

## **TRIPLE HELIX 8**

# ***Innovation Challenges and Opportunities within the Brazilian Mining Industry (\*) (\*\*)***

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## **1. Introduction**

The paper discusses innovation management applied to the Brazilian mining industry, with special focus on the opportunities for innovation and on the related challenges for generating tangible outcomes.

The Brazilian mining industry has been growing significantly over recent years. The effects of the 2008 international crisis have been neutralized by the end of 2009 for most mineral commodities. Although the impact of the crisis has been significant, the country's mining activities have been recovering and expanding ever since, in particular, due to the upcoming international sporting events scheduled to take place in Brazil in 2014 and 2016 which are pushing several initiatives for new and upgraded infrastructure all across the country.

However, the challenges for mining companies operating in Brazil are not only related to profitability, sustainability, legislation and political issues but also associated to the introduction of innovations that will unlock value by modifying the way the Brazilian mining sector operates and expands.

The paper shows that the promising future of the country's mining industry is highly dependent upon a combined effort by the authorities, the mining companies and the research institutions towards the pro-active dissemination of innovation management focus on long-term results for the mining companies.

## **2. State-of-the-Art**

Recent publications (Marceau, 2007; Global Economics Ltd., 2001) report the successful application of innovation management for the development and the increase in competitiveness of the mining industry in countries such as Australia and Canada. On the other hand, the Brazilian mining industry

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has not achieved significant results from innovation efforts and the mining sector has not been active in accessing innovation funds and R&D grants over the last few years.

It is important to note that, back in 2005, the Brazilian government has introduced new legislation to increase the level of support for innovation initiatives in the private sector. As the country's economy is largely based on natural resources with core business such as mining and agriculture, significant growth will only be achieved with the introduction of new technologies and process improvements (Brazilian Ministry of Science and Technology, 2010).

The basis of this new legislation, known as "Lei do Bem" (Brazilian Law no. 11.196/2005), is to promote the benefits of investing in R&D and innovation. The tax incentive applies to the corporate income tax and the social contribution fee and it may accommodate up to 100% of the innovation project expenses.

Although "Lei do Bem" has been introduced over 5 years ago, the vast majority of the Brazilian mining companies still do not benefit from it. For instance, the mining sector generates approximately 13.9% of the Brazilian gross national product, but it has used only 0.1% of the overall innovation benefits provided by the government in 2008. Even more pronounced is the fact that only one mining company in the entire sector has been benefited in that year.

One apparent reason for the limited usage of R&D tax incentives is the risk of rejection of the tax benefit application which has increased from 9% in 2007 to 20% in 2008. This situation indicates that, although the Brazilian government is trying to promote R&D and innovation through incentives and resources, and although the companies are in need of innovation to expand their markets and their competitiveness, most business are not yet ready to fully exploit the benefits available.

As far as global companies are concerned, there is a growing competition for the R&D dollars. A number of countries, and even provinces within specific countries, have increased their tax incentives in recent years. The general objective for a government to offer R&D incentives is to promote successful innovation which will eventually generate more income and more jobs. However, the specific legislation varies from country to country, and although it applies to global companies doing in-house R&D, additional incentives for domestic business may also apply (KPMG, 2009). The findings of a preliminary analysis carried out recently in Brazil with the specific tax benefits identified in a selection of countries are shown in Table 1.

Table 1: Comparative Analysis of R&D Incentives

Country	Minimum	Maximum	Description of the Benefits
Australia	45%	45%	Tax credit for companies with income of up to Aus\$ 20 mi.
Canada	20%	40%	Income tax credit over R&D expenses
UK	n/a	n/a	Combines tax credits and income tax deductions
The Netherlands	n/a	n/a	Allows the partial deduction of R&D salary expenses
France	30%	50%	30% of the initial €100mi. spent in R&D and 5% thereafter
Brazil	60%	100%	Deduction in the income tax and social contribution fees

Modified from: Valor Economico (2010).

Although the benefits listed in Table 1 refer only to tax credits and deductions, it is clear that a well established R&D strategy can greatly benefit innovation-driven companies.

The essential component for an appropriate R&D strategy is the capability of the proponent in structuring winning innovation projects that produce the expected results for the receiving company.

### **3. Research Focus**

This section presents a brief overview of the Brazilian mining industry and it comments on the key innovation opportunities available. It also describes a results-oriented innovation approach that has been successfully applied to a number of projects within the Brazilian mining industry as illustrated in the case studies presented in the paper.

The innovation approach is based on the “Lei do Bem” but it is applied in such a fashion to maximize the R&D benefits and outcomes for companies operating in Brazil. The specific value proposition of the proposed innovation approach is to promote R&D at very low risk for mining companies that require innovation to expand their markets and their competitiveness, benefiting from the tax incentive and the innovation resources provided by the government.

#### **3.1 Overview of the Brazilian Mining Industry**

The Brazilian mining industry plays an important role as a global supplier of mineral products. The country’s mineral industry is constantly balancing out the relationship between the domestic production context and the opportunities for growth in the world’s economy.

The most important mineral product currently in Brazil is iron ore. Even with the country having one of the world’s highest index values for home construction deficit, the production of iron ore is still far above the recorded tonnages mined out for building materials and aggregates. This makes Brazil one of the leaders in iron ore production, with significant ore reserves of competitive quality and high production capacity.

The other mineral commodities for which Brazil holds a leading position (i.e., one of the top three world producers) are not necessarily the most important ones for the country’s economy as a whole. The country is known to have large reserves and yearly mined-out production of graphite, tantalum and niobium ores but these mineral commodities still do not represent a significant contribution to the country’s GNP. On the other hand, Brazil produces relatively high volumes with large economic value of aggregates and building materials, but their impact seems to be limited to the domestic trade and it does not hold significant importance globally.

Brazil is one of the top-three world producers of iron ore, bauxite, manganese, graphite, niobium and tantalum (USGS, 2008). The country maintains important participations in the world production of these substances, usually above 10% of the total, and almost monopolises the production of Niobium.

Mining’s contribution for the Brazilian GNP in 2007 was approximately 2%, which was more than R\$ 40 billion (DNPM, 2008). The main mineral product was iron ore, with a total production of 354.7 million tons valued in R\$ 19.2 billion in 2007, equivalent to 44% of the total value of the country’s overall mineral production.

The Brazilian total exports in 2007 were over US\$ 160 billion, having generated surplus of US\$ 40 billion (DNPM, 2008). The contribution of the mining industry, taking into account only the primary mineral goods (ore, concentrates and pellets), was 8.36% of the country’s exports and 2.95% of its imports. Iron ore’s relevance is highlighted again by its role in the international mineral trade, where 79% of the exports’ value came from iron ore sales, which took up 95% of the total mineral products exported (DNPM, 2008).

#### **3.2 Innovation Opportunities within the Brazilian Mining Sector**

As discussed above, Brazilian mining industry plays an important role as a global supplier of mineral products. The country’s mineral industry is constantly balancing out the relationship between the domestic production context and the opportunities for growth in the world’s economy.

The findings of this research team indicate that some of the key innovation issues within the local mining industry are related to:

- a) Technical Service Suppliers: the main challenge for service suppliers is to increase utilization and to reduce costs of their equipment through continuous improvement programmes which will promote safer operations with higher productivity. In this case, innovation initiatives are to

be focused on automation processes and training programmes to increase productivity and final quality of the services provided to the mining industry.

- b) Mining Companies: most companies have to deal with the challenge of balancing out investment, production costs and reclamation costs. The focus for innovation initiatives for the mining companies is therefore the management of these issues without impacting the final product quality and the company's safety goals.

This means that both the challenges and the investment levels required to fund innovation initiatives within the Brazilian mining industry are highly significant. Because all innovation projects carry within themselves a certain degree of risk of failure, the internal approval for such investments is generally a challenge even if the companies' executives are fairly certain of a successful outcome.

Another important issue is the high taxation conditions for a company to operate in Brazil. This situation affects both the international competitiveness and the willingness of a Brazilian operation to invest in P&D efforts. These challenges are commonly met with practices that include the simplification of innovation initiatives and the segmentation and reduction of projects. Such practices end up increasing the risk associated to the innovation projects resulting in extended execution times and the interruption of several innovation initiatives.

### 3.3 The proposed innovation approach

The innovation approach that has been developed by the research team is based upon the following key principles:

- a) Structuring innovation initiatives as business projects taking into account all the project stages such as preparation, innovation, pilot-study, evaluation and roll-out & replication plan.
- b) Consistent planning with effective and focused project management with focus on conclusive results.
- c) Collaborative environment between project team members including the participation of technology-specialists and process-specialists from the industry, from the universities and from professional consultancies.
- d) Continuous risk management and mitigation.
- e) Technical excellence through consistent methodology and highly competent teams.
- f) Financial support from innovation-subsided loans, tax incentives and allocation of internal costs on the innovation projects.

The key concepts explored by the proposed approach are the provision of feedback and of a learning environment for the mining company to implement a particular innovation on a larger-scale throughout the company. Because of this, and as described above, the proposed approach takes particular care in the preparation phase and on the testing, evaluation and roll-out planning stages of the innovation project, as illustrated in Figure 1.

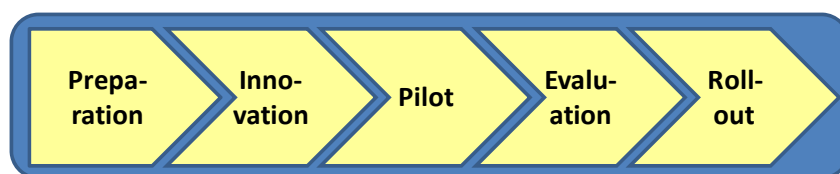


Figure 1: The "expanded" project concept.

The expanded project concept refers to the fact that the innovation projects managed with the proposed approach incorporate the essential stages of monitoring and evaluating the project outcomes, as well as the roll-out plan for the tested solution. Such additional tasks of the innovation project will provide a solid and reliable source of information for future implementations and will also guide the decision-making process (project continuation, scaling up or discontinuation) with robust data.

## 4. Findings and Analysis

The proposed innovation approach has been successfully applied and validated in a number of practical cases in Brazil, two of which are described below. The first case refers to a mining services

company in Brazil and the second example is an industrial minerals company with an opportunity to launch a new product, using a new mineral processing route.

The first case refers to a mining services company in Brazil. The company's management had identified a specific requirement to expand the functionalities of its ERP system to incorporate maintenance planning and production planning and control [PPC] routines for their service units based in a relatively large number of remote locations where the company operated. Such an integration of ERP with a custom-built PPC solution was identified as an innovation project opportunity where the proposed innovation approach has been successfully applied.

As a result, the company had an innovation loan approved by the Brazilian government of more than R\$ 4mi. which after deductions of R&D expenses and the related tax benefits came to an avoided cost of R\$ 2mi. (using a discount rate of 12% per annum, with interest rate of 5.5% per annum on the loan kicking off after 2 year and 8 further years for the innovation loan repayment).

The second example is an industrial minerals company with an opportunity to launch a new mineral product, using a new processing route. A purpose-specific, expanded project has been structured according to our innovation approach and it included mineral exploration studies for a pilot area, the required environmental permits, the development of a mineral processing route and all the investments to set up a pilot plant to produce the new mineral product.

The innovation loan approved for this project was nearly R\$ 11mi. and the company is to benefit fully from the tax deductions on the R&D expenses associated to the innovation project.

Table 2 shows the cash-flow summary of the first application example. 90% of the total project value of nearly R\$ 4.3 mi. has been financed with an innovation loan with its income divided between years 1 and 2. 34% of the appropriated project expenses have been deducted in years 2 and 3 (referring to the financial years 1 and 2), while additional 100% of the project expenses are also deducted as tax incentives according to "Lei do Bem" double-deduction principle.

*Table 2: Summary Cash-flow of the first application example of the proposed innovation approach*

YEARS		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	
<b>1 PROJECT VALUE</b>												
Expenses allowed as Operational Costs	100.00%	(2 187 692)	(2 205 889)									
<b>2 DEDUCTIBILITY AS OPERATIONAL COST</b>												
Reduction of the income tax	34.00%		471 622	474 839								
<b>3 TAX INCENTIVES OVER INCOME TAX</b>												
Deduction on the income tax base	100.00%		2 137 692	2 205 889								
Reduction of the income tax	34.00%		726 815	750 002								
<b>4 INNOVATION LOAN</b>												
Loan income	90.00%	1 918 923	1 985 300									
Grace period (months)	24											
Repayment term (months)	76			(616 456)	(616 456)	(616 456)	(616 456)	(616 456)	(616 456)	(205 485)		
Loan balance		1 918 923	3 904 223	3 287 767	2 671 310	2 054 854	1 438 398	821 942	205 485	(0)	(0)	
Loan repayments (per annum)	5.75%	(55 169)	(167 415)	(206 770)	(171 323)	(135 877)	(100 431)	(64 985)	(29 539)	(5 908)	0	
<b>5 PROJECT EXPENSES</b>		<b>(323 938)</b>	<b>810 433</b>	<b>401 615</b>	<b>(787 780)</b>	<b>(752 334)</b>	<b>(716 887)</b>	<b>(681 441)</b>	<b>(645 995)</b>	<b>(211 393)</b>	<b>0</b>	
<b>Project NPV (% per annum)</b>	<b>12.00%</b>	<b>(1 293 423)</b>										
<b>Company's own team</b>		<b>800 568</b>	<b>809 303</b>									
<b>Other deductions</b>		<b>240 400</b>	<b>361 000</b>									
<b>6 ACTUAL PROJECT EXPENSES</b>		<b>717 030</b>	<b>1 980 737</b>	<b>401 615</b>	<b>(787 780)</b>	<b>(752 334)</b>	<b>(716 887)</b>	<b>(681 441)</b>	<b>(645 995)</b>	<b>(211 393)</b>	<b>(0)</b>	
<b>Overall NPV (% per annum)</b>	<b>12.00%</b>	<b>568 972</b>										

Taking into account the company's standard discount rate of 12% and the loan repayment terms, i.e. interest rate of 5.25% per annum, 24 months of grace period and 76 months of repayment period, the

total investment of the company has been limited to just over R\$ 1.2 mi. (or only 27.8% of the overall project value). When the investments already committed by the company within years 1 and 2 were considered, the total project cost of the innovation project became an avoided cost of R\$ 593 k.

The second application example is shown in Table 3. In this case, 90% of the total project cost of over R4 10 mi. is financed with an innovation loan split into two income items in years 1 and 2. Applying the same logic as above, but considering the company's discount rate of 20% and the loan interest of 5.5% per annum, the total investment for the innovation project has been reduced to R\$ 1.45 mi. (or only 13.5% of the overall project value). When the investments already committed by the company are taken into account, the avoided cost for the innovation project was R\$ 1.40 mi.

*Table 3: Summary Cash-flow of the second application example of the proposed innovation approach*

YEARS		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
<b>1 PROJECT VALUE</b>											
Expenses allowed as Operational Costs	100.00%	(8 911 335)	(1 754 500)	-	-	-	-	-	-	-	-
<b>2 DEDUCTIBILITY AS OPERATIONAL COST</b>											
Reduction of the income tax	34.00%	-	2 846 254	592 450	-	-	-	-	-	-	-
<b>3 TAX INCENTIVES OVER INCOME TAX</b>											
Deduction on the income tax base	100.00%	-	7 129 068	1 403 600	-	-	-	-	-	-	-
Reduction of the income tax	34.00%	-	2 423 883	477 224	-	-	-	-	-	-	-
<b>4 INNOVATION LOAN</b>											
Loan income	90.00%	8 020 202	1 579 050	-	-	-	-	-	-	-	-
Grace period (months)	24	-	-	-	-	-	-	-	-	-	-
Repayment term (months)	76	-	-	(1 515 671)	(1 515 671)	(1 515 671)	(1 515 671)	(1 515 671)	(1 515 671)	(505 224)	-
Loan balance		8 020 202	9 599 252	8 083 580	6 567 909	5 052 238	3 536 566	2 020 895	505 224	(0)	(0)
Loan repayments (per annum)	5.75%	(220 556)	(484 535)	(486 278)	(402 916)	(319 554)	(236 192)	(152 830)	(69 468)	(13 894)	0
<b>5 PROJECT EXPENSES</b>		(1 111 689)	4 610 152	(932 275)	(1 918 587)	(1 835 225)	(1 751 863)	(1 668 502)	(1 585 140)	(519 117)	0
<b>Project NPV (% per annum)</b>	<b>12.00%</b>	<b>(1 448 810)</b>									
<b>Company's own team</b>		<b>800 568</b>	<b>540 000</b>	<b>12 000</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>Other deductions</b>		<b>240 400</b>	<b>1 200 000</b>	<b>2 000 000</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>6 ACTUAL PROJECT EXPENSES</b>		<b>628 311</b>	<b>6 622 152</b>	<b>(932 275)</b>	<b>(1 918 587)</b>	<b>(1 835 225)</b>	<b>(1 751 863)</b>	<b>(1 668 502)</b>	<b>(1 585 140)</b>	<b>(519 117)</b>	<b>(0)</b>
<b>Overall NPV (% per annum)</b>	<b>12.00%</b>	<b>1 398 413</b>									

Because the approach joins the tax benefits of “Lei do Bem” with purpose-specific innovation loans, the companies that have applied the approach were able to maximize the benefits of their R&D expenditure without having to depend upon the positive results of the innovation projects. Once the actual results of the innovation initiatives are accounted for, the estimated results of the projects will become highly positive.

## 5. Contributions and Comments

The paper proposes a new approach for supporting winning innovation projects with the objective of encouraging mining companies to further exploit the R&D benefits provided by the Brazilian government.

Because most mining companies are taking up ambitious growth programmes, the authors strongly believe that a strong focus on continuous improvement and operational savings activities is required. Such growth plans will be maximized through the definition of structured, results-oriented innovation strategies and implementation approaches.

However, the main challenge is to change the current innovation culture of most mining companies. A significant portion of the company's managers and executives are highly averse to risk and most operations lack in project planning and management practices. This situation creates an environment focused on short-term corrective action rather than enabling an innovative and creative context within the company.

Brazil's requirement for value-added processes within its industrial activities is widely known. Its mining industry is a particularly critical sector because its output is still highly dependent upon the commercialization of mineral commodities with low aggregate value. One of the most promising paths to overcome such limitation for the country's sustainable growth is the development of innovation initiatives which can be implemented and rolled-out productively in local operations.

The conditions established by the Brazilian government for the steering local companies towards productive innovation initiatives. Such conditions have been tested under the new approach for developing successful innovation projects proposed by this research team. The results have shown the local government conditions to be comprehensive, practical and highly attractive for Brazilian companies. In addition, financial sources for innovation are abundant and are offered through highly specialized and professional banking mechanisms.

Therefore, there are significant opportunities for innovation in the Brazilian mining industry and the country's government is offering funds and mechanisms to steer local companies towards low-risk innovation initiatives. The main challenge for the mining companies is to change their innovation approached and culture because the local conditions for technological development are available and the companies' heads should quickly learn how to benefit from them.

## 6. References

- Brazilian Ministry of Science and Technology (2010). Website: <http://www.mct.gov.br>, accessed in 28 June 2010.
- DNPM (2008). Sumário Mineral Brasileiro 2008. Departamento Nacional de Produção Mineral. Available at <[www.dnpm.gov.br](http://www.dnpm.gov.br)> (accessed on July 24, 2009).
- Global Economics Ltd (2001). "Mining Innovation: An overview of Canada's dynamic, technologically advanced mining industry". The Mining Association of Canada, November 2001.
- KPMG (2010). "Special Report: Focus on Tax". Website: [www.CompetitiveAlternatives.com](http://www.CompetitiveAlternatives.com), accessed in 10 April 2010.
- Marceau, J. (2007). "The knowledge tree: CSIRO in Australia's innovation systems". Innovation Management, Policy & Practice. Volume 9, Issue 2, September 2007. eContent Management Pty Ltd. pp 98–112.
- USGS (2008). Minerals Yearbook – 2006: Brazil. U.S. Geological Survey. Available at: <http://minerals.usgs.gov/minerals/pubs/country/2006/myb3-2006-br.pdf> , accessed in July 24, 2009.
- Valor Economico (2010). Edition of 7th June 2010. Valor Economico SA. <http://www.valoronline.com.br>