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Nuevo talento para la minería del futuro

THE WORKFORCE FOR 2021-2030 LARGE-SCALE MINING IN CHILE

Diagnosis and Recommendations

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Diagnosis and Recommendations

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Santiago, 2021

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Verónica Fincheira H
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One of the main objectives sought by the Mining Skills Council (MSC) since its foundation in 2012 has been the development of information, standards, and tools that help match the formation of technicians and professionals to the mining industry requirements. In 2020, we succeeded in our efforts to officially join the Eleva program which, in turn, gave birth to the MSC-Eleva alliance intended to serve as a beacon and strengthen the education-work relationship existing among students and workers vs. the demand from the sector.

This eighth version of the WORKFORCE FOR 2021-2030 LARGE-SCALE MINING IN CHILE study was drawn on data provided by mining and supplier companies and for the first time, it engages the participation of educational entities, which greatly enriched the discussion and the identification of challenges. Thus, the present study analyzes and delves into the educational offer available for the mining industry as well as into the human capital demand and gaps projected for the next decade.

Based on the above results, the study not only enables a view of the current human capital scenario prevailing in the large-scale mining industry but it also provides the features characterizing male and female workers performing in the industry and a comparative view with the trends observed in previous versions. The present release includes new variables and further information on the sectoral workforce, talent management, and on how companies successfully managed to secure operational continuity in a COVID-19 pandemic-challenged context. Thus, for the first time, inclusion and diversity policies for different groups were incorporated, the evolution of local employment was analyzed, and the actions adopted by the sector to face the health crisis, as the key into securing operational continuity, were compared.

On the other hand, and after 10 years since this study saw the light for the first time (2011), we have continued to explore relevant topics for the sector, such as gender-focused diversity and inclusion, identifying those concrete goals that will help increase the onboarding and retention of more women into mining. On the other hand, and considering that one of our challenges as MSC-Eleva consists in readying and driving changes into the industry 4.0-aligned education, this study also provides information on the technological impact on work skills, the point in time when changes associated to technological transformation are expected to occur, and the initiatives being undertaken by companies regarding technological changes, among others.

Everybody is welcome to read, review, and disseminate the outcomes of this study in order to support people, companies, and public agencies in their decision-making processes that will lead to further development of people's education and productivity of the mining sector, as elements called to play a key role in the economic revitalization of the regions and the country, taking mining as a driver of social development.

We would like to thank our member companies and sector-related companies for providing the information necessary to put together this report; the research team responsible for the completion of this study; the Mining Council and Fundación Chile for driving these initiatives for over a decade; and educational institutions for implementing and developing the MSC-Eleva-endorsed projects.

MSC – ELEVA 2020-2021 ALLIANCE

In 2020, the Mining Skills Council (MSC) launched its fourth biennial cycle and a new stage marked by the merging with the Eleva program with the purpose of rekindling and guiding students and workers into successful educational-work pathways associated to the work demand coming from the mining industry and to the economic revival needed by the regions of our country.

The MSC-Eleva Alliance, seeking to conform the formation of technicians and professionals to the work demand arising from that sector, defined an action plan driven by three main strategic targets: territorial deployment to help extend the regional outreach of the initiative; educational-work collaboration to boost the interaction and the link between partner companies and educational institutions in their areas of influence; and quality enhancement of vocational education offer in order to speed up the closing of gaps existing in educational institutions.

Some of the initiatives conducted in this period deal with the elaboration and publication of two studies addressing topics of wide-ranging importance and interest for the industry (Women & Mining and Local Employment) based on data available in the different editions of the WFLSM (2012-2019). As for the Work Education Standards, new educational plans were included under the new Mining Qualifications Framework (MQF). The engagement of experts in mining operations and representatives from the vocational education field was key in their development. Likewise, educational plans were provided for the transversal skills needed in the mining industry 4.0.

In addition to reinforcing the quality and relevance of the educational plan, the MSC-Eleva led the upgrade of 13 occupational profiles associated to open-pit extraction processes while it extended the validity of other 150 profiles applied in the mining sector. As a result of the profile upgrade process, for the first time ever inclusive language was introduced in the writing of the MQF standards in mining, for gender equality purposes.

These initiatives are part of the commitments pursued by MSC-Eleva in terms of continuing to drive female participation in the industry by actively involving in the Women & Mining National Table. In this case, MSC-Eleva has participated in discussion groups on masculinized positions, it has collected data on gender indicators, and it has coordinated actions to familiarize students with the industry and let them know the opportunities available in the sector.

In order to ensure the appropriateness and quality of the offer, the MSC Quality Seal has continued to recognize educational institutions that have successfully managed to adjust their programs to the requirements posed by the mining industry. An important milestone was marked by the revamping of the Best Practice Framework for Education in Mining document where not only in-person, blended, and online educational programs and training courses have been included but also a behavioral skills model has been incorporated.

To date, 63 programs have been conferred the MSC Quality Seal in all specialties, across all mining regions of the country and for the first time including short e-learning courses and programs thus guaranteeing the availability of people adequately trained to meet the current and future requirements set by the mining sector.

Finally, it must be emphasized that the MSC-Eleva Alliance is determined to maintain its commitment to position itself as a pioneering initiative and leader in human capital development, driving relevant formation and quality employment opportunities for our professional-technical talent, as a result of the collaborative work conducted by companies and educational institutions.

EXECUTIVE SUMMARY

OVERVIEW OF THE MINING INDUSTRY

The eighth edition of the Workforce in Large-Scale Mining in Chile study provides important information on the human capital challenges expected for the mobile decade 2021-2030 in the COVID-19 pandemic context. Regardless of this adverse scenario, in 2020 the mining industry accounted for 12.5% of the GDP; that is, 3.4 percentage points higher than the previous year. Despite the slight copper production decrease observed in the last year –which reached 5.73 million tons-, this drop was made up by a copper price increase with an average value of US$2.8 per pound (Mining Figures Updated, Mining Council, 2021).

On the other hand, though in 2020 the domestic employment rate was dramatically affected by the pandemic -a nearly 10-percentage point drop vs. 2019-, the mining sector was able to directly or indirectly generate over 710,000 jobs.

WORKFORCE FOR 2021-2030 STUDY

The present study provides an overview of the industry mainly focused on the features characterizing male and female workers as well as an estimate of the total demand per profile projected to be needed in the course of the next decade. This study was elaborated on the basis of reports provided by 14 mining companies and 13 supplier companies pursuing business in large-scale mining, with a sample of 43,960 and 15,673 people, respectively. Additional to said samples that contributed demographic and work-related data from their workforces, a survey conducted among Managers and Heads of Human Resources of participating companies must be added. It was intended to gather information on different and important topics for the sector, such as inclusion, diversity, local employment, technological impact, talent management, etc., among others.

MAIN OUTCOMES AND RECOMMENDATIONS

Human capital demand and gaps

According to estimates, companies are bound to attract over 25,000 new talents in the next 2021-2030 mobile decade, as a result of the combination of work retirements and the opening of new work positions. As the trend shows, most human capital demand is seen to occur among mechanical Maintainers, electrical Maintainers, and equipment Operators (mobile and fixed) that, in the aggregate, account for a cumulative demand close to 18,472 workers, equivalent to 73% of the total cumulative demand for the decade.

Three relevant action fronts of potential high impact exist to reinforce the sectoral coordination efforts to increase the quality offer of the four profiles that have consistently shown gaps in the last editions of this study: mechanical Maintainers, electrical Maintainers, mobile equipment Operators, and fixed equipment Operators: 1) enhance the quality of the vocational education offer by increasing the number of vocational high schools with an educational offer aligned to current requirements posed by the mining industry and bearing the MSC Quality Seal; 2) education-work collaboration to intensify the apprenticeship and student trainee processes through the definition of a joint action plan designed to optimize the number of graduates per year; and 3) territorial anchorage, launching regional public-private partnerships in order to further improve the quality and relevance of the respective vocational education ecosystems.

Female participation and inclusion and diversity

Women inclusion is a topic of interest for the mining industry. This is made plain when 91% of companies surveyed as part of the study confirm having implemented policies designed to encourage their participation, while 52% state having set explicit goals for the next five years. The efforts are now beginning to bear fruit: for the first time in the decade, female participation in the

industry exceeds 10% in general and 6.4% in the Main Value Chain.

The development of strategies leading to higher female participation in the industry, a larger number of women occupying decision-making positions and getting more young women interested in pursuing mining-related careers are some of the commitments the sector is expected to undertake on a consistent manner and with explicit goals, generating a cultural change across organizations based on gender equality and inclusion.

In order to move further along, three priority work fronts are recommended: 1) twice-a-year monitoring and dissemination of sectoral female employment indicators so that the phenomenon can be identified at levels of workforce stock and of flows of new female workers; 2) define sectoral goals and an action plan addressing female employment to increase women participation in the workforce with a particular focus on the four profiles showing the widest gaps; 3) campaign designed to attract female talent into enrolling in technological and digital careers.

Local employment

While this last measurement disclosed a slight reduction in the number of people living in the same region they work in, the local workforce continues to be a majority encompassing nearly 73% of workers. It must be noted that, in 2020, the mining industry increased local hiring in more than 6 percentage points relative to 2018, a difference that goes as high as 15.7 points in supplier companies.As for occupational groups within the Main Value Chain, local workers are seen to mostly concentrate in Operators jobs, both in mining as well as in supplier companies.

Local employment comes up as a top priority factor in securing the social license to operate mine sites and turned out to be a critical dimension to maintain operational continuity during the mobility restriction scenario imposed by the COVID-19 pandemic. Three priority action lines are recommended to be followed in this dimension: 1) monitoring and dissemination of local employment indicators on a twice-a-year basis so that the phenomenon can be identified at levels of workforce stock and of

new worker flows; 2) define sectoral goals and an action plan to address the number of student trainee vacancies to ease the way for more young people living in territories located close to mine site to occupy professional trainee vacancies; and 3) move ahead in training to ensure current workforce skills are kept up to date and thus prevent workers from being replaced by talents from outside the region in the wake of technological changes.

Technological transformation

Mining companies have been incorporating digital technologies for a while now in their search for higher productivity and process efficiency, and increasing safety in operations areas for their workers. Namely, the introduction of Integrated Operations Centers (IOC) and the use of big data have been identified as strategies already underway.

In order to fill the gaps existing among the skills required by workers to handle the digital technologies coming into the industry, upskilling the mining workforce, mainly Operators and Maintainers, in transversal skills 4.0 comes as a priority condition in an environment of increasing use of technology and the impact this will have in work activities.

In this scenario, moving in three different lines of action is recommended: 1) upskilling of current workforce skills by training existing workers in the fields required to skillfully perform in a highly technologized environment; 2) reskilling of the workforce impacted by new technologies by developing a work reconversion model mainly designed for Operators of mobile equipment, a work area most likely to experience radical changes in the coming decade; 3) new talent pipeline for mining 4.0, a challenge requiring regional coordination from mining and supplier companies to ensure the development of their regional educational ecosystems is properly supported in line with the future demand of talents 4.0.

INTRODUCTION

The WORKFORCE FOR 2021-2030 LARGE-SCALE MINING IN CHILE study is an important document that contributes information on the characteristics and projections on human capital for the industry, in an ever changing environment. This quantitative study is particularly focused on providing an overview of the mining industry, providing updated data on their workforce and estimates on their future needs.

The information herein cited has been collected from primary and secondary sources. Primary sources encompass demographic and work reports about their workers made available by 14 mining companies and 13 supplier companies engaged in large-scale mining in addition to a self-administered survey directed to Human Resources areas of each company. Additionally, publicly available secondary sources were consulted on matters such as statistics and databases associated to educational entities –National Council of Education, Mifuturo.cl, and National Council of Accreditation- as well as those provided by the Mining Council.

The study has been divided into four Chapters. The first one analyzes the current panorama on human capital in large-scale mining, providing sociodemographic data to help understand the characteristics of people working in the industry. It also compares current vs. previous trends reported in earlier releases. Likewise, this edition incorporates new variables that provide further details on the workforce operating in the sector, people management in the industry, and on how companies have successfully secured operational continuity in a COVID-19-challenged scenario.

The second Chapter centers on the educational offer of human capital relevant for the mining industry. In line with the above, it analyzes the mining-related higher education programs with the purpose of understanding the behavior of their enrollment and projects their graduation rate to 2030. Likewise, the educational offer is analyzed per specialty, and detailed figures on the programs provided by each of them are presented.

As for the third Chapter, it focuses on human capital demand projections from the mining industry for the 2021-2030 mobile decade as required for the sector to successfully fulfill their goals in the different projects. These figures are calculated on the basis of retirement-driven demand projections; that is, based on those workers likely to retire from work life in the coming years and on the project-driven demand forecasts, considering the project portfolio maintained by participant companies. According to the above and the cross-referencing of information on the available educational offer, the profiles exhibiting oversupply and those likely to present the largest gaps by the end of the decade could be identified. Additionally, this Chapter provides feedback from mining and supplier companies regarding the technological impact on job skills of workers performing in large-scale mining and a timeline within which these transformations are expected to occur, among others.

Finally, Chapter four identifies the challenges being faced by the industry and makes recommendations regarding topics, such as talent management, female participation in the industry, local employment, technological transformation, and human capital demand and gaps. Those recommendations were the result of a number of technical discussions held in September 2021 during the analysis of the main challenges faced by the mining sector with representatives from participant companies and educational institutions.

METHODOLOGY

PARTICIPANTS

Fourteen mining companies and thirteen supplier companies actively engaged in the large-scale mining industry took part in this version of the study.

Based on the information provided by these participants, an updated panorama surrounding the mining workforce was elaborated to identify and stay ahead of future human capital challenges, generating projections and jointly building future situational scenarios. Thus, relevant information will be available on which the actors involved in large-scale mining in Chile will be able to make decisions, especially decisions regarding talent management and development in the sector.

MINING COMPANIES

- Anglo American
- Antofagasta Minerals
- BHP
- Compañía Minera del Pacífico
- Codelco
- Collahuasi
- Freeport-McMoran
- Glencore
- Gold Fields
- Kinross
- Lumina Copper
- Lundin Mining
- Sierra Gorda SCM
- Teck

SUPPLIER COMPANIES

- Coasin Logicalis
- Enaex
- Enex
- Finning
- Komatsu
- KSB Chile
- Metso Outotec
- Orica
- Sorena
- Talleres Lucas
- Technosteel
- TTM Chile
- Vulco - Weir Minerals

INFORMATION SOURCES

PRIMARY SOURCES

Mining companies

- Own workforce database
- Report on mining-related contractor workforce
- Report on apprentices and student trainees
- Report on project portfolio associated demand
- Report on training
- Survey among HR managers and senior executives

Supplier companies

- Report on mining-related own workforce
- Report on training
- Survey among HR managers and senior executives

SECONDARY SOURCES

Publicly available data

- Database from the National Council of Education
- Statistics from www.mifuturo.cl
- Statistics from the National Council of Accreditation
- Mining statistics updated by the Mining Council

SCOPE: PROCESSES, TIERS, AND PROFILES

The analyses conducted under the present study were mainly focused on the workforce involved in the Main Value Chain where Extraction, Processing, and Maintenance play and important role.

MAIN VALUE CHAIN (MVC)

The present study is focused on the workforce associated to the following processes:

EXTRACTION
Open-pit / underground mine

EXTRACTION MAINTENANCE

PROCESSING AND HAULAGE
Concentration / hydrometallurgy / smelting / refining

MAINTENANCE PROCESSING

Workforces performing in other processes outside the Main Value Chain, such as Administration & Support, Projects, and Mining Development, were also considered in some specific analyses.

ADMINISTRATION AND SUPPORT
Staff, finances, administration, supplies, corporate

PROJECTS
Major or structural and minor projects

MINING DEVELOPMENT
Exploration, geology, development, etc.

People from different positions, classified under the following four generic tiers and profiles, participate in the MVC processes:

PROFESSIONALS

- Geologist
- Mine extraction professional
- Processing professional
- Maintenance professional
- Maintenance specialist engineer
- Extraction specialist engineer
- Processing specialist engineer

SUPERVISORS

- Extraction supervisor
- Processing supervisor
- Maintenance supervisor

MAINTAINERS

- Mechanical maintainer
- Electrical maintainer

OPERATORS

- Fixed equipment operator
- Mobile equipment operator

UNIVERSE AND SAMPLE

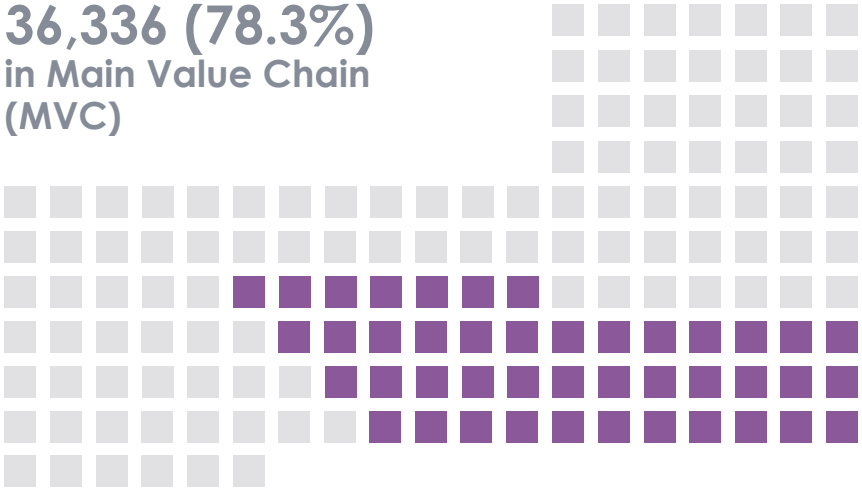
The total work-force of Chile's large-scale mining industry is 176.496 people. Of them, 46.412 are workers of mining companies and 130.084 work for supplier companies.

The Chilean large-scale mining sector brings together the main productive companies of the mining industry operating in the country.

Organized under the Mining Council, and driven by the initiative MSC-Eleva, these companies provided an important volume of information that was used to estimate the bulk of human capital existing in the industry. For this reason, the present study covers the following universe of mining-related workforce in Chile:

WORKERS FROM MINING COMPANIES[1]
46,412

36,336 (78.3%)
in Main Value Chain (MVC)



10,076 (21.7%)
in other areas

[1] Samples obtained from mining companies represent 43,960 people on whose basis the total mining-related workforce was projected.

WORKERS FROM SUPPLIER COMPANIES[2]

130,084

89,257 (68.6%)
in Main Value Chain (MVC)

40,827 (31.4%)
in other areas

[2] Samples taken from supplier companies represent 15,673 people on whose basis the total workforce of supplier companies were projected.

01

CURRENT PANORAMA

OF HUMAN CAPITAL IN LARGE-SCALE MINING

Contents:

INTRODUCTION

The present study sought to maintain the continuity of the information provided in earlier editions while incorporating new variables that help complement the analysis of the elements characterizing the people who work in mining companies.

Thus, the Chapter below shows the current scenario for the large-scale mining workforce in Chile. Thus, serial data covering from 2011

up to the latest piece of information available and collected for this report and unedited information on how mining companies perceive the topics associated to people management in the industry are provided.

NOTE ON METHODOLOGY

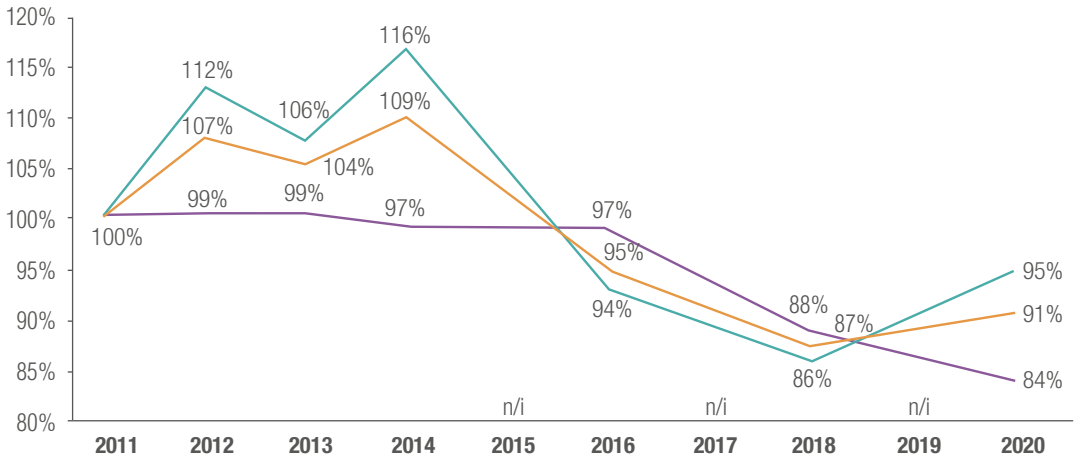
Statistics contained in this Chapter were prepared on the basis of information directly provided by participant companies, specifically up to December 2020:

- 14 own workforce databases (headcount) from mining companies and 13 from supplier companies.
- 19 reports on full-time contractor workers deployed on site.
- 23 reports on training delivered by mining companies and 10 by supplier companies.
- 23 reports on apprentices and student trainees in mining companies.
- Online self-survey responded by HR managers and senior executives. Total N of sample = 29 companies (n mining = 18; n supplier = 11). Survey conducted on = February and March 2021.

The different indicators contained in this Chapter were prepared following the collection of the above-mentioned data; the specific sources used for each analysis are indicated a required.

1. EMPLOYMENT INDICATORS

EMPLOYMENT EVOLUTION IN MINE OPERATIONS*
(Personnel associated to corporate divisions not included)



	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Own workforce	41,832	44,545	44,073	41,329	n/i	38,597	n/i	38,828	n/i	38,790
Contractor workforce	74,847	75,032	69,794	71,922	n/i	55,520	n/i	58,170	n/i	65,681
Total	116,679	119,577	113,867	113,251	n/i	94,117	n/i	96,998	n/i	104,471

*In the construction of this indicator, a subsample from participant companies all along the series since 2011 was used. Thus, tendencies can be observed more clearly and free of disruptions caused by changes of participants that would otherwise be reflected in the different editions of this study.

n/i: no information

Source: Report on internal and contractor workforce in mining companies.

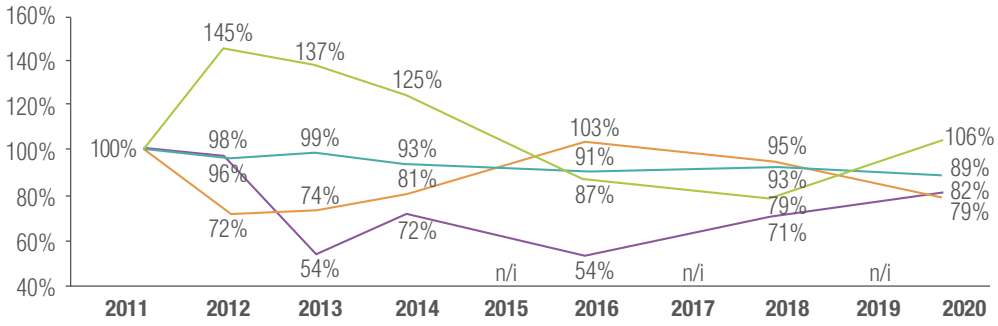
Results obtained for 2020 reveal that the mining industry is expanding, recovering a level of employment similar to the conditions existing prior to the 2016 economic contraction.

This last measurement shows that total employment is 9 percentage points below the first one (year 2011) and 4 points over the 2018 measurement.

The own workforce employment drops 4 percentage points with respect to 2018. However, contractor workforces gain 9 percentage points, revealing that the 2020 expansion is mainly concentrated in external workers.

This is proof of the efforts exerted by the industry to secure operational continuity in a pandemic-challenged scenario and evidence of copper price recovery, an optimistic scenario resulting from an anticipated copper demand increase in the world and a potential increase in the development of projects seeking to enhance copper production in our country.

EMPLOYMENT EVOLUTION IN MINING COMPANIES PER AREA*



	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Main Value Chain	35,517	34,695	36,970	36,513	n/i	34,143	n/i	35,417	n/i	33,508
Major projects	1,776	1,725	963	1,291	n/i	964	n/i	1,268	n/i	1,563
Mining development	2,231	1,539	1,637	1,872	n/i	2,209	n/i	2,094	n/i	2,032
Administration/support	6,011	8,674	8,569	7,948	n/i	5,584	n/i	5,163	n/i	6,857

* In the construction of this indicator, a subsample from participant companies all along the series since 2011 was used. Thus, tendencies can be observed more clearly and free of disruptions caused by changes of participants that would otherwise be reflected in the different editions of this study.

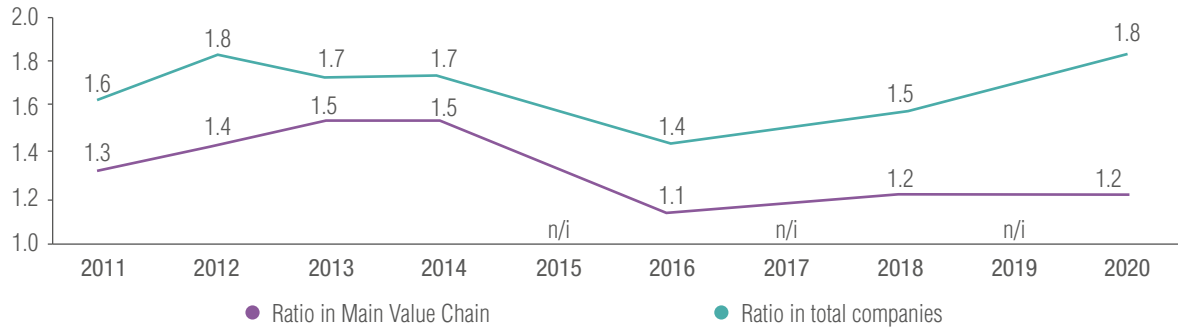
n/i: no information

Source: Report on mining company workforce.

Mining companies are starting to show a slight employment contraction in the Main Value Chain and Mining Development areas, descending 4 and 16 points, respectively, relative to 2018. In turn, Administration/Support and Major Projects exhibit a significant increase exceeding previous measurements by 27 and 11 percentage points and reaching levels closer to those observed when the series was first started.

The changes identified towards the end of the series indicate that companies might be getting prepared to handle a ramp-up in mining production in the coming years with the ensuing cost and organization challenges derived from adapting mining activities in the present context.

EVOLUTION OF CONTRACTOR WORKFORCE-OWN WORKFORCE RATIO IN MINING COMPANIES

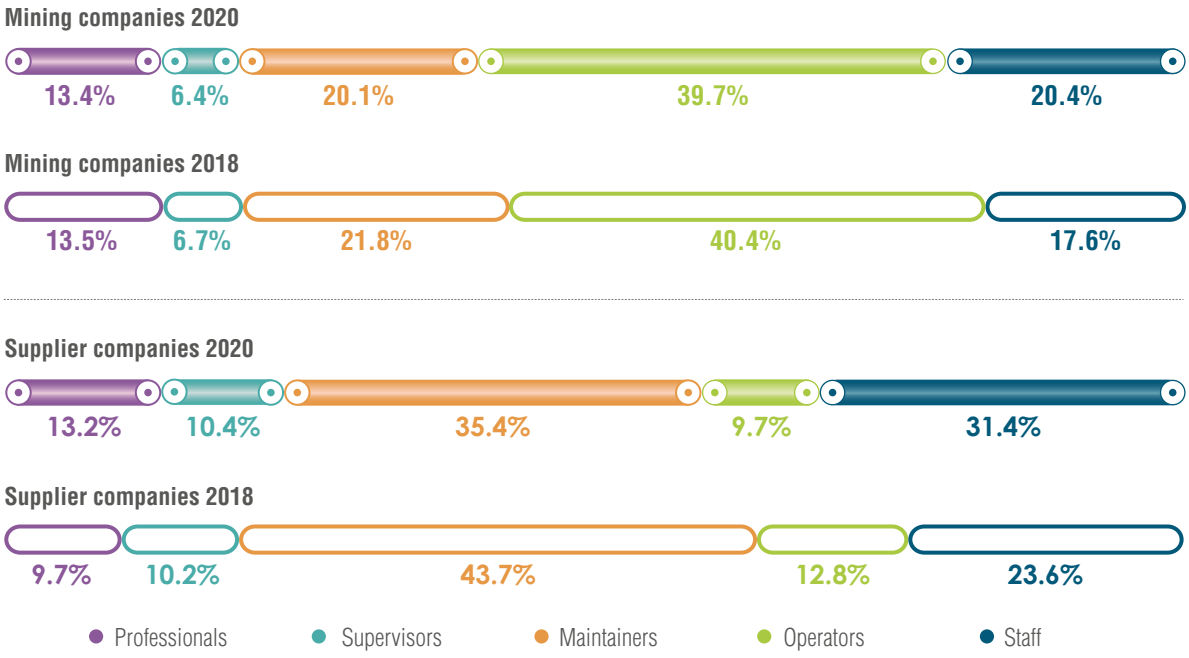


Source: Report on internal and contractor workforce in mining companies.

Just as suggested in the previous edition, the revitalization that mining activity has recently experienced has triggered an employment resurgence in the sector which has, in turn, influenced the size of contracts secured by supplier companies. In 2020, a new spike in the number of full-time contractor workers per own worker was observed to occur in mining companies (a 2:1 ratio); it even reached 2012 levels in the total company ratio but kept practically intact in the Main Value Chain with respect to 2018.

2. WORKFORCE CHARACTERISTICS

WORKERS DISTRIBUTION PER TIER



Source: Report on mining and supplier company workforces.

Workers distribution across all companies retained its regular pattern with each company type responding to its role within the industry. Mining companies concentrate most of their workforce in Operators and, Suppliers, in Maintainers. If compared with 2018, Staff stands out for its increase in workforce proportion of 2.8 percentage points in mining companies and 7.8 points in supplier companies.

COMPANY SENIORITY PER TIER

	Mining Co.			Supplier Co.		
	2018		2020	2018		2020
Professionals	9.1	↓	8.7	5.6	↑	6.5
Supervisors	14.0	↓	13.7	6.9	↑	8.5
Maintainers	10.9	↑	11.7	3.9	↑	5.6
Operators	11.8	↓	11.5	6.2	↑	6.5
Staff	10.8	↓	9.3	6.3	↑	7.1
Total	11.2	↓	10.9	5.2	↑	6.6

Source: Report on mining and supplier company workforces.

When the two last years of measurements are compared, the greatest change is seen to occur in supplier companies whose general average seniority increases in 1.4 years. This is reflected in an even larger increase of seniority years experienced in some tiers.

In mining companies, the average seniority slightly decreased across the workforce, which could be explained by a higher generational turnover in the last period, except for Maintainers, where seniority grew by practically one year.

EVOLUTION IN THE NUMBER OF PEOPLE SUPERVISED PER EACH SUPERVISOR

	2011		2018		2020
Mining Co.	11	↓	9.3	=	9.3
Supplier Co.	7	↓	5.6	↓	4.3

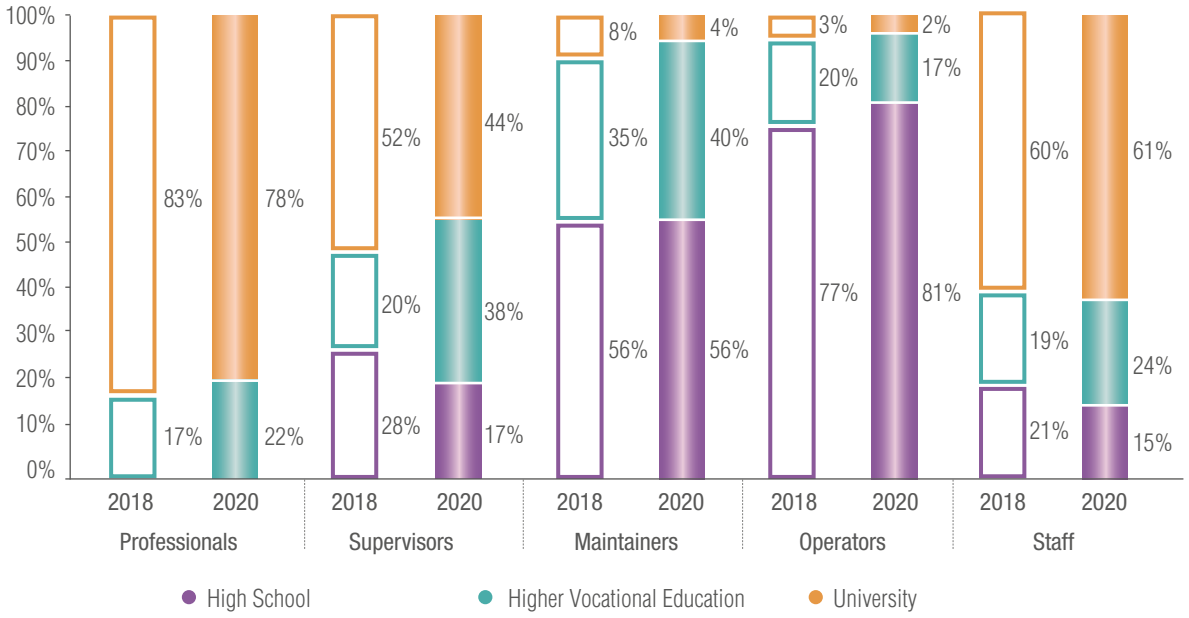
Source: Report on mining and supplier company workforces.

Though 2011 showed evidence of less people being supervised per each supervisor, mining companies have returned the same results in the last two measurements while supplier companies report a 1.3 descent in 2020.

International best practices report ranges between 10 and 15 people supervised per supervisor[3].

[3] National Productivity Commission, "PRODUCTIVITY IN THE CHILEAN COPPER MINING INDUSTRY", 2017

EDUCATION LEVEL IN MINING COMPANIES PER TIER

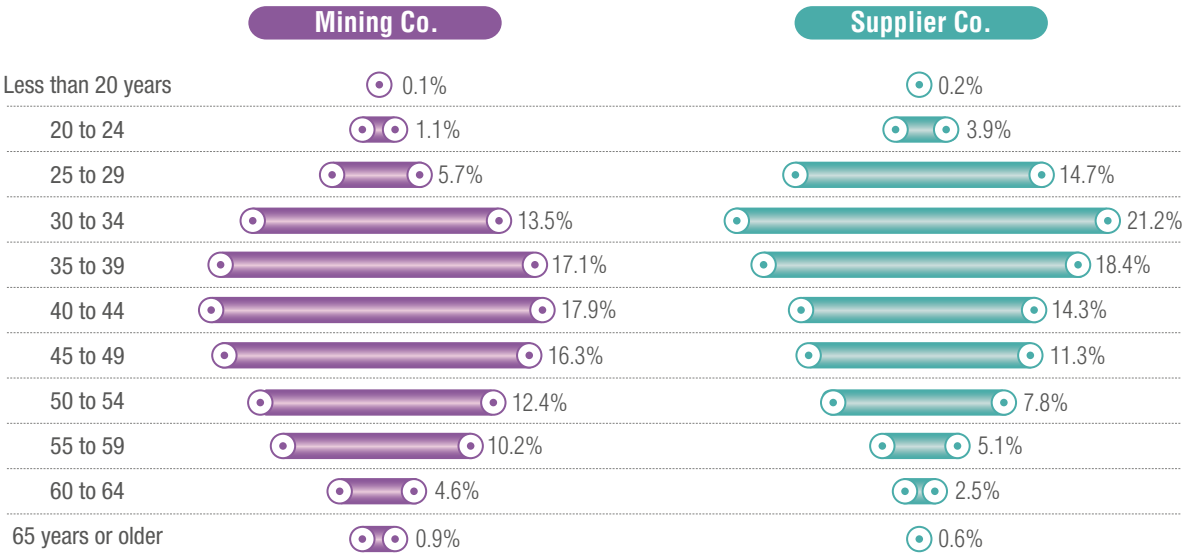


Source: Report on mining company workforce

Based on 2018 reports, the greatest change took place in the Supervisors tier where workers within the Higher Vocational Education tier (including studies in VI and TTC) grew 18 percentage points.

In contrast, the percentage of Operators with Higher Vocational Education lost 3 points but the group under High School gained 4 points. Additionally, Professionals and Maintainers workforces with Higher Vocational Education are seen to have gained 5 points.

WORKFORCE AGE 2020



Source: Report on mining and supplier company workforces.

Just as observed in previous years, in 2020 younger workforces were higher in supplier than they were in mining companies. The greatest difference is found in groups of 25 to 29 and 30 to 34 years which is where mining companies concentrate 19.2% of their workforce while in supplier companies it gets as high as 35.9%.

Between 2012 and 2018, there was an increase in age averages, which may be associated with the lower incorporation of young people. However, this last measurement shows a slight decrease in the average age in mining company workforces.

PROMEDIO DE AÑOS DE EDAD DE LAS DOTACIONES

Source: Report on mining and supplier company workforces.

HIRING OF YOUNG PEOPLE

(Percentage of people under 30 years over total workers with less than a year of seniority).

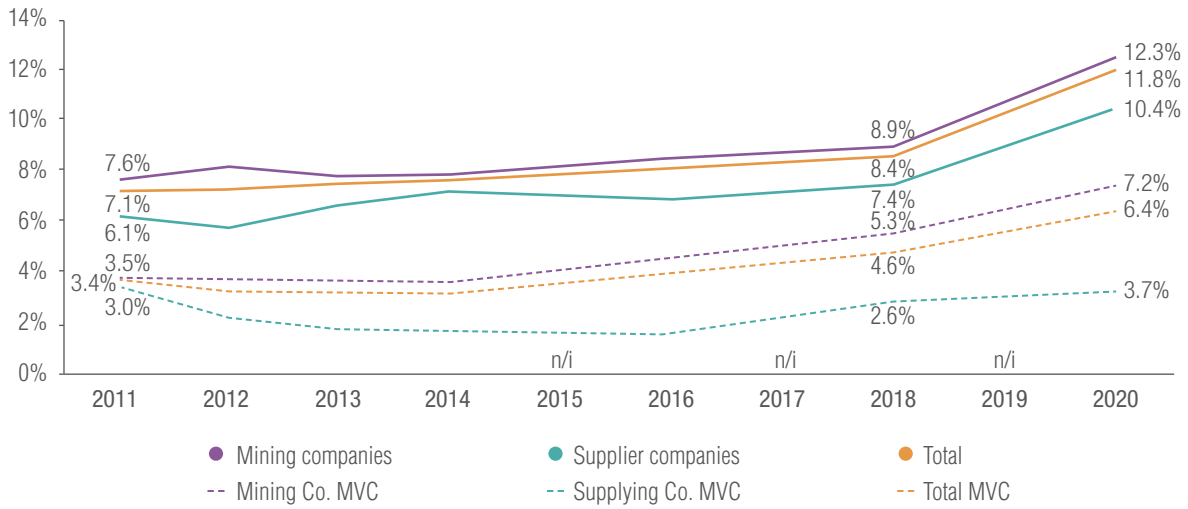
	2018		2020
Total	29.7%	↓	24.7%
Total MVC	31.3%	↓	26.1%
Mining Co.	23.9%	↓	20.8%
Mining Co. MVC	26.9%	↓	21.9%
Supplier	34.2%	↓	33%
Supplier Co. MVC	34.5%	↑	35%

Source: Report on mining and supplier company workforces

As compared with 2018, the hiring of people under 30 in 2020 presented a 20.8% decrease in mining companies and a 33% decrease in supplier companies.

3. FEMALE PARTICIPATION IN THE INDUSTRY

EVOLUTION OF FEMALE LABOR PARTICIPATION



Source: Report on mining and supplier company workforces.

Global female participation in the large-scale mining workforce in 2020 experienced a 11.8% increase which rises to 12.3% in mining companies and to 10.4% in supplier companies. Judging by the last decade trends, female participation in the mining industry has been consistently rising, though the increase occurred between 2018 and 2020 is especially significant, as female involvement in mining grew 3.4 percentage points in the industry, in general, and 1.8 in the Main Value Chain.

Despite the many chances of growth, special attention should be placed on the efforts deployed by mining companies in the last years, implementing explicit policies and goals to drive cultural changes regarding inclusion and gender-equality across organizations.

FEMALE ENROLLMENT

(Percentage of women over total workers with less than a year of seniority)

The global female hiring indicator has doubled in the last period, climbing from 11.4% to 20.9% between 2018 and 2020. The jump in the number of women with less than one year of seniority is happening in the industry, in general, and also in the Main Value Chain (15.7%).

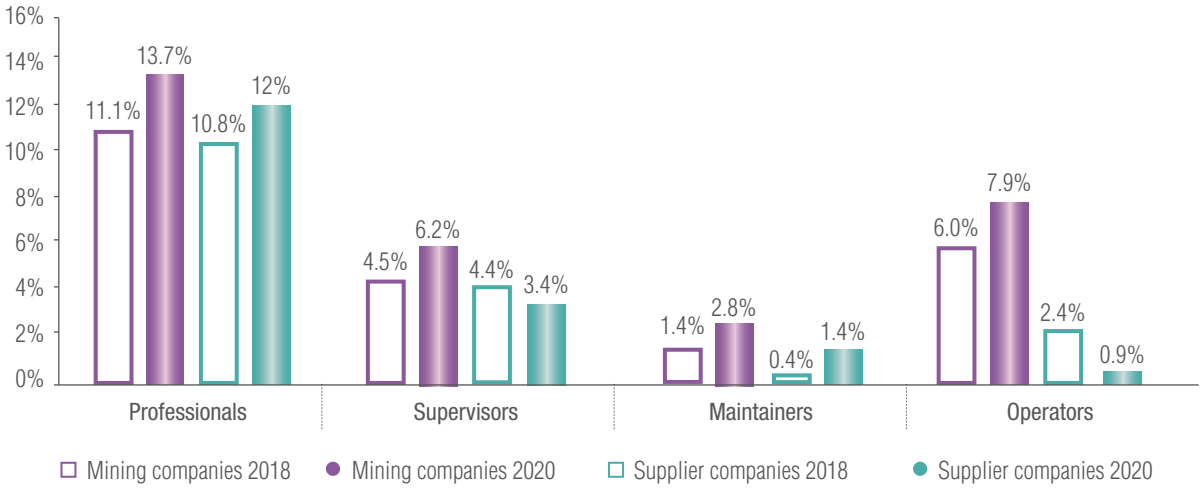
Out of all people hired last year by mining companies, 25.1% represent women while 11.9% correspond to women hired by supplier companies.

	2018		2020
Total	11.4%	▲	20.9%
Total MVC	7.0%	▲	15.7%
Mining Co.	17.3%	▲	25.1%
Mining Co. MVC	13.1%	▲	20.2%
Suppliers	6.7%	▲	11.9%
Supplier MVC	2.6%	▲	6.1%

Source: Report on mining and supplier company workforces

FEMALE PARTICIPATION PER TIER IN THE MAIN VALUE CHAIN

(Percentage of women against total workers -men and women- per tier in the Main Value Chain)

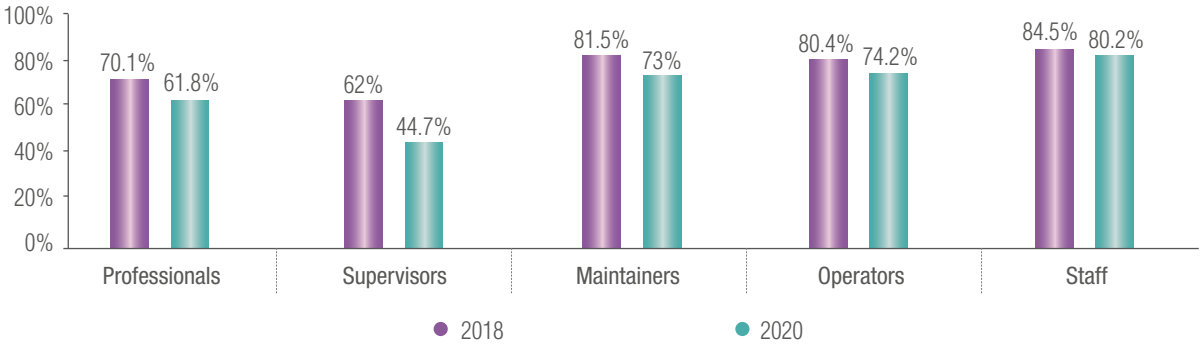


Source: Report on mining and supplier company workforces

In percentage terms, the main participation of women in the Main Value Chain continues to be concentrated in the Professionals tier where tertiary studies (vocational or field professionals) or bachelor professionals are needed to fill open positions. In the case of mining companies, the participation of female professionals moved from 11.1% to 13.7%.

Though a lower proportion of women is found in the Operators and Maintainers tiers of mining companies, between 2018 and 2020 both tiers experienced an upward turn of 1.9 and 1.4 percentage points, respectively.

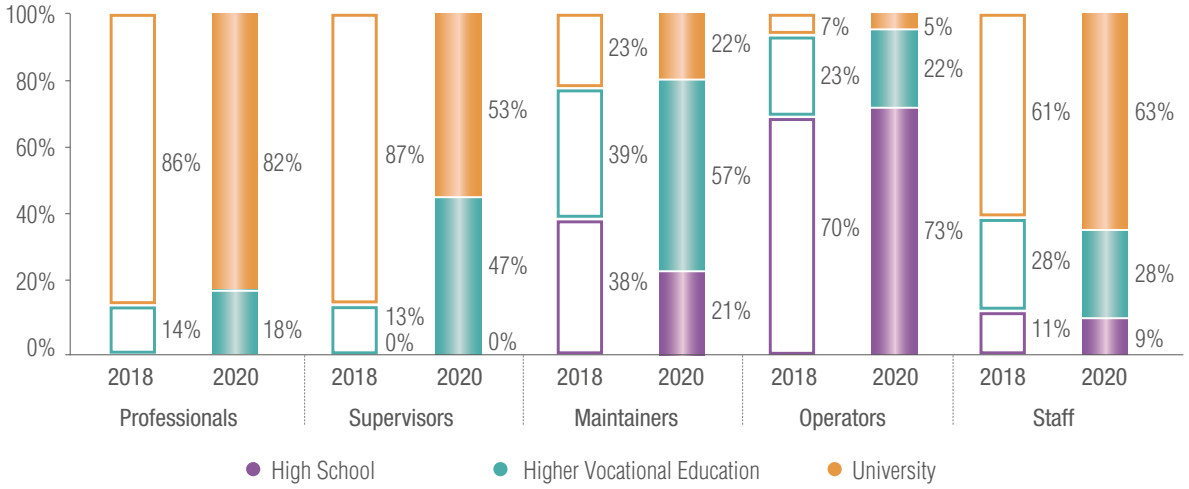
PERCENTAGE OF WOMEN LIVING AND WORKING IN MINING COMPANIES, IN THE SAME REGION PER TIER



Source: Report on mining company workforce

The great majority of women (74.4%) performing duties in mining companies are employed in the same region they live in. When a year-over-year comparison is made, all tiers present a decrease in local female employment, with Supervisors as the tier with the largest difference, reporting a drop of 18 percentage points between 2018 and 2020.

WOMEN EDUCATION LEVEL PER TIER IN MINING COMPANIES



Source: Report on mining company workforce

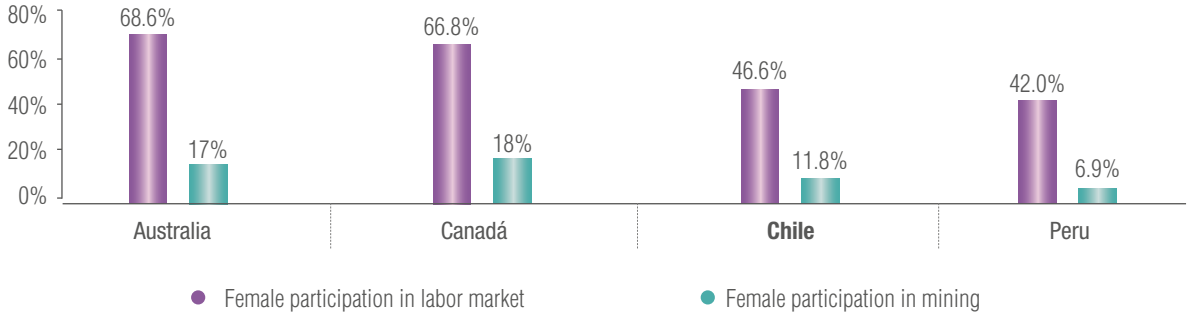
Based on 2018 reports, the greatest change in education level is observed to occur in the Supervisors tier with a 34-percentage point increase in female workers with Higher Vocational Education and an identical drop among those with University education.

Likewise, the percentage of Maintainers with higher vocational education gained 19 points while the High School group fell 17 points.

In the Operators tier maintains the high percentage of women with high school education registered in the last two reports.

Higher vocational education seems to be a good mechanism for insertion and trajectories labor for women in the Large Mining.

FEMALE PARTICIPATION IN INTERNATIONAL MINING 2020



Source: 2020 employment rate, OECD.

As pointed out by CEPAL[4], the outbreak of the COVID-19 health crisis took a high social and economic toll on women mainly, as reflected in their lower participation in the labor market, in general. However, the mining industry worldwide has reported an increase in women joining the industry with respect to previous measurements.

[4] CEPAL (2020b). The impact of COVID-19 health crisis on labor markets of Latin America.

WOMEN IN DECISION-MAKING POSITIONS

(Involving mining companies only)

Directors/Managers: person in charge of management or coordination of an area and/or department.

2020 **16.9%**

2018 **14.5%**

Deputy manager/ Superintendents: person assisting the manager in strategy planning and implementation tasks. She performs as acting manager.

2020 **12.6%**

2018 **11.3%**

Head: person responsible for the management of a certain project. In charge of fulfilling certain objectives and organizing teams.

2020 **15.7%**

2018 **7.4%**

Supervisors: person in charge of directing the work of a group of individuals, monitor their performance, and make decisions.

2020 **9.9%**

2018 **7.0%**

Source: Report on mining company workforce.

This last measurement revealed an increase in women participating in decision-making jobs (from first-line supervision up to running of company). Based on the total number of decision-making positions, 13.1% of them are occupied by women.

If compared with the previous measurement, the most significant increase of female participation is found in leadership positions, from a 7.4% increase in 2018 to 15.7% in 2020.

COMMITMENTS FROM THE NATIONAL WOMEN IN MINING TABLE

The National Women in Mining Table is a public-private dialogue platform led by the Ministry of Mining and the Ministry of Women and Gender Equality. On August 10th, 2021, its members -different trade guilds, mining & supplier companies, and representatives from the civil society- subscribed a commitment to continue to incorporate women into the industry to help advance gender equality.

The undertaken were:

- Report progress according to indicators set up in the dialogue Table in order to participate in joint measurements to be made annually.
- Organize representative panels with a minimum 30% participation of men or women, as the case may be. Care will be taken to not relegate women to moderator roles only.
- Identify, at internal level, masculinized roles, following methodology proposed at the Table in order to bring out affirmative actions where an increasingly larger number of women can participate.

MAIN INITIATIVES IN GENDER-RELATED POLICIES IN SECTOR COMPANIES

Promote an inclusive organizational culture, by growing awareness and providing ongoing training on gender topics.	95.5%
Increase female participation in their workforce.	95.5%
Encourage the presence of women decision-making positions.	90.9%
Ensure the existence of adequate infrastructure to accommodate a mixed workforce.	86.4%
Potentiate joint partnership with higher-education institutions, training centers, and vocational high schools in order to encourage women into the mining industry.	63.6%
Advance in the dissemination of the Chilean Norm 3262: 2012: Gender Equality Management System and Conciliation of Labor, Family, and Personal Life.	50.0%

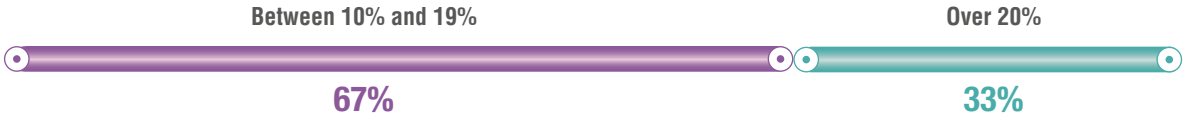
Source: Survey to mining and supplier companies.

GOALS REGARDING FEMALE PARTICIPATION IN SECTOR COMPANIES

52% of participant companies have set up their own female participation goals for the next five years. This percentage goes up to 61%, if only mining companies are considered.

67% are aiming to reach 10% and 19% as a female participation goal. Only a third of mining and supplier companies are pointing at targets over 20% in the medium term.

Have you set up female participation goals for next five years?



Source: Survey to mining and supplier companies.

4. INCLUSION AND DIVERSITY

INCLUSION AND DIVERSITY POLICY PER GROUP

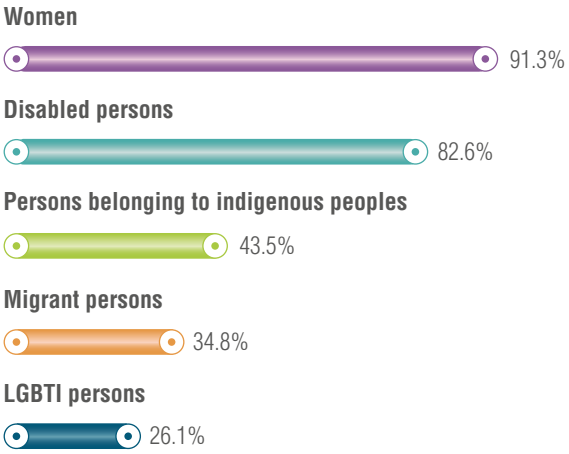
Most companies (79.3%) report having inclusion and diversity policies in place. When compared per organization type, it is in mining companies where most of these policies have been implemented (89%).

As for the groups targeted by these policies, most of the time companies place their focus on advancing women participation which presents an increase of 14 percentage points as opposed to 2018 measurements. Disabled persons come next (82.6%) and, in a lower proportion (26.1%), LGTBI persons.

Does your company have inclusion and diversity policies in place?

Source: Survey to mining and supplier companies.

WHAT ARE THE GROUP(S) WHERE INCLUSION AND DIVERSITY POLICIES ARE MOSTLY FOCUSED ON?

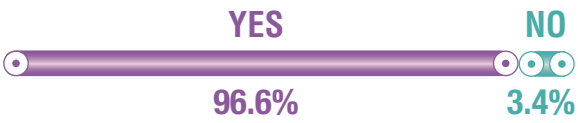


Source: Survey to mining and supplier companies.

Based on the responses provided by surveyed participants, disabled persons are estimated to represent **0.64%** of mining companies own workforce. **42% of them perform duties in the Main Value Chain.**

COMPANIES WHERE DISABLED PERSONS ARE HIRED UNDER LAW Nº 21.015 ON LABOR INCLUSION

Most companies have hired disabled people pursuant to Law 21.015 on labor inclusion. The remaining 3.4% may have taken complementary options to the law, such as transferring the hire to supplier companies or maybe they had hired disabled workers before the law was enacted.

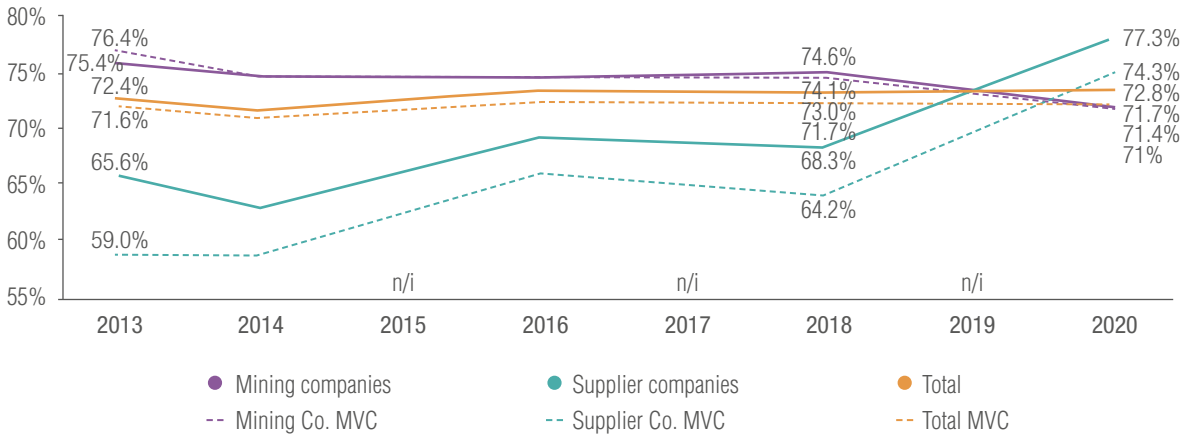


Source: Survey to mining and supplier companies.

5. LOCAL EMPLOYMENT

EVOLUTION OF LOCAL EMPLOYMENT IN THE INDUSTRY

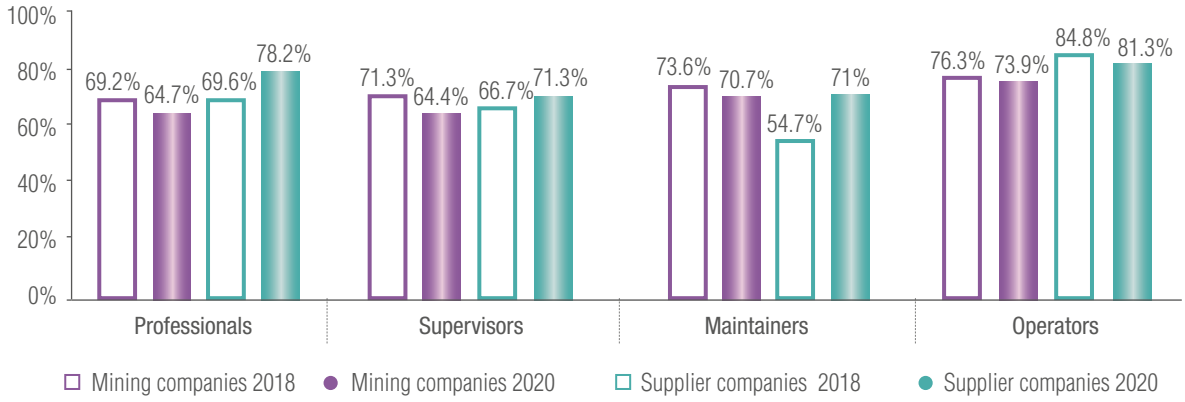
(Percentage of workers living and working in the same region in relation to total workforce)



Source: Report on mining and supplier company workforces.

In 2020, the local employment, understood as the workforce living and working in the same region, in mining companies experienced a descent of 3.2 percentage points (3.1 in the Main Value Chain) compared. 2018. Still, in recent years local employment in the industry has shown a stable behavior close to 73%, in general, and 72% in the Main Value Chain. This comes a result of an increasing tendency exhibited by supplier companies since 2014 to generate local employment with a 9-percentage point increase in the last year and 10.1 points in its Main Value Chain.

LOCAL EMPLOYMENT PER TIER IN THE MAIN VALUE CHAIN



Source: Report on participant mining and supplier company workforces.

The Operators tier continues to be at the head of the local employment indicator in the Main Value Chain, despite the decrease observe to occur in the last year in mining and supplier companies.

On the contrary, an important increase of 16.3 percentage points can be seen under local Maintainers and an 8.6-point increase under Professionals from supplier companies. In mining companies, however, the indicator shows a slight drop in all tiers, with the 6.9-point descent standing as the most significant figure.

LOCAL EMPLOYMENT IN HIRES

(Percentage of workers with less than 1 year of seniority living and working in the same region)

	2018		2020
Total	65.2%	▲	71,3%
Total MVC	63.3%	▲	71,9%
Mining companies	61.2%	▲	65,8%
Mining Co. MVC Empresas	60.8%	▲	67,6%
Supplier companies	68.1%	▲	83,8%
Supplier Co. MVC	65%	▲	81,9%

While local employment indicators exhibited by mining companies have seen a decline in total figures, the percentage of local workers with less than 1 year of seniority has moved upwards from 6.1 percentage points, in general, and 8.6 points in the Main Value Chain, both in mining and supplier companies, as result of the efforts made to increase their participation in the new hires.

Source: Report on mining and supplier company workforces.

In mining companies, the total number of new enrollments living and working in the same region showed an increase of 4.6 percentage points, in general, and 6.8 points in the Main Value Chain.

6. TALENT MANAGEMENT

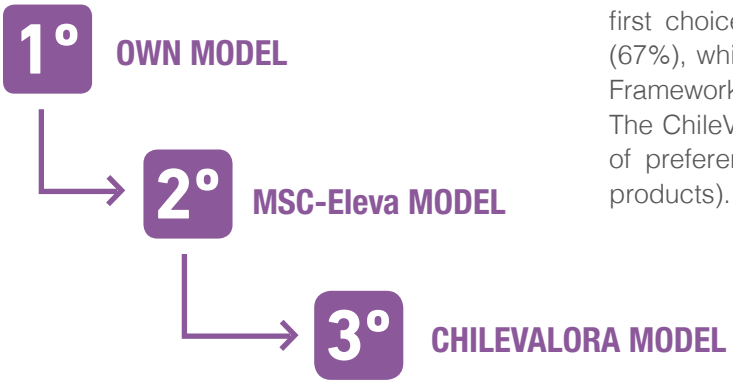
MANAGEMENT MODEL

Does the company apply a skills-based people management model?

The HR areas of nearly 80% of survey respondent companies are applying skills-based management models in order to identify the people that best meet their needs. These models are based on skills standards that include aspects such as the expected abilities, competencies, know-how, and performance to fulfill the organization's objectives.

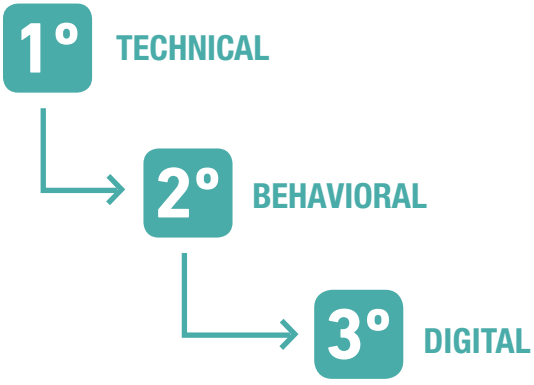
Though companies have implemented more than one people management model, when asked about the type of model, 90% of them indicated the use of an own model as their first choice followed by the MSC-Eleva model (67%), which includes the Mining Qualifications Framework and training & education packages. The ChileValora model is ranked third with 46% of preferences (use of training plans or other products).

Ranking based on management model



Source: Survey to mining and supplier companies.

Ranking based on type of skills included in the management model



As to how companies prioritize skills in their management models, the task-specific technical competencies to be met -such as specialized know-how of certain systems or equipment- come up as the most relevant ones, with 65% of preferences. Behavioral competencies are ranked second (57%) while skills associated to the handling of new technologies appear in a lower proportion (32%).

It must be noted that 37% of companies states that digital skills are not considered in their management models.

Source: Survey to mining and supplier companies.

TRAINING INDICATORS

Training hours per worker (hours of training / workforce)

2020: **24.9**

2018: **29.9**

Participation per person (attendance / workforce)

2020: **5.5**

2018: **2.4**

Investment per worker* (training investment / workforce)

2020: **$217,323**

2018: **$308,609**

Cost per participant* (training investment/ attendance)

2020: **$49,715**

2018: **$183,476**

Training index (hours of training / total worked hours)

2020: **1.31%**

2018: **1.36%**

Cost of training* (training investment/ hours of training)

2020: **$9,914**

2018: **$10,920**

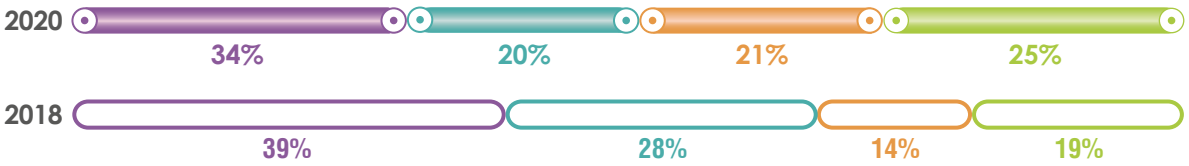
* Chilean pesos

Source: Report on training in mining and supplier companies.

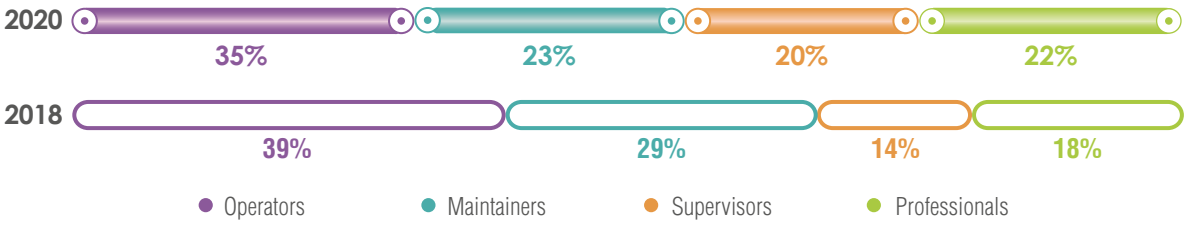
Despite the challenging scenario caused by the pandemic, the sector companies continued to train their workforces; thus when comparing the indicators witha normal year, in 2020 , training hours per worker and the training index recorded a slight decline (5 less training hours per person).

Attendance experienced a considerable increase reflected in a 3.1-point rise in participation per person while the cost per participant recorded an important decrease.

DISTRIBUTION OF TRAINING INVESTMENT PER TIER



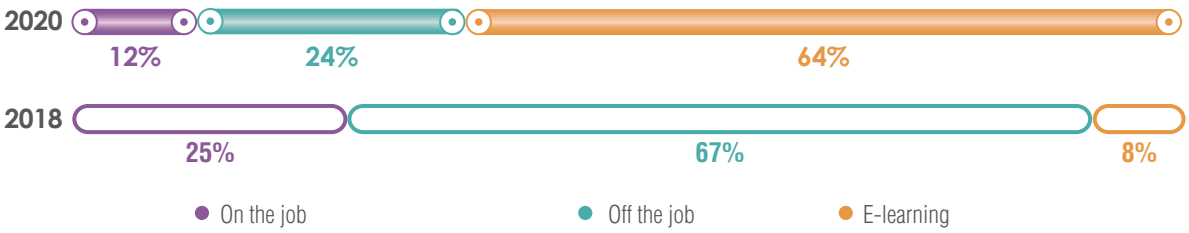
DISTRIBUTION OF TRAINING HOURS PER TIER



Source: Report on training in mining and supplier companies.

When the investment and training hours indicators of the years of measurement are compared, the results for Operators and Maintainers tiers in 2020 are seen to be lower, as opposed to the increase occurred in the Supervisors and Professionals tiers. The COVID-19 pandemic prompted adjustments in training strategies and most likely more hours and investment resources were distributed across those tiers where remote working was more feasible to be applied.

DISTRIBUTION OF TRAINING PER METHODOLOGY



Source: Report on training in mining and supplier companies.

As a result of the COVID-19 pandemic, the type of methodology usually applied for worker training purposes was modified between the years of measurement. Thus, e-learning saw a considerable increase vs. in-person training, both in on/off-the-job training modes.

It is more likely that more hours and investment resources were distributed across those tiers where remote working was more practical to be applied.

MAIN REASONS FOR COMPANIES TRAIN THEIR WORKFORCES

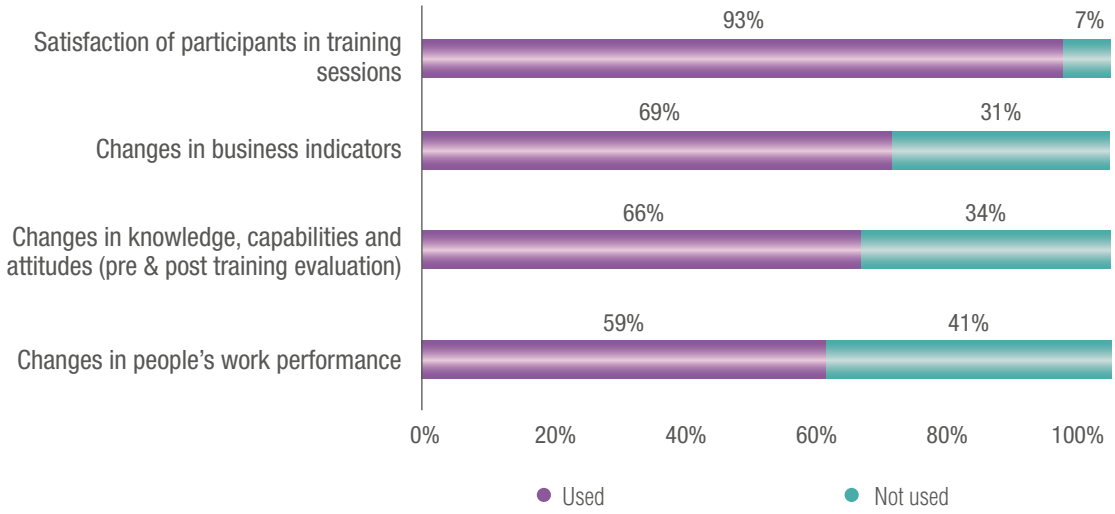
- Reduce gaps in technical skills. **55%**
- Compliance with workplace safety standards. **48%**
- Promote an inclusive organizational culture (gender, diversity, etc. issues). **31%**
- Career advancement program. **28%**
- Train workers in technology use and skills. **17%**

Source: Survey to mining and supplier companies.

The main training objectives for 2020 were focused on bridging the gaps in technical skills and meeting the workplace safety standards.

On the other hand, a lower number of companies (17%) trained their workers in technology use and skills.

ALTERNATIVES USED BY COMPANIES IN MEASURING THE IMPACT OF TRAINING



Source: Survey to mining and supplier companies.

When asked if some type of measurement was used to determine the impact received from training, most companies replied they effectively measured the level of satisfaction of participants in the training courses while almost 60% answered they applied post-training assessments to identify changes in job performance.

APPRENTICES AND TRAINEES IN MINING COMPANIES

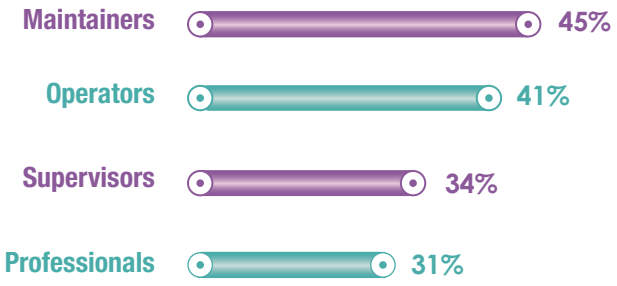
	Total tutors	Total apprentices and trainees	Average enrollment rate
2020	286	586	21%
2018	1,482	1,279	23%

Source: Survey to mining.

As compared to 2018, apprenticeship and traineeship vacancies as well as the number of available tutors showed a considerable (54%) decline.

However, when the average apprenticeship and traineeship vacancy rate is observed as a whole, the decline was actually 2 percentage points, with an average enrollment rate of 21% per company for 2020 out of the total number of people accepted.

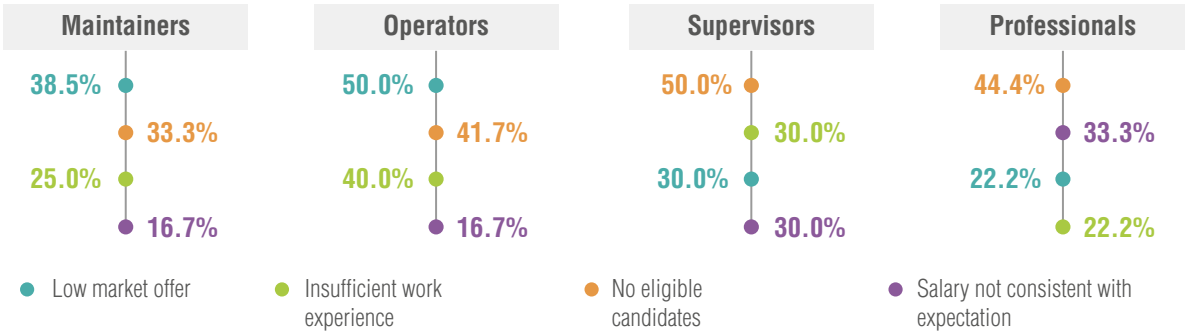
COMPANIES WITH DIFFICULTIES IN HIRING IN THE LAST YEAR PER TIER



Source: Survey to mining and supplier companies.

Participant companies were asked for possible difficulties faced in hiring new workers in the different tiers. A surprising 45% of respondents agreed to having experienced problems to hire Maintainers and 41% to hire Operators. As to Supervisors and Professionals, nearly a third of respondents admitted to some level of difficulty.

MAIN DIFFICULTIES IN HIRING DURING THE LAST YEAR PER TIER



Source: Survey to mining and supplier companies.

When asked about the main problems, in the case of Maintainers and Operators, companies rank the low market availability as the first reason, followed by the lack of adequately qualified candidates, and, in third place, the lack of work experience. In terms of Supervisors and Professionals, the main difficulty is posed by the lack of qualified candidates.

Companies rate as number one the scarce market availability followed by the lack of candidates adequately qualified.

COMPANIES BELIEVING THAT SOME SKILLS ARE NOT ADEQUATELY TRAINED PER TIER

	Technical skills	Behavioral skills	Digital skills
Operators	20.7%	44.8%	69.0%
Maintainers	24.1%	34.5%	65.5%
Supervisors	17.2%	34.5%	41.4%
Professionals	6.9%	6.9%	3.5%

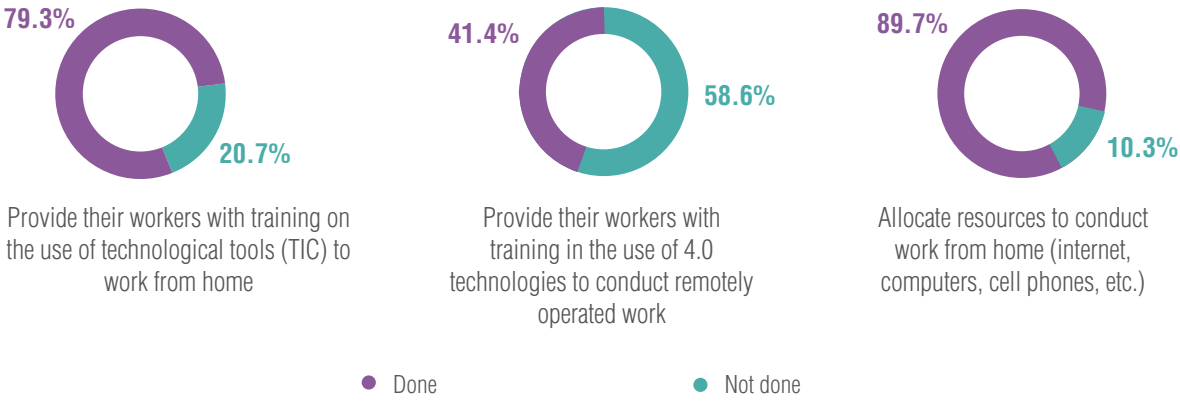
Source: Survey to mining and supplier companies.

También se les preguntó qué tan adecuada era la formación de los grupos ocupacionales en ciertas competencias. En el caso de las competencias digitales, relacionadas con el manejo de nuevas tecnologías, la mayoría de las empresas las calificó como insuficientes en los grupos ocupacionales de Operators y Maintainers, con un 69,% y 65,5% respectivamente. Respecto a las competencias conductuales, un tercio de las empresas señalan un nivel insuficiente para Maintainers y Supervisors.

7. ACTIONS TAKEN AGAINST COVID-19

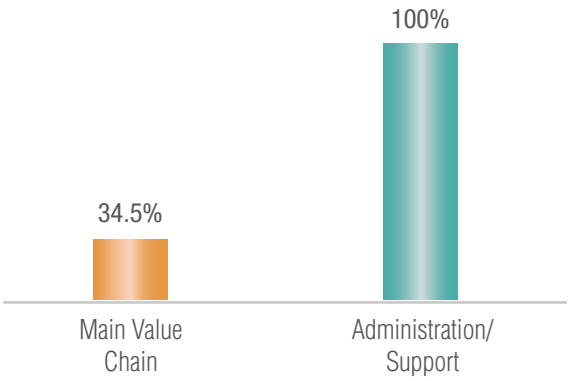
During the COVID 19 pandemic, different measures were implemented to mitigate the impact, such as mobility restrictions and conditions to provide essential and non-essential services. This forced mining and supplier companies to take different actions to face the health crisis, such as training workers in the use of technology tools (TIC) and providing resources to facilitate remote working (79.3% and 89.7%, respectively). Additionally, 41.4% of companies states having trained their workers in 4.0 technologies to conduct remotely operated work.

ACTIONS TAKEN BY COMPANIES TO DEAL WITH THE HEALTH CRISIS



Source: Survey to mining and supplier companies.

COMPANIES THAT ADOPTED REMOTE WORK PER AREA



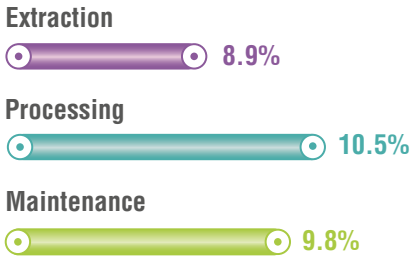
Source: Survey to mining and supplier companies.

All participant companies indicate having adopted virtual work in administration and support areas, Human Resources and Finances included, among others. A lower number (34.5%) indicated having introduced remote work in positions associated to the Main Value Chain (Extraction, Processing, Maintenance).

It must be noted that remote work was more intensively applied in supplier companies (81.8%) and in a little more than half (55.6%) of mining companies.

PERCENTAGE OF COMPANY EMPLOYEES THAT WORKED REMOTELY PER PROCESS

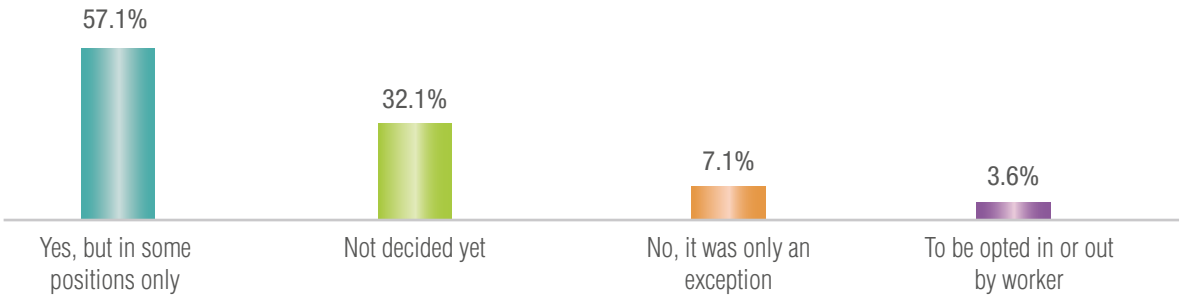
When asked about the percentage of workers in the Main Value Chain that performed remote work, this mode is estimated to have been applied in nearly 30% of the total. After sorting out the number of people who performed remote work, percentages end up being very similar for all three processes with the Processing area slightly standing out with 10.5% of workers.



Source: Survey to mining and supplier companies.

In the future, and once the pandemic is over, 57.1% of (mining and supplier) companies state to be maintaining remote work though, mainly, in support positions and in operation duties capable of being executed remotely and with technological support. On the other hand, 3.6% of companies announced to be leaving remote work as an alternative option for workers while 7.1% states that this was applied only as a result of the contingency.

LIKELIHOOD OF MAINTAINING REMOTE WORK AFTER THE PANDEMIC IS OVE



Source: Survey to mining and supplier companies.

MAIN RESULTS

- As compared with the previous study, large-scale mining is seen to be recovering employment levels mainly as a result of the growth experienced by contractor workforces. This is reflected in both the employment evolution as well as in the number of contractor workers vs. own worker in mining companies. From the above it follows that **companies opted mainly for contractor workers to ensure operational continuity in a pandemic-challenged scenario**. At the same time, mining companies present an increase in the own workforce mainly in administrative and support positions accounting for a potential reinforcement of management and HR under current circumstances.

- As for the workforce characteristics, there is an important difference in average work seniority among types of companies. This drops in 0.3 years in mining companies and increases 1.4 years in supplier companies. This is partly explained by the age difference among workforces occurred between the last two measurements: the hiring of young people in 2020 fell 1.2 percentage points in supplier companies and 3.1 points in mining companies.

- A **sustained increase in women participation in the mining industry** has been observed in the last decade, amounting to 11.8%, in general, and 6.4% in the Main Value Chain. The implementation of policies and goals intended to encourage female participation has been mainly reflected in the presence of women in decision-making positions (heads) which doubled since the last measurement. It should be noted that in two years only the global indicator of female hiring also doubled, reaching 20.9% as of 2020. A high percentage of women live in the same region they work in, this being a key factor that encourages and helps pave the way for women to join and stay in the mining industry.

- Most **companies declare to have diversity and inclusion policies in place**, mainly focused on increasing female participation in their workforce and on promoting an inclusive organizational culture, growing awareness and providing training in gender topics on an ongoing basis. With respect to disabled people, a large number of companies has already included this group in their policies and almost all of them have hired disabled people pursuant to Law N° 21.015 on labor inclusion. Still, and

based on company reports, disabled people fail to represent 1% of the own workforce and less than half that number works in the Main Value Chain. As to other groups, only a fourth of companies declared to have policies oriented to LGBTI persons while less than half that percentage has implemented inclusion and diversity policies involving indigenous peoples and migrants.

- Though local employment has suffered a small contraction in the last decade, **mining company workforces living and working in the same region have been the prevailing tendency** (close to 73% of workers). While supplier companies have shown an upward turn in local hiring in the last six years, mining companies report a 3.2-percentage point decrease in local workers, as compared to previous study. However, all this time companies have been putting great effort into increasing the participation of new local hires, as reflected in the 4.6- percentage point increase of workers with seniority with less than one year living and working in the same region.

- Most participant companies handle their people management processes with competency-based models, sometimes developed by companies themselves, followed by the MSC-Eleva model based on the Mining Qualifications Framework. On the other hand, companies reveal having gone through hard times in trying to train their personnel, as the **pandemic scenario caused a strong impact on their training strategies**. This is clearly reflected on the fact that, for the first time ever, e-learning has become the main methodology, in the cut-down on training hours and investment per worker, and in the opening of apprenticeship and traineeship opportunities. However, the ratio between training hours and total worked hours is very similar to previous measurements while an important increase in participation per person was observed, which proves workforce training continues to be a topic of paramount importance in the industry.


02

HUMAN CAPITAL

EDUCATIONAL OFFER

Contents:

INTRODUCTION

Being acquainted with the offer available for the mining industry and, particularly, the potential employability level of higher-education curricula directly associated to said sector is of key importance to identify human capital gaps.

With that goal in mind, this Chapter provides a thorough analysis and description of how career enrollments behave in higher education, mining-related programs, such as geology, mining, metallurgy, and electric and mechanical maintenance in order to assess how attracted young people are to careers dealing with the mining industry.

Additionally, a projection was made of the number of people expected to graduate from the education system in the next 10 years (2021 to 2030) and be available to join the mining-related scenario.

NOTE ON METHODOLOGY

Statistics contained in this Chapter were collected from the National Council of Education (NCE), (2020). INDICES /Estadísticas y bases de datos [online database], Santiago de Chile, http://www.cned.cl/bases-de-datos, [April 2021].

Data on employability, actual career duration, and retention level per career are of own elaboration based on information found in www.mifuturo.cl.

Institutional accreditation data was obtained from the National Council of Accreditation (NCA).

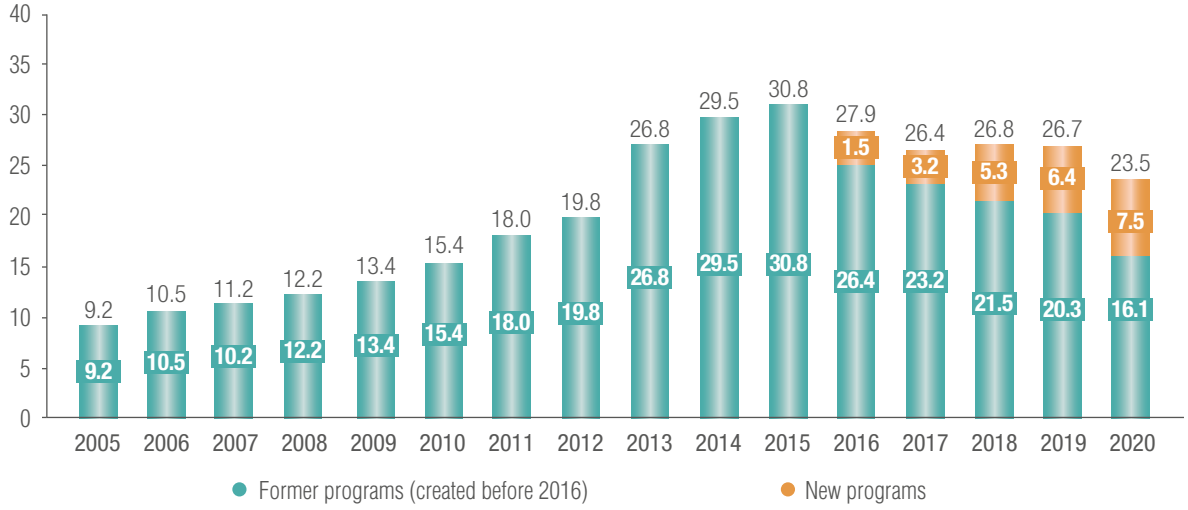
In order to obtain information on employability and actual career duration, total enrollment in mining-related careers was linked to those with available information on the NCA database. Thus, information was collected for 113 academic programs in place as of 2020, provided by 85 higher education institutions.

Work was performed at academic program and not career level: an academic program represents a career offered in one campus under a certain system. A career, instead, can be provided in one or more campuses of the institution under one or more systems (daytime hours, evening hours, in-person, etc.).

1. CHARACTERIZATION OF EDUCATIONAL OFFER

EVOLUTION OF FIRST YEAR ENROLLMENT IN MINING-RELATED SPECIALTIES, ACCORDING TO LENGTH OF TIME THE PROGRAMS HAVE BEEN IN EXISTENCE

(Nª of enrollments, in thousand people)



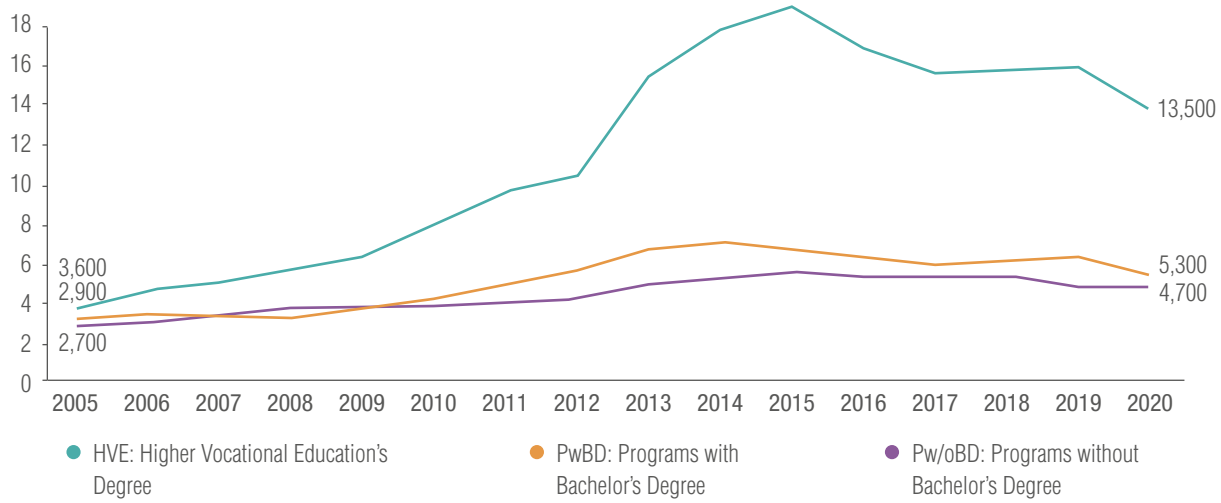
Source: Higher Education INDICES database, National Council of Education (April 2021).

In 2020, a total of 23,500 students enrolled in higher education programs associated to mining careers which reflects a 12% decrease compared with the previous year and 24% with respect to 2015, when the highest number of enrollments took place. As seen in the chart above, this decline is connected to the programs created prior to 2016 as those of more recent creation present a higher enrollment rate.

Nearly a third of total cases correspond to first-year enrollments in new programs and, since most of them have not generated graduates as of today, no information is available regarding employability or salary levels.

If compared to 2019, careers with graduated Professionals without a Bachelor's Degree (Pw/oBD) have suffered the lowest enrollment decrease (2%) while enrollments in careers graduating Professionals with a Bachelor's (PwBD) and Higher Vocational Education's (HVEs) Degree fell 14%.

EVOLUTION OF FIRST-YEAR ENROLLMENTS IN HIGHER EDUCATION IN MINING SPECIALTIES PER TYPE OF PROGRAM



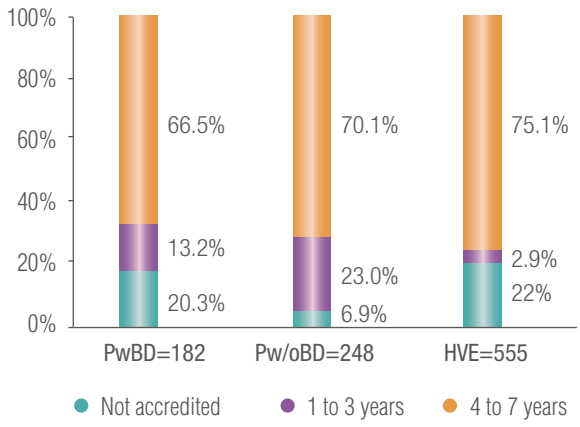
Source: INDICES Higher Education database, National Council of Education (April 2021).

The composition of enrollments in higher education programs has kept stable, despite the decline occurred in recent years. Thus, HVEs- that in 2015 represented 61% of the total- reached 57% in 2020; that is, 13,500 new enrollments. Programs of Professionals with and without a Bachelor's Degree (PwBD and Pw/oBD) exhibit similar figures in new enrollments with 23% and 20%, respectively.

Though at different points in time, all programs started to experience enrollment drops in 2015.

HVE institutions suffered the highest impact with over five thousand enrollments lost in five years; that is, a 28% decrease.

MINING PROGRAMS AND ACCREDITATION OF INSTITUTIONS OFFERING THE PROGRAMS, 2020



Source: INDICES Higher Education database, National Council of Education and data available at National Commission of Accreditation NCA - Chile (April 2021).

78% of programs connected to mining are provided by accredited institutions.

75.1% of HVE programs, the most relevant ones for the purposes of this study, are offered by institutions granted over 4 years of accreditation and 22% by non-accredited institutions, though this figure includes entities with accreditation or are too recent to produce graduates yet, as in the case of Sate-owned TTC, created as recently as 2018.

In turn, the number of accredited entities providing Programs with Bachelor's Degrees is slightly lower: 66.5% has been granted accreditation for more than 4 years and 20.3% is not accredited.

INSTITUTIONS WITH HIGHEST PARTICIPATION IN TOTAL ENROLLMENT IN MINING PROGRAMS, 2020

Type of institution	Name of participant	Total enrollment	Participation within industry type	Total participation
Vocational Training Centers	INACAP TTC	10,794	65%	14%
	CEDUC - UCN TTC	2,576	15%	3%
	OTHERS	3,382	20%	4%
	TOTAL	**16,752**	**100%**	**21%**
Vocational Institutes	DUOC UC P.I.	9,805	35%	12%
	INACAP P.I.	9,460	34%	12%
	AIEP P.I.	2,888	10%	4%
	OTHERS	5,596	21%	7%
	TOTAL	**27,749**	**100%**	**35%**
Universities	FEDERICO SANTA MARÍA TECHNICAL UNIVERSITY	4,542	13%	6%
	U. OF SANTIAGO DE CHILE	3,537	10%	4%
	INACAP TECHNOLOGY UNIVERSITY OF CHILE	3,141	9%	4%
	PONTIFICAL CATHOLIC UNIVERSITY OF VALPARAISO	2,559	8%	3%
	U. OF CONCEPCIÓN	2,082	6%	3%
	ANDRÉS BELLO UNIVER.	1,868	5%	2%
	U. OF BÍO-BÍO	1,728	5%	2%
	U. OF ATACAMA	1,665	5%	2%
	U. OF ANTOFAGASTA	1,161	3%	1%
	U. OF CHILE	1,042	3%	1%
	CATHOLIC UNIVERSITY OF THE NORTH	1,008	3%	1%
	U. OF TALCA	970	3%	1%
	U. OF LA FRONTERA	912	3%	1%
	U. OF TARAPACÁ	905	3%	1%
	OTHERS	7,288	21%	9%
	TOTAL	**34,408**	**100%**	**41%**
	TOTAL	**78,909**		

Source: INDICES Higher Education database, National Council of Education (April 2021).

In 2020, over 78 students were enrolled in higher education programs associated to the mining industry.

ENROLLMENT DISTRIBUTION ACROSS MINING PROGRAMS IN 2020

UNIVERSITIES 44%

VI 35%

VTC 21%

All mining-related programs are provided in 72 institutions though four of them cover a participation of over 5%: TTC and INACAP P.I., DUOC UC P.I., and Federico Santa María Technical University.

INSTITUTIONS WITH THE HIGHEST ENROLLMENT SHARE IN HVEs AND Pw/oBD MINING PROGRAMS, 2020

Institution	Total enrollment in mining companies 2020	Participation	Growth in relation to 2019
INACAP	23,110	43%	-6%
DUOC UC	9,805	18%	-4%
ANDRÉS BELLO UNIVERSITY	2,888	5%	3%
CATHOLIC U. OF THE NORTH	2,649	5%	-4%
SANTO TOMÁS	2,161	4%	-25%
P.I. CHILE	1,435	3%	-23%
UTFSM	1,401	3%	-26%
USACH	1,371	3%	-22%
IACC P.I.	1,002	2%	10%
OTHERS	7,962	14%	-10%
TOTAL GENERAL	**53.784**	**100%**	**-8%**

Source: INDICES Higher Education database, National Council of Education (April 2021).

As to the technological level (graduates from HVE institutions and Pw/oBD programs), the leader institution with the highest enrollment participation in mining programs is INACAP, with more than 23 thousand students, representing 43% of the total, followed by DUOC UC (18%).

In aspects of growth, the only entities showing an increase in mining-program graduates are IACC P.I. (10%) and Andrés Bello University (3%). It must be noted that universities can also offer HVE and Pw/oBD-level programs.

MSC QUALITY SEAL

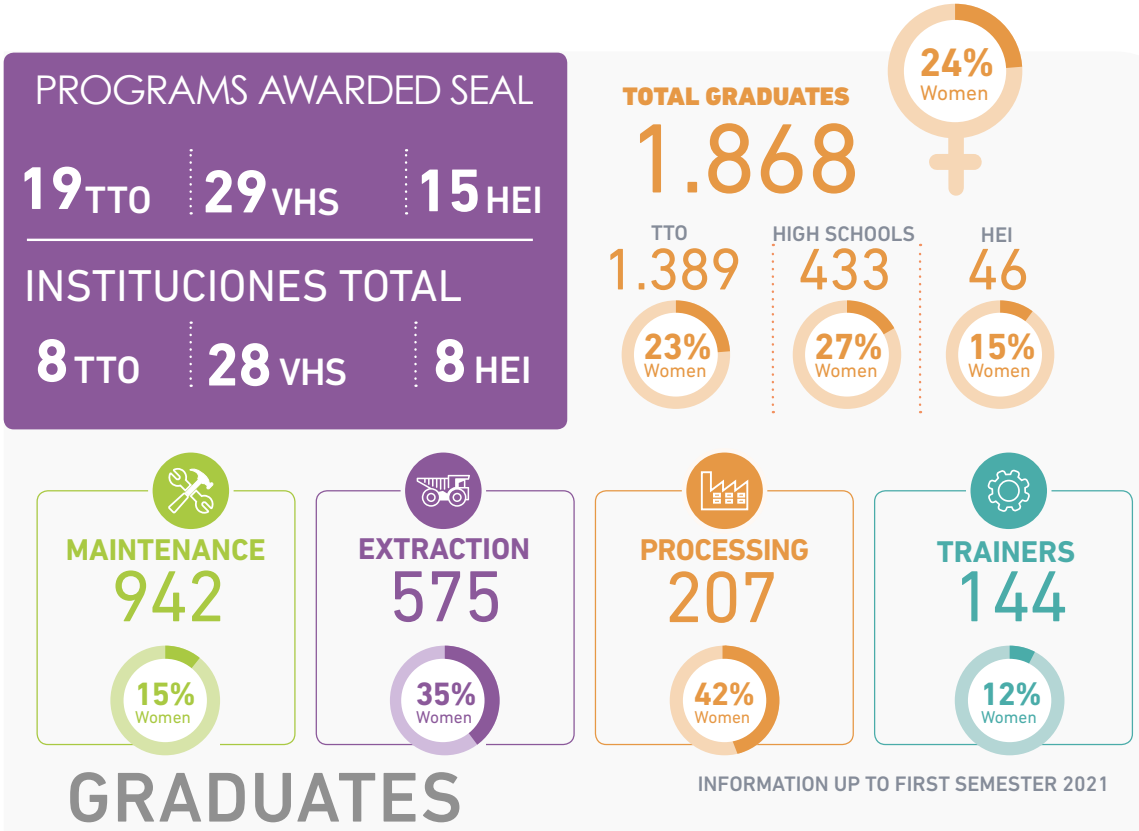
The MSC Quality Seal is a certification awarded by the Mining Skills Council to institutions providing training in the market to recognize the capacity demonstrated by an institution or company to provide training courses or programs in a certain campus in line with the Mining Qualifications Framework.

As this Seal seeks to acknowledge the capacities of an institution or company, once the Seal is awarded for a certain qualification or skill, all training programs provided by said entities can be partially (modules) or fully (qualification) extended provided they maintain the quality standards originally recognized.

The MSC Quality Seal is a token of recognition for:

- Training and education services can be hired by mining companies.
- Selection of graduates with a view to hiring.
- Selection of training institutions and programs by students.

There is an MSC Quality Seal for every specialty in any mining region in the country, thus guaranteeing the existence of adequately qualified people as may be needed by current or future mining requirements.



Currently, 63 training programs have the MSC Quality Seal, being present in all the mining careers and regions of the country, including for the first time short courses and programs in b-learning mode. This helps guarantee that people have proper training, according to current and future requirements in mining.

UPDATE OF TRAINING BEST PRACTICE FRAMEWORK (TBPF) IN THE MINING INDUSTRY

The latest edition of the Training Best Practice Framework (TBPF), updated as of July 2021, is a tool designed for institutions providing technical training in the field of mining, such as Technical Training Organizations (TTO), Higher Vocational Education Institutions (HVEI), and Vocational High Schools (VHS). It is also targeted to companies providing in-house training courses or programs.

The latest edition of the Training Best Practice Framework (TBPF), updated as of July 2021, is a tool designed for institutions providing technical training in the field of mining, such as Technical Training Organizations (TTO), Higher Vocational Education Institutions (HVEI), and Vocational High Schools (VHS). It is also targeted to companies providing in-house training courses or programs.

1	**MSC Seal for training programs**	**Based on MQF qualifications**	**Focused on TTO, HVEI and VHS**
2	**MSC Seal for training courses**	**Based on MQF Skills Units**	**Focused on TTO companies**

Both modes offer in-person, blended, and online options to meet the needs existing in current times.

To that end, the TBPFW grants quality standards on whose basis all mining-related programs and courses must be developed with the focus on five main dimensions:

TRAINING BEST PRACTICE FRAMEWORK

Best practices so that training institutions can conform their programs to minimum quality standards, all of them validated across the mining industry.

DIMENSIONS CONSIDERED

- Design of training program
- Program implementation
- Resources and infrastructure
- Outcome evaluation
- Entity management

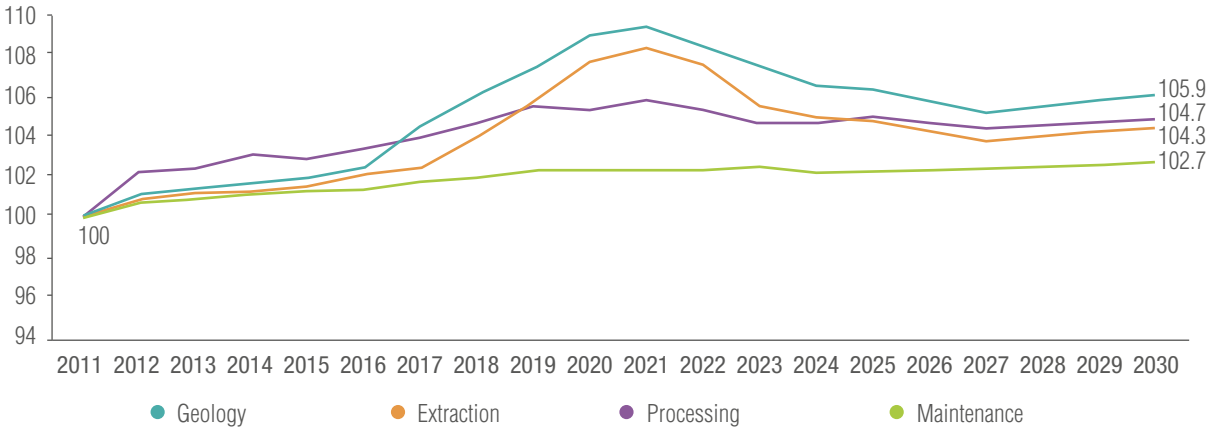
BENEFITS

Cumple Estándares Consejo de Competencias Mineras

The latest version of the Training Best Practice Framework (TBPF), updated as of July 2021, is a flexible and up-to-date instrument (directed to people who work and study or are planning on upskilling their capabilities). Thus, the TBPF adds an Entity Management dimension, a model oriented to behavioral skills, certification of online and blended training, and a MSC Seal awarded to short skills-based courses provided by companies.

2. PROJECTION OF HUMAN CAPITAL EDUCATIONAL OFFER IN MINING

EVOLUTION OF GRADUATES FROM MINING PROGRAMS PER SPECIALTY FIELD
(Base 2011=100)



Source: INDICES Higher Education database, National Council of Education (April 2021).

When compared to estimated number of students graduated from 2011 onwards and projected to graduate to 2030, the highest growth is expected to be concentrated in programs associated to Geology (5.9%), followed by Processing (4.7%), Extraction (4.3%) and, lastly, Maintenance (2.7%), which shows a tendency steadier than the rest.

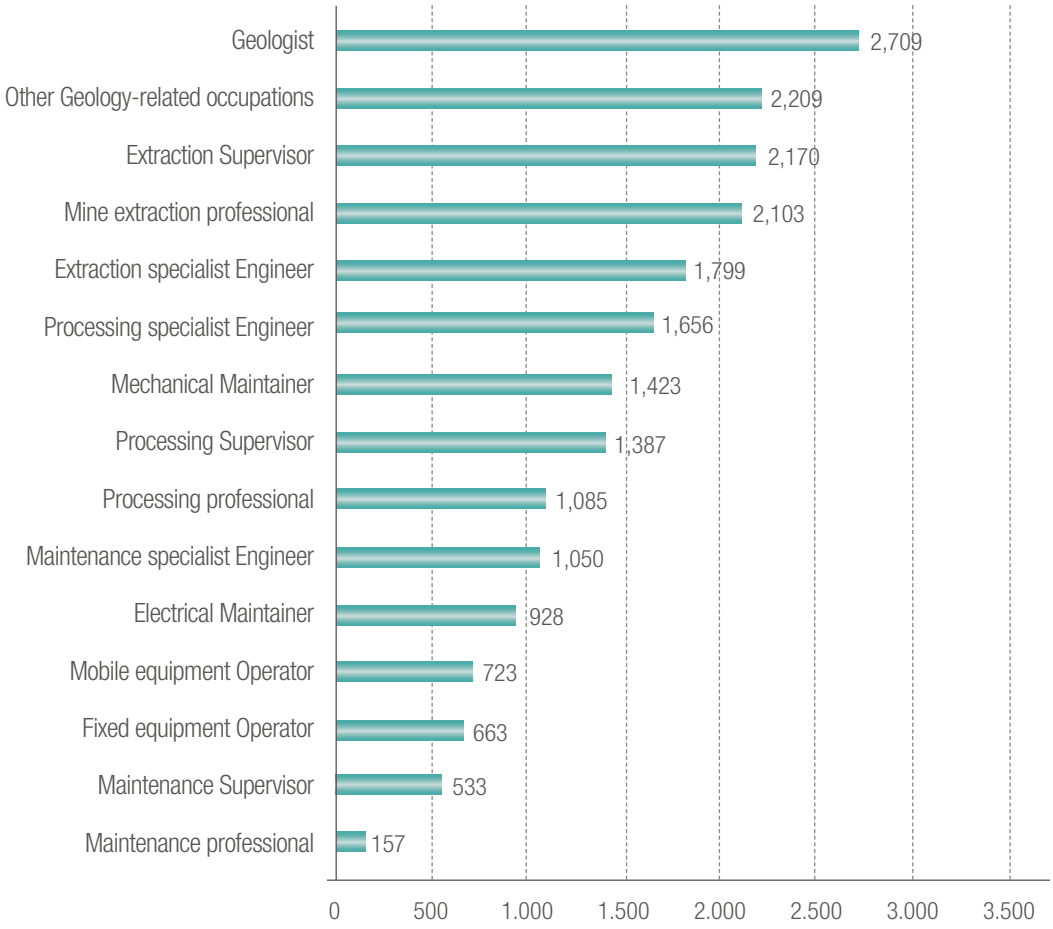
The highest increase of graduates from Geology-connected programs is expected to occur in 2021 (nearly 10% higher than 2011) to go down almost four points by the end of the decade.

On the other hand, graduates from Processing programs present a peak between 2019 and 2021; but, if compared against 2011, it fails to grow beyond 5% in any of the years under study.

Finally, out of all specialty fields, Maintenance programs will grow the least, with less than 3% relative to 2011.

However, the model applied to estimate the graduate offer does not reflect the impact the COVID-10 pandemic may have on the number of graduates.

GRADUATE SUPPLY PROJECTION'S PER PROFILE BETWEEN 2021-2030



Source: INDICES Higher Education database, National Council of Education (April 2021).

The human capital educational offer between 2021 and 2030 in the mining industry is projected to be 20,595 graduates.

Most of them will be concentrated in Extraction processes with 6,000 graduates among Professionals, Supervisors and specialized Engineers and nearly 4,900 students under profiles associated to Geology (other Geology and Geologist-related occupations).

On the other hand, in Processing, 4,100 graduates are expected to be available in Professional, Supervisor, and Engineer profiles.

As to profiles related to electrical and mechanical Maintenance (Engineers, Professionals, Supervisors, Maintainers), around 4,090 students are expected to graduate in the next coming years who are also highly coveted by other industries, like the manufacturing sector.

3. ANALYSIS OF EDUCATIONAL OFFER PER SPECIALTY FIELD[5]

GEOLOGY**

N° of current programs as of 2020

111

% programs created since 2016
(with respect to total programs dealing with the specialty)

24%

% female participation

32%

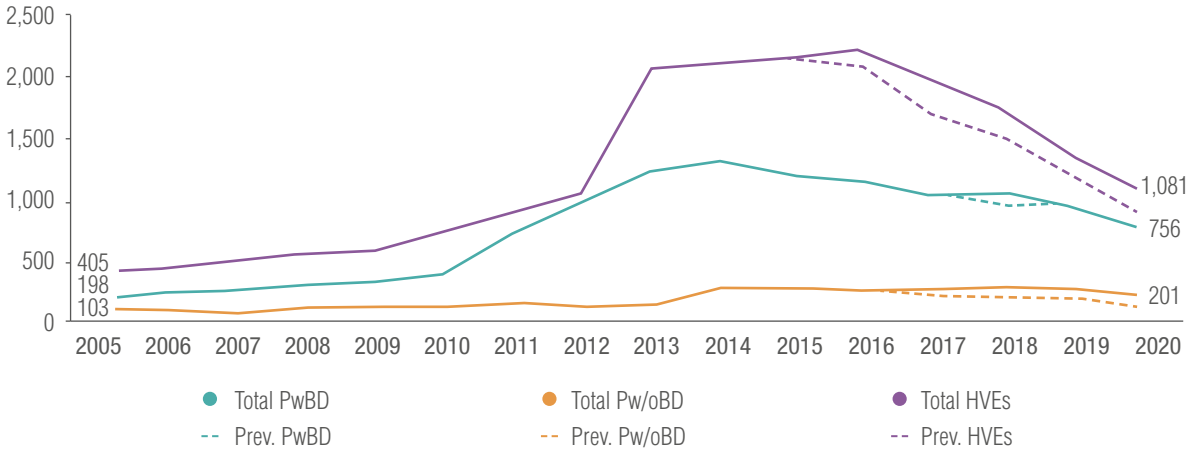
% first-year enrollment
(with respect to total enrollments in programs linked to specialty)

24%

TOTAL ENROLLMENTS: 8,360

Source: INDICES Higher Education database, National Council of Education (April 2021).

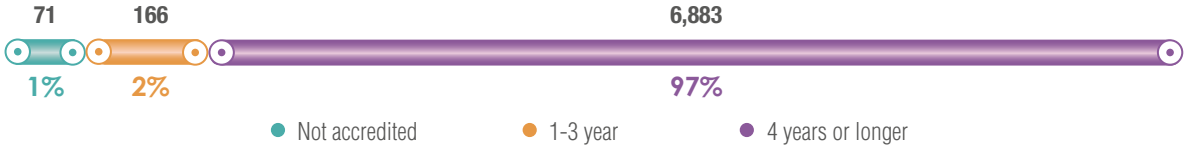
EVOLUTION OF FIRST-YEAR ENROLLMENT PER TYPE OF PROGRAM



Prev: programs created before 2016

Source: INDICES Higher Education database, National Council of Education (April 2021).

TOTAL 2020 ENROLLMENT IN HIGHER EDUCATION INSTITUTIONS PER ACCREDITATION OF INSTITUTION*

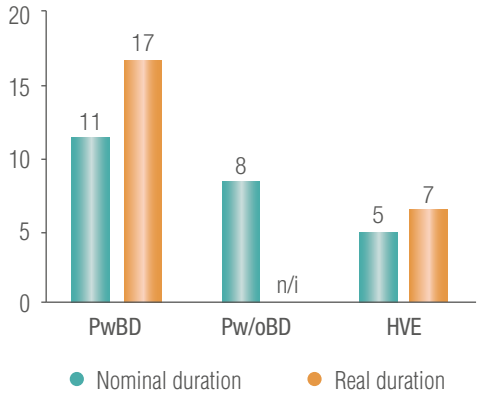


* Data available for 7.120 enrollments.

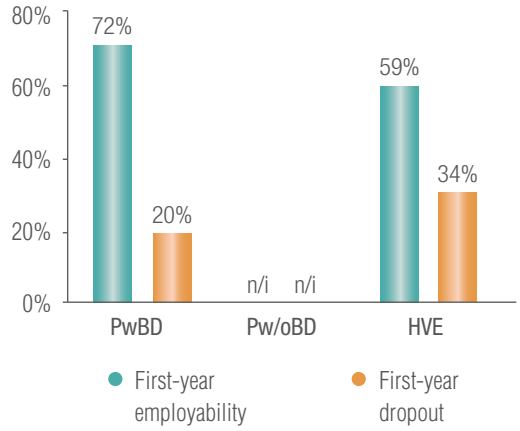
** The main programs include: Geology, Geology Civil Engineering, HVEs in Geology, HVEs in Geomining, Geomatics Civil Engineering, Land Surveying Field engineering, Geomatics Engineering, HVEs in Topography and Land Surveying.

5 This Section summarily describes the specialty fields for mining-associated training. These fields are not equivalent to operation areas within mining companies as they only summarize the whole number of students pursuing education programs that can feed one or more of the generic profiles under the study.

CAREER DURATION
(Semesters)



EMPLOYABILITY AND DROPOUT



Source: INDICES Higher Education database, National Council of Education and www.mifuturo.cl, Mineduc (April 2021).

- In 2016, **all levels** of first-year enrollments in Geology-related programs, equivalent to entry rates, **started to fall**, particularly HVEs, in recently created and previously existing programs.
- 99% of programs are **provided in accredited institutions**.
- People enrolled in Geology programs **take up to 55% longer than the nominal duration to complete their studies**.
- Program employability **varies according to type of career**: approximately 72% of BD graduates find a job in the first year while that figure is 59% for HVEs.
- Though in all earlier editions of this study **Geology has proved to be the area with highest women participation**, the gap existing in the rest of mining programs is not as wide as it used to be.

ORE EXTRACTION**

N° of current programs as of 2020

132

% programs created since 2016

(with respect to total programs dealing with the specialty)

8%

% female participation

29%

% first-year enrollment

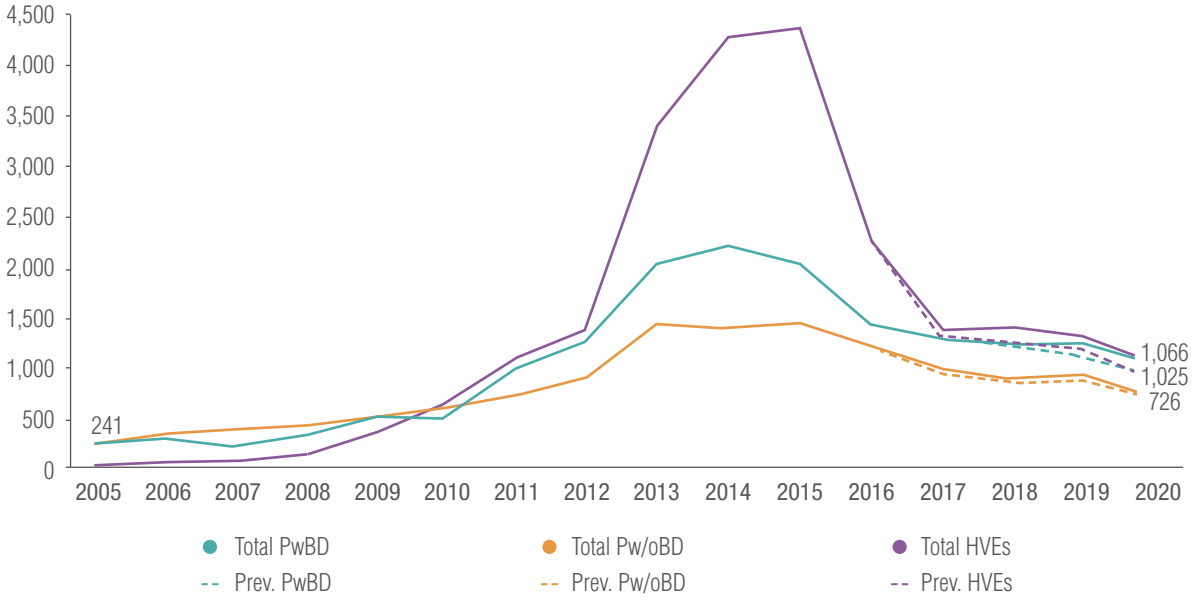
(with respect to total enrollments in programs linked to specialty)

25%

TOTAL ENROLLMENTS: 11,072

Source: INDICES Higher Education database, National Council of Education (April 2021).

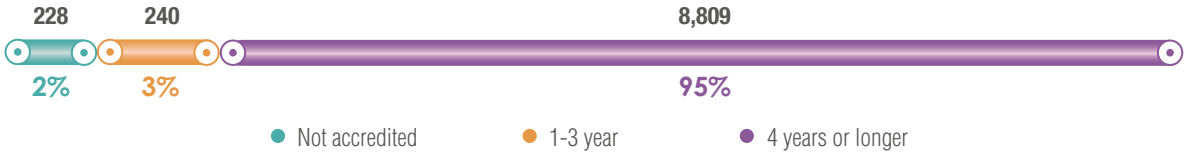
EVOLUTION OF FIRST-YEAR ENROLLMENT PER TYPE OF PROGRAM



Prev: programs created before 2016.

Source: INDICES Higher Education database, National Council of Education (April 2021).

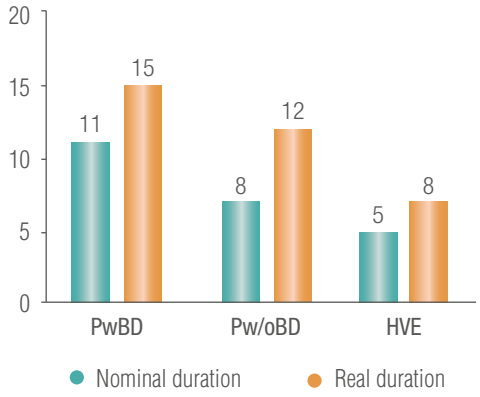
TOTAL 2020 ENROLLMENT IN HIGHER EDUCATION INSTITUTIONS PER ACCREDITATION OF INSTITUTION*



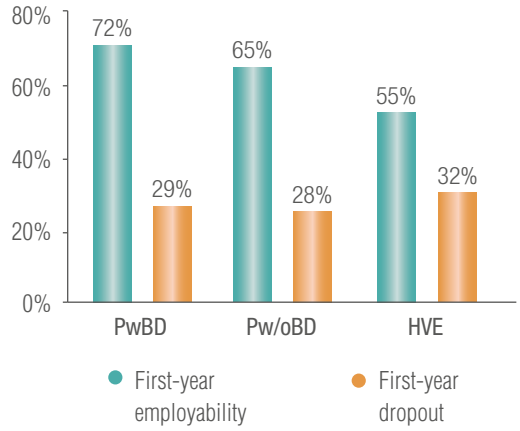
* Data available for 9,277 enrollments.

** The main programs include Mining Civil Engineering, Industrial Civil Engineering, Mining Field Engineering, Engineering, Mine Exploitation HVEs, Mines HVEs, Mining and Metallurgy HVEs, Mine Operations HVEs, Mobile Equipment Operator HVEs.

CAREER DURATION
(Semesters)



EMPLOYABILITY AND DROPOUT



Source: INDICES Higher Education database, National Council of Education and www.mifuturo.cl, Mineduc (April 2021).

- Enrollments in Extraction-related programs spiked between 2012-2017, especially in the **HVEs tier whose first-year enrollments** in Professionals with a Bachelor's Degree **doubled in 2015**; this level was repeated in 2020.
- All three types of programs **are observed to present enrollments only in recently created programs associated to HVEs**.
- Out of the nearly 11 thousand enrollments in Extraction, **95% are found in institutions granted accreditation for 4 years or longer**.
- The largest gap between nominal and real career duration is seen to occur in HVEs who, **in average, take 60% longer in completing their studies than originally scheduled**.
- The highest first-year employability is found in **BD programs, with 72%**. Dropout figures are similar in all three graduation levels with 30%.

MINERAL PROCESSING**

N° of current programs as of 2020

40

% programs created since 2016

(with respect to total programs dealing with the specialty)

23%

% female participation

31%

% first-year enrollment

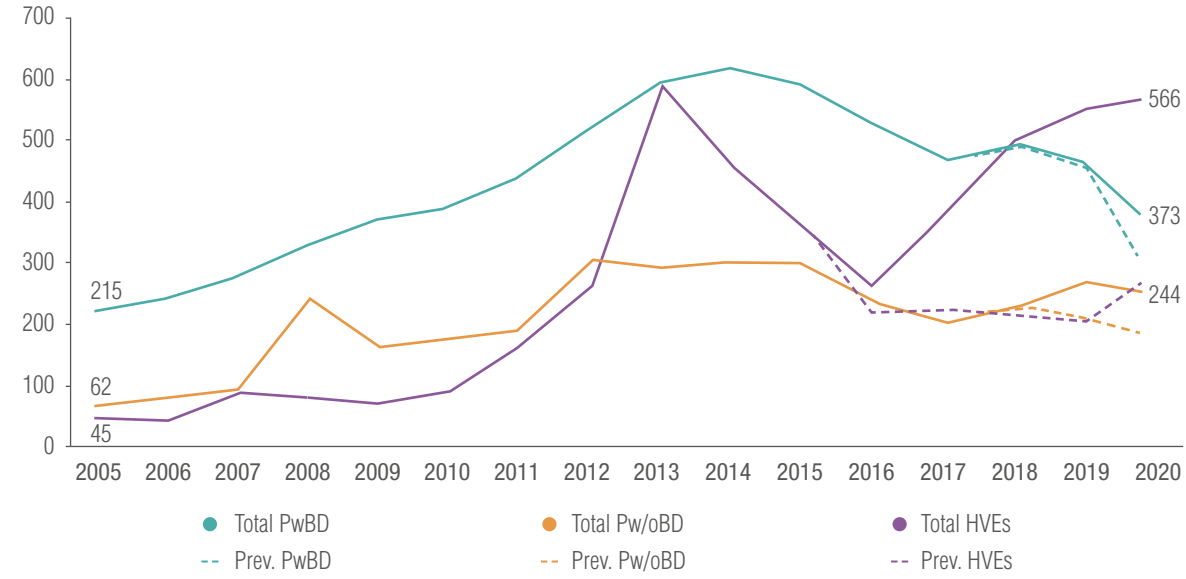
(with respect to total enrollments in programs linked to specialty)

30%

TOTAL ENROLLMENT: 3,924

Source: INDICES Higher Education database, National Council of Education (April 2021).

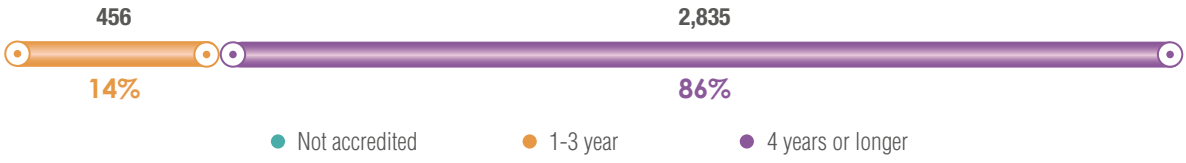
EVOLUTION OF FIRST-YEAR ENROLLMENTS PER TYPE OF PROGRAM



Prev: programs created before 2016

Source: INDICES Higher Education database, National Council of Education (April 2021).

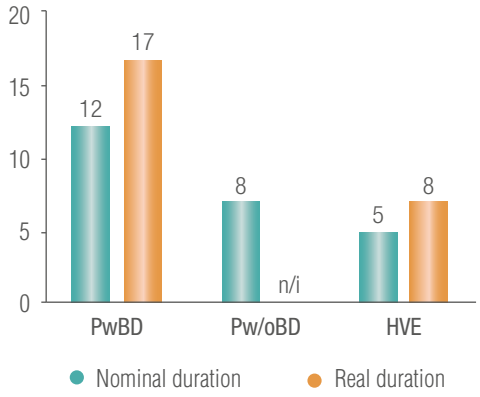
TOTAL 2020 ENROLLMENT IN HIGHER EDUCATION INSTITUTIONS PER ACCREDITATION OF INSTITUTION*



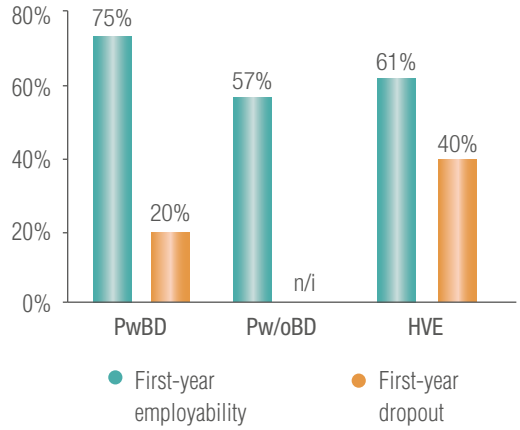
* Data available for 3,291 enrollments.

** Main programs included are Metallurgy Civil Engineering, Mineral Processing Civil Engineering, Metallurgy Civil Engineering, Metallurgy Field Engineering, Metallurgy Engineering, Geometallurgy HVEs, Metallurgy HVEs, Extractive Metallurgy HVEs, Metallurgy Mining HVEs, Mining Plant Operation HVEs, Mining Processes HVEs.

CAREER DURATION
(Semesters)



EMPLOYABILITY AND DROPOUT



Source: INDICES Higher Education database, National Council of Education and www.mifuturo.cl, Mineduc (April 2021).

- In 2020, **more than 40 Mineral Processing-related programs were available** with nearly 4 thousand enrollments, **all of them offered in accredited institutions**.
- HVEs **programs, mostly new ones, are observed to increase since 2016** while enrollments in Programs with BD were seen to decrease since 2018, very similar to the situation experienced by Programs without BD from 2019 onwards.
- The real duration of **PwBD careers exceed the nominal duration in 40%** while **HVEs careers are 60% longer,** in average.
- **Employability in these programs is higher than in PwBD** (75%) and close to 60% in Pw/oBD and HVEs.

MECHANICAL AND ELECTRICAL MAINTENANCE**

N° of current programs as of 2020

702

% programs created since 2016

(with respect to total programs dealing with the specialty)

40%

% female participation

7%

% first-year enrollments

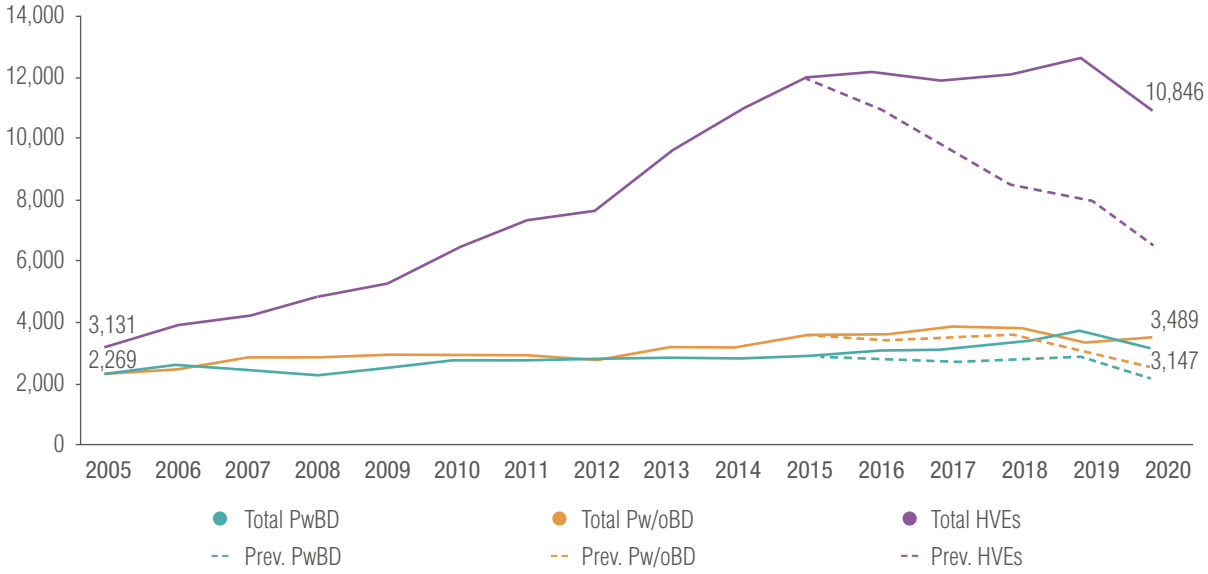
(with respect to total enrollments in programs linked to specialty)

31%

TOTAL ENROLLMENTS: 55,553

Source: INDICES Higher Education database, National Council of Education (April 2021).

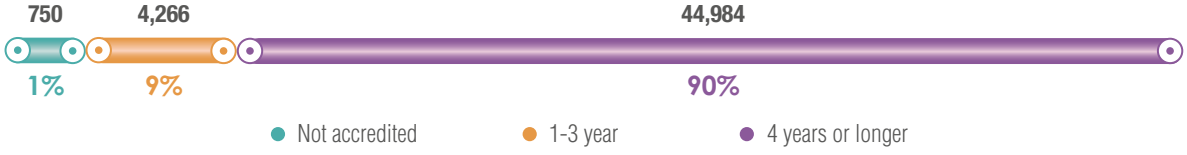
EVOLUTION OF FIRST-YEAR ENROLLMENTS PER TYPE OF PROGRAM



Prev: programs created before 2016.

Source: INDICES Higher Education database, National Council of Education (April 2021).

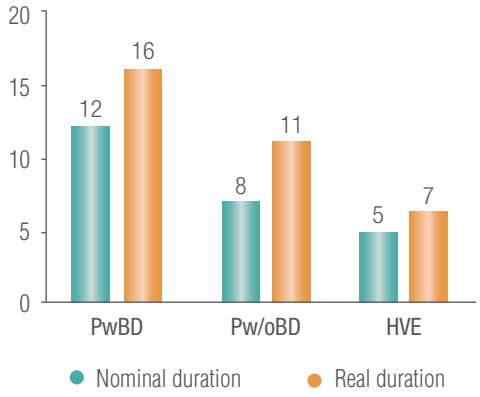
TOTAL 2020 ENROLLMENTS IN HIGHER EDUCATION INSTITUTIONS PER ACCREDITATION OF INSTITUTION*



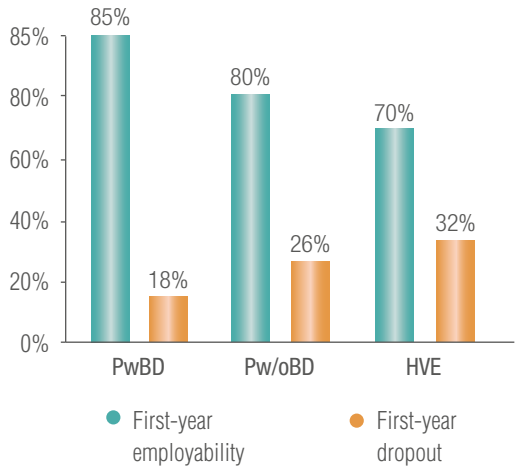
* Data available for 5,000 enrollments.

** The main programs include: Electrical Civil Engineering, Electricity Civil Engineering, Electricity and Industrial Electronics Field Engineering, Electricity and Industrial Automation Engineering, HVEs in Control, Industrial Instrumentation and Automation, Industrial Electricity HVEs, Electrical Instrumentation HVEs, Mining Plant Maintainer, Electromechanics HVEs, Electromechanical Maintenance HVEs, Industrial Maintenance HVEs, Mechanical Maintenance HVEs, Predictive Maintenance HVEs, Robotics and Mechatronics HVEs.

CAREER DURATION
(Semesters)



EMPLOYABILITY AND DROPOUT



Source: INDICES Higher Education database, National Council of Education and www.mifuturo.cl, Mineduc (April 2021).

- Enrollments linked to **Maintenance careers exceeded 55 thousand students in 2020**. Only 7% of that total was women and 40% of them joined new programs.
- The highest number of students who pursued this higher education specialty has enrolled in HVE programs; particularly, in those started after 2016, though **was seen in 2020**.
- 99% of enrollments are offered by **accredited institutions** 90% of which has been granted accreditation for over 4 years.
- Of the areas studied, this is the one with the **highest rates of employability**, all above 70%, while desertion is below 32%.

MAIN RESULTS

- **Mining-related program enrollments started to decline in 2015**, and 2020 was not an exception, in the wake of the trend shown by the entire higher education system where enrollments fell in 3.7% (mifuturo.cl) relative to the previous year as a result of the COVID-19 pandemic, among others.

- Despite the enrollment decline, the programs created after 2016 (32% of the total) and, therefore, just rolling out their first graduates, have maintained their figures very consistent with those reported in the previous study.

- **Higher Vocational Education programs have paid the highest toll.** Their first-year enrollment decline started in 2015 while 2020 showed levels below those of 2013. Fortunately, the enrollment drop seen in programs of Professionals with/without BD is less steep.

- The quality of institutions providing higher education in Chile is measured, among other parameters, by institutional accreditation, particularly from 2018 onwards, when Law N° 21.091 on Higher Education was enacted giving institutional accreditation a mandatory condition. In the case of mining programs, **HVEs present the highest number of non-accredited institutions (22%),** followed by PwBD, with 20.3% that, on the other hand, shows a 11.3% increase in relation to the previous study.

- 65% of mining program enrollments are concentrated under ten institutions only. **The highest concentration occurs in vocational careers (Pw/oBD and HVE)**, where two entities (INACAP and DUOC UC) absorb 60% of involved parties. The scenario is seen to be more diverse in university careers.

- **Women participation in mining programs is next to 30%**, except in programs associated to Maintenance where female involvement amounts to 7% only, which represents an important challenge in the future ahead for the sector.

- The sector-associated graduate offer is expected to come down starting 2024 to later on resume the trend displayed until 2017. This estimate does not consider the impacts the COVID-19 pandemic may have on new enrollments.

- The educational offer is expected to reach 20,595 in the 2021-2030 period, **with the highest concentrations in the areas of Ore Extraction (6,000 persons) and Geology (4,900 persons)**. The highest offer will come from Geologist and Other Geology-related Occupations profiles.

03

HUMAN CAPITAL

DEMAND AND GAPS

Contents:

INTRODUCTION

Human capital demand projected for the mining industry has been mainly focused on estimating the number of people required to meet its business targets.

Different factors are considered in this estimate process that influence the results, such as the macroeconomic and political scenario, the race to incorporate technologies, and, recently, the impact of the COVID-19 pandemic. The commodities cycle continues to be another relevant factor: in expansion periods, as the case has been during 2021, project portfolios start to grow.

Among the results obtained from this projection, the demand for the next decade was estimated to be lower than projections reported in previous studies even with a larger project portfolio. One of the hypothesis explaining the reverse ratio occurring between new projects and the demand for human capital states that more and new technologies are being incorporated and that some project phases are being closed to move from open-pit to underground exploitation.

NOTE ON METHODOLOGY

Statistics included in the sections below were elaborated on the basis of the following information directly provided by participant companies as of December 2020:

14 databases containing mining company own workforces and 13 databases with supplier company workforces.

- 19 reports from full-time contractor workers performing in mine operations.
- 11 reports on human capital demand per mining company project considering 23 mine sites operating in the country.
- Online self-survey applied to managers and HR heads. N total sample = 29 companies (n mine sites = 18; n supplier companies = 11). Date applied = February and March 2021.

The different indicators contained in this Chapter were generated after the above information was collected while the specific source consulted for each analysis is indicated, as appropriate.

Retirement-based projection (people eligible for retirement in the course of the next decade), prepared on the basis of workers that will be turning 60 years old or older in the workforce, considering elements such as effective retirement and its deferral by workers.

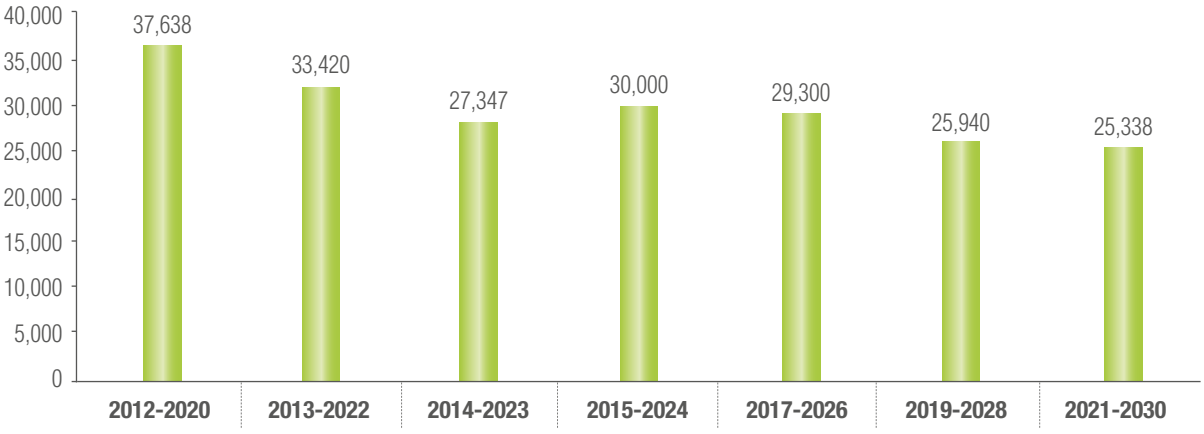
Project-based projection, based on data derived from the project portfolio provided by each mining company (report of human capital demand per project) and, in turn, associated to projects described in the document “Updated Mining Figures” by the Mining Council.

1. HUMAN CAPITAL DEMAND 2021-2030 IN LARGE-SCALE MINING

Total demand figures projected to 10 years, and reported in the different editions of this study, are a reflection of the macroeconomic dynamics affecting the mining industry. In this sense, the project portfolio has continued to grow just as seen by the time the previous study was released. Specifically, 11 new projects scheduled for the period 2021-20306 must be added to the 15 others reported by companies as moderately likely to be under development during the period 2019-2028.

The current demand estimate indicates 25,338 workers; that is, 2.3% less than projected in the previous study. This figure is mostly determined by the technological impact and the macroeconomic and political context prevailing since 2019.

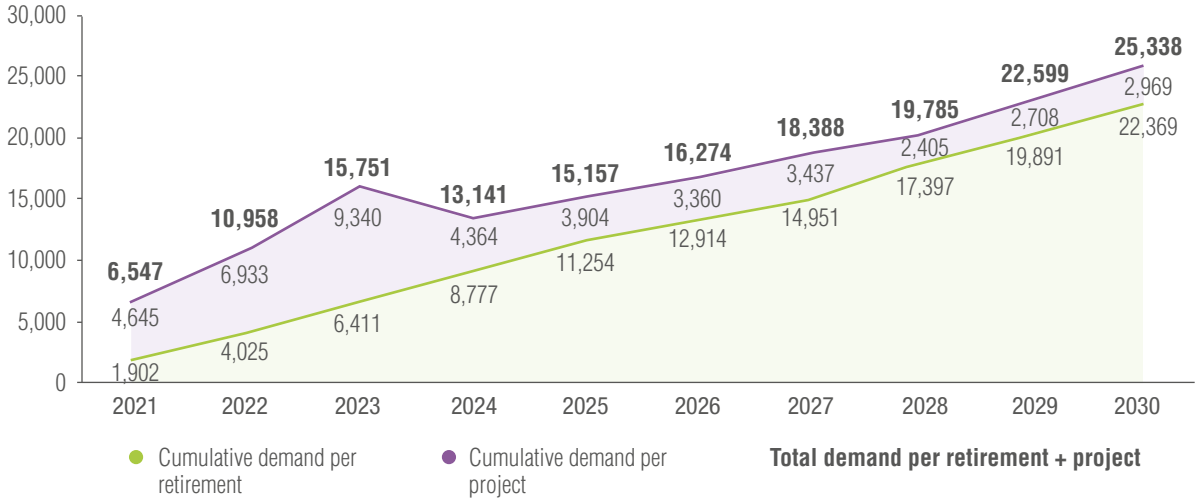
HUMAN CAPITAL PROJECTED DEMAND EVOLUTION OVER 10 YEARS
(Mining and supplier companies)



Source: Reports of mining company internal and contractor workforces, supplier company workforce, and human capital demand from mining company projects.

6 Annex D, Project Portfolios of Mining Companies.

TOTAL DEMAND FOR PROJECT OPERATION AND POTENTIAL RETIREMENT 2021 - 2030
(Mining and supplier companies)

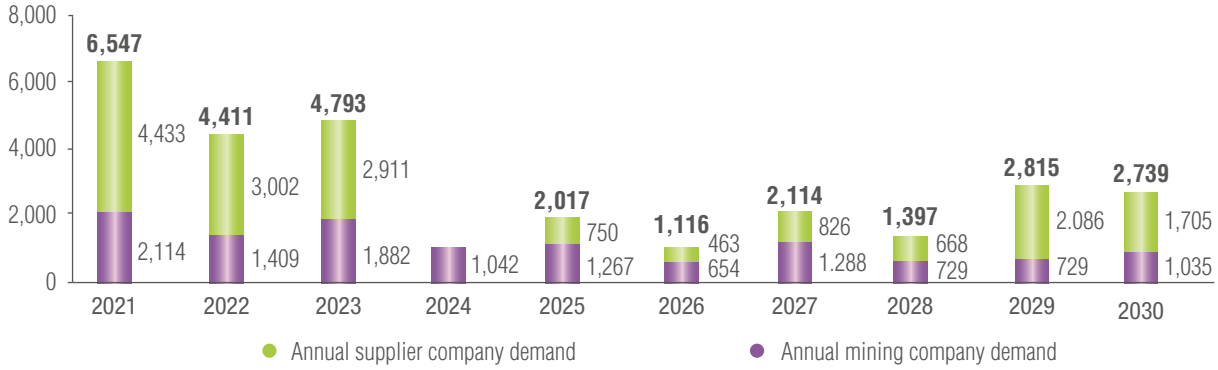


Source: Reports of mining company internal and contractor workforces, supplier company workforce, and human capital demand from mining company projects.

The total estimated demand for 2021 – 2030 amounts to 25,338 workers. In other words, the cumulative demand projection to 10 years had a 2.3% decrease; this will translate into 602 less workers as compared with figures estimated in the previous release.

Total demand for the next decade is represented by 88% of potential workers retirement while the remaining 12% reflects a demand coming from new projects.

ANNUAL DEMAND FROM MINING AND SUPPLIER COMPANIES 2021 – 2030
(Projects and retirements)

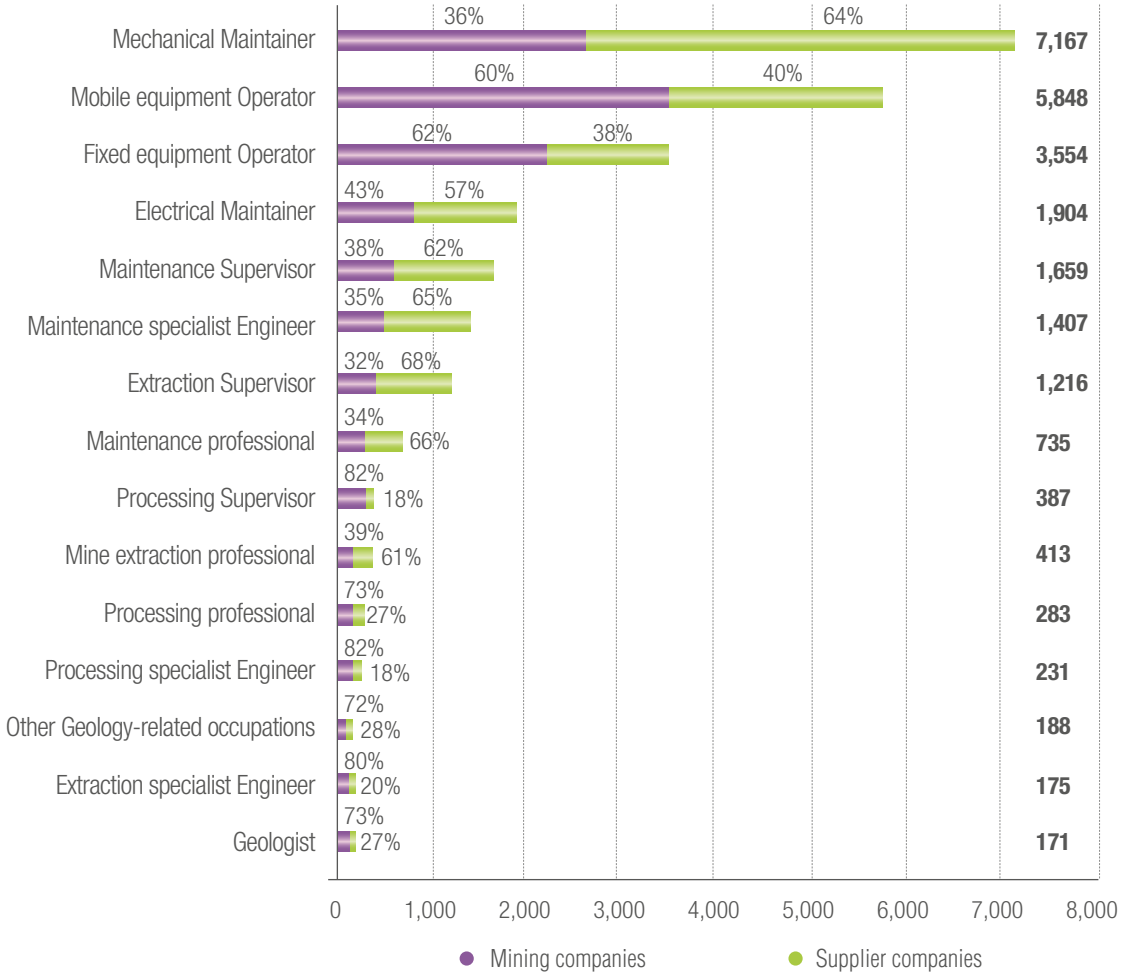


Source: Reports of mining company internal and contractor workforces, supplier company workforce, and human capital demand from mining company projects.

The projected demand for 2022 adds up to 4,411 workers including internal and contractor workers, which reflects a 33% low vis-a-vis 2021 demands. This is mainly accounted for by the 32% low in the demand from supplier companies and 33% from mining companies for 2022.

Mining and supplier companies included, the demand peak will occur in 2021, with a number of workers exceeding 6,500 individuals.

CUMULATIVE DEMAND AS OF 2030 FROM MINING AND SUPPLIER COMPANIES PER PROFILE



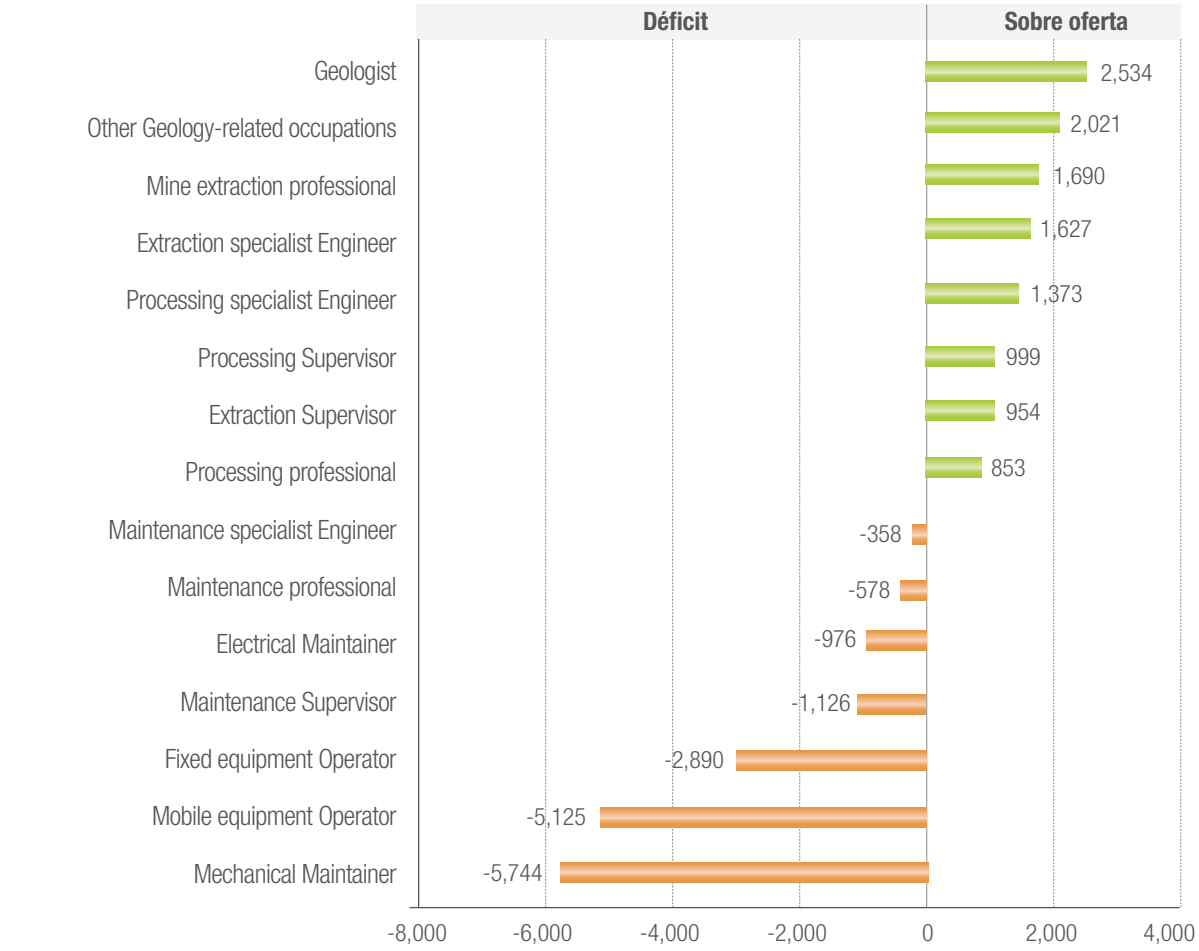
Source: Reports of mining company internal and contractor workforces, supplier company workforce, and human capital demand from mining company projects.

The profile analysis states that by 2030 most of the demand for human capital will be centered on profiles dealing with Maintenance (mechanical Maintainer; electrical Maintainer; Maintenance Supervisor; Maintenance professional; Maintenance specialist Engineer), and Operations (fixed and mobile equipment operators) representing, respectively, 51% and 37% of the industry demand in the next decade.

As for mechanical Maintainer, the tendency is seen to behave in line with the projections reported in the latest version of the study with most demand concentrated in supplier companies that represent 64% of the cumulative demand to 2030 for this profile.

2. HUMAN CAPITAL GAPS 2021-2030 IN LARGE SCALE MINING

HUMAN CAPITAL GAPS PER PROFILE BY 2030
(Number of workers)



Source: Projection of total project demand + retirement and educational offer.

The gap per profile is calculated from the difference between the education offer and the demand for the next ten years. Though profiles with the widest gaps continue to be the same as reported in previous releases of this study, a gap shrinkage of 693 workers can be seen in the mechanical Maintainer profile. The mechanical Maintainer gap was increased in 133 individuals. Likewise, a gap decrease is observed in the Fixed Equipment Operators profile and a 100-people gap increase in the Fixed Equipment Operators group.

On the other hand, the Geologist tier, the one showing the highest oversupply, presents a 272-people reduction when compared against the past estimate.

The most critical human capital shortages existing in the Maintenance areas occur in vocational training profiles (mechanical & electrical Maintainers and Maintenance Supervisors) and, as such, become a technical training priority in the coming years.

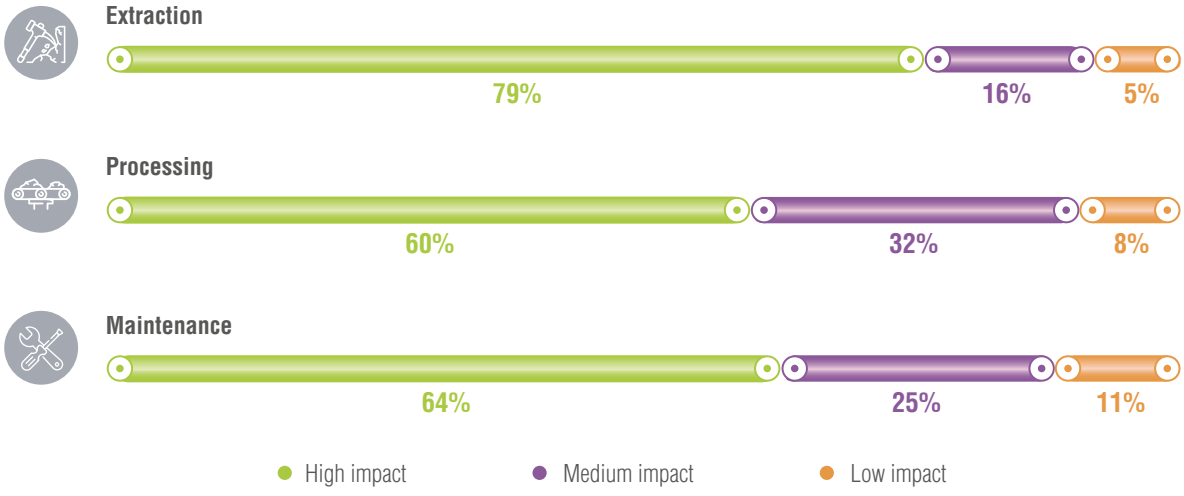
But the present challenge to meet the demand coming from Equipment Operators (fixed or mobile) profiles still persists, considering the technological changes the industry is anticipating in the short-term horizon.

3. TECHNOLOGICAL IMPACT IN LARGE-SCALE MINING

Mining and supplier companies have been gradually incorporating the technological solutions available in the market both into their current operations as well as into their projects. As a matter of fact, the results collected from the survey reveal that the skills exercised by people working in the Main Value Chain processes will be highly impacted by the incorporation of state-of-the-art technologies.

When asked about each of these processes, a high number of companies is found to expect a profound impact from new technologies on skills connected to Extraction (79% of responses), followed by Maintenance (64%) and, finally, Processing (60%).

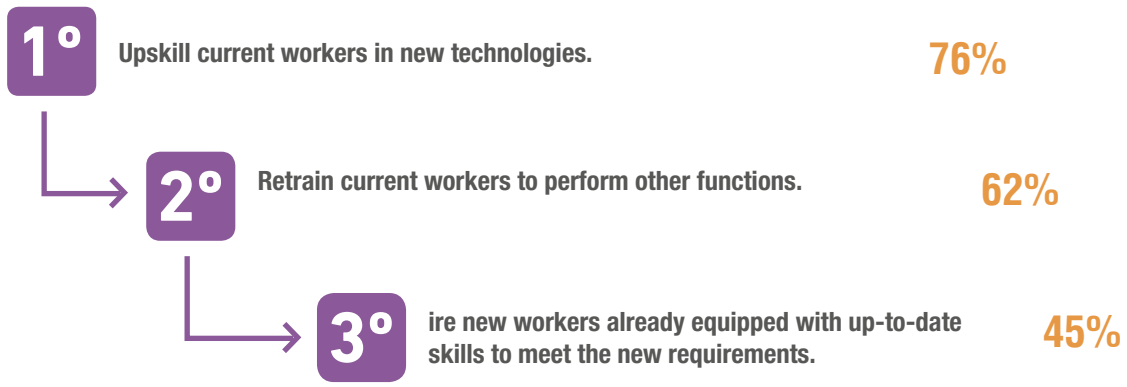
LEVEL OF IMPACT THAT NEW TECHNOLOGIES WILL HAVE OF WORKER'S SKILLS



Source: Survey to mining and supplier companies.

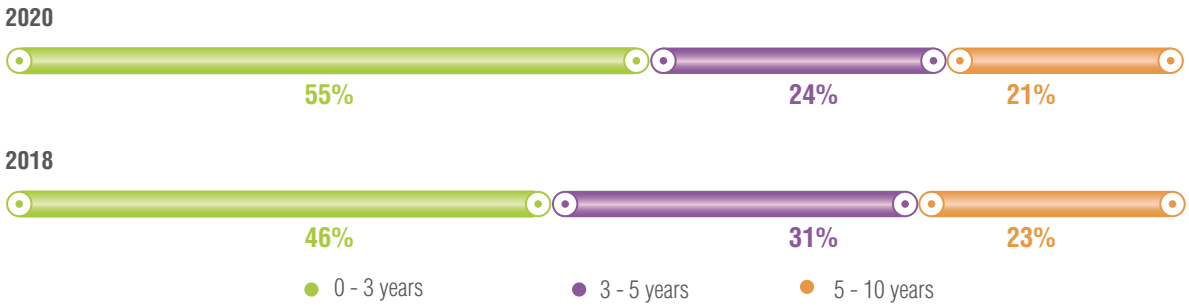
In the face of technological impact, 76% of surveyed companies report that, in most likelihood, they will upskill their workers in new technologies, followed by reskilling (62%); that is, retraining for other functions, which throws light on the strategy that mining and supplier companies are applying on their own workforces over the option of hiring new workers with skills matching the latest requirements. 45% of respondents declared this would be the most likely alternative.

ACTIONS BEING TAKEN BY COMPANIES IN THE LIGHT OF TECHNOLOGICAL TRANSFORMATION



Source: Survey to mining and supplier companies.

POINT IN TIME WHEN CHANGES ASSOCIATED TO TECHNOLOGICAL TRANSFORMATION ARE EXPECTED TO OCCUR

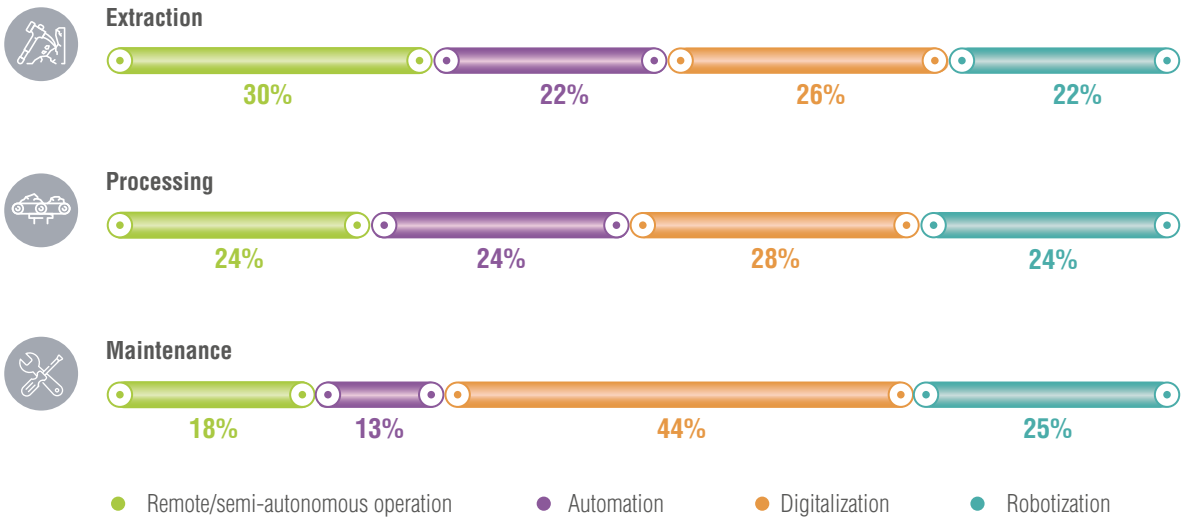


Source: Survey to mining and supplier companies.

When asked about when these changes associated with technological transformation are expected to occur, companies indicating that this is already happening and that their effects are visible in the short time (0-3 years) increased from 46% in the previous study to 55% in the present one.

As for the technological impact on the different processes, companies of the sector state that, in Extraction activities, a significant change will be seen in operations, shifting from manual to remote or semi-autonomous mode. In turn, digitalization will be increasingly incorporated into Maintenance activities, thus strengthening the equipment diagnosis and monitoring capabilities. As for Processing, no prevailing trends have been identified but only a tendency anticipating a higher level of digitalization in its processes.

IMPACTO TECNOLÓGICO POR PROCESO, SEGÚN TIPO DE TECNOLOGÍA

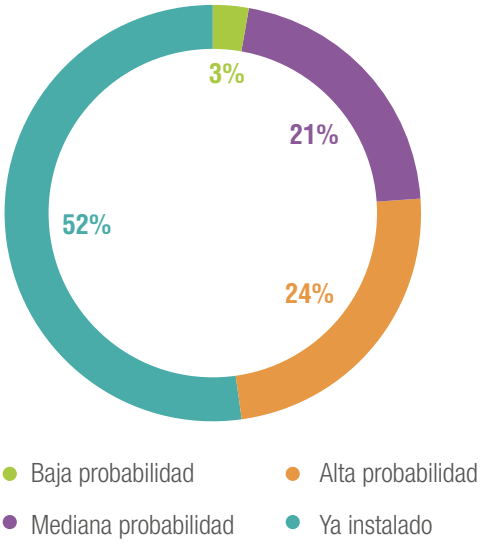


Source: Survey to mining and supplier companies

The technological evolution continues to present three steps that lead the way of transformation into mining: manual tasks will become teleoperated and are likely to end up automated. The maximum change potential in mining skills is caused by the digital transformation process populated by skills destined to be impacted by automation and digitalization.

In the long run, all skills containing some level of routine are set to be impacted by the arrival of automation. For example, process automation through Integrated Operations Centers (IOC) is one of the changes being introduced today into large-scale mining in Chile. 52% of respondents confirmed to already having installed an IOC, known also as monitoring rooms, integrated operations centers, or control rooms.

WHAT'S THE LIKELIHOOD OF INTEGRATED OPERATIONS MANAGEMENT BEING IMPLEMENTED?



Source: Survey to mining and supplier companies.

Technological advances in the industry -with the incorporation of autonomous trucks, big data, or teleoperation, among others- are expected to represent an eclectic evolution.

The above scenario challenges human capital development strategies, either one's own or third parties', into considering the need to have a workforce capable of successfully facing the different technological contexts.

MAIN RESULTS

- The **cumulative demand is expected to reach 25,338 male and female workers** by the end of the 2021 – 2030 mobile decade. Figures are still 602 people lower than projected in the mobile decade considered in the previous study. This decline might be mainly associated to the lower demand for human capital required to operate new projects derived from the potential technological impact on the different processes and the closure of project phases that shift from open-pit to underground exploitation.

- 88% of the demand projected for the next decade results from the turnover of workers transitioning to retirement by the end of the period while the remaining 12% comes as a response to new projects. **The cumulative demand will peak in 2021, with over 6,500 workers** while the lowest demand for human capital of the decade will occur in 2024 and 2028.

- The highest demand for human capital continues to concentrate around **mechanical Maintainers, electrical Maintainers and equipment Operators (mobile and fixed)** that, all in all, represent a cumulative demand close to 18,472 workers; that is, 73% of the total cumulative demand for the decade.

- Though the supply-demand gaps have remained unchanged since the previous study, the mechanical Maintainer profile has seen a 693-people reduction. **Geologists continue to present an oversupply**, though the gap has been reduced in 272 workers since earlier estimates.

- Maintenance area estimates continue to present human capital shortages. It must be kept in mind that, based on the supply-demand gaps, the key profiles to be provided training in the coming years **are those associated to vocational education (mechanical & electrical Maintainers and Maintenance Supervisors) together with Fixed and Mobile Equipment Operators**. The greatest challenge lies in meeting the demand, in light of the technological changes the industry is already anticipating in the short-term horizon, such as automation and all the repercussions it involves.

- The above is directly related to information reported by mining and supplier companies regarding the impact that new technologies will have on worker's skills. **Most companies declared they will be upskilling their workers in new technologies followed by reskilling or reconversion (retrain workers to perform other functions)**. Hiring new workers already trained to respond to new requirements appears as a third option.

- This is not a minor issue when considering a human capital development strategy with a positive impact on the mining sector. If no certainty exists as to the existence of a labor market with ideally qualified workers, hiring should be discouraged and, instead, upskilling and reskilling should be embraced.


04

CHALLENGES AND RECOMMENDATIONS

- Human Capital Demand and Gaps
- Female Participation in the Industry
- Local Employment
- Technological Transformation

INTRODUCTION

The study THE WORKFORCE FOR 2021-2030 LARGE-SCALE MINING IN CHILE presents a picture of the sector, mainly focused on the characteristics identifying the male and female workers, according to different sociodemographic variables and indicators associated to inclusion, diversity, local employment, technological impact, and talent management, among others.

The results obtained from this study provide a perspective of the challenges faced by the mining industry in Chile while contributing market intelligence on which companies, vocational & professional training entities and, increasingly, people seeking confidential information on human capital demand in mining can base their decision-making processes.

During the analysis of results, technical discussions were held with participant companies and training entities regarding the human capital challenges the industry will be facing in the coming years, as seen in this Chapter.

NOTE ON METHODOLOGY

The outcomes presented in this study were analyzed by industry and education entity representatives. The reflections and recommendations resulting from these discussions were sorted out in four dimensions each of them posing their own human capital challenges on large-scale mining. Based on said challenges, lines of action were projected for the sector and its different stakeholders.

Workshop 1

- Human capital challenges: female participation; local employment; talent management.

  Participants: 7 member companies.
  Date: September 2, 2021.

Workshop 2

- Human capital demand and supply challenges in the mining industry.

  Participants: 9 member companies and 16 training institutions.
  Date: September 7, 2021.

HUMAN CAPITAL DEMAND AND GAPS

According to estimates, companies are bound to attract over 25,000 new talents in the next 2021-2030 mobile decade, as a result of the combination of work retirements and the opening of new work positions. As the trend shows, most human capital demand is seen to occur among mechanical Maintainers, electrical Maintainers, and equipment Operators (mobile and fixed) that, in the aggregate, account for a cumulative demand close to 18,472 workers, equivalent to 73% of the total cumulative demand for the decade. On the other hand, the three least required profiles continue to be those projected to produce the highest number of graduates from tertiary education (Geologists, Extraction Specialist Engineers, and other Geology-related occupations).

Additional information complementing the data collected in the framework of the present study reveals that these gaps are most likely to act in combination with other gaps derived from the increasing incorporation of new technologies that will either replace or complement the competencies and know-how owned by the workforce currently performing in the mining industry. Therefore, significant investment efforts will be required to upskill current abilities and reskill people whose jobs are bound to experience radical changes.

CHALLENGES AND RECOMMENDATIONS

Given the above scenario, reinforcing the sectoral coordination efforts to increase the quality offer of the four profiles that have consistently shown gaps in the last editions of this study -mechanical Maintainers, electrical Maintainers, mobile equipment Operators, and fixed equipment Operators- seems to be the right path to follow.

Three relevant action fronts of potential high impact can be used to address this situation:

1. **Improve the quality of vocational education offer,** enable the graduation of new talents from Vocational Secondary Education (VE) in line with the Mining Qualifications Framework (MQF). A sectoral goal and an action plan should be defined through which technical assistance can be provided to Vocational High Schools, based on the Eleva program experience. As of today, 30 from all 82 vocational high schools in the country providing mining-related careers have been awarded the MSC Quality Seal. By way of reference, estimates consider that, if 15 vocational high schools were provided technical assistance on a yearly basis (20% of the total), over 90% of mining-related specialties would be MQF-aligned by 2025. In turn, this new formation offer should be included in next study's mining educational offer estimates to help close the gaps identified in this version. The following recommendations were made during different workshops held to analyze the outcomes with partner companies and educational entities:

    - Draw attention on the positive effects reported by companies that have hired graduates from different MSC Quality Seal-awarded and MQF-aligned institutions and programs. For example, companies might homologate the formation time required to complete MSC Quality Seal-awarded specialties to work experience for enrollment or hiring requirement purposes.
    - Reinforce teachers' skills with methodological strategies and assessments applicable to the formation of Maintainers and Operators.

2. **Education-work collaboration:** according to national and international experience, the processes involving quality education-work relationships have proved to be the most effective short-term strategies to attract talent into a sector, such as the student trainee processes and apprentice programs. In this case, a sectoral goal and an action plan should be defined in order to move forward in closing gaps, by increasing the student trainee and apprenticeship processes carried out in the sector. By way of international reference, the Minerals Council South Africa is known to have created 13,000 apprenticeship processes between 2013 and 2018 while Australia has recently set itself the goal of taking on 14,000 apprentices for training and 3,000 full-time per year to address their talent gap issues. At a domestic level, according to our latest studies, the Chilean mining sector was reported to conduct around 1,200 apprenticeship and student trainee processes per year which, due to the pandemic, were reduced to half that figure. When compared against the projected annual demand of 2,280 talents by 2025 required by the 4 most sought for profiles, the current number of apprenticeship and student trainee processes offered by the sector is found to be far below the optimum.

   Each year, nearly 4,400 students graduate vocational high schools that provide mining-related careers in the main northern mining regions. At a domestic level, an estimated of 30% of vocational students fail to complete their professional student trainee processes in mining specialties which, in turn, prevents them from obtaining a graduate degree in that career. As concluded by the research team, the optimum number of apprenticeship and student trainee processes to be offered should either double or triple the pre-pandemic levels, including online training sessions based on the successful results obtained during the COVID-19 period. For this reason, the sector should encourage the implementation of these programs through supplier companies and through apprentices performing at mines sites and projects in order to contribute to the professional development of these students. The following recommendations were made in the course of workshops held with member companies and educational institutions:

   - Increase the number of student trainee vacancies and intensify alternance or dual formation programs by installing in companies the required capacities to accommodate a larger number of students.
   - Hands-on training in latest real equipment models (e.g., Caex 794 and 797 CAT for mobile equipment Operators) and not simulators only.
   - Put in place dissemination and sensitization strategies among young people on technical formation, mainly for Maintainers and Operators programs.

Mining Skills Organization Pilot (Australia): accelerated innovation for mining 4.0

Australia is internationally recognized for having one of the best vocational training systems worldwide. As part of its economic recovery package, Australia rolled out the implementation of 3 skills organizations pilots (similar to what the MSC-Eleva alliance does in Chile) in the areas of: i) human services care; ii) digital technologies; and iii) mining. In the mining sector, this program is known as Mining Skills Organization Pilot and it is committed to making vocational formation and training become the education-work pathway of choice for employment in the minerals industry. The project consists of four main hubs: i) apprenticeships; ii) digital transformation; iii) attraction and retention; and iv) qualifications reform trials. The apprenticeship project seeks to achieve the goal set by the Australian minerals sector of taking their apprenticeship and traineeship processes levels close to the 2012 copper supercycle peak, where 3,000 individuals graduated each year while 14,000 others were in training. This means adding 5,000 new processes to the current system. The project will be specifically focused on modernizing the formation of vocational education graduates, with special emphasis on diesel engine mechanical Maintainers.

3. **Territorial anchorage:** The digitalization and automation processes occurring in mining come hand in hand with new challenges added to securing the social license to operate the different mines sites. According to the Columbia Center on Sustainable Investment (CCSI), the levers that mining projects have historically pulled to obtain their social license to operate have concentrated in the creation of local employment (direct and indirect), new business opportunities for suppliers, and economic revitalization resulting from consumption derived from local employment. Based on CCSI studies, the digitalization and automation processes in mining will be increasingly lowering the effectiveness of said historical levers, forcing mining companies to develop new axis capable of enabling their social license to operate. Under this paradigm, mining and supplier companies should consider advancing towards the development of levers by means of productive chainings that ensure their social licenses will be maintained.

   The sector is particularly recommended to move into the development of knowledge and technology chainings, contributing to the enhancement of the respective educational ecosystems along the pathways associated with technologies 4.0, based on knowledge dissemination, industry best practices and standards, making available both the infrastructure as well as the equipment that most benefit quality teaching-learning processes. For this strategy to be put in place, the creation of public-private partnerships with new regional governments, local public education services (under formation in a number of regions), and regional higher education institutions are of the essence. These should work cooperatively with the mining sector if the local reality and territorial needs are to be comprehended.

FEMALE PARTICIPATION AND INCLUSION AND DIVERSITY

The mining industry is taking a proactive position towards increasing female work participation in the context of diversity and inclusion policies. The different strategies implemented over the last decade have proved to be successful in the sustained growth of female engagement in the mining industry, reaching 11.8% at general level and 6.4% in the Main Value Chain. Special note should be taken of the important increase observed between 2018 and 2020, when female participation grew 3.4 percentage points in the industry in general and, approximately, 2 points in the Main Value Chain.

The development of strategies that help improve female participation in mining, the number of women appointed in decision-making positions, and of young women interested in pursuing mining-related careers are some of the commitments the sector is expected to undertake on a sustained basis and with explicit goals, generating a cultural change across organizations based on gender equality and inclusion.

CHALLENGES AND RECOMMENDATIONS

Increasing women engagement in the mining workforce -at mining and supplier company worker level- comes up as one of the main priorities being addressed by HR and Public Affairs departments. The Woman and Mining Table 2050 and the National Mining Policy have committed some goals on these aspects (20% female participation in the industry and 25% participation in decision-making positions by 2030). In order to move further along this line, three priority work fronts are recommended:

1. **Monitoring and dissemination of female employment indicators:** The "Woman and Mining: Evolution Over the Last Decade and Future Challenges" study, conducted by the MSC-Eleva alliance, contributed unpublished data that is highly valued by the industry. The speed of change, together with the decision to expedite women incorporation into mining, prompt the need to implement an ongoing data capture mechanism on a semiannual basis to check on progress and focus the efforts being deployed.

   Female employment should be monitored by using the two indicators included in this study: i) percentage of female employment over the total workforce (stock); and ii) percentage of female employment over enrollments of less than 1 year. Said indicators should be disaggregated by different occupational groups and handled at regional level. This goes in accordance with the commitments undertaken by the Woman and Mining Table (2021) in terms of keeping record of progress according to the indicators proposed by the Table in order to participate in the annual joint measurement.

2. **Define sectoral goals and action plan on female employment:** The action plan should be focused on Maintainers and Operators profiles, which is where the lowest female employment rates are seen to occur, and also on companies supplying the mining industry whose indicators are significantly lower than observed in mining companies. For example, in order to increase the percentage of female employment in enrollments of less than 1 year from the current 20.9% to 50%, the number of Maintainers and Operators hired each year by the sector should be doubled. Getting closer to those levels by way of apprenticeship and student trainee strategies would mean conducting a number of processes nearly twice as large as the number of women needed to be hired; that is, around 755. The following recommendations were raised during the workshops held with member companies and educational institutions:

   - Encourage more sectoral companies to set concrete goals aimed to increase women recruitment and retention in mining.
   - Offer alternatives allowing for a balance between work and personal life, options to reconcile parental rights with work life, and male and female co-responsibility.
   - Define career retention and development strategies and goals by forming and training women across organizations, as retention incentives to maintain women in the industry.
   - Incorporate the right use of gender language in the different material issued within the sector. In this sense, the 2021 Mining Qualifications Framework has been updated to promote, from the very job description stage, the incorporation of gender variables.
   - Encourage more women to occupy roles as trainers and skills certification appraisers, serving as reference for their peers and future professionals.

3. **Female talent attraction campaign to enroll in technological and digital vocational education careers:** Increasing the level of female enrollment in vocational high school, mining-related careers, particularly including technology-based careers with an important level of digital skills and know-how, rises as one of the most strategic and complex challenges to be addressed by the sector, if the extent of women participation is to be increased both in their own as well as in their supplier companies. If only the four main mining regions located north of the country are considered (Tarapaca, Antofagasta, Atacama, and Coquimbo), total enrollment amounts to 8,700 students, of which 1,900 are women; that is, 22%. This means that only 950 women are graduating from mining-related careers each year, including all four regions. This being the scenario, it is highly unlikely that the number of female Operators and Maintainers required by the sector will be incorporated in the medium-term horizon.

   In order to handle this challenge, a sectorwise campaign should be launched to attract women into enrolling in mining-related careers or other technological or digital careers, with special focus on female eighth graders (when choosing whether to pursue scientific-humanistic or vocational studies) and on female students from second year of high school, when they have to choose the career to be pursued. While these efforts will begin to bear fruit only 2 or 4 years after their implementation, this is one of the main steps capable of addressing the situation in a consistent and sustainable way in the long term.

LOCAL EMPLOYMENT

Despite the contraction trend displayed by employment in the mining industry over the last decade –at countrywide and local level-, the workforce living in the same region they work in has been a majority, with nearly 73% of workers. On the other hand, and thanks to the extra efforts made to favor local employment, local hiring was kept unchanged in times of low hiring all across the industry.

However, when broken down, figures reveal that supplier companies increased local employment in 10 percentage points in the last six years in general and in the Main Value Chain, whereas mining companies showed a 3.2-drop in local enrollment in 2020 relative to the previous measurement.

Multiple factors may account for the behavior of local employability among local workers and commuters. Complementary data explains that, in years of highest investment in mining projects, the incremental employment demand is mainly absorbed by commuter workers. On the other hand, the efforts put in by some companies towards recruiting local employment seem to be delivering positive outcomes, which might translate into a territorial impact, from the point of view of human capital development and economic growth.

CHALLENGES AND RECOMMENDATIONS

Local employment stands as a highly relevant dimension in securing the social license to operate mine sites and it turned out to be a key component in maintaining operational continuity during the COVID-19 mobility restrictions. Under this dimension, three priority action lines should be followed:

1. **Monitoring and dissemination of local employment indicators:** A first move into this line of action was published by the MSC-Eleva alliance in their study "Local Employment in Large-Scale Mining in Chile: an Overview of Present Times, Initiatives, and Future Challenges". This study found out that the real local employment levels are underestimated by the local population. In this sense, a collaborative mechanism should be implemented to systematize and disseminate local employment rates across the regions on a semiannual basis in order to shed light on the commitment undertaken by the mining sector in this regard. Local employment must be monitored against two indicators employed in this study as both of them allow for the phenomenon to be monitored at level of workforce stock and at level of flow of new workers: i) the local employment percentage over the total workforce (stock); and ii) the local employment percentage over enrollments of less than 1 year.

2. **Define a sectoral goal and an action plan to address the number of student trainee vacancies:** Undertake a sectoral commitment to significantly increase alternance learning opportunities of to enable more young people coming from territories close to mine sites to have access to training positions. This action can have a direct impact on youth employment. This action plan should be focused on the occupational tiers of Operators and Maintainers as well as on Supervisors and Professionals, be it from mining or supplier companies, and should concentrate on those regional educational institutions already awarded an MSC Quality Seal. In turn, this initiative requires the sector's technical assistance to enhance the quality of vocational high schools providing mining-related specialties to make them eligible for or allow them to revalidate the MSC Quality Seal. This issue is particularly important in the Atacama region where no educational institution has yet been awarded a MSC Quality Seal and where local employment has fallen below industry averages.

3. **Advance in training:** A third challenge has to do with the upskilling of the current workforce to prevent this from being replaced by talents from outside the region as a result of technological advances. To this end, more and better quality training should be provided to all occupational groups. In particular, the lessons learned from the COVID-19 pandemic on matters of e-learning or b-learning training can be used. The following recommendations were raised during the workshops held with member companies and educational institutions:

    - Increase e-learning opportunities for Operators and Maintainers profiles by applying hybrid models: knowledge theories are conducted through the internet while practical components are provided face-to-face.
    - In order to keep training costs low, the election of e-learning and b-learning modes must be encouraged in bidding and hiring processes while training indicators (training hours /total worked hours) should be increased by introducing e-learning training in operations and maintenance, mainly.
    - Maintain and capture learnings from operational continuity and biosecurity in the industry, beyond the pandemic, through the endorsement of best practices and shared experiences.

TECHNOLOGICAL TRANSFORMATION

The likely introduction of new technologies in the mining industry is an element to be factored in for the future demand of human capital, as technology has come to complement the tasks performed by male and female workers, improving the efficiency and productivity in a number of activities developed by the sector.

Three main steps continue to be identified in the technological evolution that will usher transformation into mining: manual will become teleoperated and is likely to eventually reach automation. The maximum change potential in mining skills is expected to occur as a result of digital transformation processes whose changes will depend on investment policies, strategies, and the conditions of each mine site individually.

CHALLENGES AND RECOMMENDATIONS

The transfer of skills, as a strategic approach towards the adoption of new technologies, is set to play a key role in sectoral company work plans in the coming years. There are three main human capital challenges being faced by the mining industry derived from the digital transformation and automation processes:

1. **Upskilling of current workforce skills:** Provide current workforces with the skills required to work in highly technologized environments. Different studies point to the lack of work skills within workforces as one of the main obstacles that hinder the advance of automation and digitalization processes. In order to address this challenge, the MSC-Eleva alliance and sectoral experts have jointly developed the Transversal Skills Model for the Mining Industry 4.0[7], where six key competencies have been identified for the Chilean context: logical-mathematical reasoning, creativity & innovation, critical thinking, data analysis, judgment & decision-making, and climate change.

   A sectoral development process should be launched offering educational options on digital and transversal skills for the mining industry 4.0 aligned to sectoral needs in order to train -every four years, as a minimum- the more than 60,000 Operators and Maintainers in this type of competences. This calls for the existence of, at least, 20 TTOs providing educational programs accredited under sectoral standards and regionally based to bolster regional educational ecosystems.

2. **Reskilling of workforce impacted by new technologies:** the sector should pursue the development of sectoral reskilling roadmaps as a strategic initiative intended to collectively address the skill conversion issues based on the WEF Reskilling Revolution experience. In this context, the development of a skill reconversion model for mobile equipment Operators comes as one of the main priorities as an occupational segment highly likely to experience dramatic changes in the coming decade. The following recommendations were raised in the collaborative workshop held with partner companies and educational institutions:

7 Available at https://www.ccm.cl/wp-content/uploads/2019/12/CompTransversales4.0.pdf

- Conduct a survey on the current technological level existing in each mine site and identify their preparedness to move to more advanced automation and optimization processes. This will help individualize the gaps relative to expected potentials which will, in turn, help define the real human capital needs that meet the skills required by the technological absorption process.

World Economic Forum (WEF) Reskilling Revolution Platform: sectoral reskilling roadmaps

This WEF platform released sectoral reskilling roadmaps for the aerospace, tourism, financial service, consumer goods, and oil industries. These roadmaps were designed to address the reskilling challenge at industry level in order to objectively assess the business case associated to massive reskilling processes and the generation of standardized, shared-use instruments at sectoral level.

3. **Pipeline of new talents for mining 4.0:** The coordination of mining and supplier companies is required for the development of educational institution ecosystems capable of responding to the demand of future talents 4.0. The identification of these new occupational profiles and a quantitative projection of their demand per region come as a first step in this direction. The methodology applied in this study is unable to capture these future talents 4.0 as it concentrates in the traditional profiles performing in the Main Value Chain in the mining industry. The next step focuses on promoting not only collaborative work with the regional educational ecosystem for the development of education-work pathways 4.0 aligned with previously defined profiles, but also the development of technology hubs 4.0 taking as reference the Industry 4.0 Testlabs established across Australia. The following recommendations were raised during the workshops held with partner companies and educational entities:

- Incorporate non-formal (TTOs and SENCE) and formal (vocational high schools, VI, VTC, and universities) education players into the joint work, as upgrading the current skills is a required measure to face the new challenges posed by the absorption of new technologies.
- Attract new talents to the industry 4.0 and promote education-work pathways through the homologation of certifications granted for work skills and/or to graduates from MSC Quality Seal-awarded institutions to years of experience.

Industry 4.0 Testlabs (Australia): public-private partnerships and educational ecosystems for industries 4.0

A strategic initiative of the Prime Minister's Industry 4.0 Taskforce of Australia. It was launched in 2018 and implemented through partnerships between the main higher-education institutions and industry players. It seeks to play a key role in the adoption of technologies 4.0 and workforce transformation. In this context, six hubs associated to technologies 4.0 were installed in Swinburne University of Technology, Flinders University, Queensland University of Technology, University of Technology Sydney, the University of Western Australia, and the RMIT University.


05

ANNEXES

ANNEX A: COMPANIES, EDUCATIONAL INSTITUTIONS, AND COLLABORATORS IN THIS STUDY

Mining companies	Name
Anglo American	Gabriela Torres Ralph Burdin Andrea Valenzuela Jennifer Cárdenas Jennifer Navarrete
Antofagasta Minerals	Ana María Rabagliati Camila Torres María Ignacia Sáez Cristian Kind Soledad Fernández María Ignacia Sáez Claudia Coscio Miguel Sagredo
BHP	Meike Holzhauer Daria Novakovskaia Magdalena Labbé Mauricio Valenzuela Elizabeth Cameron Luis Montoya
Compañía Minera del Pacífico	Carolina Lomuscio Cristian Inostroza Rodrigo Cepeda Constanza Mancilla
Codelco	Marcelo Álvarez Claudia Villa Karen Molina Felipe Vega Natalia Monardes Héctor Orellana Luis Moreno
Collahuasi	Álvaro Fritz Lisette Yáñez Fernando Hernández Hernán Soto

Mining companies	Name
Freeport McMoran	Reinaldo Montecinos Claudia Corvalán
Glencore	Felipe Condón Pablo Canales Ana Fabres Rodrigo Gallardo Nancy Araya Nibaldo Areyuna Jennifer Assen
Gold Fields	Pilar Henríquez Paulina Escobar
Kinross	Fabiola Meza Jessica Condori Marcela Gómez Daniel Agüero
Lumina Copper	Moisés Poblete Carolina Vásquez Claudio Raffo
Lundin	Carlos Barahona Christian Staeding Juan Díaz
Sierra Gorda SCM	Beata Choragwicka Nicolás Cruz Ricardo Monje
Teck	Francisca Silva Luis Aylwin Milan Marinovic Jorge Brito Nicolás Bravo Jimena Mera Marlys Torres Alejandro Gómez Sebastián Campos

Supplier companies	Name
Coasin Logicalis	Paulina Mery Marco Gálvez
Enaex	Soledad Bauer Patricio Melo Daniela Pérez
Enex	Gonzalo García Agdiel Gutiérrez
Finning	Carolina González Felipe Rau Marco Berdichevsky
KBS Chile	Hans Baumann Ivonne Aviles
Komatsu	Carola Espinoza Miguel Paredes Javier Báez Ignacio Neira Diego Badilla María José Márquez
Liebherr	Rocío Arriagada

Supplier companies	Name
Metso Outotec	Elizabeth Farías Carolina Cárdenas Macarena Vallejo Cesar Jiménez
ME Elecmetal	Franco Saldias
Orica	Tomás Cáceres
Sorena	Richard Holdermann Germán Guerrero
Talleres Lucas	Génesis Valenzuela Francisco Dittborn
Technosteel	Tomás Buttazzoni Patricia Burgos
TTM Chile	Philippe Hemmerdinger Renato León Angela Moreno
Vulco - Weir Minerals	Ricardo Garib Catalina Bustamante Alejandro Gómez

Educational institutions	Name
América Mining High School	Elizabeth Linares
Don Bosco- Calama Technical-Industrial School	Jeannette Madariaga
María Elena PT-CH High School	Ana María Cabrera
Jorge Alessandri Rodríguez High School	Nevenka Alvarez
Alameda Salesian Educational Center	Danny Urtubia
Guillermo Richards Industrial High School	Andrés Vargas
CEDUC UCN	Carlos Sainz Maritzaida Rojas
Arturo Prat University	Jacqueline Villalón Rodrigo Araya
AIEP	Oscar Arredondo
University of Antofagasta	Cesar Sandoval
IP Chile	Tania Claramut
CEIM	María Arias Milton Flores Marcos Rodriguez
Strenuus	Alex Saavedra
Automóvil Club	Carolina Gangas
Caser	Ivet San Martín
CEFOMIN	Erwin Cabezas

ANNEX B: MAIN CHARACTERISTICS OF EDUCATION SYSTEM

	Non-Formal Education	Formal Education
	Work Training	**Vocational School Graduate**
Entities providing the information	**Technical Training Organizations (TTO)**	**Vocational High-School**
Entry requirements	Requirements imposed by the different training programs. In the case of social protection programs, age limits range between 16 and 65 years old and applicants are required to belong to vulnerable social segments (information validated by the Social Protection Registry). Only workers over 18 years old and hired for a period of time as mandated by law will be eligible to apply for training through tax exemptions.	Applicants must have approved the first cycle of secondary education (1st and 2nd high-school levels). Differentiated vocational training concentrated in the last cycle of secondary education (3rd and 4th high-school levels).
Characteristics of education	Training is regulated by the National Training and Employment Service -SENCE-, either in training lines aimed for vulnerable people (social protection programs) or through tax exemptions, designed for workers from first-category taxpayer companies.	The vocational secondary education (VHS) represents a differentiated instruction seeking to provide relevant education for a specific work area.
Labor scope associated to Mining Qualifications Framework (MQF)	According to the Mining Qualifications Framework (MQF), people within this training level are equipped with the basic knowledge and skills (concepts, procedures, and techniques) that enable them to work in a defined mining industry context, under direct supervision. They can pursue continuing learning processes.	According to the MQF, people pertaining to this training level are equipped with the theoretical and practical knowledge as well as with the skills to work in a specific area of the mining industry. Though under supervision, they work with certain autonomy levels and responsibility for their own work. As for the work of others, they take limited responsibility.
Examples in mining line	**Mine equipment Operator (mobile).**	**Mid-level mine extraction technician**

	Formal Education		
	Higher Vocational Education Technician (HVETs)	**Professional without Bachelor Degree (no academic degree) (Pw/oBD)**	**Professional with Bachelor Degree (PwBD)**
	Universities, Vocational Institutes, and Vocational Training Centers	**Universities and Professional Institutes**	**Universities**
	Secondary education diploma and meet the requirements set by each institution.	Secondary education diploma and meet the requirements set by each institution.	Secondary education diploma, UAT score (if required by entity) and requirements set by each institution.
	This training equips students with the necessary knowledge and abilities to assist at specialized professional level or to work on their own. The higher-education technical diploma is granted after following and passing a 1,600-hour duration education program, as a minimum. It does not grant academic degrees.	General scientific training for an adequate professional performance. Normally, it takes four years to complete. It grants a professional-level degree.	Training provided by universities. Careers take over 8 semesters (4 or 5 years) to complete. These are the only institutions allowed to grant all types of academic degrees (bachelor's degree, master and/or doctorate).
	According to the MQF, people within this training level acquire the theoretical and practical knowledge and skills to work in a specific area of the mining industry, in the desired specialty area. With more extensive experience, expert skills can be acquired as well as higher levels of autonomy and responsibility for own job and the capabilities to plan, coordinate, and evaluate the work of others.	This training level exceeds the MQF scope. However, it develops complex theoretical and practical knowledge as well as expert skills required to work in the mining industry and to pursue continuing learning. Workers are granted autonomy and take personal responsibility for the execution of complex technical tasks and have the capabilities to plan, coordinate, and evaluate the work of others.	This training level exceeds the MQF scope. However, people within this level, in general, own systematic and specialized knowledge acquired as a discipline or in a professional field. They are trained to analyze and assess complex ideas and are capable of assuming responsible leadership of teams and knowledge development.
	Higher Education Technician, Mining	**Mining Engineer or Field Mining Engineer**	**Civil Mining Engineer**

ANNEX C: METHODOLOGY APPLIED IN THE PROJECTION OF EDUCATIONAL OFFER

1. The data on which the educational offer and graduate projections were based have been obtained from the National Council of Education (NCE). This information is available for the 2005-2020 period. In this case, the "Enrollment Index" database was used.

2. An education code was assigned to each mining-related program. This code groups together programs according to common areas that are relevant for the mining industry.

3. According to data collected from mining companies, more than 50 education codes were arranged into 15 profiles or entry gates into the industry. The rationale between them says that one education code can feed more than one profile code.

4. The following information was used to project the supply of graduates for the 2021-2030 period:

    a. 2005-2020 enrollment rate increase.
    b. Career dropout rate.
    c. Effective attraction rate to mining.
    d. Career duration.

5. The 2021-2030 enrollment rate increase was estimated on the basis of the average growth for the 2005-2020 period. If an outlier growth is observed, attraction rates are adjusted. This growth rates is used for the 2021-2030 period.

6. Career dropout rate: generated by the Ministry of Education and calculated according to type of educational institution (TTC, VI, and university).

7. As for the effective rate of attraction to mining, profiles are fed from a large variety of careers, some of them very closely related to mining (eg., mining engineering); others, of broader employability (eg., industrial engineering). It is reasonable to assume that a larger number of graduates from "very mining-related" careers will end up joining the industry which is not necessarily the case for graduates from careers that offer wider employability. In the case of mining careers, the attraction rate is a composite value obtained from the percentage of graduates estimated to end up working in the industry (not the same for the different programs), once sorted out into the profiles they are related to. This returns a composite attraction rate used in the elaboration of enrollment projections.

8. A dropout rate was applied to 2005-2020 first-year enrollments in order to forecast the number of students projected to graduate from 2021 onward, depending on career duration. In order to determine the number of students graduated in the times when no first-year enrollment information was available, the 2021 data was projected with the enrollment rate increase mentioned above. As for careers sharing a common program in early years, the enrollments recorded for those years were distributed across the enrollments per specialty in the last years of the program.

9. Based on that information, annual series were projected per profile of the number of graduates estimated to join the mining labor market.

ANNEX D: PROJECT PORTFOLIO IN MINING COMPANIES

Region	Company	Project name	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
I	Cía. Minera Teck Quebrada Blanca	Quebrada Blanca Hypogene	●	●	●	●	●	●	●	●	●	●
	Doña Inés de Collahuasi	Collahuasi Ancillary Facilities – Increase to 170 ktpd	●	●	●							
	Doña Inés de Collahuasi	Collahuasi Prod. Cap. Impr. 210 Ktpd	●	●	●	●						
II	AMSA	Oper. continuity Zaldívar	●	●	●	●	●	●	●	●	●	●
	AMSA	Polo Sur	●	●	●	●	●	●	●	●	●	●
	AMSA	Des. District Centinela	●	●	●	●	●	●	●	●	●	●
	BHP	STWM01 Spence Tailings and Waste Management Work Package 1	●	●	●							
	BHP	LSTS Laguna Seca Tailings Strategy	●	●	●							
	CODELCO	DRT	●	●	●	●	●	●	●	●	●	●
	CODELCO	DCH	●	●	●	●	●	●	●	●	●	●
	CODELCO	DMH	●	●	●	●	●	●	●	●	●	●
	CODELCO	DGM	●	●	●	●	●	●	●	●	●	●
	Sierra Gorda SCM	Sierra Gorda Debottlenecking	●	●	●							
III	Kinross Minera Chile Ltda.	La Coipa Phase 7	●	●	●	●						
	Cía. Minera del Pacífico	On-surface tailings deposition plant	●	●	●	●	●	●	●	●	●	●
	CODELCO	DSA	●	●	●	●	●	●	●	●	●	●
	Lundin Mining	Operational continuity Candelaria 2030: Throughput increase of Candelaria underground mine operation	●	●	●							
IV	AMSA	Marginal expansion Los Pelambres, Phase I	●	●	●	●	●	●	●	●	●	●
	AMSA	Marginal expansion Los Pelambres, Phase II	●	●	●	●	●	●	●	●	●	●
V	AngloAmerican Sur S.A.	El Soldado (stay in business)	●	●	●	●	●					
	AngloAmerican Sur S.A.	Chagres (stay in business)	●	●	●	●	●					
	CODELCO	DAN	●	●	●	●	●	●	●	●	●	●
	CODELCO	DVE	●	●	●	●	●	●	●	●	●	●
VI	CODELCO	DET	●	●	●	●	●	●	●	●	●	●
XIII	AngloAmerican Sur S.A.	Los Bronces Underground	●	●	●	●	●					
	AngloAmerican Sur S.A.	Los Bronces Underground (stay in business)	●	●	●	●	●					

● Engineering or construction phase ● Hiring for operation phase

ANNEX E: EDUCATION SUPPLY PER PROFILE AND YEAR ATTRACTED TO LARGE-SCALE MINING

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
Geologist	353	315	303	272	276	252	219	229	239	250	2.709
Mine extraction professional	330	304	227	199	193	183	158	164	169	176	2.103
Processing professional	114	108	101	108	111	112	104	106	109	111	1.085
Maintenance professional	14	14	15	15	17	18	16	16	16	17	157
Extraction specialist Engineer	246	230	187	179	173	157	149	154	159	165	1.799
Processing specialist Engineer	162	165	157	161	167	168	163	167	171	175	1.656
Maintenance specialist Engineer	101	102	108	98	100	104	104	108	111	115	1.050
Extraction Supervisor	343	306	225	200	197	183	168	175	182	190	2.170
Processing Supervisor	198	174	145	133	140	120	113	117	121	125	1.387
Maintenance Supervisor	53	53	56	52	52	52	51	53	54	56	533
Mechanical Maintainer	141	142	143	140	141	141	142	143	144	145	1.423
Electrical Maintainer	91	91	93	88	90	91	93	95	97	99	928
Mobile equipment Operator	72	72	72	72	72	72	72	72	72	72	723
Fixed equipment Operator	66	66	66	66	66	66	66	66	66	66	663
Other Geology-related occupations	315	288	245	211	197	183	181	188	196	204	2.209
Total	2.601	2.431	2.142	1.995	1.993	1.903	1.800	1.854	1.909	1.967	20.595

ANNEX F: DEMAND PER PROFILE AND YEAR IN LARGE-SCALE MINING

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
Geologist	40	31	34	-14	11	7	18	6	19	24	175
Mine extraction professional	139	82	92	-87	26	15	34	18	54	40	413
Processing professional	54	41	49	1	22	10	13	9	15	18	231
Maintenance professional	235	153	155	-141	40	28	66	34	93	71	735
Extraction specialist Engineer	52	36	37	-23	11	7	12	4	16	20	171
Processing specialist Engineer	79	53	55	-31	28	16	18	12	29	25	283
Maintenance specialist Engineer	334	192	208	-185	58	19	68	33	571	109	1.407
Extraction Supervisor	271	182	193	-95	92	51	146	35	116	225	1.216
Processing Supervisor	93	61	64	-7	30	19	32	31	31	33	387
Maintenance Supervisor	380	239	263	-121	131	81	184	61	165	275	1.659
Mechanical Maintainer	2053	1325	1564	-1003	526	133	536	586	665	781	7.167
Electrical Maintainer	541	363	401	-254	150	77	134	101	174	217	1.904
Mobile equipment Operator	1391	1020	999	-406	521	431	464	303	527	598	5.848
Fixed equipment Operator	838	603	644	-225	355	209	368	154	322	285	3.554
Other Geology-related occupations	45	31	34	-17	14	15	21	10	17	18	188
Total	6.547	4.411	4.793	-2.610	2.017	1.116	2.114	1.397	2.815	2.739	25.338

ANNEX G: GAP PER PROFILE AND YEAR IN LARGE-SCALE MINING

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
Geologist	313	284	269	286	265	245	201	223	221	226	2.534
Mine extraction professional	191	222	135	286	167	168	124	145	116	136	1.690
Processing professional	60	67	53	108	89	102	91	97	94	94	853
Maintenance professional	-221	-139	-141	156	-24	-10	-51	-18	-77	-54	-578
Extraction specialist Engineer	193	194	150	202	163	150	137	150	143	145	1.627
Processing specialist Engineer	83	112	102	193	140	152	145	155	142	150	1.373
Maintenance specialist Engineer	-233	-90	-101	283	41	85	36	74	-460	6	-358
Extraction Supervisor	73	124	32	295	104	132	23	140	66	-35	954
Processing Supervisor	105	114	81	139	110	100	81	87	90	93	999
Maintenance Supervisor	-327	-186	-207	173	-80	-29	-133	-8	-111	-219	-1.126
Mechanical Maintainer	-1912	-1182	-1420	1143	-386	8	-394	-443	-521	-636	-5.744
Electrical Maintainer	-450	-272	-308	343	-61	14	-40	-6	-77	-119	-976
Mobile equipment Operator	-1319	-947	-927	478	-449	-358	-392	-231	-455	-526	-5.125
Fixed equipment Operator	-772	-537	-578	292	-289	-143	-302	-88	-256	-219	-2.890
Otras ocupaciones del ámbito Geology	270	258	210	228	183	168	160	179	179	186	2.021
Total	-3.946	-1.980	-2.651	4.605	-24	786	-314	457	-905	-772	-4.744

ANNEX H: GLOSSARY

AREAS

Main Value Chain	Analytical segment considered by mining and supplier companies. It includes Extraction, Mineral Processing (from crushing to electrolytic refining), and the Maintenance areas that support the former two large divisions. This dividing line marks the specialties where specialized mining training exists and is required.
Mining development	All processes occurring prior to the Value Chain, mainly Geology and Exploration. For instance, this is where positions such as Project Coordination Superintendent, Geotechnical Assistant in the Planning area, and Drilling Engineer in the area of Geology can be found.
Major projects	All processes dealing with the development of major projects and infrastructure, in general, are associated to the VP of Projects.
Administration and support	All jobs having to do with administration, senior management, and most positions performed in corporate headquarters. Eg., Human Resources Administrator, Payment Administrator in Procurement, Occupational Safety area.

PROCESSES

Extraction	Includes drilling, blasting, loading, and haulage processes. It includes also all tasks associated to open-pit or underground extraction. Eg., Mine Production Management, Crushing and Haulage Management, Mine IV Operator position, Loader Operator position.
Processing	Considers all tasks associated to mineral processing, including concentration, flotation (sulphides), and leaching (oxides). Eg., Concentrate Production Management, Cathode Production Management, Plant II Operator position.
Maintenance	Includes all maintenance tasks associated to the extraction area; that is, mobile and semi-mobile equipment, crushing and haulage and all maintenance activities connected to Processing.

TIERS

Professionals	People performing technical functions required by company or mine operation processes (eg: mine extraction professional; Processing specialist Engineer, etc.).
Supervisor	People performing duties associated to the management of worker teams, normally on site (eg: Processing, Extraction, Maintenance Supervisor).
Maintainers	People performing duties associated to the repair or maintenance of mine or plant equipment (eg: electrical, mechanical Maintainer).
Operators	People performing duties in activities related to Extraction or Processing with direct use of mobile or fixed equipment.
Staff	Includes all positions outside the Value Chain. People working in administrative positions, senior management, and most functions conducted in corporate headquarters. (eg: Human Resources Administrator, Payment Administrator in Procurement, Occupational Safety area).

Program accreditation	Process through which the National Council of Accreditation (NCA) attests to the quality of specific career programs. Accreditations can be granted from one to seven years. The longer the years a program is accredited for, the highest its certified quality.
Acreditación institucional	Voluntary process through which the National Council of Accreditation (NCA) attests to the quality of higher education institutions. Accreditations can be granted from one to seven years. The longer the years an institution is accredited for, the highest the quality achieved and certified by the State.
Brecha de capital humano	A negative inconsistency between the supply of graduates attracted to mining and the demand for human capital. That is, when the demand exceeds the supply. The opposite is defined as oversupply.
Conmutación regional	Referred to the geographical transportation to and from the workplace. It considers geographical distances of, at least, one region.
Demanda acumulada	Estimate of people needed during a calendar year on top of the demand from previous periods. This value is used to verify how much the industry has grown in a certain period. It includes the growth-driven demand (that, in turn, considers the workforce estimates from mining and supplier companies) and the retirement-driven demand.
Demanda anualizada	Estimate of people needed in the course of a calendar year, considered as a specific unit of study. In this case, the estimates made for an X-1 year are deducted from the estimates for an X year, assuming that the workforce requirements are met each year and are not carried over to the next calendar period. It includes the growth-driven demand (that, in turn, includes the workforce estimates from mining and supplier companies) and the retirement-driven demand.

Human capital demand	Estimate of people to be required by the mining industry in order to fulfill their productive goals. It consists of two elements: the growth-driven demand (new posts to be created) and the replacement-driven demand (number of workers to be replaced considering their likely retirement based on age projections).
Formal education	Education system offered by secondary education and higher education institutions (HEI). It operates under the regulatory framework established by the Ministry of Education and other related organizations.
Informal education	Non-regulated, non-regular education system. It depends solely on each person and is not recognized by regulated entities. It translates into improved skills acquired through experience. It represents the base on which the trade occupation segment has developed.
Vocational secondary education	Provided by vocational high schools and known by the initials VHS. It provides basic preparation training for elemental work and vocational education.
Non-formal education	Education system provided by technical training institutions (TTOs). It is regulated by the Ministry of Education and operates on the basis of direct agreements reached with each Principal company and related organizations. Not authorized to grant degrees but only recognitions, such as certificates and others.
Tertiary education	Formal education aimed to provide work-oriented training. It is provided by higher education institutions (vocational training centers, vocational institutes, and universities). According to formal definition, it takes two to six years to complete.
Higher education institutions (HEI)	Provides tertiary information in one or more graduation systems. It can be a Technical Training Center (TTC), authorized to grant Higher-Level Technician degrees; Vocational Institute (VI), allowed to grant Higher-Level Technician degrees and/or Professionals without a Bachelor's Degree (Pw/oBD); or universities, granting Higher Vocational Education (HVEs) degrees and/or Professionals without a Bachelor's Degree, Professionals with a Bachelor's Degree (PwBD), or post-degrees (masters and doctorates).
Mining Qualifications Framework (MQF)	Agreements established on a per-country basis as a way of organizing and classifying, according to progression levels, the learning outcomes required for a competent performance in the industry. One of the most commonly cited definitions in literatures states that the Framework "is an instrument for the development, classification and recognition of skills, knowledge and competencies along a continuum of agreed levels. It is a way of structuring existing and new qualifications, which are defined by learning outcomes" (Tuck 2007). In Europe, the Framework (MQF) is defined as "an instrument of classification of qualifications according to a set of criteria applicable to certain levels of learning".
Graduate supply	Estimate of potential graduates from the education system in its different levels. It is calculated for each of the years considered in the period of study. It considers parameters such as first-year enrollments, dropout rate, real time to graduate, and formal career duration.
Educational offer	The cluster of institutions, careers, programs, and systems of higher (tertiary) education under analysis. As for the present study, a segment of the entire offer that may be directly or indirectly associated to the mining industry is considered. Official data issued by the National Council of Higher Education (NCHE) and the Ministry of Education (MINEDUC) is used.

Technical Training Organization (TTO)	TTOs provide education through training in work-related activities. Many times this process is intermediated by ITTOs (Intermediate Technical Training Organizations), associated to SENCE, granting official recognition. These entities provide their training services in different forms, like courses, workshops, and others.
Profiles of study	Groups resulting from the analysis of functions and positions existing within the mining industry to better understand the sector. They share a common educational base and work fields associated to macroprocesses, processes or subprocesses recognized by the industry (for example, mine extraction, open-pit mine extraction, open-pit mine extraction/haulage). Although some specificities are observed to occur in the areas typically covered by mining and supplier companies, these were homologated to facilitate the presentation of data. In the case of Chile, these have been homologated to the different profiles identified in other mining countries, such as Canada or Australia. They represent over 10,000 different specific positions.
Potential retirement	A segment from the workforce likely to be retiring from labor life due to age projections and replacement will be necessary. A worker over 60 years of age is very likely to stop working regularly in the mining industry (pursuant to labor legislation and aging curve trends).
Professional with Bachelor's Degree	Education conducive to a professional graduate with an academic degree granted by tertiary education (university). Its nominal duration is five to six years. In international jargon it is equivalent to Bachelor.
Professional without Bachelor's Degree	Education conducive to a professional graduate granted by tertiary education (VI or university). Its nominal duration is four years. In international jargon it is equivalent to VET (Vocational and Education Training).
Education programs	Minimum unit to analyze the educational supply. A program represents a career provided in one campus and under a certain system. A career, in particular, can be provided in one or more institutional campuses and under one or more systems (daytime hours, evening hours, in-person, etc.).
Programs indirectly associated to mining	A segment of programs with employability indirectly defined by areas from mining or supplier company (mining sector). Graduates from careers in these areas are likely to join the mining industry but other industries as well. It covers areas like maintenance and industrial, mechanical, electrical, electronic engineering, etc.
Programs associated to mining	A segment from the total program with employability directly defined by areas from mining and supplier companies (mining sector). It covers areas like Geology, Mines, and Metallurgy.
Intrasectoral turnover	Number of people who have moved from one employer to another within the mining industry (from a mining to another mining company; from a mining to a supplier company; from a supplier to another supplier company). In this study, this value was calculated based on information contained in the unemployment insurance fund database integrated by all workers who entered into a labor relationship after 2002 or those who, having started a labor relationships prior to 2002, voluntarily subscribed into the insurance fund.

Intersectoral turnover	Number of people who have moved from one employer to another from a company from one sector to another operating in another sector. In this case, the mining sector is considered as reference; that is, moving into and out of the mining industry. In this study, this value was calculated based on information contained in the unemployment insurance fund database integrated by all workers who entered into a labor relationship after 2002 or those who, having started a labor relationships prior to 2002, voluntarily subscribed into the insurance fund.
National Training and Employment Service (SENCE)	Public entity under the Ministry of Labor representing one of the most used tools for managing company training activities through tax exemptions. SENCE has developed Training for Work programs through which extended duration (over 200 hours) work training has been provided covering trades training.
Own or internal workers	Used in reference to mining company workers as opposed to external or third-party workers; that is, workers from companies providing services to a Principal company.
Supplier workers	Used in reference to workers from supplier companies. It refers to workers coming from companies providing services to the Principal company.
Attraction rate into mining	A weighting factor used to estimate the number of potential graduates that will end up working in the mining industry, from out of the total of potential students graduating from the tertiary education system. This index is based on data collected from companies' recruitment and selection areas, professional associations, and HVE Study Secretariats. It estimates the number of graduates employed in the mining industry and distributes that number across the profiles analyzed in the study, in line with the model.
Higher Vocational Education (HVE)	Education conducive to the degree of Technician granted by tertiary education (VTC, VI or university). Their nominal duration is 1,600 hours. In international jargon it is equivalent to VET (Vocational and Education Training).

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