# Unpacking organisational culture for innovation in Australian mining industry

**Abstract**

Innovation has become the backbone of organisations in today's increasingly changing environment. Research shows that many organisations fail to innovate due to a lack of a supportive culture. Particularly in the mining industry, with a dominant risk-averse mindset along with other barriers, such as capital intensiveness, frequent market fluctuations, and siloed and bureaucratic structures, developing an innovation culture is necessary for the future survival of the industry. However, the existing literature is still inconclusive regarding which cultural values promote innovation and is especially lacking in context-specific studies. Understanding of behaviours that should be promoted to support an innovation culture is still limited. Using a systematic literature review and 18 interviews with experts in the mining industry, this study unpacks the dimensions and behaviours that support innovation values in the context of the Australian mining industry. Findings from this study reveal 33 underlying cultural dimensions and specific organisational behaviours promoting an innovation culture. This study shed further light on how mining companies can support and promote an innovation culture.

## 1. Introduction

Innovation is one of the key drivers of firm growth and resilience (Cefis and Marsili, 2006; Tellis et al., 2009; Gumusluoglu and Ilsev, 2009). Scholars are increasingly supporting a positive link between innovation and a range of desired performance outcomes (e.g., Garcia-Morales et al., 2011), and recognising the capability of innovation as an important

competitive advantage (Teece, 2007). Despite the importance of innovation, the paths to innovation have been shown to be challenging to manage, which has led several innovation efforts to fail (MacVaugh and Schiavone, 2010).

Innovation is particularly critical in the mining industry, which has begun to show signs of reaching an inflection point. These signals include an increase in the importance of social licencing for mining operations, the urgency of clean sources of energy supply, the finite nature of minerals and metals in the bedrock, and difficulties with lower-grade new deposits (which are typically difficult to access and often in geographically remote regions) (Kurkkio et al., 2014). Although many mining companies have started new projects and initiatives in response to these signals, these innovation activities have not led to desirable outcomes or transformational changes. This is partly due to a lack of supporting structures and norms that promote innovation (Leroux and Pupion, 2018; Gruenhagen and Parker, 2020). Success or failure of an innovation can be attributed to the organisation's managerial and social aspects (E. M. Rogers, 2003). This highlights the role of organisational culture as a critical factor that can facilitate innovation efforts and outcomes. However, in traditional industries, such as mining, cultural barriers to innovation like risk-aversion, rigid structures and top-down decision-making have been found to slow down the creation and implementation of novel solutions (Bartos, 2007).

Organisational culture includes the values and beliefs that provide norms of expected behaviours that employees might follow. Schein (1992) describes organisational culture as a social force that is largely invisible yet very powerful. Empirical evidence suggests that organisational culture significantly influences an organisation's position in the market, its financial performance (Homburg and Pflesser, 2000) and employees' attitudes, greatly contributing to organisational effectiveness (Gregory et al., 2009). Some even argue that organisational culture is more powerful than the organisation's strategy and structure (Zheng

et al., 2010). An organisation's culture strongly influences employees' behaviours beyond formal control systems, procedures, and authority (O'Reilly et al., 1991). As such, organisational culture is a powerful means to elicit desired organisational outcomes. Hence, developing knowledge about the organisational culture which supports innovation in the context of mining is important for both theory and practice, as it provides a critical condition for long-term organisational success (Khazanchi et al., 2007; Tellis et al., 2009). However, within the vast literature on innovation, research about characteristics of an organisational culture that supports innovation has been subject to some limitations. Importantly, prior research does not adequately document the observable behaviours through which organisational values (i.e., the foundational building blocks of culture) can be promoted and translated into desired outcomes (Hogan and Coote, 2014). To address this gap, this study aims to further unpack the innovation culture and shed light on specific supporting values and behaviours. The following research questions have guided this research:

What are the cultural values supportive of innovation in the context of Australian mining industry? How are these values enacted?

To elaborate on innovation culture and investigate the abovementioned research questions, this study investigates cultural values promoting innovation in the Australian mining sector. Australia is one of the biggest players in the mining sector, in the Asia Pacific region and beyond. Australia was the main iron ore exporter in 2018, followed by Brazil, South Africa and Canada (IBISWorld, 2018). In the early 2000s, North America and Australasia accounted for a full 25% of the worldwide flows of mining investment (Bridge, 2004). A recent systematic literature view on the barriers to innovation adoption in the Australian mining sector found that cultural factors like a risk-averse mindset, cognitive impediments, a short-term mindset, resistance to change, short-term relationships and

reactive approaches impede innovation in Australian mining firms (Gruenhagen and Parker, 2020). Despite this recent research, there is limited empirical evidence about cultural values promoting innovation in mining specific to this major geographical area (UNIDO, 2018). As such, our study explores organisational innovation culture in the context of the Australian mining sector to provide a means to manage specific elements of an organisational culture that is supportive of innovation. In doing so, our study addresses important and timely issues that are fundamental to organisational effectiveness. This study therefore establishes some very clear guidelines for managers seeking to build a culture of innovation to facilitate the innovation process.

## 2. Innovation in the mining sector

Changing market dynamics – including the urgency of clean sources of energy supply, environmental concerns, the finite nature of minerals and metals, and challenges of lower-grade deposits – makes the mining industry volatile, pressuring companies to question their status quo and re-think their approaches to value creation (Deloitte, 2019). In response to these challenges, recent transformative efforts include applications of innovative technologies, such as artificial intelligence, machine learning, the industrial internet of things, virtual reality, drones and autonomous driving (cf. Australian Mining, 2017; Dehran et al., 2018; Deloitte, 2019; W. P. Rogers et al., 2019). Application of these technologies has the capacity to both increase productivity and efficiency and to improve health and safety conditions in hazardous mining environments. In addition, these technological innovations provide mining firms with learning opportunities to develop the knowledge and capabilities they need to deal with emerging threats and opportunities (Marin et al., 2015). Such knowledge and capability development across the mining industry can boost a country's entire economy (Marin et al., 2015; Morris et al., 2012; Pérez et al., 2014; Ross, 2014). These

signals have led to rising awareness among decision-makers that innovations are essential for the future of the mining sector.

Despite the importance of innovation, there are only some pockets of highly innovative activities in the mining sector; mainly among the suppliers and small mining firms (Bladier, 2016; Deloitte, 2016). Large mining organisations have long been regarded as slow in innovation due to their dominant conservative culture (which is resistant to change), and the barriers to innovation such as high capital intensity (Bartos, 2007). However, analysis of the reasons behind the lack of desired innovation efforts among mining organisations has been subject to limitations. Empirical research on innovation in the mining industry has mainly focused on mining suppliers and the importance of technology-intensive supplier development (Torres-Fuchslocher, 2010), knowledge-intensive linkages in the innovation ecosystem (Morris et al., 2012), innovative capability building (Figueiredo and Piana, 2018), and innovation supportive policies and institutions (Frankel, 2012). There is, however, a lack of research on the cultural factors enhancing the innovativeness of firms. In addition, the existing studies have explored innovation mainly in the context of Latin America and Africa (Barnett and Bell, 2011; Kaplan, 2012; Morris et al., 2012; Bloch and Owusu, 2012; Urzúa, 2013). With the exception of a few studies (Martinez-Fernandez, 2005; Scott-Kemmis, 2013), there is a lack of insight into innovation in the Australian mining industry. In particular, the cultural factors increasing innovativeness in the context of Australian mining organisations have been subject to limited research.

## 3. Organisational culture

Organisations use innovation to increase their effectiveness, growth, sustainability and success (Rujirawanich et al., 2011). Innovation is "the multi-stage process whereby organisations transform ideas into new/improved products, services or processes, in order to

advance, compete and differentiate themselves successfully in their marketplace" (Baregheh et al., 2009, 1334). Some scholars consider innovation as a unidimensional construct, referring to a new product or service, a new production process, or a new structure or administrative system (Damanpour, 2014). Others place more emphasis on the innovation process, seen as a path to achieve innovative outcomes (Donbi, 2008; Stauffer, 2015). This process of innovation involves creating, adapting, implementing and realising the value from new ideas (Baregheh et al., 2009).

Innovation will not be realised unless the contextual determinants of it, like the vision and mission, customer focus, management processes, leadership, support mechanisms, employee constituency, and others are present (Martins and Terblanche, 2003). Among several enablers of innovation (Valencia et al., 2010), structural and cultural factors have received specific attention from researchers (Hogan and Coote, 2014; Damanpour, 2014). In an organisational environment, innovation is often expressed through specific behaviours, such as learning, knowledge sharing, and experimenting, which are ultimately linked to a tangible action or outcome. It is argued that innovative organisations embed an innovation orientation in their organisational culture to ensure that the intensity and consistency of innovative behaviours are enhanced across different locations, organisational units and employees in the organisation (Hult et al., 2004). Therefore, innovative organisations are expected to have an organisational culture that supports innovation.

Organisational culture can be defined as the values, beliefs and hidden assumptions that organisational members have in common (Cameron and Quinn, 1999; Miron et al., 2004). Schein's (1992) model of organisational culture conceptualises organisational culture as a three-layered phenomenon – referred to as the iceberg model. On the bottom level are the basic organisational assumptions (i.e., beliefs that are taken for granted and never challenged), on the middle level are the organisational values that represent the way things

are done in the organisation and, finally, on the top are the artefacts – the most visible aspect of the culture – such as office design, physical space, the way people greet each other and jargon used in the workplace. Organisational culture is typically examined on the value level, with values being more visible than underlying assumptions and more deeply embedded in the organisational routines than artefacts. These values are enacted through specific behaviours at the individual and organisational levels, supporting innovation culture, such as risk-taking, experimenting and creativity (Hogan and Coote, 2014). The path to innovation is, therefore, facilitated by developing values and promoting behaviours supportive of innovation.

## 4. Innovation culture

Innovation culture is defined as a set of organisational cultural values, norms, and behaviours that support innovation (Stock et al., 2013). Organisations with an innovation culture are expected to learn continuously and to develop knowledge with the intention to detect and fill gaps between what the market desires and what the firm currently offers (Brentani and Kleinschmidt, 2004). Innovation culture is associated with cultural values that emphasise learning development, participative decision-making (Homburg and Pflesser, 2000) and collaborative problem-solving (Taggar and Ellis, 2007), openness and flexibility (Khazanchi et al., 2007), internal communication (Sonnentag and Volmer, 2009), competence (Subramaniam and Youndt, 2005), cooperation (Song and Swink, 2009), responsibility (Binnewies et al., 2007), appreciation (Howell and Boies, 2004) and risk-taking (Tellis et al., 2009). Research has found that an organisational culture that encourages creativity and risk-taking behaviour and promotes information sharing and collaboration assists with greater innovation outcomes (Caldwell and O'Reilly, 2003; Dobni, 2008). Organisations that support innovation tend to encourage employees to propose new and creative solutions to problems

and are more likely to implement these creative solutions (Caldwell and O'Reilly, 2003; Dewett, 2004).

Organisations with an innovation culture are outward-looking and open to new ideas which require a different orientation compared to organisations that are inward-looking, focusing on stability and efficiency. Cameron and Quinn (1999) developed a competing values framework of four culture types: adhocracy, clan, market and hierarchy. The framework categorises the culture types based on the extent to which they offer flexibility versus control and external focus versus internal focus. Based on this framework, among the four culture types, adhocracy culture (which offers flexibility and an external orientation) is argued in the literature to be supportive of innovation (Hartnell et al., 2011; Naranjo-Valencia et al., 2011). The organisational values supporting adhocracy culture are creativity, entrepreneurship and risk-taking. Cultural values that promote innovation are enforced by the organisation's structures, policies and day-to-day artefacts, practices and procedures (O'Reilly and Tushman, 2008).

Although an innovation culture is primarily perceived at the level of abstract values and beliefs, it is built, promoted, reinforced and communicated through behaviours, practices and artefacts (Homburg and Pflesser, 2000; Schein, 1992). Organisations with innovation-supporting values are expected to engage in behaviours which support creativity, risk-taking, freedom, teamwork, open communication, and are value-seeking and solutions-oriented, instilling trust, respect and quick decision-making (Taggar and Ellis, 2007 Kenny and Reedy, 2006; Martín-de Castro et al., 2013). One would expect these behaviours to be desirable and embedded in the corporate fabric (Lock and Kirkpatrick, 1995). Similarly, one would expect such a culture to reject practices and behaviours that hinder innovation, such as rigidity, control, predictability and stability (Jassawalla and Sashittal, 2003). However, existing research in innovation culture offers a limited understanding of the specific behaviours that

promote innovation values. Unpacking the innovation culture and uncovering behaviours that underpin innovation values is critical for promoting an innovation culture in organisations. Gaining a better understanding of innovation culture requires a finer-grained view of the culture and a clearer explanation of the specific dimensions and behaviours underpinning the culture of innovation. To address this gap and advance the existing conceptualisation of innovation culture, this research aims to shed light on the more concrete and observable layers of innovation culture. For this purpose, this research focused on unpacking the multilayer construct of innovation culture using information from the Australian mining industry context. Since organisational culture is recognised as a major barrier for innovation in the mining industry, we focused on this industry to elaborate on the cultural elements that can inhibit or promote innovation. Accordingly, the objectives of this study were to identify the cultural values supportive of innovation in Australian mining firms and investigate the specific and observable behaviours and dimensions which promote those innovation values in day-to-day organisational life.

## 5. Methodology

This research was conducted in the context of the Australian mining industry. To examine innovation culture, we adopted Schein's (1992) model of organisational culture as a multilayer concept which is composed of intangible values and norms, and tangible artefacts and behaviours. Based on the two-stage research design of this study, researchers in the first stage undertook an in-depth literature review which helped to extract specific organisational values related to an innovation culture. The search revealed 12 cultural values that support innovation in organisations, including empowerment, diversity, creativity, flexibility, learning, external orientation, trust, risk-taking, teamwork, reward and recognition, continuous development and proactivity. In the second stage, we investigated these

innovation values using 18 interviews with experts from the Australian mining industry. Interviews helped to determine which of these values are more important in the mining context and how these values are operationalised in the context of mining. The following sections outline the study context and provide more details about the methods used in this research.

*5.1 The study context*

The Australian mining industry provides an interesting context to study innovation culture because Australian firms deal with internal and external market uncertainty, which is very dynamic, and face global competitors in their business (Australian Bureau of Statistics 2012). In response, Australian firms need to be innovative to survive and ensure their resilience in the face of disruptive technologies emerging across different industries. A review of the existing literature revealed that only a small proportion of the articles focus specifically on the Australian context (Harzing, 2005, . Despite the contribution of a few studies (like Hogan and Coote, 2014), which have been undertaken in the context of professional services, our knowledge about organisational cultures that are supportive of innovation in the context of Australian firms is limited. A recent literature review by Gruenhagen and Parker (2020) in the mining industry revealed that the innovation research in this industry has a strong focus on Latin America, with Brazil and Chile being the most frequently studied and other geographical areas like Australia being underrepresented or neglected. This review also showed that innovation in the Australian mining industry is negatively impacted by cultural factors such as a risk-averse mindset, cognitive impediments, a short-term mindset, resistance to change, short-term relationships and reactive approaches. Focusing on the Australian mining industry, this study offers insights that further uncover this under-researched context.

*5.2 Stage 1 – Literature investigation to identify innovation values*

We comprehensively reviewed the literature on innovation and innovation culture to identify the most relevant shared values of an innovation-oriented organisational culture (see Table 1). The research team broadly searched innovation literature to develop a comprehensive list of cultural factors that support innovation. In our search, we used a range of keywords and different mixes of keywords like "innovation determinants", "innovation culture", "organisational innovation culture", "innovation and organisational culture", "innovation climate", "creativity climate", "antecedents of innovation", "innovation drivers", "innovation orientation", "innovation and performance", "innovativeness" and "factors supporting innovation". We continued the search until we reached saturation, such as new studies found did not add any new cultural factors to our list. Once the list of factors was finalised, we analysed the content (Kyngas, 2007; Erlingsson and Brysiewicz, 2017) to uncover the organisational values enforced by these cultural factors. We revealed the innovation values by identifying the shared themes at an abstract level, which could be attributed to a set of cultural factors, and moved from literal content to latent meanings (Miles and Huberman, 1994; Morse and Field, 1995).

**Table 1**

Organisational values supporting innovation

| Innovation values | Description | Effect on innovation | Some evidence from the literature |
|---|---|---|---|
| **Risk tolerance** | Believe that risk-taking, experimentation and tolerance of failure are the ways to improve performance. | Support employees in taking calculated risks within the boundary of their job and role.<br><br>Employees tend not to engage in activities that their companies consider risky. | Caldwell and O'Reilly, 2003; Dewett, 2004; Jalonen, 2012; Lane and Maxfield, 2005; Magnusson and Martini, 2008 |
| **Creativity** | Believe that generation of new ideas, ideation, and novel solutions are important. | Facilitates idea-generation and divergent thinking.<br><br>Increases employees' motivations to find novel solutions to organisational problems to improve innovation performance. | Khazanchi et al., 2007; Gumusluoglu and Ilsev, 2009; Naranjo-Valencia et al., 2011 |
| **Trust** | Valuing integrity, honesty, trustworthiness and fairness. | Promotes innovative behaviour as it decreases administrative costs and bureaucratic barriers.<br><br>Facilitates cooperation, supports teamwork and information sharing. | McAllister, 1995; Krause, Handfield, and Tyler, 2007 |
| **Empowerment** | Valuing employee empowerment and autonomy in their work. | Mobilises and energises employees to be creative.<br><br>Develops a sense of ownership and control over employees' own work and ideas, which then minimises their resistance to change. | Martins and Terblanche, 2003; Amabile, 1997; Binnewies et al., 2007; Caldwell and O'Reilly, 2003 |
| **Flexibility** | Valuing flexibility, informality and dynamism; resisting rigidity. | Supports exploration. | Tripsas and Gavetti, 2000; Matthyssens, Pauwels, and Vandenbempt, 2005; Zhou et al., 2010 |
| **Teamwork and collaboration** | Believe in the power of teamwork, collaboration | Decreases resistance to change, improves | Sethi and Nicholson, 2001; De Clercq, |

| Innovation values | Description | Effect on innovation | Some evidence from the literature |
|---|---|---|---|
| | and involvement in decision-making. | knowledge outputs and increases creativity. | Menguc, and Auh, 2009; Song and Swink, 2009 |
| **Employee recognition for innovation** | Valuing employees for their creativity and thinking and acting outside of the box. | Recognises the value of an employee's ideas, even if they cannot be put to use. | Brun and Dugas, 2008; Sethi and Nicholson, 2001; Mudambi et al., 2007 |
| | | Acknowledges and rewards employees' efforts and risk-taking irrespective of the results of their work. | |
| **Diversity** | Valuing diverse opinions and employees that come from diverse backgrounds. | Overcomes rigidity and organisational inertia. | Binnewies, Ohly, and Sonnentag, 2007; Garcia-Morales et al., 2014; Sonnentag and Volmer, 2009 |
| **External orientation** | Valuing connections, communication and knowledge sharing with external stakeholders. | Builds social capital, develops relations and trust with external stakeholders. | Chesbrough, 2003; Adner, 2006; Krause, Handfield, and Tyler, 2007 |
| **Learning** | Valuing searching for new knowledge and exchanging information. Supporting employees for their knowledge-sharing behaviours. | Increases experimentation, creativity and exploration of novel ideas. Increases idea-generation and opportunity recognition. | Subramaniam and Youndt, 2005; Sonnentag and Volmer, 2009; Sharaifirad and Ataei, 2012 |
| **Continuous development** | Believe that continuously searching for new opportunities and improvements is important. | Senses changes in their competitive environment, including potential shifts in technology, competition, customers, and regulation. | Lawson and Samson 2001; Teece, 2007; Zahra et al., 2006 |
| | | Offers a better means by which to deliver core benefits. | |

| Innovation values | Description | Effect on innovation | Some evidence from the literature |
|---|---|---|---|
| **Proactivity** | Believe that acting in anticipation of future problems, needs or changes is important. | Brings a forward-looking view along with innovative activity that aims to bring products or services to the market ahead of the competition.<br><br>Investment in personnel facilitates organisational learning and innovation. | Rauch et al., 2009; Werthes et al., 2018; O'Cass and Ngo, 2007 |

As a result, a code sheet was developed based on the cultural determinants of innovation. The research team undertook rounds of the literature analysis and conducted several discussions to organise the codes and items based on emerging categories and themes (Coffey and Atkinson, 1996; Patton, 2002). The initial coding sheet for cultural values included 25 basic values, which in the series of refinements and regroupings decreased to 17 and finally 13 values. The processes for refining the categories and themes included regrouping and relabelling the codes and associated categories based on continuously comparing and contrasting values and enactments of those values (i.e., behaviours that promote innovation) with the relevant literature. In some cases, we merged categories or split them, and, in other cases, we removed some categories from the list of innovation values. For example, we merged participativeness and teamwork based on the similarities of the items they included. We also split flexibility into flexibility and continuous development because of the difference in their focus on incremental versus radical changes and removed playfulness and friendliness due to lack of strong support. To increase credibility and trustworthiness (Patton, 2002), the results from each round of analysis were discussed with the research team, consisting of diverse views of experts from the fields of innovation and culture. Through the discussion rounds we continued to adjust the labels and adapted our next round of search and analysis to reach satisfactory inter-judge reliability (more than 90%) and to make sure that we

had reached a consensus. During the process for refining categories and themes, we made sure that the values were differentiated from each other and also covered different aspects of the innovation process. We also made sure that the relationships between the themes and the included categories and codes were stronger and well supported to increase the internal validity (Cypress et al., 2017). As a result of this process, our final code sheet covered 12 basic values supporting innovation, captured in Table 1.

*5.3 Stage 2 – Empirical study of cultural dimensions and behaviours*

*5.3.1 Data collection process*

Semi-structured interviews were used to collect data about the innovation culture values identified in the literature review. The primary purpose of the interviews was to collect information about what innovation values are important for the context of the Australian mining industry and how these values can be promoted by more observable behaviours. Participants were presented with 12 innovation values, distilled from the literature along with a definition for each value, and were asked to select the values which are most critical to promoting innovation within Australian mining companies. To ensure consistency and avoid participants' subjective interpretation (Patton, 2002), the title and definitions of values were printed on 12 separate cards that were put in front of the participant. The participants were then asked to explain why the selected values are important for innovation and how those values can be promoted in Australian mining companies. In total, 18 interviews, each lasting approximately 1 hour, were conducted with experts from the Australian mining industry, who had between 10 and 30 years of experience. Our participants, listed in Table 2, represented highly knowledgeable informants with diverse backgrounds, including geologists, research and development (R&D) personnel, external technology developers, service providers and

managers from different levels. Insights from a range of experts helped to ensure a variety of perspectives were captured, with the intention of limiting information bias (Patton, 2002).

**Table 2**

Interview participants, their positions and years of experience

| Respondent ID | Current position | Years in the mining industry |
|---|---|---|
| A | Program Leader | 20 |
| B | General Manager – Implementation | 15 |
| C | Program Leader | 30 |
| D | Chief Executive and Managing Director | 29 |
| E | Senior Consultant | 10 |
| F | Principal Mine Geologist | 20 |
| G | Principal Mine Engineer | 31 |
| H | General Manager –Program leader | 32 |
| I | Data Analytics Specialist | 13 |
| J | Senior Metallurgist | 15 |
| K | Senior Project Evaluation Specialist | 10 |
| L | Senior Researcher in Recession Development | 10 |
| M | Senior Researcher in Mining Engineer | 14 |
| N | Managing Director | 40 |
| O | Senior Metallurgist | 16 |
| P | General Manager – Stakeholder Engagement | 25 |
| Q | General Manager – Research and Innovation | 22 |
| R | Managing Director | 32 |

*5.3.2 Data analysis process*

The content analysis (Elo and Kyngas, 2007; Erlingsson and Brysiewicz, 2017) was conducted to identify the categories ofbehavioural patterns related to each innovation culture value (Schein, 1992; Ekvall, 1996). The usefulness of the technique for studying organisational culture has been emphasised frequently (McLaughlin et al., 2008). We used this approach (Mayring, 2000; Vaismoradi et al., 2016) to extend the theoretical framework of key organisational culture values supporting the innovation process. Using existing theory and prior research, data analysis began by identifying key concepts or variables as initial

coding themes (Potter and Levine-Donnerstein, 1999). We started to read the transcripts and highlighted all texts that, on first impression, appeared to represent innovation values (e.g., risk tolerance, creativity, etc.). We used NVivo for data analysis. The relevant passages from the transcripts were coded into predetermined nodes (Bazeley, 2007). To increase the reliability, any text that could not be categorised with this initial coding scheme was coded in a new node (like cyclical market, structure, management approaches, innovation process, etc.) to minimise the human error and increase consistency.

In the next step, researchers followed Gioia et al.'s (2012) approach using two rounds of coding to develop the first-order and second-order codes in each of the predetermined nodes where the data related to each value were collected. While first-order descriptive categories capture respondents' views, the second-order abstract interpretations communicate the respondents' experience and views in the frame of theoretical concepts. The first-order and second-order codes that emerged in this study in relation to risk tolerance, creativity and trust are illustrated in Figure 1 as examples of the data structure used for analysis in this study. In the first round of coding, researchers used open coding, applying respondents' words in their contextual meanings. Based on constant comparison among a variety of extracts (Strauss and Corbin, 1990), first-order categories emerged. To increase the reliability and credibility, the first-order data coding started when a few interviews were undertaken and researchers reached a general understanding of the content and context of the innovation culture in Australian mining (Bradley et al., 2007). The process began with reading all data repeatedly to achieve immersion and obtain a sense of the whole (Tesch,2013. Then, data were read word by word to derive the codes (Miles and Huberman, 1994; Morse and Field, 1995); this involved first highlighting the exact words and listing meaningful and recurrent ideas (like challenges or strategies) from the text that appeared to capture key thoughts or

concepts. As researchers iteratively read and made notes using their own judgements, labels for codes emerged.

Building upon the first-order categories, the researchers used axial coding to form second-order interpretations at the abstract level of the hierarchical data structure. The second-order coding started with two of the researchers independently going through the iterative process of comparing and contrasting the first-order codes and their implicit meanings to find similarities and differences and to delineate themes (Morse, 2015. The comparisons revealed the causes and relationships among the first-order codes and subsequently suggested plausible themes for clusters of first-order categories (Glaser, 2005). This process was guided by the literature to nominate the themes which addressed the study's research questions (Patton, 2002; Frost, 2010). To increase trustworthiness and reliability, the coding process included iterations through several rounds of discussion between researchers responsible for coding and the rest of the research team. To conduct multiple verifications (Vaismoradi et al., 2016), independent coding of the two researchers was followed by their discussion and comparison of their coding. Then the results were further discussed by the team leader to clarify the logic and reasoning behind the codes. In some cases, researchers examined some potential themes in the remaining interviews and collected more data to confirm or change them (Corley and Gioia, 2004). The resulting categories were checked with the broader research team, and labels for categories were discussed and finalised. Figure 1represents the summary of the themes that emerged in this study, and also reflects the tree diagram (Bradley et al., 2007) or data structure (Corley and Gioia, 2004, 184) illustrating the organisation of first-order and second-order codes emerging from this study.
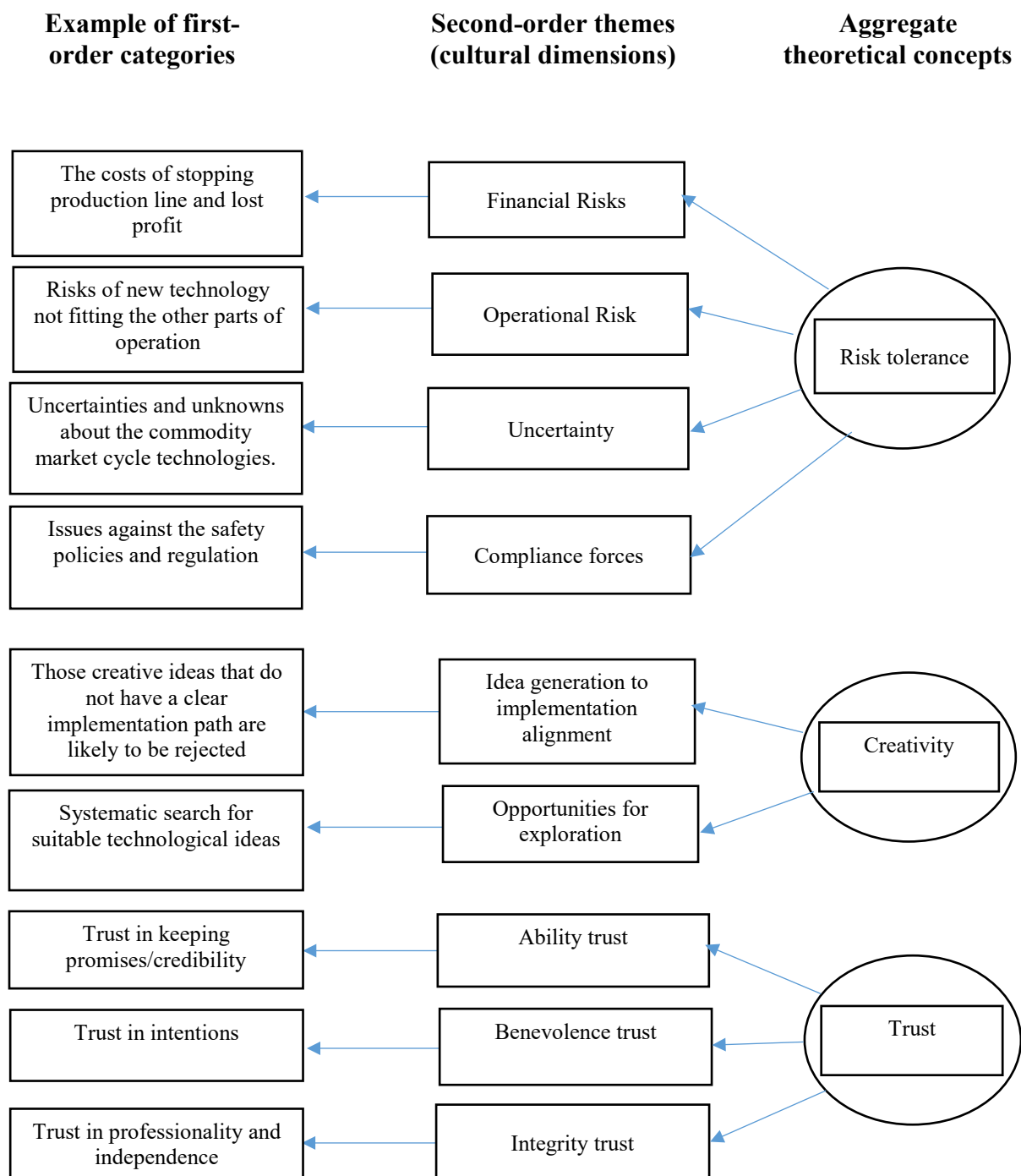
| Example of first-order categories | Second-order themes (cultural dimensions) | Aggregate theoretical concepts |
|---|---|---|



**Figure 1.** Data structure.

## 6. Findings

Findings from the empirical study confirmed and prioritised the most important cultural

values for innovation in the context of the Australian mining sector. In addition, the data

analysis revealed 33 underlying cultural dimensions and specific organisational behaviours promoting culture for innovation. A summary of these findings is captured in Table 3. The following sections present findings from the interviews structured around the 12 cultural values, from the most to the least important.

**Table 3**

Summary of findings

| Innovation values | Important for innovation | Cultural dimensions – second-order codes |
|---|---|---|
| **Risk tolerance** | **14** | Financial risks |
| | | Operational risk |
| | | Uncertainty |
| | | Compliance forces |
| **Creativity** | **11** | Idea generation to implementation alignment |
| | | Opportunities for exploration |
| **Trust** | **9** | Ability trust |
| | | Benevolence trust |
| | | Integrity trust |
| **Empowerment** | **9** | Empowering people |
| | | Empowering for step change |
| **Flexibility** | **9** | Openness to change |
| | | Structural flexibility |
| **Teamwork and collaboration** | **8** | Cross-disciplinary collaboration |
| | | Collaborative problem solving |
| **Employee recognition for innovation** | **8** | Recognition and reward for team innovation efforts |
| | | Recognitions and rewards for innovation performance |
| **Diversity** | **7** | Diversity readiness |
| | | Support for diversity |
| **External orientation** | **6** | Considerate relationships |
| | | Co-creation |
| | | Ability trust |
| | | Benevolence trust |
| | | Integrity trust |
| **Learning** | **6** | Absorptive capacity |
| | | Individual learning |
| | | Learning orientation |
| **Continuous development** | **6** | Sensing opportunities |
| | | Seizing opportunities |
| **Proactivity** | **6** | Future orientation |
| | | Support for proactivity |
| | | Disruptive opportunities |

*6.1 Risk tolerance*

Risk tolerance was the most often selected value impacting innovation in mining. A total of 78% (*n*=14) of the participants agreed that risk tolerance is critical for innovation and technology uptake in mining. In particular, the analysis uncovered four dimensions of the risk tolerance value: "financial risks", "operational risks", "uncertainty" and "compliance forces".

Firstly, data showed that innovation takes place where there is a willingness to take financial risks around cash flow or existing investments, as Participant L explained:

*...when you come along and say, "I have got this piece of technology, can you turn your plan off for an hour and I will bolt in, and we will see if it works?", well, straight away you are saying: okay, now you have lost millions of dollars.*

Secondly, there is also an operational risk related to changing or modifying operations in order to implement technological innovation: *"the problem with [the] mining industry is: it's kind of a single point of failure; [if] anything goes down the whole operation stops"*. Interviewees agreed that these risks should not stop innovative firms from adopting new technologies; however, often they do. Thirdly, encouraging, accepting and dealing with uncertainties and unknowns was also associated with the adoption of new technologies. Participant R described the situation: *"it is a business where you never really have knowns or absolutes. So, you are always trying to reduce the error and you end up trying to find what I call the best compromise" . ,* to cultivate the innovation environment, firms should be willing to bend existing structures and processes to support technological opportunities. A risk-averse mindset is well institutionalised in the mining sector (reflected in safety, structure, governance approaches, and risk management processes): *"there is incentive for innovation, but there is a bigger incentive not to hurt anybody; not to stuff up; not to break anything...I think people do*

*well in mining if they don't stuff up, you know, more than taking risks"* (Participant F). Innovative firms should promote working against that.


*6.2 Creativity*

Creativity was confirmed by 61% (*n*=11) of interviewees as an important value for innovation, particularly considering the Australian mining context where they: "*incentivise against creativity*". Two dimensions of the creativity value emerged from data to be critical: "idea generation to implementation alignment" and "opportunities for exploration". Firstly, innovative mining firms support innovation from development to implementation and support development of those ideas that are practical and can be implemented. Interviewees were concerned about ideas being developed blind to the genuine demands on sites and to the practicality of them: *"there's [a] huge amount of work in creativity ... but how do you work out from those which ones are really addressing some issues?"* (Participant C).

Secondly, opportunities for exploration is the extent to which the organisation provides time and resources for blue-sky thinking and searching for new ideas. Considering the cyclical nature of mining, respondents highlighted that it is important for the organisation to recognise when to invest in the exploration of new opportunities and when to invest in the exploitation of existing solutions. Participant M commented in this regard: *"in the boom time, mine sites [are] genuinely trying to find opportunities ... it's very much a 'cut and dry', I don't know why it would be the case"*. Another informant added that: *"... this should be switched [doing exploration in the bust time and exploitation in the boom time]"*.


*6.3 Trust*

As selected by 50% (*n*=9) of participants, trust was found to be a significant value for innovation and also a sensitive issue in the mining sector. "Ability trust", "integrity trust" and

"benevolence trust", which closely resemble Mayer et al.'s (1995) trust model, emerged from the data analysis as the relevant dimensions of this value. Firstly, trust in employees' skills and abilities was found to be critical to support innovation ideas:

> … *if you have got really strong people who are able to convey the message and have a good track record, they "look at your eyes and say this works"; but if you just came out of university and tried to make your way as an innovator in the mining industry, you would struggle, because people say: where is your credibility?* (Participant H)

Secondly, participants agreed that trust in the integrity of people is a sensitive issue in relation to the creation and implementation of ideas. Innovative firms need to be confident that employees and the organisation adhere to a set of sound principles and act based on fairness and justice for others because miners are going to rely on their advice:

> *we are trusted to be impartial ... and the people who brought me to that site trusted me to say what I thought of those two systems ... it was my professional opinion of what I thought about those systems ... you are either trusted, or you are not trusted; there is no between in that process.* (Participant B)

Thirdly, in innovation processes, people should be confident that other people have the best interests of their peers in mind, and are concerned about their success and welfare. The perception of the intention behind people affects how people respond to that: "*I think that's important to build that trust like, 'Wil from head office is coming; that's great; he is doing some interesting stuff' as opposed to 'oh, some guy is going to come and smack us because we haven't hit certain targets,'*" or what people perceive as, *"Okay, this guy want[s] to help me, so there is an authentic willing[ness] to help"* (Participant G).

*6.4 Empowerment*

Empowerment was supported by 50% (*n* = 9) of interviewees to be important for promoting innovation adoption in mining. Two dimensions: "empowering incremental changes" and "empowering step changes" emerged as the specific aspects of empowerment in Australian mining. A step change refers to a significant change in the mining operation due to the implementation of a new system, process or technology that results in extensive disruption. Data revealed that to instil innovation in their organisations, top managers need to empower their employees to express new ideas, take risks, propose changes, challenge existing practices and learn from mistakes. This becomes particularly apparent when we consider the risk-avoidance attitude which exists in mining companies: *"you don't want people coming up with new way[s] to do something and experimenting on the job. You want them to follow the standard"* (Participant A). Interviewees agreed that employees at all levels should be empowered through the *"freedom and autonomy"* to act.

Interviewees believed that although step changes are critical for the sustainability of the mining sector and that greater employee empowerment can assist in more effective implementation of step-change innovations, they are not really pursued. Accordingly, empowering employees to challenge the status quo and actively participate in the implementation of step changes become critical. Data demonstrated that the scope of employees' empowerment is limited to small improvements. Respondent D pointed to the role of *"adherence to KPIs [key performance indicators]"* as one of the reasons: *"they [employees in the mining sites] are tied to very strict KPI[s] ...it is very rare for disruptive technology decisions to be made at that level."* The scope of empowerment is limited not only to small improvements but also to the scope of decision-making: *"people who are empowered for making decisions [are] not empowered for implementation of those decisions"* (Participant M).

*6.5 Flexibility*

Flexibility was selected by 50% (*n*=9) of participants as an important value for innovation. Key dimensions of flexibility that emerged from the interviews included "openness to change" and "structural flexibility". Openness to change is defined as promoting change within the organisation in order to take advantage of innovation opportunities. Adaptable organisations are open to technological opportunities, whether they involve small changes or step changes. Interviewees agreed on the importance of openness to change and questioning the status quo, as Participant I commented: *"So you have to get out of the routine work and look at different technologies that are developed in either outside industry or [the] smallest parts that are generated in universities and in research centres."* Part of this adaptability is making sure that employees are open to diverse ideas.

Structural flexibility emerged as the second dimension of flexibility, referring to the extent to which flexible arrangements that facilitate innovation are promoted over the existing hierarchical structure. Interviewees confirmed that the mining sector tends to follow a "command and control" management approach. Staff need to know that if they have change suggestions that are valid, they will not get stocked in the multilayer structure, and they are visible to managers and will be supported formally and informally to fast-track changes, like Participant F, who mentioned: *"you should [be] relaying the point that if people look at their area and find something to improve it actually happens."*

Cultural dimensions that emerged in relation to the flexibility value indicate the importance of adaptability of both employees and the organisational structure in mining firms.

*6.6 Teamwork and collaboration*

Teamwork and collaboration were indicated by 44% (*n*=8) of the interview participants as an imperative cultural value for innovation. Two dimensions were recognised from the data: "cross-disciplinary collaboration" and "collaborative problem-solving".

Participants reported that mining firms embrace collaboration within the organisational units in their institutionalised siloed structure. However, cross-disciplinary collaboration and teamwork across units and between mine sites and the head office was lacking. It is the cross-functional collaboration that creates an avenue for knowledge sharing and fosters innovation. Participant G stated: *"it's not going to be looking at something just in the concentrator or in the mine; you need to look across the system. To do that you need to be dealing with multiple people"*. Participant C described: *concentrator* In particular, promoting collaboration between mine sites and head offices was found to be key for innovation in mining: *"I think [the] development of ideas requires integration between R&D and sites, in a way that allows understanding both ways"* (Participant H). In addition, respondents noted that innovative firms promote problem-centred collaboration to jointly solve problems and come up with new solutions. In this approach, people throughout the organisation are invited to give their ideas and engage with problems their company faces.

*6.7 Employee recognition for innovation*

Supported by 44% (*n*=8) of the respondents, employee recognition for innovation is a significant cultural value that enhances innovation in mining organisations. This value is critical in the mining sector considering its context is characterised by overemphasising efficiency and productivity. The data pointed out the importance of "reward and recognition for team innovation efforts" and "reward and recognition for innovation performance" as the dimensions of this value in the mining sector.

Participants' views suggest that innovative mining firms place great value on rewarding collaborative efforts to solve problems and come up with new ideas: *"We see in [name of the organisation] that people throughout the organisation and in the teams win together and fail together"* (Participant K). However, the norm in mining seems to focus on rewarding efficiencies rather than rewarding creativity: *"We incentivise improvement over creativity. So we are looking for less creative ways and more to do with effectiveness and efficiency. We prize efficiency-seeking over creating something new, in general"* (Participant C). Participants agreed that mining firms should appreciate and value the innovation efforts for innovation sake – not only for the sake of outcomes, as Participant J stated:

> *… if you genuinely reward people for innovation, you give them the opportunity to do something to fail, and they don't get punished for failure. Because the chances are something's going to fail, otherwise, it would not be called innovation, and you would not be called something new.*

*6.8 Diversity*

Diversity drew the attention of 39% (*n*=7) of participants as a significant cultural value that can enhance innovation in the mining sector. Interviewees highlighted the importance of "diversity readiness" and "support for diversity". The first dimension considered bringing ideas from diverse sources. Innovative firms value applying diverse ideas and cross-disciplinary approaches for identifying novel solutions. Respondent A explained this as, *"So you build up teams which have a lot of different expertise that you draw upon to solve the same problem. And you start looking at, 'How does that affect all the different roles?'"* In this regard, participants clarified that by diversity, they are referring to different views, backgrounds, knowledge, expertise or skills rather than merely referring to ethnic diversity.

Secondly, mining companies should not only value hearing diverse ideas but should also actually support and apply them appropriately. Participant K referred to the male-dominated environment in mining and the importance of supporting women's ideas despite the perceived limitations of women's fieldwork and technical experience: "*it's not just about asking ideas of women workers but actually applying them*". The importance of support and appreciation of different ideas in decision-making processes is paramount in such a context, described by one informant as: "*although people from different backgrounds attend these meeting[s], but there is a monoculture which imposes over other [sic] others' ideas.*" The participants believed that the suitable integration of different ideas in decision-making processes should be valued by companies if they seek better innovative results.

*6.9 External orientation*

As revealed in 33% (*n*=6) of the interviews, innovative mining firms value and maintain relationships with external stakeholders, including suppliers and customers, research institutions, government and the broader community. Field data supported the importance of three dimensions of this value: "equatable relationships", "co-creation" and "trust". Equate relationships refers to the dimension of external orientation being about working together with external stakeholders (suppliers, researchers, etc.) based on equal and considerate relationships where all parties have the best interests of all in mind. Participant D commented:

> … *there's a very strange relationship between mining companies and METS [mining equipment and technology services] companies across the industry. So that can range from a master/slave relationship, the miners being the master and the METS being the slave, when times are not tough … when miners [are] screaming for equipment, METS put their prices up and say: you will just have to wait.*

Another respondent provided a different example: *"miners, even the big ones, externalise the risk to companies which are mostly smaller than them saying: 'you develop the technology, you take the risk, and if it's good, we will buy it'"* (Participant L). Interviewees agreed that mining firms and their external stakeholders (METS firms, researchers, customers, etc.) should promote equal and considerate relationships where everyone has the best interests of all parties in mind. Such relationships will be based on fair risk allocation, a no-blame culture, and gain and pain sharing.

In addition, participants recommended that "co-creation" is a critical path to innovation. They believed that innovative miners value working together with external stakeholders, based on partnership and collaboration, over working separately:

> *... people are heading towards, what I would call a co-creation partnership; a genuine, strategic partnership between supplier companies and mining companies. And those mining companies who have that type of partnership, I believe, are far more advanced in improving all those different parameters than they otherwise would be.* (Participant J)

Lastly, interview data showed that the existence of trust in external relations is critical to cultivating an innovation environment in mining companies. Respondents referred to aspects of trust to be important in this regard. Some participants pointed to trust in the skills and abilities of external stakeholders in terms of having a proven track record, or understanding the mining context, as Participant F described: *"they are working off their own experience, which is drawn from a small pool, or not quite aligned with, or doesn't understand the implication of new technology for mining companies"*. Some other participants suggested that mining companies should be confident about the integrity of externals (display fairness and justice in the way they conduct their business, and adhere to sound principles) and that they are concerned

about the success of mining firms: *"So if you are a mining company and I come and say 'this if the best phone which changes your world' ... straight away all of you are sitting there going 'yeah, but you just want to sell me that phone' ... straight away there is scepticism"* (Participant O).

*6.10 Learning*

As confirmed by 33% (*n=6*) of participants, learning was highlighted as a critical value for innovation. In particular, data provided evidence of three learning-related dimensions: "absorptive capacity", "individual learning" and "learning orientation". Absorptive capacity refers to knowledge and information sharing within the organisation and the acquisition of new knowledge from outside of the organisation. Data showed that the Australian mining sector is aware of the role that new knowledge and technology play in developing a competitive advantage. Interviewees highlighted a range of activities that miners could undertake to increase their capacity for learning, such as having dedicated employees to constantly search for valuable knowledge and technology: *"it is just a matter of making sure that the employees who have been identified as being the thought leaders are given those opportunities to do courses and write papers and go to conferences and talk to people"* (Participant R). Another aspect of absorptive capacity highlighted by interviewees was a free flow of knowledge and information across the company – knowledge and information sharing between corporate offices (R&D) and mine sites (implementation) is especially important.

Individual learning, as the second dimension in that category, points to the importance of encouraging employee development in terms of domain expertise and specialised knowledge through formal education and/or peer-to-peer learning. Gaining general knowledge of mining is critical to innovation efforts. Employees in mining

companies appreciate education and developing expertise in mining operations. This could be through peer-to-peer learning: *"the person who has the confidence works with the person who doesn't"* (Participant L). Alternatively, formal education and certificates may help employees to build their career path. Field data revealed a third dimension, learning orientation, encompassing organisational support for individual and organisational learning through learning from others, learning from mistakes, pursuing the unknown and sharing lessons learned. For example, attitudes towards experimentation and failure represent support for learning, as Participant J explained: *"failure is not failure, it is just a new learning"*.

*6.11  Continuous development*

 Continuous development was selected by 33% (*n*=6) of respondents as a cultural value that influences innovation adoption in mining. Two dimensions related to this value emerged from our analysis: "sensing opportunities" and "seizing opportunities". Sensing opportunities was described by respondents as actively searching for opportunities and alternative ways of doing things to improve mining operations. Respondents who chose this value agreed that Australian miners should be better at actively exploring improvements to advance mining operations: *"we should do it [explore technological opportunities] no matter of [sic] difficulties"* (Participant Q). Opportunities for constant improvement could be based on decreasing unknowns and increasing productivity, as Participant A explained:

> *… So that leads to a constant search for "why". How can we better understand what's there? How can we better map what's happening through each stage? So there's a constant "why" and a constant search for understanding what's there and improving it.*

The second dimension, seizing opportunities, captured the extend that mining firms actually materialise these opportunities through evaluation, providing resources and building commitment to implement these solutions. This dimension refers to supporting exploration and implementation of new ideas. As reflected in the existing practice of Australian mining, opportunities to solve immediate problems or address short-term R&D priorities tend to be seized: *"the guys on-site [are] going, 'We have got a problem; we need to do something; and here's a solution and we are going to try and drive this'"* (Participant P). Innovative companies should be more strategic when capitalising on opportunities: *"when the market declines, new R&D priorities should not kill under-process innovation projects"* (Participant B).

*6.12 Proactivity*

Selected by 33% (*n*=6) of interviewees, proactivity was recognised as an organisational value important for innovation, particularly with the short-term view that dominates among mine managers: "*So they try to set up a short-term strategy that has got maximum return in that short-term that they are the manager*" (Participant Q). Three dimensions of proactivity were supported by field data, including "future orientation", "support for proactivity" and "disruptive opportunities". The evidence that emerged from the interviews indicated that mining firms that intend to be innovative need to actively search and apply information about emerging and future needs and problems of the company: *"You have to think of your rainy days when you are in golden days"* (Participant K). They also need to address emerging and future needs and problems of shareholders and society: *"So your shareholder or society says, 'You have to change your ways,' then you will change your ways"* (Participant N). Mining firms should not only be proactive in finding problems but should be proactive in finding solutions to those problems.

Furthermore, the data showed that mining companies should actively support employees to search and apply information about future needs, problems, and technologies. Employees need this support while surrounded by existing tasks: *"when they have a problem, they become very proactive in, 'how do we solve it?' They don't have the luxury to sit back and kind of go, what's going to happen in the next 6/12 months?"* (Participant E).

Respondents pointed to the importance of disruptive opportunities as they believe they are getting close to a turning point in the mining industry: *"the company simply will not be allowed to do what they have been doing; so there's going to have to be a step change in how we dispose of things, amongst other things"* (Participant M). Accordingly, mining companies should search and apply information about new disruptive technologies that provide an opportunity for technology leadership through undertaking competitive analysis, technology forecasting, and so on.

## 7. Discussion and implications

Innovation has been identified as one of the most important aspects contributing to the sustainable performance of companies (Carrillo et al, 2009; Kavin and Narasimhan, 2017). Earlier studies have provided strong evidence on the role of a culture of innovation as a crucial precursor to the types of innovative behaviours that can sustain organisations and foster organisational renewal (Hogan and Coote, 2014). This research was set up to examine the cultural values supporting innovation in organisations and investigate the cultural dimensions and behaviours that promote those values in organisations. Findings from this study helped unpack these cultural elements that construct an innovation culture in the mining industry.

While prior research on innovation culture has examined one or some cultural values supporting innovation (Cabello-Medina et al., 2005), this study takes a more inclusive

approach to systematically identify and explore a range of cultural values for innovation and the ways these values are enacted in the context of the Australian mining sector. Moreover, this study shows that some of the dimensions of innovation culture go beyond the boundaries of adhocracy culture, as defined by Cameron and Quinn (1999). While adhocracy culture emphasises flexibility and internal focus, some of the merging categories under different dimensions had elements of control and external focus. For example, "teamwork and collaboration" can facilitate cohesion as a means for control, demonstrating an aspect of clan culture (Hartnell et al., 2011). Some aspects of dimensions like "empowerment", "diversity" and "trust" can increase the morale and commitment of people, which is also aligned with clan culture (Büschgens et al., 2013). Likewise, individual learning as part of "learning" and recognition for team efforts as part of "employee recognition for innovation" can contribute to people development, promoting clan culture (Naranjo-Valencia et al., 2011). Similarly, "continuous development" represents some aspects of a market culture with its emphasis on continuous improvement for the purpose of increasing productivity and enhancing competitiveness (Hartnell et al., 2011). Having elements of market culture in the innovation culture of mining organisations makes sense because these organisations are responsive to their shareholders, and this translates to the innovation projects being oriented towards productivity and short-term performance. Lastly, we found the innovation values which are critical for innovation in the Australian mining sector while considering the specific challenges for innovation in this context. In light of this, the research makes several practical and conceptual contributions.

Firstly, using a multilayered model of organisational culture (Schein, 1992), this study uncovered 12 cultural values and 33 underlying dimensions that support culture for innovation. Since prior studies have focused mainly on abstract elements of innovation culture (Hogan and Coote, 2014), this study extended the application of Schein's model and

revealed more tangible dimensions and behaviours underpinning an innovation culture. These tangible components of innovation culture can be deliberately promoted in the organisations to support development of intangible components of it like innovation values. Therefore, identifying the relevant cultural dimensions and behaviours is important to realise and deliver innovation in organisations. Hogan and Coote (2014) empirically demonstrated that the process from innovation values to performance outcomes is, in part, dependent on specific behaviours. However, they introduced a set of behaviours which support innovation in a general sense and all the innovation values together. They did not provide a fine-grained view breaking down the general innovation-supportive behaviours into specific behavioural patterns which promote each individual innovation value. As such, findings from this study extend the work of Hogan and Coote (2014) by providing sought-after insights on the specific behaviours which support individual innovation values to enable innovation to occur. This study stands out from existing research by systematically and holistically categorising cultural values for innovation and the dimensions and specific behaviours that help enact cultural values for innovation (see Table 2).

Secondly, our study provides empirical evidence that cultural values for innovation are not associated with one single type of culture but seem to be a function of multiple types. Current research findings in this regard are inconsistent (Hartnell et al., 2011; Naranjo-Valencia et al., 2011). Many scholars have used Cameron and Quinn's (1999) established competing values framework to evaluate which type or types of organisational culture support innovation. However, existing findings are inconclusive. Hartnell et al. (2011) and Naranjo-Valencia et al. (2011) found that innovation orientation is mostly associated with the adhocracy type. However, other studies found that cultural dimensions of teamwork, associated with the clan and control types (associated with the hierarchy archetype) foster greater innovation outcomes (Jamrog et al., 2006; McLean, 2005). Büschgens and colleagues

(2013) exhibited that all culture types except hierarchy have a positive effect on innovation, while Yang et al. (2015) argued that, in the context of Chinese small and medium-sized enterprises, innovation culture is informed by only teamwork and collective culture; we found that both teamwork and individual autonomy are needed to promote innovation in the context of the Australian mining industry. Contrary to the findings of Limaj and Bernroider (2019), which suggest firms with a high balance emphasising all culture types including hierarchy are more innovative, we found no evidence of a positive role of culture types similar to hierarchy in promoting innovation. In contrast to some of those findings, but supporting Büschgens and colleagues (2013), our study demonstrates that cultural values supporting innovation appear not to be associated with one cultural type but form a function of multiple types. It appears from our findings that the values characterised by the adhocracy type (i.e. risk tolerance, creativity, proactivity and learning) prevail, but dimensions underpinning the clan type (i.e. trust, teamwork and collaboration) and market type (i.e. external orientation and continuous development) are also relevant in supporting innovation. As such, we argue that innovation culture can be considered as a separate culture type or needs to be somewhat mapped on Cameron and Quinn's (1999) model. Further to that, analysis from the interview data suggests that a hierarchical culture, institutionalised in Australian mining firms, might be a critical barrier to innovation.

Thirdly, the study demonstrates which values should be prioritised, such as risk-taking, creativity and trust, to encourage greater innovation in the Australian mining industry. Data from the interviews confirmed that the mining industry is characterised by certain features that create a barrier to innovation, such as capital intensiveness, frequent market fluctuations, and siloed and bureaucratic structures. These barriers have contributed to the development of a culture which is risk-averse and works against innovation. Fostering an innovation culture and overcoming these barriers requires an emphasis on certain cultural

values. Across the informants we interviewed, the innovation values examined have been addressed to a varying extent – depending on their relative importance. Some innovation values have been given particular emphasis. Risk tolerance was the most frequently selected cultural value (78%) promoting innovation. It appears that Australian mining firms believe that the risk-taking, experimentation and tolerance of failure are important cultural ingredients fostering an innovation orientation. The second most common innovation value was creativity (61%). The importance of establishing trusting relationships with internal and external stakeholders to promote innovation, as found in our study, is a novel contribution. Trust was found to be the third most important value (50%) supporting innovation, while existing empirical studies mostly give priority to values such as risk tolerance, flexibility, creativity, learning, diversity, teamwork and collaboration, employee recognition for innovation and empowerment (i.e., Mumford et al., 2002; Dobni, 2008; Hogan and Coote, 2014; Jin et al., 2019; Meissner and Shmatko, 2019; Sharifirad and Ataei, 2012). These findings suggest that Australian mining firms should prioritise promoting behaviours that strengthen the values of risk tolerance, creativity and trust.

*7.1 Contribution to practice*

Identifying a set of cultural dimensions associated with innovation values has an important contribution to practice. Managers in the Australian mining industry or in similar contexts across the Asia Pacific region can use findings from this study to select more concrete and tangible enablers and mechanisms that can foster innovation. Using findings from this study, leaders and managers will have greater control over their innovation efforts. As such, they can prioritise these cultural values by motivating specific behaviours identified in this study. For example, a mining company may recognise a need to co-create or outsource technological innovations along with suppliers or research institutions. Along with sensing

such a need to promote open innovation, the mining company may, for example, realise that the external orientation value associated with innovation is not sufficiently promoted. Findings from this study provide a list of strategies and behaviours aimed at promoting certain cultural values for innovation, such as external orientation. For instance, external orientation, based on this study, can be promoted by enabling greater collaboration and co-development of new ideas with external stakeholders and promoting knowledge and information sharing with them. Similarly, firms may choose to enforce certain cultural values to reach to an appropriate mix of control vs flexibility and internal vs external focus, to manage ambidexterity in their organisation (Gibson and Birkinshaw, 2004).

In mining organisations, the head office has different priorities and orientation compared to mine sites, which are normally located in different and dispersed geographical locations. While head offices are more focused on the quality of products, mine sites strive mainly for higher efficiency and productivity. Driven by different motives and contexts, the subcultures in the head office and mine sites tend to be different. In this regard, we know organisations having different subcultures may lack internal cohesion towards their innovation goals (McLaughlin et al., 2008). One practical implication of conceptualising innovation culture as a multi-dimensional construct inclusive of different culture types is managing innovation based on a holistic process and an organisation-wide culture across different units rather than managing innovation separately in each unit based on its standalone subculture. When using the conceptualisation suggested in this paper, while head offices and mine sites may keep some elements of different culture types (e.g., head office keeping more elements of adhocracy or market cultures and mine sites keeping more elements of a clan or hierarchy culture), in the bigger picture, all those elements become part of an organisation-wide innovation culture which is inclusive of different – or even conflicting – cultural elements.

*7.2 Limitations and future research directions*

In spite of the important contributions drawn from this research, there are some limitations that should be acknowledged. The first limitation relates to the source of data coming solely from the 18 interviews. Future studies could examine quantitatively the relationships between these cultural dimensions and the associated behaviours and values they represent. Doing so could form a base for developing items to measure innovation culture as a construct. This further highlights the need for research to determine which values are the most fundamental to innovation performance. As suggested by Hogan and Coote (2014), innovation values by themselves cannot increase innovation performance, and some organisational mediators like innovation behaviour mediate the relationship between innovation values and innovation performance. Innovation literature suggests mediators like resource support, innovation processes and supportive leadership as the potential mechanisms and facilitators of innovation performance. Future studies may explore and examine the mechanisms which contribute to the realisation of the impact of innovation values on innovation performance.

Data from this study came from the Australian mining industry, possibly limiting generalisability of the study to other countries or contexts. However, we should note that some of the findings of this study can still be generalised to similar contexts. Based on the views of scholars like Yang and Terjesen (2007), who support context-free paradigms contextualising a global phenomenon of interest to the local context (Peng, 2005), we can contribute to global understanding about innovation culture and the cultural dimensions promoting innovation using evidence from the Australian context. In this view, we might be able to apply a certain level of understanding developed in this study to relevant contexts.

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