Credit Scoring Through Mathematical Modeling: Applying the Sherrod Approach to Solaria Tech (Morocco, 2023)

Saoud Ikram[1], Benarafah Zineb[1], El mekaoui Marwa[1], N'quila Zineb[1], Sghir Salma[1], Balla Nouhayla[1], Faris Asmaa[2], Elhachloufi Mostafa[3]

[1]Master's student in Participatory Finance Engineering and Artificial intelligence, Faculty of Legal, Economic, and Social Sciences - Ain Sbaa, University Hassan II Casablanca, Morocco.
[2]Laboratory of Applied Modeling for Economics and Management, Faculty of Legal, Economic, and Social Sciences - Ain Sbaa, University Hassan II Casablanca, Morocco.
[3]Department of Statistics and Applied Mathematics for Economics and Management, University Hassan II Casablanca, Morocco.

ABSTRACT

This study aims to analyze and assess the credit risk of Moroccan solar energy solutions company Solaria Tech, by applying the Sherrod mathematical model. An analytical descriptive approach based on digital simulation and real financial statements of the company for the year 2023, including the budget and results calculation tables, was adopted. The study used six key financial indicators (X1) to (X6) that represent the basic ratios adopted in the Sherrod model, such as the ratio of working capital, the ratio of liquid assets, net profit to assets, and others. The results of the analysis showed that the calculated value of the Z coefficient was 8.28, which indicates that the company falls into the third category according to the bank's classification, that is, it represents an average degree of credit risk, and the study also showed the company's good ability to generate profits and finance its fixed assets through equity, which enhances its credit confidence despite some limited liquidity indicators.

The study concludes that it is important to use quantitative models such as Sherrod to support loan decisions and reduce financial risks, especially in vital sectors such as renewable energy.

INTRODUCTION

Credit risk constitutes a major challenge that financial institutions face in the contemporary period, owing to its direct effects on financial stability and the profitability of banks. Credit is key to driving economic growth, but granting it carries the risk of non-payment, which can lead to significant losses that threaten the efficiency and sustainability of financial institutions. The significant expansion and complexity of financial operations has led to an urgent need for accurate tools that help measure and manage these risks effectively, away from relying exclusively on expertise. Subjectivity or personal judgment.

In this context, quantitative models, especially mathematical programming, have emerged as an effective way to formulate lending decisions within a mathematical framework that helps to reach optimal solutions, considering profit goals, regulatory constraints, and acceptable risk levels. The field of credit risk modeling has witnessed a significant development, from traditional statistical models to the use of artificial intelligence and machine learning techniques, which has contributed to improving the prediction of risk levels, although these models often lack clear mechanisms for making the optimal decision given limited resources and multiple limitations.

This study aims to develop a mathematical programming model capable of supporting credit decisions within Moroccan financial institutions, incorporating local specificities and realistic constraints. The main question of research is: How can mathematical programming be used to build an effective framework for making optimal credit decisions that minimize losses and maximize returns? To answer this question, the study seeks to achieve four main objectives: Analyze mathematical models used in credit risk

assessment, build a mathematical model appropriate to the Moroccan context, integrate the results of statistical models or machine learning techniques into the mathematical model, and evaluate the performance of the proposed model in practice.

The study is based on a combination of quantitative and qualitative approaches. It begins by reviewing the literature on credit risk and the models used to evaluate it, as well as reviewing the applications of mathematical programming in the financial field. A mathematical model is then designed that considers the characteristics of the Moroccan financial system, and includes the definition of the objective function, variables, and associated constraints. Data is collected from local sources or via real-world simulations, and the model is applied using mathematical optimization tools. The results are analyzed to measure the effectiveness of the model in achieving its objectives, and discussed in the context of previous literature, with recommendations addressed to Moroccan financial institutions.

1.   LITERATURE REVIEW

The study was also based on a review of a previous research by a doctoral student at the University of M'sila in Algeria, in which she addressed the same topic, and highlighted the importance of mathematical models in supporting banking decision making by predicting potential losses and reducing the likelihood of default. This underscores the growing importance of this area, and the need to invest in the development of accurate and effective quantitative tools in risk management.

Credit risk is one of the most prominent challenges facing commercial banks due to its direct impact on their financial soundness and profitability. An academic study from the University of M'sila addressed this topic from a quantitative angle, focusing on the role of mathematicalmodels in estimating the probability of borrowers defaulting and predicting potential losse. (Hull, 2018).

,The study defined credit risk comprehensively, reviewing its basic types such as risk of defaultdeterioration of creditworthiness concentration risk, and counterparty. Traditional assessment tools such as baseline models, classification tables and early warning indicators were also presented(Bessis, 2015) (Anderson, The Credit Scoring Toolkit: Theory and Practice for Retail Credit Risk Management and Decision Automation, 2007).

The study then moved to advanced models, such as statistical models and logistic regressio,structural and reductionist models, to .modern models based on artificial intelligence and machine learning, because of their high accuracy in predicting risks. (Anderson, The Credit Scoring Toolkit: Theory and Practice for Retail Credit Risk Management and Decision Automation, 2007)

The study also highlighted the importance of mathematical programming in building financial models, with an explanation of their ,different forms, from linear and nonlinear modeling to dynamic and random. It showed its applications in portfolio management pricing of financial instruments, asset and liability analysis, and risk management of various kinds(M. Mokhtar, 2014).

However, the study did not address some recent models such as informal forests and augmented systems, and omitted practical applications using real data. It also ignored the impact of global crises and economic fluctuations, and did not differentiate between Islamic and conventional banks or between emerging and developed markets. (Dridi, 2011)

It also missed the organizational dimension such as the Basel standards, and the chronological evolution of the models adopted. Therefore, subsequent research should integrate quantitative models with practical applications, accounting for diverse economic and institutional contexts, to develop more precise and comprehensive credit assessment tools in the era of digital transformations. (Lieberman).

This research was based on a previous study by Riyad Mezher Abdullah and Atheer Abbas Abbadi (2022), which aimed to predict financial failure in the Bank of Baghdad using the Sherrod and Spring models. The study found that the bank suffers from clear indicators of financial weakness, and that the results fall into the category through which it is difficult to accurately predict the risk of bankruptcy, which indicates the importance of strengthening financial analysis tools and taking corrective action.

Financial failure is one of the most prominent challenges facing financial and banking institutions and is defined as the inability of an institution to meet its financial obligations when they are due. This failure does not occur suddenly but is the result of the accumulation of a set of factors and causes over a long period of time that ultimately leads to a loss of financial and operational balance (wajihad, 2022) .In the same context, financial failure is seen as the stage before the declaration of bankruptcy, as the institution has lost its ability to pay its obligations to third parties (sharife, 2022).

Researchers classified financial failure into multiple types according to its nature and dimensions. Among these types, economic failure, which occurs when a company is unable to cover its costs from the revenue generated, is an indicator of weak economic efficiency. As for financial failure, it means the inability to pay outstanding debts and obligations. There is also financial hardship, which has two types: 'apparent', when liabilities exceed the size of the assets, and 'real', when the enterprise is unable to pay even if the liabilities are equal to the assets (sharife, 2022).

The causes of financial failure are numerous and can be divided into internal and external. Internal causes include poor management, ineffective operational decision-making, accumulation of losses, and poor inventory and collection management. On the other hand, external causes are represented by volatile economic conditions, intense competition, rising exchange rates, and increasing production costs (Yahya, 2006) . (hassan, 2022) The importance of this classification lies in enabling institutions to analyze the roots of the crisis and take appropriate preventive measures.

The importance of predicting financial failure lies in its ability to provide early signals to organizations to avoid collapse. It helps senior management in making corrective decisions in a timely manner, and also provides investors and creditors with the necessary information to evaluate investment and financing risks (Al-Safwani, 2020). On the other hand, regulatory and government agencies rely on such predictions to maintain financial system stability and ensure the integrity of institutional performance (Amer, 2023). Quantitative models are among the most prominent tools used in predicting financial failure, and several models have been developed for this purpose. Most notably, the Sherrod (1981) model, which is based on six financial indicators that cover the basic aspects of financial performance, namely liquidity, profitability, and solvency, and is calculated through a Z-Score equation used to classify institutions into five categories according to the degree of risk. It is considered one of the adopted models in assessing credit risk (Lutfi, 2005). The Springate 1978 model is also one of the relatively simplified models, as it relies on four main financial ratios used to distinguish between healthy companies and those prone to failure. A company is classified as vulnerable to bankruptcy if the Z value is less than 0.96. As for the (Altman E. I., 1968) model, it is one of the leading models in this field, as it was the first to use the multiple discriminant analysis (MDA) method to predict financial failure. It incorporated five basic financial indicators into its equation, making it a widely used model in different industrial environments (Al-Kanani, 2022).

Financial indicators are vital tools that support forecasting models. Among the most prominent of these are return on assets (ROA) and return on equity (ROE), which are key indicators for measuring resource utilization efficiency. Liquidity and solvency indicators also play a pivotal role in revealing the organization's ability to meet its short and long-term obligations, contributing to objective judgments about its financial stability (Amer, 2023).

2.   METHODOLOGY

Evaluating financial performance and analyzing the risk of financial failure is one of the core topics in accounting science and financial management. Among the quantitative models developed for this purpose, the **Sherrod Model** stands out as a diagnostic tool aimed at early prediction of companies' vulnerability to financial failure by analyzing financial ratios extracted from published financial statements (AL-Hmadane, 2023).

The Sherrod model is based on logic similar to predictive models such as Altman's Z-Score model; however, it is distinguished by its mathematical structure and the number of indicators used. The model is based on the idea that financial performance can be summarized through a set of vital ratios, which are integrated into a unified equation to produce a composite value (Z-index) used to assess the financial stability of the enterprise (Altman E. I., 1968) .

The model is based on a number of pivotal financial indicators, which often include and their formulation may vary depending on the applied study the following:

Table 1: Financial ratios used in the Sherrod model

Category	Risk Classification	Z value
Grade 1	Exceptional financial health (No bankruptcy risk)	$Z \geq 25$
Grade 2	Low risk (Minor financial stress)	$25 > Z \geq 20$
Grade 3	Moderate risk (Requires monitoring)	$20 > Z \geq 5$
Grade 4	High risk (Significant bankruptcy exposure)	$5 > Z \geq -5$
Grade 5	Critical risk (Imminent bankruptcy likely)	$Z < -5$

Source: Using Altman and Sherrod Z-Score Models to Diagnose Financial Failure of Banks Listed on the Iraq Stock Exchange

Based on the results extracted from the Sherrod model shown in the table above, companies can be classified according to their level of bankruptcy risk by comparing the calculated values with predetermined criteria. This classification depends on the Z-Score calculated for each company, which reflects its financial position and degree of exposure to financial failure risk. To facilitate the interpretation and analysis process, the following table shows the classification criteria adopted in the Sherrod model and the interpretation of each category:

Table 2: Degree of risk according to the Sherrod model

Variables	Ratio	Type	Relative Weight
X_1	Net Working Capital / Total Assets	Liquidity Indicator	17
X_2	Liquid Assets / Total Assets	Liquidity Indicator	9
X_3	Shareholders' Equity / Total Assets	Solvency or Leverage Indicator	3.5
X_4	Net Profit Before Tax / Total Assets	Profitability Indicator	20
X_5	Total Assets / Total Liabilities	Solvency or Leverage Indicator	1.2
X_6	Shareholders' Equity / Fixed Assets	Solvency or Leverage Indicator	0.1

Source: Researcher's analysis, adapted from Fahmi Sheikh Mustafa's *Advanced Financial Analysis* (2008), p. 102

These financial ratios are integrated into a standardized linear scoring equation:

$$z = X_1 a_1 + X_2 a_2 + X_3 a_3 + X_4 a_4 + X_5 a_5 + X_6 a_6$$

Where coefficients a_1, a_2, ...a_n represent empirically derived weights, calibrated through statistical analysis or prior research, and are adjustable for sector-specific or regional economic conditions. (Smith, 1993).

The resulting value of the equation is interpreted as follows: According to the Z-index, the financial position of the company and the probability of its failure can be determined based on its value. If the value of With The 25 barriers, this indicates that the company is in a very good financial position and that the chances of its failure are very low. But if the value of (Altman E. , 1977) With Between 20 and 25, this reflects the existence of medium risk signals that call for careful financial control. On the other hand, if the Z value falls below 20, the organization is considered to be highly exposed to financial failure risks, and in this case, financial restructuring may be necessary to overcome these difficulties. (Altman E. I., 1968)

Sherrod's model has been applied in a number of empirical studies, including a recent study conducted on the National Tourism Investment Company in Iraq during the period 2016–2021. The study found that the average annual Z-index was above 25, which indicates good financial stability throughout the study period, despite the economic challenges faced by the country. The model has demonstrated a high diagnostic capacity, particularly in environments where accounting data is readily available. (Yassin, 2024).

The financial analysis model is an effective tool due to its ease of application, as it relies on financial data available in traditional accounting statements such as the balance sheet and the income statement, allowing researchers and analysts to use it without the need for complex external data (Higgins, 2012) . Additionally, the model enables comparative analysis across various economic sectors, especially when financial weights are adjusted or when standardized models are used to assess performance. (Krishna G. Palepu, 2008) Moreover, financial analysis is an early warning tool that helps decision-makers identify potential problems and make strategic decisions related to financing or investment before risks escalate. (Gerald I. White, 2003).

Despite its effectiveness as a tool for evaluation and decision-making, financial analysis has several limitations that must be considered. Among them is the stability of the weights used in some models, which may not reflect the specific characteristics of all companies or sectors, leading to inaccurate results when applied generally (Krishna G. Palepu, 2008). The dependence of financial analysis on **accounting statements** makes them vulnerable to recognition or even manipulation, particularly in the absence of transparency or in cases of creative accounting. (Gerald I. White, 2003). Furthermore, financial analyses does not account for qualitative factors that play a crucial role in organizational performance, such as management efficiency, political stability, or organizational culture, which are difficult to quantify despite their significant impact on financial outcomes)Higgins(2012 ،.

To enable this model, the Python programming language will be used in credit risk analysis. This analysis includes a number of algorithms, starting first with a custom model definition algorithm, which determines the relative weights of each financial indicator, along with loan classification criteria, and suggests appropriate interest rates for each rating (excellent, low-risk, medium risk, high risk, or rejected). Underlying financial indicators are then calculated, such as the ratio of working capital to total assets, the ratio of liquid assets to total assets, and other vital ratios. Each ratio is multiplied by its specific weight to get the corresponding points, and then these points are combined to derive a final sum that is used to classify the loan application and determine the proposed interest rate, according to the ranges predefined in the form. At the final stage, the algorithm produces a detailed report that includes the studied financial statements, calculated indicators, partial points, and the grand total, as well as the loan classification and the proposed interest rate.

3.   APPLIED STUDY

Solaria Tech is a Moroccan company specialized in developing smart and sustainable solar energy solutions, founded with the aim of making clean energy accessible to everyone in North Africa. The company offers a full range of products, including smart solar panels, grid-independent home solutions, high-quality installation, and maintenance services, as well as a digital application to monitor and analyze energy consumption. The company is currently seeking funding to expand its energy storage systems business. Using highly efficient lithium batteries, as part of a strategy aimed at enhancing energy independence and keeping pace with the transition towards renewable energies.

In order to model the credit risk of **Solaria Tech,** we used the mathematical model "**Sherrod**", where the company's financial statements for the year 2023, represented in budgets and tables of results accounts,

Figure 1: Balance sheet (assest) extracted from the annual report of [Solaria Tech ,2023]

Tableau :	Bilan (passif)

(1) Capital personnel débiteur (-). (2) Bénéficiaire (+). déficitaire (-)

		EXERCICE	EXERCICE PRECEDENT
CAPITAUX PROPRES (A)	Capital social ou personnel (1)	500 000,00	100 000,00
	Moins : actionnaires, capital souscrit non appelé		
	Moins : Capital appelé	500 000,00	100 000,00
	Moins : Dont versé	500 000,00	
	Prime d'émission, de fusion, d'apport		
	Ecarts de réévaluation		
	Réserve légale	24 066,05	24 066,05
	Autres réserves		
	Report à nouveau (2)	1 497 880,33	1 404 336,37
	Résultats nets en instance d'affectation (2)		
	Résultat net de l'exercice (2)	568 490,36	93 543,96
	Total des capitaux propres (A)	2 590 436,74	1 621 946,38
CAPITAUX PROPRES ASSIMILES (B)	Capitaux propres assimilés (B)		
	Subvention d'investissement		
	Provisions réglementées		
DETTES DE FINANCEMENT (C)	Dettes de financement (C)	576 221,70	614 710,72
	Emprunts obligataires		
	Autres dettes de financement	576 221,70	614 710,72
PROVISIONS DURABLES POUR RISQUES ET CHARGES (D)	Provisions durables pour risques et charges (D)		
	Provisions pour risques		
	Provisions pour charges		
ECARTS DE CONVERSION - PASSIF (E)	Ecarts de conversion-passif (E)		
	Augmentation des créances immobilisées		
	Diminution des dettes de financement		
TOTAL I (A+B+C+D+E)	TOTAL I (A+B+C+D+E)	3 166 658,44	2 236 657,10
DETTES DU PASSIF CIRCULANT (F)	Dettes du passif circulant (F)	4 496 988,18	3 530 792,08
	Fournisseurs et comptes rattachés	1 730 057,96	888 014,93
	Clients créditeurs, avances et acomptes		
	Personnel	45 646,00	43 073,00
	Organismes sociaux	32 171,40	12 617,23
	Etat	2 689 112,82	2 545 369,69
	Comptes d'associés		41 717,23
	Autres créanciers		
	Comptes de régularisation passif		
AUTRES PROVISIONS POUR RISQUES ET CHARGES (G)	Autres provisions pour risques et charges (G)		
ECARTS DE CONVERSION - PASSIF (ELEMENTS CIRCULANTS) (H)	Ecarts de conversion - passif (Eléments circulants) (H)		
TOTAL II (F+G+H)	TOTAL II (F+G+H)	4 496 988,18	3 530 792,08
TRESORERIE - PASSIF	Crédits d'escompte		
	Crédits de trésorerie		
	Banques (soldes créditeurs)		225 449,81
TOTAL III	TOTAL III		225 449,81
TOTAL GENERAL I+II+III	TOTAL GENERAL I+II+III	7 663 646,62	5 992 898,99

Figure2: Balance sheet (Liabilities) extracted from the annual report of [Solaria Tech ,2023]

were collected in order to calculate the indicators that make **up the Sherrod model**, which we have already discussed. After extracting and calculating the financial values and ratios from the budget and the table of calculating the results, we reached to:

Table 5: Values extracted from the balance sheet and the income statement (Unit: AED)

Values	2023
Working Capital	1479926.23
Total Assets	7663646.62
Liquid assets	395107.28
Total Liabilities	7663646.62
Net Shareholders' Equity	2590436.74
Net profit before tax	727833.36
Total fixed assets	1686732.21

Source: Prepared by us with the approval of the financial statements extracted from Solaria Tech.

We observe from the table that, after extracting the financial values from the balance sheet and the income statement for the year 2023, the purpose is to calculate the indicators used in the Sherrod model, in order to assess the company's position in relation to managing the associated financial risks.

To determine the independent variables of the Sherrod model, we calculated the relevant financial ratios as indicated in Table (1) above. This was done by utilizing the data extracted from the financial statements for the years under study. The following table presents these calculations.

Table 6: Independent Variables Resulting from the Application of the Sherrod Model

Variable	Ratio	Ratio Value	Relative Weight (Points)	Score (Points)
X1	Working Capital / Total Assets	0.193109925781	17	3.282868738277
X2	Cash Assets / Total Assets	0.051556041085	9	0.464004369765
X3	Net Shareholders' Equity / Total Assets	0.3380162040927	3.5	1.18305671432445
X4	Net Profit Before Tax / Total Assets	0.0949721974524	20	1.899443949048
X5	Total Assets / Total Liabilities	1	1.2	1.2
X6	Net Shareholders' Equity / Total Fixed Assets	1.53577237966	0.1	0.153577237966

Source: Prepared by us based on the financial statements extracted from the company's balance sheets and income statements.

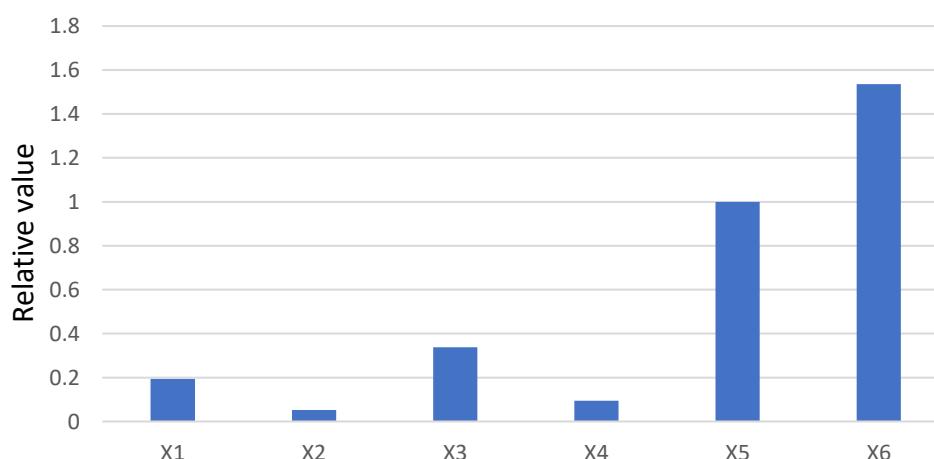## 4.   RESULTS AND DISCUSSION

Figure 1: Graph of the relative value of variables X1 to X6

Indicator 1 (X1): Working Capital to Total Assets Ratio

This indicator shows a ratio of 19.3%, meaning that approximately one-fifth of the company's assets are funded by working capital. This ratio is reasonable and indicates the company's ability to adequately finance its short-term operations. The presence of positive working capital at this level indicates that the company has sufficient liquidity to cover its current obligations without facing financial difficulties. However, the company scored only 3.28 points out of a possible 17, suggesting there is room for improvement in this indicator, possibly through better inventory management or speeding up the collection of receivables.

Indicator 2 (X2): Ratio of Cash Assets to Total Assets

The results show that liquid assets represent only 5.2% of the company's total assets, a relatively low ratio that may raise concerns about the company's immediate cash liquidity. This low ratio may reflect either weak liquidity management or a deliberate strategy to invest most funds in more productive assets. The company's score of only 0.46 points out of 9 confirms poor performance in this area. This situation may expose the company to risks related to inability to meet urgent liabilities or to take advantage of investment opportunities requiring immediate cash.

Indicator 3 (X3): Net Equity to Total Assets Ratio

The ratio of 33.8% indicates that about one-third of the company's assets are financed by equity, which is a positive indicator of the company's strong financial position and independence. This ratio reflects the company's ability to rely on its own resources to finance operations, reducing financial risks linked to excessive borrowing. This level of self-financing also provides greater flexibility in strategic decision-making without heavy reliance on external lenders. The score achieved, 1.18 points out of 3.5, reflects relatively good performance in this indicator.

Indicator 4 (X4): Ratio of Net Profit Before Tax to Total Assets

This indicator is one of the most important profitability measures as it assesses the efficiency of the company in using its assets to generate profits. A ratio of 9.5% is reasonable and indicates the company's ability to achieve an appropriate return on its investments. However, due to the high relative weight of this indicator (20 points), reflecting its importance in overall financial performance evaluation, the company's score of only 1.90 points out of 20 reveals a significant performance gap. This suggests the company needs to make additional efforts to improve asset utilization efficiency and maximize profits from these assets

Indicator 5 (X5): Ratio of Total Assets to Total Liabilities

The results show this ratio equals exactly 1.00, reflecting the company's basic accounting balance where assets equal liabilities. This balance aligns with the fundamental accounting equation stating that assets equal the sum of liabilities and equity. The company's full score for this indicator (1.20 points) reflects full compliance with accounting standards and balance in the financial structure. This indicator does not necessarily reflect strength or weakness in performance but confirms the accuracy of the presented financial statements.

Indicator 6 (X6): Ratio of Net Equity to Total Fixed Assets

A ratio of 1.536 means that equity exceeds the value of fixed assets by about 53.6%, which is a very positive sign indicating the strength of the company's financial structure. This means the company does not rely solely on external financing to fund fixed assets but has surplus equity that can be used for future growth or to withstand difficult economic conditions. This level of financial stability provides great flexibility in long-term planning and reduces financial risks associated with excessive long-term debt. The low weight of this indicator (0.1 points) means its impact on the final score is limited.
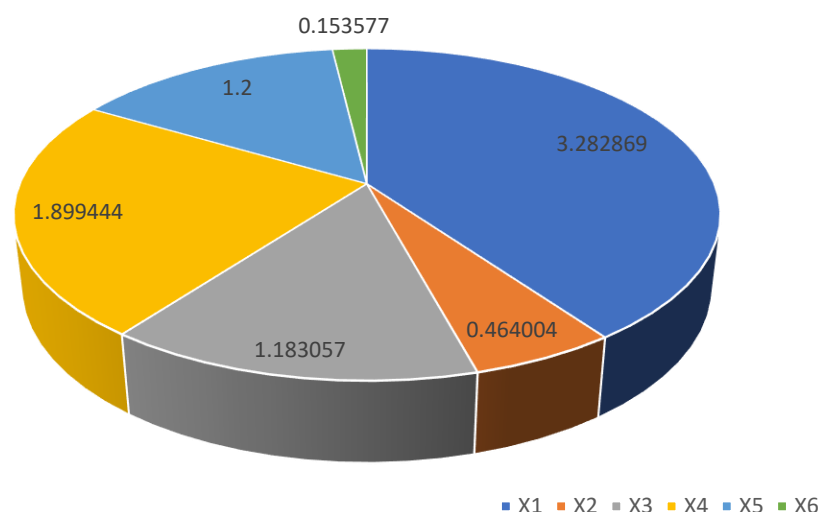
Overall Rating & Conclusion

Based on the comprehensive analysis of all financial indicators, the company attained a score of 8.28 points out of a possible 51.8, representing approximately 16%. This outcome underscores significant challenges across multiple facets of the company's financial performance, necessitating decisive and comprehensive corrective measures. The company's key strengths are evident in its solid financial independence and sufficient working capital. Conversely, the primary areas of concern include inadequate cash liquidity and a critical need to enhance profitability. Management should prioritize improving the return on assets, given its substantial weighting in the evaluation model, alongside strengthening cash liquidity to ensure the company's capacity to meet short-term obligations and leverage investment opportunities promptly.

Table 7: Loan Classification by Risk Grade and Interest Rate Determination

Year	2023
Calculated Z-Score	8,182970822
Quality Indicator	Medium Risk Loans (Category III)

Z-Score Distribution by Variables

Z-Score = 8.183

Figure 3: Z-Score Distribution by Variables

When applying the Sherrod model to Solaria Tech, an active company in solar energy solutions, the 2024 financial statements were used to derive the baseline ratios for assessing credit risk. The outcome was a Z-Score of **8.28 out of a possible 51.8**, which corresponds to only **16%** of the maximum score.

By analyzing the model's indicators, it is clear that the ratio of working capital to total assets (**X1 = 19.3%**) shows that there is reasonable liquidity to enable the company to finance its short-term operations, although not at an optimal level. The ratio of cash assets (**X2 = 5.2%**) is worrying and reflects a severe weakness in spot liquidity, which may expose the company to difficulties in meeting urgent liabilities.

On the other hand, the ratio of equity to total assets (**X3 = 33.8%**) is a positive indicator that reflects good financial independence and the ability to self-finance a significant part of assets, which alleviates external financing pressure. The profit-to-asset ratio (**X4 = 9.5%**) reflects acceptable profitability performance but does not meet the high standards required by the model, making improving profitability a future priority.

As for the asset-to-liability ratio (**X5 = 1.00**), it indicates a basic accounting balance without any excess financial buffer. The fixed assets equity financing ratio (**X6 = 1.536**) is a clear strength indicating a solid capital structure and long-term independence.

Based on these indicators, **Solaria Tech's performance is mixed**; While it exhibits a sound capital foundation and self-financing ability, it suffers from liquidity constraints and moderate profitability. Despite being in the "risk zone", the company holds potential for restructuring and recovery, especially if a comprehensive reform plan is implemented. The model was executed using Python, enabling precise and swift risk simulations and quantitative assessment.

Comparing results with a previous study

When comparing the results of applying the Sherrod model to **Solaria Tech** with the results of the previous study of Abdullah and Abbadi (2022) on the Bank of Baghdad, we notice a clear variation in the indicators achieved despite the use of the same mathematical model. While the Iraqi study indicated that there are severe difficulties in predicting bankruptcy risks due to the weakness of the bank's financial indicators, Solaria Tech Mixed indicators combining some strengths-such as equity strength and a reasonable working capital ratio-showed a clear weakness in liquidity and profitability, placing them in the third category where it is difficult to accurately predict the risk of financial failure.

This discrepancy reveals the ability of the Sherrod model to adapt to different economic environments, but its effectiveness remains dependent on the quality of the data entered and the nature of the sector under study. In the Iraqi case, the results focused on the indicators of solvency and weak profitability in the banking sector, while the Moroccan case showed the peculiarities of the renewable energy sector, in terms of high dependence on fixed assets, and weak liquidity resulting from the nature of long-term investments.

Discuss practical implications and limitations in the model:

In practice, the Sherrod model is an effective tool for supporting credit decisions, especially when used as an early warning indicator that highlights potential risk areas within an organization, without relying on it as a critical tool alone. The realistic application of this model to a company active in the renewable energy sector, such as Solaria Tech, has shown its ability to provide an accurate

initial diagnosis of financial condition, allowing financial institutions to adopt financing decisions conditional on realistic reform plans. However, the effectiveness of the model remains limited with a set of constraints, most notably the stability of the weights used, which may not reflect local or sectoral specificities, which necessitates the need to adapt them to the Moroccan context. The model also relies on accounting data, which makes it vulnerable to distortions resulting from self-assessment or poor transparency, in addition to ignoring fundamental qualitative factors such as management efficiency and political stability. Among other limitations, the model's ability to monitor temporal and dynamic changes is weak, providing only a real-time picture without tracking future developments. From this standpoint, the study recommends the need to recalibrate the weights to suit the Moroccan economic environment, or to work on integrating the Sherrod model with modern technologies such as artificial intelligence or neural networks, in order to enhance its predictive accuracy and reduce the exclusive reliance on accounting data.

5. CONCLUSION

The results of applying the Sherrod model to the company's financial statements for the year 2024 indicate a deep structural imbalance in financial performance that requires radical and urgent intervention from senior management. The overall score of 8.28 points out of a possible 51.8, which is equivalent to only 16% of the grand total, puts the company in the area of acute financial risk and calls for a radical reconsideration of all current financial, operational and management strategies. This low level of performance indicates that the company faces multiple challenges Dimensions require comprehensive and integrated solutions.

The company's relative financial independence, reflected in the equity ratio of 33.8% of total assets, is the lifeblood and the only strategic strength on which to build in the process of comprehensive financial reform. This level of self-financing provides the company with vital flexibility in making radical reform decisions without being subjected to excessive external pressure from lenders or financial institutions. This independence also gives management greater freedom to implement long-term strategies that may require short-term sacrifices. For sustainable gains.

While the acute and serious weakness in cash liquidity is manifested in the fact that liquid assets represent only 5.2% of total assets, this is an explicit red alert for imminent and potential problems in the company's ability to meet its short-term obligations. This low level of liquidity affects not only day-to-day operations, but also the company's ability to exploit urgent investment opportunities and deal with sudden financial crises. Getting only 0.46 points out of 9 points in this indicator Confirms the magnitude of the risk faced by the company in this vital aspect.

The discrepancy between the theoretically reasonable 9.5% return on assets ratio and the low score achieved in this index (1.90 out of 20) reveals a huge gap between current performance and the required standards of financial excellence. This discrepancy clearly indicates that the criteria of the Sherrod model set a high bar for outstanding performance, and that the company needs to make exceptional efforts to achieve the required levels of profitability. The high relative weight of this indicator (20 points) makes improving it a top priority that cannot be postponed.

Other indicators reveal a mixed picture that combines relative strengths with areas in need of substantial improvement. Positive working capital of 19.3% provides a reasonable safety cushion for operations, but the lack of full scores in this indicator indicates that operational cycle management can be improved. The sixth indicator related to the ratio of equity to fixed assets shows a very positive position of 1.536, reflecting the strength of the long-term financial structure and the stability of the funding base.

This comprehensive analysis reveals that the company stands at a critical crossroads, having the solid financial foundations for reform and growth, but suffering from severe operational and management problems that hinder the optimal exploitation of this potential. Success in dealing with these challenges will determine the company's future path and its ability to achieve sustainable growth and high profitability.

Considering the shocking and disturbing results revealed by the implementation of the Sherrod model, the company urgently needs to develop and implement a comprehensive, multi-phased reform plan over a period of at least five years to achieve a radical and tangible improvement in all financial and operational performance indicators. This plan must be bold, comprehensive, and realistic at the same time, considering the available possibilities and limitations, and most importantly, making the most of existing strengths to reinforce weaknesses. Where in the first stage Most urgently, it should focus intensively and focused on addressing the acute liquidity crisis through a comprehensive strategy to restructure the asset portfolio and improve the efficiency of working capital management. The primary and vital goal is to raise the ratio of cash assets from the current dangerous level of 5.2% to a safe level of 12-15% of total assets over the next twelve months. This drastic improvement in liquidity will provide the company with the necessary financial security and vital flexibility to face urgent obligations and exploit profitable investment opportunities that may suddenly appear in the market.

To achieve this ambitious goal, it requires the implementation of an integrated set of practical and immediate measures, including primarily accelerating the cycle of collection of receivables through the application of stricter credit policies and improving monitoring and collection systems. Inventory management needs to be reassessed and improved to reduce frozen capital in slow-moving goods, with modern inventory management systems in place that ensure the availability of essential commodities without overstocking. In addition, the sale of some non-core assets could be considered or unproductive to free up cash without compromising the company's core operations. After the implementation of the phase, we move on to the second and longer-term

phase that requires an intensive strategic focus on radically improving profitability through a comprehensive and in-depth review of all aspects of the cost structure and improving the efficiency of operations at all levels. The strategic objective is to raise the return on assets from the current level of 9.5% to a distinct level of 15-18% within the next two years, which will lead to a tripling of the points achieved in this vital indicator at least. This significant improvement will have a tremendous positive impact on the overall score of the company due to the high relative weight of this indicator in the Sherrod model.

In order to achieve this fundamental improvement in profitability, it requires the implementation of a multidimensional strategy that includes smart and thoughtful investment in modern technology and advanced systems that increase production efficiency and reduce operational costs. Supply chains must be redesigned and optimized to reduce costs and improve product quality, as well as develop new and innovative products and services with higher profit margins that meet evolving market needs. Investing in training and developing human resources will be a crucial factor in the success of this phase, as improving the skills of employees will reflect positively on productivity and quality. In the third and final phase, a company should focus on making the best use of the improvements achieved in the previous two phases to achieve sustainable growth and thoughtful strategic expansion. The core strength of strong financial independence and high equity ratio requires smart exploitation through the application of a balanced investment strategy that achieves ambitious growth without sacrificing carefully built financial stability. The company at this stage would be ideally positioned to invest in long-term and profitable projects without the need for excessive borrowing or exposure to unforeseen financial risks.

Developing a comprehensive strategy to diversify the business and expand the production and service base will significantly help in sustainably improving the return on assets and reducing operational risk by not relying on a single sector or product. This diversification should be thoughtful and based on comprehensive feasibility studies and in-depth analysis of target markets. Investing in R&D will be a critical factor in ensuring long-term competitiveness and developing innovative products and services that generate high profit margins.

Success in achieving these ambitious goals requires the application of a set of supportive and enhanced strategies that ensure continuous improvement and avoid setbacks, through continuous and accurate monitoring of all financial performance indicators and the application of the Sherrod model on a quarterly basis that will ensure regular and objective evaluation of the effectiveness of the actions taken and the possibility of rapid and flexible adjustment of plans and strategies as needed and changing circumstances. In addition to developing a management information system that will provide the department with accurate data and deep analysis necessary to take Decisions based on scientific and objective foundations. This system should include key performance indicators, advanced financial analytics, and future forecasts based on sophisticated statistical and mathematical models. An organizational culture that focuses on continuous improvement and innovation must be developed, while motivating employees to actively participate in the development and reform process.

The ultimate and ambitious strategic goal remains to reach 50-60% of the total points in the Sherrod model over the next five years, which will move the company from an acute financial risk zone to an outstanding and globally accepted level of performance and establish sustainable and profitable growth in the long term. This radical improvement will position the company in a strong competitive position in the market and open new opportunities for local, regional, and international growth and expansion. The implementation of this ambitious vision will require the full commitment of all levels of management and staff, with the need to provide Financial and human resources necessary for the successful implementation of the plan. Success in this major challenge will transform the company from an organization with serious financial problems to a role model in financial and operational excellence, which will benefit all stakeholders from shareholders, employees, customers, and business partners.

REFERENCES

1. AL-Hmadane, S. T. (2023). Using Sherrod Model Indicators to Predict Financial Failure.
2. Al-Kanani. (2022). *Investment decision evaluation.* Baghdad: Dar Al-Doctor.
3. Al-Safwani. (2020). The possibility of using the KIDA model for financial failure prediction. *Academic Research Journal.*, Issue 26.
4. Altman, E. (1977). Anlusis:A New Modal to identify bankruptcy risk of corporation. *journal of banking & finance*.
5. Altman, E. I. (1968). Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy. *The Journal of Finance*.
6. Amer, A. H. (2023). Using the CAMELS system in analyzing capital adequacy, profitability and liquidity. *Al-Ghari Journal for Economic and Administrative Sciences.*
7. Anderson, R. (2007). *The Credit Scoring Toolkit: Theory and Practice for Retail Credit Risk Management and Decision Automation* (éd. août 2007 (1re édition)). (O. U. Press, Éd.) Récupéré sur TheCreditScoringToolkitTheoryAndPracticeForRetailCreditRiskMgmt.DecisionAutomati
8. Anderson, R. (août 2007 (1re édition)). *The Credit Scoring Toolkit: Theory and Practice for Retail Credit Risk Management and Decision Automation* (éd. (1re édition)). Récupéré sur TheCreditScoringToolkitTheoryAndPracticeForRetailCreditRiskMgmt.DecisionAutomati

9. Bessis, J. (2015). *Risk Management in Banking*. (éd. 4ᵉ édition). (W. Finance, Éd.) Récupéré sur https://www.wiley.com/en-us/Risk+Management+in+Banking%2C+4th+Edition-p-9781118660218

10. Dridi, M. H. (2011). The Effects of the Global Crisis on Islamic and Conventional Banks: A Comparative Study. Récupéré sur https://www.imf.org/external/pubs/ft/wp/2010/wp10201.pdf

11. Gerald I. White, A. C. (2003). The Analysis and Use of Financial Statements. (Wiley, Éd.) 784. Récupéré sur https://www.scribd.com/document/487907191/Gerald White Ashwinpaul C Sondhi Haim D Fried The Analysis and Use of Financial-Statements-Wiley-2002-pdf

12. hassan, D. (2022). *Effectiveness of Banking Information Systems in Managing Credit Failure Cases.* Ouargla: Master's thesis.

13. Higgins, R. (2012). *Analysis for financial management* (éd. 10ᵉ édition). (i. a. McGraw-Hill/Irwin (série « The McGraw-Hill/Irwin series in finance, Éd.) Récupéré sur https://students.aiu.edu/submissions/profiles/resources/onlineBook/i5a6J5_Analysis_for_Financial_Management_10th.pdf?utm

14. Hull, J. C. (2018). *Risk Management and Financial Institutions.* (éd. 5ᵉ édition). (W. Finance, Éd.) Récupéré sur https://www.simonfoucher.com/MBA/FINA%20695%20-%20Risk%20Management/riskmanagementandfinancialinstitutions4theditionjohnhull-150518225205-lva1-app6892.pdf

15. Krishna G. Palepu, P. M. (2008). *Business Analysis and Valuation: Using Financial Statements* (éd. 4ᵉ édition). (C. L. Learning), Éd.) Récupéré sur https://students.aiu.edu/submissions/profiles/resources/onlineBook/L5Y5h8 Business Analysis Valuation Text and Cases Third IFRS Edition.pdf

16. Lieberman, H. (s.d.). Finance & Financial Services. *2015*. Récupéré sur https://www.traublieberman.com/practices/finance-financial-services

17. Lutfi. (2005). Financial analysis for performance evaluation and review and investment in the stock exchange. *Alexandria.*

18. M. Mokhtar, A. S. (2014). Mathematical Programming Models for Portfolio Optimization Problem. *World Academy of Science, Engineering and Technology International Journal of Mathematical and Computational Sciences*. Récupéré sur https://www.academia.edu/98433210/Mathematical_Programming Models For Portfolio Optimization Problem A Review

19. sharife, A. (2022). "Financial Failure in Economic Enterprises: From Diagnosis to Prediction and Treatment". *National Symposium, Mentouri University of Constantine.*

20. Smith, M. (1993). *Neural Networks for Statistical Modeling.* (V. N. Reinhold, Éd.) Récupéré sur https://archive.org/details/neuralnetworksfo0000smit

21. wajihad, m. (2022). An-Najah National University for Research.

22. Yahya, Y. &.-Z. (2006). *"Problem Credit Facilities in Palestinian Banks.* gaza: Master's thesis.

23. Yassin, S. T.-H. (2024). Yassin, S. T., & Al- استخدام مؤشرات نموذج شيرود للتنبؤ بالفشل المالي: بحث تطبيقي في الشركة الوطنية للاستثمار السياحي في العراق للفترة. *مجلة الدراسات الكردية*.

24. الشريف. (2022). من التشخيص إلى التنبؤ ثم العلاج. الفشل المالي في المؤسسة الاقتصادية. *ملتقى وطني، جامعة منتوري قسنطينة*.

25. الصفواني. (2020). مكانية استخدام نموذج KIDA للتنبؤ بالفشل المالي. *مجلة البحوث الأكاديمية* العدد 26.

26. الكناني. (2022). *تقييم قرارات الاستثمار*. بغداد: دار الدكتور.

27. ديب, ح. (2022). *فعالية نظم المعلومات المصرفية في تسيير حالات فشل الائتمان*. رسالة ماجستير. ورقلة.

28. عامر, أ. ه (2023). استخدام نظام CAMELS في تحليل كفاية رأس المال والربحية والسيولة. *مجلة الغري للعلوم الاقتصادية والإدارية*.

29. لطفي. (2005). *التحليل المالي لأغراض تقييم ومراجعة الأداء والاستثمار في البورصة*. الاسكندرية.

30. وجهاد, م. (2022). *جامعة النجاح للابحاث*, 52.