Insights from the Mining Sector

Business Models for Sustainability

Mining is known to cause high ecological and social impacts. Thus, it has a paramount role in terms of supporting sustainable development, especially in developing or emerging economies. How can sustainability-oriented business model innovations redefine the raw materials sector and improve the sustainability performance?

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1 Introduction

Mineral raw materials and sustainable development are very intricately linked, as they form the basis of social development in the current economic system. With the growing economic output generated by humans in all countries and with the growing world population, which is only expected to stabilize at around 11 billion in 2100, the demand for raw materials is expected to double by 2050. So to speak, human-driven activities have never had such a strong (and at same time burdening) influence on the biosphere resulting in an exceedance of planetary system boundaries. Extractive activities also have large social impacts and cause inequalities (Carvalho 2017) and have become a focus of public interest in terms of the sector's role in sustainable development. At the same time, mining and its industries are known to be a blessing in many developing and emerging regions, especially due to the increasing demand and employment that enable a regional social upswing. How is it possible to optimize the sector's ecological and social support of sustainable development and ensure profitability at the same time? How can shareholders' confidence be won, and stakeholder relations be strengthened? Is it even possible for the sector to become sustainable pioneer?

The business model is considered as a central initiative component of corporate sustainability and has recently been the focus of research moved to sustainability management, as the classic incremental approaches are not sufficient to create the necessary radical change in organizations, industries, and societies towards real, substantial sustainable development. Increasingly, there is a recognition across industry boundaries that business model innovation is both an important lever for the transition of (societal) systems to tackle pressing sustainability issues (Bocken et al. 2016) and at same time has the potential to become a major source for competitive advantages (Gminder 2005; Afuah 2004; Zott et al. 2010; Lüdeke-Freund 2018). In-depth, sector-specific research is required as to whether modified or rather completely redesigned sustainability-oriented business models can contribute to the development of integrative and competitive solutions by radically reducing negative impacts and/or creating positive external effects for the natural environment and society.

There are both a theoretical aim and a practically oriented aim of this paper: First, the theoretical aim lies in exploring the role of business models for sustainable development in the extractive industries, identifying relevant business model patterns and analysing which sustainability paradigm the findings correspond to. Furthermore, the need for empirical validation of these business model patterns will create future research questions. Second, the practically oriented aim lies in the identification of business model patterns enabling profitable raw material production with minimized, or at least, reduced ecological effects and social impacts. So far, the establishment of business models for sustainability in the raw materials sector has not prevailed much, let alone they are not known at all. To date, the material and energy efficiency is at the forefront of efforts to reduce the ecologic footprint of corporate activities. However, nowadays innovation primarily focuses entire business models or at least major parts of them, rather than just singular technologies, products, and processes. The holistic route is described by the innovation of (sustainable) business models and considers the triad of strategy types (sufficiency, efficiency, and consistency). It bears the potential to move this industry sector away from its dirty image.

The paper is structured as follows: The first two sections (2 and 3) set the theoretical basis and are followed by an investigation of the sustainability paradigms in the mining context (section 4). Based on these findings, relevant sustainable business model patterns are derived (section 5) and are discussed in the following section 6 using the case of the Rare Earth industry and one of its most important applications, the Neodymium-iron-boron permanent magnet. Conclusions are drawn in section 7.

2 Sustainable Business Model Innovation

The critical scrutiny of consumers has resulted in a rising demand for sustainable products along entire value chains, also

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shifting towards industrial goods ("pull effect"). The stakeholders of a company show narrow tolerance limits for the ecological and social footprints, especially those of "green technologies", such as wind power and e-mobility. Bearing in mind "greenwashing" has been revealed too many times, stakeholders demand more than ever for the verification of communicated sustainability. Companies and entrepreneurs are therefore well advised to identify their unique selling proposition based on sustainability and to clearly align their strategy with it, both internally and externally. Sustainability creates values and trust. Sustainability must be implemented at the core of the strategy and serves as long-term differentiator in sustainability-oriented business models.

The interest in sustainable business models is new compared to strategic management (Welge et al. 2017; Porter 2000) and the original business models (Massa et al. 2017). In recent years, there has already been a plethora of work starting to set up research (Lüdeke-Freund/Dembek 2017; Aagaard 2019; Moratis et al. 2018 to name a few). Business models represent the value creation, based on a value proposition (the benefit offered to customers and all other types of stakeholders), value delivery (how those value propositions reach and unfold for respective customers and other stakeholders), and value capture (how the company obtains net value from its interaction with customers and stakeholders (Breuer/Lüdeke-Freund 2017). Furthermore, its innovation, defined as business model innovation, describes modifications of both existing and the introduction of new forms of value creation, delivery, and capture, resulting in new qualities and/or new configurations of business model components (Breuer/Lüdeke-Freund 2017). Business model (innovation) is recognized to be an important lever for change and to tackle related sustainability issues identified to be the most pressing (Bocken/Short 2016). Furthermore, the development of new business models has emerged to be a prime technique to achieve unique strategic positions and thus competitive advantages (Breuer/Lüdeke-Freund 2017). Respondents of the latest KPMG study seem already aware of the potential that lies in business model innovation: According to the survey, 33 % of respondents asserted that today's mining companies need to embrace new business models (KPMG 2020).

Today conventional business model innovation is a well-researched and implemented domain. Business models for sustainability have a much broader scope in their ambition to generate positive or eliminate negative societal impacts. They integrate multiple dimensions of economic, social and environmental values, and they exceed the customer orientation of conventional business models by considering value creation to a broad scope of stakeholders, society and the natural environment (Bocken et al. 2015; Freudenreich et al. 2019; Schaltegger et al. 2015). Sustainable business models as a form of sustainable innovation, balance the competing and complementary interests of key stakeholder segments, and corporate sustainability should manifest as economic viability and contribute to both social and environmental sustainability, therefore satisfying the triple bottom line approach. Sustainable business model innovations seek to "create significant positive benefits or significantly reduce negative impacts for the environment and society; through changes in the way the organization and its value-network create, deliver and capture value" (Bocken/Short 2015).

3 Sustainable Business Model Patterns

A remarkably high percentage of all new business models are not new but are based on existing patterns. Creative imitation of business models from other industries enables companies to become innovation leaders in their own industry (Gassmann et al. 2013). The authors of this article consider the business model as a recombination of patterns for answering the "who – what – how – why – questions" of a business. Business model patterns are general descriptions of how business models work (Lüdeke-Freund et al. 2018). Their characteristic is their similarity in terms of configuration, structure, and structure of the model building blocks. As global design aids, these patterns are defined regardless of industries and organizational sizes, so they are generally applicable. As a result, suitable business model patterns can in principle be used in every company or organization through clever design and adaptation. As an outside-in approach, business model patterns provide an opportunity to gain the potential impact of innovations on different types of business models and to stimulate a form of creative confrontation or the mutual "fertilization" of different ideas. This "infusion" of business model ideas happens when a pattern from one context or industry is reinterpreted or applied in another. One speaks of outside-in because an external business model pattern is adapted or translated to the organization. Conversely, an inside-out approach to business model innovation means starting with the current elements in the organization. As a result, suitable business model patterns can in principle be used in any company or organization through skilful design and adaptation.

This knowledge base should now be used as best as possible to be equipped for the challenges of sustainable development posed to a mining company and considers the entire value chain. Given the breadth of potential sustainable business model innovations, it is particularly important to derive a selection of business model patterns that gain relevance in economic practice. Therefore, all known "green" business model patterns shall be identified and considered (Clinton/Whisnant 2014; Bisgaard 2012; Jenkins et al. 2011; Kiørboe et al. 2015; Beltramello et al. 2013; Rau/Oberhuber 2018). Suitable business model patterns then need to be classified regarding their individual potential and be analysed with the possible degree of realization for companies in the raw materials sector.

4 Sustainability Paradigms in Mining

Sustainability and its development are multifaceted and complex subject areas. Numerous definitions and interpretations exist in different disciplines. Hilson and Murck developed

sustainability guidelines for mining companies that translate "sustainability in mining" into six practical recommendations: (1) improved planning; (2) improved environmental management; (3) cleaner technology implementation; (4) increased stakeholder involvement; (5) formation of partnerships and (6) improved training (Hilson/Murck 2000). The question remains, if this definition on the one hand, and those exemplary sustainability guidelines on the other hand, also represent the stakeholders' demands. Still, it must be critically questioned, if these assumptions already mark the end of the line about the industry's maximum possible contribution to sustainable development?

"Because of its extracting and processing mineral resources, the mining industry is widely regarded to be one of the most environmentally and socially disruptive business activities in the world."

In academia, two main economic paradigms of sustainable development dominate: The weak sustainability paradigm economics (Solow 1974a; Solow 1974b; Solow 1993) which is also known as "substitutability paradigm" as its proponents regard natural capital to be essentially substitutable in the production of consumption goods and as a direct provider of utility. According to this paradigm, it is only the total aggregate stock of man-made, human, and natural capital, but not natural capital as such, that counts for future generations (Neumayer 2013). Within the scope of the weak sustainability paradigm technical progress gains a paramount role ("technology optimism") and is seen as enabler that relativizes the finite nature of natural resources and the resulting limitation of economic growth (Stiglitz 1974). The question "if it pays off" dominates (exploration of new deposits and recycling become economical with increasing prices, thus leading to better supply, and consequently decreasing prices, economic scarcity is eased). The insufficiency of the weak sustainability concept may be proven easily by the second law of thermodynamics, particularly in the mining context. Humanity can only use certain raw materials economically because of their physical concentration in individual deposits. Mining activities cause a continuous change in the composition of deposits. The concentration of elements steadily decreases and at same time distribution increases. It is in the inner essence of time that causes the entropy to increase irreversibly; only the rate of entropy increase can be influenced. The more effectively mineral resources are utilized, the faster entropy increases, reflecting the larger and more likely distribution of materials. However, the growing distribution of raw materials results in an increasing degree of difficulty – if not even to impossibility – to reuse them. From a certain distribution, the elements are lost and thus withdrawn from the technical and economic access (Vieweg 2019). In opposition, the strong sustainability paradigm regards natural capital as non-substitutable, in the production of consumption goods, in its capacity to absorb pollution and as a direct provider of utility in the form of environmental amenities. As regards the latter, two differing interpretations exist: One demands to preserve natural capital in value terms, the other one demands to preserve the physical stocks of certain forms of defined critical natural capital (Neumayer 2013). Since manufactured capital requires natural capital for its production, it can never be a full substitute for the biophysical structures of natural capital. Certain elements of natural capital are "critical" due to their unique contribution to human well-being (Ekins et al. 2003). The term "critical" is generally applied to elements of nature that are both irreplaceable or irreparable and currently scarce. Some elements, for instance rare earth elements – that are increasingly required in applications for future green technology (e. g. e-mobility and wind power), cannot be easily substituted due to their characteristics and at same time still have an exceptionally low recycling rate – are therefore considered as critical and irreplaceable.

It is important to strive for a central position between the two extremes that supports sustainable development beyond mere technological progress in products or processes. Sustainable innovation, in particular holistic business model innovation, considers all kinds of stakeholders and their individual values and provides the required new solutions in mining (Drusche/Krause 2021).

5 Business Models for Sustainability in the Mining Sector

Holistic approaches are increasingly required in the business context and beyond. The mining sector is no exception, but rather requires intensive consideration as it is in the centre of public interest. Performing sustainably and thus, generating shared value for all stakeholders, the environment included, is about to become a top priority soon. Managers are discussing what success really means to them and their businesses apart from economic measures. The 2020 KPMG Global Mining Survey points out that 75 % of its respondents share the opinion that the mining industry needs to redefine success using a more holistic group of measures considering the values of all its relevant interest groups including both shareholders and stakeholders. Social values, community stakeholders, health, safety, and long-term development were identified as the key measures in this context (KPMG 2020). In terms of the mining sector, that is heavily dependent on capital, this demand is recently driven by economic factors: The trend toward responsible investing is depicted by the environmental, social,

"The mining business paradigm is shifting, as miners are facing new challenges."

and governance (ESG) principles that are considered in the decision-making by both individual investors and institutional asset managers. Factors like climate change, water management, health, and safety, as well as the fair treatment of workers and communities are being critically reviewed. ESG investing is estimated at more than 20 trillion USD in assets under management, further growth is expected. Mining companies that fail to deliver value beyond compliance must expect both financial and reputational consequences (Deloitte 2020).

Because of its extracting and processing mineral resources, the mining industry is widely regarded to be one of the most environmentally and socially disruptive business activities in the world (Peck/Sinding 2003). Indeed, many of the major environmental disasters and human rights incidents that have led to growing public concern of the stakeholders about the sustainable development have taken place in the mining industry. In this discussion, the aspects of maintaining the social license to operate are increasingly playing a decisive role. Whereby the social license to operate reflects an informal social contract that aims to bridge the gap among the views of the most important stakeholders involved in mining activities (Komnitsas 2020).

When miners extract iron ore in Brazil or workers toil in Mali's gold mines, shareholders end up benefiting. As an example, BlackRock holds shares in the Australian-British mine operator BHP Billiton, the Swiss Glencore, and the gold producer Randgold Ressources as well as the Russian MMC Norilsk Group, and Freeport McMoRan, the largest copper producer in the world. BlackRock for instance, predominantly seeks to understand how a company's strategy, operations and long-term performance would be affected by the transition to a low-carbon economy and other climate risks (BlackRock 2020). The aim is to ensure that companies are effectively managing the risks and opportunities presented by climate change and that their strategies and operations are aligned with the transition to a low-carbon economy – and specifically, the Paris Agreement's scenario. Such engagement can help inform the approach taken by business leaders as they advance their sustainability practices and disclosure.

Obviously, business leaders understand and will need to realize that their early sustainability efforts and pace of progress to-date may not be enough for what is required. Their strategic and operational space is narrowing, thus making it more and more difficult for them to manoeuvre at the strategic level. On the one hand, leaders increasingly realize that their current business practices result in significant financial and human cost. Due to externalization, financial numbers capture only a small portion of real corporate economic activity in terms of impact on our natural, human, and social capital which needs to be managed as well. Companies enjoying economic success at the expense of environmentally or socially detrimental activities can expect a serious decline in business, as they will be targets for disruptions by more sustainable competitors, regulatory constraints, and other stakeholder interventions. The lack of sustainable business manners may be rooted in the shareholder value approach and the immediate competitive landscape. But a new type of leadership mind-set is striving for systems change at scale. These leaders show a "sustainability-oriented mindset" and proactively engage with diverse stakeholders (e. g. legislators, regulators, customers, competitors) through dialogue and collaboration to transform entire ecosystems toward true sustainability and therefore may achieve long-term industrial transformation.

Aside from the verification in practical studies, the increasing relevance of multiple values is also depicted in new theoretical interpretations of both strategic and innovation management that imply a new understanding and route of how business shall be done. The transition from sustainability efforts to ESG performance indicates a maturation of business practices to a more precise measurement of business model performances. As the industry becomes more sophisticated, there is a need to improve the way of collecting and tracking metrics to build ESG management accordingly.

Business models for sustainability are the lever of organizational and operational sustainability within the raw materials sector to reduce hazard and vulnerability, by means of frequency of events and number of damages. In the nexus of this article the patterns in (Bocken et al. 2019) were selected as a starting point as a comprehensive framework bringing together innovations from research and practice. These include nine sustainable business patterns (Table 1), categorized according to generic classification, namely technological, social, and organisational innovation, based on the major innovation types in (Boons/Lüdeke-Freund 2013).

One of the most promising patterns is discussed in the following: As demand for rare earth elements (REE) and other metals will continue to increase, internalising costs of harmful effects will be an incentive for the mining industry to improve its sustainability performance and implement business models patterns within the complete value chain. The permanent existence, renewal, and further development of life in a closed system with limited availability of resources is possible through Circular Economy by means through an economic approach in which the materials and energy used are not excreted from the economic process as residue or waste but are fed back

Pattern	Value proposition	Value creation & delivery	Value capture	Difference(s) between general and raw materials sector business model
Maximize material and energy efficiency	Processes that use fewer resources, generating less waste and emissions than the processes that deliver similar functionality.	The focus is on the internal operational process innovation.	Costs are reduced through increased operational efficiency leading to increased profits.	Mining companies intend to implement a broader strategy to maximize material and energy efficiency instead of a piecemeal approach.
Closing resource loops	Reduction of waste. Controlling flows of material resources and take control over materials flows.	Turns waste into value. (Industrial symbiosis)	Generation of new revenue streams. Building business which is based on services and partnerships rather than single transactions of finite resources.	Motivation and encouragement to exert control on systems across the resource lifecycle, as returning resource flows are creating value and suppliers have a demand for their own used product. Open to digital innovations.
Substitute/Use of renewable and digital processes	Reduce environmental impacts and increase business resilience in terms of power supply by using renewable power sources and electronic means in service delivery process.	Innovation in service delivery design (e. g. delivery channels) enhances the cost and accuracy of service delivery to customers.	Revenue is enhanced by providing customers more convenience, which may result in more frequent transactions. Cost saving is achieved by reducing manpower and related expenses.	Firms in the raw materials sector keep innovating with digital processes for customer contact with a target to minimize or eliminate traditional branch network.
Deliver functionality not ownership	Can encourage the right behaviours with manufacturers and users.	Can reduce the need for physical goods.	Ability to react to volatile raw material prices.	Ability to exert control on material resources prior and after use.
Adopt a stewardship role	Provision of products intended to genuinely and proactively engage with stakeholders to ensure their long-term well-being. Broader benefits to stakeholders often become an important aspect of the values proposition by engaging customers better.	Ensuring activities and partners are focused on delivering stakeholders' well-being. The value chain is ensured to deliver environmental or social benefits.	Generation of brand value, potential cost savings, and secure future business. Stakeholders' well-being generates long-term business benefits. For example, healthy and happy staff may claim fewer sick days and be more productive.	In addition to the traditional CSR activities, firms in the raw materials sector tend to adopt a shared value approach to leverage and benefit their core business, especially in terms of local communities and/or health and safety.
Encourage sufficiency	Solutions that seek to reduce demand (which was generally inflated before) by correct assessment of customer needs and reducing misselling of products and moral hazard. The focus is on the customer relationship and reward system.	This may involve changing the front-line sales staff's remuneration to a higher portion of fixed salary, promoting need-based selling by correct matching of products, and advocating sensible borrowing.	Customer satisfaction and loyalty may increase that may lead to more business. Compliance risk is lowered and reduces the chance of penalties by regulators. Societal benefit is captured: customers get what they really need in the right quantity and quality.	Firms in the raw materials sector give up the approach of "selling more" by replacing it with premier materials which match the exact needs of customers. Creating new B2B target groups by fostering sufficient behaviour from the end of the value-chain to its beginning.
Repurpose for society/environment	Creating societal benefits and environmental benefits through specializing in providing materials that match the needs of the customers.	Mining companies are using sustainability as a criterion for selecting customers and suppliers.	Only provide materials and services to sustainable companies and the disadvantaged, including "positive screening" against social and environmental benchmarks.	Mining segment its business more accurately on sustainable businesses only, not just using the current negative screening approach.
Inclusive value creation	Sharing resources, skills and knowledge and distribute wealth Leverage resources and talents.	Create new business opportunities.	Generation of new revenue streams. Building business, which is based on services and partnerships.	Collaborative platforms. Collaborative consumption.
Develop scale up solutions	Achieve scale – from small entrepreneur or start-up to business.	Create new business opportunities.	Create breakthrough innovation.	Creation of industry-wide change or rather transition.

Table 1: List of sustainable business model patterns referring to (Bocken et al. 2019)

into the production or consumption process. According to Rüttinger and Hurst, around 2000 tonnes of processing residues are produced during production of one tonne REE. As a rule, the residues are fed into sedimentation systems and deposited. The resulting waste contains radioactive thorium and chemicals such as sulfuric acid and hydrofluoric acid representing a major source of pollution and danger for the environment (Rüttinger et al. 2014; Hurst 2010). This value chain for instance, bears a high potential for the reduction of waste and especially the application of the business model pattern "Industrial symbiosis". It describes a shared use of resources and by-products by industrial actors on a commercial basis through cross-company recycling connections. The aim of industrial symbiosis is to reduce costs and environmental pollution for the companies and municipalities involved. Hence, this business model pattern goes beyond the eco-efficiency approach.

"As mining and strong sustainability exclude each other, the potential through a 'business model for balanced sustainability' is worth considering."

6 Opportunities and risks for further value creation in the Rare Earth industry

This article refers to neodymium-iron-boron (NdFeB) magnets, which present the main application for the rare earth elements Neodymium (Nd) and Dysprosium (Dy) with a major share of the REE market by volume (22%) as well as by value (37%) (Yang et al. 2017). The EU, UK included, imported more than 8,000 tonnes of NdFeB magnets with a value of about half a billion USD during the first half of the year 2021. Germany leads the import with a 40% market share. This huge import dependence in a critical sector has brought the EU to re-consider its strategy and plan to offer financial support to build an EU supply chain (Rare Earth Industry Association 2021). Ciaccia et al. (2018) noticed that roughly up to 50% of the annual neodymium demand in the EU-28 could be met by domestic secondary supply if latent Circular Economy potentials were turned into actual capacity. Circular Economy shall be interpreted following the definition of Kirchherr et al.: *"A circular economy describes an economic system that is based on business models which replaces the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes, thus operating at the micro level (products, companies, consumers), meso level (eco-industrial parks) and macro level (city, region, nation and beyond), with the aim to accomplish sustainable development, which implies creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations"* (Kirchherr et al. 2017).

Goods can be reproduced using finite resources but are dependent on them if Circular Economy concepts and renewable energies are not used. It is about long-term economic activity and increasing value through the highest possible eco- and socio-efficiency and effectiveness. The example of the current "linear" supply chain of rare earth elements such as Nd and Dy illustrates how disruption may play out and helps to understand the extent of risks. The supply chain is geographically concentrated in regions with an increasing probability of relevant climate hazards, which might lead to landslides or dam failures. The supply risk of REEs is not only related to their geopolitical and monopoly market position of supplying countries, but also to their limited substitutability and their current low recycling quota. Despite the supply risk, REEs are increasingly used in products, especially those contributing to the transition to green and low-carbon economies (Alonso et al. 2012; Glöser-Chahoud et al. 2016). Due to the expected high growth rates, mainly driven by electromobility and wind turbines, NdFeB magnets presumably actually bear a high recycling potential (Glöser-Chahoud et al. 2016; Marscheider-Weidemann et al. 2016). The current circular use of critical raw materials, to be specific the End-Of-Life recycling input Rate (EOL-RIR) of REEs is currently limited to 6–7% (European Commission 2018). According to Reimer et al. (2018), the necessary volumes above 1,000 t/year cannot be expected before 2033 to feed industrial plants economically. Considering the small market share of European magnet producers, the demand for REEs is comparatively low. Both metals are mainly imported to the EU in the form of magnets or magnet containing products. The future markets for recycled REEs are presumably in Asia (Reimer et al. 2018). Bearing in mind the three-dimensional challenges mining industry (and at same time planet and humankind) is currently facing, it is more than obvious, that incremental product, process, and technological innovations will not be sufficient. The multitude of demands implies the need for innovative sustainable business models creating multiple values by considering various stakeholders and their value interpretations. The adoption and implementation of innovation offers the extractive sector the opportunity to tackle some of the most pressing identified challenges (Gruenhagen/Parker 2020).

7 Conclusion

The connection between sustainability commitment and the economic performance of a company was not only discussed in theoretical treatises, but also taken up in empirical research. So far, the abundance of empirical evidence on the relationship between sustainability performance and a company's financial performance can be described as heterogeneous. Contributions to this question attribute the heterogeneity primarily to the lack of theoretical foundation as well as measurement and data problems. Various analyses come to the result that there is a slightly to significantly positive correlation between sustainability performance and the financial performance of companies, see also (van Beurden/Gössling 2008; Endrikat et al. 2014; Friede et al. 2015; Margolis et al. 2009; Niski et al. 2018). The mining business environment is constantly changing; it would not be an overstatement to say that the paradigm is shifting, as miners face new challenges. The pressing issues are not only about low-grade ore bodies, but also about long-term environmental impacts, the growing public awareness and increasingly critical investors in this regard. Corporate sustainability management aims to deal with the challenges described above in a way that contributes to business success and societal progress;

both are in line with the Sustainable Development Goals. If both are achieved in concert, so-called business cases for sustainability will result (Schaltegger/Lüdeke-Freund 2012).

Of course, business model innovation does not automatically offer "ready-made" business cases. However, understanding its levers to align a company's value creation with societal needs is a promising way to tackle sustainability challenges through business activities. When a company improves its ecological and/or social performance at the cost of its financial performance, or vice versa, it is on a trajectory towards weakly sustainable corporate development. Strong cases, on the other hand, integrate ecological, social, and economic performance. Ideally, real business models for sustainability allow companies to create strongly sustainable business cases (Upward/Jones 2016). The trend toward responsible investing is depicted by the ESG principles that are considered in the decision-making by both individual investors and institutional asset managers. Factors like climate change, water management, health, and safety, as well as the fair treatment of workers and communities are being critically reviewed.

Business models for sustainability could be identified as the most promising route to long-term corporate success and at same time guarantee for human wellbeing within the planetary boundaries. Current analysis in the research context on the selection of sustainability-oriented business models show that, firstly, not all patterns follow the approach of strong sustainability and, secondly, are simply not feasible in the raw material context. Considering that mining and strong sustainability exclude each other, the potential through a "business model for balanced sustainability" is worth to go reflecting livelihoods of humans. Still, the extractive industries are so far not known to be the most innovative industries. Investment in innovation should not stop at the mine gate but allow miners for a significant opportunity to push research and innovation into their products' downstream applications (PwC 2019; Deloitte 2020). Future foci shall therefore be placed on establishing business models for balanced sustainability in the mining industries considering diverse stakeholder values. Inherent sectoral structures and the resulting restrictions will have to be analysed and critically questioned to enable an innovative mining innovation ecosystem and future opportunities that disprove the current image of this important industrial sector starting a major part of further value creation.

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