GOLDSET©: APPLICATION OF A SUSTAINABILITY DECISION SUPPORT TOOL TO THE ROOF ASPHALT SHINGLES RECYCLING PROJECT OF METRO VANCOUVER

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ABSTRACT

Asphalt shingles constitute approximately 2% of the total waste currently disposed in the Metro Vancouver region, which corresponds to between 60,000 and 80,000 metric tonnes per year. Developing alternative uses for asphalt shingles would help the Metro Vancouver region achieve the Zero Waste Challenge and the Sustainable Region Initiative's goal of 70% waste diversion by 2015.

Metro Vancouver (MV) has mandated Golder Associates Ltd (Golder) to conduct a feasibility study for the use of reclaimed asphalt shingles (RAS) in road construction. In the last decade, several trials have been performed to use RAS as an input for pavement mix across North America. MV has expressed an interest in performing an integrated sustainability assessment for economic, social, environmental as well as technical aspects of using processed RAS in road construction.

This assessment is conducted using the Golder Sustainable Evaluation Tool (GoldSET), an innovative, simple Multi-Criteria Analysis (MCA) tool based on the principles of sustainable development. GoldSET has been customized to compare different options of asphalt mix: pavement containing only virgin asphalt cement, pavement containing recycled asphalt pavement (RAP), and pavement containing different ratios of RAS and RAP.

INTRODUCTION

Golder Associates Ltd ("Golder") has developed a sustainability decision support tool to evaluate the strengths and weaknesses of engineering projects with respect to environmental, social, economical as well as technical dimensions. The tool called GoldSET©[1] (Golder Sustainability Evaluation Tool) allows for an unbiased comparison of different options on the basis of sustainability principles. As such, it can help identify optimal solutions in a decision-making process based on the principles of sustainable development. This sustainability analysis results in a "triple-bottom-line" assessment, expanding the traditional analytical framework from financial performance to environmental, social and economical performance.

The purpose of a sustainability decision support tool is to offer an analytical framework which simplifies the management of complex sustainability issues involved in projects. This paper will argue that the application of a sustainability decision support tool can be instrumental in managing the business risks associated to large engineering projects. By providing a comprehensive and transparent framework to understand and manage the sustainability issues of a project, a sustainability decision support tool can achieve the following benefits:

- Improve the decision making process involving complex issues;
- Support proactive stakeholder engagements through a rigorous and transparent evaluation process allowing stakeholders to better understand the alternatives and their respective impacts;
- Ease communication with communities through visual representation of performance with respect to sustainable development and in return facilitates the issuing of social licences for project operations;
- Optimize the comparison of alternatives by providing a framework which allow different options to be compared with a set of key criteria and trade-offs leading to a facilitated decision making process; and
- Improve corporate image through supporting decisions with a sustainability framework that effectively demonstrates a corporation's willingness to move forward with sustainable development, and can consequently promote a positive corporate image.

The pavement industry is involved in major engineering projects. Most of these projects face interconnected and complex technical, economical, social and environmental challenges. In this context, the use of a sustainability decision support tool can achieve important benefits. The following sections will discuss how these benefits can be achieved with a sustainability decision support tool.

[1] Copyright, patent pending.

Sustainable Development: Implications

The paradigm called sustainable development stems from the realization that economic development must increasingly be undertaken in ways that respects the integrity of the environment while promoting social equity. The definition of sustainable development calls for a development that meets the needs of the present without compromising the ability of future generations to meet their own needs [1]. However, translating this concept into reality is a complex challenge that corporations around the world are increasingly facing with their investments.

The development of sustainable projects requires management of conflicting priorities that are challenging to embed into a business model which focuses on the maximisation of the return on investments. Profits are to be maximized in a context where the “people” and the “planet” aspects must be carefully managed. The three Ps (Profit, People and Planet) form this “tripled bottom line” that modern corporations are expected to optimize in highly competitive and increasingly scrutinized markets. Indeed, as sustainability issues are becoming more pressing and intricate, the rising scrutiny from civil society organisations, regulators, the media as well as investors renders the issue of sustainable development increasingly unavoidable to the global business community.

Figure 1 : Corporations and public agencies are facing increasing pressure to move forward with sustainability

There is a need to understand the risks and opportunities to the business model arising from the imperatives of sustainable development and how they can be managed. As shown in Figure 1, the increasing pressure from the various stakeholders of an organisation to move forward with sustainability actions is occurring in a context where socio-economic and environmental issues are becoming extremely complex to understand and manage. As a response to this challenge, many resources such as publications from the International Federation of Consulting Engineers and performance indicators from the Global Reporting Initiative (GRI) to name but a few are being proposed to provide a framework for addressing sustainability issues. The practical problem resulting from these resources is that they do not easily apply at the project level to make a difference when a project is being conceived.

Businesses need to be capable of effectively and efficiently evaluating their options with a comprehensive sustainability approach. Such an evaluation process needs to be:

- Easy to understand and communicate;
- Defensible and transparent to the stakeholders;
- Flexible so that both quantitative and qualitative information can be processed;
- Balanced in regards to the sustainability principles;
- Specific to the organisation; and,
- Pragmatic so that it can support sound business decisions.

A comprehensive analytical framework to support sustainability assessments can lead to sound business and engineering decisions; decisions in which principles and corporate policies on sustainable development can be implemented at the project level. This process means that the assessment of the various sustainability issues in a project will be synthesized in order to facilitate the trade-offs leading to optimized decisions. This process will enhance the understanding of the sustainability issues, which will in turn position the project proponents so that they can engage more proactively with their stakeholders, better manage their risks and ultimately improve the overall performance of their project.

GoldSET©: An Executable Framework for Sustainability

Golder has developed a multi-criteria analytical (MCA) framework called GoldSET© to support sustainability assessments. It is used to "operationalise" the principles of sustainable development into engineering projects. This MCA framework was first developed in 2007 to investigate the sustainability elements included in an environmental remediation project. The basis for GoldSET© was to support the evaluation process in order to make sure that the proper recommendations would be made, while including various sustainability principles. To do so, it was designed to address economical, social and environmental impacts, direct and indirect, positive and negative, short and long term. The evaluation process is divided into four main steps, as shown in Figure 2 below:

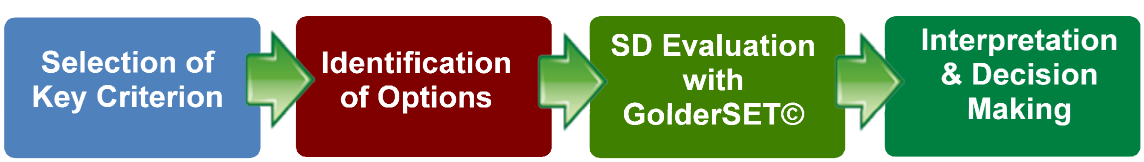

Figure 2 : The Four Steps of the Evaluation Process

During the first step of an evaluation, criteria (sustainable development indicators) tailored to the specificities of the project and the organisation are elaborated based on international and authoritative references, as well as industry specific references, corporate objectives and legal requirements. These criteria are chosen to reflect the critical issues that will determine the overall performance of a project (triple-bottom-line). During the evaluation process, the criteria will be used to evaluate impacts (step 3) which are categorized into various dimensions: economical, social, environmental and technical.

During the second step, various options that could be potentially undertaken for the realization of a specific project are developed. Those are the options that are evaluated with the criteria that have been established in the first step.

The third step is where the sustainability evaluation of the various options under consideration is performed based on a structured system for ranking the options. Tailored scoring and weighting schemes are used to compile a sustainability performance with respect to the various dimensions under consideration for each option. The framework can handle both qualitative and quantitative data. Depending on the size of the project and the level of uncertainty acceptable to the client (versus cost to reduce this uncertainty), the framework can be adapted to the requirements of the project. For instance, project costs and revenues, energy consumption, greenhouse gas emissions, water consumption and wastes can typically be calculated[2] while health and safety, impact on landscape and on cultural heritage of a site may be more difficult to quantify. A key feature of the MCA is that it provides a mean to handle both types of information. The results are presented both numerically and graphically, as shown in Figure 3 below.

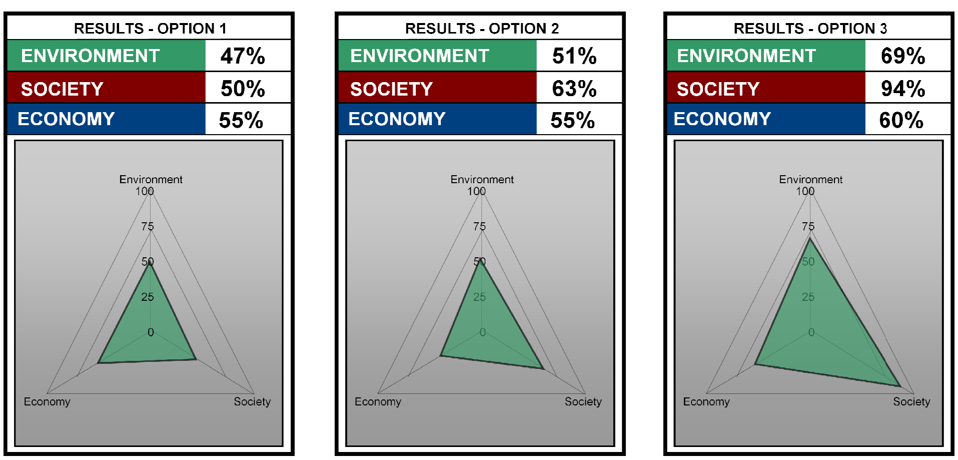

Figure 3 : Results of the SD Evaluation for Three Options

As a fourth and final step, the interpretation leading to a sound decision can be made based on the outputs of the evaluation process. The evaluation process being iterative by nature, further

[2] Various methodologies, such as a life-cycle (LCA) approach can be used with the tool.

refining can be accomplished if additional information is available or if a new option is proposed. Monte-Carlo modelling and sensitivity analyses can also be performed on the outputs to improve the reliability of the findings. In the end, however, the process will provide a tangible, transparent and optimized evaluation of the options upon which a pragmatic and legitimate decision may be taken. As shown in Figure 3, the end result is a visual compilation of the sustainability performance. This visual presentation demonstrates the elements of each option and allows for effective decisions. The three axis of the triangle present the performance of an option with respect to the three dimensions of sustainable development. Under normal circumstances, the optimized approach will be determined by the bigger, most balanced triangle.

In the end, the choice of the option to undertake will not be dictated by the framework; the decision will remain to the client's prerogative. However, although the biggest triangle is not an absolute criterion for selecting an option, the process will provide an opportunity to understand the sustainability issues and legitimize the choice of an option on that basis. The benefits provided by GoldSET© are not limited to understanding and managing the issues in order to make a decision. The tool can also be used to support the communication process with the various stakeholders. The framework is instrumental in facilitating the communication of key elements because the evaluation process is transparent and the results are presented graphically for each option, allowing effective comparisons.

Applications for the Roof Asphalt Shingles Recycling Project

The following section elaborates on how a sustainability evaluation framework is used to support the decision process for the roof asphalt shingles (RAS) recycling project promoted by Metro Vancouver. Golder Associates Ltd (Golder) was mandated to conduct a feasibility study for the use of reclaimed asphalt shingles (RAS) in road construction, including a sustainable development evaluation of different mix-design options. It is assumed that the use of RAS in road construction can lead to environmental benefits, such as reductions in life-cycle greenhouse gas emissions and energy requirements, particularly if RAS substitutes for a percentage of virgin asphalt cement requirements. However, the performance of RAS-containing mix regarding the pavement rutting and cracking had to be further tested.

Hence, the objective of the study was to provide a critical assessment of the environmental, economical, social and technical performance of asphalt mixes- incorporating various percentage of RAS and to compare them with the currently used asphalt mixes with 100 % virgin asphalt cement and with RAP and asphalt cement.

One of the key issues is the trade-off/complementarity relationship between RAP and RAS. Since both road asphalt pavement waste and roof asphalt shingles wastes are generated in the Metro Vancouver area and can be used within pavement mix, the use of RAS instead of RAP could lead to a mute effect on the overall waste diversion rate. Furthermore, the performance of the different scenarios regarding the pavement resistance to rutting and cracking could have impacts on the road maintenance costs.

In order to develop an integrated approach leading to the identification of sustainable solutions for RAS management over the long term, the evaluation criteria includes technical, environmental, social and economic elements arising from Golder's technical expertise and consultations with the client.

Methodology
As a first step, the following scenarios were to be evaluated for a performance test:

- Mix containing Recycled Asphalt Pavement;
- Mix containing 3% of Recycled Asphalt Shingles;
- Mix containing 5% of Recycled Asphalt Shingles; and
- Mix containing X% of Recycled Asphalt Shingles and Y% of Recycled Asphalt Pavement.

This evaluation is expected to result in the identification of a subset of scenarios for appropriate options, according to site conditions. As a second step, a field test is performed based on the most appropriate mix-design identified in the previous step. In both assessments, a detailed ranking scheme is developed and performs a rigorous, consistent and transparent assessment. The ranking scheme is comprised of two elements: a scoring scheme that evaluates each option with respect to the criteria and a weighting scheme that assigns relative importance (criticality of the criteria) to each criterion compared to each others. The evaluation criteria used by the framework are summarized in Table 1.

Results & Recommendations
The end result of the evaluation is the compilation of performance for each dimension under consideration. Using GoldSET©, the overall performance is then presented graphically for each option; first for the process technologies and subsequently for the deposition alternatives.

Figure 4 below illustrates an example of the graphical representation for an option.

ENVIRONMENT	78%
SOCIETY	65%
ECONOMY	70%
TECHNICAL	96%

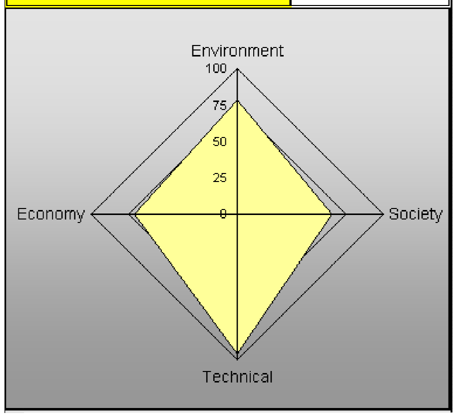

Figure 4: Example of SD Evaluation Output for an Alternative

Following the compilation of the performance for the process technologies, a sensitivity analyses is potentially performed on the alternatives in order to reduce the uncertainty associated with the findings. At this point the analyst is in a position to make recommendations with the most appropriate course of action. The end result is the identification of attractive scenarios regarding the mix design and its recycled materials content.

Further details regarding this on-going project will be presented at the conference in order to demonstrate the pertinence and usefulness of a sustainability decision support tool for the pavement sector. Preliminary results of the mix-testing and technical issues could be presented at the conference, depending on the progression of the on-going works.

CONCLUSIONS

This paper presents both the purpose and relevance of a sustainability decision support tool. It has been demonstrated that there is a need for an analytical framework to evaluate alternatives leading to sound decisions when investing engineering projects. An impartial, balanced and comprehensive assessment will enhance the understanding of how the issues impact the overall performance of a project. In turn, this understanding will be instrumental for the following elements:

- Support proactive stakeholder engagement;
- Optimize alternatives and improve operational practices;
- Provide a framework for managing the risks associated to a project; and,
- Facilitate the obtention of a social license to go forward with a project.

Using a sustainability decision support tool can therefore improve the “Triple Bottom Line” of an organization though achieving sustainable financial performance while promoting environmental integrity and social equity.

Table 1: Snapshot of Criteria for SD Evaluation

Technical criteria
Susceptibility to fatigue and thermal cracking
Risk of asbestos content
Asphalt mix properties
Impact to other processes
Environmental criteria
Virgin materials used
Solid wastes
Leachate and contamination risk
Greenhouse gas emissions
Energy consumption
Recycled resources used
Social criteria
Workers safety
Local job creation
Response to social sensitivity
Public safety
Economical criteria
Output price
Production costs
GHG offsets potential
Waste disposal costs
Benefits to the local economy