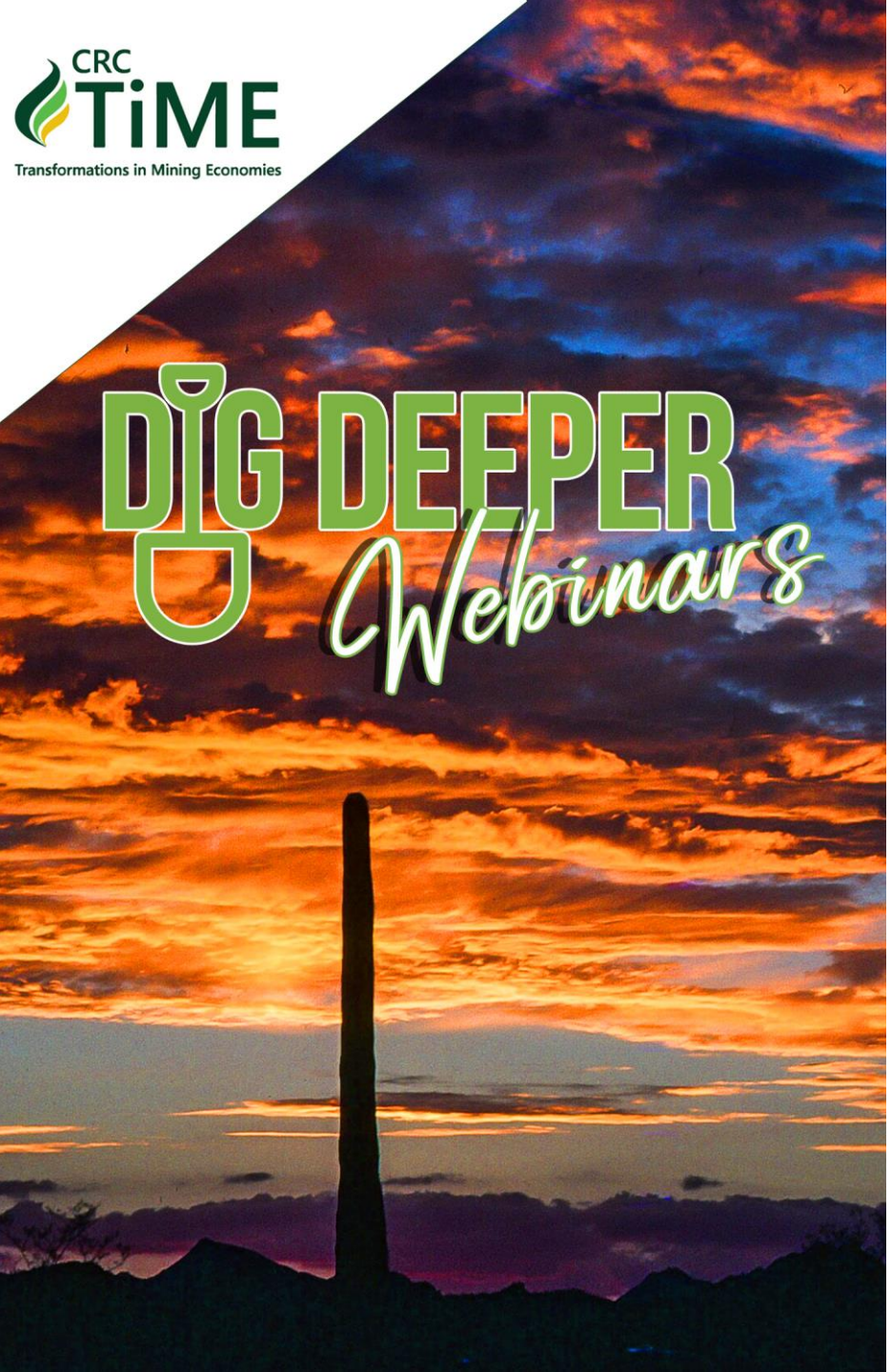

EXPLORING MINE CLOSURE PLANNING ISSUES [F2.2]

CRC TIME DIG DEEPER | DR ISAAC DZAKPATA | 03 JUN. 22

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Meet The Team

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Outline:

- Problem
- Methodology
- Key Findings
- Impact & Implication
- Q & A

Summary

1. Determine what the most important mine closure planning (MCP) challenges are, with a **focus on the interactions between mine operators and mine regulators**
2. The project involved a **comprehensive review of literature, practice and consultation (interviews) of industry MCP experts** from partner companies and regulatory agencies
3. We used a **hybrid complex adaptive system (HCAS)** views to identify the fundamental issues at the heart of the closure planning process (plan vs actual realisation).
4. Developed a new **Integrated Mine Transition Framework (IMTF)** for MCP was developed based on CAS - 3-stage approach for addressing MCP challenges
5. **This work identified 25 key issues which were grouped into the six key elements of the HCAS framework**

The Problem:

"Disconnect between mine closure planning and outcomes"

While Mine Closure Planning (MCP) is compulsory for securing a licence to operate any mine, be it surface or underground, **the real task of planning for post-mining alternatives with accurate cost estimates is a challenging problem owing to the changing nature of** :

- *closure processes in mining operation*
- *deposit knowledge and uncertainties*
- *mine ownership and costs over life of mine*
- *regulatory requirements across states*
- *requirements from external stakeholders*
- *Evidence supporting MCP outcomes*

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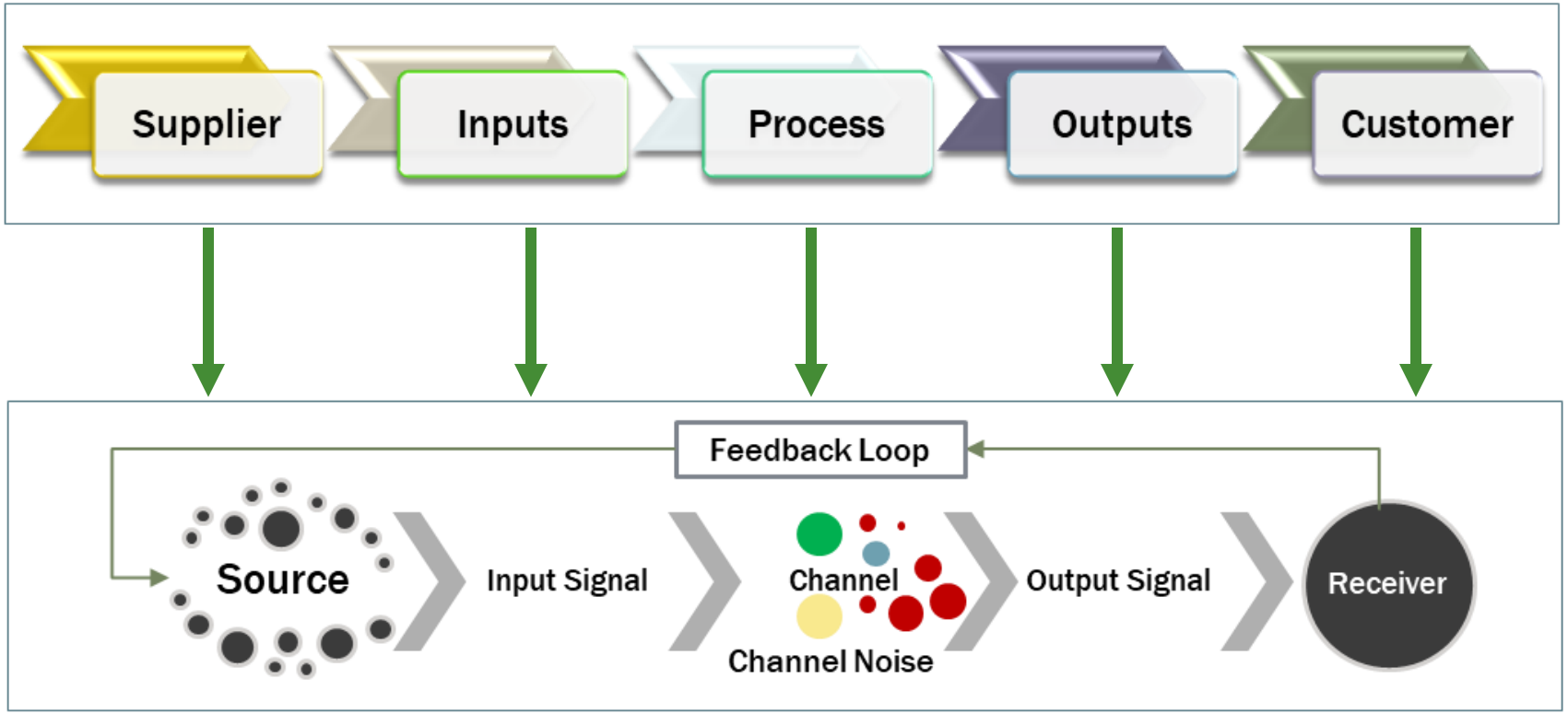
Methodology

Industry Practice & Literature Review

Industry Consultations & Surveys

Detailed Desktop Analysis

CAS Framework 1 – Supply Chain System (SIPOC)



CAS Framework 2 – Communication System

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, and Owen, 2019; Watson and Olalde, 2019

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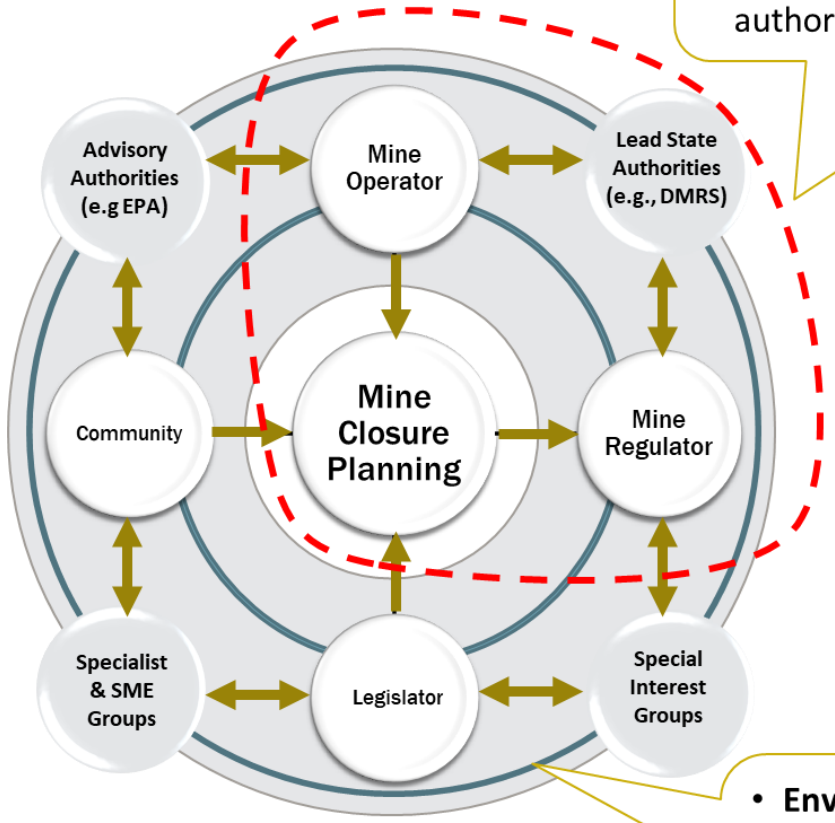
Stakeholders

- Six colleges of stakeholders are clearly defined in literature and practice, however the interactions. The interaction between the highlighted sub-group is often the decider
- highlighting a knowledge gap in the regulator's ability to effectively assess, analyse and sign-off on novel alternative land-uses.
- the participation is insufficient, as closure planning occurs at the conclusion of the mining life cycle, rather than planning for closure at an earlier stage.

Disconnect #1

Internal Stakeholders

- **Internal**: MCP as a Hybrid Complex systems involves a direct engagement between the mine operator, mine regulator and state authorities



As long as a **majority of key stakeholder are accepting of the venture**, the views of stakeholders who are opposed to the mine operation (typically in the minority) are simply disregarded or may not count.

- **Environment**: MCP as a completed system output involved the indirect engagement relate with the community, legislators, expert opinion, advisory agencies and special interest groups

External Stakeholders

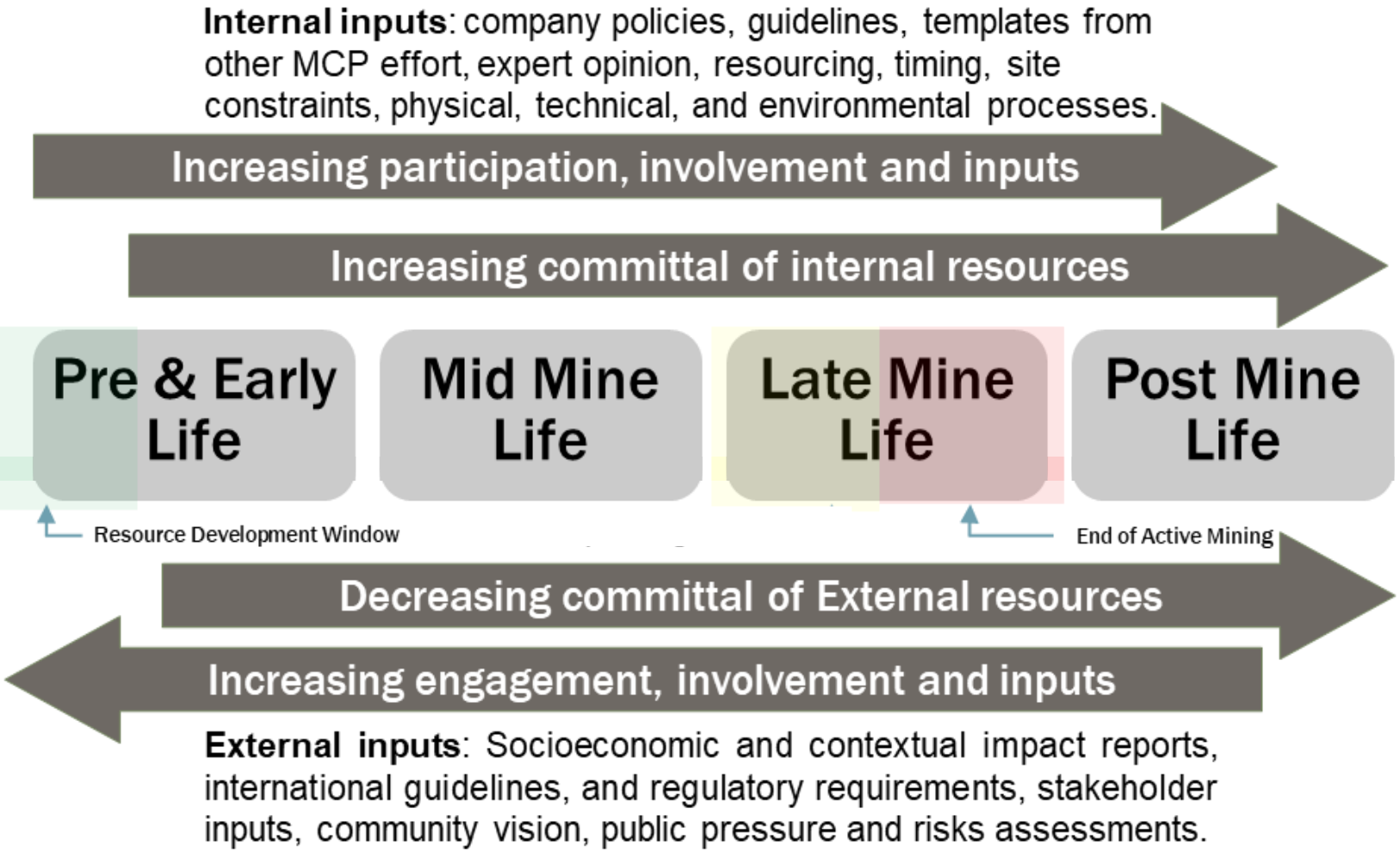
Level of knowledge around mining

- socio-demographic variables
- prior mining experience
- sources of mining information

Key MCP Inputs

- insufficient levels of internal and external resource interactions could have a major impact on the quality and inclusivity of inputs from key stakeholders affected by mine closure results.
- regulatory pressure varies from early life to post mine, with the latter receiving increased scrutiny towards closure.
- The pressure often, a new generation that is impacted quite differently owing to a different set of values, full impact of mining activities is more visible

Disconnect #2



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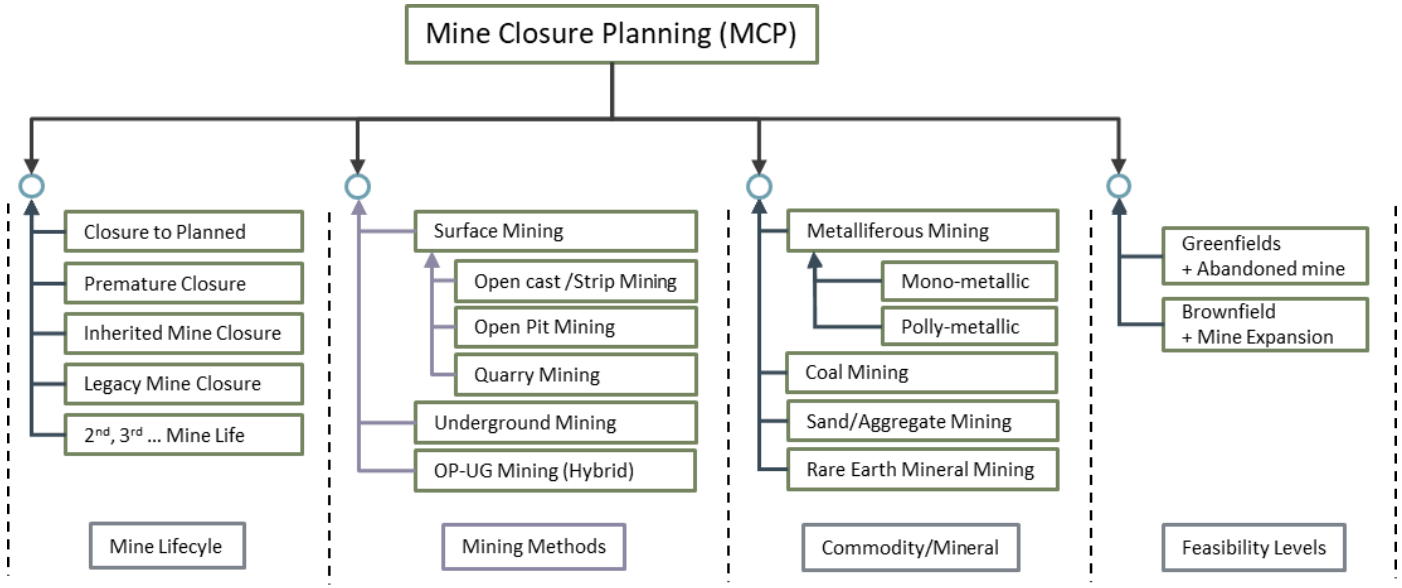
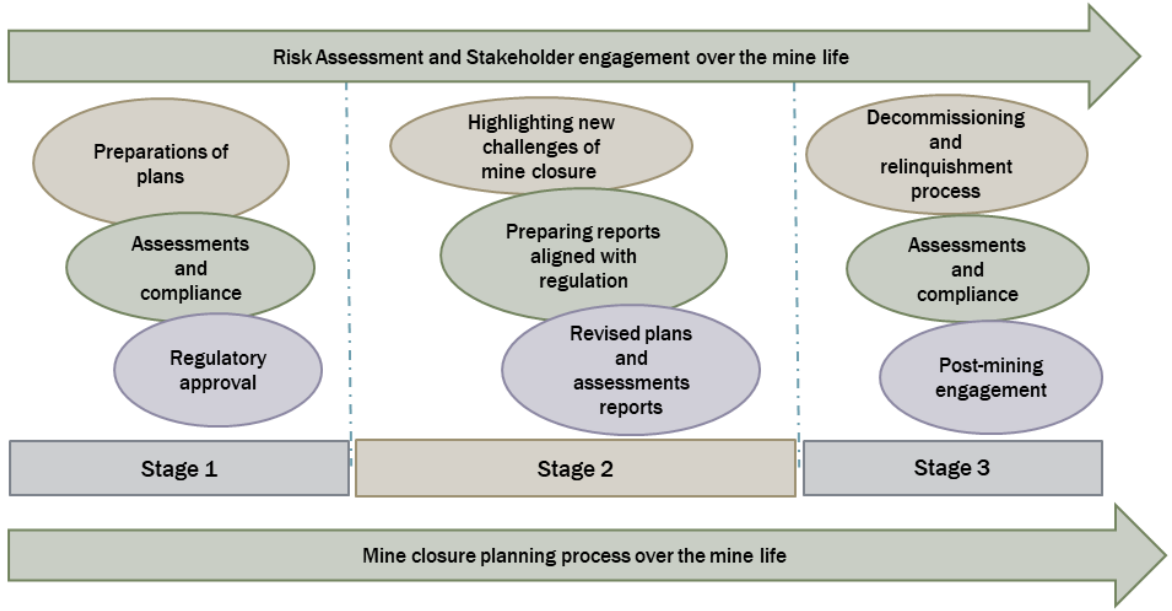
MCP Process

- … the notion suggesting a one-size-fits-all approach – there is little mention of different approaches for MCP and their associated constraints.
- a mine closure plan chosen in the initial stages may not apply to the type of exploitation that may prevail in the mine's later stages.
- **Similarly, the mine's socio-economic impact may change, requiring a change in the MCP.**
- **Disconnection #3**





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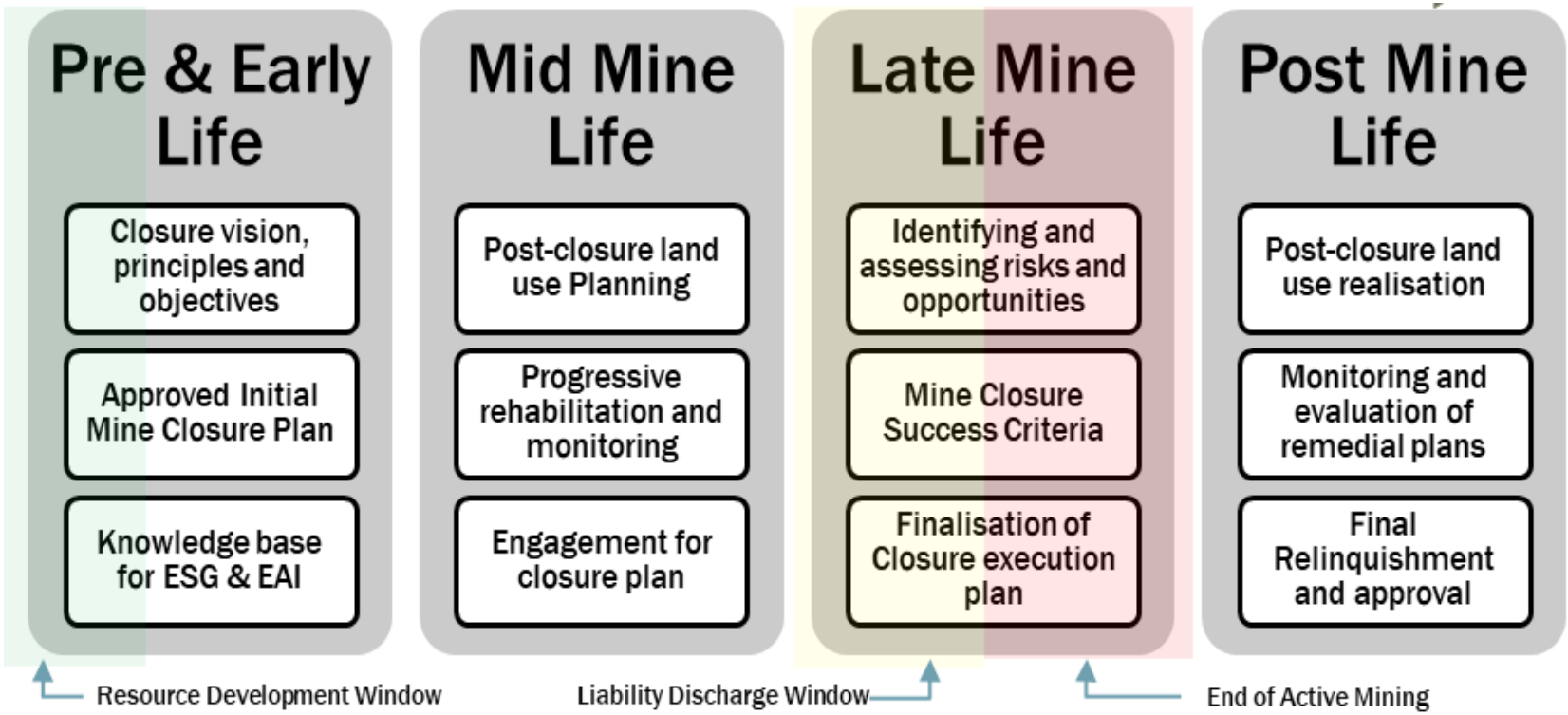
MCP Outputs

- MCP tend to carry the idea of a single document that is progressively reviewed, updated, and presented to a regulatory agency for sign-off or approval
- Variety of distinct outputs are generated for different customers or end-users throughout a mine's lifecycle.
- Some of these outputs demand for increased participation from some stakeholders over time.

Disconnect #4



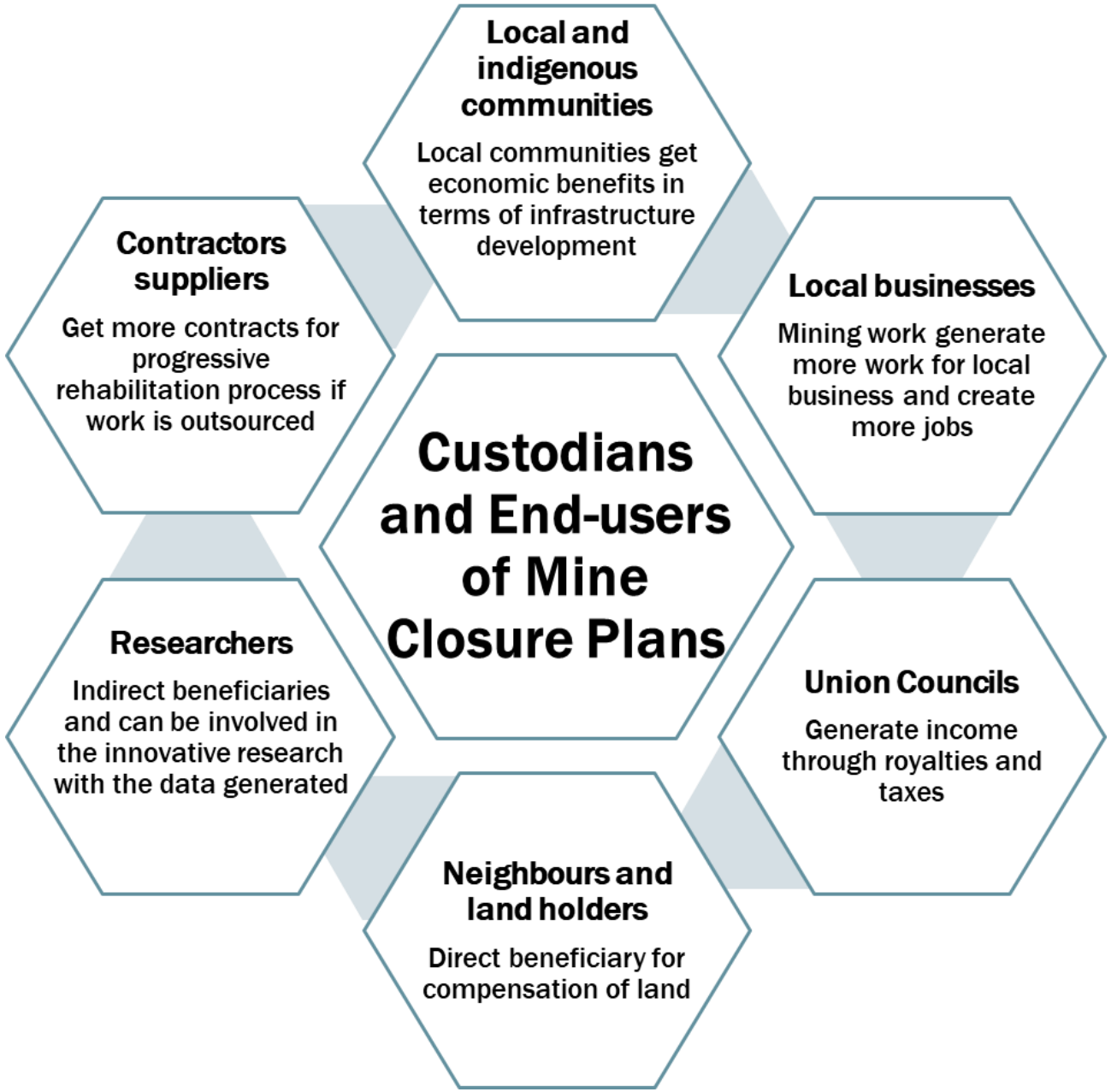
***Example**: over a 50-year mine life, expectations for MCP outputs may vary dramatically due to variations in generational interest, acceptability, and level of beneficiation from a mine as a result of changing societal demographic variables including age, education, knowledge, gender, and racial concerns. Ref: Svobodova et al., 2019.*

MCP Customers

- In the short term approvals, the participation of community organisations and their engagements in MCP are often quantified in terms of attendees at events and number of social media posts.

- In the long run, it is the end-users' perspectives on their involvement in the MCP process throughout the mining life cycle that matters.

Disconnect #5



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Summary of Key Findings

Mine Regulator

- There exists **knowledge gaps among regulatory bodies who are finding it difficult to manage**, monitor, and update the mine closure processes for an extensive number of mines and generate reports for their controls.

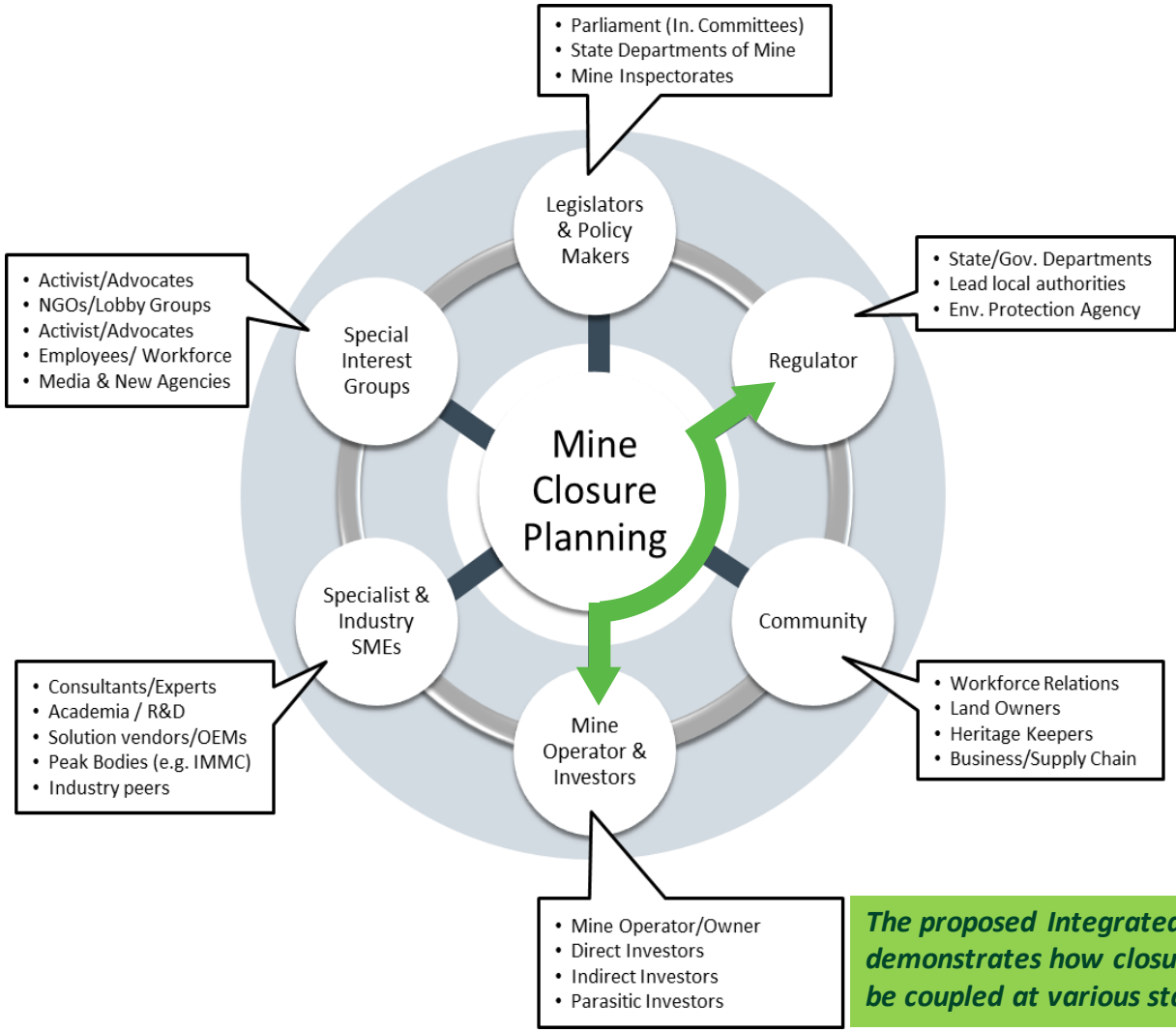
Mine Operator

- There are **disconnects present in the regulation, relinquishment, and re-purposing of mine closure** along with the key uncertainties in the mine closure risk assessment which inhibits the process of positive transition after mine closure.

Joint Action

- Investigate the development of a dynamic and intelligent knowledge-based system that serves as a decision support address all MCP issues. One that promotes benchmarking of current knowledge, tools and processes, as well as the sharing of data and knowledge

Implication for six colleges of stakeholders



The proposed Integrated Mine Transition Framework (IMTF) for MCP advances a risk management approach with full participation from internal and external stakeholders, and it ensures that closure planning is integrated into strategic mine planning.

The proposed Integrated Mine Transition Framework (IMTF) for MCP demonstrates how closure planning and strategic decision-making can be coupled at various stages of mining throughout the mine's life cycle.

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Implications

- What it means for mine closure/transitions going forward?

The report's major findings clearly show that keeping a good record of each update throughout the mining life cycle, as well as tracking changes in regulatory requirements, is a challenge

- How these foundation findings highlight the need for the new initiatives to be supported by partners

These findings highlight the need for both regulatory authorities and mine operators can prepare mine closure plans that meet the mining regulator's clearance requirements without relying heavily on external experts and consultants.

Currently, neither regulators nor mine owners have an integrated solution to manage and effectively regulate crucial input and the process of generating mine closure plans.

- How these findings highlight the need for further research.

These findings highlight the need for future MCP research to prioritise the development of an integrated knowledge-based approach for effective control and collaborative management of MCP.

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Key Findings

Regulator-side Issues

- Mine Operator's perspectives points predominantly to issues related to Inadequate data and an over-reliance on estimations, uncertainty and under-estimation of mine closure costs (MCC) – suggesting a lack of understanding of the major cost driver.
- The results of the mine regulators' responses demonstrate how the different regulators weigh and score the identified issues. E.g., regulatory agencies did not agree that integration was a major issue.
- The glove-changing ownership of mines, as well as a mindset that views MCP as an end-of-life activity, are also highlighted by regulators.

Industry consultations – perspectives of regulatory agencies

#	Key closure planning Issues/challenges	Regulator 1			Regulator 3		
		Relevance (1 – 5)	*Weighting (1 – 10)	**Score (1 – 10)	Relevance (1 – 5)	*Weighting (1 – 10)	**Score (1 – 10)
1	Insufficient data and over-reliance on estimates						
2	Uncertainty & Insufficient of material characterisation						
3	Under-estimation of mine closure Cost (MCC)						
4	Cost drivers						
5	*Integration# 1 - Process*						
6	*Integration# 2 – Resources*						
7	*Integration# 3– Technology*						
8	Revolving stakeholder doors						
9	Failure to engage stakeholders ongoing						
10	Glove-changing ownership of Mines						
11	Notion that mine closure is an EOL activity						

#	Key closure planning Issues/challenges	Regulator 2			Regulator 3		
		Relevance (1 – 5)	*Weighting (1 – 10)	**Score (1 – 10)	Relevance (1 – 5)	*Weighting (1 – 10)	**Score (1 – 10)
1	Insufficient data and over-reliance on estimates						
2	Uncertainty & Insufficient of material characterisation						
3	Under-estimation of mine closure Cost (MCC)						
4	Cost drivers						
5	*Integration# 1 - Process*						
6	*Integration# 2 – Resources*						
7	*Integration# 3– Technology*						
8	Revolving stakeholder doors						
9	Failure to engage stakeholders ongoing						
10	Glove-changing ownership of Mines						
11	Notion that mine closure is an EOL activity						

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Key Findings

Operator-side Issues

- Mine Operator's perspectives points predominantly to issues related to integration (process, resource and technology) as the revolving stakeholder doors.
- The results of the MCP managers' survey strongly support what the literature says about the need to better integrate mine closure planning procedures, resources, and technology to effectively manage the MCP outputs that are produced.
- Given the silo-based departmentalisation of mining activities, this is undoubtedly a significant challenge and requires a robust framework that

Industry consultations – perspectives of mine operators

#	Key closure planning Issues/challenges	Mine Operator - 1			Mine Operator - 3		
		Relevance (1 – 5)	*Weighting (1 – 10)	**Score (1 – 10)	Relevance (1 – 5)	*Weighting (1 – 10)	**Score (1 – 10)
1	Insufficient data and over-reliance on estimates						
2	Uncertainty & Insufficient of material characterisation						
3	Under-estimation of mine closure Cost (MCC)						
4	Cost drivers						
5	*Integration# 1 - Process*						
6	*Integration# 2 – Resources*						
7	*Integration# 3– Technology*						
8	Revolving stakeholder doors						
9	Failure to engage stakeholders ongoing						
10	Glove-changing ownership of Mines						
11	Notion that mine closure is an EOL activity						

#	Key closure planning Issues/challenges	Mine Operator - 2			Mine Operator - 4		
		Relevance (1 – 5)	*Weighting (1 – 10)	**Score (1 – 10)	Relevance (1 – 5)	*Weighting (1 – 10)	**Score (1 – 10)
1	Insufficient data and over-reliance on estimates						
2	Uncertainty & Insufficient of material characterisation						
3	Under-estimation of mine closure Cost (MCC)						
4	Cost drivers						
5	*Integration# 1 - Process*						
6	*Integration# 2 – Resources*						
7	*Integration# 3– Technology*						
8	Revolving stakeholder doors						
9	Failure to engage stakeholders ongoing						
10	Glove-changing ownership of Mines						
11	Notion that mine closure is an EOL activity						

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25 major MPC challenges to be addresses by industry

(a) Source –Input Issues	(b) Channel – Noise Issues	(c) Receiver – Feedback Issues
(1) Source 1) MCP risk Sign-off: Apparent tension in precausionary approach to MCP accptance once the mine operator has submitted their "best intent" – may take up to 1-yrs for feedabck 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.	**(3) Process** 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 precausionary approach to MCP accptance once the mine operator has submitted their "best intent" – may take up to 1-yrs for feedabck and may not receive sign-off.	**(5) Customer** 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.
(2) Inputs 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	**(4) Outputs** 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	**(6) Feedback** 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)

- A total of 25 major difficulties were identified in relation to the five aspects of the SIPOC tool, as well as the sixth element, which deals with the feedback loop between regulatory authorities and the mine operator.
- The MCP Issue categorisations utilising the Hybrid Complex Adaptive Systems Framework - overlaps in where these issues fit within the HCAS framework's six elements, while also issues that may not have been covered.
- The sixth part, feedback loop discussion, is largely neglected whenever the subject of MCP is introduced and suggested by as the necessity for an integrated feedback mechanism between the mine operator and the mine regulator

Revolving door of mine ownership as “assets”

Table 2: Examples of discharge of mine closure liability (Vivoda, Kemp and Owen, 2019).

Company	Liability Discharge action
Sumitomo Corporation	Sold its 50% stake in Isaac Plains coal mine Qld’s Bowen Basin to Stanwell Coal for A$1
Anglo American	December 2015: Sold its Dartbrook coal mine in Qld, which had been in care and maintenance since 2007, for $25 million to Australian Pacific Coal, a small company with an ASX market value of A$13 million. The company became bankrupt, and closure liabilities transferred to the state.
	February 2016: Anglo American sold its Drayton and Drayton South mines in NSW - avoiding A$275 million in rehabilitation and closure costs

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