

FRAMEWORK

Project 2.2: Hybrid Complex Adaptive System Framework for exploring mine closure planning issues

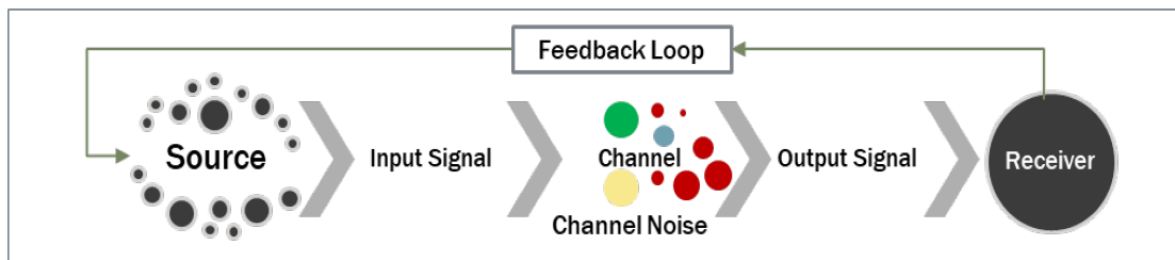
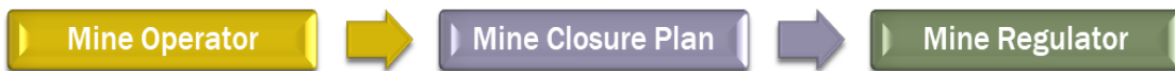


Extracted from: Dzakpata, I., Qureshi, M., Kizil, M. and Maybee, B. (2021). [Exploring the Issues in Mine Closure Planning](#). CRC TiME Limited, Perth, Australia.

These are extracts only. Each should be read in context of the full final report. Please refer to the full report for more information.

Complex Adaptive System (CAS) approach to Mine Closure Planning (MCP)

CAS Framework 1 – Supply Chain System (SIPOC)



CAS Framework 2 – Communication System

MCP issue categorisations using proposed Hybrid CAS Framework

(a) Source – Input Issues	(b) Channel – Noise Issues	(c) Receiver – Feedback Issues
<p>(1) Source</p> <ol style="list-style-type: none"> 1) MCP risk Sign-off: Apparent tension in precautionary approach to MCP acceptance once the mine operator has submitted their "best intent" – may take up to 1-yr for feedback and may not receive sign-off. 2) Skill & Know-how gap: Mine operator lack the skillsets and knowledge to assess different land use strategies without engaging content experts. 3) Huge knowledge gaps: for assessing (effectively and efficiently analyse) novel alternative land use – although awareness exists across industry 4) lack of a consistent, clear, and ambiguous set of legal requirements, over-prescriptive nature of laws, and the lack of flexibility in regulatory specifics despite evolving mine. 	<p>(3) Process</p> <ol style="list-style-type: none"> 1) Lack of integration - different focus of the lead agencies results in and extended process with sometime unrelated and complicated paperwork. 2) Inflexible Prescription: MCP development and approval process seems over-prescriptive and lack flexibility relative to regulatory integration and closure expectations of key stakeholders. (Bond et al., 2015; Pope et al., 2018) 3) MCP risk Sign-off: Apparent tension in precautionary approach to MCP acceptance once the mine operator has submitted their "best intent" – may take up to 1-yr for feedback and may not receive sign-off. 	<p>(5) Customer</p> <ol style="list-style-type: none"> 1) Rather than "regulate and control," the regulator appears to have a responsibility to monitor (guide the operator) the process to "make it happen." 2) Dual-Focus on both promotion of mining as well as enforcing environmental regulation under the Mining Act "fox managing the hen house". 3) Apparent gap in the legislative and regulatory knowledge base that inhibits regulators from drawing on lessons learned and historic event triggers to determine which land use strategy options are viable 4) Due to glove-changing ownership of Mines and financial manoeuvres mines may change hands many times – along with quality and focus of experts and skill base.
<p>(2) Inputs</p> <ol style="list-style-type: none"> 1) Currently no real understanding within the industry for how to assess what land use strategy options make sense for mines. 2) legislative implications of closure related decisions are poorly understood. 3) Far easier to carry on with status quo, irrespective of the missed opportunity – due to unenforceable consequences. 4) Regulators are unable or unwilling to engage closure experts to audit closure plans and ensure accuracy of data. 5) Focused on LOM view of mine closure planning but can only get approval for MCP for existing lease approval. 6) Under-estimation of mine closure Cost (MCC) relative to long temporal scales that closure planning must accommodate 	<p>(4) Outputs</p> <ol style="list-style-type: none"> 1) Closure plans shared between industry and regulator are to meet the regulatory commitments - plans as required by the regulator. 2) Closure plans shared between industry and regulator are to obtain SLTO and media approval. 3) Diverse regulatory focuses of the main agencies result in lengthy processes with sometimes unconnected and complicated documentation. 4) Notion that mine closure is an end of life-of-mine (EOL) activity: failing to have clear closure objectives and approaches to identified outcomes procrastination mine closure 	<p>(6) Feedback</p> <ol style="list-style-type: none"> 1) Lack of regulator-side integration : Focused on remediation actions, often in an ad hoc manner – responding to emerging social/LTO issues. Conversely, Advisory agencies (e.g., EPA): Focused on strategic & conceptual environmental protection response. 2) Lack of sufficient incentives for mines to consider alternate land use, nor disincentives for not meeting closure expectations. 3) Currently There is no integrated solution available for both regulators and mine owners to collaboratively manage and effectively control key input and the process of developing their mine closure planning (MCP)

Summary

Due to the complexity of challenges and scenarios frequently associated with the end of mine life, supply chain linkages, and the engagement of various stakeholders across a constantly expanding mine life, the ultimate work of mine closure is considered as "complex" and "unwieldy." (Vivoda, Kemp & Owen, 2019; Watson & Olalde, 2019).

The use of a Complex Adaptive System (CAS) approach to MCP is a vital piece of study work in order to establish where the major challenges are from a holistic standpoint. A robust hybrid CAS systems approach is thus proposed and used to investigate the issues that need to be addressed in the closure planning (as outlined above).

The rationale for employing the hybrid approach is that each complex system view (standalone) of MCP does not adequately address the fundamental challenges of mine closure from the perspectives of value & liability, accountability & responsibility, and uncertainty & time lapse.

On the previous page, a supply chain CAS framework is depicted in the upper half of the diagram, using elements of SIPOC (Source, Inputs, Process, Outputs, and Customers), a widely used 6-SIGMA business improvement tool (Gueorguiev, 2018; Mishra & Kumar Sharma, 2014). The second CAS framework, depicted in the lower part of the diagram, is used to look at MCP concerns through the lens of a communication system among key stakeholders, with a focus on how the interaction surrounding mine closure planning works.

These two frameworks are utilised to breakdown the MCP process into its sub-components while maintaining the complexity of interconnections between them. The source and communication channel components may contain sub-elements that are not visible at first look but have an impact on the system and may result in a different output signal.

REFERENCES

Dzakpata, I., Qureshi, M., Kizil, M. and Maybee, B. (2021). [Exploring the Issues in Mine Closure Planning](#). CRC TiME Limited, Perth, Australia.

ABOUT US

The Cooperative Research Centre for Transformations in Mining Economies is part of Australia's national innovation ecosystem. Our diverse partnership brings scale, collaboration and coordinated investment to tackle the most complex mine closure and post-mine transition challenges. Together we're rethinking what's possible to improve outcomes for people, communities, the environment and industry.

We acknowledge the traditional custodians across all the lands on which we live and work, and we pay our respects to Elders both past and present.



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