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The social image of mining; A measurement proposal

La imagen social de la minería; una propuesta de medición

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Abstract

The aim is to construct and validate a social image scale of mining and examine its influence on residents' attitudes, considering corporate social responsibility (CSR) perceptions, as well as concerns and sentiments regarding mining. Data steam from a probabilistic sample of 373 heads of households or spouses in communities along the Sonora River, Mexico. The scale and its predictive capacity are validated through confirmatory factor analysis (CFA) and structural equation modeling (SEM). Results confirm a second-order scale with four subscales (i.e., economic, social, environmental, and emotional) and a formative-causal model of image-attitude. The originality lies in the proposed scale, nonexistent within the country's mining sector. Findings confirm the scale's reliability and validity as a measure of mining's social image; nevertheless, given the exploratory nature of this research, validation in other contexts is advisable.

JEL Code: M14, M31, D91, Q56, L72
Keywords: corporative image; corporative social responsibility (CSR); mining; confirmatory factor analysis (CFA); structural equation modeling (SEM)

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Resumen

El objetivo es construir y validar una escala de imagen social de la minería y examinar su influencia en la actitud de los pobladores, teniendo en cuenta las percepciones de responsabilidad social corporativa (RSC), así como sus preocupaciones y sentimientos respecto a la minería. Los datos provienen de una muestra probabilística de 373 jefes(as) de familia o conyugues en comunidades del río Sonora, México; la escala y su capacidad predictiva se validan con un análisis factorial confirmatorio (AFC) y un modelo de ecuaciones estructurales (SEM). Los resultados validan una escala de segundo orden, con cuatro subescalas (i.e. económica, social, ambiental y emotiva) y un modelo causal-formativo de imagen actitud. La originalidad radica en la escala de imagen propuesta, de la cual carece el sector minero del país. Los hallazgos confirman que la escala es fiable y valida como medida de imagen social de la minería; no obstante, siendo esta una investigación exploratoria, se recomienda validarla en otros contextos.

Código JEL: M14, M31, D91, Q56, L72
Palabras clave: imagen corporativa; responsabilidad social corporativa (RSC); minería; análisis factorial confirmatorio (AFC); modelos de ecuaciones estructurales (SEM)

Introduction

Mexico is an important producer of metals and minerals, occupying the first positions in the world production of silver (1st place); fluorspar (2nd place); sodium sulfate and wollastonite (3rd place); celestite (4th place); lead, molybdenum, barite, diatomite, and magnesium sulfate (5th place); zinc (6th place); salt, gypsum, cadmium, feldspar, and gold (8th place); and copper (10th place) (Mexican Mining Chamber [Camimex], 2022; Spanish: Cámara Minera de México). This geological potential, along with the political climate, legislation, and public policies implemented, placed Mexico in 34th out of 84 countries the Fraser Institute (2022) considered in its 2021 annual evaluation of the Mining Investment Attractiveness Index. Nevertheless, Mexico registered lower investment attractiveness compared to other mining countries in Latin America, such as Argentina (San Juan [22] and Salta [27] regions), Ecuador (24), Colombia (29) and Chile (31) (Fraser Institute, 2022, p. 11).

As an extractive activity with low industrialization and, therefore, low value added, metallic and non-metallic mining (including mining-related services) contributed 1.4% of the national gross domestic product (GDP) in 2021 (National Institute of Statistics and Geography [INEGI], 2022a; Spanish: Instituto Nacional de Estadística y Geografía). Likewise, that year, this activity employed 115 566 workers, according to data reported by the Mexican Social Security Institute (IMSS; Spanish: Instituto Mexicano del Seguro Social) and published by Camimex (2022, p. 246). Nonetheless, for the leading states in mining production, the contribution of mining to the federal entity's GDP is a much higher percentage than the national one: Sonora (11.1%), Zacatecas (10.6%), Chihuahua (4.5%), Durango (5.3%), Guerrero (4.8%), Baja California Sur (2.8%), Coahuila (2%), and San Luis Potosí (1.9%) (INEGI, 2022b).

While the geological conditions that enable mining activity and the factors that attract investment are important, so is the social climate that affects investment and operating decisions. Hence, international business consultancies (such as Deloitte, 2018; Ernst & Young [EY], 2019; KPMG, 2019), as well as pro-mining organizations at the international (Fraser Institute, 2022; International Council on Mining and Metals [ICMM], 2022) and national (Camimex, 2022) levels, recognize the image of the sector as a key issue. Despite relevant changes in the sector, the consensus points out that practices of "difficult relations with communities" persist (Deloitte, 2018, p. 22), which must be improved based on a change in society's perceptions. Community relations and social license to operate (SLO) are considered important risks for the activity,[1] impacting investors and access to geological resources.

In general, a negative social perception of mining prevails (Devlin, 2023; Badera, 2014; Deloitte, 2018; FUNDAR, 2017; Andrews et al., 2017) since the balance between the economic aspects that contribute to a positive perception commonly associated with the generation of employment is insufficient in the face of the negative socio-environmental impacts generated by the activity. In this regard, positive perceptions of mining have been documented in Europe (Innovative Non-Invasive & Fully Acceptable Exploration Technologies [INFACT], 2018) and particularly in Spain (Requejo & Blázquez, 2018). Nevertheless, labor conditions and negative environmental impacts are socially criticized in the latter. Likewise, in Chile, socio-environmental impacts are perceived negatively, in contrast to economic ones (Viveros, 2016). Nevertheless, research on the image of mining is limited and has placed less emphasis on the impact of CSR efforts on communities (Said et al., 2022).

In the particular case of Mexico, where a negative historical image has been documented (Navarro, 2018), there is no systematic study of the image of mining, even though Camimex and the Mining Clusters of Sonora, Zacatecas, Chihuahua, Guerrero, Durango, the Bajío, and Sinaloa actively support the management of the sector's image (Fontes, 2020). Consequently, this study has a dual purpose: first, it seeks to construct and validate a scale of social image of mining, with the support of confirmatory factor analysis (CFA), and second, to explore the effect of the image on the attitude that people have toward mining, through a predictive validity test with structural equation modeling (SEM). Given that the social image is constructed from the set of ideas, beliefs, and impressions that society has about mining and its impacts, a scale is proposed that considers the perceptions of corporate social responsibility (CSR) and incorporates the concerns and emotions of the inhabitants of the communities with the socio-environmental performance of the sector.

To validate the scale, the mining sector in the state of Sonora, Mexico, and the communities that host or are linked to this activity were used to validate the scale. Sonora is a national leader in metal

[1] SLO refers to the intangible, unwritten, and dynamic contract between company and society that enables the initiation and continuation of mining operations in the community (Meesters et al., 2021).

production, with 22 metal mines in operation (Ministry of Economy [SE]; Spanish: Secretaría de Economía & Mexican Geological Service [SGM], 2020; Spanish: Servicio Geológico Mexicano), with the presence of both national mining groups (e.g., Grupo México, Fresnillo PLC-Grupo Peñoles, Grupo Frisco), and foreign corporations, mainly Canadian (Rodríguez, Almaguer, & Rodríguez, 2021). The information on perceptions was obtained from a stratified probability sample of 373 households in mining communities in the Sonora River, Mexico region, which was applied from February to March 2019 to heads of households or spouses since their perceptions influence the rest of the household members. Given the lack of a theoretical scale of the social image of mining, since surprisingly few studies exist, the present study is considered exploratory research, so the proposed scale and its results are preliminary, simultaneously creating and validating the scale and exploring the underlying structure of the data.

Theoretical and conceptual elements for the study of mining images

Image in the mining sector

Image is the mental construction of a public about a brand, company, industry, sector, or country based on the evaluation of information about certain attributes with which organizations are defined and differentiated (Capriotti, 2013); in other words, the image is an idea or attitude generated by the receiver of the information. In the 1970s, amid the global economic crisis, corporate efforts focused on improving the image and reputation of the company to achieve social legitimacy (Said et al., 2022), increasingly incorporating social responsibility policies and making it an imperative for entrepreneurial success (Hoelscher & Rustad, 2019).

In the mining sector, a negative image of its socio-environmental performance prevails, which results in resistance to mining in emerging economies and those in post-conflict (Sydd et al., 2023); therefore, improving the global or supra-organizational image (i.e., that which influences the image of all companies in the sector and vice versa) became the focus of attention of various meetings worldwide during the 1990s (Dashwood, 2014; Said et al., 2022). Thus, driven by leading companies, it led to a commitment to corporate social responsibility (CSR), framed in international standards[2] and voluntary initiatives (between society, public and private sector) in search of mining sustainability (Potts et al., 2018). Even more than any other sector, mining has joined many CSR initiatives due to increasing

[2] These efforts were framed within the international standards of the International Organization for Standardization's (ISO) ISO-26000 regulation (ISO, 2010), the ten principles of the International Council on Mining and Metals (ICMM, 2022), and the guidelines established by the Global Reporting Initiative (GRI, 2022).

pressures from external groups, such as local communities and Non-Governmental Organizations (NGOs) (Sun & Bahizire, 2023).

Theoretically, mining is an emerging thematic field in the literature on CSR, widely studied by the administrative sciences (Barnett et al., 2020; Karakaya & Nuur, 2018). In the mining field, CSR refers to the voluntary and mandatory corporate commitment, according to the regulations of each country, to improve the welfare conditions (e.g., economic, social, and environmental) of the communities; these efforts respond to the expectations of the stakeholders and seek to mitigate the negative effects of mining activity (Rodrigues et al., 2022; Said et al., 2022). Therefore, CSR should be implemented with actions perceived as beneficial by the community, as it is the most important stakeholder (Said et al., 2022).

Recently, there was a paradigm shift toward CSR 2.0 and the creation of shared value, which benefits both business and society (Hoelscher & Rustad, 2019; Barnett et al., 2020),[3] as well as community support for or acceptance of the company's operations, known as social license to operate (SLO) (Meesters et al., 2021), has been observed. Research on "CSR image" has emerged within this framework, which studies public perceptions of corporate responses to social concerns (Pérez & Rodríguez del Bosque, 2013). Although CSR can provide relational, reputational, and financial benefits to companies, the benefits to society are rarely validated, so there is a lack of evidence as to whether CSR delivers the social benefit it promises (Barnett et al., 2020).

One of the key social issues in the CSR literature is the environmental effects of mining (Karakaya & Nuur, 2018), as well as its potential conflicts with the community (Pérez Falcón et al., 2022; Sydd et al., 2023). Given the relevance of the effects of mining on the environment close to communities, the use of CSR to improve the image, mitigate impacts, and gain acceptance of the activity has remained current in academic (Devlin, 2023; Alamgir & Nasir-Uddin, 2017), business (KPMG, 2019; Deloitte, 2018), and organizational (United Nations Development Programme [UNDP] 2018) discourse. Nevertheless, only recently has interest been detected in broadening the conceptualization of CSR to study its effect on the environmental and social impacts of extractive activities (Barnett et al., 2020).

Thus, the socio-environmental field has been the focus of CSR initiatives in the mining sector, but these have gradually expanded to other areas, such as infrastructure, health, education, sports, culture, and art (International Organization for Standardization's [ISO], 2010; Deloitte, 2018); toward policies of community participation and building relations with the community (Badera, 2014); as well as economic and business development initiatives (Amin-Chaudhry et al., 2019; UNDP, 2018; ISO, 2010). Nevertheless, mining companies often fail to implement CSR, as it responds to shareholder welfare rather than corporate engagement or community interest (Isacowitz et al., 2022).

[3] With this approach, companies are expected to be more successful because they: 1) create value, for themselves and for local communities; 2) govern responsibly; and 3) act with environmental integrity.

It should not be forgotten that groups respond to CSR to the extent that they derive and perceive personal benefits, according to the relation established with the company (Bhattacharya et al., 2009), hence the importance of perceptions.[4] Nonetheless, a sustainable development approach is appropriate for the study of perceptions due to 1) the extractive nature of the sector, with a high potential to cause damage to communities and the environment; 2) the public scrutiny to which mining companies are subject, given the negative effects generated; and 3) the fact that it is a Business to Business (B2B) sector. Therefore, the analysis of the image of mining should leave aside the scales proposed by the literature based on the "product or service" and focus on the company's contribution to sustainable development in mining communities.

Proposal for a mining social image scale

The social image of the mining sector is defined in this study as a set of ideas, beliefs, and impressions that community members share about the mining activity operating in their communities. Consequently, the image is evaluated externally, that is, based on the attributes that society perceives of the sector, which are regularly manifested through the CSR actions undertaken by the companies in the mining communities. To this end, the study of images includes individual and social impressions of the perceptions of a set of attributes, which, at an appropriate level, develop more favorable attitudes.

At the supra-organizational level, there are numerous studies validating an image scale for the tourism (Marinao-Artigas & Barajas-Portas, 2021) and financial (Marinao-Artigas, 2018) sectors. Nevertheless, after reviewing the academic literature, no studies were identified concerning the construction and validation of image scales in the mining sector, except for the work of Ruíz-Martín et al. (2014.); instead, qualitative research or case studies of mining companies where images or CSR are studied are more frequent. Although the literature on image measurement is fragmented and there is little consensus on the dimensions to be evaluated (Pérez & Rodriguez del Bosque, 2013; Peloza & Shang, 2011), after reviewing these studies, the inclusion of two approaches is recognized: image-attitude and perceived benefits.

The image-attitude approach is evaluated, from social psychology, from the cognitive-affective-conative (CAC) model and its components: a) cognitive, based on knowledge, thoughts, beliefs, and ideas that one has about it (i.e., rational); b) affective, i.e., feelings or emotions that it provokes when perceived

[4] Three approaches have been identified in the study of perceptions: 1) the Carroll scale, which integrates the economic, legal, ethical, and philanthropic dimensions of CSR; 2) the sustainable development approach, which balances attention to economic, environmental, and social problems through CSR; and 3) the stakeholder approach, where CSR is designed according to the obligations and impacts on these groups (Pérez & Rodríguez del Bosque, 2013).

(i.e. irrational); and c) behavioral, predisposition to act in a certain way (i.e. conative) (Yang et al., 2022; Kim & Chen, 2021; Capriotti, 2013). On the other hand, it is suggested that benefits are evaluated as part of the rational component of the image (Marinao-Artigas & Barajas-Portas, 2021; Marinao-Artigas, 2018; Capriotti, 2013) through the perceived benefit or value; that is, what each person believes that an attribute or object can do for them.

CAC is a hierarchical cause-and-effect model (Yang et al., 2022) in which image components are activated one after another, forming a psychological decision-making process (Kim & Chen, 2021). Nevertheless, it should be considered that the behavioral component is an outcome factor of Image-Attitude, framed in predisposition and not in performance (i.e., final action); therefore, an assessment from the affective and cognitive components is suggested (Capriotti, 2013). Thus, if the Image-Attitude is positive, the individual's actions when faced with the object (e.g., mining sector) may generate or strengthen a favorable behavior.

Thus, a social image scale is proposed that captures perceptions of CSR as a cognitive component since these are the attributes that companies offer to communities and those who perceive their value (Said et al., 2022; Peloza & Shang, 2011) and this is conceived, together with affective valuations, as the constructs of the image, which outlines the attitude of the inhabitants of the communities toward mining (see Figure 1). Based on the theoretical and conceptual elements presented, the following dimensions of the scale are proposed: 1) emotional perception, related to an individual's feelings toward mining, which may be favorable, unfavorable, or neutral; and 2) cognitive perception, based on the personal assessment of social, economic, and environmental CSR policies, thus addressing a sustainable development approach. Finally, the behavioral component will be evaluated outside the scale, as it shows an intention or probability of accepting or rejecting mining in the community.

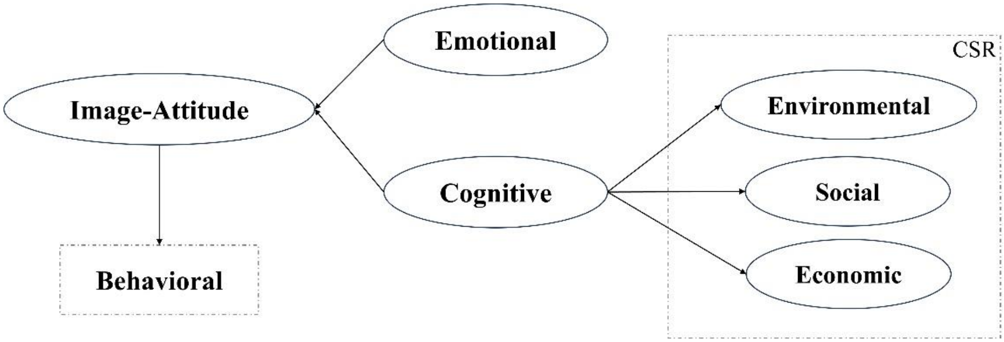

Figure 1. Theoretical model of the mining social image scale
Source: created by the authors based on the review of the literature

Methodology

The approach was quantitative, and the study design was non-experimental, exploratory, transectional, and correlational. Thus, to carry out the development and validation of the mining sector social image scale, the following stages were followed: 1) instrument design; 2) data collection; 3) exploratory analysis (EFA) of the scale dimensions; 4) confirmatory analysis (CFA) to validate and calibrate the items of the measurement model (MDM); 5) reliability and validity analysis of the proposed scale; and 6) structural analysis (SEM) for a predictive validity test of the scale within the proposed theoretical model.

Thus, an instrument with content validity was developed to record the perceptions (cognitive and emotional) of the communities' inhabitants concerning the theoretical and conceptual components discussed in the previous section. The instrument consisted of 20 items,[5] where the informant evaluates favorable statements concerning mining on a Likert scale of five positions: 1=Strongly disagree; 2=Disagree; 3=Undecided; 4=Agree; and 5=Strongly agree. After a pilot test, the instrument was applied from February to March 2019 to a probabilistic and stratified sample with the proportional allocation of $n = 363$ households, with a confidence level of 95% and an error of 5%, in communities of seven municipalities of the Sonora River region (Rodriguez, 2019a). According to census information available at the time of application, the sampling unit was the dwelling, with a universe of 6 431 inhabited dwellings (INEGI, 2015).[6]

For each dwelling, an informant was identified to report the perceptions of household members, who had to match the following profile: a) head of household or spouse; b) over 25 years of age; and c) at least five years of residence in the region. The head of household or, in their absence, their spouse, generally plays a crucial role in the decision-making of household members; therefore, understanding their perceptions helps to understand how they evaluate and value different options and how they might influence the decisions of household members. Likewise, the perceptions of the head of household affect family well-being, as their concerns and satisfactions have an impact on the emotional climate of the household.

In addition, considering the importance of the interaction between mining and community, the sample was stratified based on a) proximity to mines in the region,[7] b) population concentration, and c)

[5] The designed items were integrated as a section within the 'Survey of Sonora River Residents' (Rodríguez, 2019a), which was applied within the framework of a broader research project.
[6] There were 20 395 people living in the study region (INEGI, 2015) and it is made up of rural, sparsely populated municipalities of small territorial extension, which have registered population displacement (Orozco & Rodríguez, 2022, p. 312).
[7] The Buenavista del Cobre S. A. de C. V. mine, a subsidiary of Grupo México, is located in Cananea, but because of its scale of operation it has a major influence on the 'downstream' communities of the Sonora River region (Orozco & Rodríguez, 2022); while the Santa Elena Oro y Plata S. A. de C. V. mine, owned by Canada's First Majestic Silver

the number and layout of houses at the block and locality level. Accordingly, the sample favored municipalities close to mines, resulting in a greater relative weight in municipalities with smaller populations. A total of 373 surveys were applied (10 more than the estimated n), with the following distribution among the municipalities of the Sonora River (number of houses surveyed in parentheses): Ures (34), Baviácora (56), Aconchi (50), San Felipe de Jesús (22), Huépac (57), Banámichi (94), and Arizpe (60); the selection of blocks and houses was random.

The sociodemographic characteristics of the respondents show that 63.5% were women and 36.5% were men, with an average age of 54.5 years. 63.0% identified themselves as head of household, 34.6% as a spouse, and 2.4% referred to another household member who matched the informant profile (Rodriguez, 2019b). Regarding educational level, although 6.4% stated that they had no education, basic education prevails among the informants (62.3%), followed by high school (20.3%) and higher education (9.1%), with a non-response rate of 1. 9%, while the occupational structure was as follows: housewife (32.2%), own business (16.2%), public employee (10.5%), retired/pensioned (10.5%), commercial employee (9.9%), unemployed (4.8%), agricultural laborer (2.7%), and mine employee (2.7%)[8] (Rodríguez, 2019b).

The Statistical Package for the Social Sciences (SPSS®), version 25.0, was used for the AFE. In contrast, for the construction of the scale (CFA), validation, and evaluation of its predictive capacity (SEM), the covariance approach of the Analysis of Moment *Structures software* (known as Amos®), version 23.0 (Byrne, 2010; Arbuckle, 2019) was chosen. The approach for parameter estimation (covariances vs. partial least squares) depends on several factors: the nature of the construct, the complexity of the theoretical model, and the sample size; consequently, given the complexity of the proposed scale (Figure 1) and a "large" sample size, Amos was chosen.[9] Thus, the covariance approach is appropriate since the theory is being tested or a new scale is being developed (Diamantopoulos, 2011); moreover, greater precision in parameter estimation is achieved.

The proposed scale consists of reflective constructs, on which its psychometric characteristics of unidimensionality, reliability, and validity (i.e., convergent and discriminant) will be evaluated (Fornell & Larcker, 1981; Bagozzi & Yi, 2012; Hamid et al., 2017). For predictive validity testing, formative constructs are used, which assess the ability of the latent construct to predict an external criterion, i.e., whether it has a meaningful effect on the outcome variable (Hair et al., 2017). Likewise, to assess whether

Corp, is located in Banámichi, but its influence has extended to the neighboring municipalities of Huépac, San Felipe de Jesús, and Aconchi, which provide employment, housing, and other services to mine employees and contractors.

[8] Considering both the informant and their spouse, 6.7% of households (25 in absolute numbers) were inhabited by a mine employee (Rodriguez, 2019b).

[9] A sample is considered large when there are over 200 cases or 5 to 20 cases per parameter, or 8 cases per latent variable (Vargas & Mora-Esquivel, 2017).

the data obtained support the theoretical model underpinning the measurement scale, the absolute, incremental, and parsimony fits of the models are observed (Diamantopoulos, 2011; Byrne, 2010).[10]

Results and discussion

Construction of the measurement scale

Table 1 shows a summary of the AFE. Initially, 3 items with factor loadings $< .50$ were discarded, leaving 17 items for the analysis,[11] ordered and renumbered by size; four components were identified, which the authors called subscales, and which explain 67.0% of the total variance (see Table 1). The KMO statistic provides evidence of the correlation between items (value close to unity). Hence, Bartlett's test ($\text{p} - \text{value} \leq .05$) shows the feasibility of simplifying the information. Reviewing the rotated factor loadings (λ), each of the subscales registers a good degree of unidimensionality according to the items attached to them and a good internal consistency according to Cronbach's Alpha ($\alpha > .70$) (see Table 1). The subscales identified, ordered according to the variance explained, are labeled as environmental CSR (AMB), emotional perception (EMO), economic CSR (ECO), and social CSR (SOC).

Table 1
Subscales of the social image of mining in the Sonora River ($n = 373$)

Kaiser-Meyer-Olkin Test (KMO = 0.870)	Bartlett test ($\chi^2 = 3208.6$)		gl = 136 (0.000)	
Rotated component matrix				
How much do you agree with the following statements about metal mining...	AMB	EMO	ECO	SOC
Q1 ...cares for natural resources?	.791			
Q2 ...cares about the species in the area?	.777			
Q3 ...protects the community from hazardous environmental toxins?	.752			
Q4 ...reduces water pollution?	.716			
Q5 ...has nature protection programs?	.673			
Q6 ...does reforestation campaigns?	.671			
Q7 ...makes me feel at ease?		.868		
Q8 ...makes me feel comfortable?		.858		
Q9 ...makes me feel less fearful?		.803		
Q10...makes me feel less vulnerable?		.740		
Q11...creates more sources of employment?			.868	
Q12 ...improves the economy of the community?			.858	

[10] Estimates used the maximum likelihood (ML) method, bootstrapping (resampling to improve estimation), univariate normality and the presence of outliers (Arbuckle, 2019; Byrne, 2010).
[11] The discarded items were: mining makes me feel expectant; mining helps improve my quality of life; and mining supports the community through social programmes.

Q13...improves the economic performance of the company?			.803	
Q14...promotes the growth of economic activities?			.596	
Q15...sponsors health programs?				.823
Q16...supports educational and cultural programs?				.791
Q17...donates to social causes?				.762
Explained variance (cumulative 67.0%)	21.4%	17.2 %	15.0%	13.4%
Average factor loading	.730	.817	.752	.792
Cronbach's alpha (17 items = .860)	.874	.868	.788	.704

Note: principal component extraction, Varimax rotation, and Kaiser normalization, factor loadings less than .500 are excluded; EMO = emotional perception; AMB = environmental corporate social responsibility (CSR); ECO = economic CSR; SOC = social CSR.
Source: created by the authors based on SPSS® (v. 25.0) processing of selected items from "Survey of Sonora River Residents" (Rodríguez, 2019a).

The first component, i.e., the AMB scale, comprises six items concerning the perception of whether these CSR actions are carried out by mining (at the sector level.) These are ordered according to representativeness: care for natural resources (P1), concern for local species (P2), protection from dangerous toxins (P3), reduction of water pollution (P4), nature protection programs (P5), and reforestation campaigns (P6) (see Table 1). The second subscale consisted of four items of emotional perception about the informant's feelings regarding the presence of mining activity in the region, both positive (P7 and P8) and negative (P9 and P10); among these, the positive emotions expressed were the most loaded in this subscale (see Table 1).

The third subscale is composed of four items of economic perception (ECO), so that the associations between mining and the creation of sources of employment (P11), improvements in the economy (P12), and the economic performance of society contribute more to the construction of ECO than the promotion of the growth of economic activities (P14) (see Table 1). Finally, the fourth subscale, called SOC, is made up of 3 items of perceptions of CSR social actions: sponsorship of health programs (P15), educational and cultural support (P16), and donations to social causes (P17); among these, health programs have a stronger association with SOC (see Table 1).

In order to build the scale, it is hypothesized that the image is constructed from the covariation of the subscales, each of which has at least three indicators and satisfies the order condition (Vargas & Mora-Esquivel, 2017). Thus, it starts from a first-order measurement model (MDM) (see Figure 2, left). Nevertheless, the degree to which this satisfactorily predicts the covariance matrix, through the Chi-square statistic (χ^2), is not the desired $\chi^2_{(113\text{gl})} = 315.4\ (\text{p} - \text{value} \leq .01)$, but alternative measures suggest a good fit.[12] Furthermore, the subscales of CSR (i.e., AMB, SOC, and ECO) show a more robust correlation

[12] A significant χ^2 implies a statistically meaningful difference between the observed data and the expected data according to the model, so, ideally, a non-meaningful statistic would be expected, indicating the absence of a discrepancy between the observed and predicted data. Nevertheless, this statistic is affected by sample size, with the

(between .33 and .62) than that between EMO and other subscales, except ECO (see Figure 2, left). This information provides a guideline for evaluating a second-order MDM (see Figure 2, right) that conforms to the theoretical proposal in Figure 1.

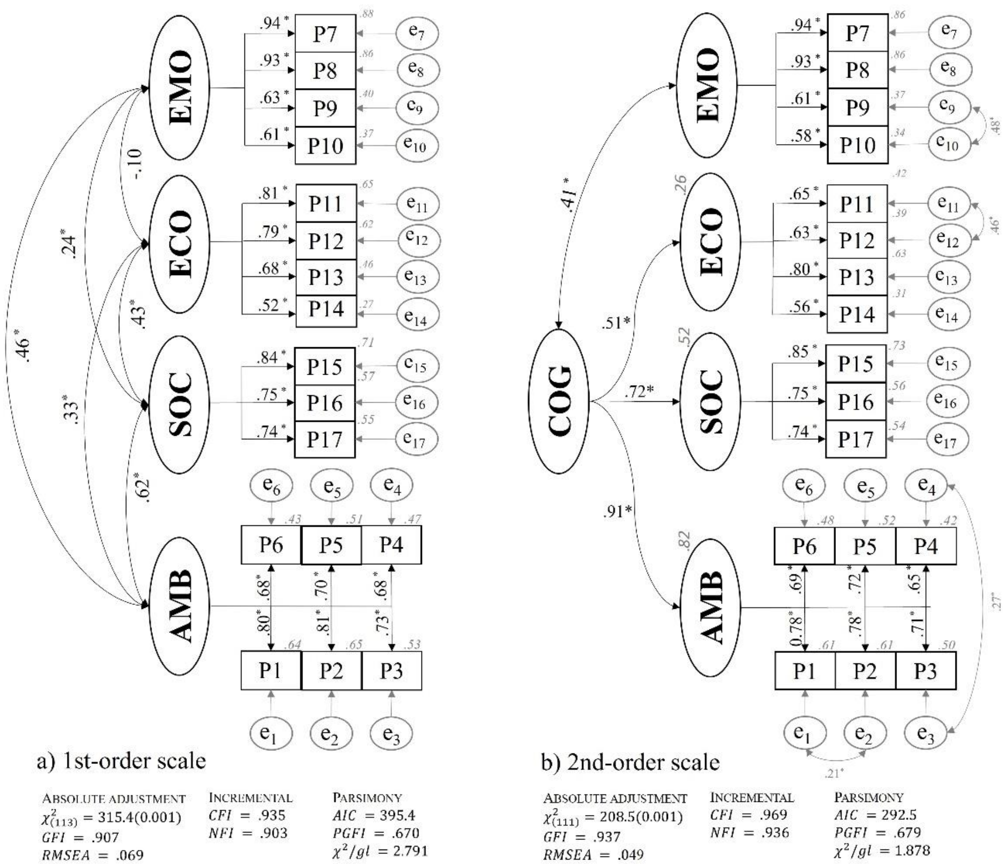

Figure 2. Mining social image scale (Standardized coefficients)
Note: both models over-identified, * $p - \text{value} \leq .01$ (99% significance level). EMO = emotional perception; AMB = environmental corporate social responsibility (CSR): ECO = economic CSR; SOC = social CSR; χ^2=Chi-square; GFI=goodness of fit index; RMSEA=mean squared error of approximation; CFI=comparative fit index; NFI=normed fit index; AIC=Akaike information criterion; PGFI=parsimonious goodness of fit index; χ^2/gl= normalized Chi-square.
Source: created by the authors based on estimates in Amos® (v.23.0).

likelihood of a meaningful χ^2 increasing as the sample size increases; it is therefore advisable to consider other measures of fit (Arbuckle, 2019; Byrne, 2010).

Figure 2 shows that when moving from a first-order to a second-order multidimensional model, the χ^2 value decreases ($\chi^2_{(111\mathrm{gl})} = 208.5$), but remains statistically meaningful ($\mathrm{p-value} \leq .01$).[13] Nevertheless, given that the increase in χ^2 between models is $\Delta\chi^2{}_{(2\mathrm{gl})} = 106.9$, being greater than the critical value of 5.991 ($\mathrm{p-value} \leq 0.05$), the second-order multidimensional scale is more appropriate than a first-order one (see Figure 2, right). It is also observed that all fit measures improve and suggest: 1) a good overall fit of the data to the model ($\mathrm{RMSEA} = .049$; $\mathrm{GFI} > .90$); 2) an adequate incremental fit, both CFI and NFI have values $> .90$; and 3) a good degree of parsimony, as ($\chi^2/\mathrm{gl} = 1.878$) and is within the suggested rank of 1 to 3, and PGFI has 'acceptable' values, even lower than other indices (Byrne, 2010).

Continuing with Figure 2 (right), the factor loading (λ_i) is the representativeness of the observed variable or item (P_i) in the latent construct (ξ_i), while e_i and δ_i are measures of error in P_i and ξ_i respectively, for $i = 1, 2, 3\ldots373$. The estimates of λ_i range between $.58$ and $.94$ and the item variance is explained by its respective subscale in a significant ratio ($.31 < R^2 < .86$), meeting the criteria of Jöreskog and Sörbom (1993), namely: 1) $\mathrm{p-value} \leq .05$; 2) $\lambda_i > .50$; and 3) $R^2 > .30$; and showing evidence of the unidimensionality of the subscales, with items associated with each other and representing a single construct (Hair et al., 2014).

Assessment of the reliability and validity of the scale

The items of the scale have good construct reliability; that is, the ratio of the item variance explained by the construct is above the suggested value of $\lambda > .70$ in most cases (see Figure 2); in others, the values are between $.50$ and $.60$, which are acceptable factor loadings in incipient stages of a scale (Hamid et al., 2017; Chin, 1998). Regarding reliability, the first and second-order subscales show internal consistency, with Composite Reliability (CR) greater than the critical value ($CR > .70$); but without exceeding the threshold of $.90$, which is not desirable (Hamid et al., 2017). These data are also supported by the McDonald reliability index [MaxR(H)] (see Table 2).

Construct validity (i.e., how well the measure defines the concept) is assessed by the average variance extracted (AVE). Table 2 shows that the subscales have convergent validity ($AVE > .50$) and are reliable as items converge or share a high ratio of common variance (Fornell & Larcker, 1981; Hair et al., 2014). In the case of ECO, with an $AVE_{ECO} < .50$ and a $CR_{ECO} > .70$ (above the critical value), its construct validity is still considered adequate, as the AVE is a more conservative or restrictive reliability

[13] Note that errors in the subscales were correlated. This is a strategy to improve model fit in cases of high residual correlation between items or redundancy due to overlapping content (Byrne, 2010).

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measure (Fornell & Larcker, 1981, p. 46).[14] Thus, irrespective of scale grade, the items accurately represent the concept of interest.

On the other hand, discriminant validity is assessed following the Fornell and Larcker (1981) criteria: 1) the construct must explain the variance of its items better than that of other constructs, and 2) the AVE of the construct must be greater than the squared inter-construct correlations ($\sqrt{AVE}$). The results in Table 2 show that discriminant validity is fulfilled for the subscales, as $MSV < AVE$ and ($\sqrt{AVE}$) greater than the absolute value of the inter-construct correlations (the diagonal of the correlation matrix in Table 2 shows the value of ($\sqrt{AVE}$); therefore, each subscale differs, and the items distinctively represent only one construct.

Table 2
Reliability and validity measurements of the social image of mining multidimensional scale

First-order scale	RC	AVE	MSV	MaxR (H)	Correlation matrix			
					AMB	EMO	SOC	ECO
AMB	0.866	0.525	0.401	0.873	.724			
EMO	0.859	0.614	0.201	0.938	.448*	.784		
SOC	0.824	0.611	0.401	0.834	.633*	.231*	.782	
ECO	0.754	0.439	0.297	0.780	.437*	.005	.545*	.662
Second-order scale					EMO	COG		
EMO	0.858	0.614	0.169	0.939	.784			
COG	0.766	0.535	0.169	0.858	.411*	.731		

Note: EMO = emotional perception; AMB = environmental corporate social responsibility (CSR); ECO = economic CSR; SOC = social CSR; CR= composite reliability; AVE= average variance extracted; MSV= maximum shared variance; MaxR(H) = McDonald reliability construct; * $p - \text{value} \leq .01$. Items on the diagonal are $\sqrt{\text{AVE}}$ between each construct and its items; otherwise, they are correlations between constructs.
Source: created based on CFA results (see Figure 2), calculations based on Gaskin and Lim (2016).

Predictive validity and scale discussion

The proposed scale was constructed from cognitive (COG: AMB, SOC, and ECO) and emotional (EMO) perceptions, representing two dimensions of a formative scale of the social image of mining. Nevertheless, as a test of the scale's predictive validity, items of community satisfaction with the presence of mining are taken from the same instrument used to collect data on perceptions. The aim is to construct an image-attitude model to explore the relations between the image dimensions and the predisposition toward social conduct or behavior concerning mining (see Figure 1).

[14] Fornell & Larcker (1981) suggest relying solely on composite reliability (CR) to conclude about construct validity; if $AVE < .50$, the variance due to measurement error is greater than the variance captured by the construct.

This behavioral element that is added to the analysis is manifested through three items, coded on a Likert scale of five positions, where the informants respond on the degree of agreement or disagreement with the following statements: 1) canceling mining activity in the community; 2) mining as a main characteristic of the community; and 3) mining gives prestige to Sonora. It should be noted that the construct 'Behavior' is analyzed outside the image scale and is included in the model for SEM analysis to have an over-identified model and estimate the structural relation within a multiple indicators multiple causes (MIMIC) model (Diamantopoulos, 2011; Bagozzi & Yi, 2012).

The IMAGE-ATTITUDE model, which includes a second-order mining image scale, is illustrated in Figure 3; for ease of interpretation, factor loadings and other estimated parameters of the subscale items are omitted, corresponding to Figure 2, right. The SEM results indicate a good model fit, as RMSEA and χ^2/gl register desired values of $.034$ and 1.423, respectively. Likewise, the incremental fit and parsimony statistics are in the desired ranges (see Figure 3). The results of the model confirm the existence of a direct and positive relation between emotional (EMO) and cognitive (COG) perceptions in the construction of the mining IMAGE-ATTITUDE, the combination of both explaining 83.0% of the variance of the formative construct (see Figure 3).

Figure 3 shows that IMAGE-ATTITUDE positively profiles the behavior of individuals in the community, with a positive direct effect of $\beta = .69$ $(\mathrm{p-value} \leq 0.01)$; furthermore, this construct shows a statistically meaningful relation with the behavioral dimension, indicating its ability to predict it and confirming the predictive validity of the image scale. Thus, an increase in IMAGE-ATTITUDE by one standard deviation (hereafter $\mathrm{s.d.}$) causes behavior toward mining activity to vary by $.69\ \mathrm{s.d.}$ The 'Behavior' items explain 47.0% of their variance, where the perception that mining brings prestige to the entity was the most important $(\lambda_1 = .46)$, followed by the predisposition to cancel mining in the community $(\lambda_2 = .41)$ and mining as a main characteristic of the community $(\lambda_3 = .37)$; nevertheless, the λ (statistically relevant) and R^2 register low values.[15]

[15] 'Behavior' is not a sufficiently reliable $(RC = .382)$ and valid $(AVE = .172)$ construct, and it is an external item to the proposed image scale, but its inclusion in the model enables the scale's predictive validity to be tested.

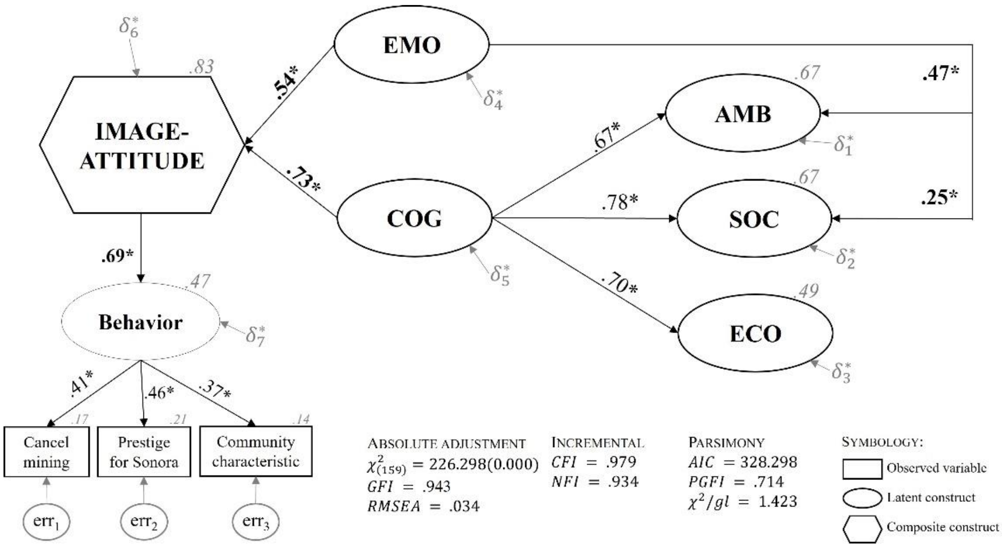

Figure 3. Structural image-attitude model (SEM) of mining in the Sonora River (Standardized coefficients)
Note: Factor loadings of scale items were omitted but corresponded to those shown in Figure 2 (right). EMO = emotional perception; COG = cognitive perception of corporate social responsibility (CSR); AMB = environmental CSR; ECO = economic CSR; SOC = social CSR; * $\text{p} - \text{value} \leq .01$ (99% significance level).
Source: created by the authors based on estimates in Amos® (v.23.0)

While the SEM shows evidence that COG is more influential than EMO in constructing the IMAGE-ATTITUDE, it is interesting to observe the degree to which these dimensions influence, for example, the predisposition toward behavior in favor of or against the cancellation of mining in the community. This effect is standardized and indirect (i.e., mediated) and statistically meaningful, so that when COG and EMO increase by $1\,\text{s.d.}$ the predisposition varies $.206\,\text{s.d.}\,(.73 * .69 * .41)$, and $.152\,\text{s.d.}\,(.54 * .69 * .41)$, respectively.

Concerning the image scale, the COG dimension reports a standardized coefficient of $\beta = .73\ (\text{p} - \text{value} \leq 0.01)$, so that when COG increases by $1\,\text{s.d.}$, IMAGE-ATTITUDE increases by $.73\,\text{s.d.}$ Similarly, COG was assessed as a second-order reflective component, according to the perceived benefits of environmental (AMB), social (SOC), and economic (ECO) CSR. Among these subscales, SOC influences COG the most ($\lambda = .78$), followed by ECO ($\lambda = .70$) and AMB ($\lambda = .67$), being statistically meaningful parameters. Thus, an increase of $1\,\text{s.d.}$ in COG implies increases of $.78\,\text{s.d.}$ in SOC; $.70\,\text{s.d.}$ in ECO; and $.67\,\text{s.d.}$ in AMB. The predictor items of SOC and AMB explain, in both cases, 67.0% of their variance and 49.0% in the case of ECO.

Regarding the EMO dimension, this exhibits a standardized coefficient of $\beta = .54$ ($p - \text{value} \leq 0.01$). It shows that an increase in EMO of 1 s. d. causes IMAGE-ATTITUDE to increase by $.54$ s. d. The EMO subscale is manifested through the sensations provoked in the individual when mining is evoked, so a favorable perception, where mining makes the individual feel calm/comfortable or less fearful/less vulnerable, contributes to constructing a positive image-attitude. On the other hand, the calibration detected a direct and positive relation between EMO and the subscales AMB ($\beta = .47$) ($p - \text{value} \leq 0.01$) and SOC ($\beta = .25$) ($p - \text{value} \leq 0.01$) (see Figure 3), which was not initially considered.

Thus, the structure of the image models is under debate; on the one hand, the suggestion of the CAC model and, on the other hand, the proposal of the Image-Attitude model evaluated here. The CAC model (Yang et al., 2022; Kim & Chen, 2021) suggests a hierarchical causality ($\text{EMO} \rightarrow \text{COG} \rightarrow \text{ATTITUDE}$), where a particular environment or situation triggers individuals' cognitive reactions, which, in turn, will stimulate feelings and emotions that will influence their behavior. Nevertheless, in the case of the mining sector, in contrast to the tourism or financial sector (Marinao-Artigas & Barajas-Portas, 2021; Marinao-Artigas, 2018), the Image-Attitude model in the context of the Sonora River communities (see Figure 3) resulted in a better fit than one of CAC structure. Nonetheless, it can be observed that emotional perceptions impact the perception of cognitive benefits, measured by CSR in the environmental (AMB) and social (SOC) domains.

The main finding is the validation of the proposed scale, which confirms the direct and positive relation of COG and EMO with IMAGE-ATTITUDE. Thus, people show a favorable attitude toward mining, concerning image, based on the cognitive benefits of CSR and positive emotions (e.g., peace of mind, safety); consequently, CSR is a key element that builds the image, shapes attitudes, and mediates behavior toward mining. Thus, despite the prominence of CSR, the emotional dimension caused by catastrophic environmental events in the sector, which are rooted in the collective memory of the community, such as the case of the 'toxic spill' in the Sonora River, should not be forgotten (Orozco & Rodríguez, 2020, 2022; Lugo-Gil & Lara, 2022), which could decrease the likelihood of 'pro-mining' behavior.

Accordingly, the formation of perceptions and attitudes contributes to the operationalization of the social license to operate (SLO), which, despite its conceptual ambiguity, is conceived as a tool for local risk management based on legitimacy, credibility, and trust (Devlin, 2023; Meesters et al., 2021). While SLO is not a compulsory license in Mexico, obtaining community and other stakeholder support is recognized. It is part of the strategy of mining companies in the country, i.e., companies are encouraged to pursue SLO to operationalize CSR (Brunet et al., 2023). Thus, the proposed image scale contributes significantly to implementing and monitoring SLO, which, together with CSR, are crucial factors in discussions about 'community mining relations.'

Therefore, managing a positive image in mining will require a much more efficient CSR strategy than in other sectors (Barnett et al., 2020), as the negative impacts of mining activity can undermine the benefits of CSR. Furthermore, CSR needs to be grounded in the reality of the communities, as the CSR discourse raises high expectations (e.g., employment and development; social services such as education, health care, road, and electricity infrastructure, among others). Hence, mismanagement of CSR strategy leads to 1) community skepticism toward CSR actions, 2) lack of commitment, 3) mistrust of the company in the eyes of the community, 4) divergent interpretations of CSR benefits between community and company, and 5) CSR initiatives that do not respond to the "real needs" or socio-cultural contexts of the community (Devlin, 2023).

Conclusions

The proposed scale and the evidence in the Sonora River, Mexico context support a multidimensional, second-order measurement of the mining social image with sufficient psychometric reliability and validity. According to the proposed scale, the image is composed of the emotional reactions in the minds of the inhabitants when evoking mining, which was enriched with a cognitive-valuative approach based on the perception of the benefits of corporate social responsibility (CSR) measures—in the environmental, social, and economic fields—undertaken by the companies in the sector in the mining communities. On evaluating the external construct 'Behavior,' the predictive capacity of the image scale to anticipate social behavior in the presence of mining activity was confirmed.

Nevertheless, it is important to note that these results should be interpreted with caution as, considering the specific context of the research, other factors (e.g., cultural, socio-economic, and political) may be influencing residents' perceptions and not only the socio-environmental performance of companies in the sector. Even when establishing reliable and validated scales to assess social perceptions, measurements are limited to an audience and are affected by changes in experiences, information, and debates about mining. Therefore, validating the image scale in different mining communities, including those with a neutral emotional charge, is recommended to contrast and consolidate the results.

This article makes notable contributions to the existing literature on the subject. Firstly, it adds to the limited academic research concerning image scales of the mining sector, as the only specific study on the subject (see Ruíz-Martín et al., 2014) is built on perceptions of the impact of mining activity on the community, ignoring the image dimensions proposed by the CAC model and the importance of perceptions of CSR, given its potential to promote local development and its growing popularity as a tool for distributing benefits to mining communities (Isacowitz et al., 2022). This posed a major challenge due to the lack of research that permitted a comparative approach across studies that would facilitate constructing and evaluating constructs.

Second, this article is a pioneering contribution, extending empirical knowledge on constructing and validating an image scale. To this end, a solid proposal of attributes to assess from the perspective of social psychology has been achieved (Yang et al., 2022; Kim & Chen, 2021; Capriotti, 2013), and the literature on the sectoral image has been extended (Marinao-Artigas & Barajas-Portas, 2021; Marinao-Artigas, 2018). In addition, a CCS model is proposed with two essential elements for the study of image in the mining sector: 1) a cognitive-valuative dimension based on perceived CSR and 2) an emotive dimension, crucial in the study of social perceptions in sectors with high socio-environmental impact.

Thirdly, this study contributes to the discussion on the creation and redistribution of the benefits of mining activity at the local level, focusing on employment generation. At the same time, company-community relations are addressed through CSR, but under the auspices of philanthropic initiatives alien to the communities' reality, i.e., a CSR strategy devoid of local content. CSR research, therefore, needs to start asking not only why companies undertake CSR but also how and when (Said et al., 2022; Barnett et al., 2020; Karakaya & Nuur, 2018) and whether such actions have any impact on profit generation and image management.

Finally, the study's implications for the mining business sector and communities are highlighted. Thus, taking into account that changing social behaviors toward mining through the cognitive dimension will be somewhat more effective than through emotional perceptions, this study: 1) justifies the relevance of CSR and provides empirical evidence in this regard; 2) makes visible the need to strengthen, diversify and broaden the perceived benefits that are key influences in shaping the image of the sector; and 3) calls for the generation of information on social perceptions, for which research in mining communities is often limited, as the study of CSR often prioritizes the use of easily accessible secondary data. For mining communities, this study is placed in the perspective of generating a qualitative change among their members and greater access to information so that they become more demanding and empowered when analyzing the economic and socio-environmental impacts of mining. Therefore, the company/sector and society can establish mutual credibility and trust relations to improve communication, knowledge, and decision-making.

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