

TECHNOLOGICAL INNOVATION AS A PILLAR OF FINANCIAL SUSTAINABILITY IN THE INSURANCE SECTOR

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Abstract: *This study explores the role of technological innovations as a pillar of financial sustainability in the insurance sector, highlighting how emerging technologies – artificial intelligence (AI), blockchain, the Internet of Things (IoT), and Big Data analytics – are transforming traditional business models. The research emphasizes the need for insurance companies to adapt to global economic and climate challenges, reconfiguring their financial and operational strategies to become more competitive, efficient, and customer-oriented. The methodology used consists of a conceptual and exploratory analysis of the specialist literature, complemented by relevant case studies illustrating the application of disruptive technologies in the insurance sector. The study examines AI's contribution to the personalization of insurance products and predictive risk assessment, the use of blockchain to enhance transparency and prevent fraud, as well as the application of IoT to real-time monitoring of user behavior or insured assets. The research findings show that adopting these technologies can significantly improve financial sustainability by optimizing processes, reducing operational costs, and increasing customer satisfaction. However, the integration of technological innovations poses significant challenges, such as high initial costs, cyber risks associated with digitalization, and compliance with strict regulations. The conclusions highlight that the long-term success of the insurance sector depends on the ability to strategically adopt disruptive technologies, balancing innovation with financial sustainability. The study contributes to the academic debate on digital transformation, emphasizing the importance of financial inclusion and adaptability in a continuously changing economic environment.*

Keywords: *Financial sustainability, Technological innovation, Artificial intelligence, Blockchain, Digital insurance, IoT*

JEL Classification: *G22, O33, M15, Q01*

INTRODUCTION

In a world of rapid and complex change, the insurance sector faces significant challenges arising from both global economic dynamics and the climate crisis. In this context, technological innovations have become an essential tool to meet these challenges, providing Emerging technologies like artificial intelligence (AI), blockchain, the Internet of Things (IoT), and Big Data analytics are reshaping traditional business models, greatly enhancing the operational efficiency and financial sustainability of insurance companies. In the current age of rapid technological advancement, artificial intelligence has become a vital resource for transforming the insurance industry. By

harnessing AI-powered technologies, insurers can analyze data with greater accuracy, deliver enhanced customer service, and conduct more precise risk evaluations.

Advanced machine learning models enable companies to design customized insurance solutions that address individual needs, ultimately boosting both efficiency and profitability. As a result, insurance policies can better accommodate the specific preferences and risk profiles of clients, fostering greater satisfaction. For example, wearables that track healthy lifestyle choices can provide data allowing insurers to offer health insurance discounts to active individuals. Similarly, telematics devices used to monitor safe driving habits may lead to lower car insurance premiums for careful drivers. This level of personalization not only strengthens customer loyalty but also draws in new market segments seeking policies that align with their lifestyles.

Additionally, one of AI's most powerful impacts in the insurance sector lies in enhancing risk evaluation processes. Leveraging predictive analytics driven by machine learning, insurers can analyze historical patterns and behavioral data to create highly accurate risk forecasts. This approach significantly reduces uncertainty and supports both financial stability and efficient operations. Such capabilities are especially critical in today's climate of unpredictable challenges, such as economic fluctuations and the growing complexity of risks linked to climate change. In health insurance, predictive models based on AI can identify risks of serious conditions in patients, allowing companies to provide preventive advice or adjust policies according to identified risks. In home insurance, AI can analyze climate data and natural disaster history to assess the likelihood of events such as floods or fires, which helps to determine the correct policy costs. Another key aspect of using AI in insurance is fraud detection and prevention. Fraud is one of the biggest challenges for insurance companies, generating significant financial losses every year. Artificial intelligence, through the ability to quickly and accurately analyze large volumes of data, plays a crucial role in identifying anomalies and suspicious behaviors. AI-based systems can analyze claims for compensation to identify unusual patterns that could indicate a fraud attempt.

This significantly reduces the waiting time for customers, improving their experience and overall efficiency of the company. Chatbots not only take on the repetitive and time-consuming tasks of insurance agents, but they can also learn from previous interactions, becoming more effective as they are used. For example, if a customer frequently asks about the policy renewal process, the chatbot may subsequently provide automatic notifications near the expiration date of the policy, thus helping to improve customer retention. As technology evolves, AI will continue to redefine how insurance companies operate, providing innovative solutions for a more sustainable, transparent and customer-focused sector. In an ever-changing world, the adaptability and adoption of these technologies are becoming not only competitive advantages, but also an essential condition for survival. Blockchain technology has become one of the most important innovations in recent years, redefining how data is secured and managed in various sectors, including insurance. By its nature, the blockchain functions as a distributed ledger that records all transactions in a transparent, immutable and secure manner. In the insurance sector, managing a large amount of sensitive data - personal data, contracts, claims history - requires a high level of security and transparency. The blockchain offers exactly these advantages through its decentralized structure. In insurance, the use of the blockchain provides access to all parties involved - insurance companies, customers, intermediaries, regulators - to the same up-to-date and verifiable information.

This transparency reduces misunderstandings, strengthens trust between the parties and provides a solid basis for the swift resolution of disputes. Fraud is one of the biggest challenges in the insurance sector, causing significant financial losses. Blockchain addresses this problem through its ability to create a safe and transparent environment for handling claims. Another major advantage of blockchain is the use of smart contracts (smart contracts). These are programmable scripts that run automatically when certain predefined conditions are met. In the insurance sector, smart contracts can be used to deal quickly with claims, eliminating the need for intermediaries to get involved and thus reducing operational costs. For example, a travel insurance policy based on a smart contract can automatically compensate a customer in case of flight cancellation. The system automatically checks

flight information through an external (oracol) data source, and if the flight is indeed cancelled, the compensation amount is immediately transferred to the customer's account without the need for manual intervention. Amid the rapid evolution of technology, artificial intelligence is revolutionizing the insurance industry by enhancing its efficiency and customer-centric approach. By adopting AI-driven systems, insurance companies can process data more effectively, improve service quality, and refine risk assessment methods. Machine learning tools allow for the development of tailored insurance solutions that address individual customer requirements, ensuring better alignment with their needs and increasing both productivity and profitability. Consequently, insurers can craft policies that reflect the unique preferences and risk profiles of customers, driving higher satisfaction levels. For instance, data from wearable devices that monitor healthy lifestyle habits can enable insurers to offer discounts on health insurance to active individuals. Similarly, telematics technology used to assess driving behaviors allows careful drivers to benefit from lower car insurance rates. This personalized approach not only boosts customer loyalty but also captures the interest of new consumer groups seeking policies that fit their lifestyles. Moreover, one of AI's most significant contributions to the sector is its capacity to revolutionize risk evaluation. With predictive analytics supported by machine learning, insurers can study historical trends and behavioral data to generate highly accurate risk projections. This precise forecasting helps to minimize uncertainty while reinforcing financial resilience and operational efficiency.

These innovations are particularly valuable in the face of increasingly complex challenges, such as economic instability and the unpredictable impacts of climate change, which demand sophisticated strategies for managing risk. In an ever-changing economic and technological environment, blockchain is a solid foundation for a safer and more transparent future in the insurance sector. Through connected smart devices, IoT enables real-time data collection, providing insurance companies with essential information about user behavior and the status of insured assets.

This technology not only revolutionises the way risks are assessed, but also contributes to the personalisation of insurance products, thereby improving customer experience and the operational efficiency of companies. IoT is based on a network of connected devices that continuously collect and transmit data. In the insurance sector, this technology plays a crucial role in asset monitoring and risk assessment. Sensors installed in homes, vehicles or wearables (weearables) gather information about usage, environmental conditions or behavior, giving insurers a clear and detailed picture of the risks associated with each customer. For example, in the case of housing, intelligent sensors can detect water leaks, temperature variations or the presence of smoke. These data allow insurance companies to intervene preventively, reducing the risk of major damage and, implicitly, the costs associated with compensation. In addition, customers benefit from an additional level of protection, with the possibility to receive real-time notifications about possible problems in their homes. One of the biggest advantages of using IoT in the insurance sector is the ability to customize policies according to the data collected. Unlike the traditional approach, in which insurance premiums are calculated based on general estimates, IoT allows setting tariffs adapted to the real behavior of users. This model not only stimulates responsible behavior, but also creates a fairer relationship between insurers and customers. A remarkable example is the use of telematics in motor insurance. Telematics monitors the drivers' driving style - speed, sudden braking, accelerations and distances travelled - and transmits this information to insurance companies. Based on this data, prudent drivers can benefit from significant discounts on insurance premiums, while those who adopt risky behavior can pay more.

This system not only rewards responsibility, but also helps reduce accidents, promoting safety on the roads. IoT enables insurance companies to take a proactive approach to risk management. By constantly monitoring assets and user behaviour, insurers can identify potential problems before they become critical. In addition, customers who demonstrate healthy behavior can benefit from discounts on insurance policies, which creates a system of mutual benefits. Although IoT offers multiple benefits, its integration into the insurance sector is not without challenges. One of the main difficulties is the management of the huge amount of data collected. Insurance companies must prioritize investments in advanced technological

infrastructure to efficiently process and analyze the vast amount of data generated by IoT devices. However, one of the main challenges associated with IoT implementation is ensuring the protection of personal data, as this technology involves collecting highly sensitive customer information. Additionally, the high upfront costs of IoT deployment present a hurdle for both companies and consumers. Smart devices like sensors or telematics can be expensive, and their widespread adoption may require financial support or incentives from insurers to encourage usage.

The integration of IoT in the insurance sector plays a pivotal role in enhancing financial sustainability. By reducing operational expenses, streamlining processes, and preemptively mitigating significant damages, IoT enables insurers to allocate resources more effectively. This technology promotes a more transparent and fair relationship with customers, offering them personalized products and enhanced protection. The Internet of Things (IoT) is proving to be a game-changer for the insurance sector, enabling companies to harness real-time data to refine risk evaluations, customize policies, and prevent potential damages. By integrating these advancements, insurers not only enhance their efficiency and market competitiveness but also contribute to a more sustainable and adaptive economic environment. However, the effective adoption of IoT relies heavily on overcoming technical challenges and implementing robust data security frameworks. As technology continues to evolve, IoT is poised to become a fundamental component of the insurance landscape, providing cutting-edge solutions that meet shifting customer expectations and address the complexities of global markets. For those insurers ready to embrace change responsibly, IoT offers significant opportunities for growth and industry innovation. In parallel, Big Data analytics has equipped insurers with tools to better understand market dynamics and predict customer needs. By analyzing diverse data sources, such as social media activities, geolocation markers, and transaction histories, companies can create innovative products that align with current contexts and individual preferences. While these technologies offer clear advantages, implementing them comes with challenges. The substantial upfront investments required for acquiring and deploying these technological solutions pose a notable hurdle, particularly for smaller companies.

Despite these barriers, the potential for long-term benefits makes these innovations a worthwhile pursuit for forward-thinking businesses in the industry. Moreover, cyber risks are a major concern given the high volume of sensitive data processed. Another obstacle is compliance with strict financial and data protection regulations. Insurance companies must invest in solutions that comply with the legislation and ensure the transparency of processes without compromising data security. Compliance with legal regulations and ensuring process transparency, while maintaining robust data security, are critical when leveraging innovative technologies like the Internet of Things (IoT). IoT has revolutionized various industries, including the insurance sector, by offering forward-thinking solutions for risk mitigation, damage prevention, and cost optimization in the realm of home insurance. This case study examines the functioning of this technology, the processes it entails, and the economic benefits it delivers, supported by mathematical calculations that emphasize the financial advantages of preventative measures. IoT operates by deploying networks of intelligent sensors connected to the internet to continuously collect and evaluate data in real-time. A noteworthy recent innovation is the implementation of strategic sensor networks designed specifically to detect and address risky situations more effectively. These networks allow for rapid identification of potential hazards, streamline intervention processes, and integrate prevention with home security systems. This evolution is reshaping the relationship between homeowners, insurance providers, and service operators, creating a smarter and more proactive ecosystem focused on risk prevention as its cornerstone. In today's sophisticated housing infrastructure, sensors serve as vital tools for identifying potential threats. When strategically placed in vulnerable areas, they can detect irregularities before they escalate into severe problems. Temperature sensors, for example, play a crucial role in safeguarding against pipe freezing or monitoring overheating in critical areas.

They record and analyze sudden changes in temperature, which might indicate thermal instability, discomfort, or even impending danger. By acting swiftly on such data, these sensors

significantly reduce the likelihood of property damage and associated repair costs. This integration of sensor-based technologies is transforming the conventional approach to home insurance, positioning prevention and real-time monitoring as central elements of the model. Consequently, insurers benefit financially from fewer payouts due to prevented damages, while homeowners enjoy enhanced safety and reduced risks.

This shift toward a prevention-focused paradigm not only optimizes costs but also fosters a stronger, more transparent partnership between all parties involved. For example, a sudden drop in temperature can signal the risk of water freezing in pipes, and early intervention can avoid compromising the water supply system. Fire alarm is a vital function of sensors specialized in smoke detection. They are able to provide immediate alerts when they identify the presence of particles characteristic of a potential fire. By transmitting these alerts in real time, the risk of fire expansion is greatly reduced, protecting lives and properties effectively. Sensor-based systems help conserve resources by detecting water losses, optimizing energy consumption by monitoring temperature, and protecting the environment by preventing major damage. In addition, the expansion of these technologies to more advanced solutions, such as the use of artificial intelligence for more accurate risk predictions, promises to further strengthen this preventive model. This technology model not only redefines industry standards, but also opens a bright path to a future where prevention replaces reaction and our homes become the ultimate expression of innovation and protection. The implementation of such an IoT system involves several stages:

COLLECTING DATA:

- Sensors collect data continuously, such as humidity level, temperature, or the presence of smoke. Each sensor generates a time series data stream (head D open paren t close paren), where:
- Open paren t close paren head D is the measured value of the sensor at time t.
- The data is transmitted in real time to a central server.

DATA ANALYSIS

The data collected is analyzed using machine learning algorithms to detect anomalies. An example of an algorithm used is Linear Regression to detect abnormal variations in humidity. If H-head open paren t close paren represents the humidity level at the time t, and the model predicts cap H prime , open paren t close paren based on normal conditions, then an anomaly is detected if:

$$|H(t) - H'(t)| > \Delta H \quad (1)$$

where:

- ΔH this gap pragule considered normal.

PREVENTION OF DAMAGE:

In case of detection of an anomaly, an alert is sent to the owner and insurer. For example, if a water leak is detected, the owner is notified instantly, and a plumber can be sent before the water causes extensive damage.

FINANCIAL CALCULATION FOR DAMAGE PREVENTION:

We assume that an undetected water leak causes average damage of EUR 5,000 (repair of walls, floor and furniture). The use of an IoT sensor, which costs about EUR 50 per year, can prevent this damage completely.

The total economy is:

$$E = C_{daun\breve{a}} - C_{IoT} \quad (2)$$

where:

- $C_{daun\breve{a}}$ it's the cost of the damage (5.000 EUR).
- C_{IoT} it's the cost of the sensor (50 EUR).

consequently:

$$E = 5.000 - 50 = 4.950 \text{ EUR}$$

If the program is implemented for 10,000 homes, the total savings are:

$$E_{total} = E \cdot N = 4.950 \cdot 10.000 = 49.500.000 \text{ EUR}$$

REDUCTION OF COMPENSATION COSTS:

With IoT prevention, insurance companies are significantly reducing the costs associated with compensation. Studies show that IoT adoption can reduce damage by up to 40%.

EXAMPLE OF REDUCTION OF COMPENSATION

We assume that an insurance company pays annual total damage of EUR 20 million for housing. If IoT implementation reduces this damage by 40%, savings are:

$$E_{IoT} = R \cdot C_{total} \tag{3}$$

where:

- R it's the discount rate (0,4).
- C_{total} the total cost of compensation (20 million EUR).

consequently:

$$E_{IoT} = 0,4 \cdot 20.000.000 = 8.000.000 \text{ EUR}$$

By integrating smart sensors that monitor and detect risks in real time, customers not only benefit from a higher level of protection, but become active partners in a safe and transparent ecosystem. Homeowners appreciate the proactivity of insurance companies, which, through the use of IoT, go beyond the traditional role of policy and compensation providers, becoming genuine partners in risk prevention. This profound change redefines industry standards and helps improve the user experience. IoT sensors installed in homes allow continuous monitoring of risk conditions such as water leaks, temperature variations or the presence of smoke. These features reduce the risk that unforeseen events will cause severe damage to homes or property. For customers, this prevention-based approach creates a sense of security and demonstrates the active involvement of insurance companies in their protection. IoT technology contributes significantly to the creation of personalized products, tailored to the behavior and needs of each customer. By collecting and analyzing data in real time, insurance companies can offer discounts or premium adjustments based on responsible customer behaviors.

Wearable devices (wearables) used by customers to monitor physical activity and health condition allow adjustment of health policies, offering discounts to those who adopt an active lifestyle. In motor insurance, telematics collects data on the driving style of drivers, rewarding prudent behavior through significant reductions in insurance premiums. Through these personalization mechanisms, IoT not only stimulates responsible behavior, but also creates a fair relationship between insurers and customers, contributing to their loyalty.

CONCLUSIONS

The deployment of IoT technology in home insurance is a revolution in the way companies operate, transforming the traditional insurance model into a collaborative partnership based on prevention and transparency. The Internet of Things (IoT) plays a vital role in streamlining processes, reducing operational expenses, and significantly enhancing customer satisfaction. Studies and satisfaction indices have shown that the adoption of IoT fosters deeper trust and stronger relationships between customers and insurance providers, creating a win-win scenario for both sides. In a world where technological advancements are continuously shaping consumer expectations, IoT is emerging as an indispensable component of modern insurance practices. However, the successful adoption of

IoT depends on overcoming technical and financial barriers, alongside establishing robust regulations for safeguarding personal data. As the cost of implementing IoT technologies continues to decline and regulatory frameworks become more standardized, IoT is poised to solidify its position as a cornerstone of the insurance industry. By integrating cutting-edge technologies with economic efficiency and social responsibility, IoT allows for the creation of a more sustainable and customer-centric insurance ecosystem.

In conclusion, IoT is no longer just a technological innovation—it is a fundamental necessity for ensuring the sustainable growth of insurance companies. Amid a complex and ever-changing global economic landscape, IoT-driven preventive approaches provide an effective solution to boost customer satisfaction, lower operational costs, and secure long-term competitive advantages. By adopting IoT, insurers can seamlessly align advanced technology with economic and social progress, paving the way for a resilient and future-oriented industry.

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