

Article

Multi-Stakeholder Initiatives as Social Innovation for Governance and Practice: A Review of Responsible Mining Initiatives

Philipp C. Sauer ^{1,*}  and Michael Hiete ² 

¹ Faculty of Science and Technology, Free University of Bozen-Bolzano, 39100 Bozen-Bolzano, Italy

² Professorship of Business Chemistry, Ulm University, 89081 Ulm, Germany; michael.hiete@uni-ulm.de

* Correspondence: psauer@unibz.it

Received: 14 November 2019; Accepted: 22 December 2019; Published: 27 December 2019



Abstract: Mining mineral resources has been found to be an ambiguous way of achieving sustainable development. It can spark the economic development of poor regions, but at the same time it is associated with severe sustainability issues, particularly in areas with governance deficits. Recent developments have spurred a vibrant debate on how to achieve the development opportunities while minimizing the sustainability impacts. As a result, voluntary multi-stakeholder initiatives (MSI) originated with differing foci, aims, and organizational designs. Such MSIs for responsible mining can be interpreted as a social innovation from two perspectives: (1) stakeholder groups cooperate to complement, concretize, initiate, and prepare, but also compete with other forms of governance and possibly replace them; (2) the MSIs support implementing responsible mining in practice. A structured review of 20 MSIs' documents along an analytical framework covering governance, change in practice, and diffusion shows that the two roles of MSIs can hardly be separated, as the change in practice is enabled via a change in governance. Moreover, the MSIs are found to be a valuable complement to traditional governance of responsible mining, as they transcend national borders, allow for the inclusion of informal miners into professionalization, and offer support to companies to enhance their sustainability performance. Nevertheless, the MSIs are voluntary and relatively young. This limits their power and requires further research for which six avenues are identified in this paper.

Keywords: multi-stakeholder initiatives; social innovation; certification schemes; responsible mining; governance; conflict minerals; sustainability; environmental impacts; social impacts

1. Introduction

Mining mineral resources has traditionally been a foundation for the creation of wealth and progress, but this has increasingly shifted away from mining. However, at the same time, mining operations are highly detrimental for the environment and associated with severe social impacts such as those upon the health and welfare of workers [1,2]. To date, such impacts are addressed by means of governance and innovation approaches, that contributed each to substantially reducing the negative sustainability impact of mining and moved the sector to higher responsibility. Note that the term *responsible mining* is often preferred over sustainable mining. This is based on the formation of mineral resources over geological time scales such that human extraction by far exceeds natural formation. As a result, there is an exhaustion of the resources in the long or even short run limiting the resources' availability for future generations. *Responsible* consequently refers to mining practices that are performed in a sustainable manner while ignoring that a mineral deposit is exploited. Moreover, the scope of responsibility is understood in a broad sense, as defined by van den Brink et al. as "the management of social, environmental and/or economic sustainability" [3] (p. 392). Still, mining is

far from delivering its expected contribution to sustainable development. This calls for a deeper investigation of the governance and innovation approaches linked to this sector and how these can be further improved [4,5]. We argue that two core governance and innovation approaches can be distinguished: first, the common and widely established approach with governmental authorities as key actors and law as key instrument, that is the authority-based approach; second, a more recent approach building on voluntary multi-stakeholder initiatives (MSIs), here termed the MSI-based approach [5,6]. The latter is considered as a social innovation: It contributes in an innovative way to improving the social situation of people and communities involved in mining. Simultaneously, it makes use—by integrating several groups of stakeholders—of a new social approach, which allows sustainability issues to be tackled outside the reach of traditional approaches [6], such as the authority-based one.

Authority-based governance has brought substantial development in industrial mining within the last few centuries. It has shifted the mainly manual mining in medieval times to highly automated operations these days. This has increased productivity and safety but also lowered the impacts and risks to the environment and society [7,8]. The described development was driven by pressure from trade unions and governments in response to the claims of affected workers and other stakeholders. Moreover, it was facilitated by innovations in mining technology for which, however, productivity was the main driver and reduced social and environmental impacts were a positive side-effect. Further improvement in terms of economic and environmental performance is expected from the digitalization of mining operations [9]. However, this trend towards more automated, less polluting, and less harming mining operations is not global but limited to industrial mining. Moreover, it is often focused on Western countries, especially with respect to environment, health and safety (EHS). Even more, recent dam failures, for example, Mount Polley tailings dam, Canada, in 2014, or Mariana and Brumadinho dam disasters, Brazil, in 2015 and 2019, or the failure of a dam of an alluvial small-scale gold mine near Krasnoyarsk, Russia, in 2019, highlight that the risks of mining are also present in industrialized countries if precautionary measures are disregarded.

Thus, industrial mining, that is mostly situated in Western countries, benefitted from the described development. As a result, this benefit is limited to the estimated eight million formal miners globally. In contrast, the three times larger informal mining sector, with its more than 25 million informal miners, could largely not profit from these developments [10]. In fact, the latter has seen a rapid growth due to steeply rising raw material prices and the closure of highly sophisticated industrial mines. Ironically, these closures were due to stakeholder pressure and the costs of this sophistication. For example, the Mountain Pass rare earth mine in California, U.S.A., was closed for both environmental and economic reasons [11]. In effect, the number of mining accidents is still high, and mining sites are frequent in the list of worst polluted places [12]. Additionally, working conditions are often poor, in particular in artisanal and small-scale mining (ASM) [13,14], and miners often lack the freedom to form labor unions, etc. [3,5]. Consequently, the majority of global miners has to work under detrimental conditions, which calls for other means of governance to establish a more sustainable sector at large.

This other means of governance could be the MSI-based approach. It encompasses the formation of initiatives that aim to establish sustainability standards including in part certification systems in the mining sector [1,15]. These MSIs are built by stakeholders as a forum to define how legitimate—that is, desirable, proper, or appropriate [16]—mining practices should be carried out and how miners and their organizations can be trained, supported, and developed to realize these practices [1]. In turn, these MSIs have been found to represent a “transnational private regulation” that is “formally independent of government but not reducible to industry self-regulation, and regulatory in that it purports to set and enforce standards for performance” [17] (p. 302). MSIs thus represent a different governance approach that goes beyond national regulation and aims to level out national differences by means of a private and non-binding governance within a sector. Still, the MSIs do not represent a homogeneous group; in fact, they are as heterogeneous as the mining sector itself. The stakeholder groups behind the initiatives range from industry only to a diverse mixture of governmental, non-governmental, and

industrial stakeholders. As a result, the aims and functions, the sustainability issues addressed, and the organizational designs of the initiatives differ considerably [1,18].

In effect, it can be contended that the authority-based approach mainly builds on technological innovation and strong nation-state governance. Instead, the MSI-based approach represents private governance that addresses the missing uptake of existing technologies and routines in the sector in particular, but not exclusively in situations where the first approach fails.

From a theoretical perspective, both can be seen as institutional innovations that establish new formal or informal rules [19] that may lead to changes in practice. However, MSIs combine the formulation of rules, i.e., the standards and conditions for certification, with the prescription of concrete guidelines for mining operations. In some cases, the MSIs also offer corrective actions and the development of operational practices [20]. MSIs thus focus on innovating the actual conduct and can be labelled as “social innovation” as they take a much more direct approach to driving change [21] that merits further investigation. The fact that stakeholders come together to develop their own governance in a negotiation process can also be considered a social innovation, which allows the sustainability issues in mining to be addressed in a different way (as will be shown below) compared to the authority-based approach.

Although MSI have long been in use in raw materials sectors [5,22], a focus on MSIs in the mining sector is considered relevant for several reasons: (i) the wide variety of sustainability topics addressed and sometimes also narrow scope such as on conflict minerals or cyanide use [1,3], (ii) the existence of different types of standards with differing stakeholder groups involved and differing goals [1,5], and (iii) the age structure of the MSIs in the mining sector, as all initiatives are rather young with strong dynamics and several initiatives even in development [18,23].

This study thus aims to contribute to answer the following research questions:

1. To what extent do MSIs represent a social innovation from a governance perspective?
2. How do voluntary MSIs for responsible mining complement the authority-based governance of sustainability in the mining sector?

Although the current body of literature provides a number of papers and reports on responsible mining and MSIs, this study moves beyond these. Its main contributions are, first, the conceptualization of MSIs from a social innovation perspective that opens up novel lines of interpretation. An analytical framework was developed that outlines how MSI-based and authority-based governance can interact and complement each other. Second, the analytical framework is applied to analyze a set of 20 MSIs for responsible mining from a social innovation perspective. Contributions of MSIs to social innovation are, thus, identified and used to enrich and concretize the analytical framework. Moreover, implications for the future development and application of MSIs to resolve social and societal challenges are described. Finally, the number of MSIs analyzed is 20 and thus larger than in previous studies which analyzed 19 [1], 16 [5], 15 [15], 7 [24] and 4 [25] MSIs, respectively.

The literature on MSIs and of main sustainability standards in mining is reviewed in Section 2: based on this review, an analytical framework for understanding MSIs as social innovation is conceptualized and presented. This framework forms the basis for applying a content analysis of 20 existing MSIs for responsible mining. The detailed categorization of 19 responsible mining MSIs by Kickler and Franken [1] represents a further source of information. The materials and methods are presented in Section 3, before Section 4 outlines the findings that provide insights into the representation of the individual parts of the framework in the MSI for responsible mining. Finally, the discussion and conclusion in Section 5 presents the study’s contributions and limitations before identifying a number of research directions.

2. Literature Review and Conceptualization

This section introduces the main literature relevant to the topic of social innovation and MSIs in general before it merges both to develop an analytical framework for MSIs as a social innovation.

2.1. The Diversity of Voluntary Multi-Stakeholder Initiatives (MSIs) for Responsible Mining

MSIs for responsible mining aim to fulfill different purposes in strongly differing contexts leading to a high diversity. The literature provides overviews in a practitioner oriented or technical manner [1,5,25,26] that outlines that the MSIs differ inter alia by their targeted raw materials, countries, firm sizes, and sustainability issues as well as in their origin or ownership, aspired stringency, coverage of the supply chain (SC), internal organization, and actors involved in their development and operation. These first three characteristics will be used in more detail for analyzing MSIs from the perspective of social innovation in Section 4, whereas the other attributes highlighting the diversity of MSIs will be presented below.

Ownership or involved organizations: the organizations involved in MSIs range from mining companies, SC actors and governmental organizations to civil society and non-governmental organizations (NGOs). Whereas in some MSIs only one or a few groups are present, more recent MSIs are organized as multi-stakeholder initiatives [27].

Mineral focus: whereas certain MSIs such as the Initiative for Responsible Mining Assurance (IRMA) have no particular mineral focus, most do, which is related to their origin as an industry or stakeholder initiative aiming for improvement in a particular sustainability issue (focal issue). Minerals covered range from coal, aluminium and dimension stones as examples for mass raw materials to gold and diamonds produced in small amounts only. Some address several mineral raw materials if these share common characteristics, for example, the conflict minerals tantalum, tin, tungsten and gold (3TG) or cyanide use in gold and silver production.

Supply chain coverage: the SC of metals is typically divided at the smelters/refiners into an upstream and a downstream part since this position represents a bottleneck [5,25] and afterwards tracing a mineral is in general infeasible [28]. Coverage may be limited to mining and beneficiation, the upstream part or just smelters/refiners (e.g., for conflict minerals) or the entire SC, partly including also recycling [1]. Different chain of custody systems [28] apply: segregation in case of more precious raw materials and in cases where price premiums are paid and mass balance or book and claim approaches for mass raw materials, cf. [1] for details.

Firm size: firm size determines the applicable mining practices and is thus relevant for an MSI. The majority of MSIs address large scale mining (LSM). Few MSIs are explicitly dedicated to artisanal and small-scale mining (ASM) [1] or size-independent. Explicitly for medium-sized companies, there are only specific standards for dimension stone and conflict minerals [1].

Sustainability issues: MSIs differ here partly as a result of the minerals in scope. Whereas for conflict minerals information about the origin of a mineral raw material might be sufficient, most require the achievement of performance levels in a variety of sustainability sub-issues (cf. Table 1 with overarching categories and issues), others require the establishment of management systems or commitments or self-reporting [5,26]. The performance levels that need to be achieved by the certified organizations are sometimes defined in a progressing manner, i.e., the requirements set by the MSIs are rather low for organizations entering but increase over time. This allows organizations to join and become certified that do not perform that well yet and would be discouraged by too ambitious requirements. Integrated in and supported by the MSI, these organizations have the possibility to develop and improve their mining practices and are motivated to do so. Otherwise they must fear being expelled. This is particularly important for ASM companies which often lack the knowledge and the resources to improve their mining practices on their own [29]. Regarding the life cycle of a mining project, exploration is rather seldom covered and mine closure related activities such as renaturation or recultivation and the build-up of necessary funds are also often lacking [1,26].

Table 1. Sustainability categories and issues in multi-stakeholder initiatives (MSIs) for mineral raw materials (after [1]).

Category	Issue
Human and workers' rights	Serious human rights abuses Terms of employment Occupational health and safety
Societal welfare	Community rights (Local) value added
Use of natural resources	Land use and biodiversity Water use Energy use Material use
Emissions and land reclamation	Closure and land rehabilitation Mine waste and waste water Air emissions and noise
Company governance	Business practices Management practices

Institutional design: Like every organization, an MSI is characterized by an organizational structure such as a board of directors, members, possibly a plenum etc. and processes implemented both internally and externally. An example for an internal process is the standard setting and revising process, whereas audit processes are typically external [20]. Complaint mechanisms and whistle blowing are further important processes. Some MSIs offer supporting services such as capacity-building measures. The institutional design is highly relevant for transparency as a key aspect for an MSI to gain credibility which is also relevant for its success as a social innovation that is presented next.

2.2. Social Innovation

Social innovations are a developing topic that is scattered across a variety of disciplines and that focuses on the stimulation of actors to find and implement new ways for addressing societal challenges such as climate change, ageing, poverty, or environmental pollution [30–32]. Social innovation has particularly built foundations within the global struggle for sustainability. In effect, it revolves around the idea of complementing the traditionally more technology-focused concept of innovation with a non-technological, i.e., social, component that aims at changing the way we act as a society and how we make sense and make use of innovation at large [30,31]. Contributing to this debate, the Organization for Economic Cooperation and Development (OECD) has launched a Social Innovation Forum in the year 2000 already within its LEED (Local Economic and Employment Development) programme. This forum defines that social innovation “deals with improving the welfare of individuals and community through employment, consumption or participation, its expressed purpose being therefore to provide solutions for individual and community problems” and, moreover, that a social innovation “can concern conceptual, process or product change, organizational change and changes in financing, and can deal with new relationships with stakeholders and territories” [33]. This study adopts this two-sided focus on stakeholder related organizational change on the one hand and the change in practice or impact on the other hand (see also [21]). We argue that MSIs for responsible mining fit this definition as they represent an organizational change by integrating different stakeholder groups to develop their own governance system, as will be shown in the following section. Moreover, this governance system defines requirements and, in some cases, also provides guidance and tools with the aim to foster responsible mining in practice. This way, MSIs support the improvement of societal welfare, as shown in Section 2.2.2.

2.2.1. Multi Stakeholder Initiatives as Social Innovation

Most MSIs are founded in reaction to conditions considered as unsatisfying or non-legitimate, i.e., undesirable, improper, or inappropriate [16] by certain actors. For example, the Forest Stewardship Council (FSC) MSI was founded in 1993 in reaction to deadlocks in intergovernmental negotiations in forestry policy at the United Nations Earth Summit of 1992 in Rio de Janeiro as a private organization to reach consensus among important stakeholders [20,34]. This underlines FSC's character as a social innovation, as it enabled a new way of crafting a solution to a societal challenge. Moreover, this solution was non-technical but relied on the involvement of relevant actors. Legitimacy is reached on the one hand by the purposes aimed at (output legitimacy), the stakeholders involved as well as their reputation (input legitimacy), and the governance (procedural fairness) of the MSI (throughput legitimacy) [22]. For example, FSC reached high input legitimacy by integrating environmental protection organizations such as Worldwide Fund for Nature (WWF), Greenpeace and Friends of the Earth in the process [34]. This "coming together to do good" can be considered as a social innovation, as each group of stakeholder contributes a certain element to the success of the MSI, which is solving a pressing issue like deforestation, overfishing or non-responsible mining. These issues originate from one industry that is seeking economically optimal decisions or it originates from individuals trying to subsist by logging, mining or fishing. Moreover, we see that fish, wood, and minerals are globally traded commodities that easily pass national and industrial sector borders, which pushes traditional governance to the limits. Additionally, individual action directed at subsistence like artisanal gold mining leads to societal challenges such as soil and water contamination with mercury that threatens agriculture and fishing [13], for example along the Amazon river [35]. In effect, solving these issues requires two main aspects.

The first is the involvement of key stakeholder groups: (a) at least those spending legitimacy, such as NGOs, (b) those implementing the defined standards (formal and informal organizations), and (c) possibly those building the bridge to clients that in the end have to finance the activities by paying a higher price or by discriminating against non-compliant products [20]. While participation in authority-based governance typically requires an ex ante formalization, informal actors may gain a voice in an MSI. Interesting examples in this regard are the Fairtrade standards that are established for 18 commodities from sectors like agriculture, mining, and textiles [36]. These are focusing explicitly on small producers in developing economies that are typically disadvantaged by the economic system established in their environment. For solving the challenges of the farmers and miners, Fairtrade is not only covering their operations, but also those of traders and buyers that exploit asymmetries of information as well as of supply and demand on local as well as global markets [29,37]. Moreover, the MSI Aluminium Stewardship Initiative (ASI), which is focused on industrial mining, takes an explicit focus on the entire SC and life-cycle of aluminium. This is based on the acknowledgement that single organizations or single industries are not able to solve the sustainability challenges in the aluminium SC. This is due to the SC's complexity and the particularities of the involved industries and countries that need to be addressed in an integrated manner [38].

The second aspect is that a well-thought-out design of the MSI is required that is typically composed of four main components [5,20,39,40]: (i) the standard requirements describing the sustainability criteria that need to be fulfilled to be compliant with what the MSI considers necessary; (ii) the standard-setting process comprising the procedures of setting and revising the standards; (iii) the implementation often reduced to compliance checking, i.e., the audit scheme implemented, but also referring to all activities the MSI undertakes to put their standards into practice such as capacity building; and (iv) the governance comprising the operational and organizational structure of the MSIs, with decision making and whistleblower mechanisms playing important roles but excluding the standard setting process mentioned above.

The current literature offers several analyses of MSIs. Tröster and Hiete [20], for example, provided an analysis of 226 academic papers on voluntary sustainability initiatives that mostly represent MSIs. More specifically for this study, Kickler and Franken [1] performed a detailed review of 19 MSIs for

responsible mining based on material published by the MSIs such as websites, standard documents, certification manuals or progress reports. They further asked for feedback from the MSI resulting in a consolidated characterization of a large number of MSIs in this field. The descriptions and characterizations of the MSIs coming from this body of literature can thus represent a valuable piece of information for further analyses, for example [1,15,18,20,23,27].

2.2.2. Understanding Responsible Mining as a Social Innovation

The focus of social innovation on new solutions and changed practices is echoed in the debate on responsible mining or responsible sourcing that are defined as “the management of social, environmental and/or economic sustainability in the supply chain through production data” [3] (p. 391). Although the definition of responsibility given transcends the boundaries of social sustainability in a narrow sense, it nevertheless focuses on a comprehensive contribution to the welfare along the SC. However, a SC always starts with raw material production such as in agriculture, forestry, or mining. These basic economic actions are the prerequisite of today’s often global SCs [41]. Moreover, mining has been found to be one of the most impactful economic operations with more than 30 Millions of formal and informal miners [10]. This social relevance is complemented by long-lasting and far-reaching environmental degradation of mine sites and surroundings as well as resource consumption, at least if the mine is poorly managed and operated [3,7,8].

Responsible mining is thus vital for “improving the welfare of individuals and communities through employment, consumption or participation” as called for by the OECD [33]. However, the dominance of other goals, such as economic performance, short-term profits, insufficient knowledge but also price pressure and increasing demand at the global mineral market, has long impeded the diffusion of more responsible mining practices [2]. This development as well as the exhaustion of mines in industrialized countries shifted mining operations in particular to regions lacking labor protection as well as poor social and environmental legislation and/or enforcement. In response to that, the mining sector has been focused by different governance approaches that are reviewed next.

2.2.3. The Dual Role of an MSI for Social Innovation: An Analytical Framework

Synthesizing the conceptualization in Section 2.2 results in the analytical framework presented in Figure 1. The framework distinguishes three zones starting from its center: (1) the internal structure and processes within an MSI termed *governance of the MSI*, (2) the direct MSI environment with which the MSI directly interacts and that it aims to govern (3) the indirect environment which includes authorities and the wider public that are not immediately governed but might well be influenced. The framework adopts the two-sided focus of social innovation outlined in Section 2.2 on *stakeholder-related organizational change* and *change in practice*. Building on Section 2.2.1, *governance of the MSI* can be divided into three main parts [5,20,39,40]: *ownership of the MSI* [5], i.e., who is member of the initiative, the *definition of scope*, i.e., the challenges that the MSI wants to address, and the *institutional design* of the MSI as an organization, i.e., the underlying processes necessary for developing, negotiating and revising the prescribed requirements and practices. “Member” of an MSI is understood in a rather broad sense and includes all organizations that are steadily involved in determining the direction of the MSI, even if they are not real members, for example, organizations invited to join the standard-setting process or external organizations on the board of directors. Since MSIs are voluntary, the different decisions regarding the governance of an MSI strongly influence how stakeholders perceive an MSI and regard it as beneficial for solving their problems which affects the implementation of responsible mining as the supposedly ultimate goal of an MSI. We acknowledge that an MSI might have different goals than a real change towards responsible mining in practice, such as appeasing critical stakeholder groups.

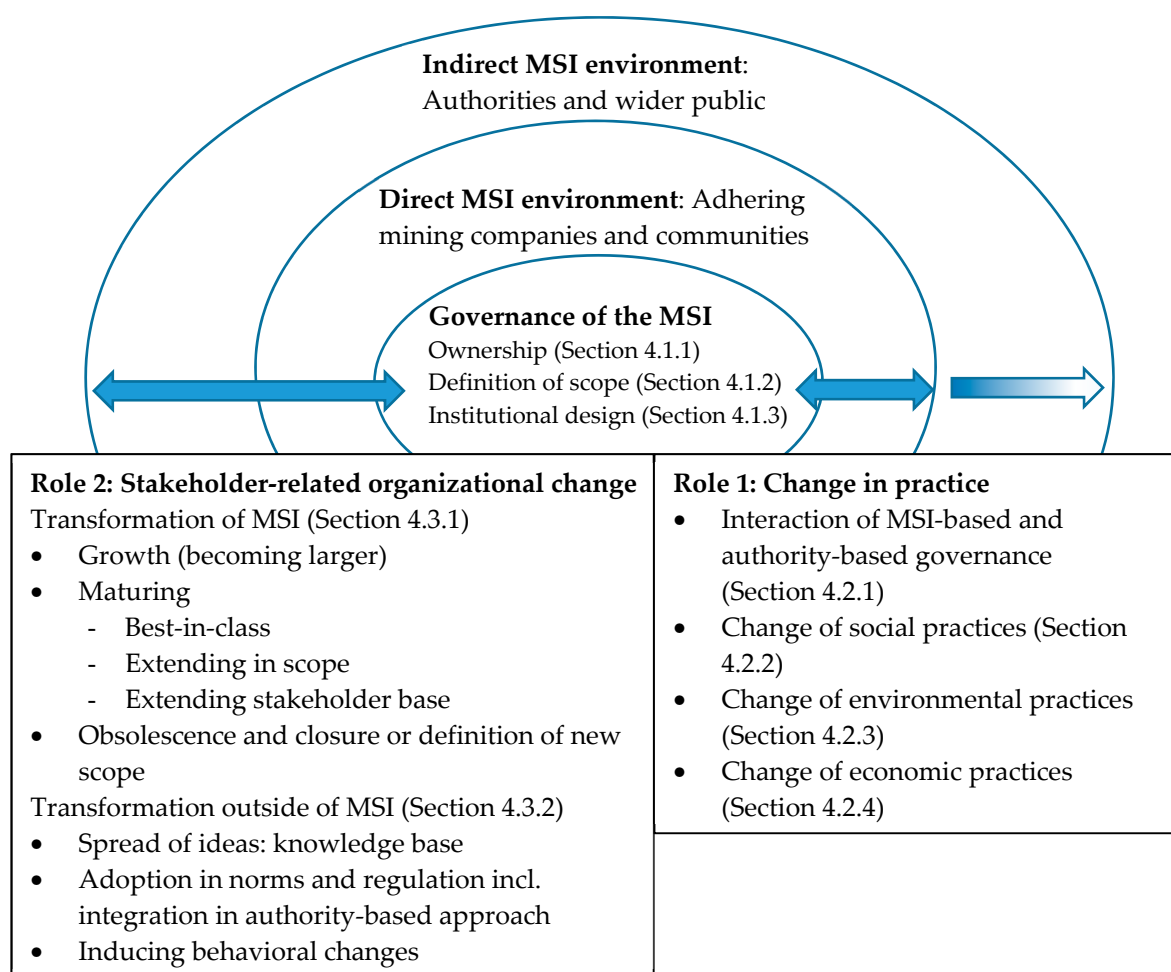


Figure 1. Analytical framework (including references to the further sections).

To understand the role of an MSI for fostering responsible mining, it is also necessary to analyze the limitations of the authority-based approach and whether the three sustainability dimensions are equally accounted for, i.e., how the triple bottom line (TBL) is addressed in the standard. Finally, the MSI needs to *diffuse* the developed solution (*transformation outside of MSI* in Figure 1), i.e., the responsible mining practices and mind-sets through the entire sector to enable the realization of a more sustainable economy. This diffusion and the associated transformations outside and inside the MSI have scarcely been addressed in prior research [23,25] and are difficult to track due to the strong dynamics in the sector that is constantly building new MSIs, while others become inactive [1,18,25]. Still, we adopt the conceptualization of MSI diffusion by Dremptic et al. [23] that distinguishes three transformation paths for MSIs (*transformation of MSI*) and broaden it by adding the underlying steps of MSI growth (becoming larger), of MSI maturing with best-in class, extension in scope and extension of stakeholder base, and obsolescence and closure or definition of new scope. We see this addition as necessary to fully understand the diffusion of responsible practices and associated transformations in the sector and MSIs. This is based on the understanding that diffusion represents “the process by which information, ideas, changes in behavior, etc. spread through a group” [42].

The central part of the framework in Figure 1, that is the *change in practices*, is clearly the most interesting from a social innovation perspective, as the two sides of the social innovation intersect. On the one hand, the voluntary *change in practice* represents a novel solution that is substantially different from the authority-based implementation relying on legislation and sanctions [18,20]. Moreover, the voluntary change based on stakeholder consent and legitimacy reached in the MSIs’ bodies and the formation of standard requirements is different from a market-driven implementation as it positions

the solution of a societal challenge as a counterweight to pure economic objectives. This novel way of *change in practice* is focused in the first research question. Furthermore, it aims to change the practices of the related industry to more responsible ones than the prior way of operation that are focused in the second research question. As outlined in the literature review above, there is some literature on MSIs, but the aspect of how exactly these MSIs contribute to the solution of societal challenges beyond authority-based governance is of particular interest to this study. We will thus leverage on different sources of evidence to provide insights regarding the three parts of the framework and explain the details of the method applied in the following section.

To further analyze the *change of practice*, we see two essential aspects. First, the reviewed MSIs represent social innovations that enable the fulfillment of high-level institutional innovations. We thus analyze the link of the MSIs to such national or supra-national institutions that have been found to be major drivers of responsible mining [3,5,43]. Second, the social innovations aim to implement responsible mining or sourcing that focusses on the three dimensions of the TBL, i.e., social, environmental, and economical sustainability [3,44]. The TBL dimensions thus complement the analysis to enable a comprehensive evaluation of the implementation before the diffusion can be investigated. The items in Figure 1 are further detailed in Sections 4.1–4.3, 5.1 and 5.2

3. Materials and Methods

This study adopts a combined research approach to enable a thorough investigation of the research questions. This framework comprises two steps that are depicted in Figure 2. In step (1), an analytical framework has been built based on conceptual reasoning [45]. This aims to build a better understanding of complex relations such as the use of new ways of stakeholder interaction to address societal challenges and the change of practice in an industry sector due to stakeholder pressure for more responsibility and the adoption of legitimate practices. This is realized by means of a process of disciplined imagination, as proposed by [46], that aims at the generalization of the researched phenomenon as undertaken in the framework presented in Figure 1. Such a disciplined imagination is based on a continuous consultation of the theory captured in literature and “abstracting, generalizing, relating, selecting, explaining, synthesizing, and idealizing” it against the phenomenon one seeks to explain [46] (p. 389). As a result of the multiple iterations, the relevant constructs can be defined that make a difference regarding the researched phenomenon. These can then be synthesized in diagrams or frameworks that build the basis for further analysis. While this approach of theorizing is borrowed from the social sciences, it is nevertheless well suited to the analysis of social innovations that seek novel and non-technical solutions to societal challenges. In order to enable an analysis based in the also more technical domain of responsible mining, we had to balance the literature base towards a coverage of the social as well as technological issues relevant to the topic. We thus consulted technical reports and papers [1,5,24,25,27] alongside social science sources [21,30,31,33]. Combining these insights into the analytical framework in Figure 1 enables the application of a social innovation perspective on MSI for responsible mining as it is done in the second step of the analysis.

This second step uses literature-based evidence to fill the parts of the framework and contribute to answering the research questions. This evidence is based on a review of the existing literature that integrates academic and practitioner literature alike to extend the knowledge on MSIs as social innovation and to deliver empirical evidence on the implementation of the social innovation. To realize this, the review is based on the content-analysis based literature analysis method proposed by Seuring and Gold [47]. Such a literature analysis consists of four steps that encompass (a) the collection of material, (b) a descriptive analysis, (c) the selection of suitable categories for the analysis, and (d) the evaluation of the material [47,48], as depicted in Figure 2. By building on content analysis, we again rely on a method established in the social sciences. This is one of the prime approaches for a rule-governed and replicable analysis of any form of written communication [48].

Such an approach that is solely focused on written communication is of course subject to several limitations that originate from the procedures applied in the single parts of research step (2) that are presented in the following sections to ensure the replicability of the study.

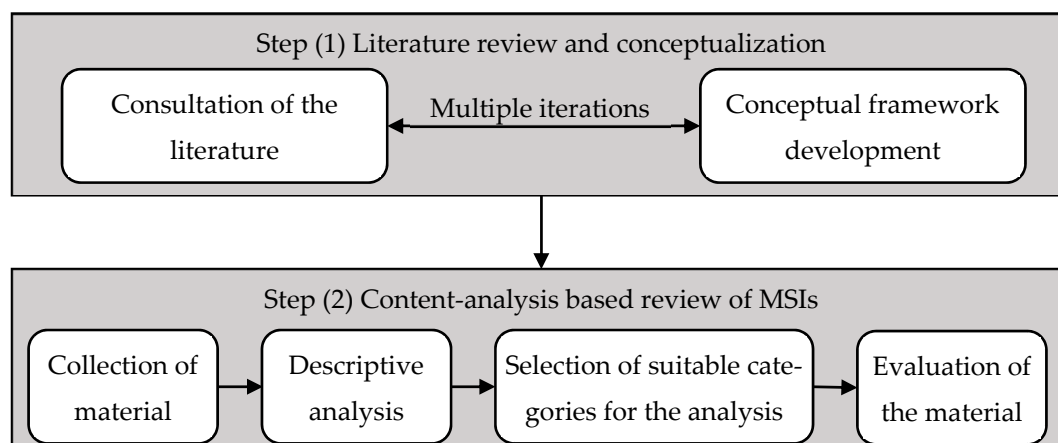


Figure 2. Research framework.

3.1. Collection of Material

In light of the existing literature on the *governance* of MSIs [1,20,39,40] and their *diffusion* [18,23] as well as the standard documents published by the MSIs themselves, we opted for a combined approach to reviewing the literature. This approach is quite unusual in the field of MSIs for responsible mining, since the available reviews focus either exclusively on academic literature [20,43,49] or practitioner documents [1,5,15,25]. However, such a combination of data sources has been called for in recent literature on academic literature reviews, as it offers new insights that go beyond established paths and mainstream ideas [49] that have led societies to the challenges social innovation wants to address [30,31]. The applied method thus builds in step (1) (cf. Figure 2) on the already available comprehensive reviews in the field of MSIs [15,20] that delivered an elaborate picture on the academic side of the debate. Combining this with a systematic review of the currently available standard documents of the MSIs for responsible mining promises to enrich our understanding of MSIs as social innovations in general and the way MSIs for responsible mining change industry practice in particular. To achieve this goal, we consolidated and updated the data sources of prior studies of MSIs for responsible mining such as [1,5,25] to arrive at a current and comprehensive set of MSIs for responsible mining. This search process resulted in a set of 20 MSIs that is reviewed by analyzing their core standard requirements that are published in the following 27 sources [28,38,50–74]. These documents represent the second part of the sample, that is, the practitioner literature. The numbered full references at the end of the paper establish the traceability of the reviewed data that is necessary to ensure the replicability of the study [47,49]. This literature set consists of a total of more than 1000 pages of documents that provide mainly insights into the practices the MSIs define as legitimate to solve the challenge they address and the means to implement them.

As a result, role 2 of the framework will mostly be populated with insights from the academic literature from research step (1), while role 1: *change in practice* will mainly rely on the results of the review of the MSI documents in research step (2).

3.2. Descriptive Analysis

The descriptive analysis outlines the formal characteristics of the reviewed material [47]. We focus here on the MSIs' documents, as these are central to the study's interest. In contrast to a typical descriptive analysis of academic material, this descriptive analysis aims to structure the scope of the

MSIs in terms of ownership, mineral focus, and supplier coverage that have been found to be critical to the solution of sustainability challenges in the minerals sector.

First, we argue that the ownership of an MSI has a major influence on all levels of the framework. It has been found to shape the recruitment of new members as well as auditors and influences the decision making of the MSI as well as its stakeholder engagement and the communication of any activities and performance [5,20,27]. Even more so, the ownership directly influences the sustainability aspects covered and likely their stringency.

Second, the mineral focus of an MSI has an influence on the requirements it sets, the stakeholder it attracts as members, the people and organizations affected by the mining activities, etc. [1,18,25,43]. Moreover, it is evident that the mining and processing of certain minerals affects the use of specific processes and inputs, like the use of cyanide for the separation of gold and silver from non-valuable materials in large scale mining [65] or of mercury in artisanal and small-scale mining that produces approximately 70% of all mercury emissions [35,75]. Furthermore, the minerals have very particular market structures. For example, precious minerals such as gold or cobalt are attracting many ASM [13,14,50,63,76] as transport and trade of the mineral is far easier than that of low-value mass minerals such as coal [52].

Third, the supplier coverage is impacting the requirements. These need to become more diverse or inclusive with a rising number of processes to be certified that might range from mining and processing to manufacturing [1,3,18,21]. Furthermore, a wider coverage of suppliers has been found to be beneficial for stakeholder acceptance that is a precursor of an MSI's success [18,20,27]. The relevance of supplier coverage is also reflected by the fact that a rising number of MSIs are implementing traceability systems that cover entire supply chains or at least their most critical parts, in order to avoid any uncertified materials end up in certified products [1,5,25].

The results of this analysis are displayed in Section 4. Starting from this characterization of the material, moreover, it is crucial to define a clear and relevant set of categories for the analysis of the material as presented below.

3.3. Selection of Suitable Categories for the Analysis

To analyze the material against the research objective, that is, understanding MSIs as social innovation, there is a need to define suitable categories that allow for such an endeavor [47]. Building on the conceptual work in research step (1), we adopt the analytical framework developed in Section 2.2.3 and Figure 1 as the basis for the analytical categories in research step (2). This provides a somewhat longitudinal orientation with its three parts of *governance of MSI*, *change in practice*, and *stakeholder-related organizational change*. Moreover, the sub-division of these parts guides the analysis of factors relevant to characterize MSIs as a social innovation from a governance perspective, as they allow for the analysis of the stakeholder-related organizational change in the governance of mining operations. Furthermore, the *change in practice* has been further detailed by incorporating individual sub-parts aimed at portraying the link of the practices prescribed by the MSIs to authority-based governance structures and to the TBL dimensions that are central to the understanding of the societal challenge in focus, i.e., responsibility and sustainability of mining operations.

3.4. Evaluation of the Material

After selecting these categories, these need to be applied in the evaluation of the material, where the categories build the analytical frame for coding the reviewed material [47]. This is achieved by working through the texts and assigning relevant text passages to the categories that abstract the given passage. To enable such a coding in a rule-governed and replicable way, the unit of analysis has to be defined [48]. In case of this study, text passages starting from one sentence up to a couple of sentences, which describe a relevant piece of content, are the unit of analysis. This allows for the identification of relevant considerations that may need some space to be explained without the risk of an over-interpretation of single terms or formulations [48]. To further ensure the validity and reliability

of the analysis, the two authors conducted thorough discussions of the reviewed MSIs' documents and the category system amongst each other and with experts from industry and academia. Such discussions, also labelled as "discursive alignment of interpretations" [47] (p. 551) have been found to establish a more coherent and solid understanding of the categories and the material, which in turn enhances the validity and reliability of the analysis [47,48]. Moreover, the categories are based on well-established academic literature that ensures consistent definitions as a sound basis for an analysis.

Still, the use of a limited set of categories for analysis as well as the reliance on written communication is limiting the analysis. One of the main issues that needs to be taken into account is the nature of the analyzed material [48]. In the case of this study, we evaluate the value of the MSIs based on their own documents. This data base is of course prone to an overly positive result, as the authors of any text are likely to put themselves and their work in a favorable light. It is thus important to outline the issues that are not addressed alongside the ones found in the coding results.

Nevertheless, the application of the described procedures have by now been widely applied in the analysis of texts from interviews, academic papers, or practitioner documents [20,43,47,48,77]. This ensures reliability and replicability of the results that are presented next.

4. Results

The results are subdivided into the outcomes of the descriptive analysis that are presented directly below and those from material evaluation presented in the remaining sub-sections of Section 4.

The descriptive analysis offers a structure for the reviewed material that is oriented along the relevant characteristics of the material [47]. These cover in this case the ownership, mineral focus, and supplier coverage, that define the limits in which the MSI is active to address societal challenges. The distribution of the 20 MSIs across these three characteristics is displayed in Table 2, which adopts the supplier coverage as lead-dimension along which the distribution of the other two dimensions is oriented to provide an overview of the reviewed MSIs for responsible mining.

Table 2. Results of the descriptive analysis of the reviewed standards (n = 20; mineral focus: multiple foci possible).

Supplier Coverage	Extraction Only	Extraction to Export	Extraction to Smelter	Entire Supply Chain (SC)	Sum
No. of MSI	5	5	3	7	20
Mineral focus					
General	4	-	-	-	4
Tin, tantalum, tungsten (3Ts)	-	2	2	-	4
Gold	1	3	2	3	9
Silver, platinum, diamonds	-	3	-	3	6
Mass minerals	-	-	-	4	4
Ownership					
State	-	2	-	-	2
Industry	2	-	3	1	6
Non-governmental organizations (NGOs)	-	-	-	2	2
Industry and NGOs	2	1	-	2	5
State and NGOs and industry	1	2	-	2	5

The top lines present the *supplier coverage* of the MSIs, that is the parts of the SC that are covered by the requirements that these MSIs set and that have been found to be crucial for the comprehensive solution of environmental or social challenges in mining, as the SC represents the customer of the mines [5,18,78]. Here, a divided picture is striking, as there is either a focus on extraction and export or a comprehensive SC coverage. This mirrors the distribution of sustainability challenges that have a

clear focus in the mining and initial processing of minerals, while the rest of the SC is in tendency less prone to environmental pollution and adverse working conditions [5,77,78]. Following a life-cycle logic, nevertheless, it is clear that any sustainability issue deep in the SC will affect the total sustainability of any company and product associated to this supply [41,79]. This logic fuels the development of MSIs with a comprehensive SC coverage [22] that shows a substantial share with seven out of the 20 MSIs, whose governance is reviewed next.

The middle lines of Table 2 display the *scope of minerals* that are focused by the reviewed MSIs for responsible mining. It becomes obvious that the entirety of MSIs is still far away from covering the entire mining sector. Instead, there are key minerals such as very valuable ones like gold, silver, platinum, and diamonds that account for more than half of all counts in the mineral focus. For these minerals, multiple MSIs exist that compete for market coverage. This focus on valuable minerals is in stark contrast to the volume of minerals mined globally and does not represent a balanced coverage of the mining sector and its contribution to societal challenges such as environmental degradation, human rights violations, and adverse working conditions [5,7,8]. However, the valuable minerals mentioned above as well as the 3Ts often serve for financing armed conflicts (e.g., blood diamonds or gold in the African Great Lakes region) explaining in part the observed distribution. Another reason is the relatively high stakeholder awareness of gold and silver that are regularly to be found in jewelry. Since that is directly visible to customers, these are directly touched by reports about related sustainability issues. This stakeholder awareness is also mirrored if the mineral focus is cross-tabulated with the supplier coverage, as done in Table 2. Looking at the results, it is striking that these valuable minerals build the majority of MSIs that incorporate a supplier coverage beyond the extraction. Besides, minerals in general or mass minerals are underrepresented. This can be interpreted in a similar way than for the precious minerals. The mass minerals represented in MSIs are coal [52], natural stones [62,74] and aluminium [38]. All of them are subject to stakeholder criticism, for example, due to negative climate impacts (coal and aluminium) and the competition with other materials that are deemed more sustainable, especially wood in construction. The MSIs were thus established to cover against this and in the case of the ASI for “reinforcing and promoting consumer and stakeholder confidence in aluminium” [38] (p. 4). This is also one of the reasons for choosing a complete SC coverage for the mass minerals, since the majority of the criticism is associated with the adverse environmental and social conditions at the first stages of the SC [5,79]. Nevertheless, this criticism needs to be countered by companies and organizations at the other end of the SC that want to sell their products that are based on the minerals [77,78]. The MSIs focusing on 3Ts also aim to counter pressure on their SCs. However, this is mainly based on regulators that require reporting on the origin of the “conflict minerals” to which the 3Ts belong [5,79]. This is also underlined by the cross-tabulation that reveals that all three MSIs covering the “extraction to smelter” portion of the SC are focusing on the 3Ts and gold. Moreover, all of them are industry initiatives that serve the members to establish compliance to US American as well as EU regulation on conflict minerals [55] that is, however, outside the immediate focus of customers [5].

The bottom lines present the *ownership of an MSI* that is the range of stakeholders that are represented in the governing bodies of the organization [5,20,40]. It shows a clear dominance of industry actors that are represented in a total of 80% of the reviewed MSIs. These industry actors either created the MSIs themselves, or—as displayed on the right end of the table—jointly, for example, with NGOs or with NGOs and state actors. While the former six MSIs might be subject to criticism as the risk of greenwashing instead of progress towards solving the societal challenge is substantially heightened [18,80], the latter 12 MSIs (the last three rows in Table 2) counter this criticism with a balanced set of owners and related owners’ interests. Such a balancing can be achieved by incorporating NGOs (this is the case in 60% of the MSIs). It is nevertheless striking that, among those MSIs having one founding stakeholder group only, the mining industry is the most frequent founder. However, there is also a high share of MSIs in which several stakeholder groups are involved (Table 2), which underlines the role of MSIs as social innovation. The strength of the MSIs is thus to bring a diverse set

of actors together. These move beyond national borders and are responsive to the challenges addressed, as any set of actors can ask for or offer tailored solutions in the standard setting and revision process. Still, we can see in the descriptive analysis that the MSIs are widely influenced by the industry and are more reactive to stakeholder and customer pressure and less proactive. This causes criticism regarding greenwashing. The independence of MSIs from governmental processes and needs of representation is both an advantage and a disadvantage, as will be presented in the following sections.

4.1. Governance of the MSI

Governance covers aspects such as who initiated and founded and thus owns the MSI (ownership), what it aims for (scope), and how the MSI is organized (institutional design) [5,20]. The scope also is related to an MSI's function to foster responsible mining, that is the change in practice from the perspective of social innovation. This is further detailed in Section 4.2. *Change in practice*. By contrast, the first three items are important for the discussion of MSIs as a social innovation from a governance and organizational change perspective and are presented next.

4.1.1. Ownership of the MSI

Although it is largely impossible for outsiders to determine who initiated the formation of an MSI, an analysis of the founding members is nevertheless illuminative and highlights the social innovation inherent in most but not all MSIs. Bettercoal, for example, was founded by eight European electric utilities only [1]. Although this kind of cooperation between competitors for sustainable supply chain management is relatively new (other examples can be found in the automotive or chemical industry, in the latter as Together for Sustainability (Tfs)), we would not judge this as social innovation in the sense of role 2: stakeholder-related organizational change, as ownership and cooperation are limited to one stakeholder group only and the contribution of such MSIs to solving sustainability issues is partly criticized [1]. Similarly, but at the other end of the SC, the International Council on Mining and Metals (ICMM) is a chief executive officer (CEO)-led organization of 26 global mining and metals companies and 35 industry associations [81] representing thus the mining and processing industry side only. Of higher interest from a social innovation perspective are the other cases. For example, the ASI goes back to 14 companies of the supply chain [1,82] and, according to ASI, was founded by “the aluminium industry, civil society, research and policy organisations, and industrial users of aluminium products” [83]. To gain credibility and legitimacy, ASI then mandated the International Union for Conservation of Nature (IUCN), a membership union of more than 1300 government and civil society organizations [84], to host and coordinate the standard-setting process [83]. Other MSIs, in particular those focusing on ASM, have their origin in the engagement of NGOs such as the MSIs Fairtrade and Fairmined Standards. These NGOs bring the challenges of ASM to the fore that traditionally have no lobby and often remain in an informal and illegal state [29,76]. This blocks them from a sound representation in and protection by authority-based governance solutions [14]. But there are also examples for MSIs integrating practically all relevant stakeholder groups. The Initiative for Responsible Mining Assurance (IRMA) was founded by a “coalition of non-government organizations, businesses purchasing minerals and metals for resale in other products, affected communities, mining companies, and labor unions” [85]. Bringing these stakeholder groups together is truly a social innovation and as a result IRMA is regarded as the MSI with “the most comprehensive and legitimate catalogue of requirements” [1] (p. 31). Surprisingly, Tröster and Hiete found that IRMA meets the demands of different stakeholder groups on design characteristics less well than others, possibly as it was still in development [27].

4.1.2. Scope of the MSI

Scope refers to both the goals of an MSI and its focus on certain (groups of) minerals, company scales, geographical regions, supply chain parts or—as in the case of the “International Cyanide Management Code For the Manufacture, Transport, and Use of Cyanide In the Production of Gold”

(Cyanide Code)—a mining practice. The MISs' goals vary and extend from strengthening the social license to operate through commitment and reporting (e.g., ICMM), to professionalization of and improvements in ASM (e.g., Fairtrade, Fairmined), providing information for more sustainable purchasing decision making (Bettercoal or Fairstone), ensuring compliance with the Dodd–Frank Act for downstream actors of the supply chain (e.g., the Conflict Free Smelter Initiative, CFSI) to making a positive sustainability impact in mining and processing, cf. [1]. The example of the MSI Bettercoal is somehow ambiguous. On the one hand, it is blamed for greenwashing by the German NGO *urgewald* [80]. On the other hand, it achieves one of the higher positions with respect to sustainability sub-issues covered in its code, but a low position for its level of detail [1]. This highlights the difficulties when evaluating MSIs: first, should an MSI be measured against current sustainability performance of certified organizations or against the progress made and how much time should be given for changes towards sustainability? Second, mine sites are operated for a longer period and by the same companies. So, how should an MSI deal with past injustice? Third, even legal mining practice in developed countries, such as mountain-top removal for coal mining in the U.S.A., is rightly considered as largely unsustainable. So, drawing the line of what is considered unavoidable and acceptable for a particular purpose and what is not is often controversial. This question is likely not separable from the purpose of mining. The acceptance for coal mining, for example, is likely also lowered due to the greenhouse gas and other air emissions during its combustion and the fact that cleaner alternatives exist.

Interestingly, however, most schemes “lack a proper impact monitoring and cannot give evidence for actual improvements on the ground” [1] (p. 24) creating some doubts since impact monitoring is a prerequisite for further improvements. The social innovation perspective thus becomes apparent in two different ways: first, the aim for changes in practices towards sustainability (cf. Section 4.2) and, second, the circumstances under which different actors come together to achieve these goals. Compared to the authority-based approach, MSIs are neither bound to national borders or neutrality nor limited by risks to intermingle in other countries' sovereignties. For example, an MSI can positively discriminate by ensuring that certified products receive price premiums at the market (Fairtrade) or simply engage with interested, mostly better performing actors and companies. The latter is more difficult in an authority-based approach, although, for example, the European Union's voluntary Environmental Management and Audit Scheme (EMAS) grants some facilities for certified organizations. Anyway, private voluntary cooperation may be better suited to support the willing without the need to be considerate of the unable or unwilling. Focusing on frontrunners bears, however, the risk of losing the others. Therefore, several schemes foresee entry and over time increasing requirements suitable for currently low-performing companies and provide capacity building and guidance to improve performance over time which is particularly relevant for ASM. For example, the Alliance for Responsible Mining (ARM) with the Fairmined Standard develops an additional Entry Standard for gold from ASM [1]. From an impact-oriented perspective, MSIs represent only a successful approach if they are in widespread use or if they pave the way for common ground (cf. [18] as well as Sections 4.3.1 and 4.3.2) as is the case of the Certified Trading Chain (CTC) that was integrated into official state documents in Rwanda and Democratic Republic of Congo [1]. So, although we see a wide scope of the MSIs that in their totality might address all relevant sustainability issues in mining, there is a need for further development of the MSIs. Otherwise, the MSIs might continue to suffer from greenwashing and non-efficiency criticism that harms their potential as a social innovation. This is, however, not only referring to their scope, but also to their institutional design that is presented next.

4.1.3. Institutional Design of MSIs

Once founded, MSIs need to be governed through appropriate processes and an organizational structure. Their design affects acceptance among stakeholder groups. Acceptance is a key issue for MSIs as, in contrast to authorities, their existence and widespread use depends on gaining acceptance among important stakeholder groups [18]. Key items affecting acceptance include progressivity of requirements, traceability of products, intensity of audits, availability of capacity-building measures, implemented

complaints mechanisms, the stakeholder composition and transparency [20,27]. The relevance of the items differs between stakeholder groups and being founded by a *multi*-stakeholder group does not necessarily mean performing better here, at least when compared with MSIs founded by supply chain actors or civil society [27]. However, lately formed MSIs tend to perform better than older ones [27]. Overall, this dependency on acceptance by different stakeholder groups is both a strength and a weakness. It forces an MSI to maintain a negotiation process continuously and to balance the views of its stakeholders. The result of this process should be an up-to-date, from a sustainability perspective demanding but still economically feasible compromise—as long as the different positions are accepted by the stakeholder groups. It can be speculated that the direct exchange between the stakeholder groups results in relatively fast negotiation and update processes allowing them to react more quickly to changing framework conditions than authority-based solutions such as legislation. In case of IRMA, however, the initial standard-setting process lasted 10 years [1] showing that the process may be longish, too. Furthermore, whereas the development of legislation often lacks transparency with widespread lobbying in back rooms, particularly from industry, integration of stakeholder interests in MSIs is an open fact and the need to acquire authority from the stakeholder groups should prevent unbalanced outcomes. However, it is also evident that MSIs do not show a separation of powers as the authority-based approach does. Whereas audits are often performed by third parties providing some distance between standards setting and execution, a neutral organization for settling disputes is largely missing. Problems may also arise if an MSI affects stakeholder groups that are not involved. Finally, although we talk of “stakeholder groups”, in general, there are just one to a few “representatives” per group involved and there is no way to assume these are really representative or have any legitimation to represent the group. In the final analysis, in contrast to the authority-based approach, the MSI-based one is likely not applicable in case of unpopular measures for one or several of the stakeholder groups. This may explain why impact monitoring is underdeveloped and compliance apparently not that important. In the case of the Responsible Jewellery Council (RJC) (one of the few MSIs with impact monitoring), 62% of the certified organizations infringe the MSI’s requirements [1].

These insights provide first contributions to the research questions, but it is furthermore important to analyze in which areas MSIs aim at changing the mining practice that is reviewed next.

4.2. Change in Practice

Social innovation focuses on establishing more responsible extraction and beneficiation activities in the mining sector and is directly addressed by the reviewed MSIs. Adopting the dual role of MSIs as social innovation, this section sheds light on the governance role of MSIs in the first Section 4.2.1. and their role in changing practices in the remaining Sections 4.2.2–4.2.4.

4.2.1. The Interaction of MSI-Based and Authority-Based Governance

To better understand in which areas the MSI-based approach has the potential to change practices, it is important to see how the MSI-based and authority-based governance approaches interact. The MSI Bettercoal, for example, focuses on “developing guidelines, tools, and methodologies to improve ethical, social, and environmental practices at the coal mining site level” [52] (p. 3). This quote shows that Bettercoal aims at operating at a higher level of detail than state regulation or supra-national frameworks that often also cover multiple industries. This increase in detail does not refer to the level of detail at which sustainability issues are described (here Bettercoal performs rather poorly [1]) but the level at which guidance is provided, such as in case of Bettercoal actionable tools and methodologies that offer concrete solutions to the specific sustainability challenges of mining and processing of a specific mineral. MSIs that focus on fairness, for example, explicitly define minimum wages or price premiums, while the Cyanide Code is very specific on the sealing of cyanide handling areas to prevent emissions to the environment.

An example of a supra-national framework in the mining sector are the OECD Due Diligence Guidelines that require “an on-going, pro-active and reactive process through which companies can

ensure that they respect human rights and do not contribute to conflict” [28] (p. 8). Additionally, Section 1502 of the US Dodd–Frank Act imposes reporting requirements regarding the use of minerals from conflict affected areas, so-called conflict minerals—mainly tantalum, tin, tungsten and gold—in the SCs of companies listed at US stock exchanges [5]. These frameworks represent institutional innovations that are put into practice with the support of some of the reviewed MSIs. The CFSI, for example, stated that its standards are specifically designed to assist downstream customers in their compliance with Section 1502 of the Dodd–Frank Act [54]. It is thus essential to understand the relation of the MSIs to the authority-based governance approach.

Each of the analyzed MSIs’ standard documents explicitly reference national regulation, mainly by clarifying that national law may not be violated. The MSIs often define requirements that are stricter than authority-based ones. Examples encompass minimum ages of workers that are 15 years for non-hazardous and 18 years for hazardous work [38] “or the minimum age outlined in national law, whichever is higher” [67] (p. 38). However, the MSIs’ requirements leave room for national or local specificities by defining, for example, that “public holidays and night work must be paid at a factor of two unless otherwise defined by national legislation, by CBA [collective bargaining agreement] or by agreements with unions” [63] (p. 49). This is beneficial to local stakeholders such as unions, but also undermines the aim of having global rules like a fixed minimum wage and might allow for a race to the bottom in cooperation with local stakeholders. Still, such a discussion on the value of local versus global legitimacy of sustainability actions is a highly difficult topic and beyond the scope of this study.

Other regular references go to supranational governance frameworks like the OECD Due Diligence Guidelines and the conventions of the International Labor Organization (ILO). This practice is beneficial for the interoperability of the MSIs, i.e., the applicability of multiple MSIs to address a single problem with a single solution instead of an individual solution per MSI [23]. Moreover, such references to international guidelines have been found to enhance the legitimacy of an MSI, as they build on a wider set of stakeholders and commonly accepted rules instead of creating new ones [18].

Finally, the MSIs focusing on conflict minerals reference the US Dodd–Frank Act and the European regulation 2017/821 that require monitoring and reporting actions from mineral importing companies. Thus, this complements the more production and export-oriented legislation on minimum ages and wages mentioned in the second paragraph of this section. The fulfillment of these actions is supported by a number of the reviewed MSIs [53–57,59,68,71], that are thus closely related to the two regulations.

These insights provide a first set of answers to the second research question that centers on how MSIs can complement the traditional authority-based governance approaches. The results, moreover, show that the two roles of MSIs can hardly be separated, as the change in practices is enabled via a change in governance. This combination of changes opens a space for the reviewed MSIs to reference existing regulation and amend it with requirements regarding practices that are legitimate to the entirety of the MSI owners and members and that are actionable for the certified organizations and companies. The issue of actionability is especially relevant with respect to the rather abstract supranational governance that is often applicable to many industries and needs to be translated into industry-specific requirements. This role is taken over by the MSIs that thus enable a change in practice. However, although the MSIs try to elevate nationally divergent regulation to a standard level, they still lack the means to enforce this change since they are voluntary. The MSIs and the legitimacy they can offer to compliant organizations can thus only be seen as a voluntary incentive that offers a reward for implementing more responsible practices and exceed national regulation. Still, the MSIs cannot enforce this change unless it becomes an industry best-practice or it diffuses into the authority-based governance. The details of this change to more responsible practices are presented in the following sub-sections that show what focal issues are addressed by the MSIs’ standard documents.

4.2.2. The Change of Social Practices in Mining through MSIs

Since social innovations focus on solving social problems, this category of practices is particularly interesting for answering the first research question. This interest is further fueled by the fact that

conflict minerals that are associated with civil war financing, forced labor, and human rights violations in mining regions [5,28,79] are the focus of half of the 20 analyzed standards. These severe issues are addressed by the MSIs by referencing the ILO conventions on workers' rights and working conditions [52] and defining a total ban on forced labor by means of debt bondage due to, for example, recruitment fees or retaining official documents of workers or any restrictions to the freedom of movement [38]. Finally, workers are protected from discrimination due to gender, religion, age, origin or any other conditions [38].

Besides the workers, the social practices address larger societal issues and the standards implement the protection of cultural heritage that might be destroyed or otherwise affected by mining operations [52,67]. Moreover, indigenous people and their lands are protected by the MSIs [38,72] since such small minorities often have at most a very limited say in national or regional parliaments or administrations.

While the aforementioned requirements are all representing legitimate issues, we again need to balance them against their enforceability by a voluntary MSI. In effect, it has to be contended, that the MSIs offer guidelines that will be evaluated on a cost-benefit ratio by mining companies. Nevertheless, the MSIs raise the awareness of local and other stakeholders for issues of exploitation and discrimination that have largely gone unnoticed before. While the guidance by the MSIs might not impact the mining companies too much, they nevertheless offer guidance to the workers on how they should be treated. Ideally, the MSIs complement their requirements with an anonymous whistle-blowing or dispute settlement procedure that gives a better voice to previously unnoticed individuals. Again, this is not as powerful as authority-based governance, but it paves the way to improved rights of workers, communities and indigenous people.

Beyond the pure protection of stakeholder rights, the standards are also driving the information of stakeholders regarding their rights as well as building the capacity of stakeholders to enable them "to campaign for legislation and public policies that promote their rights and enable a responsible ASM sector" [50] (p. 4). The MSIs, moreover, help to provide sufficient information to the stakeholders so that they can actively take part, for example, in risk assessments and other decision-making processes. These practices are prescribed to be conducted in an appropriate manner in terms of language and timeliness to avoid greenwashing via an intentional misinformation of stakeholders [67]. Beyond and above providing information, nine of the 20 standards require the implementation of complaint mechanisms concerning, for example, working conditions [62,67], sourcing conditions [38], human rights [73], and environmental protection [50]. These measures are a valuable complement to authority-based governance that may foresee stakeholder consultations but cannot inform the stakeholders sufficiently to enable their participation.

In addition to the protection of rights and enabling stakeholders to take advantage of their rights, the standards also aim to build the basis for economic prosperity during and after active mining. Such measures aim at avoiding the exploitation of a community's resources without a legitimate contribution to the community and the miners. Thus, this can happen on the level of the individual miner, who might well be subject to exploitation by armed groups that use physical violence [50,79] or middle men that use debt bondage or information asymmetries to exploit miners [29,63,86]. The MSIs aiming at fair conditions thus try to establish secure and reliable points of sale and price premiums for ASM miners [50,63]. Fairmined Gold, for example, outlined premiums of 4000 USD per kilogram of gold or platinum as well as 100 USD per kilogram of silver [50]. These premiums help to resolve debt bondage and enable the formal acquisition of mining licenses [14,76] and enabling a process of "progressive organization and formalization of the ASM sector, bringing with it improved labor rights [and] safer working conditions for miners" [50] (p. 4) (see also [29]). Only this formalization of ASM and informal miners enables their representation in and protection under authority-based governance approaches and is thus crucial to resolving their discrimination [14].

Focusing on the mining communities and regions, the MSIs impose requirements on transparent and fair tax payments [59,61] which ensure that the mining sector is contributing its share to the tax

authorities that enables an enhancement of the societal welfare. Moreover, the provision of education and health services is prescribed to actively contribute to the societal welfare. Additionally, education is seen as a main pillar for enabling a stable economy if the mining operations end and other jobs are needed.

In effect, the results of the analysis of the social practices show an overwhelming relation of the governance approaches. Solving individual and societal problems like education, compliance to taxation, and the protection of human rights are basic tasks of a country and its government. However, the explicit definition of these requirements in the vast majority of the MSIs' standard documents underlines their potential value in driving social innovation. Moreover, this shows the complementation of authority-based state governance that is sometimes not able to ensure tax payments. However, we need to note that the MSIs do not really enforce this change of practice and complementing of state governance, but they offer support to local stakeholders and communities to enforce their rights outside the MSI. This enforcement is of course again dependent on the authority-based governance underlining the complementary nature of the approaches.

4.2.3. The Change of Environmental Practices through MSIs

Just like in the social practices there is a distinction of practices and requirements for active mining as well as mine closure or material stewardship approaches. The former is mainly focused on the reduction of emissions, effluents, spillages, waste, and water usage [64]. There are mostly general calls to "minimize" emissions and treat water resources "responsibly" [38] or to "maximize efficiency of water-use" [67] (p. 12). Beyond this, management systems and emergency response plans are required by the MSIs to prevent the often long-lasting damages of spillages, dam bursts and other contaminations. Such pollution may happen in an abrupt event, but it may as well occur unnoticed over a longer time period. The latter case is addressed by some MSIs that require the implementation of environmental monitoring systems to detect long-term degradations of wildlife or water quality [65]. More complex issues such as the management of impacts on biodiversity [38,64,67,72] or the negative effect on the quality of life in neighboring communities [60,62,67] are addressed, but only at their surface with calls to minimize them during operations.

A substantial step forward in many cases might be the requirements regarding mine closure. This phase of a mine's life cycle is particularly prone to misconduct since the mine is not generating revenues any more but only costs. Thus it is a critical phase regarding the solution of societal challenges that determines to which degree the mine will continue to affect local ecosystems and agriculture and hence the viability of future development [62]. The related requirements thus range from the provision of rehabilitation plans before mine closure or even at start-up of the mine [62,66,72] and financing rehabilitation costs beyond mine closure [67,72].

In addition to practices and requirements directed at the mining itself, there are also approaches to material stewardship and life cycle analysis encompassed by three MSIs only [38,64,66]. ASI, for example, takes a very explicit material stewardship approach that incorporates the entire SC and the lifecycle of aluminium [38]. It is thus consistent that ASI is one of the standards that also incorporates recycling practices into its scope [1,51]. However, this is one of the main avenues to reduce the need for virgin material that promises to drive a less polluting minerals sector.

Summing up the review of environmental practices, these are mostly at the surface of the issues only. As such they are limited in their power to complement environmental regulation. Nevertheless, the MSIs define what is possible and which issues need to be monitored. This can be the basis for the elevated industry practices as well as newly defined authority-based governance on these issues. Affected states or communities can draw on the requirements and their legitimacy to establish a basic regulation. A particularly interesting example are the water-quality monitoring requirements by IRMA [67] that outline different approaches to water quality management. These approaches encompass the ex-ante modeling of water impacts, define thresholds for quality reductions, and require relevant data to be published. However, it has to be noted that environmental practices are

far less represented in the MSIs' standard documents than social or economic practices, which are outlined next.

4.2.4. The Change of Economic Practices through MSIs

The economic practices take a variety of foci that can best be structured against the scope of the MSI. For doing so, we classified the practices into two groups with a distinct scope that range from a business centered focus (single organization or SC) to an ecosystem focus (organization or SC and related stakeholders). This classification follows the development of business and sustainability research that constantly enlarges its focus to drive more comprehensive and systematic approaches that can address the full complexity of the challenges in focus.

The business-centered practices show a strong focus on the cooperation of companies in the SC of the individual minerals. The environmental and social practices prescribe measures to ensure sustainability and responsibility within the company, the economic practices elaborate on how this can be extended beyond the single company and how such an enhanced responsibility can be used in economic terms. This explicitly aims at "a reduction in the share reached by non-certified products, while the share of certified minerals with a transparent origin will rise" [59] (p. 14) and might be formulated as should requirements [51] up to the immediate suspension of engagement with suppliers that are non-compliant with the MSI's requirements [68,71]. The list of reasons for the suspension of engagement links into the social and environmental practices, as it covers amongst others: sourcing from areas associated to torture, inhumane and degrading treatment as well as forced labor [68,70], sourcing from armed groups, no matter whether these are state or non-state groups [68], money laundering, conflict and terror financing [70], and the handling of cyanide on the environmental side [65]. However, besides the suspension of partners, there is also a focus on developing partners to reach a higher level of sustainability. This can be organized by the MSI itself [50,62,71] or by the companies buying from those in need of training [28,72]. Such a flexible set-up of organizational cooperation to implement more responsible practices goes beyond the traditional authority-based governance and represents a social innovation that contributes to actively solving sustainability challenges instead of simply requesting their resolution.

Such an approach including the termination of supply contracts can well support the change in practice as certified organizations spread the change to their suppliers. The threat of economic losses for the supplier represents an incentive to adopt the MSIs' requirements. However, this is again dependent on the power of the companies that support this change and less on the MSI itself. Still, if a practice or requirement reaches a certain diffusion into the industry sector, it will become standard based on the earlier work of the MSI.

Beyond compliance and training, there is an offer of technological support by the MSIs. Three of them have explicitly set up databases and tracking systems that they prescribe to be used as technological systems to support the transparency and documentation efforts of their members [62,68,71]. The aim of all three systems is the establishment of a chain of custody, that they define as "a record of the sequence of entities which have custody of minerals as they move through a supply chain", but "custody of the [material] does not necessarily mean ownership and vice versa" [73] (pp. 12–13). Such systems represent one of the main advantages of an MSI as it is not bound to any kind of traditional boundaries and can thus provide overarching systems to support social innovation.

The ecosystem-centered practices transcend the boundaries of the classic business sphere and integrate the wider community and affected stakeholders into the management of the mine and its responsibility. These practices thus intersect largely with the social and environmental practices. Nevertheless, it is worthwhile taking an explicit economic lens for understanding them. The first practice revolves around the ideal of linkage creation, that is, inducing economic development based on the extraction of the minerals by the mine that should ultimately lead to a rise in living standards in resource-rich countries [61]. This creation can be understood in three sections [87,88], that are (a) fiscal linkages by paying taxes and royalties, (b) production linkages by sourcing supplies locally, and (c)

consumption linkages by enabling a domestic demand through miners' income. The (a) fiscal linkages, that build the majority of requirements, have already been reviewed in the social practices and are thus omitted here. The (b) production linkages cover the inclusion of local businesses into the SC to enable the development of mining suppliers [71,73] but also other services and material "of daily use" [59] (p. 17) that might offer diversification for the local industry. The latter is especially beneficial, as the current income from mining that is going to end with the depletion of the mine can spur other sources of income that can offer another line of economic development that might outlive the mine. The (c) consumption linkages are especially created by local employment and training of staff if required to avoid "importing" employees that might send parts of their income to their home countries, thus weakening domestic demand and development [52,66].

In effect, it becomes obvious that the ecosystem-centered practices take a particularly long-term focus that is oriented along the ideal of continuous and joint development. This contrasts today's domination, often, of short-term profit orientation. It is thus one way to counter the long-term societal challenges in mining regions. These might be amplified if mining regions cannot profit from mining revenues while enduring the environmental pollution and adverse working conditions associated to mining. However, this contrast to current business orientation is also a barrier to adoption, as managers will have to justify related investments and changes in practices against the short-term focus of their shareholders. This is again underlining the potential drawbacks of the voluntariness of the MSIs that might only be resolved if the MSIs' requirements are taken up by the traditional authorities. Solving this challenge is of course at the very core of social innovation from a practice perspective and underlines the value of the reviewed MSIs.

4.3. Stakeholder-Related Organizational Change through MSIs

Besides the aforementioned *changes in practice* of social innovation, mainly by organizations adhering to the standard requirements of an MSI, it is essential to further spread the social innovation to more companies in the sector as well as authorities and the wider public to eventually arrive at a state at which the sustainability issues on which the social innovation focuses will have been solved. External transformations are related to the concept of diffusion, i.e., "the process by which information, ideas, changes in behavior, etc. spread through a group" [42] and are captured in Sections 5.1–5.3. First, however, the focus is on the transformation of the MSI itself which can be further differentiated into MSI growth (Section 4.3.1), MSI maturing (Section 4.3.2) and possibly obsolescence and redefinition in case that the sustainability issues that the MSI wanted to solve do not longer exist (cf. Figure 1). Due to the relatively young age structure of the MSIs for responsible mining, there is little evidence for obsolescence yet, which is thus not addressed further here.

4.3.1. Transformation of MSIs

Archetypes of MSI and how they transform over time (cf. also Table 3 showing the transformation paths adapted to the perspective of social innovation) have been analyzed in detail in [18]. Hiete et al. (2019) distinguish (i) best-in-class approach in which MSIs aim at offering the best practices for a concrete sustainability issue, for example, ensuring conflict freeness, (ii) integrating more problem fields meaning that MSIs aim at further developing their standard requirements towards the ideal of sustainability by integrating more sustainability issues, and (iii) enlarging the stakeholder base to increase acceptance of the MSI. These prior works have been adapted to our focus on MSIs as social innovations in Table 3. The table presents the aforementioned archetypes of diffusion in conjunction with those characteristics of MSIs that have been found to be relevant to social innovation in Section 4.1, i.e., the stakeholders that come together in an MSI and the scope regarding industries in the middle column and societal challenges they address in the column to the right. Moving from top to bottom in the MSI transformation presents a rise in both membership and scope and presents brief advice.

Table 3. Archetypes of Social Innovation Diffusion through MSIs (MSI internal transformation perspective) ⁽¹⁾ adapted from [18,23]).

Archetypes of Social Innovation Diffusion	Membership (Stakeholders and Companies)	Scope (Esp. Requirements, Practices)
(1) MSI growth	Single MSIs assemble a rising number of stakeholders and companies from the sector that have not been part of the social innovation before	The scope of the MSIs is basically stable
(2) MSI transformation ¹		
(2a) Best in class	Stakeholders and companies that are already actively pursuing the social innovation concerned with a particular issue (mineral, conflict, child labor, toxic materials, etc.) switch towards the MSI most suitable to drive the social innovation	The practices and requirements of MSIs concerned with a particular issue (mineral, conflict, child labor, toxic materials, etc.) converge towards detailed best practices in the course of a competition or harmonization among MSIs
(2b) Integrating more problem fields	Due to a widened scope (see right-hand column) the MSI absorbs members concerned with the widened scope making its membership more heterogeneous but overall larger and the MSI thus becomes economically and politically more powerful	MSIs extend their scope from one particular issue towards two or more related issues that can be certified against common requirements and addressed via common practices. → Scope drives membership
(2c) Enlarging the stakeholder base	The MSI targets a wider set of members, especially influential stakeholders that can help to drive the social innovation	To enable the widening of the stakeholder base the MSI's scope may be evolved towards the requirements and practices that enjoy legitimacy from "old" and "new" members. → Membership drives scope

The presented archetypes of social innovation diffusion can be seen as general paths for a steady adaptation of MSIs to the ever-changing characteristics of the industries and societal challenges they focus on. Moreover, the three transformations present general trends that enable a wider adoption of the MSIs that may help to enhance the contribution of the MSIs as social innovation to solving societal issues.

MSI growth can be observed well, for example, in the ASI that recently reported having grown from 13 to 100 members in the past four years [82]. While ASI is constantly revising and evolving its standard, it is still focusing on a particular mineral and thus has a fixed mineral scope in the mining sector. Growth can happen also in other ways: not only is there an increasing number of members of certain MSIs, also the MSIs increase in number, some of them with an overlap, for example, MSIs for conflict minerals or Fairtrade and Fairmined (see below).

MSI maturing is difficult to distinguish from necessary steps still related to MSI formation as most MSIs are still young. The commonly seen extension of scope by integrating more problem fields, for example, might have been planned from the foundation of the MSI and might have been not realizable earlier due to resource restrictions. Maturing definitely accounts for necessary adjustments of an MSI to adapt to a changing environment, in particular if changes are due to the MSI's work. Bettercoal, for example, established a Multi-Stakeholder Technical and Advisory Committee (TAC) for review of a scheme [1] which enlarged the stakeholder base. The pressure from increasing competition, decreasing demand of dimension stone and increasing wages that the Fair Stone Standard experienced in 2015 [1] could be interpreted as a (at least temporary) limit to MSI growth resulting from a limited market for Fair Stone Standard products. Also, the termination of the cooperation between the Alliance for Responsible Mining (ARM) and the Fairtrade Labelling Organizations International e.V. (FLO) in 2013 after having crafted from 2006 onwards a joint standard [89] due to differing opinions on scheme management [1] could be cited here. The split has resulted in two rather similar MSIs (Fairmined Standard for Gold from Artisanal and Small-scale Mining, including Associated Precious Metals and

Fairtrade Standard for Gold and Associated Precious Metals for Artisanal and Small-Scale Mining) but with differing geographical scope. This can be indicative of specialization and possibly establishment on the market as the split was only reasonable once a certain degree of maturity had been reached. Furthermore, Tröster and Hiete [27] found that younger MSIs achieve a better performance in relation to stakeholder demands highlighting that the concept of MSIs has changed over time.

4.3.2. Transformation Outside of MSI

The effects of MSIs on social innovation are not limited to the MSIs and adhering companies. For example, MSIs make the sustainability impacts noticeable and thus influence public opinion, even though only few have implemented product labels, such as Fairtrade and Fairmined for gold or Fairstone and Xertifix for dimension stone, as most minerals only make up a small proportion of the end-product and thus are hardly visible for the end-consumer. This aspect of MSIs to support the formation of public opinion should be interpreted as diffusion, too. Another dimension of diffusion has been described already in Section 4.1.2 highlighting that the standard requirements elaborated do not only often originate from legislation or requirements with similarly high legitimacy (e.g., the guidelines of the International Finance Corporation (IFC)) but also find their way into legislation as common ground (e.g., CTC in official state documents in Rwanda and Democratic Republic of Congo [1]). Furthermore, one could argue that motivation and integration of other actors and stakeholder groups in an MSI represent also some form of diffusion. The transformation effects outside of the MSIs are further detailed in the following section that discusses how MSIs may complement the authority-based governance of mining. Furthermore, directions for future research and limitations are presented.

5. Discussion and Conclusions

This study set out to answer the question of how MSIs for responsible mining foster social innovations. It investigated MSIs as an empirical case for a social innovation and found a dual role covering a contribution of MSIs as a governance approach and a contribution of MSIs in changing practice for the benefit of the society, communities or individuals affected by mining and related activities. Taking the lens of social innovation opened a novel perspective that enabled us to evaluate their contribution to societal challenges and we could thus move beyond prior literature that analyzed the MSIs regarding one of the two roles we have found in this study. Therefore, we are confident that this contributes to the understanding of MSI transformation [18,23] and the suggestions for MSI design [1,20,27] that focus on their role of stakeholder representation. Moreover, the dual role enabled us to take a wider look on MSIs as a governance approach that can be an intermediate approach between legislative and market solutions that obviously have not been sufficient to hinder or solve sustainability issues in global mining. However, we also have to contend that its position in the middle due to its voluntariness is also limiting its immediate effect. In line with earlier studies, we found that the MSIs are, rather, an incentive and offer support for becoming more responsible [1,20]. Enforcing changes in practice to more responsibility is still the domain of the authority-based governance approach [18] or direct contracts between business partners [5,78,79]. Nevertheless, the MSIs have been found to be able to spark first steps towards a more responsible sector. They do so by providing information, requirements, and tools regarding the change of practice.

The analysis of MSIs for responsible mining as social innovation reaches wide into neighboring fields of research and practice such as the business domains of procurement and supply chain management [3,5,43,79] but also political economy [4,39,40] or the field of environmental science and technology [8,11]. This study takes the lens of social innovation to unearth the real-world application of responsible mining practices that can help to alleviate the welfare of the population and societies in mining areas [33]. However, the analysis reveals that this can hardly be achieved without the interaction of the different fields that contribute to our understanding of legitimacy in the contexts affected by mining and related SCs. These fields are also represented in the single parts of the framework that draws on *governance* and *transformation* issues for the political field in conjunction

with concrete practices for the management of the TBL dimensions. The latter is more inclined with the business and science domains that build the basis for the analysis of the sustainability impact of particular management and operations practices. The framework is thus a step forward towards a more integrated design of MSIs as recently called for by van den Brink et al. [3] and Hiete et al. [18].

5.1. Contributions to the Debate on Social Innovation

The analysis of the intersection of the MSIs with the other forms of governance presented in Section 4 underlines their value as “transnational private regulation” [17] (p. 302). As such, the MSIs can support local communities but also the wider public in effectively addressing the sustainability challenges of mining. This can be a driver or barrier for their welfare, as requested in the OECD definition of social innovation [33]. Moreover, the MSIs can transcend the limits of national regulation and establish a wider-reaching institution to outline a common path to responsible mining and eventually a more sustainable economy that is as well based on more sustainable practices as presented below.

Above and beyond the practices in the TBL dimensions, the MSIs audit the compliance to the outlined practices and offer and require corrective actions in case of non-compliance to guide the mining companies towards more responsibility. This is highly relevant for the MSI as a social innovation from a change of practice and sustainable development perspective, as it facilitates the sustainability improvements that help to alleviate the societal welfare. From a governance perspective this is interesting as well, as the MSIs aim of course for compliance of as many companies as possible but have no means of sanctioning due to their voluntary nature. This is in stark contrast to state governance that may well pressure companies for compliance but is limited in its potential for delivering support for compliance due to budgetary constraints and the requirement to treat all companies equally. The MSIs thus positioned themselves as an intermediary between authority-based governance and business practice, as an MSI defines concrete and actionable sustainability requirements along with potential paths towards compliance. These paths are, for example, supported by capacity building measures by the MSIs.

Consequently, when referring to such regulatory guidelines and detailing it, MSIs address the different levels of legislation that range from laws at the highest level, subordinate legislation like ordinances concretizing the law, down to instructions for the executive authority on how to interpret the law, and in addition provide guidance how to implement and meet the requirements. This is possible because MSIs can react faster and more flexibly than governmental actors.

Thus, the analysis revealed how MSIs can complement authority-based governance in many aspects. A particularly relevant finding is that the MSIs can move beyond the limits of the authority-based approach. This offers a valuable path towards the alleviation of social challenges related to the informality of workers that cannot afford to legally register or are denied registration and thus forced into informality [76,86]. These actors find a voice in MSIs that can, moreover, offer market access beyond middlemen that have been found to be among the main exploiters of informal and small-scale miners [86]. Moreover, the MSIs with a balanced ownership (see Table 2) are more likely to be neutral to national interests such as protectionism of national mining or manufacturing industries and can thus be better equipped to address the sustainability challenges of responsible mining. However, the voluntary nature of the MSIs limits their complementary role to the provision of a first step towards a change of practice. Substantial changes still have to rely on the authority-based approach as well as business interactions to arrive at an industry-wide adoption of responsible mining. This study also contributed to the discourse on this topic, as discussed below.

5.2. Contributions to the Debate on Responsible Mining

Our results showed that the reviewed MSIs define and help to implement a variety of practical solutions to individual and societal problems in all dimension of the TBL. These solutions are often more detailed and applicable to a wider region than related legislation or other authority-based

governance tools. The findings further underlined that the MSIs deliver this service especially where state governance is weak or absent and can, thus, be seen as a valuable governance approach for social innovations. This is in line with existing literature on responsible mining that often focuses on failed states and missing governance [4,5,79].

Moreover, the finding of an under-representation of environmental practices in the standard documents of the MSIs is in line with the literature on responsible mining [3,43] and existing reviews of MSI standard documents for responsible mining [1,24]. However, this is in stark contrast to the enormous risks that mining represents for the environment and calls for a better integration of environmental concerns, as previously suggested [43]. This relevance is also fueled by the rebound effects of environmental pollution on health or food security due to harmful agricultural operations and other vital operations and services in mining affected regions [86]. Nevertheless, it needs to be acknowledged that environmental protection is often much more capital- and knowledge-intensive compared to enhanced working conditions. Moreover, detrimental environmental practices often leave a detectable trace, while working conditions can hardly be determined *ex post* [79]. These challenges in addressing the environmental dimension are, moreover, mirrored in the rather shallow formulation of the requirements in the MSIs. This contrasts with the comparatively concrete social requirements, a criticism in line with prior studies [1]. In effect, the MSIs might bring environmental issues into the public debate but are likely not powerful enough to bring about substantial change in the environmental dimension. Such costly and unpopular measures thus need to be implemented via the authority-based approach. However, this can be driven by MSIs that fuel the debate in the wider public to which authorities eventually react. Again, we see that the MSIs can complement the authority-based governance but are limited in their power.

Furthermore, MSIs may offer capacity-building measures and other measures helpful for improving the mining companies' performance—also on payment if necessary. Requirements that a mining company has to fulfill may be designed as stepwise increasing. Such progressive sustainability requirements incite mining companies to join the MSI even if they do not perform as well as necessary yet, but motivate them to rapidly improve their sustainability performance [24]. Finally, the MSIs create visibility of sustainability issues that may be beyond the original knowledge of business actors in the SC [5,78,79] which can again help to inform and complement other forms of governance.

5.3. Limitations and Research Directions

The study at hand is of course not free of limitations. First, the framework is based on a conceptual development that could only be complemented by an empirical analysis for the *change of practice* which limits its validity. However, the remaining parts of the framework have carefully been drafted including the incorporation of a rich set of literature that reviewed these issues in recent years. Second, the *change in practice* section is based on a review of the MSIs' standard documents. This is oriented along the categories defined in Section 3.3, which leads to a bias towards finding only contents that fit the categories and that are mentioned in the texts analyzed, while other issues go unnoticed. Another categorization could, thus, lead to other findings [47]. Third, the sector of MSIs is highly volatile and diverse: new MSIs are established in mining and other sectors. This study is thus representing a particular point in time and can only cover the conception of responsibility embodied in the MSIs standards documents. This will likely evolve in recent years and more MSIs will be formed outside of Europe. Our results are, therefore, biased towards a Western idea of sustainability and are highly time dependent. Finally, content analysis is bound to the documents analyzed. These are in the case of this study provided by the MSIs and the analysis is thus limited to the issues mentioned by the MSIs. Still, we tried to reflect on omitted issues and the blind spots of the documents.

Based on the limitations and results of the study, six research directions can be developed:

First, this paper provided a first distinction of MSI-based and authority-based governance without elaborating their limits holistically. Moreover, it would be relevant to investigate if there are issues that can only be governed with one approach. This could, for example, answer the question of which

aspects of a social innovation or societal challenge cannot be governed by the traditional authorities but by a legitimate and maybe multi-national set of multiple stakeholders.

Second, a related question would be the evaluation of functions that both approaches can fulfil. In such cases, it would be valuable to understand which approach is more effective and upon which factors the effectiveness is contingent.

Third, this study added to the transformation paths of MSIs [18,23] by taking a social innovation lens and adding the aspect of MSI growth. A relevant extension of this would be a longitudinal investigation of the development of social innovations and how they can address societal challenges over time until they are eventually resolved or under control.

Fourth, having the intersection of MSI-based and authority-based governance in mind, it would also be interesting to understand how both approaches fuel each other. We found first evidence that MSIs take-up legislation and are taken-up by legislation. The identification of contingency factors would again be a valuable approach.

Fifth, and based on the previous question, we raised the issue of MSI obsolescence once the aim is fulfilled. While this seems logical from a technical perspective, we still doubt that an MSI will simply resign. Therefore, it is interesting to investigate the evolution of MSIs and how they develop their scope and aims further in light of advancements in the sector they focus upon.

Sixth and finally, we found only a shallow adoption of digital solutions in the MSIs' standard documents. Nevertheless, the MSIs' objective of implementing enhanced transparency is a good fit to digital solutions such as the blockchain technology that is seen as an ideal solution to establish a neutral, immutable, and trusted digital representation of the SC and related material flows [90]. Blockchains can, thus, be a valuable addition to the reviewed MSIs and future research could review and support their implementation in this and other forms of governance.

Author Contributions: The two authors contributed equally to the drafting and revision of the manuscript. P.C.S. performed the structured review of the MSIs' documents. All authors have read and agreed to the published version of the manuscript.

Funding: This research and the APC was funded by German Federal Ministry of Education and Research (BMBF), Research for Sustainability (FONA) platform, funding priority Social-Ecological Research (SÖF) and funding program Sustainable Economy (grant no. 01UT140, project Nachhaltig gewonnene mineralische Rohstoffe, NamiRo, 2015 to 2018).

Acknowledgments: We would also like to thank the other members of the NamiRo core team, Gudrun Franken, Rüdiger Hahn, Enrico Kallmeier, Karoline Kickler, Christian Klein, Fabian Krause, Stefan Rötzel, Frank Schmidt, Stefan Seuring, and Rasmus Tröster, for the excellent and fruitful collaboration. We also thank two anonymous reviewers for their helpful comments.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

References

1. Kickler, K.; Franken, G. *Sustainability Schemes for Mineral Resources. A Comparative Overview*, revised version; DERA: Hannover, Germany, 2017; ISBN 978-3-943566-94-9.
2. Fleury, A.M.; Davies, B. Sustainable supply chains—Minerals and sustainable development, going beyond the mine. *Resour. Policy* **2012**, *37*, 175–178. [[CrossRef](#)]
3. Van den Brink, S.; Kleijn, R.; Tukker, A.; Huisman, J. Approaches to responsible sourcing in mineral supply chains. *Resour. Conserv. Recycl.* **2019**, *145*, 389–398. [[CrossRef](#)]
4. Rajak, D. Platinum City and the new South African Dream. *Africa* **2012**, *82*, 252–271. [[CrossRef](#)]
5. Young, S.B. Responsible sourcing of metals: Certification approaches for conflict minerals and conflict-free metals. *Int. J. Life Cycle Assess.* **2018**, *23*, 1429–1447. [[CrossRef](#)]
6. Airike, P.E.; Rotter, J.P.; Mark-Herbert, C. Corporate motives for multi-stakeholder collaboration—Corporate social responsibility in the electronics supply chains. *J. Clean. Prod.* **2016**, *131*, 639–648. [[CrossRef](#)]
7. Mancini, L.; Sala, S. Social impact assessment in the mining sector: Review and comparison of indicators frameworks. *Resour. Policy* **2018**, *57*, 98–111. [[CrossRef](#)]

8. Murguía, D.I.; Bringezu, S.; Schaldach, R. Global direct pressures on biodiversity by large-scale metal mining: Spatial distribution and implications for conservation. *J. Environ. Manag.* **2016**, *180*, 409–420. [[CrossRef](#)] [[PubMed](#)]
9. Ramdoo, I. New Tech, New Deal. Technology Impacts Review. Available online: <https://www.iisd.org/sites/default/files/publications/new-tech-new-deal-technology.pdf> (accessed on 6 November 2019).
10. Zeballos, E.J.; Garry, S. *Jobs Recovery. Sectoral Coverage: An Overview of Employment Trends and Working Conditions by Economic Activity: First Semester 2010*; ILO: Geneva, Switzerland, 2010; ISBN 978-92-2-124158-4.
11. Ali, S. Social and Environmental Impact of the Rare Earth Industries. *Resources* **2014**, *3*, 123–134. [[CrossRef](#)]
12. Pure Earth. Top Ten Polluting Industries 2016. Available online: <http://worstpolluted.org/> (accessed on 7 November 2019).
13. Hilson, G.; McQuilken, J. Four decades of support for artisanal and small-scale mining in sub-Saharan Africa: A critical review. *Extr. Ind. Soc.* **2014**, *1*, 104–118. [[CrossRef](#)]
14. Wilson, M.L.; Renne, E.; Roncoli, C.; Agyei-Baffour, P.; Tenkorang, E.Y. Integrated Assessment of Artisanal and Small-Scale Gold Mining in Ghana—Part 3: Social Sciences and Economics. *Int. J. Environ. Res. Public Health* **2015**, *12*, 8133–8156. [[CrossRef](#)]
15. Mori Junior, R.; Franks, D.M.; Ali, S.H. Sustainability certification schemes: Evaluating their effectiveness and adaptability. *Corp. Gov.* **2016**, *16*, 579–592. [[CrossRef](#)]
16. Suchman, M.C. Managing Legitimacy: Strategic and Institutional Approaches. *Acad. Manag. Rev.* **1995**, *20*, 571–610. [[CrossRef](#)]
17. Bartley, T. Institutional Emergence in an Era of Globalization: The Rise of Transnational Private Regulation of Labor and Environmental Conditions. *Am. J. Sociol.* **2007**, *113*, 297–351. [[CrossRef](#)]
18. Hiete, M.; Sauer, P.C.; Dremptic, S.; Tröster, R. The role of voluntary sustainability standards in governing the supply of mineral raw materials. *GAIA Ecol. Perspect. Sci. Soc.* **2019**, *28*, 218–225. [[CrossRef](#)]
19. Shalley, C.; Hitt, M.A.; Zhou, J.; Raffaelli, R.; Glynn, M.A. Institutional Innovation. In *The Oxford Handbook of Creativity, Innovation, and Entrepreneurship*; Shalley, C., Hitt, M.A., Zhou, J., Eds.; Oxford University Press: New York, NY, USA, 2015; ISBN 9780199927678.
20. Tröster, R.; Hiete, M. Success of voluntary sustainability certification schemes—A comprehensive review. *J. Clean. Prod.* **2018**, *196*, 1034–1043. [[CrossRef](#)]
21. Jacob, K.; Guske, A.L.; Antoni-Komar, I.; Funcke, S.; Gruchmann, T.; Kny, J.; Naber, E.; Ruppert-Winkel, C.; Sauer, P.C.; Stumpf, K.H.; et al. Governance for the sustainable economy. Institutional innovation from the bottom up? *GAIA Ecol. Perspect. Sci. Soc.* **2019**, *28*, 204–209. [[CrossRef](#)]
22. Mueller, M.; dos Santos, V.G.; Seuring, S. The contribution of environmental and social standards towards ensuring legitimacy in supply chain governance. *J. Bus Ethics* **2009**, *89*, 509–523. [[CrossRef](#)]
23. Dremptic, S.; Sauer, P.C.; Tröster, R. Umwelt- und Sozialstandards im mineralischen Rohstoffsektor und die Notwendigkeit, verschiedene Stakeholder an einen Tisch zu bekommen. In *Zwölfter Runder Tisch Bayern: Sozial- und Umweltstandards bei Unternehmen*; Fonari, A., Führ, V., Stamm, N., Eds.; Eine Welt Netzwerk Bayern: Augsburg, Germany, 2018; pp. 61–70.
24. Stetter, A. Global Standards and Certification Schemes: Institutional Design and Successful Sustainability Governance. Ph.D. Thesis, Ludwigs-Maximilian-University, München, Germany, 2015.
25. Young, S.B.; Zhe, Y.; Dias, G. Prospects for sustainability certification of metals. *Metall. Res. Technol.* **2014**, *111*, 131–136. [[CrossRef](#)]
26. Mori Junior, R.; Franks, D.M.; Ali, S.H. *Designing Sustainability Certification for Impact: Analysis of the Design Characteristics of 15 Sustainability Standards in the Mining Industry*; Centre for Social Responsibility in Mining, University of Queensland: Brisbane, Australia, 2015.
27. Tröster, R.; Hiete, M. Do voluntary sustainability certification schemes in the sector of mineral resources meet stakeholder demands? A multi-criteria decision analysis. *Resour. Policy* **2019**, *63*. [[CrossRef](#)]
28. OECD. *OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas*, 3rd ed.; OECD Publishing: Paris, France, 2016; ISBN 9789264252387.
29. Geenen, S. A dangerous bet: The challenges of formalizing artisanal mining in the Democratic Republic of Congo. *Resour. Policy* **2012**, *37*, 322–330. [[CrossRef](#)]
30. Wittmayer, J.M.; Backhaus, J.; Avelino, F.; Pel, B.; Strasser, T.; Kunze, I.; Zuijderwijk, L. Narratives of change: How social innovation initiatives construct societal transformation. *Futures* **2019**, *112*, 102433. [[CrossRef](#)]

31. Edwards-Schachter, M.; Wallace, M.L. 'Shaken, but not stirred': Sixty years of defining social innovation. *Technol. Forecast. Soc. Chang.* **2017**, *119*, 64–79. [CrossRef]
32. Tirziu, A.M.; Vrabie, C. Living Labs—Instruments of Social Innovation in Rural Areas. Available online: <https://mpr.aub.uni-muenchen.de/79868/> (accessed on 15 October 2019).
33. OECD. LEED Forum on Social Innovations. Available online: <https://www.oecd.org/fr/cfe/leed/forum-social-innovations.htm> (accessed on 24 September 2019).
34. Pattberg, P. What Role for Private Rule-Making in Global Environmental Governance? Analysing the Forest Stewardship Council (FSC). *Int. Environ. Agreem.* **2005**, *5*, 175–189. [CrossRef]
35. World Wide Fund for Nature. Toxic Mercury Poisoning the Amazon. Available online: https://wwf.panda.org/news_facts.cfm?338470/Toxic-mercury-poisoning-the-Amazon (accessed on 11 December 2019).
36. Fairtrade International. Fairtrade Products. Available online: <https://www.fairtrade.net/product> (accessed on 11 December 2019).
37. Fairtrade International. Aims of the Fairtrade Standards. Available online: <https://www.fairtrade.net/standard/aims> (accessed on 11 December 2019).
38. ASI. Performance Standard. Available online: <https://aluminium-stewardship.org/asi-standards/path-asi-standardslaunch/#C2017> (accessed on 12 January 2018).
39. Bush, S.R.; Toonen, H.; Oosterveer, P.; Mol, A.P.J. The 'devils triangle' of MSC certification: Balancing credibility, accessibility and continuous improvement. *Mar. Policy* **2013**, *37*, 288–293. [CrossRef]
40. Loconto, A.; Busch, L. Standards, techno-economic networks, and playing fields: Performing the global market economy. *Rev. Int. Political Econ.* **2010**, *17*, 507–536. [CrossRef]
41. Mena, C.; Humphries, A.; Choi, T.Y. Toward a theory of multi-tier supply chain management. *J. Supply Chain Manag.* **2013**, *49*, 58–77. [CrossRef]
42. Cambridge Business English Dictionary. Meaning of Diffusion in English. Available online: <https://dictionary.cambridge.org/dictionary/english/diffusion> (accessed on 24 September 2019).
43. Sauer, P.C.; Seuring, S. Sustainable supply chain management for minerals. *J. Clean. Prod.* **2017**, *151*, 235–249. [CrossRef]
44. Elkington, J. *Cannibals with Forks. The Triple Bottom Line of 21st Century Business*; Capstone: Oxford, UK, 1997; ISBN 9781900961271.
45. Meredith, J. Theory Building through Conceptual Methods. *Int. J. Op. Prod. Manag.* **1993**, *13*, 3–11. [CrossRef]
46. Weick, K.E. What Theory is Not, Theorizing is. *Adm. Sci. Q.* **1995**, *40*, 385–390. [CrossRef]
47. Seuring, S.; Gold, S. Conducting content-analysis based literature reviews in supply chain management. *Supp. Chain Manag.* **2012**, *17*, 544–555. [CrossRef]
48. Mayring, P. *Qualitative Inhaltsanalyse. Grundlagen und Techniken*, 11th ed.; Beltz: Weinheim, Germany, 2010; ISBN 978-3-407-29142-4.
49. Carter, C.R.; Washipack, S. Mapping the Path Forward for Sustainable Supply Chain Management: A Review of Reviews. *J. Bus. Logist.* **2018**, *39*, 242–247. [CrossRef]
50. ARM Fairmined Standard for Gold from Artisanal and Small-Scale Mining, including Precious Metals. Available online: http://www.responsiblemines.org/images/sampled/EstandarFairmined/Fairmined%20Std%20200_2014_.pdf (accessed on 12 January 2018).
51. ASI. Chain of Custody Standard. Available online: <https://aluminium-stewardship.org/asi-standards/path-asi-standards-launch/#C2017> (accessed on 12 January 2018).
52. Bettercoal. Bettercoal Code. Available online: <https://bettercoal.org/docs/Bettercoal-Code-Version-1-Final.pdf> (accessed on 15 December 2017).
53. CFSI. Gold Supply Chain Transparency Smelter Audit Standard and Instruction. Available online: http://www.responsiblemineralsinitiative.org/media/docs/CFSI_CFSP_StandardandInstruction_Au_ENG.pdf (accessed on 12 January 2018).
54. CFSI. Smelter Introductory Training and Instruction Document. Available online: http://www.conflictreesourcing.org/media/docs/CFSI_CFSP_SmelterIntroduction_ENG.pdf (accessed on 12 January 2018).
55. CFSI. Supply Chain Transparency Smelter Audit Procedure for Tungsten. Available online: http://www.responsiblemineralsinitiative.org/media/docs/CFSI_CFSP_AuditProcedure_W_ENG.pdf (accessed on 12 January 2018).

56. CFSI. Supply Chain Transparency Smelter Audit Protocol for Tin and Tantalum. Available online: http://www.responsiblemineralsinitiative.org/media/docs/CFSI_CFSP_AuditProtocol_SnTa_ENG (accessed on 12 January 2018).
57. CFSI. Supply Chain Transparency Smelter Audit Protocol for Tungsten. 2013. Available online: http://www.responsiblemineralsinitiative.org/media/docs/CFSI_CFSP_AuditProtocol_W_ENG.pdf (accessed on 12 January 2018).
58. CFSI. Supply Chain Transparency Smelter Audit Procedure for Tin and Tantalum. Available online: http://www.responsiblemineralsinitiative.org/media/docs/CFSI_CFSP_AuditProcedure_SnTa.pdf (accessed on 12 January 2018).
59. CTC. Manual for the Certification of Ores in the Tin Industry in the DRC—Principles, Guidelines and Standards. Available online: http://www.robeha.de/EN/Themen/Zusammenarbeit/TechnZusammenarb/Downloads/kongo_manual_gold_en.pdf?__blob=publicationFile&v=2 (accessed on 15 December 2017).
60. DDI. Maendeleo Diamond Standards. Available online: <http://www.ddiglobal.org/login/resources/overview-maendeleo-diamond-standards.pdf> (accessed on 15 December 2017).
61. EITI. Extractive Industries Transparency Standard. Available online: https://eiti.org/sites/default/files/documents/english-eiti-standard_0.pdf (accessed on 15 December 2017).
62. Fair Stone. International Standard for the Natural Stone Industry. Available online: http://fairstone.org/wp-content/uploads/sites/2/2016/06/160520_Fair-Stone-Standard_6th_Edition_MQ.pdf (accessed on 15 December 2017).
63. Fairtrade. FairTrade Standard for Gold and Associated Precious Metals for Artisanal and Small-Scale Mining. Available online: http://wordpress.p20126.webspaceconfig.de/wp-content/uploads/2014/01/Gold-and-Precious_Metals-Standard.pdf (accessed on 15 December 2017).
64. GRI. Mining and Metals Sector Disclosures. Available online: <https://www.globalreporting.org/resourcelibrary/GRI-G4-Mining-and-Metals-Sector-Disclosures.pdf> (accessed on 15 December 2017).
65. ICMI. Cyanide Management Code. Available online: http://www.cyanidecode.org/sites/default/files/pdf/18_CyanideCode12-2016.pdf (accessed on 15 December 2017).
66. ICMM. Sustainable Development Framework. Available online: <https://www.icmm.com/website/publications/pdfs/429.pdf> (accessed on 15 December 2017).
67. IRMA. Standard for Responsible Mining. Available online: http://www.responsiblemining.net/images/uploads/IRMA_Standard_Draft_v2.0_with_MOV.pdf (accessed on 15 December 2017).
68. iTSCi. iTSCi Programme Review 2014. Available online: https://www.itri.co.uk/index.php?option=com_mtree&task=att_download&link_id=55336&cf_id=24 (accessed on 15 December 2017).
69. KP. Kimberley Process Certification Scheme. Available online: <https://www.kimberleyprocess.com/en/system/files/documents/KPCS%20Core%20Document.pdf> (accessed on 15 December 2017).
70. LBMA. Responsible Gold Guidance. Available online: <http://www.lbma.org.uk/assets/market/gdl/RGG%20v6.0%20201508014.pdf> (accessed on 15 December 2017).
71. RCM. ICGLR Regional Certification Mechanism (RCM)—Certification Manual. Available online: <https://www.icglr.org/index.php/en/rinr> (accessed on 15 December 2017).
72. RJC. Code of Practices. Available online: http://www.responsiblejewellery.com/files/RJC_Code_of_Practices_2013_eng.pdf (accessed on 12 January 2018).
73. WGC. Conflict Free Gold Standard. 2012. Available online: https://www.gold.org/sites/default/files/documents/Conflict_Free_Gold_Standar (accessed on 15 December 2017).
74. Xertifix. XertifiX Contract Draft. Available online: <http://www.xertifix.de/siegel/kriterien/> (accessed on 15 December 2017).
75. Hilson, G.; Zolnikov, T.R.; Ortiz, D.R.; Kumah, C. Formalizing artisanal gold mining under the Minamata convention: Previewing the challenge in Sub-Saharan Africa. *Environ. Sci. Policy* **2018**, *85*, 123–131. [[CrossRef](#)]
76. Siegel, S.; Veiga, M.M. Artisanal and small-scale mining as an extralegal economy: De Soto and the redefinition of “formalization”. *Resour. Policy* **2009**, *34*, 51–56. [[CrossRef](#)]
77. Brix-Asala, C.; Geisbüsch, A.K.; Sauer, P.; Schöpflin, P.; Zehendner, A. Sustainability tensions in supply chains: A case study of paradoxes and their management. *Sustainability* **2018**, *10*, 424. [[CrossRef](#)]
78. Sauer, P.C.; Seuring, S. Extending the reach of multi-tier sustainable supply chain management—Insights from mineral supply chains. *Int. J. Prod. Econ.* **2018**. [[CrossRef](#)]

79. Hofmann, H.; Schleper, M.C.; Blome, C. Conflict minerals and supply chain due diligence: An exploratory study of multi-tier supply chains. *J. Bus. Ethics* **2018**, *147*, 115–141. [CrossRef]
80. Ganswindt, K.; Rötters, S.; Schücking, H. Bitter Coal. Ein Dossier über Deutschlands Steinkohleimporte. 2013. Available online: https://www.fian.de/fileadmin/user_upload/dokumente/bittercoal.pdf (accessed on 1 December 2018).
81. ICMM. Our Organisation. Available online: <https://www.icmm.com/en-gb/about-us/our-organisation> (accessed on 11 November 2019).
82. ASI. ASI Membership Reaches 100! Available online: <https://aluminium-stewardship.org/asi-membership-reaches-100/> (accessed on 26 September 2019).
83. ASI. Tracking ASI's History and Development. Available online: <https://aluminium-stewardship.org/about-asi/asi-history/> (accessed on 11 November 2019).
84. IUCN. About: The International Union for Conservation of Nature (IUCN). Available online: <https://www.iucn.org/about> (accessed on 11 November 2019).
85. IRMA. History. Available online: <https://responsiblemining.net/about/history/> (accessed on 11 November 2019).
86. Cartier, L.E. Livelihoods and production cycles in the Malagasy artisanal ruby-sapphire trade: A critical examination. *Resour. Policy* **2009**, *34*, 80–86. [CrossRef]
87. Hirschman, A.O. *Essays in Trespassing. Economics to Politics and Beyond*; Cambridge University Press: New York, NY, USA, 1981; ISBN 9780521282437.
88. Morris, M.; Kaplinsky, R.; Kaplan, D. "One thing leads to another" Commodities, linkages and industrial development. *Resour. Policy* **2012**, *37*, 408–416. [CrossRef]
89. ARM. Past Standards. Available online: <https://www.responsiblemines.org/en/our-work/standards-and-certification/history/> (accessed on 14 November 2019).
90. Kurpjuweit, S.; Schmidt, C.G.; Klöckner, M.; Wagner, S.M. Blockchain in Additive Manufacturing and its Impact on Supply Chains. *J. Bus. Logist.* **2019**, *25*, 1217. [CrossRef]



© 2019 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>).