Analysis of Labuor Sustainability for Mining Engineers in Chile

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Abstract

In Chile there have been universities that have trained thousands of mining engineers over the country's history for decades. Since 2010 multiple academic projects were generated around the career of Mining Engineering, based on the large investments and high demand for qualified jobs that were projected by government agencies for the 2010 – 2025 period. Based on this, public and private universities and professional institutes started careers linked to mining, encouraged by the media, which wrote in their main pages about the large amounts of money that mining professionals were earning, higher than those of any other professionals in the country. Since then, academic offerings have increased in an overwhelming and uncontrolled manner. However, the projections on labor demand in relation to the professional mining engineering careers did not go as predicted. This paper reviews the traditional training that the profession has given, showing the current academic offerings in 2015, the projections for graduates up to 2023, and the job offers according to the forecasts of national and international economies. Then the supply and demand are projected jointly to show the gap that there will be between both. All this puts in evidence a discouraging panorama for the graduates from the different universities and professional institutes due to the huge oversupply that is foreseen.

Key Words

Mining engineering, employability, education, Chile.

Introduction

Talking about mining engineers in Chile may refer to various careers such as Civil Engineering in Mines (6 years), Mining Engineering (5 years), and Mining Technician (*Ingeniero de Ejecución*) (4 years) but graduates will eventually get similar jobs and/or perform the same tasks. Therefore, in order to simplify the development of the paper we will talk about "mining engineering" without making further distinctions.

The objective of the present paper is to carry out an academic exercise to show the horizon that is faced by mining engineering graduates in Chile in terms of employment, based on recent events and on the projections made under the explicit assumptions discussed in the text.

Traditional Training and the New Academic Offer

Until the first years of this century, the number of mining engineers graduating fromuniversities seemed to be sufficient to satisfy the country's demand. This demand had been satisfied over the last 40 years by five state universities, namely the Universidad de Chile, Universidad de Santiago de Chile, Universidad de Atacama, Universidad de La Serena and Universidad de Antofagasta (the last four were part of the former *Universidad Técnica del Estado until 1981,* UTE), with a low degree granting rate. This happened mainly because it is a profession that, although well paid, often involves sacrifices that other careers do not require, such as distant workplaces, absence from home several days per week, physical condition adequate for field work, enduring sometimes complicated environmental conditions (extreme cold or heat, dryness, darkness, exposure to the sun, excessive dust, toxic gases), long travelling time, among others. Historically, because of the aforementioned issues, the students' preference for this career had not been high, often being left at the end of their application preferences. Furthermore, from the standpoint of the cost to the institution, mining engineering is an expensive career due to the need to have adequate

laboratories and well trained professionals to equip and maintain them. Some examples of this kind of laboratories are rock mechanics, metallurgy, mineral concentration, structural geology, petrology, mineralogy, vein microscopy, mine ventilation and mine services. To this we must add fieldwork or visits to site, which require having permanent transport and maintenance of the vehicles and equipment used in the field. All this in addition to the requirements of the basic science and engineering courses (physics, chemistry, computing, among others).

Chile concentrates between 20% and 30% of the world's copper reserves. This is significant because starting in 2003 a growth began in the demand for commodities by a growing China, and later India, that led to a super cycle in the price of copper, which rose from 1.0 USD/pound to more than 2.5 USD/pound over the last ten years. This caused an increase in the number of mining projects and turned profitable several deposits that in the past had been considered non profitable. Consequently, employment of mining engineers reached its historical maximum, and they were considered highly desirable professionals in the market, both by producing mining companies and by companies providing supplies and services to the mining industry, increasing the average salaries even more. Since 2007 mining engineers became some of the best paid professionals in the country, surpassing the average income of geologists, physicians and dentists. Using information from different media, Table 1 shows the evolution of the salary of mining engineers five years after graduation, which doubles from 2007 to 2015(Trabajando.com, 2015) (Universia, 2015) (Laborum, 2015) (Servicio de Información de Educación Superior del Ministerio de Educación (SIES), 2006-2015).

Table 1 - Evolution of the salaries of mining engineers over the last years

Year	Average Salary (USD)
2006	2819
2007	2687
2008	3539
2009	4220
2010	3903
2011	4299
2012	4351
2013	4473
2014	5053
2015	5487

New careers

In 1981 the military regime of A. Pinochet issued the General Law of Universities, which "liberalized" the educational system. With this new legal body the dictatorship not only started the privatization of higher education through the possibility of creating private universities without state dependence, but it disrupted completely the network of existing public universities, regionalizing them and dividing them into countless universities with no relation to each other, in a deregulated higher education system.

Due to the greater demand for mining engineers, in the 2000 – 2009 period new academic offerings appeared, such as the Universidad de Tarapacá, Universidad de Aconcagua, Universidad Pedro de Valdivia and Inacap. Some of these offered different majors and outlets adapted to the clients' needs.

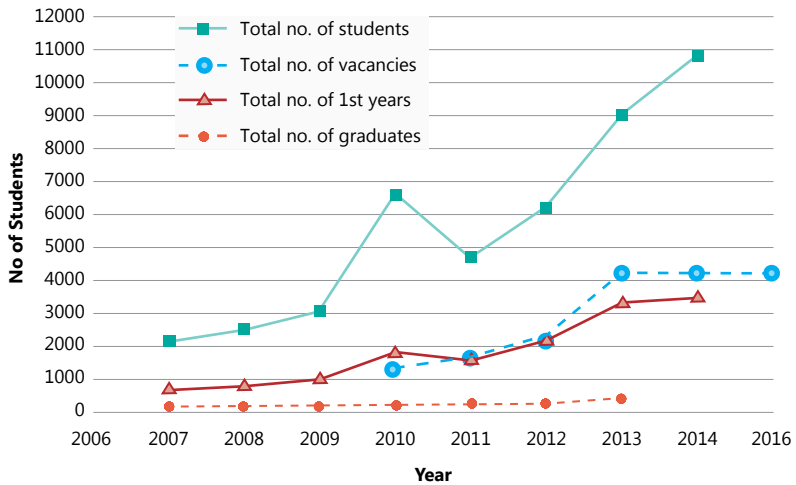
Cochilco is an *"Agency of the State of Chile that advises the Government in matters related to the production of copper and its by-products... It also protects the State's interests in its mining enterprises through the supervision and evaluation of their management and investments, and it advises the Ministries of Finance and Mining in the preparation and follow-up of their budgets"* (Cochilco, 2016). In 2010 Cochilco's Evaluation and Strategy Division, in its report called "Analysis of Demand – Offer of Project Engineering in the Mining Industry" stated that in the 2010-2020 decade mining investments for more than 50 billion US dollars would be expected, a figure that in the following year was updated to 90 billion US dollars. Furthermore, Cochilco presented "Engineering Needs for the next 10 years" at the Institute of Mining Engineers of Chile *(Instituto de Ingenieros de Minas de Chile)*, stressing the existence of a consensus in the mining sector projecting a deficit of human resources for the coming years, when the supply should grow 40% per year over the 2011-2015 period (Instituto de Ingenieros de Minas de Chile, 2010). In the face of this panorama, from 2011 there was a large increase of the academic offerings of several universities, both state and privately owned, and also of professional institutes (PI). This is illustrated in Figure 1, which shows an explosive increase in the offerings starting in 2011, the year in which the U. del Mar, U. Católica del Norte, and U. Adolfo Ibáñez presented their offerings; in 2012 it was the U. La

República, U. Andrés Bello, UCINF, and U. Católica de Valparaíso; in 2013 the PI Dr. Virginio Gómez G., U. de Las Américas, U. del Desarrollo, U. de Los leones, U. de Talca, U. de Concepción, and U. Santa María; in 2014 U. Santo Tomas, U. de Viña del Mar, U. San Sebastián, U. Central de Chile, PI Libertador De Los Andes, and PI CIISA (Servicio de Información de Educación Superior del Ministerio de Educación (SIES), 2006-2015). Table 2 shows the number of universities and the names of the careers that were offering mining engineering.

Table 2 - Increase in the number of careers and campuses.

Year	No. of universities and professional institutes offering mine engineering	Total campuses
2010	9	45
2011	12	57
2012	17	57
2013	24	87
2014	29	117
2015	25	119

Figure 1: Academic offerings of registered and graduated students per year.



The data were obtained from the information available at the Ministry of Education (Servicio de Información de Educación Superior del Ministerio de Educación (SIES), 2006-2015), whose digital information is available only for the last eight years. Figure 1 shows that the academic offerings have increased the total number of registered students, exceeding more than five-fold the number of first year students that there were in 2007. A difference is also seen between the offerings and first year registrations, showing clearly that registration is not always completed or else there is overflow. Another important data in this figure is that the total graduates come from admissions to first year at least four years earlier for mining technicians, five years earlier for mining engineering, and six years earlier for mine civil engineering. Therefore, to relate the retentions we must consider this time lag, to which must be added the actual average graduating time, which is 18 semesters (9 years) for mine civil engineering, 13 semesters (6.5 years) for mining technicians and mining engineers – see Table 3, with information provided by some universities (Servicio de Información de Educación Superior del Ministerio de Educación (SIES), 2006-2015).

Table 3 - First-year dropouts and actual duration of the career

Career	University	First Year Dropouts	Actual Duration (semesters)
Mine Civil Engineering	U. de Atacama	12%	-
	U. de La Serana	12%	18.6
	U. de Santiago de Chile	13%	17.1
Mining Technician	U. de Antofagasta	29%	-
	U. de La Serana	23%	14.9
	U. de Santiago de Chile	26%	12.7
	IP INACAP	32%	11.1

Projected Supply and Demand of Graduates: Employability

Over the last four years the competences committee of the Mining Council (it is an association of the large mining producers), through the Fundación Chile, has prepared the study "Labor Force of Large Scale Mining in Chile" *("Fuerza Laboral de la Gran Minería Chilena")* in its different annual versions (Centro de Innovación en Capital Humano para el Consejo Minero, 2011) (Centro de Innovación en Capital Humano para el Consejo Minero, 2012) (Centro de Innovación en Capital Humano para el Consejo Minero, 2013) (Centro de Innovación en Capital Humano para el Consejo Minero, 2014). This document reports on the specialists that will be required in the projected next ten years in the different specialization areas of mining and on the projected offerings, according to that time's training offers. The study, updated with 2014 data, gives the projected total demand for mining engineers in Large Scale Mining, both by mining companies and by suppliers, in their different roles such as extraction professionals, engineers specialized in extraction, extraction supervisors, and processing supervisors. This projection is made taking into account both the projects on file for future development as well as the economic perspectives of future demand for commodities.

On the other hand, according to Table 3, which shows dropouts (2014) from the first year of a career and taking into account the graduation rate of students six years later, we can make a projection of the potential graduates who will get their degrees in the 2014-2023 period, assuming that the retention rate is increasing and the actual duration of the careers is getting shorter due to the current (and future) requirements for accreditation of the careers by the Ministry of Education. In this way, different retention scenarios are projected in the careers (offers of engineers) with 30%, 40%, 50% and 60% since 2014, and the demand for mining engineers in Large Scale Mining, and this is reflected in Figure 2. To this end it has been assumed that the number of registrations remains constant (the same figure as in 2014) over the next ten years and that no campuses, careers or universities are closing.

Similarly, Figure 3 shows the projection of the accumulated offer at 30%, 40%, 50% and 60% retention in the careers since 2014, and the demand for mining engineers accumulated in Large Scale Mining between 2014 and 2023. It should be noted that Figures 2 and 3 consider only new graduates since 2014, reaching around 18,000 new mining engineers in 2023 if 60% retention is considered (the worst case) and almost 9.000 new mining engineers if 30% retention is considered (best case).

Figure 2: Projection of the offer of graduates according to the average retention and the demand for mining engineers in Large Scale Mining per year.

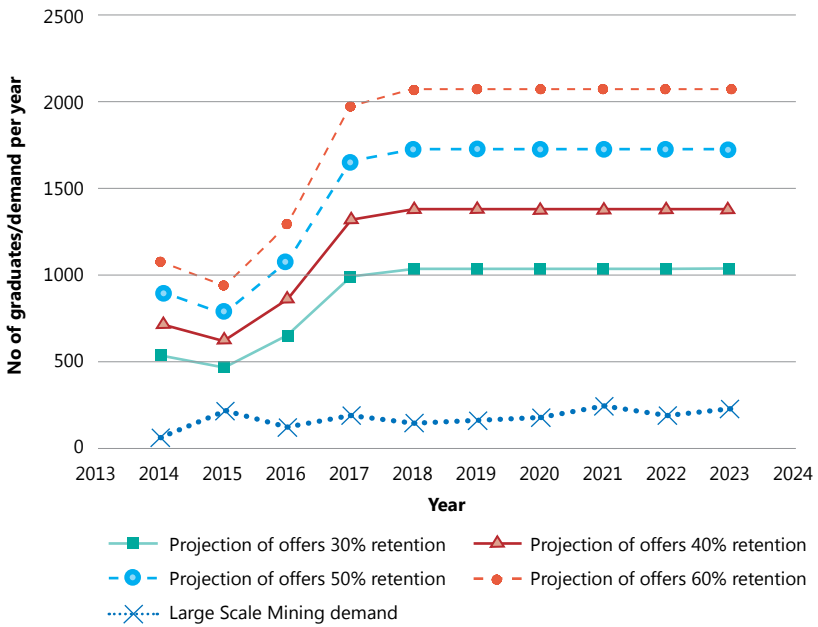
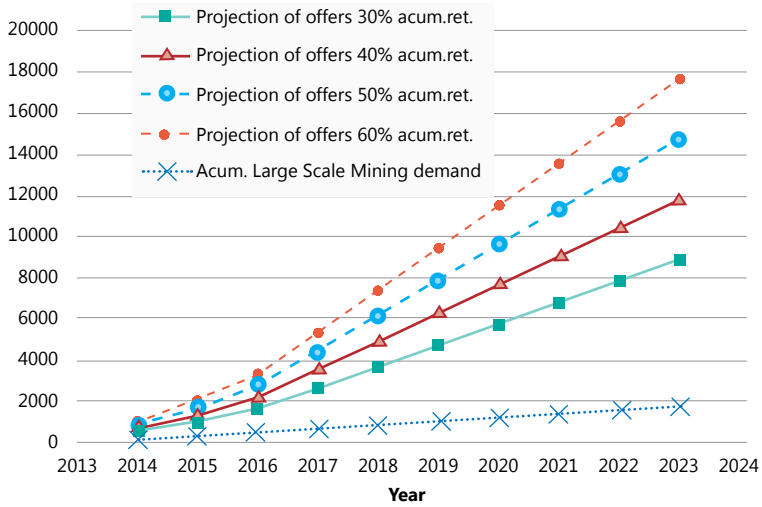


Figure 3: Projection of the accumulated offer of graduates according to the average retention and the accumulated demand for mining engineers in Large Scale Mining per year.



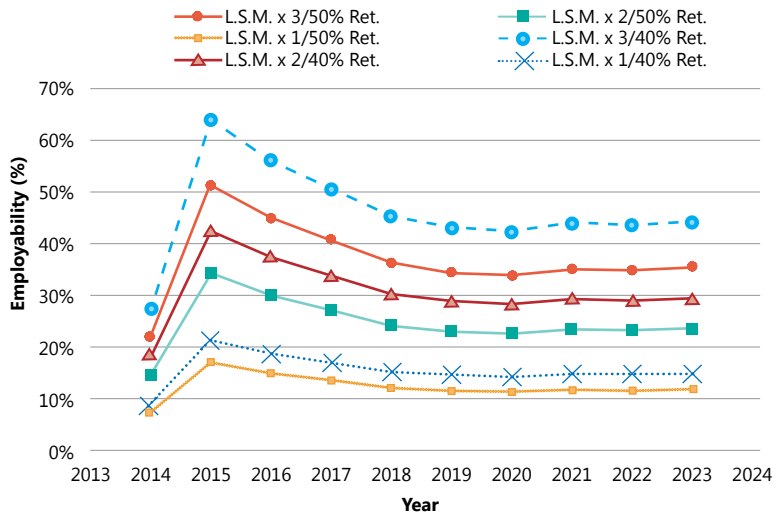
Analysis and Reflections

Making a brief analysis of the data shown in Figures 2 and 3, the difference between offer and demand would give by 2023 in the best case an employability in Large Scale Mining of 21.4% (with 30% retention) and of 12% (with 60% retention) in the worst case. This would mean that in the worst case there would be one out of ten engineers employed, and in the best case, two out of ten.

However, it can be argued that the employability does not consider middle and small scale mining, plus engineering companies, services, and mining support in these fields, or else the creation of new companies, and innovation that can cover part of the offer. Unfortunately, no current or projected data on employability in this respect are available, so a simple exercise can be made, making the assumption in which three

cases are defined: the pessimistic, the moderate, and the optimistic. The "pessimistic" considers only employability in Large Scale Mining (L.S.M.) and its suppliers, or "x1", i.e., the data of demand contributed by the study of Labor Competences of the Mining Council, which have been projected in Figure 4. The "moderate" considers that beside Large Scale Mining there is an equivalent in middle-scale and small-scale mining plus others, which can contribute twice, or "x2", of the contribution of Large Scale Mining to employability. And the "optimistic" considers that beside Large Scale Mining there is an equivalent in middle- and small-scale mining plus others which can contribute three times, or "x 3" of the contribution of Large Scale Mining in terms of employability. In this way, this scenario can be graphed considering 40% and 50% retention in the offer of graduates with respect to registrations in first year, and considering a Pesimistic (x 1), Moderate (x 2) and Optimistic (x3) demand, as shown in Figure 4. It has been estimated that 40% and 50% retention in the offer of graduates with respect to registrations in first year is a most realistic scenario. All this is graphed in Figure 4.

Figure 4: Projection of employability in three scenarios according to retention per year.



Under the stated scenarios, employability would reach an optimistic scenario at 43% employability (with three times the employment projected by Large Scale Mining and 40% retention of first year registration), while in the pessimistic case the employability would be 12% (only with the employment projected for Large Scale Mining and 50% retention of first year registrations).

In Chile there has been an important drop in the employability of recent graduates according to an article in "El Mercurio" newspaper, in which inquiries were made at several recruiting companies such as *First Job, Page Personnel, and Adecco Profesional.* According to this *"mining supply companies are those that have mostly restricted their offers of untrained people between April 2013 and April 2015 by 93%, followed by mining companies, with a drop of 77%..." (El Mercurio, 2015).*

A survey made by the Psychology Institute of the *Pontificia Universidad Católica* for the National Youth Institute (*Instituto Nacional de la Juventud*) (Instituto de Psicología de la Pontificia Universidad Católica de Chile, 2014) shows a trend of young people preferring nowadays a good working environment, a good relation with their colleagues, and satisfaction with the work they are doing. Because of the characteristics mentioned previously about mining professionals must face, it is imperative that those who choose to study mining engineering do so by real vocation, since the near future is uncertain and it is highly probable that there will be low employability. It would be regrettable for someone to study something that they do not like only because they believe that they will get a high salary, wasting their financial resources that are often scarce to pay for their career and end up unemployed a large part of their life.

It can be inferred that in a scenario with low employability there will be two important effects: a substantial salary drop, reaching values even lower than those of 2006, and on the other hand, with so many offers of available engineers, they may displace to current mining technicians, occupying or competing for the positions that they occupy, such as nonprofessional foremen and supervisors. A possible third effect may be added, which is the migration of professionals to work in other countries.

A point that must be kept in mind is that students who have finished their studies but have not graduated also compete for jobs, in many cases getting their degrees several semesters or even years after leaving school, so this group can be an additional competing factor in work positions.

As a result, it can be stated that the careers linked with mining are not sustainable according to the effort and money invested in studying a long career and considering how costly is now education in Chile, all this in relation to the number of careers opened nowadays and the projected demand for professionals.

Finally, a question may be asked: Is it necessary for the State to invest money in training professionals with such an uncertain occupational future?

Conclusions and Recommendations

The academic exercise made in this paper gives a view of the perspective faced by mining engineers. Based on the sources examined and on the projected scenarios and the assumptions made, employability by 2023 may, in the best case, be close to 43%, and in the worst case around 12%.

One recommendation for the State is it must establish development policies for the country at middle and long-range in order to answer questions such as: what do we want to be or where do we want to be ten or thirty years from now? This would allow setting goals, and according to them, establish policies and plan the actions to achieve them, so it can be made better use of the resources to finance those careers that have priority for the country and will allow reaching those goals.

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