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REVIEW SCIENTIFIC PAPER

Unified Criteria for Damage Assessment – Theoretical Models, Methodological Framework and Application in Contemporary Practice

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Abstract: Damage assessment represents a crucial component of legal, economic, technical, and insurance procedures; however, contemporary practice still demonstrates significant inconsistencies in assessment criteria, methodologies, and interpretation of results. Different sectors—including judicial systems, insurance, transportation, industry, construction, and digital security—apply their own assessment models that are frequently incompatible with one another, leading to inconsistent decisions, legal disputes, and reduced legal certainty.

The objective of this paper is to develop the concept of a unified interdisciplinary framework for damage assessment based on universal principles of objectivity, measurability, reproducibility, and transparency. The study examines existing damage assessment approaches through a comparative methodological analysis encompassing quantitative models (econometric, statistical, and engineering approaches), qualitative models (expert assessments, legal standards, and normative frameworks), and hybrid models integrating numerical and descriptive parameters.

Particular attention is devoted to identifying key variables influencing the final assessment outcome, including direct costs, indirect losses, loss of profit, temporal factors, escalation risk, and intangible effects. Based on this analysis, a universal assessment model is proposed that integrates standardized weighting coefficients and a multiparametric evaluation matrix.

The proposed framework consists of three levels of assessment: basic assessment (quantification of immediate damage), extended assessment (analysis of secondary consequences), and strategic assessment (long-term effects and risk projections). This structure enables the systematic application of unified criteria across different domains while preserving the specificity of individual cases. The principal contribution of the study lies in defining methodological guidelines that support the standardization of expert evaluations, reduce assessor subjectivity, and enhance the reliability of findings in judicial, administrative, and commercial proceedings.

The results indicate that implementing unified criteria significantly improves legal certainty, procedural efficiency, and cross-sector compatibility of assessments. It is concluded that methodological standardization of damage assessment represents a necessary step toward establishing a transparent and internationally harmonized system for evaluating harmful events, particularly in the context of globalization and digitalized economies. The paper also provides recommendations for institutional implementation of the proposed model through regulatory standards, professional protocols, and specialized training of assessors.

Keywords: damage assessment, standardization of criteria, evaluation methodology, interdisciplinary model, legal certainty, loss quantification.

INTRODUCTION

Damage assessment represents one of the fundamental elements of contemporary legal, economic, technical, and insurance systems, as its accuracy directly influences decision-making processes in judicial, administrative, and commercial proceedings. In modern societies characterized by rapid technological development, globalization of markets, increasing interdependence of economic activities, and the digital transformation of business processes, the need for reliable and standardized damage assessment methodologies has become increasingly important. Previous studies in the fields of economics, law, valuation theory, and risk management have emphasized the necessity of objective and transparent assessment procedures capable of producing consistent and reproducible results [1], [3], [5], [16].

Despite significant advancements in assessment methodologies, contemporary practice remains characterized by considerable fragmentation of approaches. Different sectors—including insurance, transportation, industry, construction, environmental protection, and digital security—have developed their own assessment frameworks based on specific disciplinary perspectives and evaluation criteria. Consequently, similar damage events may produce substantially different assessment outcomes depending on the methodology applied, resulting in inconsistencies, legal disputes, increased transaction costs, and reduced legal certainty [1].

Traditional damage assessment models primarily focus on direct financial losses and material consequences. Although such approaches are suitable for evaluating immediate economic impacts, they frequently neglect broader dimensions of damage, including temporal effects, uncertainty factors, escalation risks, reputational consequences, social impacts, and other intangible losses. Modern risk management theory emphasizes that harmful events should be analyzed not only through their immediate consequences but also through their long-term effects and potential future implications [3], [4], [5].

The increasing complexity of socio-economic systems further highlights the limitations of conventional assessment models. Industrial accidents, environmental disasters, cyberattacks, transportation disruptions, and large-scale infrastructure failures often generate interconnected consequences that extend beyond direct material damage. Such events produce cascading effects across multiple sectors, requiring comprehensive assessment methodologies capable of integrating economic, legal, technical, and social dimensions into a single analytical framework [11], [12], [17].

Another important challenge concerns the assessment of intangible damage. While direct material losses can generally be quantified using established financial methods, intangible effects such as reputational harm, psychological consequences, loss of public confidence, and diminished market position remain difficult to

evaluate objectively. Existing approaches often rely on expert judgment and qualitative evaluations, introducing significant levels of subjectivity into the assessment process [8], [14], [21].

The lack of universally accepted standards also presents a significant obstacle to the comparability of assessment results. International organizations and professional bodies have increasingly advocated the adoption of standardized procedures and harmonized assessment criteria. Frameworks such as ISO 31000, ISO/IEC 31010, and International Valuation Standards provide valuable guidance for risk assessment and valuation activities; however, they do not offer a fully integrated methodology capable of encompassing all relevant dimensions of damage assessment [3], [16], [22].

In response to these challenges, this paper aims to:

- systematize existing theoretical and methodological approaches to damage assessment;
- identify the principal limitations of contemporary assessment models;
- develop a unified interdisciplinary framework for damage assessment;
- propose a multiparametric model integrating quantitative, qualitative, temporal, and stochastic components;
- establish methodological foundations for the standardization of assessment procedures across different sectors.

The central hypothesis of this research is that it is possible to develop a universal damage assessment model capable of standardizing evaluation procedures without compromising the specific characteristics of individual cases. Such a model should integrate direct and indirect losses, risk factors, temporal dynamics, and intangible consequences into a coherent analytical framework applicable across diverse domains.

The scientific contribution of this study lies in the integration of economic, legal, engineering, and risk-management perspectives into a unified assessment methodology. Furthermore, the proposed model introduces temporal and stochastic dimensions into the evaluation process and develops a structured framework for incorporating intangible losses, thereby addressing several limitations of existing approaches [5], [9], [11].

The remainder of the paper is organized as follows. Section 2 reviews previous research and existing damage assessment models. Section 3 presents the research methodology and analytical framework. Section 4 introduces the proposed unified damage assessment model and demonstrates its practical application through an illustrative example. Finally, Section 5 discusses the principal findings and presents conclusions and recommendations for future research and institutional implementation.

REVIEW OF PREVIOUS RESEARCH AND DAMAGE ASSESSMENT MODELS

Economic Models of Damage Assessment

Within economic theory, damage assessment has traditionally been based on the principles of financial compensation, value maximization, and efficient resource allocation. Classical economic approaches evaluate damage through direct financial losses and measurable economic consequences. Widely used methods include Cost-Benefit Analysis (CBA), Net Present Value (NPV), Discounted Cash Flow (DCF) analysis, and opportunity-cost assessment. These methods enable the quantification of direct and indirect losses and provide a structured framework for economic decision-making [2], [10], [13].

Modern economic studies emphasize the importance of incorporating future cash flows, uncertainty factors, and long-term economic consequences into damage assessment models. Disaster economics and risk-based valuation methodologies have further expanded traditional approaches by considering the broader economic impacts of catastrophic events and systemic disruptions [6], [17].

Despite their practical usefulness, economic models exhibit significant limitations. Their primary weakness lies in the tendency to focus predominantly on monetary indicators while neglecting social, environmental, reputational, and psychological consequences. Consequently, purely economic approaches often underestimate the total impact of harmful events and fail to capture the full spectrum of damage experienced by affected stakeholders [8], [13].

Legal and Normative Approaches

Legal systems traditionally assess damage through the principles of compensation, causation, proportionality, and fairness. In most jurisdictions, damage is classified into actual loss and loss of profit, with compensation determined according to the specific circumstances of each case. Courts frequently rely on expert opinions and professional evaluations to establish the extent and monetary value of damage [1], [16].

Legal scholars have long emphasized that the purpose of damage compensation is not only to restore financial equilibrium but also to preserve legal certainty and public confidence in the justice system. However, substantial differences often exist among jurisdictions regarding assessment criteria, compensation limits, evidentiary standards, and methods for evaluating non-material losses.

One of the principal shortcomings of legal approaches is their dependence on expert judgment. Since experts may apply different methodologies, assumptions, and evaluation criteria, similar cases can result in significantly different compensation outcomes. This

variability introduces subjectivity into the assessment process and may lead to inconsistent judicial decisions, particularly in complex commercial, environmental, and technological disputes [1], [16].

Engineering and Technical Approaches

Engineering damage assessment methodologies focus primarily on the physical consequences of harmful events. These approaches are widely applied in transportation systems, civil engineering, industrial facilities, energy infrastructure, and manufacturing processes. Assessment techniques typically involve reliability analysis, life-cycle analysis, structural integrity evaluation, failure analysis, and maintenance-cost estimation [7], [15], [18].

Reliability engineering provides a rigorous framework for quantifying technical losses by analyzing system performance, failure probabilities, and recovery costs. Such approaches are particularly valuable in industries where operational continuity and safety are critical. Engineering models often achieve a high level of precision because they rely on measurable technical parameters and objective performance indicators [15].

Nevertheless, technical approaches are generally limited to the engineering domain and rarely incorporate broader economic, legal, social, or reputational consequences. As a result, while they provide accurate estimates of physical damage and restoration costs, they may significantly underestimate the total impact of harmful events on organizations and society [9], [15].

Risk-Based Assessment Models

Recent developments in risk management theory have introduced probabilistic and stochastic dimensions into damage assessment. Risk-based models consider damage as a function of both the probability of occurrence and the severity of consequences. This perspective allows decision-makers to evaluate not only realized losses but also potential future impacts and escalation scenarios [4], [5], [11].

International standards such as ISO 31000 and ISO/IEC 31010 have significantly contributed to the development of systematic risk assessment methodologies. These frameworks emphasize the identification, analysis, evaluation, and treatment of risks across organizational and societal contexts [3], [22].

Risk-based approaches offer several advantages, including the incorporation of uncertainty, dynamic modeling of harmful events, and support for preventive decision-making. However, many existing risk assessment frameworks do not provide detailed methodologies for converting risk indicators into comprehensive damage estimates. Consequently, there remains a gap between risk analysis and practical damage quantification [4], [11], [12].

Hybrid and Interdisciplinary Models

Recognizing the limitations of single-discipline approaches, recent research has increasingly focused on hybrid and interdisciplinary assessment frameworks. These models combine quantitative and qualitative methods in order to provide a more comprehensive evaluation of harmful events [8], [11].

Multi-Criteria Decision Analysis (MCDA), the Analytic Hierarchy Process (AHP), fuzzy logic systems, and integrated risk-assessment frameworks have become widely used tools for incorporating subjective factors into formal analytical models. Such methods enable decision-makers to evaluate multiple dimensions simultaneously and to assign relative importance to different assessment criteria [8], [14], [19], [20].

Hybrid models are particularly valuable in situations involving uncertainty, incomplete information, and conflicting stakeholder interests. They provide greater flexibility than traditional methods and facilitate the integration of economic, legal, technical, and social perspectives into a single evaluation framework.

Despite considerable progress, no universally accepted model currently exists that integrates all relevant dimensions of damage assessment while maintaining methodological consistency, transparency, and practical applicability across different sectors. This limitation continues to represent one of the most significant challenges in the field [11], [14].

Identification of the Research Gap

The review of existing literature reveals several persistent shortcomings in contemporary damage assessment methodologies:

- fragmentation of assessment approaches across sectors and disciplines;
- insufficient integration of quantitative and qualitative variables;
- inadequate consideration of temporal dynamics and long-term effects;
- limited incorporation of uncertainty and escalation risks;
- absence of standardized weighting coefficients and evaluation matrices;
- difficulties in quantifying intangible and reputational losses;
- lack of a universally applicable interdisciplinary assessment framework.

These limitations demonstrate the need for the development of a unified methodology capable of integrating economic, legal, engineering, and risk-management perspectives into a coherent and standardized assessment system. Addressing this research gap constitutes the primary motivation for the development of the unified damage assessment model proposed in this paper.

The following section presents the methodological framework employed in developing the proposed model

and explains the procedures used for identifying variables, constructing the analytical structure, and validating the conceptual framework.

RESEARCH METHODOLOGY

Research Design

This study employs an interdisciplinary and integrative research approach designed to develop a unified framework for damage assessment. The methodological concept combines qualitative and quantitative analytical techniques with the objective of identifying the essential dimensions of damage assessment and integrating them into a comprehensive evaluation model.

The research design is based on five sequential phases:

1. Systematic review and classification of existing damage assessment models;
2. Identification of key variables influencing damage evaluation;
3. Development of a conceptual and mathematical assessment framework;
4. Construction of a multiparametric evaluation model;
5. Theoretical and illustrative validation of the proposed framework.

This approach enables the combination of deductive reasoning, derived from established theoretical principles, and inductive reasoning, based on the comparative analysis of existing methodologies. The integration of these approaches provides a robust foundation for developing a model that can be applied across different professional and institutional contexts.

Data Sources

The study is primarily based on secondary data sources obtained from scientific literature, professional publications, international standards, and institutional guidelines. The analyzed sources include:

- scientific articles in economics, law, engineering, and risk management;
- international standards and regulatory frameworks (ISO 31000, ISO/IEC 31010, International Valuation Standards);
- OECD and European Commission methodological guidelines;
- expert reports and professional valuation procedures;
- case studies from transportation, insurance, industrial, environmental, and digital-security sectors;
- publications addressing risk analysis, multicriteria decision-making, and damage quantification methodologies.

The use of secondary sources is appropriate because the objective of the research is conceptual model development rather than empirical testing. Existing scientific

knowledge provides sufficient theoretical foundations for identifying common principles and methodological gaps in contemporary damage assessment practices.

Research Methods

Several complementary research methods were applied throughout the study.

Comparative Analysis

Comparative analysis was used to evaluate similarities and differences among existing assessment models. Particular attention was devoted to identifying:

- assessment criteria;
- evaluation procedures;
- treatment of uncertainty;
- incorporation of qualitative factors;
- applicability across different sectors.

The comparative approach enabled the identification of methodological strengths and weaknesses associated with each model category.

Descriptive Analysis

Descriptive analysis was employed to classify and characterize the principal components of damage assessment systems. This method facilitated the systematic organization of concepts, variables, and methodological approaches found in the literature.

Synthesis Method

The synthesis method was applied to integrate findings from different scientific disciplines into a coherent analytical framework. Through synthesis, economic, legal, engineering, and risk-management perspectives were combined to establish the foundation of the proposed unified model.

Modeling Method

Modeling represents the central methodological component of the study. Based on identified variables and relationships, a multiparametric assessment model was developed that incorporates quantitative, qualitative, temporal, and stochastic dimensions of damage.

Identification and Classification of Variables

A critical stage in the research process involved identifying variables that significantly influence damage assessment outcomes.

The analysis revealed four primary categories of variables:

Quantitative Variables

Quantitative variables represent directly measurable economic consequences and include:

- direct financial losses;
- repair and restoration costs;
- indirect economic losses;
- loss of profit;
- operational interruption costs.

These variables can generally be expressed in monetary terms and constitute the traditional basis of damage assessment.

Temporal Variables

Temporal variables capture the dynamic nature of harmful events and include:

- duration of damage consequences;
- recovery period;
- delay-related impacts;
- escalation over time.

The inclusion of temporal factors enables the assessment of long-term consequences rather than limiting evaluation to immediate losses.

Risk Variables

Risk variables reflect uncertainty and future developments associated with harmful events. These variables include:

- probability of escalation;
- uncertainty of outcomes;
- vulnerability of affected systems;
- exposure to additional losses.

The incorporation of risk variables allows the model to account for potential future consequences and supports proactive decision-making.

Qualitative Variables

Qualitative variables encompass effects that cannot be directly measured through conventional financial indicators. These include:

- reputational damage;
- psychological consequences;
- social impacts;
- institutional credibility losses;
- public trust deterioration.

Although more difficult to quantify, such variables often represent a significant portion of the overall impact of harmful events.

Development of the Unified Assessment Model

Following the identification and classification of variables, a unified assessment model was developed based on a multiparametric structure.

The model integrates four fundamental dimensions:

- economic dimension;
- temporal dimension;
- risk dimension;
- qualitative dimension.

Unlike traditional approaches that focus exclusively on direct financial losses, the proposed framework considers damage as a dynamic phenomenon influenced by multiple interacting factors.

The model is based on weighted aggregation, where each component contributes proportionally to the final assessment outcome. Weighting coefficients may be determined through expert judgment, multicriteria decision-making methods, statistical calibration, or institutional standards.

This structure provides:

- methodological flexibility;

- sectoral adaptability;
- transparency of evaluation procedures;
- comparability of assessment outcomes.

Validation Procedure

Because the study focuses on conceptual model development, validation was conducted through two complementary approaches.

Theoretical Validation

Theoretical validation involved examining:

- consistency with established scientific theories;
- compatibility with international standards;
- methodological coherence;
- completeness of included variables.

The proposed framework was compared with existing economic, legal, engineering, and risk-based models to ensure that all relevant dimensions of damage assessment were adequately represented.

Illustrative Validation

Illustrative validation was performed through hypothetical scenarios designed to demonstrate the operational logic of the model.

The simulation-based approach enabled:

- testing of variable interactions;
- examination of weighting effects;
- assessment of model behavior under different conditions;
- preliminary verification of practical applicability.

Although illustrative validation does not replace empirical testing, it provides an important initial evaluation of model functionality.

Research Limitations

Several limitations should be acknowledged.

First, the research relies predominantly on secondary data and theoretical sources. Second, the proposed model has not yet been empirically tested using a large sample of real-world cases. Third, weighting coefficients have not been statistically calibrated and therefore remain subject to future refinement. Finally, qualitative variables continue to require expert judgment, which may introduce a degree of subjectivity into the assessment process.

These limitations should be viewed as opportunities for further development rather than weaknesses of the conceptual framework itself.

Future Research Directions

Future research should focus on:

- empirical validation using real assessment cases;
- statistical calibration of weighting coefficients;
- development of software tools supporting automated assessment procedures;
- application of artificial intelligence and machine-learning techniques for model optimization;

- integration of the framework into regulatory and institutional assessment systems;
- development of international standards for unified damage assessment.

The completion of these research activities would significantly contribute to the practical implementation and broader acceptance of the proposed methodology.

The following section presents the Unified Damage Assessment Model, including its conceptual structure, mathematical formulation, evaluation matrix, and illustrative application.

UNIFIED DAMAGE ASSESSMENT MODEL

Conceptual Framework of the Model

The proposed Unified Damage Assessment Model is based on the integration of deterministic and stochastic components of damage evaluation. Unlike traditional approaches that treat damage as a simple function of direct costs, the proposed framework considers damage as a dynamic phenomenon influenced by multiple interdependent variables.

The model integrates four principal dimensions:

- Economic dimension;
- Temporal dimension;
- Risk dimension;
- Intangible impact dimension.

This approach enables a comprehensive assessment of harmful events by simultaneously considering direct and indirect consequences, future uncertainties, and non-material effects.

The conceptual structure of the model is founded on three assessment levels:

Level I – Basic Assessment

This level quantifies direct and immediately measurable damage.

It includes:

- direct financial losses;
- repair and replacement costs;
- operational interruption expenses.

The objective of this level is to establish the minimum measurable value of damage.

Level II – Extended Assessment

This level incorporates secondary consequences resulting from the harmful event.

These include:

- indirect economic losses;
- loss of profit;
- business interruption effects;
- supply-chain disruptions.

The purpose of this level is to evaluate the broader economic implications of damage.

Level III – Strategic Assessment

The strategic level focuses on long-term and systemic consequences.

It includes:

- escalation risks;
- future uncertainty;
- reputational damage;
- social and institutional impacts.

This level provides decision-makers with information regarding long-term sustainability and strategic consequences.

The integration of these three levels allows a comprehensive and multidimensional evaluation process.

Mathematical Formulation of the Model

Based on the identified variables, the following general damage assessment function is proposed:

$$D = \sum_{i=1}^n w_i X_i + \sum_{j=1}^m a_j R_j + \beta T + \gamma I \quad (1)$$

where:

D - represents the total assessed damage,
 X_i - denotes direct and indirect damage components,
 w_i - represents weighting coefficients,
 R_j - denotes risk-related factors,
 a_j - represents risk influence coefficients,
 T - is the temporal factor,
 β - is the temporal coefficient,
 I - is the intangible damage index, and
 γ - is the coefficient of intangible impact.

The first term represents measurable economic losses, the second term incorporates risk-related effects, while the final two terms introduce temporal and intangible dimensions into the assessment process.

The proposed formulation enables flexible adaptation to different sectors while preserving methodological consistency.

Incorporating the Temporal Dimension

One of the most significant limitations of conventional assessment approaches is the treatment of damage as a static quantity.

In reality, many harmful events produce consequences that evolve over time.

To address this limitation, damage growth is modeled using an exponential function:

$$D(t) = D_0 e^{rt} \quad (2)$$

where:

$D(t)$ - represents the value of damage at time t ,
 D_0 - is the initial damage value,
 r - is the escalation rate, and
 t - denotes elapsed time.

This formulation is particularly relevant in:

- judicial proceedings involving delayed compensation;
- industrial accidents;

- infrastructure failures;
- environmental incidents;
- prolonged business interruptions.

The temporal component enables the assessment of cumulative effects and future losses that may emerge long after the initial harmful event.

Intangible Damage Index

The quantification of intangible losses remains one of the most challenging issues in contemporary assessment practice.

Examples include:

- reputational damage;
- psychological consequences;
- loss of public confidence;
- deterioration of institutional credibility;
- market-position losses.

To address this issue, an Intangible Damage Index (IDI) is proposed:

$$I = \sum_{k=1}^p \lambda_k y_k \quad (3)$$

where:

I - represents the intangible damage index,
 y_k - denotes qualitative indicators, and
 λ_k - weighting coefficients determined through expert evaluation or multicriteria analysis.

The index transforms qualitative effects into measurable assessment parameters while preserving analytical transparency.

Weighting coefficients may be established through:

- Analytic Hierarchy Process (AHP);
- Delphi expert methods;
- multicriteria decision analysis;
- institutional assessment standards.

$$D = \sum_{i=1}^n w_i X_i + \sum_{j=1}^m a_j R_j + \beta T + \gamma \sum_{k=1}^p \lambda_k y_k \quad (4)$$

Equation (4) represents the expanded form of the Unified Damage Assessment Model. In this formulation, total damage is expressed as a function of direct and indirect economic losses, risk-related factors, temporal effects, and intangible consequences. The integration of the Intangible Damage Index into the model enables the inclusion of qualitative impacts that are traditionally difficult to quantify, thereby providing a more comprehensive and realistic assessment of harmful events. The model is sufficiently flexible to be adapted to different sectors, including legal, insurance, transportation, industrial, and public administration applications.

$$D_{\text{total}}(t) = \left(\sum_{i=1}^n w_i X_i + \sum_{j=1}^m \alpha_j R_j + \beta T + \gamma \sum_{k=1}^p \lambda_k Y_k \right) e^{\gamma t} \quad (5)$$

Equation (5) presents the dynamic version of the Unified Damage Assessment Model by incorporating the temporal escalation factor. This formulation assumes that the consequences of a harmful event may increase over time due to delayed recovery, operational disruptions, legal disputes, market reactions, or other cumulative effects. The exponential term enables the simulation of damage growth and provides a framework for evaluating long-term consequences and future risks. Consequently, the model supports not only retrospective assessment of realized losses but also prospective analysis of potential damage development under different scenarios.

The transition from Equation (4) to Equation (5) transforms the model from a static assessment framework into a dynamic decision-support tool, enabling both current damage evaluation and future impact forecasting. This represents one of the principal methodological contributions of the proposed unified assessment approach.

The mathematical framework combines concepts from risk analysis, multicriteria decision-making, and integrated assessment methodologies reported in contemporary scientific literature [3], [5], [8], [9], [14].

Unified Damage Assessment Matrix

To facilitate practical implementation, a standardized evaluation matrix is proposed.

Table 1. Unified Damage Assessment Matrix

Component	Quantitative Value	Weight	Total Contribution
Direct Damage	X_1	w_1	$w_1 X_1$
Indirect Losses	X_2	w_2	$w_2 X_2$
Loss of Profit	X_3	w_3	$w_3 X_3$
Time Factor	T	β	βT
Escalation Risk	R	α	αR
Intangible Damage	I	γ	γI

The matrix provides a transparent framework for evaluating the contribution of each component to the total damage value and facilitates standardization across different sectors.

Distribution of Weighted Components

Figure 1 illustrates the relative influence of individual assessment components within the proposed model.

The distribution demonstrates that direct material damage remains the dominant assessment component. However, indirect losses, temporal effects, risk factors, and intangible impacts collectively account for a sub-

stantial proportion of total damage, highlighting the importance of adopting a multidimensional assessment framework.

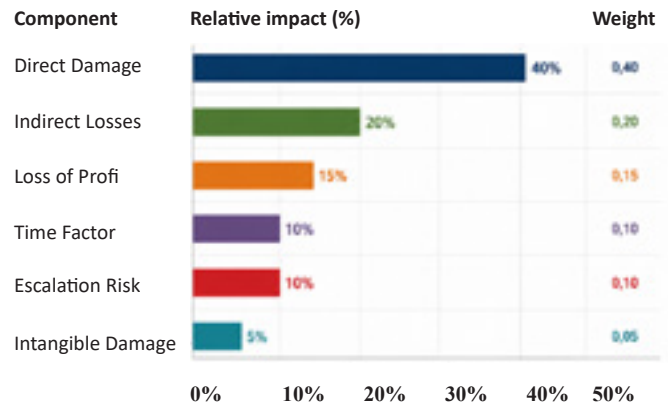


Figure 1. Distribution of weighted components in the Unified Damage Assessment Model

Illustrative Application of the Model

To demonstrate the practical application of the proposed framework, consider a transportation accident involving the following parameters: Direct damage: €10,000; Indirect losses: €5,000; Loss of profit: €3,000; Time factor: 1.2; Escalation risk: 0.3; Intangible damage: €2,000.

Assuming the following weights: $w_1 = 0.40$; $w_2 = 0.20$; $w_3 = 0.15$; $\beta = 0.10$; $\alpha = 0.10$; $\gamma = 0.05$ the assessment becomes:

$$D = 0.4(10000) + 0.2(5000) + 0.15(3000) + 0.1(1.2) + 0.1(0.3) + 0.05(2000) = 5550.15$$

The example demonstrates how the model integrates multiple dimensions into a single transparent and reproducible assessment outcome.

Comparative Analysis of Existing and Proposed Models

Table 2. Comparative Analysis of Damage Assessment Models

Model	Advantages	Limitations
Classical Financial Models	Simple and widely applicable	Ignore intangible effects
Legal Assessment Models	Normatively grounded	Subjective and inconsistent
Engineering Models	Highly precise	Limited to technical systems
Risk-Based Models	Include uncertainty	Difficult to quantify total damage
Proposed Unified Model	Integrated, flexible, interdisciplinary	Requires standardization and calibration

The comparison indicates that the proposed framework overcomes several limitations of existing approaches by integrating economic, legal, technical, temporal, and risk-related dimensions within a single methodological structure.

CONCLUSION

Damage assessment represents one of the most important components of contemporary legal, economic, technical, and insurance systems. The quality and accuracy of assessment procedures directly influence decision-making processes, legal certainty, financial compensation, resource allocation, and the overall effectiveness of judicial, administrative, and commercial proceedings. As modern societies become increasingly interconnected and technologically complex, the need for objective, transparent, and standardized damage assessment methodologies becomes progressively more significant.

The review of existing literature and assessment practices demonstrates that contemporary damage evaluation remains characterized by substantial methodological fragmentation. Economic, legal, engineering, and risk-management disciplines have developed independent approaches tailored to their specific objectives and professional requirements. Although these approaches provide valuable analytical tools within their respective domains, they frequently fail to capture the multidimensional nature of damage and often produce inconsistent assessment outcomes. Similar harmful events may therefore receive substantially different evaluations depending on the methodology applied, resulting in reduced comparability, increased uncertainty, and potential legal disputes.

The findings of this study indicate that traditional assessment models exhibit several important limitations. Most existing methodologies focus primarily on direct financial losses while paying insufficient attention to indirect consequences, temporal dynamics, escalation risks, and intangible impacts. Furthermore, many assessment procedures continue to rely heavily on expert judgment without providing standardized mechanisms for integrating qualitative and quantitative factors into a unified analytical framework. These shortcomings reduce transparency and may introduce a significant degree of subjectivity into the evaluation process.

To address these limitations, this paper proposed a Unified Damage Assessment Model that integrates economic, legal, technical, and risk-management perspectives into a single methodological framework. The proposed model combines measurable economic losses, probabilistic risk factors, temporal effects, and intangible consequences through a multiparametric mathematical structure. Unlike conventional approaches, the model recognizes damage as a dynamic phenomenon whose overall impact extends beyond immediate material losses.

The principal scientific contributions of this research can be summarized as follows:

- development of a comprehensive multiparametric damage assessment model;
- integration of quantitative, qualitative, tempo-

ral, and stochastic variables into a unified framework;

- introduction of a dynamic temporal component capable of modeling damage escalation over time;
- development of an Intangible Damage Index for the evaluation of non-material consequences;
- establishment of a standardized assessment matrix suitable for application across different sectors;
- creation of methodological foundations for future standardization of assessment procedures.

The proposed framework offers several practical advantages. First, it improves transparency by explicitly defining assessment variables and weighting mechanisms. Second, it enhances objectivity through the systematic incorporation of measurable and qualitative indicators. Third, it increases reproducibility by providing a structured methodology that can be consistently applied by different assessors. Finally, it facilitates cross-sector comparability by integrating multiple dimensions of damage into a common evaluation structure.

From an institutional perspective, the implementation of unified assessment criteria could significantly contribute to improving legal certainty, reducing inconsistencies in expert evaluations, enhancing the quality of judicial and administrative decision-making, and supporting the harmonization of professional assessment practices. Such benefits are particularly important in the context of increasingly complex economic activities, digital transformation, environmental risks, and globalized business operations.

Despite its contributions, the study is subject to certain limitations. The proposed model has been developed primarily on the basis of theoretical analysis and secondary data sources and has not yet undergone large-scale empirical validation. In addition, weighting coefficients and qualitative indicators require further calibration through statistical analysis and expert consensus-building processes. Consequently, the model should be regarded as a conceptual and methodological foundation rather than a finalized operational standard.

Future research should therefore focus on empirical testing of the model using real-world damage assessment cases from different sectors. Additional studies may explore the application of machine-learning algorithms and artificial intelligence techniques for optimizing weighting coefficients, improving predictive accuracy, and supporting automated assessment procedures. Further development may also include the creation of specialized software platforms and decision-support systems based on the proposed framework.

In conclusion, the results of this research suggest that the standardization of damage assessment methodologies represents a necessary step toward establishing a transparent, objective, and internationally harmonized

system for evaluating harmful events. The proposed Unified Damage Assessment Model provides a scientifically grounded foundation for achieving this objective and offers a promising direction for future academic research, professional practice, and institutional implementation in the field of damage assessment.

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Conflict of Interest Statement

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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