A Sustainable Roads Rating System for South Africa

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Abstract—

The Sustainable Roads Forum's Rating Tool is a rating system for road projects which promotes the use of sustainable best-practices in the planning, design and construction of roads.

The Tool, being developed by key stakeholders within the roads industry of South Africa, allows road authorities to set sustainability intervention targets for their projects and to start measuring and reporting them in a clear, transparent and aligned manner. The Tool provides a list of design and construction interventions, guidance for implementation and a unified method of reporting.

It also introduces the concept of a carbon footprint and attempts to start quantifying the reduction in the carbon footprint resulting from the interventions, which in turn will help the role players better understand and report on road infrastructure's carbon footprint and related offsets.

The tool can be used as a training tool, a self-evaluation tool, or, if required, for independent third-party certification (provided that a third-party organisational structure is established).

The interventions attract credits on compliance and result in a project score, which is then compared to the initial score set for the project.

Unlike similar tools in use, which predominantly weight scores based on the environmental aspect of sustainability, this tool provides a unique focus on the socio-economic impact of road projects in the context of South Africa's inequality, unemployment challenges, skills development and history of restricted movement.
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This paper will give an outline of the rating system, with detail of the first pilot application of the tool on the N3 National Road corridor upgrade between Pinetown and Pietermaritzburg, in the province of KwaZulu-Natal, South Africa

Keywords—Sustainable roads; rating tool; carbon footprint; interventions; certification

I. INTRODUCTION

With the realization that we are exceeding a number of biophysical planetary limits [1], a plethora of initiatives have evolved to change human behaviour and so help reduce our carbon footprint and become more sustainable in our approach to life on earth.

One of the more successful approaches to changing industry behaviour has been the introduction of rating systems to apply best practice interventions to infrastructure projects and measure them against set targets. The Green Buildings initiative[1] and their rating systems were pioneering in changing behaviour and realising the commercial value of building in a more sustainable manner. Initially the concept of *greener* buildings was largely supported in the private sector but there is now an increasing acceptance in the public sector.

Several attempts have been made to set up rating systems for the broader infrastructure industry, but these have in most cases, become more generic and watered down in approach [2][3][4]. Whilst the Green Building approach successfully diversified its tools so that different tools were available for the different types of buildings, general civil infrastructure tools such as Envision and CEEQUAL took a one-size-fits-all approach. Recognising the shortfalls of trying to use one tool that could simultaneously promote the best practice of roads, dams, buildings, power plants, toll systems, etc, the roads industry in South Africa started pursuing a rating system which would be entirely specific to roads. This initiative coincided with the Washington University in the United States launching Greenroads[2], and contact was taken up with them to possibly localise their tool to South African conditions.

The group of South African key stakeholders which worked towards the early localisation of Greenroads included representatives from the Council for Scientific and Industrial Research (CSIR), the Department of Transport (DoT), the Development Bank of South Africa (DBSA), South African Road Federation (SARF), Construction Industry Development Board (CIDB), South African National Roads Agency Limited (SANRAL), KwaZulu-Natal Department of Transport (KZN

[1] http://www.worldgbc.org

[2] www.greenroads.org

DOT), the City of Cape Town, eThekwini Metro, South African Bitumen Association (SABITA), the Cement and Concrete Institute, The Federation of Civil Engineering Contractors (SAFCEC) and Consulting Engineers South Africa (CESA). This group would be referred to as the Greenroads South Africa Interim Board.

As with many of the rating systems that have been developed in first world countries, their focus is mainly on environmental (i.e. natural resources) considerations. It was felt that as a developing country, a South African rating system would need to balance environmental concerns with economic value and social equity concerns, thereby putting more emphasis on the so-called triple bottom line of sustainability. When the Greenroads Foundation was not prepared to change their approach as drastically as the South African stakeholders felt necessary, a decision was taken to develop our own rating system, which would also take into consideration the socio-economic needs of the country. The Interim Board was renamed to the Sustainable Road Forum (SuRF).

After the Greenroads relationship was concluded, Royal HaskoningDHV, which was represented on SuRF as a representative of CESA, undertook the earliest stages in developing a new localised rating system for the roads industry. Through support from the South African National Roads Agency the system was brought to trial stage, and is being tested on the multi-billion rand N3 Corridor freeway upgrade, between eThekwini and uMgungundlovu in the province of KwaZulu-Natal.

II. APPROACH

A. Certification

Most rating systems rely on independent certification to verify compliance and then award a sustainability grading for a project, to protect the integrity of their system. This certification is normally carried out by an independent third party, which results in a cost that can be fairly substantial and requires the establishment of an independent third party to review and audit the process. The cost of an auditor is not appealing to some of South Africa's roads authorities, who feel that it is not justified in the case of roads, as, unlike with commercial buildings, there is no direct commercial benefit for providing road users with a certified sustainable "green" road. A certified green building on the other hand can justify the higher up-front costs by commanding higher rent for tenants whilst offsetting long-term costs via lower life-cycle costs. To accommodate the concerns of South Africa's various roads authorities, the decision was taken by SuRF to structure the SuRF Tool ("The Tool") in such a manner that it would be flexible enough to be used at three levels: -

1. for the purposes of capacitating users in respect of sustainability considerations (i.e. a "menu" of best-practices for South African roads)
2. as a self-assessment tool, (i.e. a "guidebook" with project examples and reporting structures to ensure that interested design teams can move towards best-practices in a uniform and transparent way)
3. for third party certification, should this need arise in future. This would require the establishment of a certification authority.

Rating systems generally make use of credits, which are allocated on achieving targeted interventions. These credits are then aggregated to give a consolidated score, which are graded into levels of sustainability. For Green Buildings South Africa[3] this is star rating, which has a commercial value for the developers, as these buildings tend to attract higher rentals and have a better occupancy, as tenant companies become more conscious of being seen to be sustainably minded. The Tool also adopts a form of grading, but the immediate commercial value is measured differently with a focus on providing sustainable best-practices, job creation, value-for-money decisions, and transparency in reporting. The end goal is to shift typical practice in the direction of international best-practice via the following:

1. easy access to typical best-practices
2. streamlined guidance in implementing and reporting said best-practices and
3. incentivisation via a scoring system.

B. Framework of the System

Compliance with legislation and adopting industry norms and standards on sustainability is taken for granted, but rating systems need to take typical design practice a step further by introducing sustainability best practices which go in incremental steps beyond what is already common on roads projects. The system therefore needs to have some flexibility so that the interventions can be expanded and refined up as new ideas are developed.

SuRF's Tool is set up so that road authorities can set targets for relevant credits they wish to apply to specific projects for use by their service providers. These are then used for progress reporting purposes and final scoring on completion of the project phases.

The voluntary take-up of the draft tool by roads authorities has been slow with much of the initiative coming from design consultants interested in differentiating themselves within the industry. Pilot tests of the tool and industry application are key to ensuring improvement and relevance of the tool. In the interest of moving forward and increasing industry exposure, SuRF members have been exploring the option of institutionalising the rating system and possibly also including it into the supply chain process.

The new Roads Policy for South Africa is currently being developed by the Department of Transport and the opportunity existed to incorporate sustainability into the policy. Public consultations of the proposed policy statements on sustainability, including a rating system, have taken place and the policy will hopefully be tabled in parliament later in 2018. If the policy is adopted as it stands, the development of some form of a sustainable transportation rating system similar to the SuRF

[3] https://gbcsa.org.za/

Tool will form part of the Roads Policy. It is proposed that the SuRF Tool be adopted as the rating system for the Department of Transport, subject to further refinement and development, and porting to a more flexible and accessible digital platform.

III. RATING SYSTEM STRUCTURE

SuRF's Tool has been developed entirely within a single Excel spreadsheet, with the intention to migrate to more flexible cloud-based database solutions in future.

The system has been designed to cater for the planning, design and construction phases of a project, with lifecycle elements involving all three. Each project phase is to be evaluated with the same system, but documented separately. This allows for a comparison of the different phases and to identify project successes and shortcoming in terms of implementation.

For example, at the project inception, a target score is established by selecting which interventions/credits are suited for the project. During the design stage, the Tool guides the design team through the process of incorporating the targeted interventions/credits into the permitting, planning and construction stages (via the tender document). Implementation during the construction stage is verified through reporting by the construction team, again by using the Tool.

Shortcomings in implementation would be identified along the way where some interventions identified early in the project fail to be properly implemented either during design or construction.

During the design stage, the design consultant incorporates documentation and information provided by the tool to lay the groundwork for the interventions/credits to be achieved. This could include copying best-practice project specifications from the Tool into the project Tender Document or ensuring some form of community outreach or project permitting is undertaken at an early stage. During the construction stage, the Tool includes tables where site data such as monthly water and energy use can be tracked and easily reported to the client.

Six categories are used throughout the system as structural elements, namely: Environment, Culture and Impact (ECI), Natural Resources (NR), Design Innovations (DI), Movement, Safety and Health (MSH), Human Capital (HC) as well as Economics and Industry (EI). Credits under each of these categories are furthermore reported on according to the three pillars of sustainability, namely; Environment, Economy and Social Equity.

There are four main components to the system: capturing of project details, goal setting, a performance overview and performance scoring. These components are elaborated below.

A. General Project Data

A data sheet is provided for the capturing of key project data, assumptions and critical conversion factors. The information captured here is used for a range of hard-coded calculations within the system. Feedback obtained through application of the system to projects will progressively inform and refine the assumptions and conversion factors going forward.

B. Goal Setting

The next component of the system is optional, but recommended. It provides for upfront identification of goals or targets in relation to individual sustainability dimensions or specific credit items. This upfront engagement with the credits and individual interventions provides the project owners with the opportunity to familiarize themselves with the rating system and choose from an extensive list of road-specific best-practices which might be applicable to their project. A project owner would therefore identify criteria against which their project should be evaluated and, where relevant, a level of performance for selected credits. The goal setting is done on six section summary sheets, each corresponding to a broad sustainability category.

It should be noted that there are currently ten intervention levels that are considered mandatory minima. The purpose is to ensure that "best-practices" aren't implemented at the expense of certain critical "typical practices". The mandatory interventions are:

- Relevant environmental, social and heritage resources related permits obtained
- Compilation of an Environmental Management Plan
- Proper disposal of hazardous waste
- Use of energy efficient plant
- Initial and follow-up pedestrian surveys
- Noise impact assessment
- Early community engagement
- Youth Skills Development (in-service training)
- Percentage of works reserved for labour intensive construction and targeted enterprises
- As-built data reporting

Once actual performance data are entered into the self-assessment sheets of the system, the project's actual performance is compared to what was originally planned or intended. This is further separated out in terms of whether the performance relates to the environment, economy or social equity.

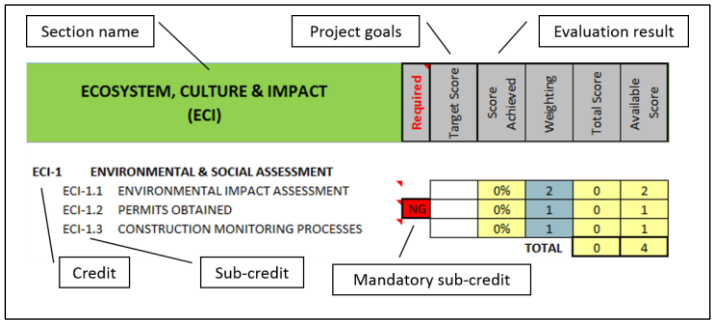

Fig. 1. Components of the goal setting

C. Scoring Summary and Dashboard

The summary and dashboard provides a mid-level overview of the sustainability of the project as captured by the self-assessment component. The reporting is at credit level, with 41 credits spread between the system's six sustainability categories. Evaluation results are shown as actual values compared to available values.

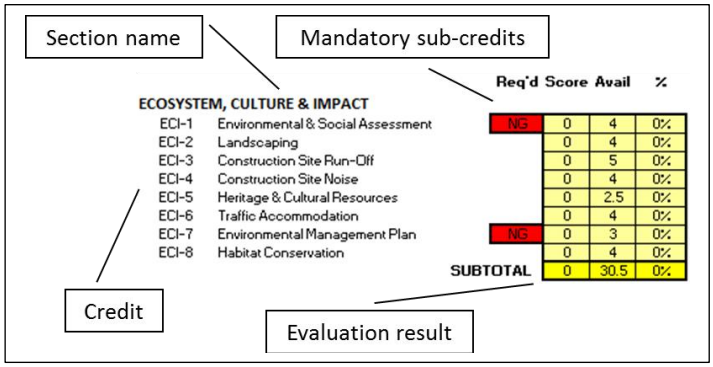

Fig. 2. Components of the summary sheet

The 'available' score only includes the items deemed as relevant in the goal setting system component (i.e. if the project doesn't include new structures, the credit "low maintenance structures" is not relevant). The 'actual vs. available' comparison is also shown in graph form, both as a percentage and as actual scores.

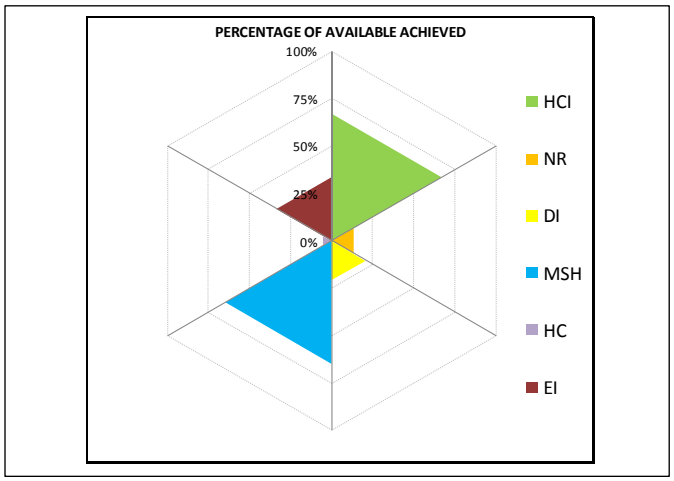

Fig. 3. Example of evaluation result graph

Due to their specific local importance, job creation and carbon footprint are highlighted in the summary sheet. The performance in terms of number of jobs, local spend and targeted enterprises spend, as well as greenhouse gas emissions for different project components are reported on.

D. Self-Assessment

The fourth, and largest, component of the system is the self-evaluation sheets. Project data are entered directly into the sheets. Formulae built into the sheets then use the entered data to produce normalized values for sub-credits that combine for credit and sustainability category summary values.

The section starts with three sheets intended to bring to prominence the issue of resource scarcity – specifically water use, energy use and waste recycling. Monthly reporting is required, and the data are used for calculations in related credits.

The sheets in the remainder of the section each correspond to a single intervention/credit, and contain some background and explanation of each credit, as well as a reporting forms that may include several sub-credits. As far as possible, repetition of data entry is avoided, with many sheets drawing on information entered in the tabs located at the very beginning of the Tool called General Project Data, Water, Energy or Recycling sheets.

Credit sheets also allow for the insertion of various forms of digital evidence to substantiate performance, as well as verification checks by an auditor or reviewer of the data.

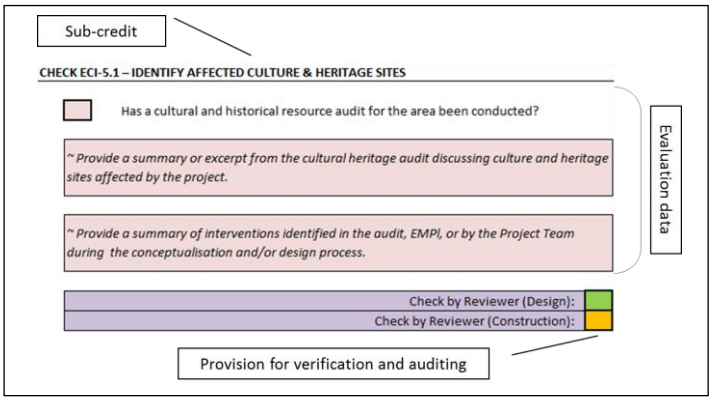

Fig. 4. Example of a credit performance evaluation

IV. AVAILABLE CREDITS

As indicated earlier, the 41 available credits are grouped in six themes. The themes and corresponding credits are listed in Table I. Note that each main credit may consist of detail contributing sub-credits.

TABLE I. LIST OF CREDITS

ECOSYSTEM, CULTURE & IMPACT	**MOVEMENT, SAFETY & HEALTH**
ECI-1 Environmental & Social Assessment	MSH-1 NMT & Pedestrian Safety
ECI-2 Landscaping	MSH-2 Multi-Modal Travel
ECI-3 Construction Site Run-Off	MSH-3 Scenic Views & Landmarks
ECI-4 Construction Site Noise	MSH-4 Aesthetics
ECI-5 Heritage & Cultural Resources	MSH-5 Vehicular Noise Impact Reduction
ECI-6 Traffic Accommodation	MSH-6 Road Visibility (Lighting and Markings)
ECI-7 Environmental Management Plan	MSH-7 Real-Time Travel Data
ECI-8 Habitat Conservation	MSH-8 Independent Road Safety Audits
NATURAL RESOURCES	**HUMAN CAPITAL**
NR-1 Water Usage & Tracking	HC-1 Community Engagement
NR-2 Fossil Fuel Use Tracking	HC-2 Environmental Education & Awareness
NR-3 Improved Lighting	HC-3 Young Staff Skills Development
NR-4 Construction Site Recycling (excl. layering)	HC-4 Road Safety Education Outreach
NR-5 Use of Regional and In Situ Materials	HC-5 Job Creation & Labour Optimisation
NR-6 Energy Efficient Plant	HC-6 Project Legacy
DESIGN INNOVATIONS	**ECONOMICS & INDUSTRY**
DI-1 Recycled Materials	EI-1 Cost-Benefit Analysis w/ Social & Environment
DI-2 Warm Mix Asphalt	EI-2 Life cycle Inventory in CO_2e
DI-3 Cut/Fill & Mass-Haul	EI-3 As-Built & Inspection Data
DI-4 Longer Life Pavement	EI-4 Pavement Performance Monitoring
DI-5 Future Upgradeability	EI-5 Resource Coordination
DI-6 Low Maintenance Structures	EI-6 Disaster Mitigation
DI-7 Innovative & Cost-Effective Interchanges	

Calculation of carbon footprints expressed as carbon dioxide equivalents has been introduced into the tool to streamline and provide uniformity across roads authorities and consultancies. The concept of carbon footprint reporting as a measure of the overall greenhouse gas footprint associated with a project will become increasingly important to road authorities as they need to support their government's greenhouse gas emission reduction targets.

Carbon footprint calculations can be complex and rely on various assumptions, thus requiring specialists to carry them out. This makes the work prohibitively expensive and only possible on the largest projects and subject to non-uniformity. To ensure a simplified approach in a single tool, more industry research will need to be done on local emission factors to be able to report fully on the carbon footprint for a wide range of projects in South Africa. The groundwork has nevertheless been put in place in the existing draft SuRF Tool. Additional expertise is required to turn this important but challenging calculation into a reliable and industry-accepted reality.

As future mobility disruptors such as electric and autonomous vehicles are introduced into our road networks, together with 5G capability, further Tool credits will need to be developed to take advantage of this technology and its potential impact on sustainability of the roads sector.

V. TRIALS ON THE N3 CORRIDOR

The N3 Corridor freeway upgrade project consists of 16 work packages, assigned to twelve (12) different design and construction teams. Most packages are currently in the design phase. The project owner, SANRAL, instructed the Project Leads on the various packages to test particular portions of the Tool on their project components and to provide feedback on the functionality, practicality, design and usefulness of the Tool.

To facilitate feedback, an open-ended survey was circulated to the consulting teams roughly six (6) months after the instruction was given. This elicited a response from half of the project teams.

The limited feedback received suggests that there is still varied appreciation of the role and value of the Tool, and limited adoption of it as a positive differentiator on road construction projects. This is clearly demonstrated by a comment that seemingly disregards the 'triple bottom line' value of sustainable design and construction, querying the value of interventions that add to the overall cost of the project.

In several cases, a comment indicated that information will only become available after detail design and construction, or subject to contribution from third parties. Although true for some credits, this suggests that the importance of pro-active identification of design innovation or alternatives is overlooked. One of the aims of the tool is to encourage design that is not business-as-usual, and this requires a push for sustainable interventions as part of the early designs. Furthermore, by externalizing the responsibility for sustainability, incentive for change is diluted.

The functionality and user-friendliness of the tool can also be improved. Some comments suggested specific editorial changes that can fix calculation steps or provide example content, while the level of satisfaction with the guidance provided in the Tool varied. A specific comment requested provision for more project team information, which can then be used to allocate responsibilities. As expected, collation of the information is difficult for one person. The user-friendliness of the tool will therefore rely on future design revisions that facilitate the information collection. Some more thought also needs to go into information collection on labour spend/opportunities to make the reporting easier.

Feedback also suggests that information can be obtained from Bills of Quantities drawn up for the construction projects. This points to an opportunity to create active linkages between standardised project data sets and the values required by the Tool.

The absence of standardised Life Cycle Inventory (LCI) tools in the local construction industry is mentioned in some comments. LCI tools that provide for internalization of social and environmental costs should be more prevalent, both in availability and use, if the value of sustainability is to be demonstrated on complex projects.

VI. CONCLUSIONS

Much literature is available on organisational change or the uptake of innovation or new technologies. Inevitably, response to a new idea starts off as resistance to change, until sufficient merit and uptake momentum are demonstrated [5][6]. The initial feedback on the SuRF Tool trials is indicative of some resistance, but also the willingness of some 'early adopters' to contribute to the development of a tool that will assist in the transformation of an entire industry.

Should a sustainability rating system become mandatory, as suggested in the draft Roads Policy for South Africa, the process of implementation and adoption will benefit from the lessons learnt from the implementation of the SuRF Tool. Key junctures can be identified where specific intervention is required to facilitate successive levels of adoption.

For the SuRF Tool, it is clear from initial implementation that further industry capacity building is required. This can be in relation to general awareness of issues related to sustainability, as well as in the form of tools and mechanisms that facilitate a consistent incorporation of sustainability into construction projects.

When considering the typical process of organisational change, as described by Carnall [7] and interpreted in terms of the likely two-phase implementation of the SuRF Tool, then it becomes clear that a critical intervention will be required between the initial pilot phase and final industry-wide roll-out of a sustainability rating tool.

This critical intervention requires a functional rating tool, distilled from iterative improvement and revision cycles, and marks a shift from it being used only by 'early adopter' actors to its universal acceptance and application.

The criticism, scepticism, apprehension and resistance currently present in the industry need not be feared. Instead, it should be valued as a crucial indicator of the types of reactions that will beset the shift to universal roll-out. The further

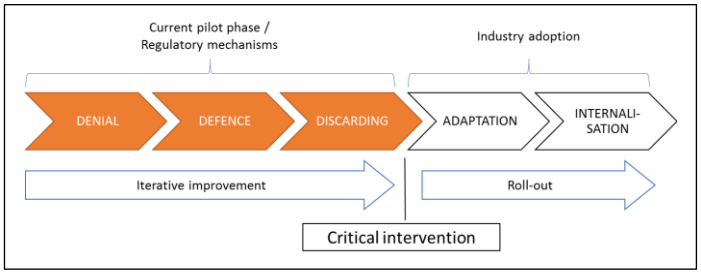

Fig. 5. SuRF Tool adoption cycle (after Carnell [7])

development of the Tool can be directed in response to the feedback received, but importantly, capacitation of the industry can prepare the way for structured integration of sustainability into road construction projects.

ACKNOWLEDGEMENT

The time committed by the project teams working on the N3 Corridor freeway upgrade project to complete the feedback survey is acknowledged. Their feedback informs further development of the concept, the tool and generally, innovation in the road construction industry.

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