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Review

# Eliciting Drivers of Community Perceptions of Mining Projects through Effective Community Engagement

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**Abstract:** Sustainable mining has received much attention in recent years as a consequence of the negative impacts of mining and public awareness. The aim of this paper is to provide mining companies guidance on improving the sustainability of their sites through effective community engagement based on recent advances in the literature. It begins with a review of the literature on sustainable development and its relationship to stakeholder engagement. It then uses the literature to determine the dominant factors that affect community perceptions of mining projects. These factors are classified into five categories: environmental, economic, social, governance and demographic factors. Then, we propose a new two-stage method based on discrete choice theory and the classification that can improve stakeholder engagement and be cost-effective. Further work is required to validate the proposed method, although it shows potential to overcome some of the challenges plaguing current approaches.

**Keywords:** sustainability; mining; local community perspective; community acceptance

## 1. Introduction

In the past decade, concerns over how to ensure sustainable development (the ability of current generations to meet their needs without compromising the ability of future generations to meet their own needs) have increased over the world [1–10]. Mining companies have been forced to adapt their operating practices to fit this paradigm under public pressure. While there is no doubt that mineral and metal products have made a significant contribution to ensuring sustainable development, the juxtaposed adverse impacts cannot be ignored. The negative environmental and social impacts of mining operations have attracted attention from governments, non-governmental organizations, the public and other stakeholders. How mining can contribute to sustainable development has become a key challenge for the industry.

Currently, most of the major mining companies produce audited, annual sustainability reports that document their sustainability impacts [11]. The mining industry has progressed from environmental compliance (and associated standards, like ISO 14001), to corporate social responsibility (CSR) programs, to social license to operate (SLO) and now to sustainability reporting with standards like the Global Reporting Initiative (GRI) [12–18]. Additionally, there are calls for mines and mining businesses, like their counterparts in other sectors, to operate in a way that creates shared value for all stakeholders [19]. Furthermore, modern mine or project management involves obtaining, and maintaining, a social license to operate [12] and free, prior and informed consent, which is a related concept [20].Social license to operate and informed consent require mines to actively engage their stakeholders. Stakeholder engagement has, thus, become a key component of managing mines or projects for sustainable outcomes [21]. Several organizations, including the International Finance Corporation (IFC) and the International Council on Mining & Metals (ICMM), have proposed guidelines for adequate stakeholder engagement [22–31]. The peer-reviewed literature also contains many contributions in this area [12,32–38]. All of these show that mines and mining businesses have a role to play in the sustainable development of their host communities and the world, at large.

However, there are still numerous mining projects that have been postponed, interrupted and even shut down due to poor community engagement [12,13,33,37,39,40]. Stakeholder-related risk has been shown to be one of the major non-technical risks responsible for delays in mining projects [33]. From a mine operator's standpoint, community engagement is the best way to mitigate these community-related risks and achieve sustainable outcomes (e.g., informed consent and social license to operate). Community engagement should elicit the dominant factors or issues affecting community members' views of a mining project and how these factors affect perceptions of a project [41]. While previous research has discussed the factors that affect community perceptions of mining projects (individually or a few at a time) [42–49], the literature lacks a systematic review that synthesizes this knowledge to inform further research and industrial practice. Furthermore, an approach is needed to use our current understanding of these factors and how they drive community perceptions to facilitate effective engagement.

To bridge this gap, we conducted a comprehensive review of the literature to establish the dominant factors affecting community members' views of a mining project. This research divides the factors found in the literature into five categories: environmental, economic, social, governance and demographic aspects. This classification is based on previous research by the authors [40,41]. The authors also propose a novel two-stage approach, based on this classification and discrete choice theory, for effective stakeholder engagement. This research could provide mine operators with guidance on how to improve social license to operate, obtain free, prior and informed consent and, thus, improve the sustainability of their operations.

## 2. Methods

To identify the dominant factors that drive community perceptions of mining, a systematic review of published mining community engagement studies was conducted to identify English language studies available in print or online between 1990 and 2016. Peer-reviewed publications were identified through searches in major abstract databases (e.g., Web of Science, Scopus, Compendex, Google Scholar). Search terms included: "sustainability(able) mining", "mining community(ies)", "community engagement", "community acceptance", "stakeholder analysis", "stakeholder engagement", "discrete choice experiment(s)" and "discrete choice model(l)ing". Studies were included if they were relevant and published as full text articles (not just abstracts).

The authors screened search results for relevance by reviewing titles and abstracts. The review mostly focused on peer-reviewed journal publications since the intention was to rely on rigorous research to address the stated objectives. In a few cases, relevant papers in peer-reviewed conference proceedings were included in the list of reviewed papers. Furthermore, some technical reports from reputable government agencies, non-governmental and industry groups were included in the list of references for review.

We relied on the results of the literature review and our own previous research [41] to classify the factors. Subsequently, we used the classification to formulate a classification of the factors and formulate our proposed approach for effective community engagement. The literature review results are presented in Sections 3 and 4. Section 5 contains the classification and the proposed approach.

## 3. Sustainability, Stakeholder Engagement and SLO

Sustainable development is defined as the ability of current generations to meet their needs without compromising the ability of future generations to meet their own needs [50]. In order to make it possible to apply this definition to decision making, several refining definitions have been offered by various authors. For example, sustainable development has been defined to include social, economic and environmental impacts, which has been widely referred to as the triple bottom line [51]. Furthermore, it has been defined in relation to social, natural, human, physical and financial capital (the five capitals) [52]. These definitions provide various frameworks for assessing development to determine whether it is sustainable or not [40].

Recently, concerns about corporate sustainability have increased over the world [1–10]. Besides bad publicity due to negative environmental impacts and the resulting stricter government legislation and public pressures, poor sustainability performance affects the long-term profitability of a business. Thus, businesses have both an interest and a responsibility to incorporate sustainable development concepts into their long-term business strategy [5,40,53–56].

Sustainable development can only be given real meaning by investigating the ideas through a multi-stakeholder approach [8] (a stakeholder is any group or individual who can affect or is affected by the achievement of the organization's objectives [57]). The Institute of Social and Ethical Accountability [58] defines stakeholder engagement as "the process of seeking stakeholder views on their relationship with an organization in a way that may realistically be expected to elicit them." A mining project and its stakeholders are interdependent. This relationship is confirmed by Rotheroe [8], who indicates that industry has to engage stakeholders in the decision making process and throughout the whole project to achieve sustainable development [59].

In recent years, mining has witnessed an increasing demand for sustainable development from the public and regulators, as well as internal advocates who cite the sector's own long-term benefit [60]. Many mining companies realize the important role of other stakeholders and emphasize stakeholder engagement in the process of mine planning and design, permitting, operation and closure. For the mining sector, ICMM [21] defines stakeholders as a comprehensive list of people and groups who may be affected by, can affect or have an interest in a project. Examples include the local and indigenous groups, employees and contractors, labor unions, suppliers, governments and regulators, media, non-governmental organizations and investors [61,62]. In mining industry terms, the community is generally defined as the inhabitants of the immediate and surrounding areas who are affected by a company's activities [63]. Actually, local communities are the first stakeholder on the ICMM Checklist of possible stakeholders [21]. However, in practice, it is difficult to define the limits of the "local" community, and communities can be excluded from consultation when they should be included. This challenge is exacerbated by the fact that it is not easy to predict how communities may be affected by the secondary impacts of mining; particularly, social and economic impacts.

It is increasingly evident that mining community engagement is important for the success of mining operations (indeed, for all industrial activity). The examples of mining projects that have been disrupted due to lack of community support, cited earlier, are proof of this [12,13,33,37,39]. Community engagement is critical for obtaining permits prior to commencing mining; because without community engagement prior to commencing mining, it is not possible to obtain free, prior and informed consent, which is a best practice for modern mining projects, especially when mines are located on lands that historical belong to indigenous peoples [20]. In fact, community acceptance (i.e., informed consent) is a requirement for the permitting process in some jurisdictions (e.g., Peru passed the Law on the Right of Consultation of Indigenous Peoples in 2011 in accordance with various international conventions they had ratified). In the USA, the local community's acceptance is not necessarily a requirement for granting a permit. However, public participation is required during environmental impact assessment [64].

This concept of community approval of mining operations and its relationship to socio-political risk has been formalized as the social license to operate, in the last decade [12]. The social license to operate (SLO) is defined as a community's perceptions of the acceptability of a company and its local operations [12]. SLO is inversely proportional to the level of socio-political risk faced by a mining operation. Others, however, point out that SLO is nebulous and question whether it is useful, as a practical matter. For example, Owen and Kemp [65] contend that corporate goals to "obtain" or "retain" SLO assume that it can indeed be granted by communities in a manner similar to legally-mandated permits, which have specific permit conditions and carry specific consequences if the conditions are violated by the company. Regardless of its operational usefulness, SLO, conceptually, is a measure of community-related socio-political risk and is used in this work in that sense. Community-related risk is one of the major non-technical risks responsible for delays in mining project execution [33]. For a mining project, the cost of delays can be significant. Davis and Franks [33] estimated the cost of such delays to be approximately US$ 10,000/day, during the exploration stage of a new mine. Good community engagement that leads to acquiring social license to operate is the best way to mitigate these community-related risks.

Mine managers are gradually coming to understand the special importance of the host community and are attempting to address this issue. It is common to see mine managers referring to local communities as "primary" or "key" stakeholders [26]. However, even with increased effort, the mines and mining businesses still struggle to avoid conflicts with host community members. In fact, there appears to be a rise in the number of conflicts in the face of increased community engagement from mines [60].

The host community's perception of a mining project is often different from the perception of the mine's management (or proponents) and other stakeholders [66]. In order to reduce the perception dissonance between the mine's management and the host community, it is important for management to understand the factors that shape a community's perception of a project. Without this view, management may perceive a project to be acceptable to the community although the community may have a totally different perception. Such differences in perception are likely to lead to discontent and possible conflict between the members of the community and the mine's management. This affects the mine's social license to operate.

A community consists of individuals, who interact with each other more frequently than with those outside the community [67]. The community's perceptions emerge from individuals' choices and strategic interactions [68]. Individuals' choices are the basis for understanding the strategic interactions and the community's perception. For example, McGee [69] shows that community responses were characterized by private rather than public responses and individual rather than collective actions. There are other examples of community groups that facilitated a collective response to environmental contamination [70]. Hence, the community's perception of a mining project is an aggregation of the individual perceptions of the community members. In this study, we focus on the factors affecting individuals' choices and how to acquire good information on individual preferences to explain community perceptions.

There is no one unique formula for mining companies to understand the host communities' perceptions of a project. Take the stakeholder analysis matrix in Table 1, for example. It is the approach suggested by ICMM [26] and the most widely-used method for stakeholder analysis in the minerals sector. This method requires the analyst(s) to evaluate each stakeholder's view of the project (positive, neutral, negative), how influential they are (high, medium, low) and how they will be impacted by the project (high, medium, low). The analyst then fills a stakeholder analysis matrix (Table 1) with stakeholder information and then classifies the stakeholders into three groups: highly influential supporter of the project, neutral about the project and highly influential opponent of the project.

**Table 1.** Stakeholder analysis matrix [26].

| Name/Group of Stakeholders | View of Project | | | Influence | | | Impact | | |
|---|---|---|---|---|---|---|---|---|---|
| | Positive | Neutral | Negative | High | Middle | Low | High | Middle | Low |
| X | √ | □ | □ | √ | □ | □ | □ | □ | √ |
| Y | | √ | | | √ | | | | √ |
| Z | □ | □ | √ | √ | □ | □ | √ | □ | □ |

With this method, an individual in the local community may consider the characteristics of the project, its effect on him or her and the general costs and benefits when he or she is asked "impWhat is your view of the project?" Then, he or she can make a decision on whether his or her view of the project is positive or negative. This sort of instrument that elicits responses affected by many factors is prone to confounding effects. What is more, the results obtained from this approach are difficult to act upon. For example, the company even after obtaining data using this result still does not know how to bridge the gap between the stakeholder's perceptions and the company's aspirations with only data on positive or negative views of the project.

This method only elicits the community's view of the project as a whole without information on which aspects of the project are acceptable or unacceptable to community members. For effective community engagement, the approach should inform why and how the local community prefers one project over another. The approach proposed in Section 5 provides such information.

## 4. Factors Affecting Individual Perception of Mining

There are many factors that can affect an individual's perception of a mining project. It is important to understand these factors because they drive the community's perception, which is a summation of the individual perceptions. The community's perception of the project directly affects the mine's social license to operate.

There is a significant amount of work in the literature on the factors that affect an individual's perception of mining. Generally, the factors that affect community acceptance are mining impacts, governance and community demographics.

### *4.1. Mining Impacts*

#### 4.1.1. Positive Impacts

Mining operations can result in three positive impacts on the host community: job opportunities, income increase and infrastructure improvement.

The impact of job opportunities and related economic impacts (income increases) in the United States (U.S.), for example, are summarized in Table 2. In 2012, U.S. mines provided more than 634,000 jobs directly and 1.27 million jobs indirectly or induced [71]. ICMM describes job opportunities as the first issue and claims that the most frequently-asked question by members of local communities is, "how many jobs will go to their community members", when they hear that a mine may be developed in their community [26]. In some instances, individuals may be disillusioned when the new mining jobs are taken by migrants into the community and may have a negative view of job opportunities. However, the literature suggests that community members, generally, consider increased job opportunities a positive impact [41,70].

**Table 2.** Economic contribution of U.S. mining.

| Item | Direct | Indirect and Induced | Total |
|---|---|---|---|
| Employment | 634,600 | 1,268,800 | 1,903,440 |
| Labor Income (billions of dollars) | $46.2 | $71.0 | $118.2 |
| Contribution to GDP (billions of dollars) | $102.1 | $123.0 | $225.1 |
| Taxes Paid (billions of dollars) | $18.9 | $26.9 | $45.8 |

Source: IMPLAN (IMpact analysis for PLANning) modeling system (2012 database) [71].

Income increases due to higher paying jobs and/or the unemployed joining the mine's supply chain is another important impact of mining [26,72]. For example, the direct labor income created by U.S. mining in 2012 was over $46 billion with the total (direct, indirect and induced) exceeding $118 billion [71]. Petkova et al. indicate that the relatively high incomes of people working in the mining and allied industry were seen, by the local community, to generate positive impacts on all towns [72].

Infrastructure improvement is another obvious positive impact of mining. The host community infrastructure that often receives improvements due to mining include health services, educational institutions, power and water supply, sewerage and sanitation and transportation infrastructure [26]. Some of this investment in infrastructure is for business purposes (for instance, a quarry needs to improve roads so their product can be transported efficiently to market). However, a significant portion also comes through corporate social responsibility programs that invest in the host community. For example, BHP Billiton Ltd. says it is committed to invest 1% of pre-tax profits, which amounts to US$ 241.7 million, in community programs [61].

#### 4.1.2. Negative Impacts

However, mining also has juxtaposed adverse impacts, including environmental pollution, increases in housing costs, labor shortages for other businesses and traffic and crime increase. The environmental issue is the main issue raised by those concerned with the impacts of global mining and the first reason often cited by residents for rejecting mining [37]. The environmental impacts include water use and pollution, air, land and noise pollution.

Mining affects water resources through the use of large amounts and contamination of water. In the U.S. state of Nevada, for example, the United States Geological Survey (USGS) estimates that the water table surrounding open-pit mines has dropped by 300 meters [73]. There are many sources of contaminants at a mine site that a can pollute water bodies nearby. These include sediments from exposed soil, diesel fuel (large amounts of fuel are stored on site) and process chemicals (e.g., cyanide for gold processing and sulfuric acid for copper processing). Acid mine drainage (AMD) is recognized as one of the more serious environmental problems in the mining industry due to the number of watersheds affected and the costs incurred for remediation [74]. It is an acidic leachate with high concentrations of heavy metals and sulfate that result from the oxidation of sulfidic minerals. AMD can severely contaminate surface and ground-water, as well as soils [74–76]. For example, at the Summitville gold mine in Colorado, AMD polluted seventeen miles of the Alamosa River, severely impacting aquatic life. The place was designated as a Federal Superfund site and cost the U.S. Environmental Protection Agency (US EPA) $30,000 a day to rehabilitate [77]. Opponents of mining are concerned about potential environmental impacts, in particular, possible water contamination [11].

Mining activity can potentially impact terrestrial ecosystems. For example, contaminated water can impact terrestrial ecosystems, including accumulation of toxic elements in soil, soil acidification, damage to soil biota, loss of soil fertility, plant contamination, plant toxicity and food chain contamination [78]. Solid waste is another big issue, since mining products are, mostly, a small fraction of total excavated mass. In surface gold mining, for example, one ton of ore is likely to yield less than one gram of gold, with the rest ending up as tailings. In addition, several tonnes of barren rock may be mined to expose the ore. The amount of solid waste tends to increase with time since improved mining technology makes it possible to exploit lower-grade deposits with time.

Air pollution is another important impact. The major area of concern is dust, from excavation and transportation, causing air quality degradation [25]. In addition, the processing (including refining) of material produces pollutants (e.g., oxides of nitrogen and sulfur) that pollute the air. Worldwide, smelters add 142 million tons of sulfur dioxide to the atmosphere every year, 13 percent of global emissions [77]. Furthermore, air pollutants result from fuel use to power equipment at mine sites.

Noise pollution results from traffic, blasting and operating heavy machinery [25]. Noise pollution is the single largest type of community complaint [23]. For instance, BHP Billiton reports that out of 536 complaints in 2008 at all BHP sites, 200 were related to noise [79]. Ivanova and Rolfe [80] also identified noise impacts, together with vibration and dust, as a significant factor (90% confidence) in explaining community members' preferences for mining developments.

All of these environmental issues affect how community members perceive a particular mining project. If members of the community perceive that a particular mine (e.g., due to its reputation for environmental violations) has a reputation for poor environmental performance, they are less likely to accept the mine and, thus, grant SLO [37,81].

Beside the environmental issues, increases in housing costs and labor market shortages are negative impacts of mining projects that affect individual's perceptions of mining. Petkova et al. [72] observed significant increases in housing costs in Bowen Basin in Queensland, Australia, following the boom in coal prices between 2003 and 2008 (Table 3). The growth rates of median weekly rents from 1998 to 2008 were all at least 160% for the five studied communities with reported data. Unsurprisingly, they found accommodation in short supply in all six surveyed communities. Furthermore, Ivanova and Rolfe [80] found that "housing and rental prices" were significant, at the 5% level, for explaining the preferences for mine development options. Mining can lead to labor shortages, especially for other businesses in the local community that cannot compete with large mines for talent. Petkova et al. found that businesses in five of the six studied communities complained of difficulty recruiting from the labor pool [72]. Intuitively, one would expect that individual's in the local community incur other costs as their living expenses rise with the higher living costs. However, housing costs tend to be the bulk of household costs incurred as a result of new mines.

**Table 3.** Accommodation and staff shortages [40,72].

| Median Weekly Rents | Moranbah | Nebo | Rolleston | Blackwater | Springsure | Coppabella |
|---|---|---|---|---|---|---|
| 1998 | 137 | 117 | 80 | 145 | 100 | N/A |
| 2003 | 235 | 220 | 85 | 140 | 137 | N/A |
| 2008 | 680 | 450 | 220 | 380 | 260 | N/A |
| Growth rate 1998 to 2008 | 393% | 283% | 175% | 162% | 160% | N/A |

Traffic and crime have been observed to increase in host communities with the onset of large-scale mining. For example, two social impact assessment (SIA) studies of Central Queensland's Coppabella coal mine report that residents perceive that crime risk, general anti-social behavior and crimes against property were increasing in the community [82]. The police confirmed this observation in absolute terms, although they observed that the criminal activity increase was proportional to population growth from 2003 to 2006. This link between criminal activity and mining is supported by other research. Hajkowics et al. observes that indicators of crime and domestic violence reflect serious social problems in mining communities [83].

Traffic increase has also been observed in the SIA studies [82]. For instance, residents near the Coppabella coal mine in Australia believed that traffic volumes and accidents have increased, including the large trailers and mining equipment. Road use statistics indicated that traffic volumes had increased. The additional traffic can be associated with miners traveling between their residence and employment site. Other studies (environmental impact assessments (EIAs)) in Bowen Basin, Australia, also observe an increase in road traffic and traffic incidents [82,84]. A possible reason for the increased traffic incidents is the higher occurrence of drivers travelling home while fatigued after the end of their shift.

Taken together, the negative perceptions of a mining project due to these negative impacts drive community perceptions, which in turn affect the community's willingness to grant SLO.

#### 4.1.3. Other Impacts

Besides the obvious positive and negative impacts, mining projects can also cause population increases and cultural impacts. Furthermore, two additional attributes of the mine can affect the communities' perception of the intensity and duration of impacts: mine buffer (how far the mine is from the community) and life (duration of mining operation). These impacts are difficult to characterize as negative or positive. For example, whereas one person may think a mine with a long life is a good thing (e.g., because the jobs will last longer), another person in the same community might think otherwise (e.g., because the impacts will last longer).

A consequence of a boom in mining is the associated population growth, especially in small communities without enough skilled labor [85]. Resource exploitation can be directly linked to local population changes, as there is often population growth from migrants looking for job opportunities. This is shown by the population census of four mining communities in Bowen Basin, Queensland, Australia, in Table 4 [72]. The mining boom started in 2001, and the population growth is apparent in four of six studied communities. The population growth from 2001 to 2006 varied from +2.4% to +18.5%.

**Table 4.** Description of the case study communities [72].

| No. Permanent Residents | Blackwater | Moranbah | Nebo | Springsure |
|---|---|---|---|---|
| 2001 * | 4913 | 6124 | 238 | 770 |
| 2006 ** | 5031 | 7133 | 282 | 829 |
| Growth rate 2001 to 2006 | +2.4% | +16.5% | +18.5% | +7.7% |

Australian Bureau of Statistics (ABS) * [86]; ** [87].

A new mining company and migrants looking for job opportunities have impacts on the local community's lifestyle and traditions (culture). Indigenous populations' ways of life can be particularly affected in such situations. The diverse cultural backgrounds of the mining communities and management styles of the mining companies are a factor in determining the extent of this impact [88]. ICCM specifically identifies cultural (heritage) impacts as a factor in community engagement [26]. Cultural impacts include any effects on the cultural norms and practices, which include effects on intangible and tangible cultural heritage, and access to and the vibrancy of cultural facilities. This will be of critical importance when indigenous peoples are present within the area of impact for the mining project.

Besides the above two factors, mine buffer and life affect the mining community's perceptions of the impacts of the mine. Community opposition to a mining operation is an all too familiar picture, and this phenomenon has been called the "not in my backyard" ("NIMBY") syndrome or NIMBY-ism [89]. The key to NIMBY opposition is the location of the proposed project. For an increasing number of people today, their backyard is so vast that projects located relatively far away are still affected by this phenomenon. Ivanova and Rolfe (2011) found "buffer for mine impacts" to be a significant (at the 5% level) factor that explains community preferences for mine developments. The mine life is a measure of the persistence of all impacts (positive and negative). Therefore, it determines how long the job opportunities and noise impacts, for example, will last. It is a measure of the "length contract", which has been found to be a significant factor (at the 1% level) for explaining local acceptability of renewable energy adoption in an ageing population [90].

### *4.2. Governance*

In most jurisdictions, mineral rights are held by government on behalf of the public. Even in cases where mineral rights are held by private individuals or entities, land use and other business restrictions require that a mining company obtain a permit from government prior to initiating a mine. During mining, all aspects of mining activity are regulated by the government. Consequently, mineral resources are seen as something of a public trust that is given to a mining company to exploit with the consent of the public. During permitting, the mine owner proposes a development plan for the project, which is approved, often with modification, when a permit is granted. The permit conditions and the general regulatory framework for mining activity become compliance obligations that the mine must meet to keep the public trust. The government and its representatives, as representatives of the people, make decisions on whether to approve a permit application, what conditions to impose and how to regulate an active mine. The way these decisions are made have a significant impact on the community's perception of the mine's owners and government. Perceptions that government officials are not acting in the best interest of the community (whether independently or under the influence of mine management) can undermine the legitimacy of the mine. Hence, a key factor that affects the community's perception (and hence, social license to operate) is governance, including the mechanism for making permit decisions and the availability of transparent information.

The decision making mechanism and availability of independent and transparent information complement each other. Local communities need to have the right to be engaged in the decision making mechanism first for independent and transparent information to be useful for them. Additionally, available independent and transparent information is the foundation for them to make meaningful contributions to the decision making process. The decision making mechanism describes how decisions are made when disagreements arise on the outcome of the permitting process or other regulatory process. The information refers to all information relevant to the decision to permit a mine or evaluate regulatory compliance, including reports on mining impacts and baseline studies, such as those contained in an environmental impact assessment (EIA), for example. These decision making mechanisms vary from purely legal (i.e., the mining company meets the regulatory requirements) to those that take cognizance of the SLO and seek legitimacy [91]. In most recent cases, the information is provided by the mining company and/or government. The local community often does not trust the available information on the potential impacts from both sources [26]. Community members are more likely to trust the information if they perceive it to be independent and transparent, provided (or reviewed) by multiple groups with technical expertise but no commercial stake in the industry. The information should cover both the broad industry and also relate to specific proposals, which can facilitate local community participation in the decision making and help the community develop.

### *4.3. Community Demographics*

Compared to the mining project's impacts and characteristics, there is much less in the literature that discusses demographic factors that affect an individual's likelihood to support a (proposed) mining project in their community. Age, gender, income and number of children were found to be significant, at the 1% or 5% significant level, in explaining respondents preferences for various mining projects in a choice experiment in a mining community [80] (Table 5). The positive coefficients of female (gender), number of children and age implies that the individuals who are female, older or that have more children were more likely to prefer a mining project than individuals who are male, younger or that have fewer children.

**Table 5.** Demographic factors [80,92].

| Factors | Coefficient | Standard Error |
|---|---|---|
| Female [1] | 1.243 ** | 0.259 |
| Number of children [1] | 0.261 ** | 0.098 |
| Income [1] | 0.000 * | 0.000 |
| Age [1] | 0.037 * | 0.015 |
| Education [2] | −0.422 * | −2.293 |

** Significant at the 1% level; * significant at the 5% level; [1] Ivanova and Rolfe 2011; [2] Dimitropoulos and Kontoleon 2009.

Dimitropoulos and Kontoleon [92] observed that the level of education was significant for local acceptability of wind-farm investment at the 5% level. The level of education may be important for mining decisions, as well. The negative coefficient of education, in Table 5, implies that there is a higher probability that people with a higher education level will be opponents of the mining project than people with a lower education level.

In an attempt to understand the local community after a massive demonstration and violent conflict, Muradian et al. [91] uses gender, level of education, age and job field as important background characteristics. Other research indicates job field may be a useful factor [93].

Nonetheless, it seems reasonable to assume that demographic factors have an impact on community perceptions of a project. The community is not one homogenous block, and views vary depending on several factors that may include gender, age, income, level of education, number of children and job field.

## 5. Classifying Factors for Effective Community Engagement Leading to SLO

### *5.1. Factors' Classification*

Effective community engagement requires that stakeholders engage members of the community on the issues that matter to the community. In order to do this, mine managers need to be able to use all tools available to them for community consultation (e.g., surveys, focus group discussions, town hall meetings) [26,67,94]. However, the limitations of these approaches mean that the many issues that need addressing may not be adequately addressed individually. Some sort of classification is necessary to ensure management elicits relevant information efficiently (e.g., reduce the cost of surveys or the number of focus group discussions required to acquire the same information). It is only when this efficiency (i.e., balance between costs and time and eliciting relevant information) is achieved that the engagement program will be effective and lead to social license to operate.

There are many subjective ways to classify the factors that affect community support. In this work, the authors attempted to classify the factors equally into five main groups: environmental, economic, social, governance and miscellaneous others and demographics factors. The classification is designed to facilitate efficient communication between the mining company and the local community. This classification is also subjective and not a general one; but it has proven to be appropriate for the preliminary community engagement research [95]. The classification is shown in Figure 1. Four of the classes deal with issues that community engagement needs to elicit opinions on while the last class groups demographic factors that may play a role in explaining the diversity of opinions within the host community. Such classification is important because it can be used to facilitate efficient and effective community engagement.

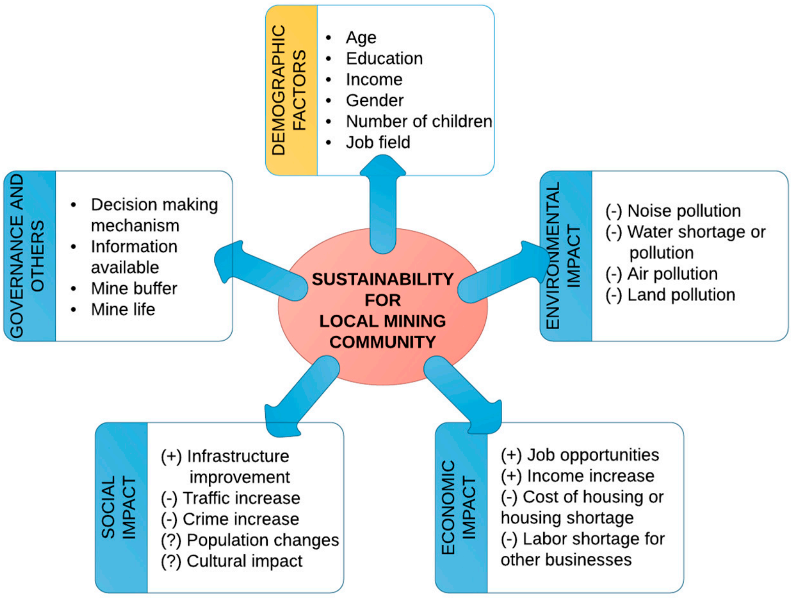


**Figure 1.** Classification of factors for effective community engagement. (+) and (−) are used to indicate factors that have positive or negative impacts, respectively.

*5.2. Two-Stage Framework*

Beside the ICMM approach involving the stakeholder analysis matrix (Table 1), discrete choice theory can also be used for mining community engagement using the classified factors. Discrete choice theory [96] has been used successfully to understand community preferences for mining development [80,84]. Compared to the stakeholder analysis matrix method, this method provides a more quantitative way to evaluate the effect of the characteristics of mining projects and demographic factors on community perceptions. Discrete choice experiments (a survey where respondents are asked to select their preferred alternative when presented with multiple hypothetical or real alternatives) and modeling (statistical modeling of discrete choice experiment results using one of several theoretical models) are the two main components of applying discrete choice theory.

A sample discrete choice experiment (DCE) choice set is shown in Table 6. This choice set is designed using four factors, which are the four upper level impacts (Figure 1). Each factor has three levels (high, medium/status quo and low). The combinations of the different levels of the factors are used to generate alternative mine development scenarios for respondents drawn from the local community. Respondents have to be drawn with valid statistical sampling techniques to ensure the sample is representative and adequate to support the conclusions [97]. In the survey, respondents drawn from the local community will be shown several choice sets, but with different alternatives. Each time, respondents will be asked to choose the alternative they prefer, if a new mine were to open near them (their residence).

**Table 6.** Sample Stage 1 discrete choice set.

| | Environmental Impact | ECONOMIC Impact | Social Impact | Government Approval Process and Other Ancillary Factors |
|---|---|---|---|---|
| Option A | Same as a similar mine in the area | Same as a similar mine in the area | Same as a similar mine in the area | Same as a similar mine in the area |
| Option B | 20% worse than a similar mine in the area | Same as a similar mine in the area | 20% better than a similar mine in the area | 20% better than a similar mine in the area |
| Option C | 20% better than a similar mine in the area | 20% better than a similar mine in the area | Same as a similar mine in the area | 20% worse than a similar mine in the area |

In this method, the respondent is asked to choose one of the alternatives (A, B or C), compared to the stakeholder matrix approach, where he or she is only asked to indicate whether his or her view of the project is "positive", "negative" or "neutral". The difference is that the proponent of the project will get more information about what drives the community's preferences: environmental impacts, economic impacts, social impacts or the government approval process and other ancillary factors. The additional information collected by the DCE approach can help the mining company to better understand the community's perception of the mine, as an initial step. DCE has been used to understand mining community perceptions of mine developments [81,92].

We are proposing a new framework where DCE can be used in a two-stage approach for effective community engagement. In this approach, Stage 1 uses DCE to elicit views from respondents based on the four broad factors: environmental, social and economic impacts and governance and others. Stage 2 elicits views on an expanded list of factors from any of the broad factors that are found to be of particular interest to the respondents in Stage 1. A key part of discrete choice experiments and modeling is identifying and classifying the factors that affect an individual's preferences. This first step (identifying and classifying factors) can be accomplished with the factors and classification presented in this study. Using the four broad factors based on the classification in this work, a Stage 1 discrete choice experiment (DCE) can be conducted and the resulting data used for discrete choice modeling.

If necessary, a Stage 2 survey can be designed using a hybrid of the upper level factors (the four categories) and lower level factors of the upper level factors that are found to be significant. For example, assume the Stage 1 survey shows that only economic impacts are important (either positive or negative) to the community and that respondents are neutral on the other impacts. The Stage 2 survey can then have the following factors: governance, environmental impacts, social impacts, job opportunities, income increases, housing costs and labor shortage for other business. The proposed survey can collect much more useful information without being unduly complex or costly when compared to the traditional approach of applying DCE to stakeholder analysis [81,92]. This advantage exists in cases where the number of relevant factors considered in the DCE is high (e.g., Que [92] considers 16 factors).

What is more, the demographics can be tracked in both stages. As the literature suggests, demographic factors have an impact on community perceptions of a project. The community is not one homogenous block, and views vary depending on several factors that may include gender, age, income, level of education, number of children and job field. The data from any survey can be analyzed to evaluate whether demographics play a role in explaining diversity in perceptions.

We believe this two-stage approach is advantageous because it is cost-effective and time-flexible. Compared to the stakeholder matrix method (Table 1), the Stage 1 survey is likely to cost the same and take as much time, but result in more detailed information for assessing community preferences. The Stage 2 survey, if found necessary, will provide managers and researchers more information by which to examine the broader concepts in detail. Additionally, the cost of this second stage will only be incurred when found necessary.

However, there are two main limitations of the proposed approach. First, the approach requires a classification (grouping) of factors prior to any input from the community. Since the remainder of the community engagement depends on the validity of the classification, invalid classification can lead to misleading results. The classification in Figure 1 has been validated in the U.S. context [41]. There is no reason, however, to believe that this classification is universally valid without further research. Second, by using a two-stage approach where only some of the primary factors are included in the Stage 2 surveys, some confounding effects between the primary factors can be lost in the data. This could be an issue in situations where the effects of a particular factor may be heightened in the presence of another factor.

Overall, we believe that this two-stage approach would be beneficial. However, further work is required to examine whether it is valid and under what conditions it is valid. Such research can be done by conducting surveys with all relevant factors and in two stages, as proposed. The results of the two kinds of surveys can be compared to see if the results are consistent.

## 6. Conclusions

This study presents 17 factors that affect community members' views of a mining project, which impacts a mine's social license to operate. This is done through a comprehensive review of the literature. The authors classify the 17 factors found in the literature into five categories: environmental, economic, social, governance and demographic aspects. The work also proposes a two-stage community engagement approach based on the classification of the dominant factors presented in this work and discrete choice theory. The approach is cost-effective and less time consuming than traditional community engagement. Further work is required to validate the proposed approach. The aim of this paper is to provide mining companies guidance to improve their chance of obtaining a social license to operate for their operations through better community engagement.

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