

# Identification of External Risks Affecting the South African Mining Sector and Their Mitigation Strategies

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## Abstract

The mining sector plays a huge role in building the economy of different countries. The contribution of the mining industry to the gross domestic product in South Africa has declined over the years due to different challenges such as risks and uncertainties. The main purpose of the study was to identify the external risks affecting the mining industry in South Africa and their mitigation strategies.

A total of 21 mines from 6 South African provinces were covered. The commodities covered in the study include gold, platinum, coal, copper, iron ore, and diamond. The external risks affecting mines globally that were identified from the literature review include fluctuation of commodity prices risk, volatility of exchange rates risk, political risk, environmental risk, health risk and pandemics risk. The survey used in the study revealed that South African mines are also faced with similar risks. Some more risks affecting South African mining that were identified through the questionnaire include illegal mining, attracting and retaining skilled labour, cyber-attacks, socio-economic challenges, load shedding and HIV/AIDS. The results revealed that most mining companies apply similar mitigation strategies such as hedging and insurance to combat the external risks.

## Keywords

External Risk, Mitigation Strategies, Mining Sector, South Africa

## 1. Introduction

The mining industry has always played a crucial role in human existence. It is one of the top two earliest human endeavours together with agriculture (Balasubramanian, 2017). The global mining industry has from the past experienced difficult times, with various challenges that involve the political and economic stability of countries (Mining and Quarry world, 2019). The concern regarding global production and supply of minerals continues with more interest on critical minerals which are used for new or green technology (Brown, et al., 2018).

South Africa is one of the top ten producers of gold, platinum, coal and diamond (Phakathi, 2017). Additional minerals produced in the country in notable quantities include manganese, chromite, nickel and phosphate (DMR, 2017). According to Mckinsey (2019), the mining value chain contributes above 300 billion to South Africa's gross domestic product (GDP). Vegter (2019) stated that in 1980, the mining industry was the second biggest contributor to South Africa's GDP at 21% just after the manufacturing industry that contributed 22%, although the mining industry declined to 6<sup>th</sup> place in 2016 at 8% and 7% in 2018.

Besides the South African mining industry being of paramount importance, it has experienced local and global socio-economic problems that have led to its reduction in competitiveness and performance (Phakathi, 2017). One of the

challenges facing the industry is risks and uncertainties. According to Trench et al. (2014), mining risks can be classified into 3 categories, namely: safety risks, technical risks and external risks. Mine safety risks refer to the chances of employees being harmed or injured in the work environment, technical risks refer to risks associated with the technicalities of mining, while external risks refer to elements outside of the mine that have the potential of disrupting mining activities or those that can cause a threat to the feasibility of mining.

External risks if not expected and planned for, can negatively impact the mining industry and the country at large. Some of these mine challenges lead to outcomes such as the decline in mine foreign direct investment, the closing down of shafts, some mines being under care and maintenance, bankruptcies of certain operations and a constant decrease in the net profit margin of some of the successful companies (Marsh, 2015). The research aims to identify the external risks affecting the South African mining sector and the strategies that can be used to mitigate those risks. Risk evaluation assist organizations with development of corporate governance, securement of company assets and resources, optimization of strategic management, and reduction of reactive decision-making (Meiryani, 2018).

## **2. Literature Review**

Mining organizations face a lot of risks that have to be properly managed for the success of the industry. Risk refers to the probability that the actual event may be different than the planned or expected event or the effect of uncertainty that could have a negative impact on achieving the business objectives (Najjaar, et al., 2017).

### **2.1. Identification of External Risks Affecting Mines Globally**

The following are the identified external risks that affect mines globally

#### **Fluctuation of Commodity Prices**

Studies reveal that there has been a high fluctuation of commodity prices over the last two decades (Magud and Sosa, 2017). The fluctuation continues to stir a variation of concern from the makers of policy and macroeconomics, emphasising the value of analysing commodity prices (Sekine and Tsuruga, 2018). The results of commodity fluctuations can affect companies in different ways, the fall of commodity prices can lead to a decrease in sales revenue for producers, decrease in input costs for commodity consumers and decrease in production viability (Barned, 2012). The rise of commodity prices can increase sales revenue for producers and reduce profitability for consumers (Barned, 2012), producers might want to increase supply, which may result in a competition.

#### **Volatility of Exchange Rates**

Exchange rates volatility impacts growth (Dumitrescu, et al., 2012). The volatility of exchange rates can lead to market uncertainty, inflation uncertainty, volatility in profit of traders, unfavourable balance of trade and impacts on production costs (Soleymani and Chua, 2014). Several studies show that exchange rate volatility can discourage exports, some findings however suggest exchange rate volatility has a mixed impact on exports (Sugiharti, et al., 2020). The exchange rate volatility affects struggling economies more than they affect thriving economies (Soleymani and Chua, 2014).

#### **Political Risk**

Political risk can be referred to as the possibility of occurrence of uncertainty that has the potential to affect or harm economic or business operations or the probability of political events, decisions and conditions of a country affecting the business environment in a manner that profit margins for investors will be decreased or investors losing money (Campisi and Caprioni, 2017). In most cases, these risks arise from factors such as government institutions, societal characteristics, government policies and economic structures (Campisi and Caprioni, 2017).

#### **Environmental Risk**

Natural disasters are capable of destroying the normal functioning of society. They pose huge threats to the environment, property and life. They can either be caused by nature, human activities or accidents (Penna and Rivers, 2013). According to Deraniyagala (2016), in the classifications of most frequent mineral supply disruptions, natural disasters came third after accidents and labour unrests. Natural disasters can cause interruptions such as mine closures, damage to employees' homes and travelling routes, power outages and physical damage to the mine.

**Health Risk**

Although mining is an important aspect of most countries’ economies, it can be a source of ill health due to unsafe working environment and work procedures (Pilusa and Mogotlane, 2018). Depending on the kind of commodity being excavated, mining exposes mineworkers and communities to different hazardous injuries, materials and occupational diseases. Many companies receive health compensation litigations either from employees that worked for the mine years back or from community members that got affected due to mining happening in their communities.

**Pandemics/Epidemics Risk**

Epidemics or pandemics are infectious diseases that affect a lot of people, wide geographic areas and crosses international borders. The diversity and number of infectious diseases have significantly risen since the 1980s (Kavanagh, et al., 2019). The intensity of some of the diseases is affected by factors such as weather and climate.

**2.2. Global External Risks Mitigation Strategies**

Table 1 below is a summary of the mitigation strategies that are used by different mining operations globally to combat the external risks. The table represents a summary, some operations combine and apply some of these strategies simultaneously or one at a time, depending on the state of the organization at that point in time.

Table 1: Summary of global external risks mitigation strategies

Risk	Strategies	Source
Fluctuation of commodity prices	<ul style="list-style-type: none"> <li>Hedging, commodity sourcing</li> </ul>	(Ding, et al., 2019), (Maniar, 2017) (Pellegrino, et al., 2019)
The volatility of exchange rates	<ul style="list-style-type: none"> <li>Operational flexibility, hedging currency swaps and multi-currency diversification</li> </ul>	(Juan, et al., 2020) (Yu, et al., 2020)
Political	<ul style="list-style-type: none"> <li>Insurance, local joint venture, employing a lobbyist and increasing the hurdle rate</li> </ul>	(Gertz, 2018), (Giambona, et al., 2017)
Environmental	<ul style="list-style-type: none"> <li>Increase design and construction standards, pumping equipment and backup generators, multiple transport routes, insurance, review emergency procedures and develop contingency plans</li> </ul>	(Smith, 2016)  (Nelson and Schuchard, 2011)
Health	<ul style="list-style-type: none"> <li>Minimizing carbon emissions, promoting energy efficiency, limitation of radioactivity doses, strengthening and improvement of routine practices related to workplace health and safety</li> </ul>	(GB Minerals, 2015)  (Zhou, et al., 2018)
Pandemics	<ul style="list-style-type: none"> <li>Employee education and health promotion, reporting and communication, learning from previous experiences of pandemics and more research</li> </ul>	(Magubane, 2020)  (Djalante, et al., 2020)

### 3. Methodology

Saunders et al. (2019)'s research onion was used to dissect the study's methodological process. The layers of Saunders et al. (2019)'s research onion, consist of research philosophy, research approach, research choices, research strategy, research time horizons, and research techniques and procedures, from the outer layer to the inner layer respectively. The researcher's philosophical view of this study is pragmatism. The researcher used the inductive research approach because the researcher had no hypothesis before the commencement of the research. The findings and conclusion of the study were derived from the data collected. A survey was used as research strategy, and an online google forms questionnaire with both qualitative and quantitative questions was used to gather data. Cronbach's alpha and exploratory factor analysis were used to determine the reliability and validity of the questionnaire. The researcher carried the study using cross-sectional time horizon because of suitability and also due to time and financial constraints.

### 4. Data Collection

The research question was answered by the use of a questionnaire. The questionnaire was divided into 4 sections, with section 1 to 3 being closed-ended questions and section 4 being open-ended questions. The population were mine employees from different mines across South Africa, specifically, graduates (mining and related fields such as geology, metallurgy, safety and rock engineering) and those employees in management positions starting from the miner, including all other positions above the miner such as shift boss, section manager, production manager and mine manager. The researcher specifically chose these requirements because these individuals would most likely possess the necessary knowledge required to answer the questionnaire. The researcher searched for qualifying participants using LinkedIn, social media and word of mouth. The researcher further asked for referrals of qualifying participants from the participants that the researcher initially contacted. The researcher sent out the questionnaire link to all participants by herself, no participant was requested to forward the questionnaire link to someone else. The research data was collected from 67 individuals out of 108 (62% response rate) from 21 mining operations in 6 provinces of South Africa.

### 5. Results and Discussion

#### 5.1. Validation

##### Reliability

Cronbach's alpha (Cronbach, 1951) was used to determine the reliability of the research instrument. Cronbach's alpha gauges the reliability of a questionnaire by determining the internal consistency of items on a survey instrument (Cronbach, 1951). The alpha coefficient ranges from 0 to 1, the acceptable values of alpha ranges from 0.70 to 0.95 (Tavakol and Dennick, 2011). The Statistical Package for the Social Sciences (SPSS) software was used to determine the alpha coefficients. Table 2 below shows the Cronbach's alpha results of section 2 and 3 of the questionnaire.

Table 2: Reliability test results

Section 2 of the questionnaire			Section 3 of the questionnaire		
Variable no	Number of items	Cronbach's alpha	Variable no	Number of items	Cronbach's alpha
1	4	0.53	1	2	0.35
2	3	0.61	2	4	0.71
3	2	0.80	3	4	0.51
4	2	0.75	4	5	0.89
5	2	0.60	5	4	0.75
			6	5	0.86

Six variables have a good Cronbach's alpha above 0.7. Two other variables have a Cronbach's alpha above 0.6 which is moderate. Three variables have a Cronbach's alpha below 0.6, which means the results of these variables must be treated with caution.

### Validity

The researcher used face validity, content validity and construct validity to determine whether the instrument measures what it intended to. The research instrument was given to untrained people who have no knowledge of the subject, to determine the face validity of the instrument. The research instrument was also given to 3 experts in the mining industry to measure the appropriateness of the instrument for content validity.

The exploratory factor analysis was used to determine the construct validity of part 3 of the research instrument. The exploratory factor analysis was only used for part 3 of the questionnaire because it cannot be used with the kind of data in the other sections, that is, dichotomous data in part 2 and qualitative data in part 4.

The purpose of factor analysis is to reveal any hidden variable that causes the distinct variables to covary (Costello and Osborne, 2005). Table 3 below shows the factor loadings, which describe the relationship between each item and each extracted factor. Factor loadings have a relative value, that is, the higher factor loadings indicate a stronger relationship between the items and the factors. All the Likert scale items had a factor loading greater than 0.3, which means all items had construct validity. The obtained KMO value of the items is 0.75, which means there was no sample size issue.

Table 3: SPSS validity test results

Variables	Item	Factor loadings	Variables	Item	Factor loadings
1	1	0.945		3	0.789
	2	0.674		4	0.702
2	1	0.918		5	0.568
	2	0.714	5	1	0.388
	3	0.941		2	0.533
	4	0.926		3	0.456
3	1	0.840		4	0.684
	2	0.495	6	1	0.624
	3	0.622		2	0.786
	4	0.574		3	0.872
4	1	0.973		4	0.683
	2	0.738		5	0.917

## 5.2. Numerical Results

### Demographics

F = Number of respondents

Table 4: Demographics

Number of mines	Commodities	F	Provinces	F	Highest qualification	F	Discipline	F	Experience (years)	F
21	Copper	2	Gauteng	14	Certificate	6	Mining	42	<3	1
	Gold	21	Limpopo	16	Diploma	27	Geology	8	3-5	5
	Iron ore	8	Northern Cape	11	Degree	17	Safety	13	5-10	27
	Platinum	17	Free State	11	Honours	15	Metallurgy	1	10-15	25
	Diamond	14	Mpumalanga	5	Masters	2	Rock Engineering	1	15-25	8
	Coal	5	North West	10			Survey	1	>25	1
							Mechanical Engineering	1		

Table 4 above shows the demographics of all the participants. A total of 21 South African mines were covered. The minimum number of participants per mine was 2 people and the maximum number of respondents per mine was 5 people. The nature of the questions in the survey required participants with post-matric qualification or participants that are in management positions. All the respondents who participated had a post-matric qualification, with most participants having a diploma, followed by a degree and honours degree. Only two participants had masters degrees.

Out of the 67 respondents, 42 are in mining directly and the rest of the respondents belong to different departments. This is because departments in any mine form only a small percentage of the total workforce. The purpose of different departments at mines is to support the main mining department. Seventy seven point six percent (77.6%) of the participants have a working experience between 5 and 15 years, 9% below 5 years experience and 13.4% above 15 years experience. The more the experience, the more the knowledge. With over 70% of the participants being between 5 and 15 years and 13,4% above 15 years, the researcher is confident that the participants are informed and at the right position to answer the survey questions.

### Identification of Risks

External risks affecting mines globally that were identified from the literature review were used as a basis to identify external risks in South African mines, Table 5 below shows the identification of risks responses from participants. The 5 variables in this section had Cronbach's alpha of 0.53, 0.61, 0.80, 0.75 and 0.60 respectively as can be referred to in table 2. This means the results of variable 1, 2 and 5 have to be treated with caution due to the low internal consistency of the items.

Table 5: Identification of external risks results

	Yes		No	
	F	%	F	%
<b>Has any of the following risks ever affected your operations in any way?</b>				
Fluctuation of commodity prices	67	100	0	0
Volatility of exchange rates	65	97	2	3
Pandemics/epidemics	67	100	0	0
Labour relations	66	99	1	1
<b>Has the following governmental actions ever affected your operations in any way?</b>				

Government Instability	61	91	6	9
Government regulations	66	98	1	2
Corruption	63	94	4	6
<b>Was your company ever affected by any of the following environmental challenges?</b>				
Natural disasters	1	1	66	99
Climate change problems	61	91	6	9
<b>Has your company ever experienced the following as a result of employee health issues?</b>				
Civil unrest	14	21	53	79
Compensation litigations	28	42	39	58
<b>Has any of the following risks from mining communities affected your operation in any way?</b>				
Land claims	21	31	46	69
Social unrest	48	72	19	28

Certain external risks such as fluctuation of commodity prices and volatility of exchange rates affect all mining operations, locally and globally, that is, they cannot be avoided. Risks such as pandemics occur unexpectedly and also cannot be avoided. Political risks such as corruption depend on the political climate of a country, 94% of the participants stated that corruption does affect their operations. Certain external risks such as environmental risks depend on the location of a country, that is, there are certain countries that are susceptible to natural disasters while countries such as South Africa rarely experience natural disasters, also if they occur, they do so with lower magnitudes. 91% of the participants responded that climate change issues do affect their operations, this is because climate change in South Africa just like globally is a huge challenge.

Only 42% of the participants stated that their operations do get affected by health compensation litigations, 75% of which are from gold mining. This is because the rock mined in gold mines contains silica, which is very harmful. Silicosis which is caused by silica dust can take years to manifest, most workers only realise they have been affected after retirement and hence pursue compensation litigations. 14% of those affected by compensation litigations are from coal mining due to the coal mine dust which is also harmful. Coal mining only counts for 14% of the compensation litigations because only two coal mines were covered in the study. The researcher believes that if more coal mines were covered the percentage would have been higher.

Out of the 67 respondents, 46 respondents stated that they do not get affected by land claims and 21 stated that they do. The issue of land claims depends on the different operations and the areas they are based at, that is, either in remote areas or closer to communities. Land claims in mining usually occur when members of communities close to mines are re-claiming the land that was stolen from them in the past or in surface mining operations whereby the extension of the operations or the pit reaches or passes the boundaries of the land owned by the communities.

72% of the recorded operations get affected by social unrests. One of the government requirements from mines before they get approved for mining licence is the social labour plan, which is a document that states how the mines will develop the communities they operate in. Some mining companies keep their promises which lead to happy communities and no social unrests while others do not, which lead to social unrests.

### **Risk Mitigation Strategies**

Table 6 below shows risk mitigation strategies responses from participants. The Cronbach's alpha of the 6 variables in this section are 0.35, 0.71, 0.51, 0.89, 0.75 and 0.86 respectively as shown in table 2. The results of variables 1 and 3 have to be treated with care due to the low internal consistency. All the items in this section had construct validity.

Table 6: Risk Mitigation Strategies Results

		Never		Rarely		Sometimes		Often		Always	
		F	%	F	%	F	%	F	%	F	%
<b>Risk</b>	<b>Mitigation strategies</b>										
<b>Fluctuation of commodity prices</b>	Hedging	1	1	13	19	6	9	45	67	2	3
	Commodity sourcing	0	0	12	18	24	36	31	46	0	0
<b>Volatility of exchange rates</b>	Operational flexibility	1	1	2	3	18	24	34	51	12	18
	Hedging	2	3	9	13	14	21	40	60	2	3
	Currency swaps multi-currency diversification	2	3	9	13	50	75	6	9	0	0
	Multi-currency diversification	2	3	10	15	49	73	6	9	0	0
<b>Political</b>	Insurance	0	0	10	15	16	24	39	58	2	3
	Local joint venture partner	0	0	2	3	11	16	32	48	22	33
	Employ a lobbyist	2	3	19	28	25	37	20	30	1	1
	Increasing the hurdle rate	2	3	2	3	62	93	1	1	0	0
<b>Environmental</b>	Insurance	1	1	0	0	15	22	39	58	12	18
	Increase design and construction standards	0	0	1	1	4	6	31	46	31	46
	Multiple transport routes	1	1	2	3	1	1	30	45	33	49
	Pumping equipment and backup generators	1	1	1	1	3	9	20	30	42	63
	Review emergency procedures and develop contingency plans	0	0	0	0	8	12	29	43	30	45
<b>Health</b>	Improvement of routine practices	0	0	1	1	4	6	25	37	17	25
	Minimizing carbon emissions	0	0	2	3	5	5	36	54	24	36
	Incorporation of engineering measures into design.	0	0	0	0	8	12	22	33	37	55
	Limitation of radioactivity doses	0	0	1	1	2	3	51	76	13	19
<b>Pandemics</b>	Employee education and health promotion	0	0	1	1	1	1	21	31	44	66
	Reporting and communication	0	0	1	1	1	1	18	24	47	70
	Learning from previous experiences of pandemics	1	1	2	3	1	1	15	22	48	72
	More research	0	0	0	0	5	8	44	66	18	24



Access to personal protective equipment	1	1	0	0	1	1	26	39	39	58
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As can be seen from table 6, most participants responded that their organizations do use the listed external risk mitigation strategies, the difference is in the frequency of usage. This is because organizations try and use different strategies, either simultaneously or one at a time to try and combat the risks. Only less than 3% of the participants responded that their organizations never use a certain strategy, which is a very small percentage, that is, we can conclude that most organizations have used different strategies to combat external risks in their operations.

Table 7 below shows external risks affecting South African mines listed by participants together with their mitigation strategies. Some risks were however listed without mitigation strategies, which calls for further research on strategies that can be used to mitigate those risks.

Table 7: External risks listed by participants and suggested mitigation strategies

External risks in South African mines	Suggested mitigation strategies
Illegal mining	<ul style="list-style-type: none"> <li>• Stricter security measures</li> <li>• Employee and community anti-criminal awareness</li> </ul>
High competition and decrease in global demand	<ul style="list-style-type: none"> <li>• Marketing</li> <li>• Leveraging footprint to add value</li> </ul>
Attracting and retaining Skilled labour	<ul style="list-style-type: none"> <li>• Introduction of retention bonuses</li> <li>• Research and apply measures to attract and keep skilled labour</li> </ul>
Cyber attacks	<ul style="list-style-type: none"> <li>• Protective measures for IT and understand their levels of exposure</li> <li>• Awareness</li> </ul>
Socio economic challenges	<ul style="list-style-type: none"> <li>• Community development programmes                             <ul style="list-style-type: none"> <li>• Community involvement</li> </ul> </li> <li>• Establish long term partnerships with communities on social issues</li> <li>• Strategic contracts awarded to local suppliers</li> </ul>
Load shedding	No strategies recommended
HIV/AIDS	No strategies recommended
Labour unrests from contractors	No strategies recommended
Divestment impediments	No strategies recommended

### 5.3. Proposed Improvements

For those external risks that cannot be prevented or avoided by individual companies, such as pandemics, companies should rather incorporate mitigation strategies in their operational and financial plans. Although the strategies cannot eliminate the risks, the impacts of external risks are reduced for companies that are better prepared as compared to companies that are not prepared. Some of the results of the impacts of external risks such as the increase in operational costs will be avoided. For other external risks such as health risk, illegal mining and cyber-attacks that depends on the management of an organization, companies should actively engage in research on strategies they can employ in their organizations so they can always be prepared to avoid impacts.

## 6. Conclusion

The external risks affecting mines globally that were identified from the literature review include fluctuation of commodity prices, volatility of exchange rates, political risks, environmental risk, health risk and pandemic risks. The survey which used the external risks identified globally as a basis of identifying external risks in South Africa revealed that South African mines are also faced with similar risks. Some more risks affecting South African mining that were identified through the questionnaire include illegal mining, high competition and decrease in global demand, attracting and retaining skilled labour, cyber-attacks, socio-economic challenges, load shedding, HIV/AIDS, contractor labour unrests and divestment impediments.

It was deduced from the study that there is no particular correlation between the risks. Certain external risks such as fluctuation of commodity prices affect all mining operations, locally and globally and will always be there as long as the mines are operating and trading. Certain external risks affect operations depending on the geographical location of an operation, a country's governance, and type of commodities mined, while other external risks affect operations randomly. When these risks strike in different operations, the outcomes are mostly different as they depend on how the specific risks were handled. Although operations apply different mitigation strategies to combat the risks, certain strategies are popular within operations such as the hedging strategy for risks such as fluctuation of commodity prices and strategies such as insurance for environmental and political risks. It was also revealed that most operations use many different strategies, either simultaneously or one at a time depending on the state of the organization then.

The impacts of external risks on operations listed by participants include: loss of production, high production costs, loss of mining rights, damage to mine properties and elevated social instability, while the impacts of external risks on employees include retrenchments, loss of lives and loss of other beneficial work incentives. 80% of all the participants mentioned the loss of jobs or retrenchments as the main impact on employees. This is of high concern, especially in a country like South Africa with a high unemployment rate and high levels of poverty. The research also revealed that poor countries or poor and marginalized communities get impacted more by the consequences of uncertainties that were not planned for as compared to countries with enough resources.

## References

- Badri, A., Nadeau, S. & Gbodossou, A. A Mining Project is A Field of Risks: A Systematic and Preliminary Portrait of Mining Risks. *Journal of Safety and Security*, 2(2), pp. 145-166, 2012.
- Balasubramanian, A. An overview of mining methods. *Centre for advanced studies in earth science*, pp. 1-8, 2017.
- Barned, J. *Achieving Financial Success – an essential guide for small business*, Australia: CPA Australia Ltd, 2012.
- Brown, T. J., Idoine, N. E., Raycraft, E. R. & Shaw, R. A. World Mineral Production 2012-16. *British geological survey*, pp. 1-87, 2018.
- Campisi, J. M. & Caproni, E. Social and political risks: Factors affecting FDI in China's Mining sector. *Thunderbird International Business Review*, 59(6), pp. 709-724, 2017.
- Costello, A. & Osborne, J. Best practices in exploratory factor analysis: four recommendations for getting the most from your analysis. *Practical Assessment, Research, and Evaluation*, 10(10), pp. 1-9, 2005.
- Cronbach, L. J. Coefficient alpha and the internal structure of tests. *Psychometrika*, Volume 16, pp. 299-334, 1959.
- Deraniyagala, S. Economic recovery after natural disasters. *UN Chronicle*, 53(1), pp. 31-34, 2016.
- Ding, S., Zhang, Y. & Duygun, M. Modeling price volatility based on a genetic programming approach. *British journal of management*, Volume 30, pp. 328-340, 2019.
- DMR. *Annual Report 2017/2018*, Pretoria: Department of Mineral Resources, 2017.
- Dumitrescu, E., Arezki, R., Freytag, A. & Quintyn, M. *Commodity prices and exchange rate volatility: lessons from South Africa's capital account liberalization*. Washington D.C: International Monetary Fund, 2012.
- GB Minerals, 2015. *Summary of impacts and mitigation measures*, Farim: Knight piesold.
- Gertz, G. Commercial diplomacy and political risk. *International studies quarterly*, Volume 62, pp. 94-107, 2018.
- Giambona, E., Graham, J. R. & Harvey, R. H. The management of political risk. *Journal of international business studies*, Volume 48, pp. 523-533, 2017.
- Juan, D., De-bing, N. & Xiao-wo, T. Exchange rate risk hedging and wholesale price contract under demand and exchange rate risk pooling. *International conference on service systems and service management*, pp. 1-5, 2020.
- Kavanagh, M., Thirumurthy, H., Katz, R. & Ebi, K. Ending pandemics : US foreign policy to mitigating today's outbreaks and the health impacts of climate change. *Journal of international affairs*, 73(1), pp. 1-16, 2019.
- Magubane, K., 2020. *fin24*. [Online]  
Available at: <https://www.news24.com/fin24/Companies/Mining/minerals-council-unveils-9-point-plan-to->

[mitigate-coronavirus-risk-at-mines-20200306](#)

[Accessed 02 August 2020].

- Magud, N. & Sosa, S. Corporate Investment in Emerging Markets: The role of Commodity Prices. *Economia*, 18(1), pp. 157-195, 2017.
- Maniar, H. Scenario of commodity risk. *The journal of modern project management*, 4(3), pp. 75-85, 2017.
- Marsh. *Mitigating Off Strategy Risk: Mining Industry Risk Challenges and Solutions*, United Kingdom: Marsh Ltd. 2015.
- Mckinsey. *Putting the shine back into South African mining*, Johannesburg: Mckinsey & Company, 2019.
- Meiryani, A., The importance of risk management in an organization. *International journal of scientific & technology research*, 7(11), pp. 103-107, 2018.
- Mining and Quarry world, 2019. India developments: India-intense period adapting to change. 16(6), 2019.
- Najjaar, R., Yasseen, Y. & Small, R. *Risk Management*, Johannesburg: South African institute of professional accountants, 2017.
- Nelson, J. & Schuchard, R. *Adapting to climate change: A guide for the mining industry*, New York: BSR, 2011.
- Pellegrino, R., Constantino, N. & Tauro, D. Journal of Purchasing and supply management. *Supply chain finance: A supply chain*, 2019.
- Penna, A. N. & Rivers, S. J. *Natural disasters in a global environment*. 1st ed. Hoboken, New Jersey: John Wiley and Sons, 2013.
- Phakathi, S. *Production, safety and teamwork in a deep level mining workplace: perspectives from the rock face*. 1st ed. Howard House, Wagon Lane: Emerald publishing limited, 2017.
- Pilusa, M. L. & Mogotlane, M. S. Worker knowledge of occupational legislation and related health and safety benefits. *Curations*, 41(1), pp. 1-6, 2018.
- Saunders, M., Lewis, P. & Thornhill, A. *Chapter 4: Understanding research philosophy and approaches to theory development*. 8th ed. Harlow, United Kingdom: Pearson Education Limited, 2019.
- Sekine, A. & Tsuruga, T. Effects of commodity price shocks on inflation: a cross-country analysis. *Oxford Economic papers*, 70(4), pp. 1108-1135, 2018.
- Smith, M. *Assesing climate change risks and opportunities for investors*, Australia: Investor Group on Climate Change, 2016.
- Soleymani, A. & Chua, S. Y. Effect of exchange rate volatility on industry trade flows between Malaysia and China. *The journal of international trade and economic development*, 23(5), pp. 626-655, 2014.
- Sugiharti, L., Esquivias, M. A. & Setyorani, B. The impact of exchange rate volatility on Indonesia's top exports to the five main export markets. *Heliyon*, 6(1), pp. 1-14, 2020.
- Taherdoost, H. Validity and reliability of the research instrument ; how to test the validation of a questionnaire/survey in research. *International journal of academic research in management*, 5(3), pp. 28-36, 2016.
- Tavakol, M. & Dennick, R. Making sense of Cronbach 's alpha. *International journal of Medical Education*, Volume 2, pp. 53-55, 2011
- Trench, A., Packey, D. & Sykes, J. P. Non-Technical risks and their impact on the mining industry. *Mineral Resource and Ore Reserve Estimation*, pp. 605-617, 2014.
- Vegter, I. *Why Mining Still Matters: The socio economic importance of the mining industry*, Johannesburg: South African Institute of Race Relations, 2019.
- Yu, X. et al. Hedging the exchange rate risk for international portfolios. *Mathematics and computers in simulation*, Volume 73, pp. 85-104, 2020.
- Zhou, L., Cao, Q. & Yu, K. Research on occupational safety, health management and risk control technology in coal mines. *International journal of environmental research and public health*, pp. 1-13, 2018.

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