

Applying Modern Actuarial Models to Improve Decision-Making Efficiency in the Algerian Insurance Sector

تطبيق النماذج الاكتوارية الحديثة لتحسين كفاءة اتخاذ القرار في قطاع التأمين الجزائري
ط.د. مسعي بلال، مخبر مستقبل الاقتصاد الجزائري خارج قطاع الخروقات، جامعة أحمد بوقرة – بومرداس،

b.messai@univ-boumerdes.dz

د. يحيوي نصيرة، مخبر مستقبل الاقتصاد الجزائري خارج قطاع الخروقات، جامعة أحمد بوقرة – بومرداس

nacera.yahiaoui@yahoo.fr

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Abstract

This study examines the role of modern actuarial models as a decision-support tool in the Algerian insurance sector. Using a qualitative-analytical methodology, the research highlights the growing importance of actuarial modeling in improving risk assessment, pricing accuracy, solvency evaluation, and long-term strategic planning. The paper reviews the structure of the Algerian insurance market, identifies key institutional and operational challenges—such as the shortage of qualified actuaries and limited digital infrastructure—and compares Algeria's position with regional peers like Morocco and South Africa.

The findings indicate that the integration of modern actuarial techniques could enhance decision-making efficiency, reduce financial volatility, and align the Algerian insurance industry with international regulatory frameworks such as Solvency II. Policy recommendations include developing actuarial education programs, promoting data standardization, adopting risk-based supervision, and reinforcing institutional governance.

Keywords: Actuarial models, Decision-making, Insurance sector, Algeria, Risk-based supervision, Solvency II, Financial regulation.

الملخص

يتناول هذا البحث دور النماذج الاكتوارية الحديثة كأداة مساعدة على اتخاذ القرار في قطاع التأمين الجزائري. اعتمدت الدراسة منهجاً وصفيًا تحليليًا لبحث أهمية هذه النماذج في تحسين تقييم المخاطر، وتسعير الأقساط بدقة أكبر، وتقدير الملاءة المالية، ودعم التخطيط الاستراتيجي على المدى الطويل. كما تم تحليل بنية سوق التأمين في الجزائر والتحديات التي تواجهها، خصوصًا نقص الكفاءات الاكتوارية، وضعف البنية الرقمية، وعدم توفر قاعدة بيانات موحدة، مع مقارنة التجربة الجزائرية بتجارب دول رائدة مثل المغرب وجنوب إفريقيا.

توصلت الدراسة إلى أن دمج النماذج الاكتوارية الحديثة يساهم في رفع كفاءة اتخاذ القرار، وتقليل تقلبات المالية، وتطوير الإشراف القائم على المخاطر بما يتماشى مع معايير **Solvency II** الدولية. وأوصت بضرورة إنشاء برامج أكاديمية لتكوين الاكتواريين، وتحسين حوكمة البيانات، وتبني الرقابة القائمة على المخاطر، وتعزيز الإطار المؤسسي والتنظيمي للقطاع.

الكلمات المفتاحية: النماذج الاكتوارية، اتخاذ القرار، قطاع التأمين، الجزائر، الإشراف القائم على المخاطر، سولفنسي 2، التنظيم المالي.

¹ Corresponding author: Messai Bilal, e-mail address: b.messai@univ-boumerdes.dz

Introduction

The insurance sector is a cornerstone of economic stability and financial development, serving as a key mechanism for risk transfer and resource mobilization. In recent years, the complexity of risks—driven by globalization, technological disruption, and climate change—has necessitated the adoption of more advanced analytical and predictive tools in insurance decision-making. Among these, modern actuarial models have emerged as essential instruments for ensuring the sustainability, solvency, and competitiveness of insurance companies. Actuarial science, once rooted in deterministic statistical methods, has evolved into a data-driven discipline that leverages stochastic processes, predictive analytics, and artificial intelligence to enhance decision quality and strategic foresight (Haberman & Renshaw, 2013, p. 42).

In the global insurance landscape, actuarial models are increasingly integrated into decision-making processes across pricing, underwriting, capital management, and claims forecasting. Their predictive capabilities enable insurers to anticipate risks more accurately and optimize financial performance under uncertainty. However, in many developing markets, including Algeria, the effective application of modern actuarial techniques remains limited. The Algerian insurance industry continues to rely heavily on traditional, experience-based approaches, with minimal use of advanced risk models or data analytics. This limitation hinders insurers from achieving optimal pricing, adequate reserving, and proactive risk management, ultimately affecting market efficiency and financial resilience (World Bank, 2023, p. 17).

Despite notable reforms in the Algerian financial sector, the integration of modern actuarial models in insurance decision-making remains in its infancy. Insurers often depend on deterministic methods that fail to capture the dynamic nature of modern risks—ranging from climate hazards to cyber threats. Consequently, decision-makers face challenges in accurately pricing policies, forecasting claims, and ensuring solvency under volatile market conditions. This raises a critical research question:

To what extent can modern actuarial models improve the quality and reliability of decision-making in the Algerian insurance sector?

This paper aims to:

1. Explore the theoretical foundations and practical applications of modern actuarial models as decision-support tools.
2. Analyze the current state of actuarial practice and decision-making in the Algerian insurance market.
3. Assess the potential benefits, challenges, and prerequisites for implementing modern actuarial modeling techniques in Algeria.
4. Provide policy and strategic recommendations for enhancing actuarial capacity and integrating advanced modeling into insurance decision processes.

The significance of this study lies in its **practical and strategic implications** for the Algerian insurance sector. As the industry seeks to modernize and align with international standards—particularly those inspired by **Solvency II** and **risk-based supervision**—the deployment of

modern actuarial tools becomes vital for sustainable growth. Beyond regulatory compliance, actuarial models can strengthen **data-driven decision-making**, improve **risk-adjusted profitability**, and support **long-term financial planning**. The research thus contributes to bridging the gap between academic actuarial theory and applied decision-making in emerging markets.

The study adopts a **descriptive and analytical methodology**, combining qualitative and quantitative perspectives. It relies on a review of scientific literature, reports from international organizations such as the **OECD**, **World Bank**, and **International Association of Insurance Supervisors (IAIS)**, as well as statistical data from the **Algerian National Insurance Council (CNA)** and the **Bank of Algeria**. The analysis emphasizes comparative insights from other emerging insurance markets—such as Morocco, South Africa, and Egypt—where actuarial modernization has yielded measurable decision-making improvements.

I: Theoretical and Conceptual Framework of Modern Actuarial Models

1. Definition and Evolution of Actuarial Models

Actuarial models are mathematical and statistical frameworks used to quantify, analyze, and manage risk and uncertainty in insurance and finance. Traditionally, actuarial modeling relied on deterministic approaches—based on fixed assumptions and static parameters—to estimate premiums, reserves, and life expectancies. However, the increasing complexity and volatility of modern financial and demographic risks have led to the emergence of **stochastic and predictive actuarial models**, which account for randomness, variability, and uncertainty (Haberman & Renshaw, 2013, p. 42).

The evolution of actuarial science has been closely linked to advances in **data analytics**, **computing power**, and **artificial intelligence**. In the 21st century, actuarial modeling moved beyond traditional mortality and loss models toward **dynamic, simulation-based, and machine-learning-driven frameworks** capable of capturing nonlinear risk interactions and real-time market fluctuations (Wüthrich & Merz, 2022, p. 118). These models integrate statistical techniques such as **Monte Carlo simulations**, **generalized linear models (GLMs)**, **Bayesian inference**, and **time-series forecasting**, enabling insurers to develop more reliable predictions of claims, pricing, and solvency.

From a theoretical perspective, modern actuarial models can be categorized into three main generations:

1. **Classical deterministic models** – based on historical averages and simple probability distributions (e.g., life tables, expected value models).
2. **Stochastic models** – incorporating random variables and probability distributions to simulate multiple scenarios (e.g., Value-at-Risk, ruin theory, stochastic mortality models).
3. **Predictive and machine-learning models** – using large datasets and algorithms to detect complex patterns in policyholder behavior, claims frequency, and market trends (Wüthrich & Merz, 2022, p. 120).

The transition from traditional to modern actuarial modeling reflects a paradigm shift from **reactive risk estimation** to **proactive and data-driven decision-making**, marking actuarial science as a critical pillar of enterprise risk management.

2. Types of Modern Actuarial Models and Their Applications

Modern actuarial practice employs several advanced modeling techniques designed to improve **decision accuracy, pricing efficiency, and solvency control**. The most prominent include:

- **Stochastic Models:** Used to simulate uncertainty in claims, mortality, and asset-liability management. These models provide probability distributions of possible outcomes rather than single-point estimates, improving capital allocation and solvency assessment (Dhaene et al., 2018, p. 233).
- **Generalized Linear Models (GLMs):** Widely used for pricing and claims frequency modeling. GLMs allow actuaries to include multiple explanatory variables (e.g., driver age, vehicle type, geographic region) and identify their impact on risk exposure (Ohlsson & Johansson, 2010, p. 58).
- **Machine Learning Models:** Emerging as a complement to classical actuarial techniques, they enable insurers to analyze unstructured data (e.g., telematics, customer behavior, text data) and develop personalized risk profiles (Henckaerts et al., 2021, p. 214).
- **Solvency II and Dynamic Financial Analysis (DFA) Models:** Integrated frameworks for assessing the financial stability of insurers under various economic scenarios. They support regulatory compliance, risk-based capital allocation, and strategic decision-making (Gatzert & Wesker, 2012, p. 179).

For example, under **Solvency II**, European insurers are required to calculate a **Solvency Capital Requirement (SCR)** using either a standard formula or an internal model. This model-based approach allows companies to better reflect their specific risk profiles, leading to more efficient capital management and improved decision-making.

3. Decision-Support Function of Actuarial Models

The primary value of modern actuarial models lies in their ability to **transform complex data into actionable insights** that support strategic decisions. In the insurance sector, these models serve as decision-support tools in four key areas:

1. **Pricing and Underwriting:** Actuarial models enable precise premium calculations based on risk segmentation, ensuring fair pricing and competitive advantage. Advanced models also detect adverse selection and fraud through predictive analytics (Ohlsson & Johansson, 2010, p. 66).
2. **Reserving and Claims Forecasting:** Stochastic reserving models estimate future claims distributions, enhancing the adequacy of reserves and reducing solvency risk.
3. **Risk and Capital Management:** Through scenario analysis and stress testing, actuarial models assist management in evaluating financial resilience and optimizing capital under uncertainty (Dhaene et al., 2018, p. 235).

4. **Strategic Decision-Making:** Predictive actuarial tools contribute to investment decisions, product development, and reinsurance optimization by simulating long-term financial outcomes (Henckaerts et al., 2021, p. 217).

Empirical studies show that insurers applying data-driven actuarial frameworks achieve **10–15% higher underwriting profitability** and **up to 20% more accurate solvency forecasts** compared to those relying solely on deterministic models (OECD, 2022, p. 39). Moreover, the integration of machine learning models has been shown to reduce claim fraud losses by nearly **25%**, significantly improving operational efficiency (IAIS, 2021, p. 18).

II: The Algerian Insurance Sector: Structure, Challenges, and Decision-Making Practices

This axis reviews the Algerian insurance market's structure and size, current risk-assessment and decision-making practices, the main obstacles to actuarial modernization (skills, data, digitalization and regulation), and comparative lessons from peer countries that have integrated modern actuarial methods. Empirical figures and authoritative sources are cited throughout to quantify the sector's position and readiness for modern actuarial adoption (Algeria Invest, 2024; Africa-Re, 2024; IAIS, 2021).

1. Overview of the Algerian insurance market: structure, size, main actors, and regulatory environment

Algeria's insurance market is small relative to GDP but expanding steadily. Total gross written premiums reached **DZD 181.3 billion (~USD 1.3 billion)** in 2024, a **4.4%** increase year-on-year (Algeria Invest, 2024). Non-life dominates the market, representing about **83%** of premiums (DZD 150.4 billion), while life & health together account for roughly **11–12%** (DZD ~20.1 billion) (Algeria Invest, 2024). Market penetration (premiums/GDP) is low—around **0.5–0.7%**—and insurance density is approximately **USD 27–30 per capita**, indicating substantial untapped demand (Africa-Re dashboard, 2024; Algeria Invest, 2025).

The market structure includes **~25 insurance and reinsurance companies**, an extensive agency network (**≈ 3,000+ agencies**) and **~40–50 licensed brokers** operating as primary distribution channels (POIdata; Algeria Invest, 2025). The National Insurance Council (Conseil National des Assurances — CNA) is the principal supervisory body; regulatory reforms and supervisory notes are issued periodically, but the supervisory regime is still evolving toward risk-based frameworks (CNA reports summarized by industry press) (Atlas Magazine, 2024).

Table N1: Key market indicators (latest available)

Indicator	Value (latest)
Total written premiums (2024)	DZD 181.3 billion (~USD 1.3 bn)
Non-life share of premiums	83% (DZD 150.4 bn)
Life & health premiums (2024)	DZD ~20.1 billion
Q1 2025 premiums (production)	DZD 56.9 billion (↑13.3% y/y)
Market penetration	0.5–0.7% of GDP
Insurance density	USD 27–30 per capita
Number of insurers	25 companies
Number of agencies	3,037 agencies

2. Current practices in risk assessment and decision-making: reliance on traditional models and expert judgment

Underwriting, pricing and reserving practices in Algeria remain largely **experience-based** and **deterministic**. Common techniques include historical loss ratios, simple frequency-severity analyses, and standard claims-triangle reserving methods. Stochastic reserving, internal capital models or advanced predictive pricing (GLMs, machine learning) are used only in isolated pilots by a few firms; the majority of companies rely on rule-based pricing and actuarial judgment (industry reviews; Atlas Magazine, 2024).

Decision-making processes are typically centralized within underwriting and actuarial departments but constrained by limited data granularity and legacy IT systems; many underwriting decisions still depend on expert adjustments rather than automated scorecards or model outputs. Stress testing and formalized scenario analysis (DFA / Solvency-type exercises) are not yet universal across firms, which hampers forward-looking capital planning and enterprise risk management (IAIS thematic reviews; World Bank lessons on emerging markets) (IAIS, 2021; World Bank, 2023).

Illustrative point: the 2024/2025 MTPL tariff adjustments (government-mandated increases) forced rapid repricing across the market and exposed variation in companies’ pricing models—those with richer datasets were able to calibrate prices more quickly and maintain margins, while others had to rely on approximate adjustments (MEIR, 2024; Algeria Invest, 2025).

3. Challenges in actuarial modernization: lack of qualified actuaries, limited digitalization, data unavailability, and regulatory gaps

3.1 Human capital and skills shortage

There is a documented shortage of qualified actuaries and data-science professionals in Algeria’s insurance firms and at supervisory authorities. University actuarial programs and professional pathways are expanding but have not yet produced sufficient mid- and senior-level actuarial talent required for internal model development, model validation, and advanced pricing (industry sources; Algeria Invest, 2024). This skills gap reduces firms’ capacity to design, interpret and govern complex models (OECD, 2022).

3.2 Data quality and availability

High-quality, granular historical data (policy-level exposures, claims run-off by cause, telematics, geolocation, loss adjuster reports) are essential for GLMs and ML models. In Algeria such datasets are fragmented—held at firm level with limited standardization—and there is no widely accessible industry-level datawarehouse for actuarial research and benchmarking. Data gaps increase model uncertainty and limit the ability to segment risk finely (CNA/industry summaries; Africa-Re country notes).

3.3 Digitalization and IT infrastructure

Legacy core systems, manual processes for claims handling, and limited adoption of telematics/digital distribution hinder automated feature extraction and real-time model scoring. Some insurers have begun digital projects, but scalable platforms for model deployment (MLOps), single-window reporting and API integration remain limited (OECD, 2022; IAIS, 2021).

3.4 Regulatory and governance gaps

While the CNA supervises solvency and market conduct, formal guidance on internal model approval, model governance, model-risk management and AI/ML use in underwriting is either nascent or absent. International standard-setters (IAIS) have published thematic guidance on AI/ML supervision and model risk—guidance Algeria’s regulator may consider adopting—but local regulatory frameworks still need to evolve toward risk-based supervision and model validation regimes (IAIS, 2023; IAIS, 2025).

Table N2: Key barriers to actuarial modernization (summary)

Barrier	Effect on model adoption
Shortage of actuaries/data scientists	Limits internal model development & validation (OECD, 2022)
Fragmented data & low granularity	Reduces model accuracy; increases calibration risk (Africa-Re, 2024)
Legacy IT & limited telematics	Hinders automated scoring and real-time pricing (IAIS, 2021)
Limited regulatory guidance on models	Slows investment due to governance/approval uncertainty (IAIS, 2023)

4. Comparative insights: lessons from countries that successfully integrated modern actuarial modeling (e.g., South Africa, Morocco)

4.1 South Africa — Solvency Assessment and Management (SAM) and actuarial integration

South Africa implemented the **Solvency Assessment and Management (SAM)** regime (a Solvency II-style framework) which required insurers to adopt risk-based capital assessment, internal models, and robust actuarial governance. The SAM implementation increased firms’ investment in actuarial capacity, improved capital allocation and strengthened supervisory review processes (FSB/KPMG analyses; van Vuuren et al., 2017). Key lessons: (a) phased implementation with supervisory guidance; (b) strong emphasis on model governance, validation

and transparency; (c) capacity building programs and industry-regulator dialogue (van Vuuren et al., 2017; KPMG, 2016).

4.2 Morocco — Regulatory modernization and actuarial strengthening (ACAPS)

Morocco’s insurance regulator (ACAPS) has actively modernized regulation, improved consumer protection and encouraged digitalization and professionalization in the sector. Morocco’s market is larger and more diversified (total premiums USD 5.3 billion in 2022) and has higher penetration and density than Algeria (ACAPS / MEIR reports). ACAPS’s focus on actuarial standards, solvency monitoring and encouraging insurers to adopt GLMs for motor pricing provides a practical template: regulatory clarity + incentives (reduced capital charges / recognition of internal models) can accelerate model adoption (MEIR, 2022; ACAPS publications).

4.3 Transferable lessons for Algeria

- **Phased regulatory roadmap:** adopt incremental steps (pilot internal models, phased capital recognition) to give firms time to build capacity (South Africa model).
- **Capacity building & professionalization:** invest in actuarial education, certification and in-company training (South Africa & Morocco experience).
- **Data governance & industry datawarehousing:** create standardized reporting templates and consider an industry claims repository to support benchmarking and model calibration (Morocco/industry practice).
- **Clear model governance requirements:** issue guidance on model documentation, validation, explainability and auditor oversight—reducing uncertainty and encouraging investment (IAIS guidance; SAM lessons).

Table N3: Comparative snapshot: Algeria vs Morocco vs South Africa (selected metrics)

Metric	Algeria (latest)	Morocco (latest)	South Africa (latest)
Total premiums (approx.)	DZD 181.3 bn (USD 1.3 bn, 2024)	USD 5.3 bn (2022)	USD 20–30 bn (market scale larger)
Penetration (% of GDP)	0.5–0.7%	higher (2–3%)	13% (life-dominant, much larger)
Actuarial modernization	nascent; pilots only	advancing; regulator active	advanced; SAM / strong actuarial capacity
Regulatory stance	evolving; limited model guidance	proactive (ACAPS)	risk-based (FSB/SAM)

(Sources: Algeria Invest, 2024–2025; MEIR/ACAPS 2022; KPMG/FSB/SAM literature 2016–2018; Africa-Re dashboard 2024.)

Synthesis and implications for decision-support adoption

Algeria’s insurance market shows growth and product diversification signals (e.g., rapid Takaful growth, expansion in agri-insurance), but structural constraints—low penetration, data fragmentation, human capital shortage and regulatory uncertainty—limit widescale adoption of

modern actuarial models. International experience suggests that a combined approach (regulatory roadmap, investment in data & talent, pilot internal models, and industry data sharing) yields the best results. If Algerian insurers can capture even modest efficiency gains (conservative estimates from OECD/IAIS literature suggest 5–10% improvement in underwriting margins or operational losses reduction), the impact would be financially meaningful given the DZD 181.3 billion premium base (OECD, 2022; IAIS, 2021).

III: The Role of Modern Actuarial Models in Enhancing Decision-Making in the Algerian Insurance Sector

In the era of digital transformation and data-driven decision-making, actuarial modeling has evolved far beyond traditional statistical estimation. Modern actuarial models—encompassing Generalized Linear Models (GLMs), stochastic reserving techniques, Dynamic Financial Analysis (DFA), and machine-learning-based predictive systems—have transformed the way insurers measure risk, calculate premiums, and assess solvency. In emerging markets such as Algeria, where the insurance industry is expanding but remains underpenetrated, these tools can substantially improve decision accuracy, operational efficiency, and compliance with international standards (OECD, 2022; IAIS, 2023).

This axis explores four major components: the main applications of actuarial models; the quantitative and qualitative benefits they bring; empirical evidence of their potential impact in Algeria; and the barriers and enabling factors for their effective implementation.

1. Applications of Actuarial Models: Pricing, Risk Assessment, Solvency, and Claims Forecasting

Actuarial models serve as the backbone of modern insurance management. Their applications are diverse and impact multiple stages of decision-making:

- **Premium calculation and risk pricing:**
GLMs and credibility models allow insurers to incorporate multiple risk variables—such as age, driving record, location, and exposure period—into pricing frameworks, replacing outdated flat tariffs. These models reduce adverse selection and increase fairness across policyholders (Ohlsson & Johansson, 2010; IAIS, 2023).
- **Reserving and claims forecasting:**
Stochastic reserving techniques (e.g., Mack and Bootstrap models) provide full distributions of reserve outcomes rather than point estimates, improving solvency forecasting and reducing capital volatility (Dhaene, Denuit, Goovaerts, Kaas, & Vyncke, 2002).
- **Solvency assessment:**
Dynamic Financial Analysis (DFA) and internal capital models simulate insurer balance sheets under stress scenarios, helping managers estimate solvency capital requirements (SCR) and optimize reinsurance programs (van Vuuren, Reyers, & van Schalkwyk, 2017).
- **Claims management and fraud detection:**
Predictive models based on machine learning improve claims triage and detect anomalies

that may indicate fraud, raising claim-handling efficiency and reducing loss ratios (Decerto, 2023).

Table N4: Key Actuarial Model Applications and Decision Outcomes

Application	Model Type	Decision Outcome
Pricing & underwriting	GLMs, Bayesian models	Fairer and more granular pricing
Reserving & forecasting	Bootstrap, Mack models	Reduced reserve uncertainty
Solvency & capital modeling	DFA, Monte Carlo simulations	Efficient capital allocation
Claims & fraud detection	ML, anomaly detection	Reduced fraud and leakage

(Source: OECD, 2022; IAIS, 2023; Decerto, 2023)

2. Quantitative and Qualitative Benefits

The adoption of modern actuarial models yields measurable financial and operational improvements.

- **Quantitative benefits:**
According to OECD (2022), predictive pricing and reserving models typically improve underwriting profitability by **5–15%**, depending on market maturity. Stochastic reserving increases reserve adequacy and reduces forecasting errors by **10–20%** (Dhaene et al., 2002). In claims operations, predictive analytics can enhance fraud detection rates from **50% to over 80%**, cutting claims leakage by **5–10%** (Decerto, 2023).
- **Qualitative benefits:**
Beyond measurable gains, model adoption fosters governance and regulatory compliance. Model documentation, validation, and auditability improve transparency, while automation reduces human bias in underwriting and reserving (IAIS, 2023). Additionally, predictive models enable faster product innovation and tailored insurance offerings—particularly relevant for Algeria’s micro-insurance and agricultural lines (World Bank, 2024).

Table N5: Estimated Impact of Actuarial Model Adoption

Indicator	Expected Improvement	Source
Underwriting margins	+5–15%	OECD (2022)
Reserve forecast accuracy	+10–20%	Dhaene et al. (2002)
Fraud detection rate	+30 percentage points	Decerto (2023)
Claims handling costs	–5 to –10%	IAIS (2023)

3. Empirical Insights and Sector Data: The Algerian Context

The Algerian insurance market provides a promising yet challenging environment for actuarial modernization. In 2024, total gross written premiums reached **DZD 181.3 billion (~USD 1.3 billion)**, with a dominant non-life segment (83%) (Algeria Invest, 2024). In early 2025, the market grew by **13.3%**, indicating renewed activity and capacity for modernization investment (Algeria Invest, 2025).

If actuarial models led to a modest **5% improvement in underwriting efficiency**, the Algerian market could generate an additional **DZD 7.5 billion** annually in retained profit—resources that could fund digital transformation, staff training, and risk management systems (Algeria Invest, 2024).

Empirical evidence from comparable markets such as **Morocco and South Africa** shows that insurers adopting modern actuarial tools experience tangible performance gains. In South Africa, the Solvency Assessment and Management (SAM) framework improved capital adequacy and risk-adjusted profitability (van Vuuren et al., 2017). Morocco’s regulator (ACAPS) reported improved pricing transparency and solvency monitoring after encouraging GLM-based motor pricing (ACAPS, 2022).

These comparative insights indicate that Algeria, with structured regulatory support and capacity building, could realize similar outcomes.

4. Barriers and Enabling Factors

Despite the potential, several structural and institutional barriers hinder Algeria’s actuarial modernization:

- **Data fragmentation and quality issues:**
Insurers maintain heterogeneous datasets, lacking standardized claim codification and centralized data repositories. This reduces model precision (OECD, 2022).
- **Shortage of qualified actuaries:**
Algeria currently has a limited pool of certified actuaries and data scientists capable of developing or validating advanced models (IAIS, 2023).
- **Regulatory uncertainty:**
The absence of detailed guidance on model governance, validation, and AI use in underwriting creates hesitancy among firms (IAIS, 2023).
- **Technological constraints:**
Legacy systems, manual claims processing, and limited API infrastructure impede integration of machine-learning tools (OECD, 2022).

However, **enabling factors** exist:

- **Regulatory engagement:**
The National Insurance Council (CNA) can adopt a phased “sandbox” approach, allowing pilot actuarial projects under supervision.

- **Data infrastructure:**
A centralized claims database or industry data warehouse would substantially enhance model calibration.
- **Capacity building:**
Partnerships between universities, insurers, and international actuarial associations (e.g., IAA, IFoA) can bridge the human capital gap (World Bank, 2024).

Table N6: Barriers and Enablers to Actuarial Modernization in Algeria

Barrier	Impact	Enabling Factor
Limited actuarial expertise	Slows model adoption	Scholarships and professional training programs
Fragmented data	Low predictive accuracy	Centralized data warehouse and reporting templates
Legacy IT systems	Inefficient model deployment	Digitalization and API integration
Regulatory gaps	Uncertainty and risk aversion	Risk-based supervisory framework (IAIS model)

Modern actuarial models can significantly enhance decision-making within Algeria’s insurance sector by improving pricing accuracy, risk assessment, and capital efficiency. International evidence suggests measurable financial gains and stronger governance when these models are implemented within a clear regulatory and data framework. For Algeria, the key lies in **sequenced adoption**: (1) pilot projects in pricing and claims forecasting, (2) data standardization, (3) actuarial capacity building, and (4) regulatory alignment with IAIS principles.

VI: Strategic Perspectives and Policy Recommendations

The modernization of Algeria’s insurance industry through the integration of advanced actuarial models is not merely a technical reform—it represents a **strategic transformation** toward a more data-driven, transparent, and resilient financial system. As Algeria deepens its financial sector reforms and pursues digitalization goals under Vision 2035, aligning insurance practices with global standards such as Solvency II and the IAIS Core Principles becomes crucial (OECD, 2022; World Bank, 2024).

This section proposes strategic and policy-oriented perspectives to enable Algerian insurers and regulators to adopt modern actuarial tools effectively. The discussion covers integration strategies, human capital development, digital and data infrastructure, regulatory frameworks, and long-term supervisory evolution.

1. Strategies for Integrating Modern Actuarial Models into Decision Processes

The adoption of actuarial models in Algerian insurance companies requires a **phased integration strategy** that aligns with organizational maturity and data availability. International best practices suggest a **four-phase approach** (IAIS, 2023; ACAPS, 2022):

Phase	Strategic Action	Expected Outcome
Phase 1	Diagnostic assessment of current actuarial capabilities	Identification of data and skills gaps
Phase 2	Pilot implementation of GLM-based pricing and reserving models	Validation of model reliability
Phase 3	Institutionalization of actuarial governance (model validation, documentation)	Improved transparency and decision accountability
Phase 4	Expansion toward enterprise risk management (ERM) and solvency modeling	Full integration of actuarial tools in strategic planning

For Algeria, **motor insurance** and **property lines** are ideal pilot sectors given their data richness and large market share (over 60% of non-life premiums) (Algeria Invest, 2025). Model deployment should be accompanied by the creation of internal actuarial units supervised by a Chief Actuary and a Risk Committee.

2. Capacity Building and Human Capital Development

Human resources form the foundation of actuarial modernization. Algeria currently faces a **severe shortage of qualified actuaries**—fewer than 25 professionals are estimated to hold formal actuarial credentials, compared to more than 500 in Morocco and 1,000 in South Africa (IAIS, 2023; World Bank, 2024).

To bridge this gap, a **national capacity-building strategy** is recommended:

- **Establishing actuarial education programs** at major universities (University of Algiers 3, Oran, and Constantine) with curricula aligned to the International Actuarial Association (IAA) syllabus.
- **Scholarships and certification support**, in cooperation with foreign actuarial bodies (IFoA, SOA, IAA).
- **Mandatory continuing professional development (CPD)** under the supervision of the National Insurance Council (CNA).

Table N7: Comparative Overview of Actuarial Workforce in Selected African Countries (2023)

Country	Estimated Number of Qualified Actuaries	National Training Programs	Regulatory Support
Algeria	25	Limited	Emerging (CNA)
Morocco	500	Strong (ISFA Rabat, ACAPS support)	Advanced
South Africa	1,000	Mature (ASSA)	Full Solvency II adaptation

(Sources: IAIS, 2023; World Bank, 2024; ACAPS, 2022)

Such initiatives would create a new generation of professionals capable of developing, validating, and interpreting actuarial models locally—reducing dependence on foreign expertise.

3. Digital Transformation and Data Governance in Insurance

Modern actuarial modeling is only as effective as the **quality and integrity of available data**. In Algeria, insurers face persistent challenges in data fragmentation, incomplete claims histories, and manual recordkeeping (OECD, 2022). To overcome these issues, a coherent **data governance and digital transformation strategy** is essential, including:

- **Centralized Insurance Data Platform (CIDP):**
A unified data warehouse hosted by the Ministry of Finance or the Insurance Supervisory Commission to consolidate anonymized data from all insurers.
- **Standardization of data formats and reporting templates:**
Harmonized claim codes, exposure metrics, and policy identifiers would enhance comparability and model accuracy.
- **Investment in digital infrastructure:**
Deployment of **Application Programming Interfaces (APIs)** and cloud-based data analytics solutions for real-time actuarial monitoring.
- **Cybersecurity and privacy safeguards:**
Ensuring compliance with Algeria’s Law No. 18-07 on personal data protection and IAIS standards on data ethics.

According to the World Bank (2024), digital transformation could reduce operational costs in insurance by **10–15%** and improve data accuracy by **up to 25%**, enabling more reliable actuarial projections and reducing capital inefficiencies.

4. Regulatory and Institutional Support

Strong regulatory backing is indispensable for sustainable actuarial reform. Algeria’s **Insurance Supervisory Commission (Commission de Supervision des Assurances, CSA)** and the **Ministry of Finance** play pivotal roles in setting technical standards, licensing actuaries, and supervising risk-based capital frameworks.

Key policy actions include:

- **Issuing model governance guidelines:** Requiring insurers to document, validate, and periodically audit actuarial models (IAIS, 2023).
- **Introducing a professional licensing regime** for actuaries under the CNA’s oversight.
- **Establishing a regulatory sandbox** to test new actuarial and AI-based models under controlled environments.
- **Aligning solvency reporting standards** with IAIS and Solvency II principles, gradually moving toward a risk-based capital (RBC) regime.

Table N8: Priority Regulatory Actions for Actuarial Integration

Regulatory Dimension	Recommended Action	Expected Impact
Governance	Model validation & audit policy	Improved reliability and transparency
Human capital	Actuarial licensing and CPD framework	Enhanced professional accountability
Data infrastructure	Standardized reporting formats	Consistent industry benchmarking
Supervision	Risk-based capital monitoring	Stronger solvency and resilience

5. Future Outlook: Toward Risk-Based Supervision and Solvency II–Inspired Frameworks

Globally, the insurance industry has shifted from **rule-based supervision** to **risk-based supervision (RBS)**, focusing on solvency, governance, and capital adequacy. For Algeria, adopting a **Solvency II–inspired framework** represents a logical next step toward modernization and regional competitiveness.

Such a framework would rest on three pillars:

1. **Quantitative requirements** (capital adequacy, technical provisions).
2. **Qualitative governance** (risk management and internal control).
3. **Transparency and disclosure** (market discipline).

Countries such as South Africa (SAM Framework) and Morocco (Solvency-based reform under ACAPS) have successfully implemented hybrid versions of Solvency II adapted to local realities (van Vuuren et al., 2017; ACAPS, 2022).

For Algeria, a **gradual transition plan (2025–2030)** is recommended:

- 2025–2026: Develop data and actuarial capacity.
- 2027–2028: Introduce pilot risk-based capital requirements.
- 2029–2030: Adopt a full Solvency II–like supervisory regime.

This approach would ensure stability, regulatory preparedness, and stakeholder confidence.

The integration of modern actuarial models in Algeria’s insurance decision-making requires a coordinated strategy anchored in four pillars: **capacity building, digital infrastructure, regulatory modernization, and risk-based supervision**. With strong institutional backing and phased implementation, Algeria can align its insurance industry with international standards, enhance solvency oversight, and strengthen financial resilience.

The convergence of technology, human capital, and governance will position Algeria as a regional leader in actuarial innovation across North Africa.

Conclusion

The research aimed to explore how **modern actuarial models** can serve as a decision-support tool in the Algerian insurance sector, which remains in a transitional phase between traditional risk assessment methods and data-driven actuarial practices. The study demonstrated that, despite Algeria's steady insurance market growth — with total premiums exceeding **181 billion DZD in 2024** and a penetration rate of approximately **0.5% of GDP** (Algeria Invest, 2025) — the sector still suffers from limited diversification, outdated decision frameworks, and insufficient actuarial capabilities.

Through an in-depth theoretical and comparative analysis, the study established that the implementation of **modern actuarial tools**—including Generalized Linear Models (GLMs), stochastic reserving, and solvency capital assessment—has the potential to transform the Algerian insurance industry into a more resilient and transparent financial system. By integrating these techniques into core business processes, insurers can improve the **accuracy of premium pricing**, enhance **claims forecasting**, and strengthen **risk-based capital management**.

Overall, the study concludes that actuarial modernization is not a mere technical upgrade, but rather a **strategic necessity** for sustainable growth, investor confidence, and alignment with international regulatory frameworks such as **Solvency II** and the **IAIS Core Principles**.

Research Results

Based on the analytical framework and reviewed data, the main findings can be summarized as follows:

1. **Limited actuarial integration:** Most Algerian insurers continue to rely on deterministic or expert-based decision methods, with minimal use of predictive modeling or stochastic techniques.
2. **Human capital deficit:** The number of qualified actuaries in Algeria remains below 30, compared to over 500 in Morocco and 1,000 in South Africa (IAIS, 2023; World Bank, 2024).
3. **Low insurance penetration and digital readiness:** Despite consistent growth, penetration remains below 1% of GDP, indicating vast untapped potential (OECD, 2022).
4. **Regulatory and data constraints:** Lack of standardized data collection, weak digital infrastructure, and absence of clear actuarial governance policies hinder model deployment.
5. **Positive comparative evidence:** Countries that adopted actuarial models—such as South Africa (SAM framework) and Morocco (ACAPS reforms)—achieved measurable improvements in solvency ratios, capital efficiency (up to 15%), and claim management accuracy.
6. **Institutional readiness emerging:** The Algerian Ministry of Finance and the Insurance Supervisory Commission (CSA) have begun drafting reforms toward risk-based supervision, signaling a favorable environment for actuarial advancement.

Recommendations

To accelerate the integration of actuarial science into decision-making and regulation, the following recommendations are proposed:

- Develop a **national actuarial governance framework** mandating model documentation, validation, and independent auditing.
- Introduce **risk-based supervision (RBS)** aligned with Solvency II principles by 2030.
- Establish a **regulatory sandbox** to test and approve AI- and ML-based actuarial models.
- Create **degree and certification programs** in actuarial science in partnership with local universities and international institutions (IFoA, SOA, IAA).
- Launch **scholarship and professional mobility programs** to train future actuaries abroad.
- Establish a **National Actuarial Council** to oversee professional standards, ethics, and continuing education (CPD).
- Build a **Centralized Insurance Data Platform (CIDP)** to collect anonymized market-wide data for actuarial analysis.
- Promote digital transformation by adopting **cloud-based analytics, API integration, and cybersecurity standards**.
- Enforce **data reporting and standardization protocols** to improve accuracy and comparability across insurers.
- Encourage insurers to pilot actuarial-based decision models in **motor and property lines**, which represent over 60% of market share.
- Provide **tax incentives** or regulatory benefits for insurers investing in actuarial modernization.
- Foster **regional cooperation** with African actuarial associations for knowledge exchange and benchmarking.

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