrastructure over the past 5 years, influenced by the heavy investment in, especially, national assets: ports, rail, airports and national roads, much of this in preparation for the 2010 Fifa soccer World Cup. The authors strongly caution, however, against a perception that this is 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).

5. Conclusion

The intention behind the SAICE infrastructure report card initiative has been for engineering professionals to provide a public opinion on the condition of infrastructure in the manner of 'expert witness'. The public is informed about the importance of infrastructure in their daily social and economic intercourse, by highlighting the current status of its condition. Furthermore, many decision-makers are technical lay-people. The reports will enable better-informed decisions to be made, especially regarding maintenance management and planning for new expenditure. At the same time, the role and relevance of civil engineers and civic institutions is highlighted.

The reception to these publications in some countries has been sensationalist by the media, and the reaction from much of the public sector has usually ranged from criticism to denial. By contrast, the reception of the first SAICE report in South Africa can only be described as 'mature'. There is broad recognition that SAICE has provided the first national-scale credible benchmark against which progress (or regress) can in future years be measured. Initial indications are that the reaction to the new report card will be equally influential.

There is broad consensus that the initiative should be sustained and extended, but that at the same time the independence of the benchmarking process should not be compromised.

The future of the project must also consider embracing the participation of partners such as aid agencies, and SAICE's own partners such as statutory institutions, Voluntary Associations, the African Engineers Forum, the World Federation of Engineers Organisation, United Nations Educational, Scientific






and Cultural Organization (Unesco) and others. The assistance and inspiration provided by ASCE and ICE towards the launching of the report card process and the first SAICE IRC in 2006 is acknowledged. Future co-operation might include the promotion of the process in other developed and developing countries as a leadership initiative by societies of engineers.







The reports and the indicated trends since 2006 make it possible


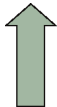
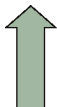


to conclude that, while government should not change its drive to provide new infrastructure to address backlogs, the challenge is to supplement this by at the same time also focusing on the maintenance of both new and old infrastructure. If this is not done, the already considerable legacy of that infrastructure that is dysfunctional for want of sound operation and adequate maintenance in the past, and that therefore needs rehabilitation or replacement at considerable cost, will increase rapidly.


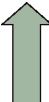

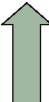



Appendix

South Africa's built environment infrastructure report cards

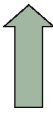
Sector	2006 grade	2011 grade	Trend	Brief condition report from 2011 report
Water	D+ for bulk infrastructure	D- for bulk infrastructure		There has been further deterioration in the ageing bulk water infrastructure portfolio as a result of insufficient maintenance and neglect of ongoing capital renewal. Persistent, serious salination of key river systems and eutrophication in many dams and rivers continues. Acid mine drainage is a cause for concern in the vicinity of gold- and coalmines. Large dams require urgent refurbishment. Farm dams are deteriorating because of lack of maintenance, threatening accelerated sedimentation of bulk storage infrastructure. The level of water supply in certain systems has fallen far below the 98% assurance of supply recommended in the National Water Resource Strategy. Owing to long lead-times required for development of new supply schemes, the situation is likely to become worse before it becomes better.
	C+ for major urban areas	C+ for major urban areas		Major and ongoing strides in provision of water infrastructure since 1994, but insufficient maintenance has led to many problems of compliance with quality and reliability requirements. This is especially so outside metropolitan areas. Recently introduced improved monitoring might help. Water wastage (through leaks) is still too high. Serious shortage of skilled personnel and officials; governance failures increasing. Increase in protests in urban and rural areas – an effort to force improvement in services.
	D- for all other areas	D- for all other areas		
Sanitation (including wastewater)	C- for major urban areas	C- for major urban areas		Serious problems continue with management of many wastewater (sewage) treatment works. Wastewater leakage and spillage, especially into major rivers, is still too high. Recently introduced improved monitoring might help. Unsustainable design and construction becoming more apparent, e.g. on-site sanitation facilities not easily emptied once full. Inadequate operation and maintenance capacity, and shortage of skilled personnel.
	E for all other areas	E- for all other areas		

Sector	2006 grade	2011 grade	Trend	Brief condition report from 2011 report
Solid waste management	C– for major urban areas	C for collection in major urban areas		Approximately 60% of households receive an adequate refuse removal service. In the major urban areas, the percentage is over 80%, while in the rural areas it is as low as 20%.
	D for all other areas	C+ for disposal in major urban areas D for collection in all other areas D for disposal in all other areas		Landfill sites in metros are generally licensed, but not all are well managed. Many other municipalities, especially rural municipalities, have unlicensed landfill sites, or licensed sites that are not operated according to acceptable/appropriate standards. Hazardous waste and medical waste disposal is an increasing concern.
Roads (total 747 000 km)	C for national highways (approx. 16 000 km)	B for national highways (approx. 16 000 km)		The national highways network is in the good to excellent range with the proportion of roads in poor to very poor condition never exceeding the international benchmark of 10%. The South African National Roads Agency Limited (Sanral) continues to demonstrate world-class management, with excellent monitoring and maintenance systems. Close to 80% of the network has exceeded its 20-year structural design lifespan. SANRAL's current success in maintaining the national road network will see its responsibilities and network allocation expand further. These will be severe challenges.
	D– for all other roads	D– for paved provincial roads		The provincial paved road network has deteriorated significantly over time. Shortages of skilled personnel in provincial departments, inadequate funding and outdated systems, and the lack of routine and periodic maintenance, have all contributed to the current condition.
		C– for paved metropolitan roads		Less than 10% of the paved metropolitan roads are in poor to very poor condition. Balancing the need for the upgrading of township roads with the necessity to perform routine and periodic maintenance remains a challenge given the limited resources.
		D for paved district and local municipal roads		In general, municipalities lack capacity, skilled resources and funding to effectively manage their road networks. Reliable condition data are scarce. Few municipalities make use of pavement management systems to prioritise their needs. Based on the limited data available, the paved road network, on average, nevertheless appears to be in a fair condition.

Sector	2006 grade	2011 grade	Trend	Brief condition report from 2011 report
		E for all provincial, metropolitan and municipal gravel roads		Maintenance of gravel roads, which constitute 75% of the total length of the proclaimed South African road network, has been neglected. Condition data are scarce. Approximately 50% of the provincial gravel roads and 30% of the municipal gravel roads for which condition data are available are in a poor to very poor condition. In addition, an estimated 140 000 km of gravel roads still need to be proclaimed.
Airports, nine state- owned commercial facilities only (operated by The Airport Company of South Africa (ACSA))	B	B+		ACSA provides world-class aviation infrastructure at most of its airports. It demonstrates a model of excellent maintenance and operational practice, with first-rate institutional memory. A profitable company, it is strongly driven not only by the need to meet statutory requirements but also by its own high standards.
Ports	C+ Eight commercial ports only	B– Eight commercial ports only		Expenditure on upgrading and providing new port infrastructure owned and operated by Transnet has continued at a steady pace since 2006, with a number of large projects already complete, including the new port, Ngqura. Other ports' infrastructure is ageing but well maintained.
		C Fishing harbours (new subsector)		The repair and maintenance programme completed in 2007 drastically improved the condition of the 12 proclaimed fishing harbours. However, to prevent deterioration, urgent follow-on maintenance is required, particularly of mechanical installations such as slipways.
Rail (approx. 21 000 km)	B for heavy haul (ore and coal) lines	B+ for heavy haul (ore and coal) lines		These lines (approx. 1500 km) are in a good condition and are well maintained. Infrastructure expansion will provide capacity for increased volumes. Some operational issues do exist. The additional capital expenditure on these lines has enhanced the state of the network.
	C for general freight lines being retained	C+ for general freight lines on the core network		Condition of the network has improved slightly. Some bottlenecks exist on specific lines. Operational performance needs to increase – which should attract the higher volumes to take advantage of infrastructure investment. More needs to be done regarding service levels and reliability.

Sector	2006 grade	2011 grade	Trend	Brief condition report from 2011 report
Electricity	E for uneconomical general freight lines	D for active branch lines		Just over half of the branch lines have been closed or lifted and active lines are maintained to provide network flexibility or for future expansion. Transnet's focus on the core network means that further deterioration will occur to the active branch lines that do not have concessions or are earmarked for expansion. (The score appears to have improved from an E to D, if only active branch lines are taken into account.)
	D+ for passenger lines	C- for passenger lines (excluding Gautrain)		The capital investment programme is slowly starting to reduce the backlog, but not quickly enough. Operational inefficiencies do exist and passenger volumes are restricted by inadequate and failing rolling stock. Theft and vandalism is another major concern and safety remains a significant issue.
	C+ for Eskom's (state utility) generating and bulk transmission capacity	C+ for Eskom's generating infrastructure		Eskom's generation infrastructure (95% of South Africa's generation capacity) is in a satisfactory condition with a reasonable maintenance regime. It can meet current demand. Major capital investment is being undertaken to meet needs. Risks associated with ageing infrastructure, new project completion and coal supply do remain.
		B- for Eskom's transmission network		Eskom's high-voltage long-distance transmission infrastructure is in a better than average condition, with a reasonable maintenance regime. It can meet current demand and handle minor incidents across the network. However, major capital investment in the next 5 years is required to meet needs.
Hospitals and clinics	C+ for Eskom's local distribution	D for local distribution		Local distribution, generally characterised by inadequate operation and maintenance capacity and shortage of skilled personnel, is deteriorating. In many areas, infrastructure is ageing and/or overloaded.
	C- for municipal distribution in major urban areas			Municipal-owned infrastructure in particular is below standard and poorly maintained.
	D- for municipal distribution in other areas			
	C for hospitals	D+ for hospitals		Generally deteriorating condition. Serious lack of credible and current condition data. Poor financial and procurement management with too-little dedicated maintenance resources. Serious systemic and capacity failures are typical. Lack of skilled support staff to care for infrastructure.
	D+ for clinics	D for clinics		Similar to hospitals. Instances also of poor building quality and specification. Lack of empowerment at facility level to care for infrastructure.

Finally, an overall grade for built environment infrastructure as a whole:

Sector	2006 grade	2011 grade	Trend	Brief condition report from 2011 report
Public ordinary schools (approx. 25 000 total)		D+ for public ordinary schools (new sector)		In general, far too little maintenance of education infrastructure, resulting in conditions deteriorating across all provinces. Urban and ex-Model C schools are generally better maintained than rural schools. Degradation over time means that many schools now need urgent maintenance to ensure environments are suitable for teaching and learning, and to avoid expensive unplanned repairs.
Overall grade		C-		The focused investment over the past 5 years has resulted in more new infrastructure and an improvement in the condition of some existing assets. However, infrastructure at municipal level remains poor and is deteriorating in many places. Further, the resilience of all new and previously existing infrastructure is questionable without a much improved commitment to maintenance.

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