ESTIMATING THE INCIDENCE OF OPERATIONAL RISKS ON CORPORATE SUSTAINABILITY IN THE CEMENT INDUSTRY THROUGH FINANCIAL SIMULATION

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Abstract: This study estimates the impact of operational risks on corporate sustainability in the cement industry through a financial simulation. The methodology is based on a case study in the cement industry and identifies company's operational risks before classifying them through a taxonomy of environmental, social and economic variables. The impact is quantified using a stochastic model with a Poisson distribution for frequency and a PERT distribution for severity. The results show that it is possible to quantify aggregate losses through the proposed probability distributions, eliminating the limitations faced by companies in the absence of historical information, and it is concluded that the average impact of these risks on FCF varies between 7.52% and 13.13% for the case study, also demonstrating that the impact is reduced when risks are proactively managed. Finally, the proposed model allows calculation and simulation of the financial impact of these risks on the company's free cash flow and establishes strategies for cost mitigation and financial optimization. This research has two limitations: the validation in a single industry and the limitation of using solver for optimization.

Keywords: Operational Risk Model, corporate sustainability, Monte Carlo simulation, cement industry

JEL: D81, Q01, G0.

DOI: https://doi.org/10.58861/tae.bm.2024.3.03

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1. Introduction

Operational risk management allows companies to identify and understand the potential threats that can affect their operations, which can generate unexpected losses (Bonet et al., 2021). Therefore, risk management must estimate the threats and adverse events influencing financial stability (Berger et al., 2022). Operational risk management involves several practical steps, including quantification and cost optimization of risk management, for the efficient and sustainable management of a company (Kamble et al., 2018). Hence, it is crucial to link sustainability guidelines in the overall corporate framework (Lozano, 2012) with the risk management process to be able to reduce potential losses and ensure the generation of value in the medium and long term (Yang, 2011).

Therefore, the object of this study seeks to find a way to model and optimize the impact of operational risks on corporate sustainability. For this purpose, this paper develops a case study within the cement industry and uses financial simulations to estimate the impact of operational risks on corporate sustainability. This industry has been selected because of its relevance in the economy (Sherif et al., 2023), as cement production and consumption are often used as indicators of economic activity and growth in a country because of their significant contributions to the Gross Domestic Product (GDP). Therefore, the cement industry plays the role of a global indicator providing information on the overall health of the economy, as well as early signals of economic trends (Peres et al., 2022).

However, it should be noted that the cement industry also has negative consequences, such as carbon dioxide emissions during the cement manufacturing process. Cement production is energy intensive and requires numerous natural resources, including minerals and water, which raises sustainability and efficiency concerns (Yosef et al., 2023). Hence, risk analysis in this industry is relevant because of the importance of the industry and the rising concerns in numerous countries, such as Colombia (Pedraza et al., 2021). To develop a case study within the cement industry, operational risks are classified using a taxonomy (Batista et al., 2022) and linked to sustainability guidelines (Lozano, 2008). Once the risks have been identified and classified, the aggregate losses are quantified by the means of two probability distributions, where the Poisson distribution is used to quantify the frequency (Hussain, 2020), and the Program Evaluation Review Technique (PERT) quantifies distribution for severity (Liu et al., 2021). From this, aggregate losses are analyzed, and costs are optimized for risk management

(Snyman & Wilke, 2018), where finally the impact on free cash flow to the firm (FCFF) is quantified.

The research results show how the effect of operational risks on sustainability guidelines can be estimated, as well as its impact on a company's free cash flow (FCF). This information allows companies to decide how to allocate resources to mitigate risks (Herbon & Tsadikovich, 2023), as sufficient risk management can lead to significant cost optimization (Mori et al., 2017). Operational risk management and cost optimization are key components of long-term sustainability (Areia et al., 2023). The remainder of this paper is structured as follows. Sections 2 and 3 explain the theoretical framework and methodology, respectively. Subsequently, Section 4 presents the empirical results and finally, Section 5 concludes the paper.

2. Theoretical framework

Theoretical evidence suggests that corporate sustainability is a critical issue in the business world (Maitland & Baets, 2021), where companies increasingly seek to balance their financial objectives with their social and environmental responsibilities. In this context, the identification of operational risks has emerged as a fundamental aspect which can significantly impact a company's ability to maintain its commitment to long-term sustainability (Gupta & Gupta, 2020). Previous research has highlighted the importance of proactively identifying these risks (Bravo Sepulveda et al., 2023), as they can help companies avoid crises and significant financial losses. Studies suggest that companies that pay attention to this aspect are better prepared to face challenges, protect their reputations, and comply with regulations while improving their operational efficiency (Callahan & Soileau, 2017).

Analyzing the operational risks related to corporate sustainability is essential to ensure regulatory compliance, protect reputation, enhance operational efficiency, access more efficient financing, and make firms more resilient against long-term challenges, which can ultimately lead to better financial and sustainable performance (Boikanyo & Naidoo, 2023). Prior studies have demonstrated a connection between operational risks and corporate sustainability, indicating how these are intrinsically related to today's business context (Alshehhi et al., 2018). Operational risks can have a direct impact on corporate sustainability (Patel et al., 2020) because they are related to environmental, social and economic aspects. Therefore, to achieve effective corporate sustainability, companies must identify, measure, and manage the operational risks that may arise over the long term (Kumar & Choubey, 2023).

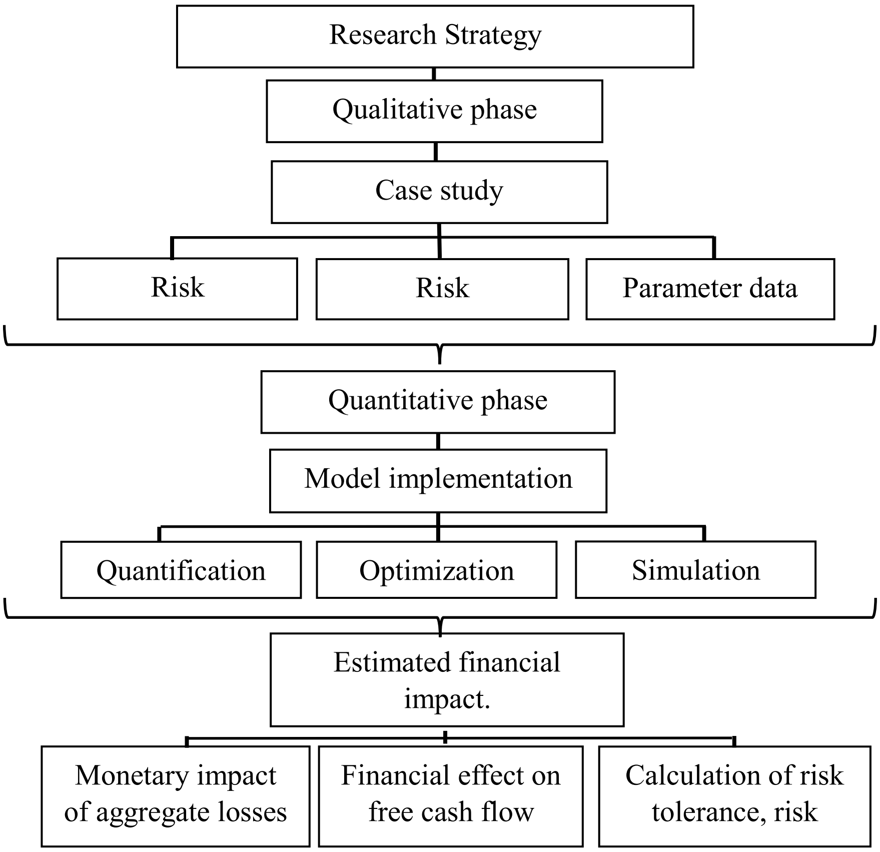
Accordingly, this study proposes to assess the probability of occurrence and the economic impact of adverse events by means of probability distributions that quantify the frequency and severity of such events. These techniques have been created because the lack of historical information in a company does not represent a problem. This is because, as organizations have evolved (Makarova, 2021), the need to manage these risks effectively through other quantification methods has become critical (Shreve & Kelman, 2014).

Thus, operational risk management has evolved toward more sophisticated and quantitative models aiming to help companies effectively identify, measure and mitigate (Makarova, 2021) the risks that can affect their continuity and sustainability (Brennan et al., 2023). For this research, we take as a reference the modeling of risks based on a statistical convolution between frequency and severity, using the Poisson distribution for the quantification of frequency and the PERT distribution for severity (Bravo Sepulveda et al., 2023). A simulation based on the generation of random variables (Kritzman, 1993) is then conducted to generate stochastic models that attempt to mimic the past performance of a dataset and explore how it might evolve. Once the Monte Carlo simulation is performed, possible scenarios are obtained, and confidence intervals are generated to evaluate the possible losses of the company for its different sustainability guidelines and advice on reduction of business risks (Shadchenko et al., 2023).

3. Methodology

3.1. Research strategy

The research strategy is based on a sequential mixed analysis starting with a qualitative phase in the form of a case study (Escobar-Sierra et al., 2021), using a single case study in the cement industry. The single case focuses on the identification of operational risks and classifies them into sustainability guidelines, which allows for a more complete understanding of the characteristics and circumstances of the case (Plano Clark et al., 2023). Subsequently, a quantitative phase is developed, in which an experimental design is created through a Monte Carlo simulation for the quantification and optimization of operational risk management, as shown in Figure 1.



Source: Own elaboration

Figure 1. Research strategy

3.2. Case study industry selection

To select the industry, we start by examining the case study from the global to the specific. The industrial sector was first selected because operational risk is more evident in this industry due to the nature of its operations and activities (Gabrielli et al., 2022). Firms in the industrial sector face several operational challenges due to the complexity of their operations (Dutta et al., 2020), which makes operational risk more evident in this industry and requires careful management to minimize its negative impact (Suryawanshi & Dutta, 2022). Furthermore, the global environmental challenges drive industrial sector companies to improve their performance at a level of vulnerability to potential shocks and disruptions in their operations, which may affect their sustainability (Pertheban et al., 2023).

This study uses the cement sector as a reference based on the economic importance of the sector, the risks involved, its link and effects on global sustainability, its relationship with the environment, the georeferencing of the company taken as a case study in Colombia, the access and availability of information, and the depth of data that could be accessed to gather detailed and comprehensive information about the research topic, allowing a better understanding of its complexity while avoiding biased conclusions, which, in turn, contributes to the validity and usefulness of the research.

3.3. Data collection instrument

To develop empirical validation through the case study, we collected information through semi-structured interviews, empirical research, and web scraping. We systematically recorded all the collected data and documented all sources.

The risk information collected for the research was provided by a company in the cement industry in Colombia. This information was obtained from interviews with the company's risk management directors, and financial statements from the Bloomberg platform, which are public information, were also taken. In addition, information was sought from the financial statements of five cement companies in Colombia, which could be consulted in the EMIS databases. Subsequently, the effect of the risks on these companies was compared, which provided a comprehensive and comparative view of how these risks impact the cement industry.

3.4. Model implementation

With the information gathered in the interviews, document analysis and web scraping, the experimental design was created through Monte Carlo simulation, for which an aggregate loss model was constructed (Bonet et al., 2021), and the expected losses were calculated for each sustainability guideline through a process of statistical convolution (Bravo Sepulveda et al., 2023). The total impact of operational risks on corporate sustainability is obtained and finally contrasted against the company's FCF to review the financial impact generated by calculating the average impact and other measures of business attitude towards risk, such as risk appetite, tolerance, and risk capacity. To do this, a simulation developed in Excel using @Risk software was performed, implementing all research steps proposed by performing 100,000 iterations per simulation. The detailed results of the model implementation are presented below.

4. Empirical Results

4.1. Identification process results

The first phase comprises the identification and classification of risks to evaluate and mitigate the possible operational threats that a company may face and analyze their effect on corporate sustainability. The qualitative results reveal a diversity of potential risks in each sustainability guideline. This qualitative ranking provides a detailed view of potential threats and their implications, allowing the company to appropriately prioritize its risk management efforts. Using this methodological approach, a risk-identification matrix was developed, presented in Table 1, which allowed us to identify 36 operational risks within the business structure of the case study. These risks were comprehensively classified according to each sustainability guideline, providing a comprehensive view of the potential challenges that could affect a company's operations in its quest to achieve its sustainability and corporate responsibility objectives.

Table 1.
Operational risks identified and classified under the taxonomy in the sustainability guidelines.

	Risk	Risk definition	Endogenous	Exogenous
Environmental	Riskθ_1	Non-compliance with environmental regulations	✓	
	Riskθ_2	Inadequate waste management	✓	
	Riskθ_3	Deforestation	✓	
	Riskθ_4	Emission of pollutants may affect local flora and fauna.	✓	
	Riskθ_5	Air Pollution	✓	
	Riskθ_6	Depletion of water resources	✓	
	Riskθ_7	Water pollution	✓	
	Riskθ_8	Greenhouse gas emissions	✓	
	Riskθ_9	Risk of spills and leaks	✓	
	Riskθ_{10}	Extreme weather events and changes		✓
	Riskθ_{11}	Supply chain disruption		✓
	Riskθ_{12}	Water resource scarcity		✓
	Riskθ_{13}	Changes in environmental regulation and policies		✓
	Riskθ_{14}	Landslides		✓
Social	Riskφ_1	No operation due to declaration of protected areas		✓
	Riskφ_2	Malicious acts by terrorist groups		✓
	Riskφ_3	Tensions with the community		✓
	Riskφ_4	Land use conflicts		✓
	Riskφ_5	Social demands		✓
	Riskφ_6	Affectation in the relationship with workers		✓
	Riskφ_7	Intercommunity conflicts		✓
	Riskφ_8	Excessive employability requirements		✓
	Riskφ_9	Indirect violation of human rights	✓	
	Riskφ_{10}	Public health effects on the community and workers	✓	
	Riskφ_{11}	Unsafe road practices	✓	

Economic	Riskε_1	Higher production costs		✓
	Riskε_2	Impact on cement demand		✓
	Riskε_3	Non-compliance with operational obligations		✓
	Riskε_4	Increase in accounts receivable cycles		✓
	Riskε_5	More costly operational financing		✓
	Riskε_6	Decrease in financial efficiency due operation.	✓	
	Riskε_7	More costly financing for operations in other currencies		✓
	Riskε_8	Fluctuations in income from other currencies		✓
	Riskε_9	Operating cost overruns due to variation in commodities		✓
	Riskε_{10}	Localized unemployment due to plant closures	✓	
	Riskε_{11}	Influence on prices	✓	

Source: Own elaboration

4.2. Measurement process results

To determine the input parameters for each distribution, the risk frequencies are analyzed to estimate their probability of occurrence, since the number of events that can occur per year is identified, this information is provided by the company, for which the case study was made according to the historical occurrence of events or what is expected in terms of risk in the company, based on which the parameter λ of the Poisson distribution is obtained. Afterwards, we assigned individual monetary impact values to determine the minimum, most likely, and maximum impact of each risk on the application of the PERT distribution. The reference values are listed in Table 2.

Table 2.
Inputs of the probability distributions used in the modeling.

	Risk		Frequency Inputs		Severity Inputs		
			Events per year	Events per year	Minimum	Most likely	Maximum
Environmental	Riskθ_1	Non-compliance with environmental regulations	1	8.33%	10	1,765	5,000
	Riskθ_2	Inadequate waste management	1	8.33%	5	20	5,000
	Riskθ_3	Deforestation	1	8.33%	300	2,414	58,621
	Riskθ_4	Emission of pollutants may affect local flora and fauna.	3	25.00%	5	1,765	5,000
	Riskθ_5	Air Pollution	2	16.67%	5	1,765	5,000
	Riskθ_6	Depletion of water resources	1	8.33%	167	10,000	18,750
	Riskθ_7	Water pollution	2	16.67%	300	20,000	40,000
	Riskθ_8	Greenhouse gas emissions	2	16.67%	10,345	30,172	155,172
	Riskθ_9	Risk of spills and leaks	1	8.33%	5	1,765	5,000
	Riskθ_{10}	Extreme weather events and changes	4	33.33%	862	12,931	21,552
	Riskθ_{11}	Supply chain disruption	3	25.00%	2,586	6,034	9,483

	Riskθ_{12}	Water resource scarcity	1	8.33%	2,155	2,586	3,448
	Riskθ_{13}	Changes in environmental regulation and policies	3	25.00%	172,414	189,655	215,517
	Riskθ_{14}	Landslides	1	8.33%	862	2,586	6,897
	Riskφ_{1}	No operation due to declaration of protected areas	1	8.33%	300	2,414	58,621
	Riskφ_{2}	Malicious acts by terrorist groups	3	25.00%	1,724	3,448	21,552
	Riskφ_{3}	Tensions with the community	2	16.67%	431	862	1,724
	Riskφ_{4}	Land use conflicts	2	16.67%	300	2,414	6,897
	Riskφ_{5}	Social demands	2	16.67%	431	862	1,724
Social	Riskφ_{6}	Affectation in the relationship with workers	1	8.33%	431	862	1,724
	Riskφ_{7}	Intercommunity conflicts	2	16.67%	431	862	1,724
	Riskφ_{8}	Excessive employability requirements	2	16.67%	431	862	1,724
	Riskφ_{9}	Indirect violation of human rights	1	8.33%	86	431	862
	Riskφ_{10}	Public health effects on the community and workers	3	25.00%	431	1,121	4,741
	Riskφ_{11}	Unsafe road practices	3	25.00%	43	5,172	12,931
	Riskε_{1}	Higher production costs	5	41.67%	32	140	160
	Riskε_{2}	Impact on cement demand	2	16.67%	76,280	152,559	172,575
	Riskε_{3}	Non-compliance with operational obligations	1	8.33%	51,724	68,966	103,448
	Riskε_{4}	Increase in accounts receivable cycles	1	8.33%	125	1,321	1,415
	Riskε_{5}	More costly operational financing	3	25.00%	25,862	38,793	77,586
Economic	Riskε_{6}	Decrease in financial efficiency due operation.	1	8.33%	575	862	1,724
	Riskε_{7}	More costly financing for operations in other currencies	3	25.00%	53	88	212
	Riskε_{8}	Fluctuations in income from other currencies	3	25.00%	3,667	7,981	15,961
	Riskε_{9}	Operating cost overruns due to variation in commodities	2	16.67%	7,906	34,576	86,207
	Riskε_{10}	Localized unemployment due to plant closures	1	0.27%	5,029	10,057	15,086
	Riskε_{11}	Influence on prices	1	0.27%	21,552	112,069	215,517

Source: Own elaboration

The frequency reference values presented in Table 2 are the times of occurrence per year and the probability that the event occurs in that period. Nevertheless, the severity reference values are expressed in terms of PERT distribution parameters and are in SMMLV (Minimum Legal Monthly Wages in Force), where in Colombia the SMMLV for 2023 is set at 1,160,000 COP.

These values provide a solid and locally relevant basis for assessing the risk severity in Colombia.

4.3 Financial impact

The estimated and average financial impact generated by risks depends largely on the size of the firm, as well as the generation of FCF, its level of equity and assets. Regardless of their size, firms face various risks in their operations, and the magnitude of these risks can vary significantly depending on their size and the financial resources at their disposal. Additionally, the risk tolerance, appetite and capacity levels were uniquely determined for each company. Therefore, specific thresholds were established in this study: risk appetite (the 40% percentile), risk tolerance (the 60% percentile) and risk capacity (the 99% percentile). These definitions reflect the specific strategy and risk posture of the case study in the context of the research and serve as a fundamental framework for financial decision-making and risk management.

Appendix A1 presents the research results for each sustainability guideline analyzed individually in terms of FCF impact, showing the FCF portion impacted by operational risks. The results are presented as simulated expected values of sustainability risks contrasted against FCF, evaluating how sustainability challenges impact the operating profits within the case study, where it should be noted that the risks related to environmental aspects vary between 3.09% and 97.46%, social risks between 0.51% and 7.43% and economic risks between 0.35% and 67.19%.

This study reveals that environmental risks generate the greatest financial impact in terms of risk capacity, followed by economic and social risks. Subsequently, the total expected losses comprising the three sustainability guidelines were calculated to obtain the inherent risk exposure.

This sum represents the expected risk impact for the company, which is contrasted against the FCF to calculate the average financial effect of inherent risk, resulting in an average impact of 13.13%. In addition to the evaluation of the average impact, appetite, tolerance and capacity were analyzed within the results, obtaining the inherent risk in each of the corresponding percentiles presented in Appendix A2, where the total inherent risk results in terms of appetite represents 12.82%, tolerance 27.27% and capacity 123.73%.

This indicates that the analyzed aggregate operational risks in all the sustainability guidelines have an average impact of 13.13% on the company’s

FCF. However, when evaluating the different risk levels in more detail, we notice that an impact of up to 123.73% of the FCF can be generated in catastrophic events corresponding to the 99% percentile of the scenarios. In this context, the temporal driver in risk and sustainability management implies recognizing the importance of taking action to address critical situations that could jeopardize a company's long-term financial stability. Exceeding the FCF by more than 100% indicates that the risks are significantly greater than the company's current capabilities to cope with them. Therefore, proactive and efficient risk management is essential to avoid financial crisis scenarios that could lead to bankruptcy. This implies implementing preventive strategies and measures, as well as building solid contingency plans addressing potential risks and threats.

Therefore, after the inclusion of the company's controls, we obtain an estimate of the risk impact after their management, where a noticeable reduction of up to 7.52% appears in the average impact on the FCF. In addition to the average impact, an analysis of appetite, tolerance and capacity was also carried out, the results of which are presented in Appendix A3, where the residual risk results in terms of appetite were 2.92%, tolerance 8.53% and capacity 99.60%.

The decrease in the average impact on the FCF and the levels of appetite, tolerance and capacity is due to the effective mitigation of many of these events by taking out tort liability policies, fixed asset damage policies, portfolio insurance and financial coverage, which facilitates decision-making and the implementation of effective risk management strategies to safeguard the financial health of the case study by generating coverage that corresponds to the mitigation of each risk. Thus, the residual risk calculation plays a crucial role in decision-making and the development of effective strategies that ensure the continuity of operations and the protection of company assets.

Finally, with the purpose of applying this application to the cement industry in Colombia, a reference company was created based on the data of the five main cement companies in the Colombian sector, as shown in Appendix A4, with data obtained from the financial statements of the reference companies. This initiative seeks to estimate the average impact on the sector, based on the assumption that the effects of sustainability risks are proportional to the financial size of each company. This approach has allowed us to obtain a broader perspective on the possible sustainability challenges faced by the sector.

The benchmark company was formed using sector averages as we sought to ensure the applicability and relevance of the results obtained within the scope of this research. Based on the above, the risk impact on the FCF of the sector average was analyzed as a reference. This methodology provides a solid and representative approach to assess how operational risks impact financial health and sustainability at the corporate level in a generalized and contextualized manner. The validation provides a deeper understanding of possible risk scenarios and strengthens the robustness of the results, shown in Appendix A5, where the results of the financial impact of operational risks on corporate sustainability of a generalization case are between 11.27% and 19.68%, where the lower range is for medium impact with control implementation and the upper range corresponds to medium impact without risk management

The above findings suggest that the impact observed in an average company based on industry data bears remarkable similarities to the results obtained in the specific case study. For the case study, the average impact on the FCF without risk management corresponds to 13.13%, contrasted against the average impact of 19.68%. The case study indicates that the average impact on the FCF with implementation of controls is 7.52%, which confirms that the approximate risk range around 11.27% on the FCF. This finding reinforces the validity and applicability of the study and supports the idea that patterns and trends identified at the sector level are representative of specific situations. The consistency between the results obtained at the company and the specific case study highlights the relevance of sector data as a reliable framework for understanding and predicting the impact of specific variables, offering valuable insights for informed and strategic decision-making at the corporate level.

5. Conclusions

The research concludes that the average impact of these risks on FCF varies between 7.52% and 13.13% for the case study, demonstrating also that the impact decreases when risks are proactively managed. Furthermore, to generalize the sector, a reference company was created, showing an average impact of operational risks between 11.27% and 19.68% of the impacts on the FCF, which confirms the results of the case study.

Nevertheless, the research deepened the calculations of operating risks impact and the spread on corporate sustainability by analyzing the result of the aggregate losses in each of its percentiles, identifying measures of appetite, tolerance and risk capacity to conclude that the risks that generate the greatest financial impact are environmental risks, followed by economic and finally social risks. The aggregate losses have an impact on the FCF of up to 123.73% in its 99% percentile without the allocation of controls, which confirms that if the operating risks exceed the maximum financial limit, creating a threatening temporality scenario, as stated by Lozano. In this scenario, a company is exposed to bankruptcy, risking its financial stability and operational continuity, which shows the importance of integrating sound operational risk management into business strategies to ensure long-term sustainability.

Although the research develops the case study before making a comparison with the sector, the findings must be validated for each particular case depending on the specific situation of each company. Conversely, through the result of the estimation of the general financial impact in our study, we seek to allow companies to approximate a level of exposure compared to a given industry. However, these results also depend on the size of the company. In general, larger companies with higher levels of equity and assets may have a more substantial risk-absorption capacity, allowing them to face financial challenges with greater flexibility, while smaller companies may be more susceptible to significant financial impacts in the event of adverse events. Risk management and risk impact assessment are therefore crucial considerations for all companies but must be tailored to the specific characteristics of each entity in terms of size and financial capacity.

This study provides a framework that enables practical implications for companies to identify operational risks that may threaten sustainability, providing quantification techniques and procedures to proactively manage operational risks that can help prevent additional costs in risk management and avoid their materialization, addresses operational risks and improves corporate sustainability and a company's ability to operate and grow in a responsible and sustainable manner.

The research has two main limitations. The first lies in the type of empirical validation through a single case study, as there may be limited representativeness, focusing the research only on the cement sector, which may provide biased results to companies in this sector. Finally, in simulation, the use of a solver to perform the optimization process has a limitation in the allocation of resources for the controls. Therefore, it is recommended for future research to test the model in other industries as this study only validates the model for the cement industry. To improve the optimization process, future research should consider the implementation of genetic algorithm methods. These algorithms offer the advantage of greater accuracy in analysis as they are based on natural evolution and selection of the most appropriate solutions over multiple generations.

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Appendix A

Appendix A1: Results of the case study showing the impact on FCF for the materialization of operational risks in terms of risk appetite, risk tolerance and risk capacity.

Entrepreneurial attitude towards risk	Sustainability Guidelines		
	Environmental	Social	Economic
Appetite (40% percentile)	3.09%	0.51%	0.35%
Tolerance (60% percentile)	7.10%	1.19%	9.28%
Capacity (99% percentile)	97.46%	7.43%	67.19%

Source: Own elaboration

Appendix A2. Total inherent risk results in terms of appetite, tolerance, and capacity.

Entrepreneurial attitude towards risk	Impact on FCF
Mean	13.13%
Appetite (40% percentile)	12.82%
Tolerance (60% percentile)	27.27%
Capacity (99% percentile)	123.73%

Source: Own elaboration

Appendix A3. Residual risk results in terms of appetite, tolerance, and capacity.

Entrepreneurial attitude towards risk	Impact on FCF
Mean	7.52%
Appetite (40% percentile)	2.92%
Tolerance (60% percentile)	8.53%
Capacity (99% percentile)	99.60%

Source: Own elaboration

Appendix A4. Information on the five main cement companies in the Colombian cement industry.

Company	Operating profit	Operating Tax	Operating profit after taxes	Depreciation Amortization	Gross cash flow	Δ OPEX investment	Δ CAPEX investment	FCF	% of partici-pation
Cement Company$_1$	$1,175,622	$387,955	$787,666	$961,740	$1,749,407	$342,901	$722,583	$683,923	75.82%
Cement Company$_2$	$161,502	$53,296	$108,206	$141,555	$249,761	$4,675	$148,736	$169,098	18.75%
Cement Company$_3$	$103,711	$34,225	$69,486	$34,916	$104,403	$3,977	$68,124	$32,302	3.58%
Cement Company$_4$	$6,215	$2,051	$4,164	$20,872	$25,036	-$28,528	$41,131	$12,433	1.38%
Cement Company$_5$	-$4,398	-$1,451	-$2,946	$18,618	$15,671	$1,522	$7,534	$4,288	0.48%
Participation - Total industry								$902,046	100%

Source: Own elaboration

Appendix A5. Results of the financial impact of operational risks on corporate sustainability of a generalization case.

Company	FCF	Monetary impact without risk management	Monetary impact with implementation of controls	Medium impact without risk management	Medium impact with control implementation
Empresa de referencia	$ 180,409	$ 35,496	$ 20,326	19.68%	11.27%

Source: Own elaboration

ISSN 0861 - 6604
ISSN 2534 - 8396

BUSINESS management

PUBLISHED BY
D. A. TSENOV ACADEMY
OF ECONOMICS - SVISHTOV

3/2024

BUSINESS management 3/2024

The printing of the issue 1-2024 is funded with a grand from the Scientific Research Fund, Contract KP-06-NP5/42/30.11.2023 by the competition "Bulgarian Scientific Periodicals - 2024".

Submitted for publishinq on 12.09.2024, published on 16.09.2024, format 70x100/16, total print 80

BUSINESS management

D. A. Tsenov Academy of Economics, Svishtov

Year XXXIV * Book 3, 2024

CONTENTS