University of Zurich[UZH]

UZH Blockchain Center

Analysis of Implementing a Smart Contract in Weather Insurance using Chainlink Oracles

Bachelor Thesis

Submitted in partial fulfillment of the requirements for the degree of Bachelor of Science

Author

Aeberhard Elia Andreas

Gmeindhusplatz 4
5223 Riniken

Matriculation Number: **19-925-957**

Email: elia.aeberhard@uzh.ch

Supervisor

Prof. Dr Claudio J. Tessone

Blockchain & Distributed Ledger Technologies

Department of Informatics

University of Zurich

Date of Submission: [Date]

Executive Summary

Write this last. It is an overview of your whole thesis, and is between 200-300words.. . .

Contents

List of Figures

Chapter 1

Introduction

Introduction text ?

1.1 Background

In 2016, global disasters accounted for USD 175 billion in economic losses. USD 54 billion of these economic losses were insured, resulting in uninsured losses of USD 121 billion (Swiss Re Institute 2017). These losses highlight the importance of wheather insurance in providing financial protection for individuals, business and governments. For comparison, the international humanitarian assistance reached USD 28 billion in 2015, making the unsinsured losses of 2016 over 4 times that amount (Initiatives 2016).

1.1.1 Existing Weather Insurance

Traditional weather insurance primarily consisted of crop insurance. The policy in this contract was typically conducted bilateral between an individual or business and the insurance company. If a loss incured on the crop of the individual or business due to weather conditions, an assessment had to be done by the insurance company and the insurance payout was determined based on the specific circumstances (Michler et al. 2022).

Crop insurance has some major problems associated with it. One of these problems is the manual process of analyzing and determining the loss in a monetized amount by an insurance company representative. Other problems include systemic risk, where many insurance holders in the same region are in risk of being affected through weather conditions simultaneously, and asymmetric information, where, for example, insurance holders act more riskily than they normally would because they know they are insured (Makki 2002).

A more modern approach to weather insurance compared to the traditional crop insurance is weather-based index insurance. The key difference here is that weather-based index insurance relies on a measurable variable (such as a temperature drop below a certain threshold or a specific amount of rainfall). The underlying weather data is provided by a reference weather station. The goal is for the criteria (e.g. the temperature threshold) to reflect the financial loss experienced by the insurance holder, for example the loss of a corn field due to adverse weather conditions (Kajwang 2022).

1.2 Problem Statement

Even though the weather-based index insurance approach poses a significant improvement compared to the traditional weather insurance, there are still a lot of problems associated with it. These problems include high administrative costs, delayed payouts, scalability and lack of trust in the underlying systems and insurance companies. (Skees et al. 2008). These limitations reduce accessability and the range of weather insurance solutions for individuals and business, especially in more developing areas.

To address these problems, this thesis proposes a weather insurance solution based on blockchain technology. Through decentralized, transparent systems and globally available weather data, the solution aims to reduce the administrative costs, enable automatic and instant payouts, improve the scalability and encourage more trust among the insurance holders.

1.3 Objectives

The main objective of this thesis is to analyze possible implementations of a blockchain-based weather insurance solution that addresses the challenges and drawbacks of traditional crop insurance und weather-based index insurance. The specific objectives are as follows:

- Identify and analyze the key challenges of current weather insurance solutions.
- Propose a blockchain-based weather insurance design that utlizes decentralized oracles and globally available weather data.
- Evaluate the proposed solution.
- Compare the blockchain-based solution to traditional crop insurance and weather-based index solutions to analyze the potential and improvements in efficiency, transparency and user trust.

Chapter 2

Literature Review

This chapter dives deeper into the existing challenges and limitations of the current weather insurance models with a focus on weather-based index insurance. It then introduces the concept of using smart contracts in insurance in combination with chainlink oracles and google cloud public datasets. Finally, the chapter examines regulatory and technical challenges associated with implementing a blockchain-based weather solution.

2.1 Key limitations in existing weather insurance

In this section every key limitation of existing weather insurance will have its own dedicated subsection.

2.1.1 Administrative costs

In Traditional crop insurance the administrative costs make up 35% to 40% of the insurance outlays while the remaining portion goes towards other costs such as the insurance payout and the reinsurance costs (Glauber 2004). The majority of these administrative costs consist of loss assessment, monitoring, claims, and underwriting expenses.

In index insurance the administrative costs are significantly lower than in crop insurance because the payouts are based on predefined weather indices rather than assessing individual losses. This index-based insurance model also reduces moral hazards since the payouts are triggered by weather events rather than individual actions. (Kusuma et al. 2018) proposes a weather-based index insurance for rice in Indonesia. It is desgined to be cost-effective by basing the insured amount on the cost of inputs (e.g. seed and fertilizer) rather than covering the individual revenue loss.

In section 2.2 the thesis will discuss how smart contracts can be used to lower administrative costs through automated processes even more than weather-based index insurance.

2.1.2 Systemic risk

A key limitation for existing weather insurance is the systemic risk it poses. (Xu et al. 2010) explains how weather risk is systemic in nature, meaning that weather-related events like droughts or floods often affect entire regions rather than isolated areas.In such an event, a large number of insurance holders would file claims simultaneously, making it difficult for the insurance company to payout all these claims at the same time. It further shows that systemic risk is one of the key reasons why existing weather-based insurance markets have struggled and often require government subsidies, especially in the case of crop insurance.

Based on (Salgueiro and Tarrazon-Rodon 2021), which shows how geographic diversification of the insurance solution reduces the systemic risk, this thesis proposes that a solution based on blockchain technology, which allows for global scalability and diversification, could further reduce systemic risk by creating more decentralized risk pools.

2.1.3 Fraud and manipulation

2.1.4 Lack of transparency and trust

2.2 Smart contracts in Insurance

In 2017 the insurance company AXA launched fizzy, a flight insurance based on smart contract technology. It was one of the earliest examplex of the adaption of blockchain technology in the insurance industry. Fizzy was quite simple. A customer entered his flight details and paid a premium for the insurance. Later Fizzy then used an oracle to check whether the flight has been delayed for more than 2 hours and if so would trigger a payment automatically (Hoffmann 2021).

2.3 Chainlink and Google Cloud Public Datasets

For the prototype this thesis will use Chainlink, a decentralized oracle service, in order for our smart contract to access real-world weather data. The decentralized nature of Chainlink improves the security and reliability of the data-inputs (Beniiche 2020).

Specifically, Global Surface Summary of the Day (GSOD) wlil be used as the weather data source. Over 9000 station provide weather data for the dataset with each station having to report a minimum of 4 observations per day of a set of measured variables including temperature, wind speed, pressure among others. (Environmental Information 2023). The entire dataset is hosted on the Google Cloud Platform (GCP) and is updated daily.

Additionally, the Global Forecast System (GFS) is used which provides weather data prediction globally of up to 16 days. It is a numerical system based on four different models (atmosphere, ocean, land and sea model) and is hosted on the Google Cloud Platform (GCP) alongside Global Surface Summary of the Day (GSOD) (Environmental Information n.d.).

2.4 Technical and regulatory challenges of Smart Contracts

(Gatteschi et al. 2018) expresses concerns that the technology is still being explored and not yet ready for its benefits to become more evident. One challenge faced by smart contracts in the insurance industry is technical readiness. Oracles are the external data sources that provide real-world information to smart contracts. The integrity of the smart contract is dependent on the reliability of these oracles and the validity of their data.

Another important point to consider are the different kinds of legal problems associated with smart contracts. For one there is no accepted universal definition of a smart contract which leads to difficulties in defining their legal status across different jurisdictions. There are also concerns about consumer protection laws since an automated transaction initiated by a smart contract may violate local regulations if consumers are unable to legally contest or reverse it (Ferreira 2021).

Chapter 3

Methodology

3.1 Research Design

3.2 Data Collection

3.3 Prototype development

Chapter 4

Development of the Prototype

4.1 Requirements

4.2 Inclusion of Chainlink and Google Cloud Public Datasets

4.3 Designing the architecture and the data flow

4.3.1 Architecture

Example figure

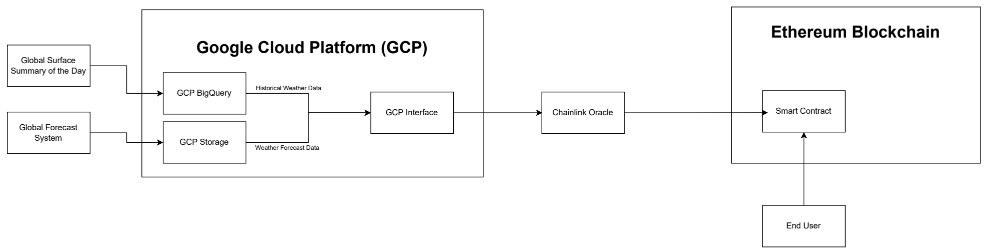

Figure 4.1 – Diagram showing the architecture of the smart contract

Chapter 5

Analysis and Discussion

5.1 Technological and regulatory barriers of the prototype

5.2 Real-world application of the prototype

5.3 Analysis of smart contracts in the insurance industry

Chapter 6

Summary and Conclusion

6.1 Summary of findings

6.2 Conclusions

6.3 Future work

Appendices

Appendix A

Appendix title 1

Test appendix 1

Bibliography

Beniiche, Abdeljalil (2020). “A study of blockchain oracles”. In: *arXiv preprint arXiv:2004.07140*.

Environmental Information, NOAA National Centers for (2023). *Global Surface Summary of the Day - GSOD*. Accessed: 2024-10-21.

— (n.d.). *Global Forecast System (GFS)*. Accessed: 2024-10-21.

Ferreira, Agata (2021). “Regulating smart contracts: Legal revolution or simply evolution?” In: *Telecommunications Policy* 45.2, p. 102081.

Gatteschi, Valentina, Fabrizio Lamberti, Claudio Demartini, Chiara Pranteda, and Víctor Santamaría (2018). “Blockchain and smart contracts for insurance: Is the technology mature enough?” In: *Future internet* 10.2, p. 20.

Glauber, Joseph W (2004). “Crop insurance reconsidered”. In: *American Journal of Agricultural Economics* 86.5, pp. 1179–1195.

Hoffmann, Christian Hugo (2021). “A double design-science perspective of entrepreneurship–the example of smart contracts in the insurance market”. In: *Journal of Work-Applied Management* 13.1, pp. 69–87.

Initiatives, Development (2016). *Global Humanitarian Assistance Report 2016*. Accessed: October 1, 2024. Development Initiatives.

Kajwang, Ben (2022). “Weather based index insurance and its role in agricultural production”. In: *International Journal of Agriculture* 7.1, pp. 13–25.

Kusuma, Aditya, Bethanna Jackson, and Ilan Noy (2018). “A viable and cost-effective weather index insurance for rice in Indonesia”. In: *The Geneva Risk and Insurance Review* 43, pp. 186–218.

Makki, Shiva (2002). *Crop insurance: inherent problems and innovative solutions*. Ames: Iowa State University Press.

Michler, Jeffrey D, Frederi G Viens, and Gerald E Shively (2022). “Risk, crop yields, and weather index insurance in village India”. In: *Journal of the Agricultural and Applied Economics Association* 1.1, pp. 61–81.

Salgueiro, Andrea Martinez and Maria-Antonia Tarrazon-Rodon (2021). “Is diversification effective in reducing the systemic risk implied by a market for weather index-based insurance in Spain?” In: *International Journal of Disaster Risk Reduction* 62, p. 102345.

Skees, Jerry R et al. (2008). “Challenges for use of index-based weather insurance in lower income countries”. In: *Agricultural Finance Review* 68.1, p. 197.

Swiss Re Institute (2017). *Natural catastrophes and man-made disasters in 2016*. Sigma No. 2/2017. Accessed: October 1, 2024. Swiss Re.

Xu, Wei, Guenther Filler, Martin Odening, and Ostap Okhrin (2010). “On the systemic nature of weather risk”. In: *Agricultural Finance Review* 70.2, pp. 267–284.

Eidesstattliche Erklärung

Der/Die Verfasser/in erklärt an Eides statt, dass er/sie die vorliegende Arbeit selbständig, ohne fremde Hilfe und ohne Benutzung anderer als die angegebenen Hilfsmittel angefertigt hat. Die aus fremden Quellen (einschliesslich elektronischer Quellen) direkt oder indirekt übernommenen Gedanken sind ausnahmslos als solche kenntlich gemacht. Die Arbeit ist in gleicher oder ähnlicher Form oder auszugsweise im Rahmen einer anderen Prüfung noch nicht vorgelegt worden.

....	....
Ort, Datum	Unterschrift des/der Verfassers/in