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THE LEGAL REGULATION OF PREDICTIVE INSOLVENCY IN THE AGE OF BLOCKCHAIN AND ARTIFICIAL INTELLIGENCE

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ABSTRACT

Background: *Insolvency proceedings in most jurisdictions open late, after cessation of payments has become manifest and enterprise value has eroded. Blockchain and artificial intelligence are presented as remedies: the former as a means of securing the integrity of financial records, and the latter as a means of detecting distress before default. The legal literature treats the two separately and rarely asks what a court may do with their output. The question is particularly relevant in the United Arab Emirates (UAE). Federal Decree-Law 51 of 2023 defines instability of financial position as an expected failure to pay debts within three months. It allows a debtor who fears inability to pay to seek a preventive settlement. The statutory trigger is therefore already predictive, yet Federal Decree-Law 46 of 2021 does not state what a distributed ledger record proves, and no rule governs reliance on algorithmic assessments.*

Method: *The study combines doctrinal analysis of the primary texts with a functional comparison. The UAE is the principal jurisdiction; the European Union, the United Kingdom, and Singapore serve as reference frameworks, selected against four criteria fixed in advance and assessed against five uniform criteria, including the legal status of early detection, the evidential treatment of ledger records, and the constraints on automated decision-making. The computational literature on bankruptcy prediction is used only as a stated factual premise. An applied study runs a constructed, dated scenario of a Dubai trading company through the applicable law and the rules proposed here, and produces draft statutory provisions.*

Results and Conclusions: *Immutability establishes that a ledger entry has not been altered, not that it was correct. The predictive advantage of machine-learning models is reported mainly for listed companies and is not established for the small and medium enterprises that dominate insolvency. Predictive output can therefore support access to a voluntary preventive procedure, but not a coercive measure against a debtor. The UAE's deficiency is evidential rather than conceptual. Under the current law, the scenario company could have filed for preventive settlement five months before cessation of payment but received no evidential support to do so. At the same time, the court had to examine the ledger platform itself. Under the proposed rules, the filing is supported by an accredited assessment, the ledger dispute is confined to the underlying commercial question, and a creditor relying on a model must disclose it and bear the burden of proof. The article proposes three draft provisions, a sequenced implementation plan with assigned authorities, and a research agenda for empirical validation.*

1 INTRODUCTION

Insolvency law is the mechanism through which distressed enterprises are reorganised or liquidated. It aims to preserve economic value and maintain credit market confidence, and its theory has long turned on the tension between creditor protection and debtor rehabilitation. International standards now treat early intervention, informal workouts, and the insolvency of micro and small enterprises as integral to an effective regime.[1] However, proceedings in most systems still open late, after cessation of payments becomes manifest and restructuring options narrow.

Two technologies are proposed in response. A distributed ledger can produce tamper-evident, auditable records of transactions and asset ownership.[2] Machine-learning models

1 World Bank, *Principles for Effective Insolvency and Creditor/Debtor Regimes* (World Bank Group 2021) <https://doi.org/10.1596/35506> accessed 18 January 2026.

2 Fran Casino, Thomas K Dasaklis and Constantinos Patsakis, 'A Systematic Literature Review of Blockchain-Based Applications: Current Status, Classification and Open Issues' (2019) 36 Telematics and Informatics 55 <https://doi.org/10.1016/j.tele.2018.11.006> accessed 18 January 2026; Dirk A Zetzsche, Ross P Buckley and Douglas W Arner, 'The Distributed Liability of Distributed Ledgers: Legal Risks of Blockchain' (2018) 2018(4) University of Illinois Law Review 1361 <https://illinoislawreview.org/print/vol-2018-no-4/the-distributed-liability-of-distributed-ledgers/> accessed 18 January 2026.

can detect deteriorating creditworthiness earlier than conventional ratio analysis.[3] Together they suggest an insolvency system that acts on evidence of distress before default. This article addresses whether the law can receive that evidence.

UAE insolvency law already contains a predictive trigger. Article 1 of Federal Decree-Law 51 of 2023 defines instability of financial position as the debtor's "failure or expected failure to pay off its due debts within three months", and Article 56(1)(a) allows a debtor to seek a preventive settlement where "there are reasons that make it expect or fear inability to repay all or any of its debts when they fall due."[4] Legal consequences are, therefore, attached to a forecast. However, it says nothing about how to prepare the forecast. Federal Decree-Law 46 of 2021 provides that an electronic document does not lose legal force because of its electronic form (Art. 5(1)) and that its admissibility is not precluded on that ground (Art. 18(1)).[5] However, it does not state what a distributed ledger record proves or on what conditions an algorithmic assessment may be relied upon. In practice, the forward-looking trigger depends entirely on the debtor's own judgement, and the machine-generated evidence that could establish it has no defined legal status. Neither the legislator nor the courts have resolved this. The research problem is the gap between a statutory trigger that is predictive in concept and an evidential law that cannot yet support it.

The research questions are as follows:

RQ1: What does a distributed ledger record prove, and what should the law presume from it in insolvency proceedings?

RQ2: How far can machine-learning output support a legal finding of expected inability to pay?

RQ3: What legal, regulatory, and ethical obstacles stand in the way of integrating both technologies, and how do they vary across jurisdictions?

RQ4: Which evidential and procedural rules should govern ledger records and algorithmic assessments, and who should bear the burden of proof?

RQ5: What institutional reforms would move UAE insolvency practice from a reactive to a preventive orientation, and in what order?

3 Flavio Barboza, Herbert Kimura and Edward Altman, 'Machine Learning Models and Bankruptcy Prediction' (2017) 83 Expert Systems with Applications 405 <https://doi.org/10.1016/j.eswa.2017.04.006> accessed 18 January 2026.

4 UAE Federal Decree-Law 51 of 2023 'Promulgating the Financial and Bankruptcy Law' [2023] Official Gazette 762, arts 1, 56(1)(a) <https://uaelegislation.gov.ae/en/legislations/2190> accessed 18 January 2026.

5 UAE Federal Decree-Law 46 of 2021 'On Electronic Transactions and Trust Services' [2021] Official Gazette 712(1), arts 5(1), 18(1) <https://uaelegislation.gov.ae/en/legislations/1539> accessed 18 January 2026.

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The propositions below are doctrinal claims about what the law should provide. They are not statistical hypotheses and are not tested against data generated by this study:

> **P1:** A ledger record can reduce information asymmetry in insolvency, provided the law separates the record's integrity from the truth of its contents.
>
> **P2:** Machine-learning models can detect distress earlier than traditional indicators. This premise rests on the computational literature[6] and is advanced conditionally; no conclusion in this article depends on treating it as established.
>
> **P3:** Predictive output may lawfully open the door to a voluntary preventive procedure, but it may not, by itself, found a coercive measure against a debtor.
>
> **P4:** The UAE can achieve a preventive orientation through a small number of connecting provisions, because the procedural, evidential, and supervisory components already exist.

The study covers corporate debtors subject to Federal Decree-Law 51 of 2023.[7] It excludes entities in the Dubai International Financial Centre and the Abu Dhabi Global Market, which have their own regimes. Its temporal scope is the law in force on 1 September 2026. Substantively, it addresses the evidential and procedural treatment of ledger records and predictive assessments; it does not examine the insolvency treatment of crypto-assets as property, as in Remolina et al.[8]

Three streams of scholarship are relevant. On blockchain, review applications across sectors and identify unresolved regulatory and scalability problems.[9] Cong and He show that the economic value of blockchain and smart contracts lies where information asymmetry is acute, as in ordinary insolvency.[10] Zetzsche et al. analyse liability allocation where no single party controls the ledger,[11] and De Filippi et al. argue that blockchain functions as a "confidence machine" whose trustworthiness depends on governance rather than code.[12]

6 Barboza, Kimura and Altman (n 3).

7 UAE Federal Decree-Law 51 of 2023 (n 4).

8 Nydia Remolina, Aurelio Gurrea-Martínez and Daniel Liu, 'The Treatment of Digital Assets in Insolvency' in Jason G Allen and others (eds), *The Oxford Handbook of Digital Assets and the Law* (OUP 2026) <https://ink.library.smu.edu.sg/sol_research/4794/> accessed 18 January 2026.

9 Casino, Dasaklis and Patsakis (n 2).

10 Lin William Cong and Zhiguo He, 'Blockchain Disruption and Smart Contracts' (2019) 32(5) The Review of Financial Studies 1754 <https://doi.org/10.1093/rfs/hhz007> accessed 18 January 2026.

11 Zetzsche, Buckley and Arner (n 2).

12 Primavera De Filippi, Morshed Mannan and Wessel Reijer, 'Blockchain as a Confidence Machine: The Problem of Trust & Challenges of Governance' (2020) 62 Technology in Society 101284 <https://doi.org/10.1016/j.techsoc.2020.101284> accessed 18 January 2026.

For prediction, classical models such as Beaver and Altman used financial ratios and discriminant analysis.[13] Barboza et al. compared support vector machines, bagging, boosting, and random forests with those models and reported materially higher accuracy.[14] Kou et al. showed that the choice of algorithm changes financial risk classification.[15] Rudin argued that in high-stakes decisions, black-box models should not be used where an interpretable model performs comparably, because post-hoc explanations of opaque models are unreliable; the argument applies directly to adjudication.[16]

On technology and insolvency law, Mangano proposed a sandbox approach to blockchain securities in insolvency,[17] and Remolina et al. address the classification and distribution of digital assets.[18] Comparative scholarship has long observed that legislative reform without institutional capacity yields formal rights without practical remedies.[19]

These streams treat the two technologies separately, and none asks what a court may do with their output. No study has examined the evidential status of ledger records and predictive assessments against a statutory trigger that is itself predictive, as the UAE's statutory trigger now is. This article fills that gap.

The study uses a doctrinal and functional comparative method. The doctrinal component interprets the texts governing insolvency, electronic records, data protection, and automated decision-making. The comparative component asks how each system responds to the same problem, namely the late detection of distress and the status of machine-generated information, rather than comparing institutions that share a name without sharing a function. No empirical data were collected.

Jurisdictions were selected against four criteria: (i) a preventive or early detection mechanism in force; (ii) a binding instrument on electronic records or trust services; (iii) an operative or emerging framework for automated decision-making; and (iv) primary

13 William H Beaver, 'Financial Ratios as Predictors of Failure' (1966) 4 Journal of Accounting Research 71 <https://doi.org/10.2307/2490171> accessed 18 January 2026; Edward Altman, 'Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy' (1968) 23(4) The Journal of Finance 589 <https://doi.org/10.1111/j.1540-6261.1968.tb00843.x> accessed 18 January 2026.

14 Barboza, Kimura and Altman (n 3).

15 Gang Kou, Yi Peng and Guoxun Wang, 'Evaluation of Clustering Algorithms for Financial Risk Analysis Using MCDM Methods' (2014) 275 Information Sciences 1 <https://doi.org/10.1016/j.ins.2014.02.137> accessed 18 January 2026.

16 Cynthia Rudin, 'Stop Explaining Black Box Machine Learning Models for High-Stakes Decisions and Use Interpretable Models Instead' (2019) 1(5) Nature Machine Intelligence 206 <https://doi.org/10.1038/s42256-019-0048-x> accessed 18 January 2026.

17 Renato Mangano, 'Blockchain Securities, Insolvency Law and the Sandbox Approach' (2018) 19(4) European Business Organization Law Review 715 <https://doi.org/10.1007/s40804-018-0123-5> accessed 18 January 2026.

18 Remolina, Gurrea-Martínez, and Liu (n 8).

19 Paul J Omar (ed), *International Insolvency Law: Reforms and Challenges* (Routledge 2013) <https://doi.org/10.4324/9781315092522> accessed 18 January 2026.

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materials available in English or Arabic. The UAE is the principal jurisdiction. The European Union, the United Kingdom, and Singapore serve as reference frameworks, examined only insofar as they address problems identified in the UAE analysis.

The primary materials are Federal Decree-Law 51 of 2023 on Financial Restructuring and Bankruptcy[20] and its Executive Regulation;[21] Federal Decree-Law 46 of 2021 on Electronic Transactions and Trust Services;[22] Directive (EU) 2019/1023 on preventive restructuring frameworks;[23] the General Data Protection Regulation;[24] the Artificial Intelligence Act;[25] the United Kingdom's Corporate Insolvency and Governance Act 2020;[26] and Singapore's Insolvency, Restructuring and Dissolution Act 2018.[27] Secondary materials are not treated as legal authority; where they supply a factual premise, the dependence is stated.

Each system is assessed against five criteria: (1) whether early detection is a legal duty or a facility; (2) upon whom it operates; (3) the evidential status of electronic and ledger records; (4) the constraints on automated decision-making; and (5) the availability of a controlled testing environment. The applied study in Section 8 runs a constructed but realistic fact pattern through current UAE law and the rules this article proposes, and produces draft statutory provisions.

Section 2 identifies the structural deficiencies of conventional insolvency systems. Sections 3 and 4 examine what blockchain and machine learning can and cannot contribute. Section 5 sets out the legal constraints on their joint use, including the evidential rules a

20 UAE Federal Decree-Law 51 of 2023 (n 4).

21 UAE Cabinet Resolution 94 of 2024 'Concerning the Executive Regulations of the Financial Restructuring and Bankruptcy Law Promulgated by the Federal Decree-Law 51 of 2023' [2024] Official Gazette 783 <https://uaelegislation.gov.ae/en/legislations/2582> accessed 18 January 2026.

22 UAE Federal Decree-Law 46 of 2021 (n 5).

23 Directive (EU) 2019/1023 of the European Parliament and of the Council of 20 June 2019 on Preventive Restructuring Frameworks, on Discharge of Debt and Disqualifications, and on Measures to Increase the Efficiency of Procedures Concerning Restructuring, Insolvency and Discharge of Debt, and Amending Directive (EU) 2017/1132 [2019] OJ L 172/18 <https://eur-lex.europa.eu/eli/dir/2019/1023/oj> accessed 18 January 2026.

24 Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the Protection of Natural Persons about the Processing of Personal Data and on the Free Movement of Such Data, and Repealing Directive 95/46/EC (General Data Protection Regulation) [2016] OJ L 119/1 <https://eur-lex.europa.eu/eli/reg/2016/679/oj> accessed 18 January 2026.

25 Regulation (EU) 2024/1689 of the European Parliament and of the Council of 13 June 2024 Laying Down Harmonised Rules on Artificial Intelligence and Amending Regulations (EC) no 300/2008, (EU) 167/2013, (EU) 168/2013, (EU) 2018/858, (EU) 2018/1139 and (EU) 2019/2144 and Directives 2014/90/EU, (EU) 2016/797 and (EU) 2020/1828 (Artificial Intelligence Act). [2024] OJ L 2024/1689 <https://eur-lex.europa.eu/eli/reg/2024/1689/oj> accessed 18 January 2026.

26 UK Corporate Insolvency and Governance Act 2020, c 12 <https://www.legislation.gov.uk/ukpga/2020/12/contents> accessed 18 January 2026.

27 Singapore's Insolvency, Restructuring and Dissolution Act 40 of 2018 <https://sso.agc.gov.sg/Act/IRDA2018> accessed 18 January 2026

court needs. Section 6 proposes a five-pillar framework, and Section 7 applies it to the UAE against the three reference systems. Section 8 is the applied study. Section 9 sets out the implementation sequence, limitations, and research agenda, and Section 10 states the findings and recommendations.

2 STRUCTURAL DEFICIENCIES OF CONVENTIONAL INSOLVENCY SYSTEMS

In many jurisdictions, insolvency legislation has grown through piecemeal amendments. It intersects with company, secured transactions, tax, and employment law, and new asset classes raise questions of classification, custody, and distribution that existing statutes did not anticipate.[28] Delay compounds fragmentation: the period from opening to final distribution may run to years, during which costs and depreciation erode the estate. The shortfall between legislation and implementation is most marked where judicial specialisation and practitioner capacity lag behind legislative change, which is why current international standards address institutional capacity alongside substantive rules.[29]

The debtor knows more about its financial condition and related-party dealings than any creditor and may have reason to withhold or distort that knowledge. Unsecured creditors cannot verify it independently, and they price the risk into lending, raising the cost of capital for all enterprises. Courts and practitioners face a parallel capacity constraint: assessing complex financial arrangements or the feasibility of a plan requires expertise that is scarce in many systems. The same limitation leaves decision-makers poorly placed to interrogate a technical output, a risk examined in Section 5.

Where assets, creditors, or operations span several jurisdictions, resolution requires coordination among courts applying different rules. The UNCITRAL model law on cross-border insolvency makes recognition and cooperation easier, but leaves substantive law to each state, and divergent priority and valuation rules continue to invite forum shopping.[30] Experience in fields where multilateral convention allocates liability across jurisdictions shows both the reach of convention-based harmonisation and the interpretive divergence that survives it.[31] Out-of-court settlement offers flexibility but operates without judicial oversight and depends on the credible threat of formal proceedings, so a technology-enhanced framework must serve both tracks.

28 Remolina, Gurrea-Martínez and Liu (n 8).

29 World Bank (n 1).

30 UNCITRAL Model Law on Cross-Border Insolvency (adopted 30 May 1997) <https://uncitral.un.org/en/texts/insolvency/modellaw/cross-border_insolvency> 18 January 2026.

31 Ahmed Moustafa Aldabousi, 'The Joint Responsibility of the Air Carrier Established in Accordance with International Conventions on the Status of Air Terrorism' (2024) 16(2) Pakistan Journal of Criminology 133 <https://doi.org/10.62271/pjc.16.2.133.144> accessed 18 January 2026.

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Many of these deficiencies are, at their core, information problems: stakeholders cannot obtain, verify, and act on accurate financial information in time. Blockchain addresses the verification side by providing a shared, tamper-evident record.[32] Machine learning addresses the timing side by identifying deterioration patterns that periodic reporting misses.[33] Neither addresses the legal side: what the law may conclude from the record or the forecast. Sections 3 and 4 test each technology against that question.

3 BLOCKCHAIN IN INSOLVENCY PROCEEDINGS

Verifying a debtor's records in conventional proceedings may require examining thousands of transactions across accounts, periods, and jurisdictions. A distributed ledger reduces the risk of manipulation, destruction, or fraudulent conveyance because a recorded entry cannot be altered without detection.[34] The ability to trace an asset from acquisition to transfer or encumbrance is particularly valuable in avoidance actions, where it provides an objective basis for claims of preferential or undervalue transactions.[35] Ledger-based continuous auditing can, in principle, replace periodic sample-based review with monitoring of every transaction.

These benefits come with a qualification central to this article. Immutability protects a record after it is written; it says nothing about whether the entry was correct when made. The value of a ledger in insolvency therefore depends on the reliability of its inputs and on a legal rule stating what the record proves.

Smart contracts can automate claim registration, dividend calculation under statutory priority rules, and monitoring of a confirmed plan.[36] Their determinism is also their limitation: coded rules may yield outcomes that are technically correct but unjust where the facts outrun the code, and irreversibility becomes a defect when an error must be corrected. Any procedural use must preserve a route to judicial correction. For the same reason, permissioned ledgers, in which participation is restricted to authorised entities, suit insolvency better than public chains, because they permit defined governance and access control.[37]

Those features matter most for data protection. Regulation (EU) 2016/679 confers rights of erasure and rectification that an immutable ledger cannot honour directly.[38] Common responses include storing personal data off-chain, with only a hash recorded on-chain,

32 Casino, Dasaklis and Patsakis (n 2).
33 Barboza, Kimura and Altman (n 3).
34 Cong and He (n 10).
35 Zetzsche, Buckley and Arner (n 2).
36 De Filippi, Mannan and Reijer (n 12).
37 Zetzsche, Buckley and Arner (n 2).
38 Regulation (EU) 2016/679 (n 24) arts 16, 17.

and rendering data inaccessible through key destruction. Decentralisation also blurs the allocation of data controller and data processor responsibility, which regulation must restore by designation.

Regulatory sandboxes allow new technologies to be tested under supervision with temporary modification of the applicable rules. Mangano proposed this approach for blockchain securities in insolvency, arguing that the technology's legal consequences cannot be settled in the abstract.[39] Financial-sector sandboxes are now common, and the UAE has signalled its readiness to regulate emerging commercial sectors through dedicated licensing and supervisory arrangements rather than waiting for general legislation.[40] An insolvency-specific sandbox would require defined admission criteria, stakeholder participation, and published evaluation metrics.

Blockchain offers greater transparency, reduced information asymmetry, automated compliance, and better cross-border coordination. Its constraints are equally real: technological (scalability and interoperability), legal (regulatory uncertainty and the tension with data protection), and institutional (limited practitioner capacity and the absence of common standards). Their relative weight varies with each jurisdiction's legal framework and infrastructure. The key point is that a ledger's legal value depends on an evidential rule that most systems, including the UAE's, have not yet formulated.

4 ARTIFICIAL INTELLIGENCE IN INSOLVENCY PREDICTION

Researchers have studied bankruptcy prediction since Beaver and Altman,[41] whose models relied on financial ratios and linear discriminant analysis. Those techniques impose assumptions that do not capture the non-linear dynamics of corporate distress. Machine-learning methods relax those assumptions. Barboza et al. found that support vector machines, bagging, boosting, and random forests outperformed discriminant analysis and logistic regression in predicting bankruptcy one year ahead.[42] Kou et al. showed that algorithm selection materially affects financial risk classification and that the choice itself requires a principled evaluation method.[43]

These results require qualification before attaching any legal consequences. Reported accuracy depends on the dataset, and most published models are trained on listed companies in mature markets, where standardised disclosure produces dense and reliable

39 Mangano (n 17).

40 Ahmed Moustafa Aldabousi, 'Managing Commercial Space Activities: Legal and Regulatory Challenges in the UAE's Space Sector' (2025) 23(2) Problems and Perspectives in Management 423 <https://doi.org/10.21511/ppm.23(2).2025.30> accessed 18 January 2026.

41 Beaver (n 13); Altman (n 13).

42 Barboza, Kimura and Altman (n 3).

43 Kou, Peng and Wang (n 15).

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inputs. Insolvency populations are dominated by small and medium enterprises, whose reporting is thinner, later, and less consistently audited. Corporate failure is rare, so headline accuracy may be high while auditing of the firms that actually fail remains weak, and performance degrades out of sample and across credit cycles. What is absent is evidence that the reported advantage survives transposition into a judicial setting, where a false positive is not a misclassified observation but an enterprise pushed prematurely into restructuring. The framework in Section 6 is therefore built on the premise that predictive output is probabilistic evidence to be weighed, not a finding to be adopted.

Beyond binary prediction, analytics can indicate the stage and causes of distress and project performance under different scenarios. Financial statements remain the foundation, supplemented by market data, payment behaviour, trade-credit information, and macroeconomic indicators. Newer sources, such as consumer and brand signals in digital markets, can reveal commercial deterioration before it reaches the accounts,[44] although their evidential reliability is correspondingly lower. The value of early detection lies in timing: earlier intervention preserves more enterprise value and higher employment. Early-warning systems could be operated by the debtor itself, by credit institutions, or by a supervisory authority, and the choice among these has direct due-process consequences, discussed in Section 5.

The right to a reasoned decision requires that the basis for a determination be intelligible to the affected party. Techniques such as SHAP and LIME produce post-hoc explanations of complex models by identifying the features that most influenced a given output. Rudin cautions that such explanations may not faithfully describe what the model actually computed, and that in high-stakes settings an inherently interpretable model is preferable whenever it performs comparably.[45] For insolvency, the required degree of explainability should follow the system's function. A tool that informs a human decision-maker who retains discretion calls for disclosure and documentation; a tool whose output determines whether proceedings open or how claims are treated calls for full explainability, bias testing, and human review.

Predictive models depend on financial data held mainly by banks, which confidentiality and regulation restrain from sharing. Techniques such as federated learning, in which each holder trains locally and shares only model updates, ease that constraint without removing it. This section's legal conclusion is narrower than the computational literature's headline claims. Predictive output is probabilistic evidence of expected distress, and its legal use must be calibrated to the consequence it is asked to support.

44 Abdelrehim Awad and Ahmed Moustafa Aldabousi, 'Analyzing the Impact of Viral Marketing on Brand Equity Dimensions in Egypt's Home Appliances Sector: A Customer and Legal Perspective' (2024) 20(4) Innovative Marketing 100 <https://doi.org/10.21511/im.20(4).2024.09> accessed 18 January 2026.

45 Rudin (n 16).

5 LEGAL AND ETHICAL CONSTRAINTS ON HYBRID SYSTEMS

Due process in insolvency requires notice, an opportunity to contest claims and evidence, access to the basis of a decision, and a right of review. Algorithmic assistance threatens each of these where the system's operation or the basis of its output is inaccessible. Bias compounds the risk. It may enter through training data that reflects historical credit patterns, through variables that act as proxies for protected characteristics, or through model design. A model that overestimates risk in a sector may push viable enterprises into proceedings. Periodic bias audits and a supervisory power to order retraining or suspension are the minimum response.

A regulatory framework must account for what a technology costs and how it fails. The costs of a permissioned ledger include node operation, key management, integration with court and registry systems, security auditing, and user retraining. Where estates are too small to meet practitioners' fees, these costs determine whether the technology is used, and a framework indifferent to cost will widen rather than narrow the enforcement gap.[46]

Distributed architecture displaces cybersecurity risk rather than eliminating it. Key compromise, defective smart-contract code, and attacks on the consensus layer each produce the same legal problem: an immutable record of a fraudulent or erroneous entry that the system is designed not to correct. The legal question is therefore which authority may declare such a record legally ineffective, on what evidence, and by what procedure. Operational dependence on private node operators and software maintainers raises a further question since the continuity of a public function becomes contingent on private conduct.

The final constraint is behavioural. Where a predictive score is available, decision-makers tend to defer to it, and this tendency is strongest where they lack the technical competence to question it, as described in Section 2. Automation bias turns a decision-support tool into a decision-making one without changing the legal framework that authorises it. A system that is formally advisory but followed in practically every case is, in operation, determinative, and the safeguards proposed below reflect that.

A court presented with a blockchain record, or with an algorithmic assessment of a debtor's viability, faces two different problems that should not be assimilated.

A ledger record is documentary evidence whose probative value depends on technical matters: the integrity of the hashing and consensus mechanism, the identity and authority of the party making the entry, the reliability of the off-chain input, and the time of recording. A court cannot verify these from the record alone. The workable approach is to accord the record a rebuttable presumption of integrity as to what was recorded and when, conditional on proof that the ledger met stated technical requirements. The presumption extends to non-alteration and not to the truth of the contents. Immutability establishes that an entry

46 Mangano (n 17).

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has not been changed; it establishes nothing about whether it was correct when made, and a rule that conflates the two turns a technical property into an evidential conclusion the technology does not support.

An algorithmic assessment is not documentary evidence; it is closer to expert opinion. It should be admitted on the conditions that govern expert evidence: disclosure of the method, the training data, the known error rates and their distribution across debtor classes, the validation history, and the party responsible for deployment. A model whose error profile cannot be disclosed cannot be tested, and untested evidence should not be relied upon to restrict a debtor's disposal of its own assets. Regulation (EU) 2024/1689 adopts a convergent position by classifying as high-risk those systems intended to assist judicial authorities in researching and interpreting facts and law, and by requiring that the final decision remain human.[47] The evidential consequences, however, must still be worked out in procedural law.

The burden of proof should follow the direction in which the output operates. Where a predictive assessment is invoked to open or accelerate proceedings against a debtor, the party invoking it must establish both the system's reliability and the applicability of its output to that debtor; the assessment does not shift the burden to the debtor to disprove its own distress. Where a debtor invokes an early-warning output to access a preventive procedure, a lower threshold is appropriate, because the consequence is opening a negotiation rather than restricting a right. Four safeguards follow: reasons expressed in legal rather than statistical terms; disclosure of the material inputs relied upon; a right to adduce contrary evidence and to require human reconsideration; and a record sufficient for appellate review of the weight given to the output.

The two technologies can also be combined to meet these constraints. Recording each input, model version, output, and human intervention on a ledger produces an audit trail against which an algorithmic output can later be tested.[48] That design helps, but it does not replace the evidential rules set out above. A court still needs to know what the ledger proves and on what terms a forecast may be used, and Section 6 turns those answers into a framework.

6 PROPOSED LEGAL FRAMEWORK

The framework has five pillars. The first three are given operative form in Section 8.

The first pillar is an evidential rule for ledger records: a rebuttable presumption of non-alteration where (1) the system uses generally accepted consensus and cryptographic mechanisms, (2) the data-entry process is controlled and verifiable, and (3) the record carries metadata establishing provenance.[49] The presumption does not extend to the truth of the contents, and the court may appoint a technical expert when the contents are challenged.

47 Regulation (EU) 2024/1689 (n 25) Annex III, point 8(a), Recital 61.
48 Casino, Dasaklis and Patsakis (n 2).
49 Zetzsche, Buckley and Arner (n 2).

The second pillar is risk-based regulation of predictive systems. Advisory tools require disclosure, documentation, and quality assurance; tools that affect rights, claim treatment, or distribution require explainability, bias testing, human oversight, and an effective right of challenge.[50] The third pillar is data protection compliance: approved techniques for honouring data-subject rights on a ledger, designated data controller and data processor roles, and an impact assessment before deployment.

The fourth pillar is an insolvency-specific sandbox with transparent admission criteria, participation by creditors, debtors, practitioners, and the judiciary, and published results.[51] The fifth is international harmonisation through UNCITRAL's insolvency programme and regional bodies such as the Gulf Cooperation Council. Harmonisation must also account for the dispute-resolution tracks that run alongside insolvency. In Islamic finance, arbitration clauses and Sharia-compliance review create parallel forums whose relationship to insolvency proceedings remains unsettled,[52] and a ledger-based claims register must accommodate awards and determinations issued in them.

Together, the pillars support a system operating at three levels. Early-warning tools assess financial condition and alert the debtor; ledger platforms manage claim registration, asset tracking, and distribution, subject to judicial correction; and analytical tools help courts evaluate plans under the evidential conditions of Section 5.

7 THE UAE FRAMEWORK AND COMPARATIVE ASSESSMENT

The principal instrument is Federal Decree-Law 51 of 2023 on Financial Restructuring and Bankruptcy, which came into force on 1 May 2024 and repealed Federal Decree-Law 9 of 2016.[53] The Cabinet issued its Executive Regulation by Cabinet Resolution 94 of 2024.[54] The 2023 law applies to onshore commercial companies, government-owned entities, and free-zone entities. It also applies to natural persons, while entities in the Dubai International Financial Centre and the Abu Dhabi Global Market are subject to their own regimes. Three features are material. First, the law replaces the former preventive composition procedure with preventive settlement and restructuring procedures that a debtor may initiate before cessation of payments becomes manifest. Second, it establishes a specialised Bankruptcy Court with a dedicated administrative

50 Rudin (n 16).

51 Mangano (n 17).

52 Ahmed Moustafa Aldabousi and others, 'Arbitration in Islamic Banking: Exploring Legal and Practical Implications for Dispute Resolution' (2025) 20(2) Banks and Bank Systems 15 <https://doi.org/10.21511/bbs.20(2).2025.02> accessed 18 January 2026.

53 UAE Federal Decree-Law 51 of 2023 (n 4); UAE Federal Decree-Law 9 of 2016 concerning Bankruptcy (adopted 20 September 2016) <https://uaelegislation.gov.ae/en/legislations/1475/download> accessed 18 January 2026.

54 UAE Cabinet Resolution 94 of 2024 (n 21).

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unit, addressing the capacity deficit described in Section 2. Third, standing is distributed: the debtor may apply within sixty days of cessation of payment (Art. 15(1)), an ordinary creditor may apply only for an unconditional, undisputed, due debt above the prescribed threshold and after a thirty-day payment notice (Art. 16(1)), and a regulatory authority may apply in respect of the debtors it supervises (Art. 18).[55] Article 14 already allows every procedure under the law, from filing to voting and attendance at hearings, to be carried out through modern technology.[56] The UAE framework has therefore already moved towards an early intervention model. It lacks a rule on how to prove the expectation of distress, which Articles 1 and 56 already make legally relevant.[57]

The first gap is evidential. Federal Decree-Law 46 of 2021 on Electronic Transactions and Trust Services, which repealed Federal Law 1 of 2006 on 2 January 2022, establishes a regulated framework for trust services, introduces graded categories of electronic signature and seal, and provides that an electronic record does not lose legal effect by reason of its form.[58] It does not, however, address what distinguishes a distributed ledger from an ordinary electronic record: custody without an identifiable record-keeper, consensus validation in place of a controlling entity, and immutability that precludes correction. Earlier work on the conclusion of smart commercial contracts by intelligent software agents under UAE law identified the same difficulty from the contractual side: the law recognises electronic form without determining who is bound by, and who answers for, an automated act.[59] The likely result is that a ledger record is admissible in the UAE as an electronic record. At the same time, its weight, and the technical conditions on which that weight depends remain undetermined. That gap is narrower than is sometimes asserted, but it is the operative one.

The second gap concerns automated decision-making. The UAE has a Minister of State for Artificial Intelligence and a National Strategy for Artificial Intelligence 2031, but no binding instrument governing the use of predictive systems in legal decision-making, leaving permissible uses, validation standards, and liability for erroneous output unsettled.

The third gap concerns data. Any monitoring system would process commercially sensitive and personal information. UAE law already treats the unauthorised electronic disclosure of a merchant's private information as a matter warranting criminal protection.[60] A predictive

55 UAE Federal Decree-Law 51 of 2023 (n 4) arts 15(1), 16(1), 18.

56 ibid, art 14.

57 ibid, arts 1, 56.

58 UAE Federal Decree-Law 46 of 2021 (n 5); UAE Federal Law 1 of 2006 'On Electronic Commerce and Transactions' (adopted 30 January 2006) <https://tahseen.ae/media/2670/uae-2006-ecommerce-and-transactions-law-english.pdf> accessed 18 January 2026.

59 Ahmed Moustafa Aldabousi, 'Legal Problems of Conclusion of Intelligent Software Agent for Smart Commercial Contracts in the Era of Blockchain: UAE as a Model' (2022) 14(S3) Universidad y Sociedad 713 <https://rus.ucf.edu.cu/index.php/rus/article/view/3005> accessed 18 January 2026.

60 Muayad Ahmad Obeidat and others, 'Criminal Protection for Merchants from Crimes of Electronic Publishing Regarding Invasion of Privacy in UAE Legislation' (2024) 16(3) Pakistan Journal of Criminology 779 <https://doi.org/10.62271/pjc.16.3.779.792> accessed 18 January 2026.

system operating without a defined legal basis for its data processing would therefore be exposed under that protective regime as well as under data protection rules. Finally, the framework contains no mechanism for continuous financial monitoring, so proceedings still ordinarily begin only after distress becomes severe.

National policy, including the Emirates Blockchain Strategy 2021 and the National Strategy for Artificial Intelligence 2031, supports technological adoption across government.[61] The courts already use electronic filing and remote hearings, and the sandboxes run by the Central Bank, the Securities and Commodities Authority, and free-zone authorities provide experience that could be extended to insolvency-focused testing.

The comparison is deliberately asymmetrical: the reference systems are examined only as far as they address the deficiencies identified above.

The European Union has gone furthest in converting early detection into a legal obligation. Article 3 of Directive (EU) 2019/1023 requires Member States to ensure that debtors have access to clear and transparent early-warning tools capable of detecting circumstances that could give rise to a likelihood of insolvency. It expressly contemplates using information technology for that purpose.[62] Two design features are instructive. The duty is one of access rather than outcome, and a warning does not automatically carry legal consequences. The trigger lies with the debtor rather than a supervisory authority, which avoids the due-process difficulties that arise when an algorithmic assessment is deployed against a debtor. The framework proposed here extends that model. The European position on the technology itself is more restrictive: Regulation (EU) 2016/679 constrains processing on an immutable ledger,[63] and Regulation (EU) 2024/1689 subjects judicial-assistance systems to conformity assessment, human oversight, and logging obligations.[64]

The United Kingdom pursued the same objective through procedure. The Corporate Insolvency and Governance Act 2020 introduced a standalone moratorium and a restructuring plan with cross-class cram-down, widening the window within which an early signal can be acted upon.[65] It imposed no early-warning duty, however, and its treatment of electronic and algorithmic evidence rests on general rules. The experience in England and Wales shows that procedural flexibility and informational capability are separable reforms, and that the first does not produce the second.

61 'Emirates Blockchain Strategy 2021' (*UAE Government*, updated 30 December 2024) <https://u.ae/en/about-the-uae/strategies-initiatives-and-awards/strategies-plans-and-visions/strategies-plans-and-visions-untill-2021/emirates-blockchain-strategy-2021> accessed 18 January 2026; *UAE National Strategy for Artificial Intelligence 2031* (UAE Minister of State for Artificial Intelligence Office 2018) <https://staticcdn.mbzuai.ac.ae/mbzuaiwpprd01/2022/07/UAE-National-Strategy-for-Artificial-Intelligence-2031.pdf> accessed 18 January 2026.

62 Directive (EU) 2019/1023 (n 23) art 3.

63 Regulation (EU) 2016/679 (n 24).

64 Regulation (EU) 2024/1689 (n 25).

65 UK Corporate Insolvency and Governance Act (n 26).

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Singapore's contribution lies in consolidation and proportionality. The Insolvency, Restructuring and Dissolution Act 2018 brought personal and corporate insolvency into a single statute, consolidated the regulation of practitioners,[66] and later introduced simplified procedures for smaller estates. The point for present purposes is practical: predictive tools matter most for debtors least able to afford formal proceedings, and a framework that ignores cost will not reach them.

***Table* 1. Comparative matrix of the four jurisdictions**

Criterion	European Union	United Kingdom	Singapore	United Arab Emirates
Early detection of distress	Legal duty on Member States to provide early warning tools (Dir. (EU) 2019/1023, Art. 3)	No equivalent statutory duty; detection left to directors' duties and practice	No equivalent statutory duty; emphasis on accessible procedures	No duty; preventive settlement available on the debtor's own application
Locus of the trigger	Debtor	Directors and creditors	Debtor and creditors	Debtor, creditors, and regulatory authorities under the 2023 Law
Status of electronic and ledger records	Electronic records recognised; ledger records constrained by Reg. (EU) 2016/679	General rules of evidence; no ledger-specific instrument	General rules of evidence; no ledger-specific instrument	Electronic records recognised under Decree-Law 46 of 2021; ledger records unaddressed
Constraints on automated decision-making	High-risk classification, conformity assessment, and human oversight (Reg. (EU) 2024/1689)	Data protection framework; no sector-specific AI instrument	Sectoral guidance; no binding cross-sector AI statute	National AI strategy in place; no binding framework for legal decision-making contexts

66 Singapore's Insolvency, Restructuring and Dissolution Act (n 27).

Criterion	European Union	United Kingdom	Singapore	United Arab Emirates
Controlled testing environment	Regulatory sandboxes mandated under Reg. (EU) 2024/1689	Financial-sector sandbox; no insolvency-specific facility	Financial-sector sandbox; no insolvency-specific facility	Sandboxes operated by the Central Bank, the SCA, and free-zone authorities; none extends to insolvency

Read against these frameworks, the UAE position is neither the most advanced nor the most deficient, but asymmetrical. Its insolvency law, recast in 2023, already provides the procedures that early detection would feed; its electronic transactions law, recast in 2021, already recognises electronic records; and its regulators already operate sandboxes. What is missing is an instrument connecting these three assets. The familiar paradox of comparative insolvency law, that the systems most in need of rescue mechanisms are least equipped to operate them, applies here in reverse: institutional capacity exists, but legal authorisation lags.[67] The required reform is therefore narrower than a wholesale legislative programme. Section 8 tests that claim on a concrete case.

8 APPLIED STUDY: A WORKED SCENARIO AND DRAFT PROVISIONS

The claim of Sections 5 to 7 is that the UAE's deficiency is evidential rather than conceptual. The test is a single fact pattern run twice: first through the law in force,[68] then through the rules this article proposes. The scenario is constructed for this study, and its parties are fictitious. Its facts reflect the distress of a trading company dependent on construction-sector receivables, and the dates are chosen to engage the statutory time limits.

Al Noor Building Supplies LLC ("the Company") is a mainland Dubai limited liability company that distributes construction materials. It has sixty-four employees, a turnover of AED 41 million in 2025, and a working-capital facility of AED 14 million from a UAE bank ("the Bank"). The Company records its invoices to property developers on a permissioned receivables ledger operated by a consortium of banks for invoice financing.[69]

67 Omar (n 19).

68 UAE Federal Decree-Law 51 of 2023 (n 4).

69 Karem Sayed Aboelazm, 'The Judicial Constitutional Review for the Legislative Omission: A Comparative Study' (2025) 17(1) Krytyka Prawa 316 <https://doi.org/10.7206/kp.2080-1084.766> accessed 18 January 2026.

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On 1 February 2026, the Bank's early-warning model assigns the Company a twelve-month probability of default of 9 per cent. By 15 April 2026, the figure is 38 per cent. The model's explanation identifies two drivers: receivable days have risen from 71 to 128, and invoices of AED 3.1 million owed by two developers appear on the ledger as more than ninety days overdue. On 20 April, the Bank informs the Company. The Company's cash-flow forecast shows it will not meet a supplier instalment of AED 2.6 million due on 30 June or a facility repayment of AED 1.8 million due on 31 July.

On 20 April, the Company falls within the statutory concept of instability of financial position, since it expects to fail to pay due debts within three months.[70] It may apply for preventive settlement because it has reason to "expect or fear" inability to pay.[71] Nothing obliges it to do so, and the Bank's assessment has no defined legal status. Management decides to wait for the developers to pay.

The Bank cannot act. No debt is yet due, so the conditions of an unconditional, undisputed, payable debt and a prior thirty-day notice under Article 16(1) are unmet, and the Company is not a supervised entity for Article 18.[72] This result is correct in principle: a creditor should not be able to open proceedings on a forecast.

The Company misses the supplier instalment on 30 June. The supplier serves a payment notice expiring on 20 July, and cessation of payment occurs ten days later, on 30 July.[73] The sixty-day period in Article 15(1) runs to 28 September, and the Company files on 20 September.[74] By then, two suppliers have withdrawn credit, and one developer disputes an invoice of AED 0.9 million, alleging defective delivery.

The evidential phase exposes the gap. The Company relies on the ledger to prove the amount and date of its receivables. The record is admissible as an electronic document,[75] but no rule states what it proves. The developer's challenge to the delivery therefore spills over into a challenge to the record itself, and the court appoints an expert to examine the platform. The Bank then tenders its model output to argue that the restructuring plan is not feasible. No rule requires disclosure of the model's method or error rates, and the Company has no way to test it.

Under Section 8, the Company obtains an accredited early-warning assessment on 20 April and files for preventive settlement on 5 May. The assessment is prima facie evidence of the Article 56(1)(a) condition, so the filing is not contested on that ground.[76] The assessment is available to the Company alone and gives the Bank no new route to initiate proceedings.

70 UAE Federal Decree-Law no 51 of 2023 (n 4) art 1.
71 ibid, art 56(1)(a).
72 ibid, arts 16(1), 18.
73 ibid, art 1.
74 ibid, art 15(1).
75 UAE Federal Decree-Law 46 of 2021 (n 5) arts 5(1), 18(1).
76 UAE Federal Decree-Law 51 of 2023 (n 4) art 56(1)(a).

The ledger record of the developer invoices carries a presumption that it has not been altered since the recorded time of entry. The developer's allegation of defective delivery goes to the truth of the underlying claim, which the presumption does not cover, so the dispute is confined to the commercial question, and no platform expert is needed unless the developer adduces evidence that the ledger was compromised.[77] If the Bank relies on its model to oppose the plan, it must disclose the method, data categories, and error rates, and it bears the burden of showing that the output is reliable and applies to this debtor. Table 2 compares the two paths.

***Table* 2. Outcome of the scenario under current law and under the proposed rules**

Issue	Law in force	Proposed rules
Earliest filing	20 April available under Art. 56(1)(a), but unassisted; actual filing 20 September, after cessation of payment	5 May, supported by an accredited assessment (Art. A)
Status of the Bank's model output	Undefined	Prima facie evidence for the debtor's own filing; no ground for creditor action
Creditor initiation on a forecast	Excluded (Art. 16(1))	Still excluded (Art. A(4))
Ledger invoice record	Admissible under Federal Decree-Law 46 of 2021, Arts. 5(1), 18(1); weight undetermined; platform expert appointed	Presumed unaltered (Art. B); dispute confined to the delivery defence
Model output against the plan	No disclosure duty; debtor cannot test it	Disclosure required; burden on the Bank (Art. C)

Three conclusions follow. First, UAE law has already accepted prediction as a legal concept: Articles 1 and 56(1)(a) attach consequences to an expected inability to pay.[78] The deficiency the scenario exposes is evidential, confirming the asymmetry identified in Section 7 and explaining why a small number of connecting provisions can close it. Second, Article 16(1)

77 Karem Sayed Aboelazm, 'Supreme Constitutional Court Review of the Legislative Omission in Egypt in Light of International Experiences' (2024) 10(17) Heliyon e37269 <https://doi.org/10.1016/j.heliyon.2024.e37269> accessed 18 January 2026.

78 UAE Federal Decree-Law 51 of 2023 (n 4) arts 1, 56(1)(a).

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already embodies the limit proposed in Section 5.[79] Because a creditor may act only on a due and undisputed debt, a forecast cannot found coercive action, and the proposed rules preserve that position rather than disturb it. Third, separating integrity from truth has practical effect. It confines the dispute over the ledger record to the underlying commercial question and removes the need for a technical inquiry in the ordinary case. The scenario does not show that the earlier filing would have saved the Company; that would require data this study does not have. It does show that, under current law, the preventive procedure the legislator created in 2023 was available on 20 April, and that nothing in the evidential framework helped the Company or the court use it.

The following provisions translate the framework into operative text. Article A would be inserted into the Executive Regulation issued by Cabinet Resolution 94 of 2024;[80] Article B into Federal Decree-Law 46 of 2021;[81] Article C into the procedural rules applicable before the Bankruptcy Court.

***Table* 3. Proposed provisions**

Provision	Proposed text
Article A: Early-warning assessment (Executive Regulation)	(1) The Bankruptcy Department may accredit tools that assess the likelihood of a debtor's instability of financial position, in accordance with technical standards issued by resolution of the Minister. (2) An assessment shall be issued to the debtor alone and shall not be disclosed to any third party without the debtor's consent. (3) An assessment indicating instability of financial position, submitted with an application under Article 56(1)(a) of the Law within ninety days of its date, shall constitute prima facie evidence that the condition in that clause is met. (4) An assessment shall not by itself constitute a ground for an application under Article 16 or Article 18 of the Law, or for any measure restricting the debtor's management of its assets.
Article B: Distributed ledger records (Federal Decree-Law 46 of 2021)	(1) A record entered in a distributed ledger that meets the technical requirements issued by the competent authority shall be presumed not to have been altered since the time of entry shown in it, and to have been entered by the holder of the key with which it was signed. (2) The presumption does not extend to the accuracy of the contents of the record. (3) The presumption may be rebutted by evidence of malfunction, compromise of the signing key or the consensus mechanism, or non-compliance with the technical requirements, and the court may appoint a technical expert for that purpose.

79 ibid, arts 16(1).
80 UAE Cabinet Resolution 94 of 2024 (n 21).
81 UAE Federal Decree-Law 46 of 2021 (n 5).

Provision	Proposed text
Article C: Algorithmic assessments (procedure before the Bankruptcy Court)	(1) A party relying on the output of an automated system concerning a debtor's financial position shall disclose the method, the categories of data used, the known error rates, the validation record, and the person responsible for the system. (2) Where the output is relied upon to open, accelerate, or convert proceedings, or to oppose a debtor's plan, the party relying on it shall bear the burden of establishing the reliability of the system and the applicability of its output to the debtor. (3) The court shall not rely on such output unless paragraph (1) has been complied with, shall state its reasons in legal terms, and shall hear contrary evidence at the request of the affected party.

9 IMPLEMENTATION PATHWAY, LIMITATIONS, AND RESEARCH AGENDA

Legal authorisation should precede technical deployment, and deployment should precede any mandatory element. Measures creating rights or duties for debtors come last, because they should not be imposed before the evidential and supervisory apparatus that controls them is in place. Table 4 sets out the sequence.

***Table* 4. Proposed implementation sequence for the UAE**

Horizon	Measure	Instrument	Responsible actor
Short term (0–18 months)	Evidential rule: distributed ledger records carry a rebuttable presumption of integrity, conditional on stated technical requirements; technical requirements are issued as subordinate rules.	Amendment to the Electronic Transactions and Trust Services Law, with implementing decision.	Legislator; Telecommunications and Digital Government Regulatory Authority.
Short term (0–18 months)	Extension of an existing regulatory sandbox to insolvency-technology applications, with defined entry criteria, evaluation metrics, and publication of results.	Regulatory decision of the supervisory authority.	Central Bank; Securities and Commodities Authority; free-zone regulators.

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Horizon	Measure	Instrument	Responsible actor
Medium term (18–36 months)	Procedural rules governing the admissibility and weight of algorithmic assessments: disclosure of method and error profile, human reconsideration, and reasons in legal terms.	Amendment to the procedural rules applicable before the Bankruptcy Court.	Legislator; Ministry of Justice; Bankruptcy Court.
Medium term (18–36 months)	Voluntary early-warning facility available to debtors, modelled on the access-based duty in Directive (EU) 2019/1023 and carrying no automatic legal consequence.	Executive regulation under the Financial Restructuring and Bankruptcy Law.	Cabinet; Ministry of Justice (Bankruptcy Department).
Medium term (18–36 months)	Certification and continuing-competence requirements for insolvency practitioners and judicial staff in the evaluation of technical evidence.	Professional regulation and judicial training programme.	Ministry of Justice; judicial training institutes.
Long term (36 months and beyond)	Integration of ledger-based asset and claim registries with court case management, subject to evaluated sandbox outcomes.	Implementing regulation and inter-institutional agreement.	Ministry of Justice; Ministry of Finance; registry authorities.
Long term (36 months and beyond)	Cross-border recognition arrangements for technologically mediated insolvency records, pursued through existing harmonisation channels.	Bilateral and multilateral instruments; UNCITRAL work programme.	Ministry of Justice; Ministry of Foreign Affairs.

The study is doctrinal; it collected no operational data, and the scenario in Section 8 is constructed. The premise that machine-learning models outperform conventional indicators comes from studies of listed companies, and its extension to the small and medium sized enterprises that dominate insolvency populations is an assumption. Four research programmes follow. The first is retrospective validation of published models against UAE insolvency filings, with error rates reported separately for failed and surviving firms. The second is a sandbox pilot of a ledger-based claims register in one court, with pre-registered metrics for duration, cost, and disputed claims. The third is a comparative study

of the early-warning tools implemented under Directive (EU) 2019/1023,[82] the only existing body of practice under an access-based duty. The fourth is a simulation of the proposed evidential rules against decided cases.

10 FINDINGS AND RECOMMENDATIONS

Immutability proves that a ledger entry has not been altered; it does not prove that the entry was correct. An evidential rule must keep the two apart (Sections 3 and 5). The reported advantage of machine-learning prediction rests on listed-company datasets and has not been shown for insolvency populations. Predictive output is probabilistic evidence and should be weighed as such (Section 4). A formally advisory tool that decision-makers follow in practically every case operates as a determinative one. Safeguards must attach to how an output is used, not to its label (Section 5). UAE law already attaches legal consequences to a forecast of inability to pay.[83] The deficiency is evidential, not conceptual (Sections 7 and 8). Federal Decree-Law 46 of 2021 admits ledger records as electronic documents but does not state what they prove, so their weight is left undetermined (Sections 7 and 8).[84] Article 16(1) of Federal Decree-Law 51 of 2023 already prevents creditors from acting on forecasts.[85] The proposed rules preserve that limit (Section 8).

The European Union's access-based early-warning duty is the closest model for the UAE. The United Kingdom shows that procedural flexibility does not supply informational capability, and Singapore shows that cost determines whether small debtors are reached (Section 7).

In the scenario, the proposed rules allow the preventive procedure to open before any default and confine the dispute over the ledger to the underlying commercial question (Section 8).

Some recommendations can be made from this study.

To the federal legislator: insert Article B (Table 3) into Federal Decree-Law 46 of 2021, creating a rebuttable presumption of non-alteration for ledger records that meet published technical requirements and excluding the accuracy of their contents from it.

To the Cabinet: amend Cabinet Resolution 94 of 2024 to include Article A (Table 3), establishing an accredited, voluntary early-warning assessment that serves as prima facie evidence of the condition in Article 56(1)(a) and gives creditors no new ground of application.

82 Directive (EU) 2019/1023 (n 23).

83 UAE Federal Decree-Law 51 of 2023 (n 4) arts 1, 56(1)(a).

84 UAE Federal Decree-Law 46 of 2021 (n 5).

85 UAE Federal Decree-Law 51 of 2023 (n 4) art 16(1).

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To the Ministry of Justice and the Bankruptcy Court: adopt Article C (Table 3) as a procedural rule requiring disclosure of method, data categories, and error rates before an algorithmic output is relied upon and placing the burden of proof on the party that invokes it against the debtor.

To the Telecommunications and Digital Government Regulatory Authority: issue the technical requirements to which Article B refers, covering consensus mechanisms, key management, timestamping, and audit logs.

To the Central Bank and the Securities and Commodities Authority: extend an existing sandbox to insolvency-technology applications, with defined admission criteria and published evaluation results.

To the Bankruptcy Court, pending legislation: treat algorithmic assessments as expert-type evidence, decline to rely on any model whose method and error profile are not disclosed, and state reasons in legal rather than statistical terms.

To the Ministry of Justice and the research community: support a retrospective validation study of prediction models on UAE insolvency filings before any mandatory element is considered.

The article shows that the UAE's statutory trigger for preventive settlement is already predictive, identifies the evidential gap that prevents it from operating on evidence, and supplies the provisions that would close that gap without giving creditors a coercive use of forecasts. Its method is doctrinal, and the research agenda in Section 9 identifies the studies needed to test its central premise.

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АНОТАЦІЯ УКРАЇНСЬКОЮ МОВОЮ

Дослідницька стаття

ПРАВОВЕ РЕГУЛЮВАННЯ ПРОГНОЗОВАНОЇ НЕПЛАТОСПРОМОЖНОСТІ В ЕПОХУ БЛОКЧЕЙНУ ТА ШТУЧНОГО ІНТЕЛЕКТУ

Ахмед Мустафа Алдабусі*, Тарек Абдельсалам, Амер Фахурі, Саад Алі Рамадан, Фуад Аль-Шайбі та Раїда Раафат

АНОТАЦІЯ

Передумови. *У більшості юрисдикцій провадження у справах про неплатоспроможність відкриваються із запізненням — після того, як припинення платежів уже стає очевидним, а вартість підприємства суттєво знижується. Блокчейн і штучний інтелект розглядаються як засоби вирішення цієї проблеми: перший — як інструмент забезпечення цілісності фінансових записів, другий — як спосіб виявлення фінансових труднощів до настання дефолту. У юридичній доктрині ці технології здебільшого досліджуються окремо, а питання можливості використання судом результатів їх застосування залишається недостатньо висвітленим. Особливої актуальності ця проблема набуває в Об'єднаних Арабських*

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Еміратах. Федеральний декрет-закон № 51 від 2023 року визначає фінансову нестабільність як очікувану нездатність виконати боргові зобов'язання протягом трьох місяців, надаючи боржникові, який обґрунтовано побоюється настання неплатоспроможності, право ініціювати процедуру превентивного врегулювання. Таким чином, законодавче регулювання вже ґрунтується на прогностичному підході; утім, Федеральний декрет-закон № 46 від 2021 року не визначає доказового значення записів у розподіленому реєстрі, а законодавство загалом не містить норм щодо врахування алгоритмічних висновків.

Методи. *Дослідження поєднує доктринальний аналіз першоджерел із функціональним порівняльно-правовим методом. ОАЕ є основною юрисдикцією дослідження; як порівняльні орієнтири обрано Європейський Союз, Велику Британію та Сінгапур на підставі чотирьох попередньо визначених критеріїв. Їхню правову базу проаналізовано за п'ятьма уніфікованими критеріями, зокрема правовим статусом механізмів раннього виявлення, доказовим значенням записів у розподіленому реєстрі та правовими обмеженнями щодо автоматизованого ухвалення рішень. Результати наукових досліджень у сфері обчислювальних методів прогнозування банкрутства використовуються лише як фактична основа дослідження. У межах прикладного дослідження змодельовано ситуацію з торговельною компанією, зареєстрованою в Дубаї, із зазначенням відповідних дат, та проаналізовано її крізь призму чинного законодавства і запропонованих у статті правил, у результаті чого розроблено проєкти відповідних законодавчих положень.*

Результати та висновки. *Незмінність записів у блокчейні засвідчує лише відсутність подальших змін, а не достовірність первинно внесеної інформації. Прогностична ефективність моделей машинного навчання підтверджена переважно для компаній, акції яких перебувають в обігу на фондовому ринку, і не є доведеною для суб'єктів малого та середнього підприємництва, які становлять переважну більшість серед неплатоспроможних боржників. Відтак результати застосування прогностичних моделей можуть слугувати підставою для звернення до добровільної процедури превентивного врегулювання, проте не можуть бути підставою для застосування заходів примусу щодо боржника. Прогалина в законодавстві ОАЕ має передусім доказовий, а не концептуальний характер. Відповідно до чинного законодавства модельована компанія могла б звернутися із заявою про застосування процедури превентивного врегулювання за п'ять місяців до фактичного припинення платежів, однак не мала достатніх доказів для обґрунтування такої заяви; до того ж суд був би змушений досліджувати безпосередньо платформу розподіленого реєстру. Згідно із запропонованими нормами звернення до суду підтверджується акредитованою оцінкою, предмет доказування у спорі щодо запису в розподіленому реєстрі обмежується встановленням обставин відповідних комерційних правовідносин, а на кредитора, який посилається на аналітичну модель, покладаються обов'язок розкрити інформацію про її використання та тягар доказування. У статті сформульовано три проєкти законодавчих норм, поетапний план їх упровадження із закріпленням компетенції уповноважених органів, а також напрями подальших емпіричних досліджень.*

Ключові слова: *законодавство про неплатоспроможність; прогнозована неплатоспроможність; докази на основі блокчейну; штучний інтелект; прогнозування банкрутства; раннє попередження; алгоритмічна підзвітність; регуляторні пісочниці; Об'єднані Арабські Емірати.*

ABSTRACT IN ARABIC*

مقال بحثي

التنظيم القانوني للتنبؤ بالإفلاس في عصر سلسلة الكتل (البلوك تشين) والذكاء الاصطناعي

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الملخص:

الخلفية:

تفتتح إجراءات الإعسار في معظم النظم القانونية في وقت متأخر، بعد أن يغدو التوقف عن الدفع ظاهرًا وتكون قيمة المشروع قد تآكلت، وتطرح تقنيتا سلسلة الكتل والذكاء الاصطناعي بوصفهما علاجًا لهذا القصور: الأولى وسيلةً لضمان سلامة السجلات المالية، والثانية وسيلةً لرصد التعثر قبل وقوع الإخلال بالسداد. غير أن الأدبيات القانونية تتناول التقنيتين كلًّا على حدة، ونادرًا ما تتساءل عمّا يجوز للمحكمة أن تفعله بمخرجاتهما، وتبرز هذه المسألة بحدّة في دولة الإمارات العربية المتحدة؛ إذ يعرف المرسوم بقانون اتحادي رقم (51) لسنة 2023 عدم استقرار المركز المالي بأنه التعثر المتوقع في سداد الديون خلال ثلاثة أشهر، ويجيز للمدين الذي يخشى العجز عن السداد أن يطلب الصلح الواقي من الإفلاس، ومن ثم فإن المعيار التشريعي ذو طبيعة تنبؤية في ذاته، بيد أن المرسوم بقانون اتحادي رقم (46) لسنة 2021 لا يبين ما يثبته القيد في السجل الموزع، ولا توجد قاعدة تنظم الاستناد إلى التقييمات الخوارزمية.

المنهجية:

تجمع الدراسة بين التحليل التأصيلي للنصوص الأصلية والمقارنة الوظيفية. وتُعدّ دولة الإمارات العربية المتحدة النظامَ القانوني الرئيسي محلّ الدراسة، في حين يُتّخذ الاتحاد الأوروبي والمملكة

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المتحدة وسنغافورة أطرًا مرجعية، جرى اختيارها وفق أربعة معايير محددة سلفًا، وتقييمها وفق خمسة معايير موحّدة، من بينها الوضع القانوني للكشف المبكر، والمعاملة الإثباتية لقيود السجل الموزّع، والقيود الواردة على اتخاذ القرار الآلي. ولا تُستخدم الأدبيات الحاسوبية المتعلقة بالتنبؤ بالإفلاس إلا بوصفها مقدمةً واقعيةً مُصرّحًا بها. وتُخضِع الدراسةُ التطبيقية سيناريو افتراضيًا مؤرَّخًا لشركة تجارية في دبي لأحكام القانون النافذ وللقواعد المقترحة في هذا البحث، وتنتهي إلى صياغة مشروعات نصوص تشريعية.

والاستنتاجات النتائج:

إن عدم القابلية للتعديل يُثبت أن القيد في السجل لم يُعدَّل، لا أنه كان صحيحًا. كما أن الأفضلية التنبؤية لنماذج تعلم الآلة ثابتة أساسًا في الشركات المدرجة، وغير ثابتة بالنسبة إلى المنشآت الصغيرة والمتوسطة التي تمثل الغالبية العظمى من حالات الإعسار. ومن ثمّ يجوز أن تدعم المخرجاتُ التنبؤية اللجوءَ إلى إجراء وقائي طوعي، دون أن تصلح سندًا لاتخاذ تدبير قسري في مواجهة المدين. ويكمن القصور في التشريع الإماراتي في الجانب الإثباتي لا في الجانب المفاهيمي. ففي ظل القانون النافذ، كان بوسع الشركة محلّ السيناريو أن تتقدم بطلب الصلح الواقي قبل خمسة أشهر من توقفها عن الدفع، غير أنها لم تجد ما يدعم طلبها من الناحية الإثباتية، وكان على المحكمة في الوقت ذاته أن تفحص منصة السجل ذاتها. أما في ظل القواعد المقترحة، فيُدعَم الطلب بتقييم معتمد، ويُحصَر النزاع حول السجل في المسألة التجارية الأصلية، ويلتزم الدائن الذي يستند إلى نموذج تنبؤي بالإفصاح عنه ويتحمّل عبء الإثبات. ويقترح البحث ثلاثة مشروعات نصوص تشريعية، وخطة تنفيذ مرحلية تُحدَّد فيها الجهات المختصة، وبرنامجًا بحثيًا للتحقق التجريبي.

المفتاحية الكلمات:

قانون الإعسار؛ الإعسار التنبؤي؛ أدلة سلسلة الكتل؛ الذكاء الاصطناعي؛ التنبؤ بالإفلاس؛ الإنذار المبكر؛ المساءلة الخوارزمية؛ البيئات التنظيمية التجريبية؛ الإمارات العربية المتحدة.