

EXPERIENCE IN IMPLEMENTING A PRACTICAL MECHANISM FOR INCORPORATING SUSTAINABILITY PRINCIPLES INTO MINERAL PROCESSING PLANT DESIGN AND OPERATION

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Abstract

The collaborative development of a new management framework to implement sustainability principles into the minerals (and other) industries has been reported upon previously [1, 2]. The response to date has been that such a framework is required and would add value to business and protect environmental and social values. The ongoing development of SUSOP[®] has included how to integrate the framework into existing project management and business management systems.

Many organisations, including those in the resources industry have Board-level endorsed principles on sustainability. A key challenge, however, is how to systematically integrate these high-level principles into the design and operation of mineral processing plants. Current project management systems do not readily deliver the innovative solutions that are needed to address key sustainability issues, such as minimal impacts on the environment, significantly lower carbon emissions, and maintaining the societal 'licence to operate'.

In an effort to meet this challenge the Sustainable Operations framework, called SUSOP[®], was conceived and developed through the Co-operative Research Centre for Sustainable Resource Processing (CSRP) in Australia. Somewhat analogous to HAZOP (Hazard and Operability Studies) which is well entrenched in the resources industry, the SUSOP[®] is a holistic, systematic and rigorous set of processes for identifying and assessing sustainability opportunities and risks within the organising architecture of a sustainability framework.

A multi-faceted approach has been taken in the development of SUSOP[®]. Utilising the expertise of research and industry collaborators, drawing on the substantial body of published work on sustainable development, and most importantly undertaking 'live' case studies with the minerals industry have been critical features in enhancing SUSOP[®]'s development.

This paper presents the key elements of SUSOP[®], how the case studies enhanced its development, and the early results of promoting the use of this new systematic and rigorous approach for embedding sustainability principles into mineral processing plant design and operation.

1. Introduction

Many mining companies and industry bodies, such as the International Council on Mining and Metals [3] and associated bodies such as the Minerals Council of Australia [4], have developed and adopted sustainability principles and policies. This is an important part of demonstrating their and the member's commitment to building and running operations in a socially and environmentally responsible manner. Practically applying these principles and policies presents a difficult challenge to practicing engineers working on new project developments or conducting the day-to-day activities at an operational site. In short, these principles and policies do not readily assist the average engineer in his or her daily work tasks.

Consequently, sustainability principles are not intrinsically embedded into corporate systems. They are in fact typically used to ensure that the project or operation is at best compliant with all the important principles or policies. For a new mining project, this occurs once all major decisions are made, allowing little scope for the resulting operation to make a meaningful contribution to sustainable development (SD). Effectively, new mining operations are routinely designed, built and run in a similar manner to existing operations. In current standard practice, no part of developing a new mining operation allows for sustainability principles to be the driver of innovative solutions.

Now and increasingly so into the future, operations will need to be fully equipped to deal with the critical aspects of sustainability

and ensure their continuing licence to operate (e.g. community encroachment, increasing government pressures, increasing scarcity and subsequent costs of raw materials, water, and energy). For any new project, each environment and local community offers a distinctive set of opportunities and sustainability hazards which can be a source of inspiration for new and innovative solutions.

To provide practical solutions to core sustainability issues such as reduced carbon emissions, minimal environmental impacts, and maintaining the societal licence to operate, the ideals of sustainability need to become entrenched into project management systems. Utilising a sustainability framework will ensure consistency from project to project and result in a more comprehensive understanding of the overall contribution that resource operations can make to overall societal sustainable development. Without such a framework as part of the standard project management system, new projects will continue to replicate existing operations with only modest enhancements to satisfy corporate sustainability principles.

A new, holistic framework for incorporating sustainable development principles into the design and operation of mineral processing plants, called SUSOP[®] (SUStainable OPERations), has been developed through the Cooperative Research Centre for Sustainable Resource Processing (CSRP). This paper presents the key elements of SUSOP[®], and highlights both the value that it delivered to real project case studies and how the case studies enhanced its development.

2. Features of SUSOP®

2.1 Background

SUSOP® was developed through a collaboration of researchers and practicing engineering consultants, with the express intention of creating a framework that incorporated the principles of sustainability into process design and operations. The team believed that the rigour that HAZOP (Hazard and Operability) studies brought to safety could also be applied to ensure that the ideals of sustainability could be integrated into the design and operation of resource projects. In developing the framework, the collaborative research team specified that it must work in conjunction with the current practices and constraints in the industry and be integrated into the standard project development cycle. This would give it the flexibility to provide the appropriate guidance, tools and deliverables to fit the level of detail and opportunity available at each phase of a project[5]. The key elements of the framework are presented in this paper.

2.2 General Overview

SUSOP® is a guiding framework for projects that enables a proper contribution to sustainability by the industrial facilities being studied, designed, built or operated.

There are three major elements of the SUSOP® framework:

- 1) Sustainability opportunities and risks identification (SUSID™). A significant characteristic of this element is that it includes 'new ideas' generation. This is the most substantial element of and is made up of four steps:

Step (i) Familiarisation with Sustainability Concepts and Project Context;

Step (ii) Goal Scoping and Opportunities and Risks Identification;

Step (iii) Analysis of Sustainability Opportunities and Risks;

Step (iv) Prioritisation of Sustainability Opportunities and Risks.

- 2) Sustainable Development (SD) Assessment – to conduct a detailed evaluation of the shortlisted or high-priority opportunities and risks.

- 3) Decision Support - to provide assistance with decision-making at project toll gates.

All elements are supported by the Knowledge Base which includes information on sustainability frameworks and principles, details on case studies, relevant SD tools and databases to assist in the evaluation and assessment stages, resources for workshops and relevant public domain information and data. A schematic summarising the framework is presented in Figure 1.

The main outputs are presented in the Sustainability Register™, which works in a similar manner to a conventional risk register and includes:

- 1) Opportunities for improving the contribution to societal sustainability and business performance of the project;
- 2) Supporting SD Balance Sheets™ for top ranking opportunities to schematically show the positive and negative impacts across the chosen sustainability framework (the default is the Five Capitals Sustainability Framework which comprises natural, human, social, manufactured, and financial capitals [6]);
- 3) Sustainability risks that could potentially impact on the project's viability;

- 4) Action plans for each item (opportunities and risks) in the register before proceeding through the next project toll gate.

2.3 Participants

Participants will vary depend on the stage that the project is at and the type of project being considered. Typically core project staff (e.g. process engineers and plant designers) plus environmental, community and risk experts are part of the SUSOP® study team. A trained SUSOP® Lead directs the overall study and a trained SUSOP® Facilitator runs workshops. It is important to achieve a balance of in-house and external people in the team to avoid group-think as well as bring in different perspectives. The team should include people of differing backgrounds, experience and attitudes, and expansive, unconstrained, lateral thinkers should be included and encouraged. This greatly enhances the potential for generating innovative and alternative opportunities as well as identifying possible sustainability risks.

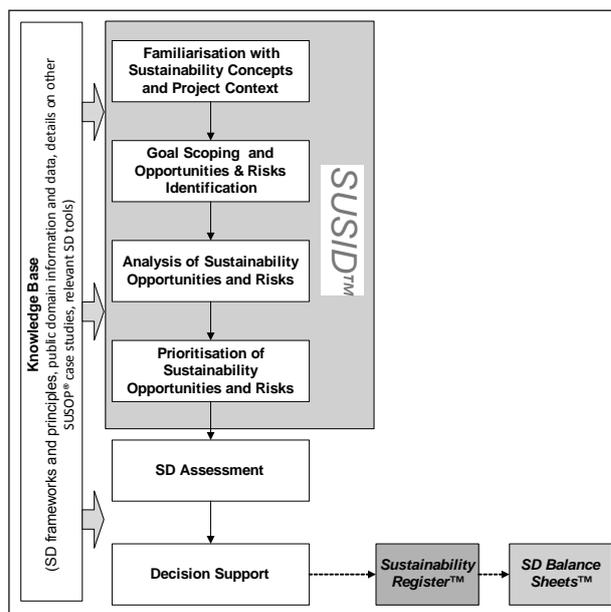


Figure 1: SUSOP® Framework

3. SUSOP® Key Elements

This section provides further details on each of the three key elements in the framework.

3.1 SUSOP® Key Element 1. Sustainability Opportunity and Risks Identification (SUSID™)

3.1.1 SUSID™ Step (i) - Familiarisation with Sustainability Concepts and Project Context

Through a workshop style process, a common understanding of the project context and core sustainability knowledge amongst the participants is created. Typically this step includes the full complement of participants. By the end, participants have an understanding and appreciation of the:

- project's key characteristics;
- core sustainability knowledge including SUSOP®'s default sustainability framework, Five Capitals [4], the International Council on Mining and Metals ten Sustainable Development principles [1]; and/or corporate sustainability principles or policies;
- connections between the project characteristics and key aspects of the sustainability framework

3.1.2 SUSID™ Step (ii) - Goal Scoping and Opportunities and Risks Identification

This step also uses a workshop style process to identify:

- Appropriate, practical and achievable sustainability goals for the project (i.e. identifying which outcomes would be considered successful and how it would be measured or quantified)
- Opportunities to potentially achieve these goals and sustainability risks that might threaten the goals or affect the project's viability.

The participants should be the same as in SUSID™ Step 1 Familiarisation.

The sustainability goals should align with the company's corporate sustainability principles and policies and will provide the basis for the identification of opportunities and risks. Sustainability opportunities and risks are identified through structured techniques, including specific prompting elements based on sustainability concepts, to identify opportunities that could potentially achieve one or more of the sustainability goals and mitigate various risks that may affect the project's viability.

Innovative opportunities typically emerge when participants understand and appreciate the connections between the project and the broader societal and environmental context.

Potential risks to a project relating to the broader sustainability issues should be identified and, if possible, potential solutions to mitigate these risk should be proposed.

All opportunities and risks are listed in the Sustainability Register™ which is a 'live' document until the completion of a project phase and treated in the same manner as a conventional risk register. It is carried forward by the project team in the usual project management system. The process of capturing and reflecting on the group learnings is an important and valuable step as it begins the formal registering of the group work outcomes.

3.1.3 SUSID™ Step (iii) - Analysis of Sustainability Opportunities and Risks

In this step the Study Lead and SUSOP Practitioners conduct further analysis to verify the outcomes from the previous step and produce an initial shortlist of opportunities and risks. The basis for short listing is those opportunities that could make the biggest contributions to sustainability, and risks that could potentially have significant negative impacts on sustainability.

Potential for other opportunities or risks is initially investigated and a detailed list of all opportunities and risks with supporting evidence is compiled. Linkages are established between opportunities across themes (e.g. energy, enterprise development etc.) to develop a preliminary understanding of the overall sustainability impacts.

3.1.4 SUSID™ Step (iv) - Prioritisation of Sustainability Opportunities and Risks

Utilising a workshop process, the shortlist of opportunities and risks for future evaluation and assessment is conducted with the same participants as in steps (i) and (ii) above.

The participants review the prioritised list of opportunities and risks taking into consideration the contextual setting (regional environmental and social consideration) for the project. For example, if there is a plentiful fresh water supply, initiatives to conserve water will be given a lower priority than those which are more critical, for example development of self-sustaining local enterprises. At the end of this step, the participants agree on a prioritised list of opportunities and risks for immediate action (as items for further exploration and assessment in the next element).

All identified opportunities and risks will be carried forward through the Sustainability Register™, with prioritised opportunities and risks being identified. Eventually all opportunities and risks on the Sustainability Register™ must be addressed (either implemented or resolved).

3.2 SUSOP® Key Element 2. Sustainable Development Assessment

An appropriate level of further assessment (i.e. appropriate to the stage of the project under study) of the identified top ranking opportunities and risks is conducted in this element. Participants include the the Lead and Practitioners plus project personnel for review.

Where possible, quantitative tools are used to examine and evaluate the top ranking opportunities and risks on the basis of their sustainability impacts (positive and negative). Standard tools and approaches (e.g. life cycle assessment, social impact tools, footprinting etc.) are applied to the prioritised opportunities and risks to deliver a comprehensive understanding of the positive and negative impacts.

Based on assessment results the Sustainability Register™ is updated and action plans are developed that propose an appropriate 'next step' for each register item, such as further study or integration into the project scope. The outcomes are then reviewed to ensure consistency with the project's business and technical context and its drivers.

3.3 SUSOP® Key Element 3. Decision Support

The key aim of the final element is to produce a final stage revision of the Sustainability Register™, including the relevant SD Balance Sheets™, which provide assistance with decision-making at project toll gates (the decision points at which the project is approved to proceed to the next stage). Similar to the Sustainable Development Assessment element, participants comprise the Lead and Practitioners plus project personnel for review. SD Balance Sheets™ are generated, schematically showing the positive and negative impacts of the opportunities and risks compared with the business-as-usual approach. An example of an SD Balance Sheet™ is presented in Figure 2.

Multi-criteria analysis techniques can be applied to the outcomes from the SD Balance Sheets™ to provide substantive guidance on the selection of initiatives that will deliver enduring sustainability benefits as well as satisfy key business performance criteria.

The outcomes are then subject to ongoing review in subsequent project stages until all identified risks and opportunities are either addressed or removed (with good reason) from the register.

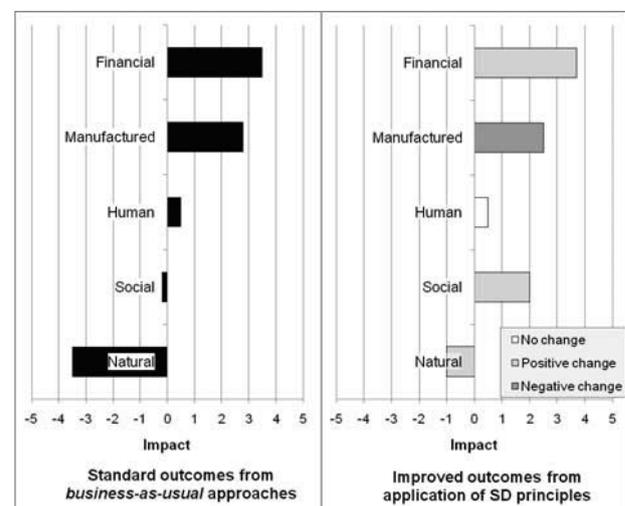


Figure 2: SD Balance Sheet™ Example (Note: change is capital for application of SD principles is relative to respective capital in business-as-usual)

4. Case Studies

In this section we describe the general outcomes the application of the SUSOP® framework which has resulted in numerous benefits to the project proponents and the host community. This is followed by two case studies which show the application of SUSOP® from an industry perspective. The two case studies produced sustainability opportunities and constraints that assisted with decision making in the subsequent project development phases. Specific information on each case study has not been included in order to maintain client confidentiality.

General outcomes obtained by application of the framework include:

Quicker regulatory approvals – By anticipating issues and being pro-active in addressing them in the early stages of a project, the regulator's job is made easier. When the regulator is presented with the proposal, the issues have already been highlighted and responses have been prepared for those issues. Regulatory authorities have commented that "...application of the framework will result in a more efficient approvals process and better environmental outcomes."

Stronger community engagement – This can be obtained through shared infrastructure, programs to monitor the health and well being of the workforce, plus supporting local enterprises that will enhance capacity and skills in the local community.

Better environmental outcomes – Examples can include reduced waste and better waste utilisation, cleaner and reduced effluents, reduced draw on limited natural resources such as water and fossil fuels and enhancement of bio-diversity.

Lower business risk (possibly leading to lower financing costs). Issues that are likely to occur and have a large impact will most probably be picked up with standard project management processes. However, high impact, low frequency events and high frequency low impact events are systematically identified and considered as part of the business of developing a project, the result being a more robust project with greater certainty of the outcomes.

Stronger social licence-to-operate – if the local, regional and national good is included in the decision making process, this will lead to a strong social (and regulatory) licence-to-operate.

4.1 Case Study #1 - Concept Phase Project

4.1.1 Project Background

Due to pending expiration of retention leases, the developer was faced with a deadline for site selection. Through employing standard business practices the developer could not provide definitive guidance on which sites to retain and which to relinquish. As a result, SUSOP® was applied in an attempt to make this distinction on a sustainability basis.

4.1.2 Process

An initial SUSID™ workshop, comprising participants from the SUSOP® research team plus company personnel and their consultant engineers, was held to identify the sustainability goals and opportunities related to each of the proposed locations. From SUSID™, nearly 70 possible sustainability opportunities across all aspects of sustainability were identified. These were then grouped into clusters of linked sustainability opportunities to produce an enhanced understanding of dependencies and deliver a better appreciation of the overall potential SD benefits. High imported fossil fuel costs and high expatriate labour costs were considered high priority business risks that could prevent the operation from being in the lowest operating cost quartile

4.1.3 Outcomes

The linked sustainability opportunities were the basis for developing a staged integrated plan (refer to Figure 3). This plan focussed on implementing alternative energy and local skills to address these risks with review steps at each phase of the project development. It also supported several sustainable development benefits, including increased skill levels, lower greenhouse gas emissions, and more secure energy supply to the local community. By applying SUSOP®, several business-related sustainability risks and opportunities were identified which led to the generation of the staged integrated plan (Figure 3). This was the basis for providing differentiators between the sites.

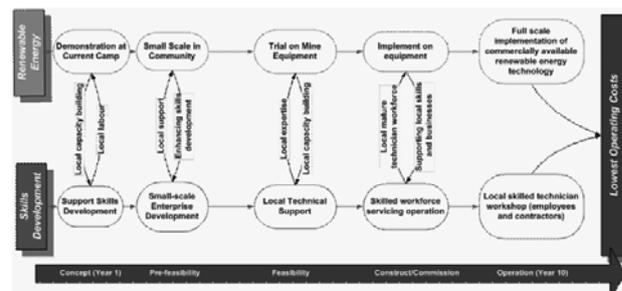


Figure 3: Staged Integration Plan

4.2 Case Study # 2 - Pre-feasibility Phase Project

4.2.1 Project Context

An operating company wanted to assess the sustainability performance of a range of proposed effluent treatment options at a mineral processing operation. The aim of this case study was to identify sustainability opportunities and evaluate the sustainability performance of the proposed options by applying the SUSOP® framework.

4.2.2 Process

An initial SUSID™ workshop, comprising participants from the SUSOP® research team plus representatives from the operating company and their engineering consultants, was held to identify the sustainability goals and opportunities related to each of the effluent treatment options. A detailed analysis of the identified sustainability opportunities related to the effluent options was then conducted by the SUSOP® research team in preparation for the 2-day prioritisation workshop. A shortlist of key sustainability opportunities and risks related to the effluent treatment options were agreed on at the end of the prioritisation workshop.

4.2.3 Outcomes

As a result of this study, sustainability opportunities to support effluent management have been identified, such as creating local enterprises to provide consumables, producing 'green' by-products and implementing a small-scale wetland to replace a more conventional effluent treatment facility. By applying SUSOP® the four possible effluent treatment options were ranked on a sustainability basis; one with the identified sustainability opportunities and another as originally proposed by the company. In addition, the identified opportunities for each effluent management option would substantially satisfy key elements of the company's Sustainability Policy.

4.3 Learnings from Case Studies

Each case study produced learnings which were then incorporated into the SUSOP® framework to improve its ability to effectively generate opportunities for delivering both sustainable development benefits and improved business performance. A summary of the key learnings are presented in Table 1.

Table 1: Summary of Case Study Learnings

Project Context	<ul style="list-style-type: none"> Participants need to understand and appreciate the true context of the project under consideration. As much information as practically possible should be made available to the study team, including the project history, the options already covered and the relationship of this project to other projects in the company's portfolio.
Recording	<ul style="list-style-type: none"> Recording and reporting of risks and opportunities is critical for integrating into the ongoing project plan. Need to flag sustainability "highlights" and potential "show stoppers" to guide project development.
Categorisation	<ul style="list-style-type: none"> Need to sort opportunities into different categories rather than producing a single (long) prioritised list. This approach assists the client in understanding the timing and scope for implementing these opportunities. For example, some opportunities have huge benefits but are not applicable in the short-term while other opportunities can apply to specific location options or context.
Clustering	<ul style="list-style-type: none"> Opportunities should be clustered into "concepts". This provides a more useful approach for understanding and appreciating the dependencies between the individual opportunities and the overall sustainable development benefits. For example, the development of local enterprises can be linked with potential by-product re-use opportunities to improve both resource utilisation and enhancement of the local economy and skills.

5. Essential Framework Features

As mentioned earlier in this paper, major mining companies have adopted Board endorsed sustainability principles and/or policies articulating their commitment to sustainable development. To show real support to the ideals of sustainability, developers of new resource projects need to adopt approaches within their project management systems that generate initiatives to enhance the contribution that the resulting operation will make to sustainable development. This goes beyond being compliant with minimum requirements or just satisfying each principle once the project is complete. The sustainability principles or policies should be the basis for driving innovation and delivering solutions that make a substantial contribution to the aspirations of sustainable development.

For a project developer it is important to understand the commitment for applying a sustainability framework and the resulting benefits, over and above, the standard project management systems. As a point of comparison, although the HAZOP process can be time-consuming, it is widely incorporated into the current project management systems because it is considered best-practice for managing industrial workplace safety. To emulate the safety benefits that HAZOP delivers, an analogous SD mechanism needs to:

- Be a holistic approach employing a cross-disciplinary team to assess a project with respect to the wider ecological and social context in which it will operate and to allow project decision makers to identify and review innovative and integrated solutions that incorporate environmental and social contexts.
- Not compromise defined financial objectives (e.g. net present value, rates of return on investment, etc.) but to help reduce inherent or hidden business risks and thereby secure financial outcomes.
- Have an ability to secure a more robust licence to operate by identifying early on in the project life (e.g. conceptual phase), social, human and environmental considerations or key issues which can then be "engineered out" or "engineered in" during the project development rather than "managed" once the project is complete.

- Be able to elicit critical sustainability issues that could be technically feasible and financially attractive and therefore likely to progress in normal project management process, but might, for example, generate significant stakeholder concern or even outrage and affect the operation's social licence to operate.
- Contain mechanisms to consider and investigate alternative, price competitive resources that could improve an operation's viability (such as renewable energy, industry waste heat, re-processed industrial effluents, and organic and inorganic by-products) which are likely to require upfront decision making.

6. Conclusions

Through the Cooperative Research Centre for Sustainable Resource Processing (CSRP), a collaborative research effort between industry and research organisations identified the key characteristics of a framework for incorporating the ideals of sustainability into project management systems. These characteristics have been incorporated into the development of SUSOP®, a guiding framework for projects that enables a proper contribution to sustainability by the industrial facilities being studied, designed, built or operated. It can be applied to any stage of the project cycle - from corporate planning, through design and operation, to decommissioning and rehabilitation stages – and its development has been enhanced through the application to real case studies at the concept and pre feasibility project stages. Implementation of SUSOP® aims to give greater certainty in developing resource projects that can significantly enhance the contribution that industry can make to society and sustainable development. The efficacy of the approach has been demonstrated through application to case study projects.

7. Acknowledgements

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