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Qualitative analysis of the subcontract bidding process in mining projects

Análisis cualitativo del proceso de licitación de subcontratos en proyectos mineros

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Abstract

Chile is the fifth largest economy in Latin America and one of its main economic activities is mining, a sector in which subcontracting has grown exponentially in the last decade. However, despite its importance, the process of awarding subcontracts lacks a deeper understanding that identifies its inefficiencies and opportunities for improvement. This context motivates the study of the subcontract bidding and awarding process within a contractor company in mining projects. A database with real projects was used, comprising 13 projects with an average of 33 subcontracts executed during 2023, complemented by a qualitative content analysis of interviews with 18 experts. This combination of quantitative and qualitative analysis aims to identify critical areas of the current process and propose potential improvements. Our results reveal inefficiencies in the approval and supplier management stages. Proposed improvements include the implementation of training, streamlining of approvals and greater control over suppliers. These results suggest that optimizing the outsourcing process would not only increase efficiency but also could improve project quality. Future research might focus on modeling subcontracting processes to test potential improvements.

Keywords: Bidding; Subcontracts; Mining.

Resumen

Chile es la quinta economía de América Latina y una de sus principales actividades económicas es la minería, sector en el que la subcontratación ha crecido exponencialmente en la última década. Sin embargo, a pesar de su importancia, el proceso de adjudicación de subcontratos carece de un conocimiento más profundo que identifique sus ineficiencias y oportunidades de mejora. Este contexto motiva el estudio del proceso de licitación y adjudicación de subcontratos dentro de una empresa contratista en proyectos mineros. Se utilizó una base de datos con proyectos reales, compuesta por 13 proyectos con un promedio de 33 subcontratos ejecutados durante 2023, complementada con un análisis de contenido cualitativo de entrevistas a 18 expertos. Esta combinación de análisis cuantitativo y cualitativo tiene como objetivo identificar áreas críticas del proceso actual y proponer posibles mejoras. Nuestros resultados revelan ineficiencias en las etapas de aprobación y gestión de proveedores. Las mejoras propuestas incluyen la implementación de capacitaciones, agilización de aprobaciones y un mayor control sobre los proveedores. Estos resultados sugieren que optimizar el proceso de subcontratación no sólo aumentaría la eficiencia, sino que también podría mejorar la calidad del proyecto. Las investigaciones futuras podrían centrarse en modelar procesos de subcontratación para probar posibles mejoras.

Palabras clave: Licitación; Subcontratos; Minería.

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1. Introducción

Mining is one of the main economic activities in Chile, a country that is positioned as the largest copper producer in the world (Lagos et al.,2020); (Barros et al.,2022), contributing approximately 26% of copper global production (Consejo Minero, 2022); (Abbas et al.,2024). This sector not only accounts for about 15% of Chile's GDP (COCHILCO,2022) but also has a significant impact on employment generation. Although mining directly contributes about 3% of the country's jobs, it is estimated that in indirect jobs the total contribution might reach 10% of national employment (Consejo Minero, 2022). Additionally, according to data from the Socioeconomic Impacts of Mining in Chile report, mining exports accounted for 55% of the country's total exports in 2023, with copper, lithium and other strategic minerals production standing out (Cardemil, 2023). In this context, mining projects have become drivers of economic development, with subcontracting playing an increasingly relevant role in them.

In the last decade, subcontracting has grown exponentially in mining projects (COCHILCO, 2021), reaching significant levels of close to 70% participation in the execution of works and specialized services (COCHILCO, 2021). Subcontracts allow contractors to optimize resources and specialize in tasks with a direct impact on the quality and efficiency of projects. According to the National Survey of Working Conditions and Labor Relations (ENCLA, 2019), the increase in subcontracting in mining might be a consequence of the complexity and size of mining projects. However, this trend has also revealed the importance of an efficient and transparent awarding process to ensure the success of contracts.

This study focuses on analyzing the subcontract bidding process in mining projects in Chile, using a database from a real-life contractor company operating in the sector. The correct selection of subcontractors and the clear definition of contractual conditions are critical aspects for the success of a project. The objective of the study is to identify inefficiencies in the current process and propose potential improvement alternatives.

2. Literature review

A literature review was conducted taking as a central focus the bidding processes in the mining industry, where subcontractors play a crucial role, as they are responsible for a large percentage of the tasks in large-scale mining projects (Hinze and Tracey, 1994); (Abdullahi, 2014). For this reason, their selection must be careful; the general contractor must thoroughly evaluate the capabilities of subcontractors to meet the time, quality, and cost objectives of the project, given their direct impact on success, for instance, by reducing delays and cost overruns (Afshar and Zavari, 2024); (Mbachu, 2008). During the bidding process, it is crucial to define the minimum standard of work and to ensure that documents and proposals are accurate and consistent, thus ensuring that the selected contractor has the necessary skills and resources to execute the work without compromising the initial design (Chick and Suckling, 2023).

Existing studies have identified several factors that influence the bidding process. For instance, (Bingol et al., 2024) in the United States and Turkey emphasized selecting a subcontractor in mining with a focus on performance and trust between contractor and subcontractor. Similarly, (Hartmann and Caerteling, 2010) in the Netherlands highlighted the importance of the bidding price and trust among contractors and subcontractors in the bidding process and previous track record in terms of quality, technical expertise and cooperation (Hartmann and Caerteling, 2010).

Kadan et al (2024) emphasized the impact of financial and performance evaluations on project performance, although the management of the subcontract once awarded is not part of this study, it might be useful to have this information from the post-bidding stage. Mbachu (2008), in the South African context, reaffirms that the quality record is crucial at the prequalification stage, while the bidding price is decisive for the award of the subcontract. Likewise, (Bingol et al., 2024) emphasized that, although contractors usually opt for the subcontractor with the lowest price, it is critical to evaluate past performance to make an informed decision. (Arslan et al., 2008) developed the Web-based Subcontractor Evaluation System (WEBSES) that optimizes subcontractor selection through multi-criteria evaluations, eliminating reliance on the lowest bid price, reducing the time and costs of the selection process, eliminating unqualified subcontractors, improving the quality of decisions and avoiding the problems of traditional practices.

Just as the selection of a subcontract is crucial, so are the previous stages. For example, (Laryea, 2009) investigated the consultation stage, identifying the existence of inefficient processes and discussing that the main costs in bidding consultations come from man-hours and document volume. To reduce these costs, three strategies are suggested: process queries efficiently, reduce the volume of documents and adequately manage communication. Finally, another recurring factor of concern in bidding processes is collusion and corruption (Porter, 2005). It is important

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to note that these processes can be subject to manipulation. (Carbone et al., 2024) Highlighted the frequent collusion of companies seeking to award projects. It is essential to highlight the complexity and strategies of collusive agreements, as well as to evaluate the interactions and patterns within bidding networks to understand their dynamics. Several authors have proposed strategies to detect collusion in these processes, including the use of machine learning (Huber and Imhof, 2019); (Imhof and Wallimann, 2021), process control charts (Padhi and Mohapatra, 2011), and analytical methods based on statistical data (Busu and Busu, 2021).

Although the existing literature addresses subcontract bidding, there is a limited number of studies that take a holistic approach to optimizing the entire subcontract bidding process. This gap in research underscores the need to develop holistic approaches that comprehensively address all aspects involved in the bidding process.

3. Methodology

This study will employ a combination of existing quantitative data and a qualitative research approach. To facilitate the understanding of the bidding process used by the contractor from which we obtained the database, Figure 1 shows the subcontract bidding process used by the contractor in mining projects. The idea of using a mixed (quantitative and qualitative) method approach is to get a further understanding of the problem under study; to do so, the qualitative analysis provides context to the numbers provided by the quantitative information.

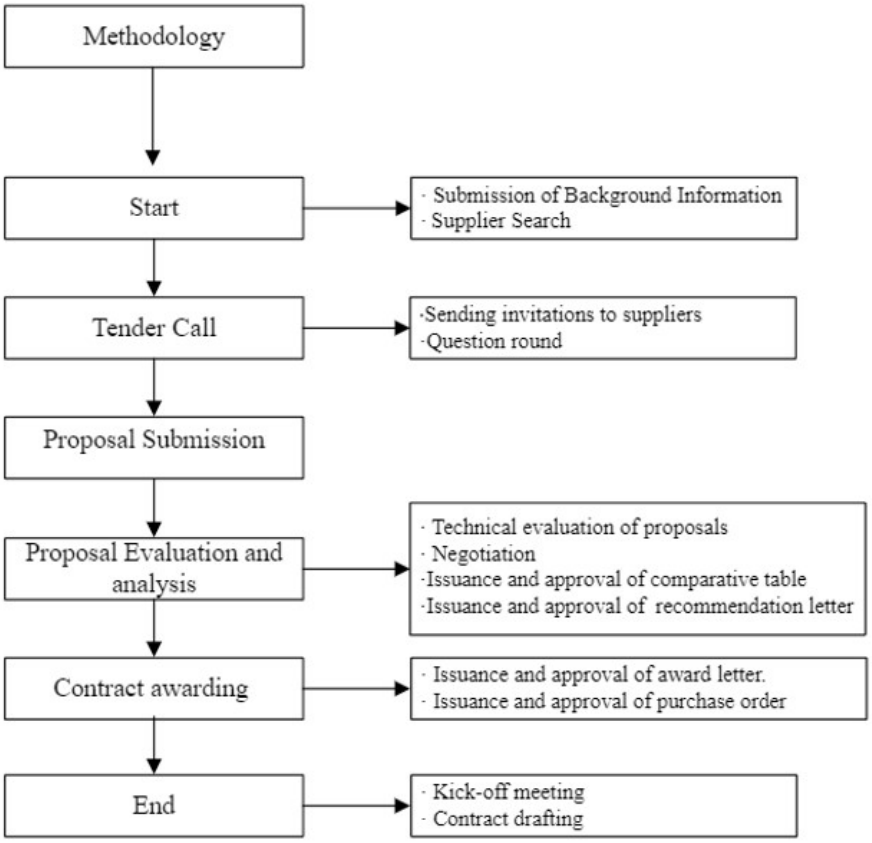

Figure 1. Flowchart of the Bidding Process, extracted from the contractor's procedures

First, a review of the existing literature obtained from specialized databases such as Scopus and Web of Science was carried out. The purpose was to identify problems and recommendations in the literature regarding the bidding processes for the selection of subcontractors. Second, statistical data were collected on the durations of the bidding processes in the contractor company under study. Finally, interviews were conducted with experts in bidding processes in mining to gather information that would be compared with the literature review and the database. This intends to compare the quantitative data with the qualitative ones provided by experts with experience that can provide insightful opinions about the bidding process.

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3.1 Data collection

Quantitative data was obtained from a database provided by a contractor company that is shown in (Table 1). The database includes information on 13 projects executed in 2023, with an average of 33 subcontracts of different specialties. (Table 2)

Table 1. Subcontracts Database.

Project	Location	Number of subcontracts	Duration of bidding process [days]		
			Minimum	Maximum	Media
1	Antofagasta	28	21	118	43
2	Iquique	54	5	124	34
3	Antofagasta	17	7	68	38
4	Marchihue	42	15	126	126
5	Portezuelo	65	25	230	111
6	Antofagasta	67	33	192	104
7	Antofagasta	18	9	118	51
8	Antofagasta	32	41	59	48
9	Antofagasta	13	10	40	22
10	Antofagasta	27	12	144	54
11	Antofagasta	15	22	104	49
12	Antofagasta	14	27	232	107
13	Antofagasta	17	12	312	106
Total		**426**			
Average		**33**	**18**	**143**	**69**

Table 2. Deadliness was established to carry out a complete bidding process according to the Company's Internal Procedures.

Description subcontracts	Range ofdeadlines [days]
Electrical Specialty	7 – 20
Mechanical Specialty	7 – 20
Structural Assembly	7 – 14
Civil Works	7 – 14
Transportation	7 – 14
Basic services	7 – 14

The qualitative data were collected through 18 semi-structured interviews with experts involved in the contractor's bidding process. These experts were divided into three groups: suppliers, bidding managers and applicants to ensure that the research has a broad view of the subject, using different perspectives on the same process and being able to contrast the information gathered with the researched literature.

3.2 Sampling

Qualitative research follows a common guideline for determining sample size, generally aiming to reach what is called the saturation point, which is when an additional interview provides little if any new information about the subject at hand (Kvale and Brinkmann, 2009). The saturation point is typically reached between 8 to 12 interviews. Comparable studies in engineering and construction management have employed a similar number of interviewees (Faust and Kaminsky, 2017); (Hennink and Kaiser, 2022); (Kvale and Brinkmann, 2009).

Additionally, as this study is exploratory, convenience (Stratton, 2021) and snowball (Parker et al., 2019); (Etikan et al., 2016) sampling methods were applied. These methods were used to make sure that interviewees had experience with the subject, and that their opinions contributed to

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the study. Of note, although these sampling approaches may limit the generalization of results to the entire population, they allow the authors to study and provide some exploratory insights about this topic.

3.3 Interview design

The interviews were conducted between January and March 2024 and will be divided into questions that seek to characterize the interviewee (years of experience, role and level of education) and content questions focused on the objectives of the study. Some of the questions included are:

- How would you describe the Bidding Process?
- What do you think are the weaknesses of the bidding process and why?
- What do you think are the positive highlights of the bidding process and why?
- In your opinion, what variable should be measured to improve or optimize this process?

3.4 Selection of interviewees

The interviewees were selected based on their experience in the bidding process, with years of experience ranging from 8 to 33 years, and an average of 14 years, as shown in (Table 3).

Table 3. Characterization of the interviewees.

Item	Role / Area in the Company	Position	Level of education	Years of experience
1	Applicant / Project	Engineer control of costs	Industrial engineer	11
2	Applicant / Project	Engineer control of costs	Industrial engineer	14
3	Applicant / Project	Engineer control of costs	Construction engineer	8
4	Applicant / Project	Assistant Project Manager	Computer Technician	33
5	Applicant / Project	Engineer control of costs	Construction engineer	12
6	Applicant / Project	Engineer control of costs	Construction engineer	11
7	Tender Manager / Central Office	Subcontracts Analyst	Industrial Management Engineer	14
8	Tender Manager / Central Office	Subcontracts Analyst	Civil Engineer	14
9	Tender Manager / Central Office	Subcontracts Analyst	Management Engineer	15
10	Tender Manager / Central Office	Subcontracts Unit Leader	Industrial Engineer	13
11	Tender Manager / Central Office	Subcontracts Unit Manager	Industrial Engineer	20
12	Tender Manager / Central Office	Subcontracts Analyst	Civil Engineer	13
13	Supplier / External	Sales Manager	Management Engineer	10
14	Supplier / External	Assistant Sales Manager	Management Engineer	12
15	Supplier / External	Sales Manager	Complete Secondary Education	18
16	Supplier / External	Sales Manager	Industrial Engineer	15
17	Supplier / External	Assistant Project Manager	Civil Engineer	10
18	Supplier / External	Project Manager	Electrical Engineer	11
			Average years of experience	**14**

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The interviewees were contacted via e-mail or telephone, while the interviews were conducted via video or telephone call and were carried out with the informed consent of the participants before recording the content, ensuring the confidentiality of the data collected. The duration of the interviews ranged from 25 to 60 minutes.

3.4 Qualitative data analysis

The analysis of qualitative data will be based on the live coding method of interviewee responses. Interviews will be recorded after obtaining the consent of the participants, and then transcribed, reviewed, analyzed and coded. This method will enable a flexible and dynamic exploration of emerging themes, facilitating the iterative identification of categories and subcategories.

In relation to the real-time coding process, written excerpts will be labeled during data analysis (Saldaña, 2013). Coding consists of identifying key ideas from the interviews and then grouping them into multiple categories and subcategories, thus providing an analytical structure (Saldaña, 2021); (Namey et al., 2008). Categories will represent broad, general concepts, while subcategories will capture more specific themes that emerge within those main categories. This coding process resulted in dictionaries that define the categories and subcategories identified, as shown in (Table 4) and (Table 5).

Table 4. Coding dictionary of characterization of the bidding process.

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Category	Definition	Subcategory	Definition	Example
Process (Stages)	Description of the ordered sequence of actions that the company follows to award a subcontractor.	Background Delivery	A stage where the requester gathers all technical background information that will frame the bidding process.	"...They must issue a purchase request with all the necessary documentation..."
		Call for applications	Sending invitations to suppliers specifying requirements, conditions and selection criteria for the contract to be awarded	"...Send invitations with a document folder of the process..."
		Presentation of Proposals	Stage of delivery of technical, economic, and financial offers by interested suppliers.	"...Once the bidding deadline is met, suppliers must submit their offers via email...
		Proposal Evaluation	Stage in which an objective analysis of the received proposals is carried out to verify compliance with requirements and enable comparison.	"...Send them for technical validation, and once obtained, create a comparative table to select the best offer..."
		Contract Award	Selection of the supplier to execute a task, formalizing the terms and conditions of the contract.	"...The analyst must award the supplier through the award letter, notifying them of the contract conditions..."
		Contract	Signing of the employment contract between the selected supplier and the company, establishing obligations and responsibilities.	"...While the relevant contract is being drafted..."
Deadlines	Time required to complete a bidding process.	[0 – 6 days]	Time ranges between 0 to 7 days.	
		[7 – 30 days]	Time ranges between 8 to 30 days.	"...On average, 14 days..."
		[31 – 90 days]	Time ranges between 31 to 60 days.	"...It can take up to 45 days..."
		[91– 180 days]	Time ranges between 61 to 90 days.	"...It can extend from 3 to 6 months..."

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Category	Definition	Subcategory	Definition	Example
Greatest Difficulty	Variable or stage that represents the most significant challenges to carry out the process.	Established Deadlines	Time available to complete a bidding process.	"...The most complex part is the deadline the analyst has to manage the bidding..."
		Challenging Stages	Identifies all phases of the bidding process except for the contract stage	"...The question and answer process is very time-consuming, bureaucratic, and complicated..."
		Administrative Factors	Essential variables for the efficient and organized functioning of the bidding process.	"...As I mentioned, I think what has cost us the most is accessing the system..."
Training	Educational process to develop technical skills or competencies in those involved in the bidding process.	Yes	Conducting training sessions.	
		No	Lack of training sessions.	"...We have never received formal induction..."

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Table 5. Coding dictionary of management of the bidding process.

Category	Definition	Subcategory	Definition	Example
Weaknesses	Areas with potential deficiencies that could affect the transparency, fairness, or efficiency of the process.	Supplier Management	Comprehensive management of relationships and interactions with suppliers to meet quality, cost, time, and service requirements.	"…There is no formal supplier database…"
		Conflicting Stages	Identifies the following stages as deficient: Background Delivery, Proposal Evaluation, and Contract.	"…We are weak in the collection of background information…"
		Requirements and Procedures	Includes specific conditions and methods to follow, covering document approvals and required commercial demands.	"…The company's bidding process is very robust, making it difficult to meet deadlines…"
		Deadlines	Situations where the established timelines are not met.	"…The bidding process has very lengthy deadlines…"
		Training	Educational process to develop technical skills or competencies in those involved in the bidding process.	"…Many people claim to be unfamiliar with the process..."
Highlights	Positive aspects that are correctly executed.	Requirements and Procedures	Includes specific conditions and methods to follow, covering document approvals and required commercial demands.	"…While the manuals are incomplete or outdated, they still serve as a guide to resolve issues…"
		Best Practices	Actions recognized as effective, efficient, and appropriate for achieving desired results, such as transparency and equality in the process, as well as the record and history of all bidding processes executed.	"…They make the process more transparent and better safeguard equality of opportunities for bidders…"

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Category	Definition	Subcategory	Definition	Example
		Highlights of the stages	Identifies the following bidding stages: Background Delivery, Proposal Evaluation, and Award, as standout phases.	"…The analysis presented by the analysts is quite thorough…"
		Communication	Effective and timely transmission of information.	"…Communication is smooth, and it helps guide us…"
Key Performance Indicator (KPI)	Performance or success metric in bidding processes.	Scheduling and Resource Capacity	Management of timelines and workload to meet established deadlines.	"…The execution times of the bidding process…"
Recommendations	Specific suggestions or advice aimed at improving the process.	Supplier Management	Comprehensive management of relationships and interactions with suppliers to meet quality, cost, time, and service requirements	"…It would be good to establish agreements with suppliers…"
		Training	Educational process to develop technical skills or competencies in those involved in the bidding process.	"…I would like to have more training…"
		Communication	Effective and timely transmission of information.	"…Most of the time we don't get a response…"
		Requirements and Procedures	Includes specific conditions and methods to follow, covering document approvals and required commercial demands.	"…The procedures should be clearer and more specific…"
		Scheduling and Resource Capacity	Management of timelines, planning, and workload to meet established deadlines.	"…I would change the approval workflow…"
		Proposal Evaluation	Stage where a detailed and objective analysis of the received proposals is carried out.	"…We should improve the format we are using for the comparison chart…"

After completing the coding, the frequencies of each category and subcategory will be calculated to facilitate the analysis. These frequencies will be divided into two types: one showing how many times each topic was mentioned and the other indicating how many respondents addressed that topic. This qualitative approach will complement the quantitative data available, allowing for a deeper understanding of the issues inherent in the bidding process under investigation.

4. Limitations

Considering the restrictions of this study, it is relevant to mention that it focuses specifically on the mining industry in Chile. Therefore, the findings and conclusions reached may not apply to other geographic areas or other construction industries.

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This study focuses only on private tenders, from the need to the formal award, excluding subcontract management during the execution of the work. In addition, the analysis was conducted using an inductive approach with coding structured interpretation of the data, recognizing that other analytical methods may generate different interpretations.

5. Results

The data collected on the categorization of the bidding process reveals that the interviewees have diverse knowledge of this process since none of its stages was mentioned by all the interviewees. However, most of them agree that the greatest difficulty is found in some of the stages of the process, such as the submission of background information, technical evaluation, consultations and responses or awarding. Conversely, the timeframe is generally between 7 and 30 days, with 55.6%, as shown in (Table 6).

The percentages were calculated as follows: (Equation1) and (Equation 2)

$$Percentage\ Value\ of\ Excerpts = \frac{N°\ of\ Excerpts}{Total\ N°\ of\ Excerpts} \quad (1)$$

$$Percentage\ Value\ of\ Interviewees = \frac{N°\ of\ Interviewees}{Total\ N°\ of\ Interviewees} \quad (2)$$

Table 6. Frequencies of coding dictionary of characterization of the bidding process.

Category	Subcategory	N° de Extracts (N° of Interviewees)	Percentage Value	
			Extracts	Interviewees
Process	Delivery of background	12 (12)	17,6 %	66,7 %
	Call for applications	15 (15)	22,0 %	83,3 %
	Presentation of proposals	14 (14)	20,6 %	77,8 %
	Evaluation of proposals	10 (10)	14,7 %	55,6 %
	Evaluation of proposals	14 (14)	20,6 %	77,8 %
	Contract	3 (3)	4,5 %	16,7 %
	Total	**68 (18)**	**100%**	**100%**
Deadlines	[0 – 6 days]			
	[7 – 30 days]	10 (10)	55,6 %	55,6 %
	[31 – 90 days]	7 (7)	38,9 %	38,9 %
	[91 – 180 days]	1 (1)	5,6 %	5,6 %
	Total	**18 (18)**	**100%**	**100%**
Greatest Difficulty	Established Deadlines	1 (1)	4,2 %	5,6 %
	Challenging Stages	18 (17)	75,0 %	94,4 %
	Labors administrative	5 (3)	20,8 %	16,7 %
	Total	**24 (18)**	**100%**	**100%**
Training	Yes	-	-	-
	No	25 (18)	100 %	100%
	Total	**25 (18)**	**100%**	**100%**

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The data collected on the management of the bidding process—shown in (Table 7)—show that most of the interviewees identify requirements and procedures as a deficiency, with 38%. This is followed by supplier management and conflicting stages, each mentioned at 27.6%. In addition, recommendations for process improvements focus on Scheduling and Resource Capacity, Requirements and Procedures and Training, these being the three subcategories with the highest percentage of mentions. In contrast, the traceability of the process is mentioned as a positive variable with 38%. Of note, 100 % of the interviewees agree that the best performance indicator is the time related to the bidding process.

Table 7. Frequencies of coding dictionary of management of the bidding process.

Category	Subcategory	N° de Extracts (N° of Interviewees)	Percentage Value	
			Extracts	Interviewees
Weaknesses	Supplier Management	8 (6)	27,6 %	33,3 %
	Conflicting Stages	8 (8)	27,6 %	44,4 %
	Requirements and Procedures	11 (10)	38,0 %	55,6 %
	Deadlines	1 (1)	3,4 %	5,6 %
	Training	1 (1)	3,4 %	5,6 %
	Total	**29 (18)**	**100 %**	**100 %**
Highlights	Requirements and Procedures	3 (3)	16,7 %	16,7 %
	Best Practices	10 (10)	55,6 %	55,6 %
	Highlights of the stages	3 (3)	16,7 %	16,7 %
	Communication	2 (2)	11,0 %	11,1 %
	Total	**18 (18)**	**100 %**	**100 %**
Key Performance Indicator (KPI)	Scheduling and Resource Capacity	19 (18)	100 %	100 %
	Total	**19 (18)**	**100 %**	**100 %**
Recommendations	Supplier Management	2 (2)	5,4 %	11,1 %
	Training	7 (7)	18,9 %	38,9 %
	Communication	5 (4)	13,5 %	22,2 %
	Requirements and Procedures	10 (8)	27,0 %	44,4 %
	Scheduling and Resource Capacity	10 (10)	27,0 %	55,6 %
	Proposal Evaluation	3 (3)	8,1 %	16,7 %
	Total	**37 (18)**	**100%**	**100 %**

6. Discussions

Our results emphasize the heterogeneity in the interviewees' level of knowledge and understanding of the different phases of the bidding process. While some evidenced a deep understanding of all the stages, others expressed only a superficial or partial knowledge of specific phases of the bidding process. This pattern is reflected in the fact that none of the stages mentioned in the subcategories were identified by all the interviewees.

Of note, the stages of the bidding process, excluding the contract phase, were consistently indicated as the most challenging by the interviewees (see (Table 6). These results suggest an urgent need for training and professional development in this area, given that 100% of the interviewees indicated that they had never received prior training in this regard, as one of them pointed out "We have never received a formal induction". Meanwhile, another interviewee commented, "There are many who say they do not know the process works" further highlighting the lack of adequate training. Unfortunately, these results go in the opposite direction discussed in the literature where it is emphasized the importance of meeting clear minimum working standards and ensuring the accuracy and consistency of documents, as indicated by (Chick and Suckling, 2023).

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Interestingly, the good practices of the process lead with 55.6% of the mentions, which included key aspects such as traceability, transparency of the process and equal opportunities for suppliers (see (Table 6)). One respondent commented: "They make the process more transparent, take better care of equal opportunities for bidders", which reinforces the importance of these elements in the overall perception of the bidding process. The outstanding transparency and equality of opportunity mentioned, together with the excellent traceability of the process, are aspects that strengthen the integrity of the bidding process studied. This result is particularly encouraging since, according to authors such as (Porter, 2005), (Carbone et al., 2024), (Huber and Imhof, 2019), (Padhi and Mohapatra, 2011), and (Busu and Busu, 2021), collusion and corruption remain major concerns in the bidding processes.

Among the weaknesses identified, the subcategory of Requirements and Procedures stands out, which received 38.0 % of mentions (see (Table 7)). Among the problems pointed out we found the ambiguity of written procedures, their limited application and difficulties in document approvals. The centralization of tenders and the administrative and commercial requirements are also noted, which generates inefficiencies. One interviewee emphasized the need for "procedures to be clearer and more specific" to improve operability and compliance with regulations. Conversely, in Supplier Management (27.6 %), the lack of feedback on offers and the urgency of improving agreements with suppliers were emphasized. One interviewee suggested that "...There is no formal supplier database..." to optimize the business relationship and ensure more efficient collaboration. Finally, Conflicting Stages (27.6%), such as providing background information, evaluating bids and drafting contracts, were also identified as critical areas. One interviewee reported that "we are being weak in terms of background information gathering", which affects the agility and accuracy of the bidding process, highlighting the need to strengthen these aspects to avoid delays and errors.

When looking at the recommendations to improve the bidding process, one interviewee suggested that they would "change the flow of approvals" to improve efficiency in the allocation and use of resources. Regarding Requirements and Procedures, the need was noted for "procedures to be clearer and more specific" to facilitate their application and reduce ambiguities. Similarly, in Training, another interviewee mentioned "I would like to have more training", highlighting the importance of continuous training to strengthen the competencies of the team. Workers with more training would allow them to be more efficient and precise when participating in the bidding process. For example, if the bidding process is organized with more realistic durations, participants may become more aware of the times involved during the process and expect some delays. Additionally, a better understanding of suppliers might improve confidence among participants, which is critical for the success of the bidding process. This approach aligns with (Afshar and Zavari, 2024) and (Mbachu, 2008), who emphasize the importance of thoroughly evaluating the capabilities of subcontractors to meet project time, quality and cost objectives, given their direct influence on success by avoiding delays and cost overruns. As such, it is essential to use time to enhance the bidding process, as unanimously pointed out by the interviewees.

In this context, when comparing the deadlines established by the company's procedure with the statistical data and the interviews conducted, differences were observed. While the procedure establishes a maximum of 20 days for the most complex subcontracts (see (Table 2)), the statistics reveal an average of 69 days and a maximum of 312 days (see (Table 1)). Conversely, interviewees reported that processes are usually completed in less than 30 days. This disparity between the expected and actual duration of processes not only points to inefficiencies in the process but also affects project planning. When subcontract assignment times exceed expected deadlines, delays are generated that can lead to economic losses, affecting both the continuity of activities and the coordination of resources. Therefore, it is essential to review and streamline procedures to align actual timelines with expectations and thus improve the efficiency of the bidding process.

7. Conclusions

This study provides a critical overview of the challenges and opportunities within the bidding process, highlighting the urgent need to improve training, optimize procedures, and strengthen supplier management to ensure a more efficient, transparent and equitable practice in bidding activities. Specifically, this study revealed a disparity in the level of knowledge and understanding among participants about the various stages of the bidding process in mining. Such diversity emphasizes the need to implement structured training and professional development programs. It is of concern that 100% of the interviewees indicated that they had not received prior training, which not only affects the efficiency and effectiveness of the process but also limits the potential for continuous improvement within the bidding processes.

Conversely, it is encouraging to have found that good process practices, including traceability, transparency and fairness to suppliers, were emphasized by a high percentage of interviewees. This contrasts with traditional concerns about collusion and corruption in bidding processes emphasized by the literature. Transparency and equal opportunities are fundamental pillars to mitigate these risks. However, the study also

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identified critical areas for improvement, such as ambiguity in written procedures, difficulties in document approvals, and conflicting stages such as bid evaluation and contract drafting. These shortcomings underscore the need to review and optimize existing requirements and procedures, as well as to improve supplier management to foster effective feedback and strengthen contractual arrangements.

The proposed recommendations aiming at resource scheduling, continuous training, and effective communication highlight the importance of rigorously evaluating subcontractor capabilities to ensure that project objectives are met in terms of time, quality, and cost. This approach is crucial to align expectations with operational reality, as evidenced by the discrepancies found between the established deadlines and the actual execution times of the bidding process.

Ultimately, future research could explore the effectiveness of different training and professional development programs specific to the various stages of the bidding process to be explored. Additionally, it would be valuable to conduct longitudinal studies to assess the long-term impact of improvements in procedures and supplier management on the efficiency of the bidding process. Finally, additional research could analyze how emerging technologies, such as artificial intelligence can be used to simulate or optimize bid evaluation and contract decision making. For instance, the modeling of the bidding process may be implemented using a Discrete Event Simulation (DES) approach that according to the literature is well suited to model a wide variety of processes.

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9. Declaration of AI-Assisted Tools in Manuscript Preparation

In this work, the chatbot “ChatGPT 4.0” has been used to optimize technical aspects such as spelling, grammar, syntax, and writing style, and for assistance in some translation sections. It is important to note that the use of this tool was strictly limited to these technical areas and did not influence the content, analysis, data interpretation, or conclusions presented. All ideas, arguments, and results presented are the independent work of the authors.

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