

## INSOLVENCY AS A RISK FACTOR FOR BANKRUPTCY IN COLOMBIAN CONSTRUCTION COMPANIES DURING THE YEARS 2019 TO 2022

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**Abstract:** This study examines the probability of bankruptcy and insolvency in Colombian construction companies between 2019 and 2022. The Z2 model has been shown to have an 82% accuracy rate in predicting the risk of insolvency, demonstrating its value as a preventive measure. According to the research, risk levels increased significantly from 2019, particularly in 2020 when a notable increase in companies with a high probability of going bankrupt was found as a result of the limitations of the pandemic. The results show a clear correlation between the levels of bankruptcy risk and financial attributes such as the structure of own funds. In addition, a strong association between the results of the model and the capital structure of the companies is confirmed. Beyond offering revealing information for the construction sector, this study creates prospects for future research in other economic sectors affected by similar circumstances.

**Keywords:** Risk, bankruptcy, insolvency, Capital structure, management strategy.

### 1. Introduction

Financial management often poses obstacles in organizations that are considered important, and the way these challenges are managed can dictate the success or failure of an institution. There is no navigation chart for the management of business, nor tricks or plans that work perfectly during its management, however, in finance there are ratios that can give us a reading on the real state of organizations and helps to ensure the orientation of strategies efficiently for their normal operation and maintenance over time.

Being able to predict when it is a good time to make an investment or decide when it is necessary to resort to financing sources to carry out a project, are often doubts that financial managers must solve, using the data of financial indicators is essential to obtain accurate answers and make informed decisions. This is how, through the interpretation of ratios and their constant analysis, it can guide the course of an institution.

The objective of managers and financiers is to preserve and increase the value of a company over time, ensuring this objective depends on a complete reading of its finances, otherwise, an inadequate reading or the simple ignorance of its figures can cause liquidity problems, solvency, operation among others. In addition, adverse situations such as economic crises, legal or political conflicts, considered as external factors, can create difficulties for an entity to acquire inputs and cause a decrease in demand for its products in the market, failures in the timely provision of

services, decrease in the quality of products, among other negative aspects that are sometimes beyond the control and scope of management. An example of this was the health emergency of the years 2020 and 2021 that the entrepreneurs experienced, they presented difficulties in determining how much longer their companies could be sustained in operation under the conditions of the emergency. In 2021, an investigation by Confecámaras showed that more than 80% of entrepreneurs declared a 38.4% reduction in staff, 65.2% noticed a decrease in sales and 29.5% experienced a drop of more than 80% (Comfecámaras, 2021). These effects were difficult to predict because the world had never faced a pandemic like the one experienced during those years. Despite the efforts and strategies implemented by the government to help Colombian companies, some were forced to cease operations and close companies.

At the same time, in addition to the previous effects, Colombia presented an accumulated inflation of 9.1% for August 2022, a very high value compared to the 2021 CPI of 5.6% and the 2020 CPI of 1.6% (Macro Data, 2022). These inflationary increases that occurred worldwide were effects of the pandemic; and they reflected the cost overruns of the aid that many of the companies received during the years 2020 and 2021, in addition for both the real sector, and for companies the increase in inflation represented “a substantial decrease in their income, which caused problems to continue their operations, including significant problems to pay their salaries and other financial commitments, as well as difficulties in obtaining financing for working capital” (Georgieva, 2022). For the above reasons, the concern arises up to this point, about whether there is any financial tool that can show the general state in which an entity is located, and whether there is how it should be calculated and interpreted to prevent or avoid bankruptcy. To determine the risk to which companies are exposed, it is necessary to examine their actual situation using indicators that offer a broad overview of their degree of liquidity, profitability, leverage level, solvency and volume of activity. The Altman Z Score model is a widely used and well-known method that helps to estimate the 95% risk of insolvency of a company and determines whether it is close to bankruptcy (Chiriboga, 2021).

The study by Belalcázar Grisales and Trujillo Ospina, which began with the question: "Is the Altman Z Score method an adequate indicator of the financial evaluation of Colombian small and medium-sized enterprises?", was one of the first studies that suggested examining the Altman Z Score method in Colombian SMEs and comparing the results between companies that had filed for bankruptcy and those that were still operating. The election became effective. Being an effective tool to apply together with periodic evaluations that determine the state of each company over time, the model is a solid predictor of the financial situation of SMEs in Colombia. Business owners, administrators, financial institutions and government agencies wishing to know the financial status of the target organization may find this model useful” (Belalcazar Grisales, R & Trujillo Ospina, A, 2016).

In times of crisis, as those that are currently being experienced, entrepreneurs have had to overcome the pandemic, government changes, increases in inflation and an increase in interest rates, among others. The function at this point of an expert in the financial area is to guide the entrepreneur through tools that allow generating strategies, to maximize the generation of value in his company. This would be possible if it is possible to determine the current state of insolvency of the organization through financial models such as the Z Altman.

This scenario of uncertainty allows us to raise the following question, according to the method of Z ALTMAN, which Colombian construction companies are financially insolvent?

The objective of this study is to show the usefulness of the Altman Z Model to evaluate the degree of financial bankruptcy of a sample of Colombian construction companies between 2019 and 2022. As a way to identify irregularities in insolvency and stop possible bankruptcies in Colombian

construction companies. as well as the inflationary behaviors of recent years and the liquidity problems faced by companies during the years 2019 to 2022.

## 2. Literature Review

### 2.1 Altman Z Score Model.

This model, which uses econometric principles, allows to analyze the bankruptcy status of a company using five financial indicators as variables. It was developed by Edward Altman in 1968 and used a sample of 66 institutions, 33 of which had filed for bankruptcy in the previous 20 years. The remaining companies were selected from those that were still operating.

To be able to conclude on five variables, the author used 22 indicators and a discriminant analysis that involved collinearity, correlation, logic and prediction of values. This is reflected in the function:

Namely:

$$X1 = (\text{Working Capital}) / (\text{Total Assets})$$

$$X2 = (\text{Retained Earnings}) / (\text{Total Assets})$$

$$X3 = (\text{Earnings before interest and taxes}) / (\text{Total Assets})$$

$$X4 = (\text{Capital Market Value}) / (\text{Book value of Total debt})$$

$$X5 = \text{Sales} / (\text{Total Assets})$$

The results of the function can be classified in the following form:

If  $Z \geq 2.99$  : Minimum probability of bankruptcy

If  $Z \leq 1.81$  : High Probability of bankruptcy

If  $1.81 < Z < 2.99$ : Middle Zone, it is defined as observation zone and there is no good definition. It can be inferred as an alert before falling into FAVORABLE red zone

### 2.2 Model Z1 Altman

It is inconvenient to apply this model to companies that do not participate in the financial market, since it was developed exclusively to evaluate industrial companies that are listed on the stock exchange. Consequently, a new function Z1 is created and the variable X4 is modified, replacing the book value of the equity by the market value. In the same way, certain modifications are observed in the coefficients of the function, namely:

His interpretation:

If  $Z \geq 2.99$  : Low probability of bankruptcy

If  $Z \leq 1.23$  : High probability of bankruptcy

If  $1.23 < Z < 2.99$ : Middle Zone, it is defined as observation zone and there is no good definition. It can be inferred as an alert before falling into the red zone

### 2.3 Model Z2 Altman

The author, in an attempt to solve the problem of the sector and create a function that is applicable for all types of companies eliminates the variable X4 and recalculates its distribution among the other variables allowing this new function to weigh the creation of profits compared to the asset of the company as it is X2 and X3, the function is expressed as follows:

His interpretation:

If  $Z \geq 2.60$ : Low probability of bankruptcy

If  $Z \leq 1.10$  : High probability of bankruptcy

If  $1.10 < Z < 2.60$ : Middle Zone, it is defined as observation zone and there is no good definition. It can be inferred as an alert before falling into the red zone).

Being able to predict when it is a good time to make an investment or decide when it is necessary to resort to financing sources to carry out a project, are often doubts that financial managers must solve, using the data of financial indicators is essential to obtain accurate answers and make informed decisions. This is how, through the interpretation of ratios and their constant analysis, it can guide the course of an institution. The application of Altman's Z2-Score prediction model, allows to establish the classification of each company in the risk zone and identify the determinants that influence the financial failure of the industry, in order to provide the entrepreneur with an advance view of his financial situation for a rational decision-making. The Z-Altman model manages to predict the state of failure of companies, as well as to know the real state of 14% of companies that are in a state of insolvency (Morocho & Coronel, 2022).

In times of crisis, as those that are currently being experienced, entrepreneurs have had to overcome the pandemic, government changes, increases in inflation and an increase in interest rates, among others. The function at this point of an expert in the financial area is to guide the entrepreneur through tools that allow generating strategies, to maximize the generation of value in his company. This would be possible if it is possible to determine the current state of insolvency of the organization through financial models such as the Z Altman. Financial planning and prevention through the analysis of risk scenarios have bases that MSMEs can implement when it comes to preventing risks and future bankruptcies. At the same time, the use of Models such as: Z Altman, Ohlson, Behaver and DuPont, have financial indicators and reasons that, if analyzed in depth, can constitute the information bases to prevent the bankruptcy of an MSME organization (Cejudo Fabián, 2022).

Altman developed a Z-score model, which used the financial information of organizations to predict the probability of business bankruptcy two or three years in advance, the results of the measurements indicate that the model can be applied as a predictive financial tool to measure the probability of financial insolvency of companies (Roque & Caicedo, 2022)

## **2.4 Business Solvency**

The ability of a company to meet all its short-term and long-term payment commitments is known as financial solvency. It speaks of the organization's ability to produce enough income to cover its obligations and continue to function without jeopardizing its financial stability (Circulantis, 2020).

## **2.5 Liquidity**

The ability of a certain company to repay its short-term debts is known as liquidity. This means that, in order to pay its current obligations, the company needs resources that are quickly transformed into cash flows (Alterfinance Group, 2020).

## **2.6 Patrimonial Structure**

The formation of the net worth of an entity, which includes all its assets, liabilities and net worth, is called the equity structure. This structure is essential to evaluate the economic condition of a company and understand the financing of its assets (Fastercapital, 2024).

## **3. Methodology**

Procedure: The present research has a deductive paradigm, with quantitative and positivist approach with longitudinal design. For the calculation of the sample, stratified sampling was used, which according to Hernández (2014), the study population is divided into homogeneous segments, groups or strata. Determination of the sample, in this type of sampling the study population is divided into homogeneous segments, groups or strata, which comprise a set of companies based on quantitative and qualitative criteria such as: The size of the company, geographical location, participation in the

sector according to sales volume, seniority or trajectory. In this way, it is intended to obtain subgroups adequately represented by their respective samples. Stratified Sampling was developed in three stages:

Stage 1. Define the strata: For this stage it was necessary to define the criteria used and their relevance in the selection of the sample, once the criteria have been defined, the population of companies is divided into strata, taking into account the previous criteria.

For the development of this Stage was consulted in the database of the Superintendency of Companies <https://siis.ia.supersociedades.gov.co/#/massivereports> from where financial information was downloaded from companies that apply Individual and separate Full IFRS, Individual and Separate IFRS SMEs. The years taken into account were 2019, 2020, 2021 and 2022 that were valid until the date of presentation of this research. To identify the population, the first filter used was economic activity. All the companies belonging to the population under study have as their main economic activity 4111 – Construction of Residential Buildings.

Stage 2. Selection of the sample for each of the strata a simple random sampling was carried out within each stratum to select the companies that will be the object of study.

Stage 3. The strata were defined by regions, grouping the total of companies into (3) groups namely: Group 1: Caribbean Region, Group 2: Andean Region and Group 3: Pacific Region, Orinoquía and Amazonia; then proceed to apply the simple sampling by strata. Between 303 and 315 companies in the construction sector with financial operations were selected between 2019 and 2022.

**Sample by strata (regions)**

<b>Stratum (region)</b>	<b>2019</b>	<b>2020</b>	<b>2021</b>	<b>2022</b>
<b>Caribbean</b>	36	40	39	46
<b>Andean</b>	237	242	239	231
<b>Peaceful Orinoquia and the Amazon</b>	33	33	32	38
<b>Total</b>	<b>306</b>	<b>315</b>	<b>310</b>	<b>303</b>

Table 1. Sample by strata 2019 to the 2022 Colombian construction companies

The following hypotheses are proposed during the study: The selected financial model can predict the risk of bankruptcy of an entity (H:1), The financial characteristics of companies such as the wealth structure are related to the levels of insolvency risk (H:2) and to anticipate bankruptcy, there is a correlation between the results of the Z2 Score model and the structure of wealth (H:3).

For the validation of the hypotheses, the research was developed in three phases, during the first one financial information of Colombian construction companies from the years 2019 to 2022 was obtained from databases of the Superintendency of Companies. In the calculation phase, the composition of liabilities and equity was determined through the analysis of the equity structure and the same companies were simultaneously submitted to the Z2-Score model, and as a result, the insolvency applications submitted by some of them to the Superintendency of Companies during the analysis Phase were validated. At the same time, the Pearson, Spearman and Kendall correlation coefficients were also applied to the data to determine the relationship between the results of the Z2-Score model and the wealth structure.

The Z2-Score model uses econometric principles that allow analyzing the bankruptcy status of a company using five financial indicators as variables. It was developed by Edward Altman in 1968 for which he used a sample of 66 institutions, 33 of which had filed for bankruptcy in the previous 20 years.

The remaining companies were selected from those that were still operating.

To be able to conclude on five variables, the author used 22 indicators and a discriminant analysis that involved collinearity, correlation, logic and prediction of values. This is reflected in the function:

$$Z = 0.717x_1 + 0.847x_2 + 3.107x_3 + 0.420x_4 + 0.998x_5$$

Illustration 1. Z2 Altman Function

The following are the variables, the model, the coefficients and the financial data that will be used:

$X_1 = (\text{Working Capital})/(\text{Total Assets})$

$X_2 = (\text{Retained Earnings})/(\text{Total Assets})$

$X_3 = (\text{Earnings before interest and taxes})/(\text{Total Assets})$ .

$X_4 = (\text{Book value of capital})/(\text{Book value of Total debt})$

$X_5 = \text{Sales}/(\text{Total Assets})$  According to the results of the function can be classified as follows: If  $Z \geq 2.99$  : Low probability of bankruptcy

If  $Z \leq 1.23$  : High probability of bankruptcy

If  $1.23 < Z < 2.99$ : Gray zone, it is defined as observation zone and there is no good definition. It can be inferred as an alert before falling into the red zone. To ensure the validity and correctness of the examined data, multiple regression assumptions such as linearity, error independence, homoscedasticity and residue normality were used.

#### 4. Results and Discussion

After As mentioned above, the companies taken into account for the present study were selected according to the criteria of Volume of assets and Volume of Sales. It is important to highlight that for the study a previous stratified sampling was carried out where from a total population of 1,439 companies with main economic activity 4111-"Construction of residential buildings" that by 2022 the following additional conditions for the study had to be met

Condition 1: They must have Financial Statement reports of at least (2) years including 2022.

Condition 2: The volume of assets by 2022 must be more than 20,000,000

Condition 3: The sales volume for 2022 must be Greater than or equal to 0.

Based on these conditions, the companies used per year are detailed below, once they are selected, the equity structure analysis was performed to determine if there is any correlation between the composition of the equity and the insolvency and liquidity risk to which it may be exposed. The analysis of the composition of the equity is chosen over the volume of the assets, since the equity structure allows determining the distribution that companies have from the amounts in the Liabilities and the Equity, in this sense the volume of the equity is selected since the assets can be measured above their fair value, a strategy commonly used to access loans and stimulate solvency. This in some cases arises as a consequence when the operating area is not robust enough to meet liquidity needs. Taking into account the patrimonial structure, the sum of these should always be 100%. However, it is possible to see companies with negative equity and liability levels above 100%, which would indicate high levels of indebtedness and possible insolvency.

In accordance with the above, the analysis of patrimonial composition was carried out identifying the following ranges for the volume of the structure. Similarly, using the traffic light tool, the cut-off points were determined to classify the companies. Based on this information, a heat map is made with the distribution of the patrimonial structure of the 315 companies.

##### 4.1 Patrimonial structure of construction companies object of study.

The initial results indicate that by 2022, 114 companies, that is, 37% have a wealth structure where the volume of their Wealth is less than 19%. At the same time, 114 companies, that is, 37% have a

volume of equity between 59% and 20% and finally 76 companies, that is, 25% of the total have an equity of more than 60% in their structure.

<b>% Participation</b>	<b>Passive % Participation</b>	<b>Equity Number Companies</b>	<b>of Weighting</b>
100%	0%	18	6.0%
80%	20%	95	31.4%
70%	30%	36	11.7%
60%	40%	36	11.7%
50%	50%	17	5.7%
40%	60%	25	8.3%
30%	70%	22	7.3%
20%	80%	24	7.9%
0%	100%	30	9.8%
<b>TOTAL</b>		<b>303</b>	<b>100%</b>

Table 2. Relationship of Participation of Liabilities and Equity

The results indicate that 95 companies, that is, 31.4% have a Liabilities-Equity Ratio of "80% Liabilities - 20% Equity", this being the vast majority. Followed by 11.7% for the relationship "70% Passive - 30% Equity" and "60% Passive - 40% Equity". 25% of companies have a relationship where their equity is greater than 70%.in.

#### 4.2 Result of the variables of the Altman Z2 model.

<b>Indicator Result</b>	<b>2019</b>		<b>2020</b>		<b>2021</b>		<b>2022</b>	
	<b>Quantity</b>	<b>Weighting</b>	<b>Quantity</b>	<b>Weighting</b>	<b>Quantity</b>	<b>Weighting</b>	<b>Quantity</b>	<b>Weighting</b>
<b>High probability of bankruptcy</b>	146	47.7%	164	52.1%	150	48.4%	141	46.7%
<b>Grey area</b>	125	40.9%	106	33.6%	117	37.7%	114	37.5%
<b>Low probability of bankruptcy</b>	35	11.3%	45	14.3%	43	13.8%	48	15.9%
<b>TOTAL</b>	<b>306</b>	<b>100%</b>	<b>315</b>	<b>100%</b>	<b>310</b>	<b>100%</b>	<b>303</b>	<b>100%</b>

Table 3. Results Indicator Altman all regions 2019-2022

In general, there is a 12% increase in the percentage of companies with a High Probability Risk in the years 2019 to 2020. However, for the following years 2021 and 2022 the increase over the initial year is 9% and 6% respectively. Despite this, an increase of 11% in companies in the gray area is identified by 2021. The findings show similar patterns of high probability of bankruptcy for 2020 and 2021, with increases compared to 2019 of 9% and 6%, as well as an increase in the gray area for 2022 of 26%. This happens at the Caribbean level, which includes companies from all the

departments of Atlántico, Bolívar, Cesar, Córdoba, La Guajira, Magdalena, San Andrés and Providencia, and Sucre.

At the Andean region level, companies from the departments of Antioquia, Bogotá, Boyacá, Caldas, Cundinamarca, Huila, Norte de Santander, Quindío, Risaralda, Santander and Tolima are included. In this region, by 2020, there are 12% increases in companies that have passed a High probability of bankruptcy rating, while by 2021 and 2022, this percentage decreases by 8% and 1%, respectively. Likewise, there is an increase of companies in the gray area by 12% by 2021. In the Pacific, Orinoquía and Amazonia regions, companies from the departments of Cauca Nariño, Valle, Casanare, Meta and Caquetá were grouped together. The results indicate, like the other regions, the High Probability increase trend for the year 2020 with an increase of 5% compared to the previous year, for the following years 2021 and 2022, a decrease of 17% and 9% is evident. On the other hand, the number of companies in the Middle or Gray Zone for the same years remains stable.

#### 4.3 Risk of bankruptcy in the participating companies.

An individualized analysis of the companies that presented “High probability of bankruptcy” and “Gray Area” results for the year 2022 was carried out by consulting their status with the Superintendency of Companies, in order to verify if they presented any of the following situations: (1) Reorganization, (2) Judicial Liquidation, (3) Forced Administrative Liquidation, (4) Restructuring Agreement, (5) Voluntary Liquidation or (6) Mandatory Liquidation.

This postulate, in turn, confirms the link between the equity structure and the results of the execution of the method, as well as the possible association between "High Probability" or "Gray Area" results and structures with less than 20% equity.

Based on the data, 72 Matches were found in the 303 companies in the sample for 2022. Of which (38) are in “Reorganization In Execution”, (16) are in “Judicial Liquidation In Process” and (18) have “Reorganization In Process” process. It is important to note that when a company initiates this procedure, it can take from a few months or even a few years, and the public is informed either by changing the name of the company or by consulting the SIC databases.

82% of the 72 companies have a rating of "HIGH PROBABILITY" and "MEDIUM OR GRAY AREA", according to the results of the model, which are compared with the previous ones; only 18% have a rating of "LOW PROBABILITY OF BANKRUPTCY". This result allows to validate the hypothesis (H:1) about the effectiveness in the efficiency of the model with a performance higher than 80% to evaluate the risk of insolvency and business bankruptcy. Once the first hypothesis was verified, the hypotheses (H:2) and (H:3) were validated based on the equity composition and the results of the Z-score of the analyzed companies; the results by company are detailed below. Subsequently, we proceed to demonstrate the positive correlation between the variables by starting from the following assumption: Independent variable (x): Results of Z, Dependent variable (y): Composition of wealth.

Correlation Coefficients	
Pearson	67.1%
Spearman	72.0%
Kendall	53.9%

Table 4. Correlation coefficients of variables

These correlation coefficients, which link the model data to equity participation, were obtained from the previously collected data. For this purpose, three correlation tests (Pearson, Spearman and Kendall) and the Excel Real Statistics add-on were used. The two variables investigated have a positive association from "MODERATE" to "STRONG", according to the Pearson Coefficient correlation values. The results of Spearman's Coefficient also indicate a "STRONG" positive

correlation, but unlike the previous one, this indicator takes into account the evaluation of monotonous or monotonous relationships (implying increasing monotony in this case). Consequently, it is less susceptible to outliers, indicating that the order of the data is maintained even in the presence of such values. The results of the test Dubin-Watson with a D statistic of 0.672 and the d'Agostino-Pearson test with a p value of 0.95 indicated positive or normal results for the assumptions of autocorrelation and residual normality. The Breusch-Pagan test was used to check the homoscedasticity assumptions, and the results showed a p-value of 0.6599.

The above confirms that the size of a company affects its financial stability and that leverage has a strong direct correlation with it; the higher the leverage, the higher the risk. This is related to the results of (Morocho & Coronel, 2022). In the same way, it is identified that when calculating the existing correlations in the financial stability of an organization, such as the relationship between the item of indebtedness and that of own resources, it is related to the findings of (Roque & Caicedo, 2022), which affirm that the stability of an organization increases with the amount of indebtedness that is under control from the perspective of the model.

According to the correlation results of the study, there is a proportional relationship between the composition of net worth and the results of the "MODERATE" to "STRONG" model, indicating that the higher the proportion of net worth, the lower the probability of bankruptcy. This result is also consistent with the research of (Roque & Caicedo, 2022) and (Becerra-Vicario, Alaminos, Aranda, & Fernandez, 2020).

## 5. Conclusion

The results of the research yield significant and relevant conclusions that will continue to be the subject of future studies, not only for the construction industry but also for other economic sectors, supporting the evaluation of the trends of Latin American companies.

The Z2 model can predict the risk of bankruptcy and insolvency by 82%, a significant result that underlines the importance of the model continuing to be used as a prevention and early warning mechanism in companies. This has been possible thanks to the staggered development of the research phases, which has allowed the verification of the hypotheses formulated for their execution.

Accordingly, and as a result of the effects caused by the Global Emergency Situation, the application of the model using the years 2019 to 2022 as a time window made it possible to identify a significant increase in companies with results lower than 1.10 by 2020, considered as having a "High probability of bankruptcy". This year, the construction industry had difficulties in carrying out its operations, in particular due to limitations on the departure of workers, curfews and lockdowns. There was the same volume of HIGH PROBABILITY signatures in the Caribbean in 2020 and 2021. In contrast, modest decreases are observed for 2021 and 2022 in the Andean region. The validation of the hypothesis in the development of the third objective regarding the correlation that exists between the patrimonial structure and the results of the Z2-Altman model indicates according to the Spearman coefficient a 72% considering it "Strong", this validates the assumption raised and opens the possibilities to carry out more studies in other sectors.

According to the results, the correlation between the wealth structure and the results of the Z coefficient model indicates that prudent financial management is essential to reduce the risk of insolvency; in turn, this result offers financial managers a clear understanding of how financial indicators can affect the stability and expansion of their companies, in addition to opening new avenues of study in other sectors. In light of these results, I think it is essential that both researchers and professionals continue researching and using financial models such as the Z-Score in order to be able to foresee the financial problems that can make the difference between the survival and failure of a company.

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