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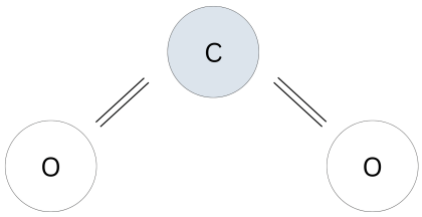

The Role of Market Mechanisms in Upholding Quality and Integrity in the Voluntary Carbon Market

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Cover Image: Structural formula of a carbon dioxide (CO_2) molecule

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Abstract

While climate change is progressing further and further, the window of opportunity for countermeasures is rapidly shrinking. An effective countermeasure to slow the progression of climate change could be the Voluntary Carbon Market (VCM), which allows companies and individuals to voluntarily offset their CO_2 emissions using Voluntary Carbon Credits (VCCs). Despite its potential for climate mitigation, the VCM faces deep-rooted challenges. After recent years of growth, the VCM has experienced decreasing trading volumes in 2022 paired with doubts about the integrity of the VCM and the quality of its VCCs. Consequently, there is a need to understand what hinders the quality of VCCs and the integrity of the VCM. Therefore, this thesis aimed to understand the market's functioning regarding VCC quality and VCM integrity by analyzing the role of its market mechanisms in ensuring these two factors.

In order to gain in-depth insights into the market mechanisms of the VCM, both theoretical results of a literature analysis and practical findings from a qualitative case study of a real-world VCM scenario - the Acorn program - were used. Therefore, interviews (n=4) and a content analysis were conducted. The results of this research showed that the VCM is a complex interplay of different players and market mechanisms. While the literature often perceives these actors and market mechanisms as static, in reality, the role and importance of an actor or mechanism can vary greatly. Although the importance of the various market mechanisms differs depending on the project type, important general recommendations for the VCM can be identified. The lack of a centralized registry, insufficient market data, and an overall lack of transparency across the entire value chain of the VCM became evident. Improving these factors would not only enable projects to create high-quality VCCs but also contribute significantly to the integrity of the entire VCM. Ultimately, this would strengthen the VCM's role in global climate mitigation efforts and help bridge the climate financing gap essential for achieving sustainability goals.

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List of Abbreviations

BCRU	Buffer Pool Carbon Removal Unit
CCPs	Core Carbon Principles
CCQI	Carbon Credit Quality Initiative
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CPR	Common Pool Ressources
CRU	Carbon Removal Unit
CTX	Carbon Trade Exchange
ECX	European Climate Exchange
EU ETS	EU Emissions Trading System
GHG	Greeenhouse Gas
IAD	Institutional Analysis and Development Framework
ICVCM	Integrity Council for the Voluntary Carbon Market
IPCC	Intergovernmental Panel on Climate Change
MVB	Monitoring and Verification Body
NBS	Nature-based Solution
NDCs	Nationally Determined Contribution
OTC	Over-the-Counter Transaction
SDG	Sustainable Development Goals
TSVCM	Taskforce for Scaling up Voluntary Carbon Markets
VCC	Voluntary Carbon Credit
VCM	Voluntary Carbon Market
VCMI	Voluntary Carbon Markets Integrity Initiative
VVB	Validation and Verification Body
VV Cycle	Validation and Verification Cycle

1 Introduction

In 2022, the Intergovernmental Panel on Climate Change (IPCC) stated: “Any further delay in concerted anticipatory global action on adaptation and mitigation will miss a brief and rapidly closing window of opportunity to secure a livable and sustainable future for all”. Man-made climate change and its fatal effects on life on Earth continue to rise unabated. It manifests in consequences such as the rise in global temperatures, the increase in extreme weather events, or the melting of the polar ice caps, which threaten all life on Earth (IPCC, 2021). The main driver remains the extensive CO_2 emissions of the Global North (Hickel, 2020; Jabareen, 2023; Pardikar, 2020). Global CO_2 emissions continued to rise in 2023, further reducing the remaining CO_2 budget of the 1.5°C target of the Paris Climate Agreement (Friedlingstein et al., 2023; Tiseo, 2024).

As already mentioned in the introductory quote, without immediate action and effective climate mitigation measures, these effects will become irreversible and destroy the foundation for human well-being and ecological stability (Rockström et al., 2009). Therefore, efficient and accessible methods are needed that enable society to act and protect the climate in the time left. In this environment, the Voluntary Carbon Market (VCM) has emerged as an opportunity to counteract the rising global CO_2 emissions. Entities such as companies, organizations, or individuals are participating in the VCM, where they can purchase Voluntary Carbon Credits (VCC) to offset their carbon emissions.

1.1 Problem Statement

In recent years, the VCM has experienced a period of exponential growth, reaching a value of $2 billion in 2021, which is approximately four times its value in 2020 (Mikolajczyk & Bravo, n.d.). This growth was primarily driven by increased buyer motivation (Kreibich & Hermwille, 2021). However, 2023 marked a critical turning point, revealing deep-rooted challenges that threaten the viability of the market. A significant decrease in VCCs trading volume from 2021 to 2022, coupled with increased scrutiny of VCM projects' real environmental impact in 2023, highlights the market's unstable state (Donofrio & Procton, 2023; Greenfield, 2023a).

In contrast, this decline in volume was followed by an increase in prices over the same period. For example, in the case of VCCs from projects in Asia, the volume of VCCs decreased by 53% from 218.3 $MtCO_2e$ in 2021 to 102.8 $MtCO_2e$ in 2022, while the price per unit increased from $3.09 to $7.45 reflecting a 141% increase (Donofrio & Procton, 2023). This indicates a shift in market dynamics within the VCM, where higher prices are often seen as indicators of higher quality. Consequently, the increase in prices suggests a growing demand for high-quality credits (Carr et al., 2023). A survey by Ponce de León Baridó et al. (2023) underscores this by stating that the quality of VCCs has become the most important consideration for buyers in the VCM, reflecting a trend toward greater sophistication among buyers who increasingly seek to understand the true impact of their VCCs (Donofrio & Procton, 2023).

In addition to the growing emphasis on quality within the VCM, the Integrity Council for the Voluntary Carbon Market (ICVCM) identifies enhancing the overall integrity of the VCM as a key factor in regaining strength and achieving further growth. The ICVCM's guiding principle, "build integrity, and scale will follow" (2024), highlights the essential role of integrity and quality in advancing the market. Addressing these two factors seems vital for the future growth and effectiveness of the VCM in protecting the climate. Without addressing the key issues of the quality of VCCs and VCM integrity, the market's potential for expansion remains compromised.

1.2 Aims and Objectives

This thesis aims to provide a comprehensive analysis of the integrity of the Voluntary Carbon Market (VCM) and the quality of Voluntary Carbon Credits (VCCs). It seeks to explore the mechanisms within the VCM that influence these two factors, aiming to deepen the understanding of their functioning and interdependencies. The research's aims can be broken down into the following objectives:

1. To examine the most apparent challenges the VCM is facing, focusing on their implications for market integrity and the quality of VCCs.
2. To identify and analyze the main actors and market mechanisms within the VCM, providing an overview of how these elements contribute to the market's functionality.

3. To investigate the specific market mechanisms that influence the quality of VCCs and the integrity of the VCM, detailing how these mechanisms operate and interact within the broader market framework.
4. To apply theoretical insights to a scenario within the VCM, evaluating how current mechanisms are implemented in practice and identifying areas for improvement.

1.3 Research Question

To pursue the objectives mentioned above, the thesis will address the following **research question**: *What role do market mechanisms play in ensuring the integrity of the VCM and the quality of VCCs?* This overarching question aims to develop an in-depth understanding of the various mechanisms used in the VCM to ensure the quality of VCCs and the integrity of the VCM. Further **sub-research questions** are intended to provide support to the overarching research question:

(1) What are the main actors and market mechanisms within the VCM?
(2) What are the most apparent challenges in the current VCM?
(3) Which market mechanisms influence the quality of VCCs and the integrity of the market?
(4) How can the market mechanisms be used and improved to ensure the quality of VCCs and the market's integrity?

2 The Voluntary Carbon Market

The following literature review provides a comprehensive overview of the development of the VCM, its current trends, and its challenges. Additionally, it establishes the theoretical foundation for understanding the market mechanisms that impact the quality of VCCs and VCM integrity. This review will serve as the foundation for the examination of a real-world VCM case in the empirical section of this thesis.

2.1 Climate Change and GHG Emissions

Climate change is accelerating, with extreme weather events becoming more frequent, occurring simultaneously, and inflicting severe damage on Earth (F. Chen et al., 2023; Zhou et al., 2023). The financial and human costs are staggering and are projected to reach up to $3.1 trillion by 2050 resulting in approximately 250,000 additional deaths annually between 2030 and 2050 (Bennett, 2023; Newman & Noy, 2023; WHO, 2023). Despite these alarming trends, greenhouse gas (GHG) emissions continue to rise, as can be seen in Figure 1.

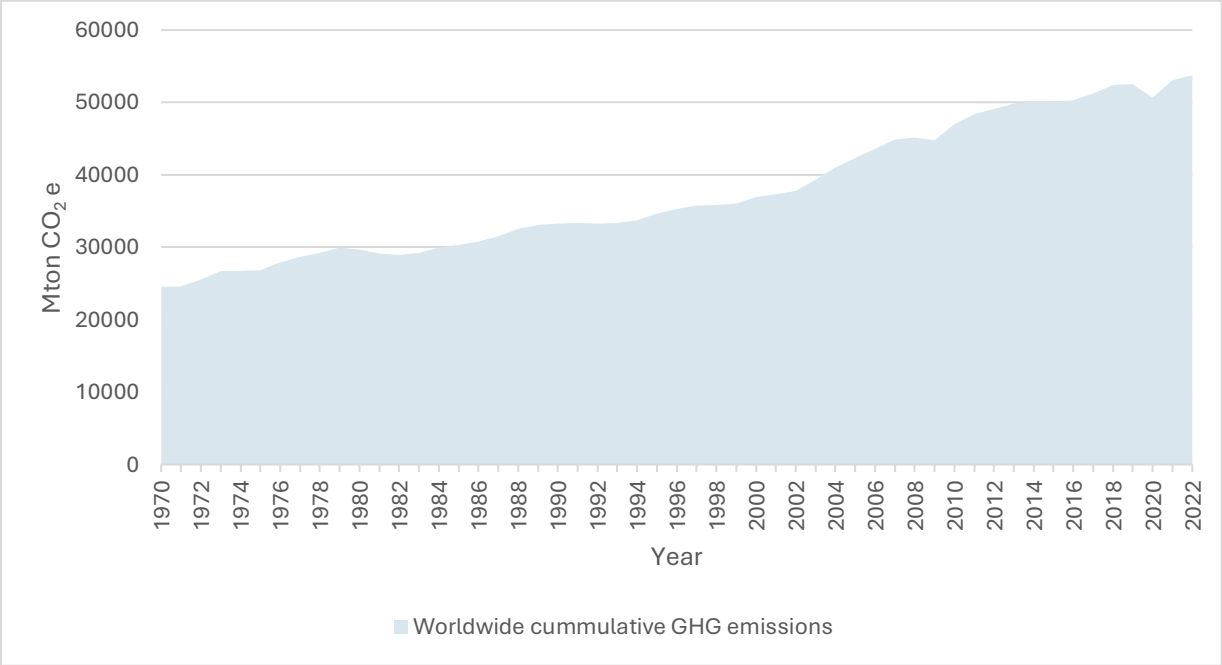

Figure 1. *Worldwide cumulative GHG emissions from 1970 to 2022*

Note. Adapted from European Commission (2023)

In 2022, global cumulative GHG emissions increased by about 1.4% compared to 2021 with global GHG emissions primarily consisting of CO_2 (European Commission, 2023; Friedrich et al., 2023; Tiseo, 2023). Despite the urgent need for climate action and the increasing GHG emissions, there remains a significant gap in climate finance. In 2022, the VCM successfully channeled approximately $1.3 billion in investment flows to mitigate CO_2 emissions (WEF, 2023). Looking forward, the VCM has the potential to bridge the climate finance gap, estimated at $4 trillion by 2030, by potentially reducing

2.6 billion metric tons of GHG emissions and supporting the transition to a net-zero future (Gawl et al., 2023; WEF, 2023).

2.2 The Development of Carbon Markets

In the 1960s and 1970s, scientists were drawing attention to the link between global warming and human behavior (Calel, 2013; Kruse, 2024; Peterson et al., 2008; Walther, 2022). During the same time, pioneering economists proposed the idea of market-based emissions trading for improved environmental protection (Calel, 2013; Coase, 1960; Crocker, 1966; Dales, 1968; Lyu et al., 2023). However, the concept of emission trading was only implemented years later, with the first carbon project being initiated in the late 1980s (Bellassen & Leguet, 2007; Faeth et al., 1994; Trent, 1992).

The Kyoto Protocol, approved in 1997 and established in 2005, marked a turning point in environmental governance and the development of carbon markets (Calel, 2013; Newell et al., 2014). It set emission reduction targets for the participating Annex B parties and introduced market-based mechanisms, so-called 'flexible mechanisms': The Joint Implementation Projects and the Clean Development Mechanism (CDM) (Breidenich et al., 2017; Calel, 2013; Hepburn, 2007; Newell et al., 2014). Article 17 of the Kyoto Protocol allowed the Annex B parties to meet their assigned emission reduction targets through the use of these mechanisms, which allowed them to trade their emission allowances (Michaelowa, Shishlov, et al., 2019; Schneider & Broekhoff, 2016). So-called compliance markets were on the rise (Wessel & de Boer, 2023).

In the 2000s, another market emerged alongside the compliance markets: the VCM[1]. The pioneering efforts of the Kyoto Protocol mechanisms promoted international compliance carbon trading but also formed the foundation for the VCM when the activity in the CDM slowed down (Benessaiah, 2012). In contrast to the CDM, buying credits through the VCM did not directly contribute

[1] There is no centralized VCM, but rather many decentralized markets. The term "Voluntary Carbon Market" is used in this thesis to refer to the collective activities across various decentralized voluntary carbon markets where individuals, organizations, and entities engage in the issuance and sale of VCCs for the purpose of carbon offsetting. This term serves as a shorthand to refer to the broader landscape of VCC transactions.

to a country meeting its GHG emission reduction obligations but helped buyers to voluntarily offset their carbon footprint (Bayon et al., 2007).

The ratification of the Paris Agreement in 2015 represented a pivotal change in global climate governance, fundamentally reshaping the legal framework for both compliance markets and the VCM. This shift was driven by the understanding that achieving a sustainable future requires a fundamental transition towards low-emission economies and societies. In contrast to the Kyoto Protocol, where only Annex B Parties adopted legally binding reduction targets, the Paris Agreement breaks with the statistical distinction between developed and developing countries. In the past, the "uncapped environment," where there were no reduction targets, constituted the primary source of supply for both compliance markets and the VCM (Michaelowa, Hermwille, et al., 2019). In contrast, under the Paris Agreement, countries that previously had no mitigation commitments are now required to develop and communicate nationally determined contributions (NDCs) that cover a significant portion of their economies (Article 4.2, PA, UN-FCCC, 2016). Consequently, the uncapped environment will be considerably smaller and continue to diminish (Kreibich & Hermwille, 2021).

2.3 The Functioning of the VCM

Compliance markets are steered by regulators. Most compliance markets such as the EU Emissions Trading System (EU ETS) function under a cap-and-trade system, where emitters receive emission allowances and the legal obligation to limit their GHG emissions by these allowances. Surplus emission allowances can be traded between the various parties (Borghesi et al., 2016). The VCM, on the other hand, operates mostly independently of the rules and frameworks of the compliance markets (ISDA, 2021).

The VCM generates VCCs corresponding to one ton of CO_2 equivalent (tCO_2e) that has been avoided or removed from the atmosphere (ISDA, 2021; Kreibich & Hermwille, 2021). Despite a decline in traded volume in 2022, the value of Carbon Removal Units (CRUs) remained higher than Certified Emission Reductions (CERs), indicating a robust demand for CRUs. While CRUs are generated from

projects that actively remove CO_2 from the atmosphere, CERs are generated from projects that reduce or avoid future emissions (Donofrio & Procton, 2023).

VCM projects include a wide range of types, including renewable energy, chemical processing, industrial manufacturing, and forestry and land use. The latter sector represented the largest and most valuable category in 2022, with its VCCs accounting for 47% of the trading volume. The forestry and land use category includes so-called nature-based solutions (NBS) such as improved forest management, afforestation/reforestation/revegetation, or agroforestry, which are projects that promote the protection, restoration, and sustainable management of ecosystems (Abatable, 2023; Donofrio & Procton, 2023). Although NBS are traded at similar volumes to technology-based projects such as air capture, NBS exchanged at a significant price premium (Donofrio & Procton, 2023; Ponce de León Baridó et al., 2023).

2.4 The Market Ecosystem

To analyze the mechanisms of the VCM, it is essential to understand its market ecosystem. Figure 2 illustrates a simplified version of the complex VCM ecosystem, which consists of numerous actors and their interactions.

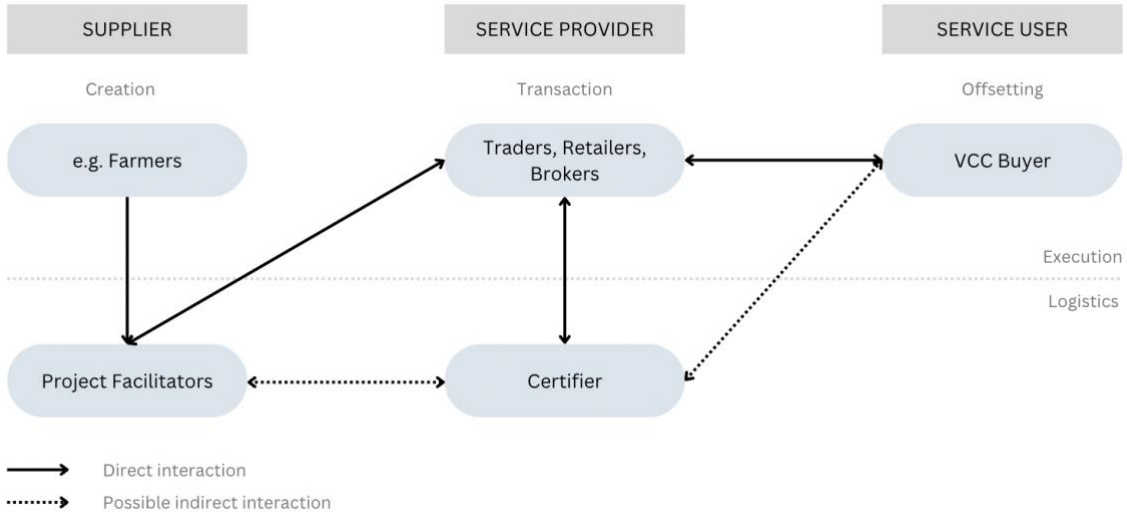

Figure 2. *Simplified visualization of the VCM ecosystem*

Note. Adapted from Larro (2023, p. 18)

As illustrated in Figure 2, the VCM consists of three key components and associated actors that are linked through the creation and transaction of VCCs. The nature of the project influences the interactions between the various actors. The analytical part of this paper will examine a case study of an agroforestry-based VCM project, which will be explained later.

The **supplier pillar** includes project developers, which are organizations or individuals who initiate a VCM project. Project developers play a key role because their initiative starts the life cycle of a VCC as they engage in a variety of tasks including scoping out, physically creating, registering, filing for certification, and securing funding (Battocletti et al., 2023; F. Chen et al., 2023). In the above example of an agroforestry project, farmers play an important role, as they provide the agricultural land for implementing the project (Bakthary et al., 2023).

Service providers act as intermediaries in the VCM ecosystem. To ensure the quality of the initiated project, the project developers rely on two central actors. Amongst the most important service providers are standardization setters such as Verra, the Gold Standard, or PlanVivo, whose standards define what constitutes a high-quality VCC according to their standards (Wessel & de Boer, 2023). These organizations also define the monitoring, reporting, and verification requirements for the project. Standard setters use the service of validation and verification bodies (VVBs), who audit the projects to ensure they meet the standard setter's requirements (Battocletti et al., 2023; Kreibich & Hermwille, 2021). If someone purchases a VCC, it is recorded in the respective registry of the standard under which the VCC is issued (Ahonen et al, 2022; F. Chen et al., 2023).

Furthermore, the VCM includes brokers and marketplaces. While for many years the VCM was dominated by brokers, the diversity of players and methods for purchasing VCCs is now growing (S. Chen et al., 2021; Favasuli & Sebastian, 2021). Brokers facilitate over-the-counter (OTC) exchanges via bilateral contracts between buyers and projects, usually for infrequent and small amounts. Recently, marketplaces, such as the Carbon Trade Exchange (CTX) and the European Climate Exchange (ECX) have emerged as alternatives, that aim to streamline transactions and broaden market accessibility (CTX, n.d.; Peters-Stanley, n.d.; Spilker & Nugent, 2022)

The last important pillar is the **demand side** of the VCM. This pillar includes end-users of the VCM: the purchasers of VCCs, typically companies or individuals seeking to offset their emissions (Battocletti et al., 2023; Kreibich & Hermwille, 2021).

2.5 Research Gap

2023 marked a critical and potentially decisive phase for the VCM, as the record values and optimistic market estimates reported earlier faced increased scrutiny. In the previous year, the market's value had risen to $2 billion and was estimated to reach $100 billion by 2030 due to predicted strong future growth (Blaufelder et al., 2021). In 2022, however, the VCM recorded a 51% decline in trading volume compared to 2021 (Donofrio & Procton, 2023). In 2023, this was followed by scrutiny and public debates about the environmental benefits of NBS, particularly REDD+ forest conservation projects (Greenfield, 2023a). This resulted in an atmosphere of caution towards the integrity and transparency of the market. Furthermore, lawsuits were filed against companies such as Delta Airlines, which had based its net zero strategy largely on the purchase of VCCs. These lawsuits called into question the effectiveness and credibility of VCC strategies (Greenfield, 2023b). As a result, companies such as Nestlé and Shell began to reconsider or even withdraw their VCC strategy (Temple, 2023; Twidale & Mcfarlane, 2023).

If the VCM is to regain its former strength and meet future expectations as an effective tool for climate mitigation, there is a need to understand how the VCM can be improved. As Hermville and Kreibich (2021) noted, while earlier literature focused on the functioning of the VCM, more recent studies have shifted away from this topic. Earlier authors were pivotal in laying the groundwork for understanding how the VCM operates within a broader environmental and economic context (Bellassen & Leguet, 2007; Bumpus et al., 2010; Bumpus & Liverman, 2008). As research evolved, the focus shifted towards examining the legitimacy, narrative frameworks, and the broader conceptual implications of the VCM, especially in light of the Paris Agreement (Ahonen et al., 2022; Blum & Lövbrand, 2019; Kreibich & Hermwille, 2021). This new focus has led to a gap in current research into the detailed functional mechanisms of the VCM.

The objective of this thesis is to redirect attention to the functioning of the VCM, with a particular focus on the increasing importance of the quality of VCCs and the overall integrity of the market. By identifying and analyzing the most important market mechanisms that ensure these factors, this research can provide insights for enhancing the VCM's effectiveness. It is important to address this research gap to improve current practices and form a robust functioning of the VCM and reinforce the VCM's role as an important climate mitigation tool.

2.6 Current Challenges of the VCM

To better understand the current shortcomings of the VCM in terms of quality and integrity, it is crucial to identify the issues it faces. The challenges within the VCM can be categorized into three main pillars, as illustrated in Figure 3. The following section summarizes the literature findings on these challenges and connects them to the relevant market mechanisms.

Figure 3. *Pillars of concern in the VCM*

Note. Adapted from Wessel & de Boer (2023)

2.6.2 Concerns about VCC Quality

The first pillar that needs to be considered is the quality of VCCs. While, as mentioned above, the quality of VCCs appears to be the main criterion for many buyers of VVCs (Donofrio & Procton, 2023; Ponce de León Baridó et al., 2023), ensuring and evaluating the quality of VCCs is difficult in practice. The question arises as to what criteria constitute high quality and how compliance with these criteria can be ensured.

The quality of a VCC is highly influenced by its environmental integrity. Recent research has highlighted the overestimation of the additionality of several projects in the VCM (Badgley et al., 2022; Guizar-Coutiño et al., 2022; West et al., 2020). The term 'additionality' refers to the proposition that the carbon reduction or avoidance would not have occurred in the absence of the intervention by the VCM project. To demonstrate that a VCC creates additional impact, it is necessary to establish a baseline that provides information on how GHG emissions would have developed in the absence of the implemented measure (Michaelowa, Hermwille, et al., 2019; Michaelowa, Shishlov, et al., 2019; Miltenberger et al., 2021). According to a recent study, many projects, especially NBS, that were issued under the leading standard setters did not meet the requirements for additionality (Compensate, 2021).

The concept of additionality is complex, involving concerns about imperfect data and baseline manipulation (Liu & Cui, 2017). Furthermore, projects that initially qualify as additional may lose this status as circumstances change over time (Purdon, 2015). This complexity is increased by the new requirements of the Paris Agreement, which complicate additionality assessments due to unclear NDC terms, technical implementation challenges, and unrealistic emissions assumptions (Spalding-Fecher et al., 2017). In addition, there have been concerns about the possibility of leakages. Leakage occurs when the implementation of a project measurably increases GHG emissions outside the scope of the project (Schneider et al., 2020; Wongpiyabovorn et al., 2023). Leakage is hard to measure and decreases the quality of a VCC immensely (Meyfroidt et al., 2020).

The quality of a VCC is also defined by the permanence of its climate mitigation effects (Battocletti et al., 2023; Schneider et al., 2020). Non-permanence refers to scenarios where the effect does not last for an extended period, usually ranging from 30 to 100 years (Miltenberger et al., 2021, p. 4). Particularly in the case of NBS, which are exposed to variable factors such as the weather, permanence is an increased risk (Wongpiyabovorn et al., 2023). In addition, the environmental integrity of a credit can be affected by the risk of double counting, i.e. when two or more entities claim the same VCC (Hood et al., 2014; Schneider et al., 2020). Double counting is often caused by incomplete data

due to inconsistent accounting protocols and a lack of coordination between registries of the VCM (Battocletti et al., 2023).

Another factor that determines the quality of a VCC is the socio-economic impact of the generating project on local stakeholders and communities (Schneider et al., 2020). As many VCM projects are being facilitated in the Global South, it is important that a project not only prevents possible negative impacts on local communities but also generates co-benefits in addition to the revenues of the project (Valiergue & Ehrenstein, 2023; Wongpiyabovorn et al., 2023). If human rights are violated or biodiversity suffers, the quality of a VCC is reduced. VCCs that generate co-benefits, such as community development, are generally considered higher quality and attract a higher price (Lovell et al., 2009). While the demand for VCCs with co-benefits is increasing, quantifying, monitoring and pricing co-benefits remains a significant challenge (Karhunmaa, 2016; TSVCM, 2021).

Based on the literature, ensuring the quality of VCCs involves addressing several challenges. These include establishing and maintaining additionality, managing the risks of non-permanence, preventing leakage, avoiding double counting, and ensuring positive socio-economic impacts, so-called co-benefits.

2.6.2 Concerns about the VCM's Integrity

In recent years, not only concerns about the quality of VCCs have been raised but also the integrity of the VCM itself. These concerns led to the introduction of several initiatives that are trying to enhance the integrity of the VCM, such as the Voluntary Carbon Markets Integrity Initiative (VCMI), the Carbon Credit Quality Initiative (CCQI), and the Integrity Council for the Voluntary Carbon Market (ICVCM) (Healy et al., 2023). The ICVCM established Core Carbon Principles (CCPs) to provide a common benchmark for higher market integrity, which are shown in Figure 4 (Healy et al., 2023; ICVCM, n.d.-a; Kreibich & Hermwille, 2021).

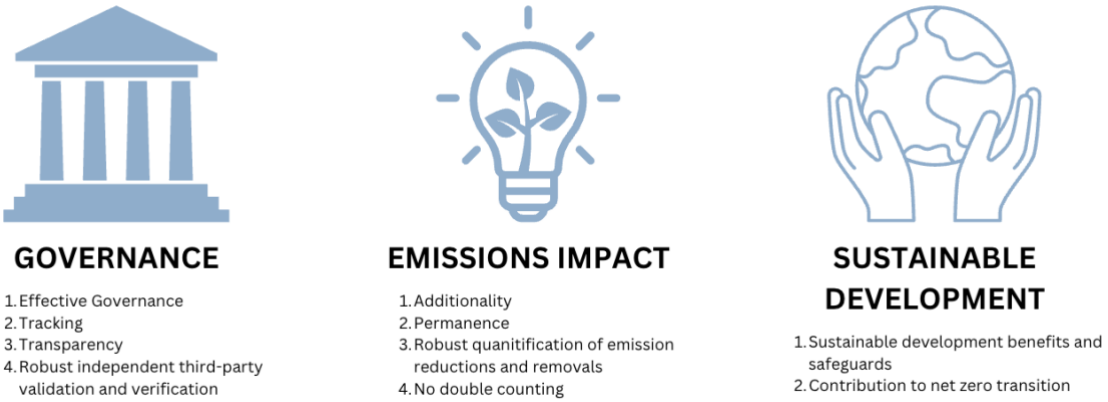

Figure 4. *The Core Carbon Principles*

Note. Adapted from ICVCM (n.d.-b)

When examining the CCPs, it becomes evident that the quality of VCCs is also a determining factor in the VCM's overall integrity. However, the CCPs state that integrity is also affected by various other factors. The CCPs call for projects to "make use of a registry to uniquely identify, record and track mitigation activities" (ICVCM, n.d.-b). The CCPs call for this criterion since the VCM has been characterized as highly fragmented with many diverse actors, especially in registries. A registry in the voluntary carbon market is a system that documents and tracks the creation, transfer, and retirement of VCCs (Ahonen et al., 2022). The VCM includes numerous registries, such as the Verra/VCS Registry, the Gold Standard, and the American Carbon Registry but it lacks a centralized one (Bai et al., 2023; Blaufelder et al., 2021; TSVCM, 2021). Without central registration, there is a continuing risk that VCCs could be sold or claimed more than once (Schneider et al., 2017).

Fragmentation not only affects the registries but also the standardization bodies. The multitude of methods and varying quality standards contribute to the complexity of the VCM (Blaufelder et al., 2021; TSVCM, 2021). Furthermore, a recent study has pointed out notable limitations in information and document disclosures of standard setters, further contributing to the lack of integrity of the VCM through the lack of publicly available data (Knox-Hayes et al., 2020; Wyburd & Dufrasne, 2024). This lack of publicly available data is also prevalent in other areas of the VCM. Specifically, the absence of comprehensive information on pricing and other decision-relevant factors hinders customers' ability to

make informed purchasing decisions. This lack of transparency presents a significant challenge to maintaining the integrity of the VCM (Rosales et al., 2021; TSVCM, 2021).

The final pillar of concern is that of the integrity of claims made by buyers of VCCs. As previously stated, the growth of the VCM has been driven by the increasing number of net-zero claims from companies supported by the purchasing of VCCs (Kreibich & Hermwille, 2021). At the same time is the reputation of the VCM significantly shaped by the behavior of its participants (Battocletti et al., 2023). Concerns about the claims of VCC buyers arise primarily from the lack of transparency of many companies about their net-zero claims (Fankhauser et al., 2022; Hale et al., 2022). Therefore, it can be questioned whether corporate claims accurately reflect the company's actual climate mitigation efforts. There is a risk that potentially non-authentic claims could “put the achievement of the temperature goals of the Paris Agreement on climate change at risk by negatively affecting the capital deployment and deterring government action” (Trouwloon et al., 2023). Critics have argued that the purchase of VCCs is often employed as a convenient alternative to implementing substantive emission reductions within the value chain (Hale et al., 2022; Schneider & La Hoz Theuer, 2019).

In conclusion, concerns about the integrity of the VCM are primarily due to issues such as fragmentation of registries and standards, insufficient data disclosure, and non-transparent claims of its buyers. These factors make the VCM non-transparent and lacking in integrity, which not only damages its reputation but also makes it more difficult for the actors in the VCM to operate.

2.7 Results from the Literature Review

In 2021, the Taskforce for Scaling up Voluntary Carbon Markets (TSVCM) identified the key challenges within the VCM and mapped them to the respective mechanisms within the market as shown in Figure 5. To identify the key VCM mechanisms that play the most significant role in the quality of VCCs and the integrity of the VCM, the most apparent challenges from the literature have been highlighted in **blue**. From these challenges, the literature identifies the market mechanisms that are most critical for ensuring the quality of VCCs and maintaining the integrity of the VCM.

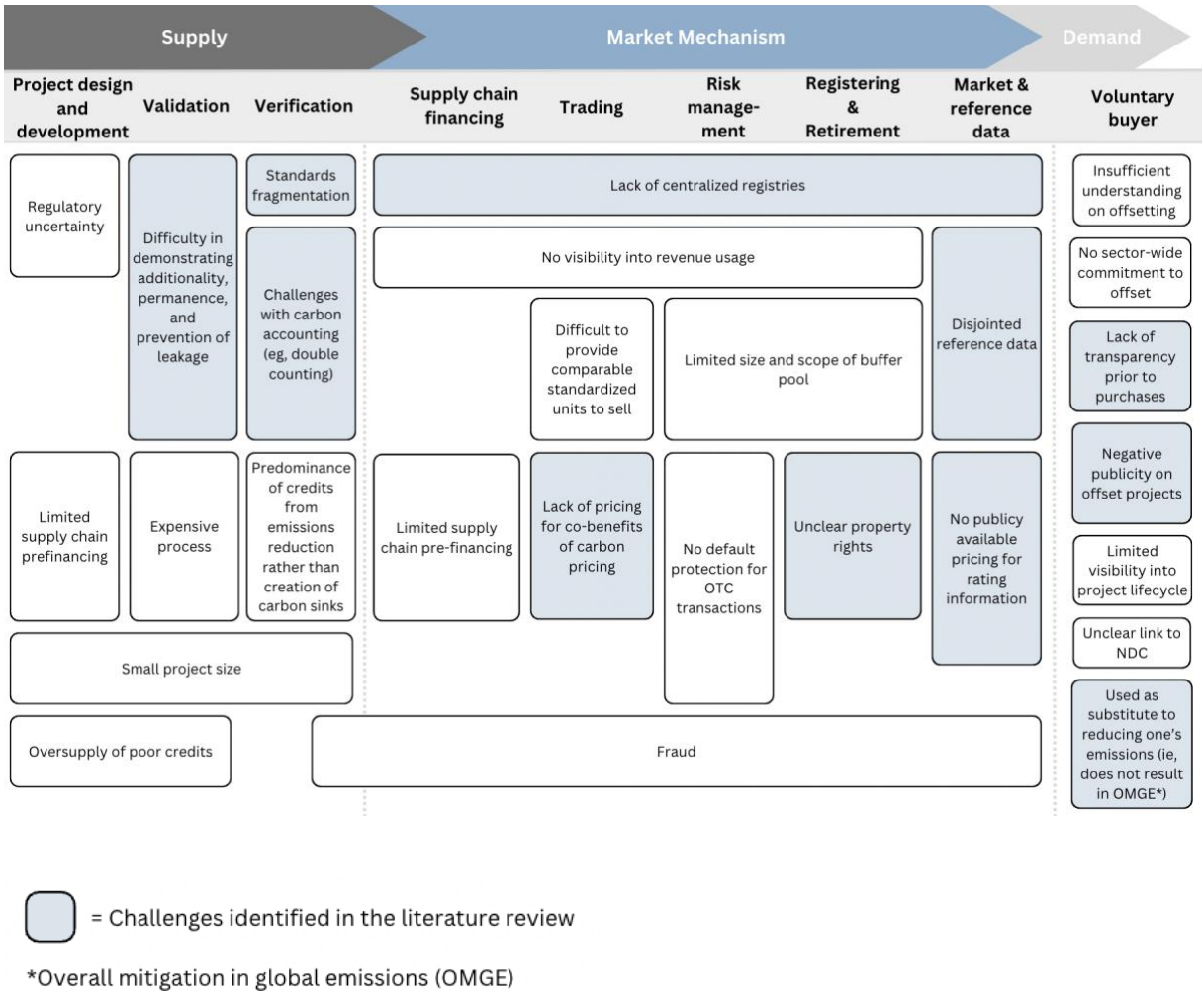

Figure 5. *Challenges for the quality of VCCs, the VCM integrity, and respective market mechanisms*

Note. Adapted from TSVCM (2021)

The purpose of any market is the exchange of goods. However, in the context of this thesis, the term "market mechanism" is to be understood more comprehensively, encompassing the set of rules, institutions, and processes that regulate the functioning of the VCM. These mechanisms extend beyond economic transactions to also include the broader spectrum of activities necessary for the creation and trade of VCCs. Consequently, the mechanisms on the supply side, as well as the activities of purchasers on the demand side, are regarded as "market mechanisms" since they play a vital role in ensuring the quality of VCCs and the integrity of the VCM.

To gain a comprehensive understanding of the functioning of market mechanisms, it is essential to recognize that the VCM is not merely a straightforward exchange of goods. Rather, it is a

highly complex and interconnected system involving a variety of actors and interactions. To identify the most relevant market mechanisms, Table 1 will elaborate on the market mechanisms highlighted in the literature analysis, specifically focusing on those that encompass more than one challenge highlighted in blue.

Table 1. *Relevant market mechanisms for the quality of VCCs and VCM integrity*

Mechanism	Description
Validation	As emphasized by the ICVCM, the integrity of the market and the environmental integrity of a VCC are ensured by an independent third-party validation (ICVCM, n.d.-b). Validation is typically conducted in order to initially approve a project, and is a prerequisite for the registration of the project under a carbon standard (Bakthary et al., 2023; Schneider et al., 2020). During the validation process, an accredited VVB is responsible for validating that a project complies with all the relevant rules and requirements of the relevant standard. The process of validation includes an independent review of project documentation and activities, as well as carbon accounting in accordance with the approved methodologies of the standards (Verra, n.d.).
Verification	Verification is a central mechanism in the VCM. In contrast to validation, which is usually carried out once before project implementation, verification is carried out regularly after project implementation (Verra, n.d.). The verification process includes document review, interviews, project visits and assessment of monitoring techniques by a VVB. This lends credibility to the carbon offsets (Kökey, 2024). Furthermore, validation examines the project design, whereas verification assesses the actual performance of the project (Verra, n.d.).
Trading	Trading in the VCM involves all processes of the buying and selling of VCCs, including pricing, which can vary based on project type, location, and standard

	(Donofrio & Procton, 2023). As described above, the trading can vary from OTC transaction and marketplaces. Each trading form has its specific dynamics and impacts on the VCM (S. Chen et al., 2021).
Registering & Retirement	Registries track projects and issue verified VCCs, each assigned a unique serial number. This system records credit ownership and manages the transfer and retirement of credits (Schneider et al., 2017). Retirement refers to the process of permanently removing a VCC from the market, ensuring that it can no longer be sold or traded. This act of retiring a VCC signifies that the carbon reduction or removal it represents has been claimed and accounted for by an entity (Whiting, 2023).
Market and Reference Data	Market and reference data are crucial components of the VCM as they provide transparency and support informed decision-making. This data includes information on factors such as pricing, project details, verification and validation outcomes, property rights and retirement statuses (TSVCM, 2021).
Voluntary buyers	The buyers in the VCM play a crucial role in influencing the demand for high-quality VCCs. Their purchasing decisions serve as mechanisms that influence market dynamics. Moreover, the manner in which buyers utilize VCCs has a significant impact on the reputation of the VCM (Battocletti et al., 2023; Hale et al., 2022).

3 Analytical Framework

This chapter explains the analytical framework that serves as a bridge between the literature review and the empirical analysis of the VCM case that is central to this thesis, the so-called Acorn program. The framework is based on two building blocks: The Institutional Analysis and Development Framework (IAD) as a theoretical lens for analyzing the VCM and the evaluative criteria derived from the literature review.

3.1 The Institutional Analysis and Development Framework

Elinor Ostrom, the first woman to be awarded the Nobel Prize in Economics in 2009, was an American professor at Indiana University. Ostrom's research focused on the collective management of resources (Lopez & Moran, 2016; Montes et al., 2022; Tarko, 2021). Her critique of Garrett Hardin's 'The Tragedy of the Commons' and her concept of a Common Pool Resource (CPR), defined as a “natural or human-made resource system where it is costly, but not impossible, to exclude potential beneficiaries from obtaining benefits from its use” (Robert et al., 2021, p. 3) was highly influential in political economics and environmental management. Ostrom examined the effectiveness of groups in managing CPRs, such as overfishing or overgrazing (Lopez & Moran, 2016). Therefore, the professor developed a framework to explain complex institutional arrangements in managing CPRs: The IAD (Ostrom, 2011; Poteete et al., 2009).

The IAD is applied to analyze collective decision-making processes (Cole, 2014). It offers a structured approach to comprehending how individuals and groups collaborate to manage the use of CPRs (McGinnis, 2019; Montes et al., 2022; Ostrom, 2011; Poteete et al., 2009). Figure 6 shows that the IAD comprises several components and phases.

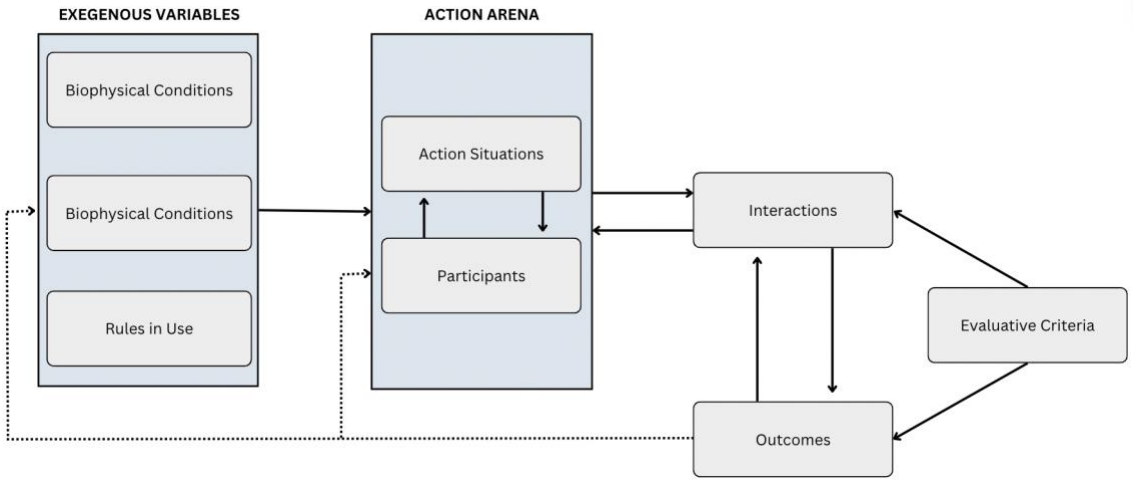

Figure 6. *The Institutional Analysis and Development Framework (IAD)*

Note. Adapted from Ostrom (2005)

To "describe, analyze, predict, and explain behavior within institutional arrangements" (Ostrom, 2011, p. 11), the first step in the IAD is to identify the action arena. This arena serves as the comprehensive context or "playing field" on which various action situations unfold. These situational moments refer to specific interactions or 'games' that occur within the arena, where 'participants' produce outcomes through their interactions (Ostrom, 2011). In an action situation, participants can represent both individuals and groups. Participants bring personal and material resources into the situation, which determine the possibilities of their actions (Poteete et al., 2009, p. 59).

The action arena is influenced by exogenous variables (*IAD Framework*, n.d.). These variables form the contextual framework through the nature of the resource under consideration (biophysical and material context), the rules in use (institutional settings), and the characteristics of the community under consideration (socioeconomic conditions) (Milchram et al., 2019).

The action situation, including its interactions and outcomes, is assessed and evaluated based on specific situational criteria (Milchram et al., 2019). Furthermore, identifying feedback loops enables participants to learn from experience, adapt behavior in future action situations, and thus continuously improve the effectiveness of institutional arrangements (Milchram et al., 2019).

In this thesis, the IAD serves as the theoretical foundation for analyzing market mechanisms within the context of a specific practical case in the VCM. The traditional application of the IAD focuses on policy analysis for managing CPRs and social interactions (Ostrom, 2011). Extending this application, the world's atmosphere can also be understood as a globally overused commodity for which CO_2 emissions need to be managed. The VCM forms an action situation in which CO_2 concentrations in the atmosphere can be managed, based on the various interactions between participants in the VCM. The IAD is to be modified for a systematic consideration of the actors and mechanisms of the VCM. The aim is to use the perspective of a proven and important framework for understanding CPR management and to operationalize it to meet the requirements of the new form of CPR management, the VCM. Elinor Ostrom proposed that the IAD could be more accurately described as a "metatheoretical conceptual map" (Ostrom & Cox, 2010, p. 455), which will be operationalized for the aim of this thesis. The approach for this is as shown in Figure 7.

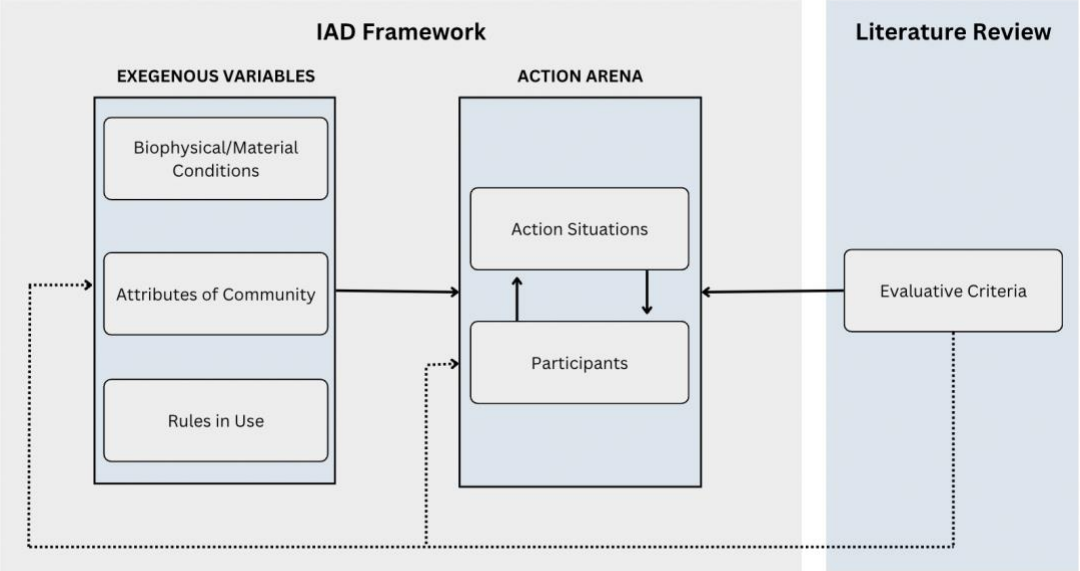

Figure 7. *Conceptual model of the IAD and evaluative criteria to assess the Acorn case study*

Note. Adapted from Ostrom (2005)

To achieve this, the three main components of the IAD - the exogenous variables, the action arena, and the evaluative criteria - are operationalized to analyze the project from the VCM. In the first step, external variables such as biophysical conditions (e.g. geographical location of projects), rules in use (e.g. operational, institutional, and compliance rules), and community attributes (e.g. economic and social characteristics of the community at stake) are analyzed to understand their influence on action situations. In the second step, the action situations within the Acorn program will be identified and analyzed.

3.2 Evaluative Criteria

To understand what action situation affects the quality of VCCs and the integrity of the VCM the most, evaluative criteria were derived from the literature review. These criteria are based on the main challenges regarding the VCC's quality and the VCM's integrity (Chapter 2). By applying these criteria to the case study of this thesis – the Acorn program - specific mechanisms and interactions that most significantly impact the VCC quality and VCM integrity can be pinpointed.

Table 2: *Evaluative criteria based on Literature Review*

Criteria Category	Criteria
VCC Quality	
Environmental Integrity	Ensurance of Additionality
	Prevention of Permanence
	Leakage Prevention
	Double Counting Avoidance
Socio-Economic Impact	Co-Benefits
VCM Integrity	
Fragmentation	Nature of Standard
	Nature of Registry
Transparency	Disclosure of Information (Pricing, Property rights…)
Claims of Buyers	Transparency and emission reduction efforts of buyers

4 Research Methodology

This chapter focuses on the research methodology for this thesis, elaborates on the approach taken in its implementation, and reflects on the methodologies used.

4.1 Research Approach and Design

As shown in Figure 8, this thesis can be broken down into three central components. First, the literature review was used to identify the most important market mechanisms for the quality of VCCs and VCM integrity. In addition, the analytical framework was established. The conclusions and insights of the theoretical phase were applied to a case study for which content analysis and interviews were conducted. The results were combined and evaluated in a final phase.

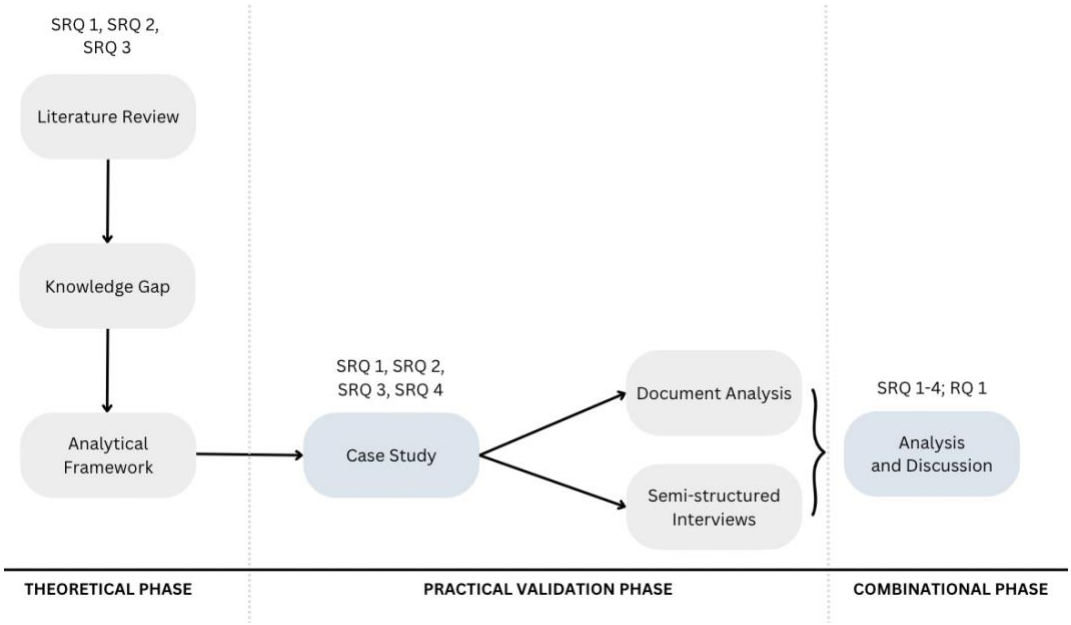

Figure 8. *Visual representation of the research process*

4.2 Methods for Data Analysis

For this thesis, a constructivist, qualitative approach was chosen, examining the Acorn program's mechanisms within the VCM, and understanding the nuanced roles and impacts of these mechanisms through detailed qualitative analysis (Moses & Knutsen, 2019). The conducted case study stemmed from an interpretive epistemological stance, utilizing qualitative methods such as content analysis and semi-structured interviews for understanding the subjective experiences of stakeholders within the VCM. An interpretive stance is particularly suited for this research as it allows for an exploration of the complex interactions within the case study of a VCM project, which quantitative methods may not fully capture (MacIntosh & O'Gorman, 2015).

According to Gray (2014), case study approaches are useful when exploring "how" and "why" questions. This aligns well with this research into how certain market mechanisms influence the quality of VCCs and the integrity of the VCM. Given the complexity and contemporary nature of the VCM, the case study method is ideal for gaining detailed insights into its current dynamics and challenges (Gray, 2014; Yin, 2009).

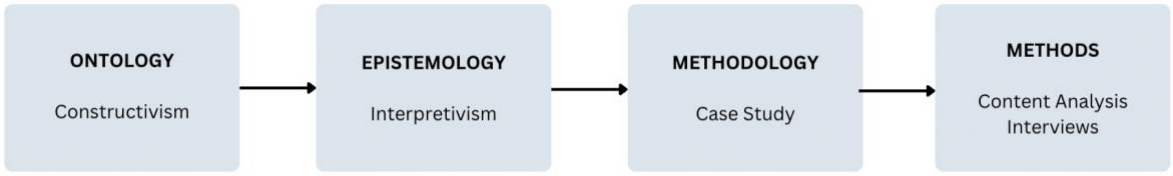

Figure 9. *Visualization of the research approach*

Note. Adapted from Gray (2014)

As outlined in Figure 9, the methods employed for the case study were content analysis and interviews. This approach was essential for a comprehensive understanding of the Acorn program and its overall context. For the content analysis, the analyzed content stemmed from 2021 the earliest, which was the year the Acorn program was started. The data collection process primarily relied on internet searches using the search engine Google. Keywords such as "Acorn project VCM," "Acorn carbon credits," "Acorn program partners," and related terms were used to identify relevant articles, reports, and other content. The search focused on sources that provided detailed insights into the Acorn project and its mechanisms within the VCM. Sources included official websites and publications by the Acorn project, articles and reports from partners of the Acorn project, and other publicly available content on Acorn, including news articles.

Subsequently, four interviews were conducted. These interviews aimed to go beyond the foundational understanding offered by the content analysis, exploring the motivations behind the program, the challenges it faces, and particularly the functioning of the relevant market mechanisms within the VCM in this specific case. To provide a holistic perspective of the Acorn program, interviews were conducted with two Acorn project staff members, one interviewee from Solidaridad and one from the PlanVivo Foundation, both collaborators of the Acorn program which will be introduced in the analytical section. Semi-structured interviews were chosen for this case study because they provide a flexible, yet focused approach that allows for an in-depth exploration of the identified themes from the literature review while allowing for new insights and perspectives to arise from the participants (Adams, 2015). The guiding questions for the interviews can be found in Appendix B. Three of the interviews were conducted via Zoom and lasted approximately 60 minutes. The interviews were

recorded and later transcribed. One interview was conducted in the form of a written questionnaire, whereby the interview questions were sent to the interviewee and the interviewee returned them in written form. All interviews happened in the calendar weeks 20-23.

4.2.1 Methods for Data Analysis

Both the data from the content analysis and the interviews were analyzed using thematic analysis in accordance with Braun and Clarke (2006). To analyze the collected data, a combination of deductive and inductive coding methods was used. First, as advised by Braun and Clarke (2006), the content was familiarized by thoroughly reading the data, allowing for an in-depth understanding of the material. This initial step involved taking preliminary notes and identifying potential patterns. Coding was then employed to explore the functioning and roles of various actors within the program, as well as to identify the key mechanisms influencing the VCM. This approach allowed for the emergence of themes directly from the data. This iterative process provided a nuanced understanding of the program's operation.

First, inductive coding allowed for identifying new patterns that emerged from the interviews (Seale, 2012). Additionally, deductive codes derived from the literature review as can be seen in Appendix D were used to apply the evaluative criteria of the analytical framework. This dual approach facilitates a comprehensive understanding by balancing pre-existing theoretical insights from the literature with the discovery of novel insights from this research. By integrating content analysis with in-depth interviews, this case study offers a nuanced and detailed exploration of the Acorn program. Appendices C and E show the inductive and deductive coding.

4.2.2 Reflection on Data Gathering

For the case study's content analysis, most of the data collected stemmed from websites and were not third-party reviewed, introducing a potential bias into the thesis. This reliance on online sources, while necessary for capturing the most current information on the Acorn program, means that the quality and reliability of the data might vary. Efforts were made to select credible sources, but the variability in online content must be acknowledged. The interviews conducted aimed to delve deeper into specific

aspects of the Acorn program, providing valuable qualitative insights. However, while the initial aim was to involve a diverse range of stakeholders, including buyers of the VCCs, this was not fully achieved. All interview partners were associated with Acorn, introducing a degree of bias into the results. This association may have influenced the perspectives shared, emphasizing positive aspects while potentially underreporting challenges or criticisms. To mitigate this bias, the evaluative criteria from the second chapter were rigorously applied, ensuring a more balanced and objective analysis. These criteria provided a structured approach to evaluate the data, helping to maintain a critical perspective and enhance the reliability of the findings.

5 The Acorn Program

This chapter presents the empirical results from the assessment of the Acorn case study based on document analysis and conducted interviews. It will follow the analytical framework that was introduced. Interviewees are anonymized by codes which can be found in Appendix A. Using the evaluative criteria defined, the chapter will determine the quality of Acorn's VCCs and the project's influence on the integrity of the VCM. Furthermore, this chapter will explore the role of market mechanisms in achieving these outcomes.

5.1 Exogenous Variables

Before examining the exogenous variables impacting the program, it is important to introduce Acorn. **A**groforestry **C**RUs for the **O**rganic **R**estoration of **N**ature (Acorn) is a VCM initiative of the second biggest Dutch cooperative bank Rabobank (van de Mortel, n.d.). Acorn's mission is to facilitate smallholder farmers' access to the VCM (Acorn, n.d.-d). To achieve this, Acorn encourages smallholder farmers to adopt agroforestry practices to generate carbon removal units (CRUs). In cooperation with Microsoft, Rabobank has built a platform that connects farmers and corporations who wish to offset their CO_2 emissions (Acorn, n.d.-a).

5.1.1 Biophysical Conditions

The approach of using agroforestry to enable smallholder farmers to join the VCM is a key biophysical condition and forms the operational foundation of the Acorn program. Agroforestry is the practice of growing trees such as mango, avocado, and cashew alongside agricultural crops. The practice provides environmental benefits such as improving soil health, but also creates an extra stream of income for farmers through the harvest of fruits, enhancing their financial stability alongside their agricultural yield (Acorn, n.d.-b; Solidaridad, n.d.-a). Through participation in the Acorn program and, therefore, the VCM, the farmers can gain further benefits from the practice of agroforestry. Acorn measures the biomass growth by the planted trees and turns it into CRUs. The CRUs represent one metric ton of CO_2 stored in the planted trees (Acorn, n.d.-g; PlanVivo, 2024a).

Acorn operates on a large geographical scale. The currently 28 projects of Acorn are focused on regions severely affected by the effects of climate change, particularly in Africa and Latin America (Acorn, n.d.-e). Acorn is also expanding to Asia (P2). While the projects are being facilitated in the Global South, the Acorn team is situated in the Global North, which creates a spatial gap within the program (P2).

5.1.2 Attributes of Community

The main participants in the Acorn program are smallholder farmers who own less than ten hectares of land (Acorn, 2021; P2). These farmers often practice subsistence farming (i.e. for the farmer and the farmer's family) and have limited access to financial resources and markets, making them particularly vulnerable to economic and environmental volatility: "*Unpredicted or less regular rains and more changes in weather patterns that are unexpected […] affect their crops and therefore income predictability*" (P3). Acorn recognizes this and connects farmers to the VCM, expanding their market reach "*by giving them access to this additional market and an income*" (P3). Farmers encounter significant financial obstacles when attempting to join the VCM (Solidaridad, n.d.-b). Initiating a project typically requires approximately 150-300 euros per hectare (P3). Acorn is addressing this issue by pre-

financing the farmers to enable them to access the VCM (P1, P3). In addition to financing, Acorn places great emphasis on educational support (P2, P3).

5.1.3 Rules in Use

Acorn's rules in use can be derived from the program's ten guiding principles "to ensure high-quality projects and CRUs" (Acorn, 2021), which will be explained in more detail in the following sections:

> 1. All Acorn projects meet the eligibility requirements and actively involve smallholder farmers in the transition to agroforestry to improve their livelihood and that of their community.
> 2. All of Acorn's local partners have clear responsibilities and are compliant with international and national legislation.
> 3. All Acorn CRUs are generated with integrity by additional and real project interventions.
> 4. All Acorn projects realize ex-post carbon sequestration, as well as demonstrable socioeconomic and environmental improvement compared to the baseline.
> 5. All Acorn CRUs are ex-post, science-based and data-driven in their quantification and measurement, and these are demonstrated to be accurate and verifiable.
> 6. All Acorn projects take mitigating actions for potential CO_2 emissions that are attributable to the project.
> 7. All Acorn CRUs are traceable, uniquely registered and accounted for.
> 8. All Acorn projects deliver CRUs that are based on durable sequestration and come with an appropriate durability period.
> 9. All Acorn projects adopt robust solutions for reversal risk.
> 10. All data acquired by Acorn is handled with the highest level of integrity and with stakeholder consent. (Acorn, 2021)

5.2 Action Arena

To understand the action situations in the Acorn program, it is important to note that Acorn's role in the VCM can be understood as "*ambiguous*" (P1). While actors' roles within the VCM are often clearly distinguishable, Acorn takes on a multifaceted role. Acorn functions as a project developer by initiating funding, although it does not directly implement the projects on-site (P1). At the same time, Acorn acknowledged that it also acts as a monitoring and reporting body: "*Then you could say we are partly a monitoring and reporting body because we do the calculations of the delta biomass ourselves*" (P1). Acorn also acts as its standard setter with its registry (P2). Acorn's multiple roles create various action situations that involve different actors, which will be discussed in more detail in the following sections.

5.2.1 Onboarding and Baseline Determination

To initiate and implement their projects, Acorn works with local partners already in close contact with local farmers (Acorn, n.d.-h). Local partners include organizations such as Norandino, FarmStrong Commodities, Ghana's Ministry of Food and Agriculture, and Solidaridad (Acorn, n.d.-e). The local partners, who are already promoting and establishing agroforestry locally, also do "*the work in the farm […], sensitize farmers on the program and […] provide information*" (P3) on the possibility of working with Acorn. The farmers then "*provide their consent and their agreement to be part of this program*" (P3). Before the project is certified and can issue CRUs under Acorn, it goes through a process illustrated in Figure 10.

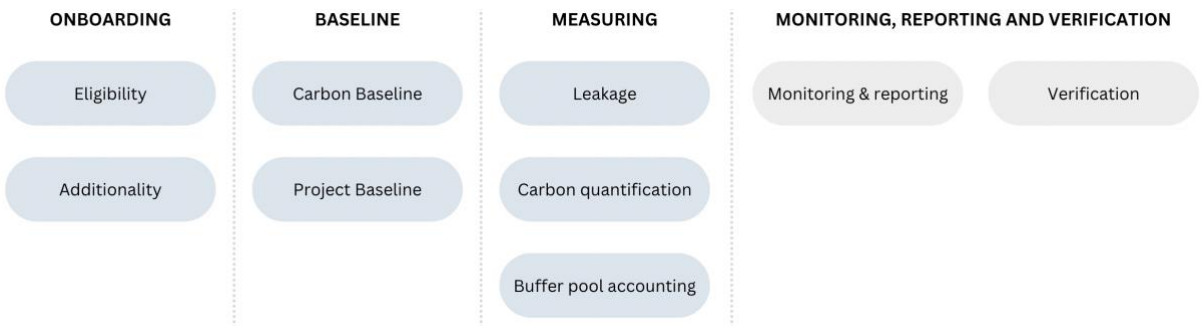

Figure 10. *Acorn's certification process*

Note. Adapted from Acorn (2024)

While the first three steps take place in the project development phase, monitoring, reporting, and verification occur at a later stage. The local partner is responsible for the collection of data and uploading it to the so-called Acorn Portal (Acorn, n.d.-f): "*We do the first part, the first mile let's say and then we link up with Acorn for the second mile*" (P3). The local partner fills out an eligibility checklist with the farmers to decide whether they are eligible for the Acorn project (Acorn, n.d.-g). An additionality test is performed for each project to ensure it maintains its environmental integrity, as "*it is also a difficult case-by-case decision*" (P3).

Not only the carbon baseline is established by the local partner, but also the project baseline concerning environmental and socioeconomic factors, which Acorn defines as "*central to the Acorn proposition*" (Acorn, 2021). Therefore, Acorn asks questions such as: "*How is the livelihood right now? What is the ecosystem baseline right now?*" (P2). To become a certified Acorn project, the data is evaluated by both Acorn and PlanVivo. The PlanVivo Foundation is a standard setter, with whom Acorn cooperates. PlanVivo has approved Acorn's validation and verification framework and certifies projects under Acorn:

> *We [Acorn] as the certification team do a first internal review. When we think it's sufficient, we submit to Plan Vivo in Basin Edinburgh for external certification. And then we'll be back and forth for several rounds until they give the green light. When it's externally certified by Plan Vivo, the project will officially become an Acorn project. Otherwise, it will fail.* (P2)

Additionally, local project committees are established by the local partners. The farmers participate in these committees "*where they can have their governance structure in their say*" (P3). Given the significant spatial disparities between project implementation and project developers, Acorn considers it crucial "*that there is an equal power dynamic*" (P2).

5.2.2 Measuring

Acorn uses an 'ex-post' approach in generating its CRUs, whereby CRUs are based on actually realized, not projected, carbon sequestration. At Acorn, carbon sequestration is calculated by measuring above-ground biomass and multiplying it by a factor to include below-ground biomass (Acorn, 2021). When initiating a project in the Acorn program, ground truth data is first collected by defining sample plots, counting the trees per sub-plot, and measuring the average biomass. In addition, a Light Detection and Ranging (LiDAR) sensor and satellite data are used (Acorn, n.d.-i). Based on this data, models are trained to measure changes in biomass over the last year. The CRUs are calculated by converting the amount of CO_2 sequestered into CRUs (Acorn, 2021). Acorn cooperates with a network of remote sensing partners to develop algorithms for scalable biomass measurement (Acorn, n.d.-i).

The program guarantees a durability of twenty years, with annual monitoring during CRU generation and periodic checks afterward to ensure CO_2 remains stored (Acorn, 2021). Acorn has also set up a buffer pool of 15% of its issued CRUs from which Acorn can source buffer carbon removal units (BCRU) in the case of "*unexpected, premature release of carbon stock*" (Acorn, n.d.-b). At the time of this research, this buffer pool consists of 47,091 BCRUs, which solely exists to replace sold CRUs and to "guarantee a buyer that their CRUs are always nature-based and ex-post" (Acorn, n.d.-f, 2021).

5.2.3 Monitoring, Verification, and Reporting

According to Acorn, their validation and verification framework "Acorn Framework for Voluntary, Ex-Post, Agroforestry Carbon Removal Units" is "*tailormade for small-scale agroforestry farmers*" (P2). While other standards like Verra or the Gold Standard include many categories of projects, the Acorn framework solely focuses on agroforestry and the specifics of smallholder farmers (P2; P3). To ensure third-party verification, PlanVivo assessed and approved the framework (PlanVivo,

2021). Acorn has defined a validation and verification (VV) Cycle, which is shown in Figure 11 and will be described in the following.

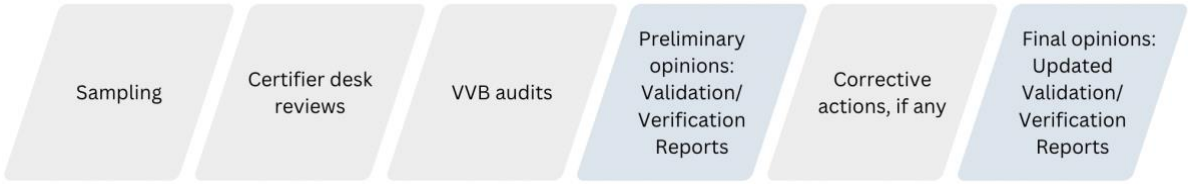

Figure 11. *Simplified depiction of the VV Cycle*

Note. Adapted from Acorn (2024)

Acorn uses a sample approach to their VV Cycle: "*To confirm the veracity of the projects and the Acorn program as a whole, Acorn continuously undergoes a Validation and Verification Cycle. In this process a representative sample of projects is selected for review based on the sampling approach*" (P4).

Accordingly, projects are selected annually to go through the VV Cycle: "*We also now use this sampling strategy. Every year we run the scenario to see which and how many projects are selected for validation and verification*" (P2). During sampling, projects are grouped into clusters according to characteristics such as country size and location. A random selection is then made, favoring projects with higher risks. When a project is selected as a sample, it goes through the VV Cycle (Acorn, 2021). Projects that are not yet validated and already issued CRUs are validated and verified. Validated projects that issue or have issued CRUs are only verified. Validated projects that have been extended to a new ecoregion are validated in the new region and, if CRUs are issued there, verified (Acorn, 2021, 2024). In contrast to other standards, whose projects must be validated and verified before selling VCCs, Acorn's projects can already create CRUs through Acorn's certification step (P2). According to Acorn, this is possible because Acorn's projects are all "*identical to one another because they all follow the same methodology*" (P1). Acorn bears the costs for validation and verification: "*We do a sampling base, validation, and verification based on the sampling strategy because we also bear the validation*

and verification cost. If you want farmers to bear that, they're never going to receive any accrued revenue" (P2).

First, PlanVivo performs a desk review (P4). They are then forwarded to independent VVBs for validation and/or verification, who conduct desk reviews and on-site audits. The VVBs assess the accuracy, completeness, quality, and authenticity of the project documentation and report on conformance or non-conformance to the Acorn framework requirements. Following corrective action and re-verification by the VVB, a final opinion is issued and the VV cycle is completed (Acorn, 2021, 2024). If non-conformities are identified in several cases, the entire portfolio is subjected to an audit: "*And if we identify similar issues, appears amongst several projects, then we do like a whole check among all the portfolio*" (P2).

5.2.4 Pricing, Trading and Retirement

Acorn uses a specific approach for pricing its CRUs which Acorn considers as a "*very clear and transparent benefit-sharing mechanism*" (P1). One important pillar of this pricing approach is the minimum price of twenty euros for one CRU (Acorn, n.d.-c). In doing so, Acorn is trying to move away from competing with competitors for the lowest price of a CRU. The program recognizes that ultimately, it is the farmers who bear the consequences of low prices: "*Because if you offer at the lower price who will be sacrificing the end: it's the farmers, because they get less*" (P2).

Acorn has established a transparent model for income distribution that ensures that 80% of income from the sale of a CRU is distributed directly to the farmers, 10% to its local partners, and 10% to Acorn itself to cover operational costs (P1). This 80:10:10 distribution is supposed to ensure that the benefits of participating in the VCM reach the smallholder farmers. The program rigorously tries to maintain this revenue distribution: "*It is also very hard to maintain this percentage looking at the costs of the program, but that is something we are all working on to keep, to safeguard this division of share value distribution in the supply chain*." (P3)

Currently, Acorn is trading their CRUs via bilateral contracts with their buyers. According to PlanVivo "*handling sales instead of direct project sales significantly enhances value, leading to higher*

prices and greater benefits for the community" (P4). However, Acorn is considering moving back to an auction system, which the program has used before. But "*this auction requires also more liquidity in the market […] to make this really successful*" (P1). Microsoft can be identified as the biggest buyer of Acorns CRUs with a total amount of 462,000 CRUs (retrieved on June 5, 2024) (Acorn, n.d.-f), which can be seen in Acorn's registry, in which all CRUs ever issued under the program are registered (PlanVivo, 2024b). Here, specific information about the CRU can be derived, such as the buyer, the date of issuance, the retirement date, the local partner, etc. (Acorn, n.d.-f). Information is disclosed about "*when, where and by whom the carbon is being sequestered and […] for every carbon removal unit, you can see how this has been developed*" (P1).

5.3 Evaluation

In the following section, the evaluative criteria (Table 1, p. 27) derived from the literature review will be operationalized to assess how Acorn addresses the VCM's integrity and the quality of VCCs, identifying the market mechanisms involved in this process.

5.3.1 Environmental Integrity of VCCs

In the case of Acorn, the proof of **additionality** happens in the project development phase:

> *To begin with a project undergoes an Eligibility Assessment to determine if a project is suitable for Acorn and meets the requirements set out in the Acorn Framework by assessing the project design (in terms of additionality). This is done by the Acorn Certification Team as well as Plan Vivo Secretariat.* (P4)

This has been heavily criticized by a recent article by "Follow the Money", an investigative journalism platform (Joosten & Gijzel, 2024). The article calls Acorn's sample approach "*highly unusual for the Voluntary Carbon Market*" and suggests more external, third-party verification (Joosten & Gijzel, 2024). Acorn recognizes that they are approaching their VV cycle differently to other standards: "*For Acorn, we have a slightly different approach than the majority of the carbon standards*" (P2). For Acorn,

the CRUs can be sold without third-party verification of a VVB, only relying on the certification of PlanVivo. Acorn recognizes that there is "*room for improvement*" (P1) regarding their certification and VV sample approach, because "*it also has proven it didn't catch on*" (P1).

However, the certification and sampling approach is an important measure to the program's mission to close the financing gap for smallholder farmers and reduce their vulnerability to climate change. Acorn closes this funding gap by, for example, covering the costs of validation and verification so that smallholders can also benefit from the advantages of the VCM (P2). However, this poses an additional challenge for Acorn, as it must cover costs that other project developers do not while maintaining the revenue distribution, which is "*very hard to maintain […] looking at the costs of the program*" (P3). The sampling approach and monitoring with satellite data are part of the efforts to retain the quite unusually high revenue distribution in the project (P1).

Acorn addresses **leakage** by implementing measures to monitor and mitigate the displacement of emissions to areas outside the project boundaries. The use of LiDAR and satellite data helps in tracking changes in biomass and detecting any shifts in carbon stocks (Acorn, n.d.-i). Therefore, Acorn "*deems it reasonable to assume that the risk of leakage in its projects is negligible to non-existent*" (Acorn, 2021). Nevertheless, the risk of leakage for Acorn also depends on the location of the project (P3). A factor that poses a risk to Acorn is that "*permanency with agroforestry […] is not necessarily the highest*" (P3). To respond to this challenge with agroforestry, Acorn approaches **permanence** in setting up their buffer pool of BCRUs. It has to be noted that BCRUs have been used since the project initiation in 2020, speaking for the permanence of Acorns CRUs (Acorn, n.d.-f).

The issue of **double counting** has recently become a significant concern for Acorn's CRUs. In April 2024, Acorn faced accusations of double counting 120,000 CRUs within their largest project in the Ivory Coast (Carbon Pulse, n.d.; Joosten & Gijzel, 2024). This incident has placed the project on hold (Acorn, n.d.-e). The Ivorian Government has called Acorn to withdraw their CRUs from the VCM since they are "*state property and already contracted to another party*" (Carbon Pulse, 2024). Given that 120,000 CRUs exceed the available buffer pool, this poses a significant challenge for Acorn. Acorn argues:

> *We started in 2021 the project in Cote d'Ivoire. At the time, we were not aware of any other overlapping projects. Our VVB argued in the first half of 2022 that there was no overlap on other projects. […] Also, all the farmers have been asked and all of the farmers argued they were not part of another program. […] At the end of 2023, in July 2023, we got information about the decree stating that all emission reductions are part of the government. Operationally, we argue we do not overlap.* (P1)

Again, there is an emphasis on the project design of Acorns projects, as they ask for the participation in other projects of their farmers in this phase: "*We do ask clearly if they are part of another initiative or program*" (P3). However, this is not externally validated by a VVB before the project becomes a sample in the VV Cycle. Acorn is still in debates with the Ivorian Government and has recognized dealing with different governments as one of their most important challenges: "*The relevance to liaise with governments is also something that we already identified as a risk*" (P1). The program must deal with many different governments: "*Not every government is very friendly […] they have different approaches and then we have to tackle differently because they are not united*" (P2).

5.3.2 Socio-Economic Impact of VCCs

Acorn's "*strongest characteristic of this program compared to its competitors is the co-benefits*" (P3). Acorn's selling points to "*external parties of what makes Acorn different from other programming standards is […] the benefit-sharing mechanism*" (P2), meaning the 80:10:10 revenue distribution rule of Acorn. Acorn emphasizes that their core objective is not the creation of CRUs, but "*develop[ing] an agricultural system that's more sustainable while supporting farmers or protecting them from climate change by fueling money from the Global North to the Global South*" (P1). Therefore, Acorn recognizes financing to farmers as essential: "*The first income comes two years plus down the line so for both local partners implementing and for the farmers themselves. With the lack of grants or other financing you need pre-financing to start the activities*" (P3).

Besides supporting the financial stability of their farmers, Acorn also asks the local partners to choose from "*several additional indicators they can freely choose from, at least one*" (P2). These indicators are for example "gender equality" or "youth empowerment" (P2), which the project has to improve during its operations. The "*end goal is that farmer can be self-sustainable even without Acorn many years from now*" (P2), highlighting Acorn's commitment to empowering smallholder farmers. This is often not the case in other programs: "*And there are carbon projects, unfortunately, that engage farmers without their knowledge or very minimal knowledge or very, very minimal benefit from being part of a carbon scheme or program*" (P3). However, risk management regarding the social and environmental co-benefits is not easy to implement and monitor (P2). Therefore, Acorn is developing a risk monitoring system: "*That's what we are working on right now as well, like to develop this risk monitoring system to really see not only for the carbon reversal risk but also the environmental and social risks*" (P2).

5.3.3 Fragmentation of the VCM

Instead of adopting the most prevalent, established standards, Acorn has developed its own framework and methodology, thereby introducing an additional standard to the VCM. However, Acorn argues that no standard in the VCM landscape can be applied to the case of agroforestry and small-holder farmers: "*Because I think when Acorn was founded like three or four years ago, they were trying to find first which standards are the most suitable for smallholder farmers, and we found none*" (P3). Because of the diverse projects within the VCM, it is hard to find a common standard that defines what makes a high-quality VCC: "*It will never work with a high level of heterogeneity, the high diversity of those credits in the VCM*" (P1). Acorn recognizes that this heterogeneity will also increase when not only Acorn, but the whole VCM grows: "*So the market is really growing, not just Acorn, the whole VCM is like exploding, growing, and then like maintaining quality is like a really important issue*" (P2). One interviewee pointed out, that the European Union (EU) is trying to establish a standard by 2028 for all VCCs generated in the EU. However, "*there's still a lot of ambiguity*" (P2) within the to-be-developed standard by the EU and it's not close to being applicable.

Acorn also registers their CRUs under their own registry. However, all interviewees underlined that the lack of a meta-registry is one of the biggest challenges and Acorn is willing to participate in such a registry:

> *But what is definitely needed is a more or one uniform meta registry where all at least land-based projects are being displayed. We have our all our polygons publicly available - I'm happy to share them with everyone. If you all put them on one map and […] Verra, PlanVivo, and all registries join, then you can see the polygons and if it's a land-based polygon. (P1)*

> *So there is no overarching registry saying who is claiming the polygon and where it is. This is also the biggest issue. (P2)*

> *Some countries have registries. Most countries do not have registries. We need to investigate at the beginning of a program what other initiatives, buyers and programs are there before starting, and then keep updating that regularly. (P3)*

5.3.5 Transparency in the VCM

One of the core principles of the Acorn program is transparency in the VCM: "*We really want the whole process to be transparent. By making the benefit-sharing mechanism transparent and communicating clearly to the stakeholders […] and then trying to promote other standards to do so as well"* (P2).

While the benefit-sharing mechanism is one of the most important factors, "*another point on transparency is about the pricing*" (P2). In the VCM, "*unless they are willing to disclose the price, you can only gather like a fraction of information*" (P2) about the pricing of VCCs. Acorn's approach of setting a minimum price of twenty euros also contributes to the transparency of the program: "*That also adds on to the why we see ourselves as integer, we […] also want to set the minimum price of 20*

euros" (P2). This, also paired with the disclosed information on the registry, enhances the decision-making abilities of the buyers of CRUs: "*It's the transparency in general, when, where and by whom the carbon is being sequestered and creating the transparency to the level of a buyer*" (P1). The transparency on the Acorn website is enabled by the data-driven approach of the CRUs, which enables Acorn to disclose detailed information about each CRU (P1).

5.3.6 Claims of Buyers

To further follow their core mission of supporting and "*empowering smallholder farmers and fighting climate change*" (Acorn, n.d.-b), Acorn also wants to ensure that buyers, which must be businesses and not individuals, also contribute to this mission. Therefore, Acorn requires them to "*not just buy a few carbon credits and tick a box*" (Acorn, n.d.-b). The buyers are not to be businesses from the fossil fuel industry, must be committed to a science-based target (SBTi), the Net Zero Banking Alliance or must prove another strategy to reduce their GHG emissions (Acorn, n.d.-b). At the same time, Acorn's buyers seem to hold Acorn accountable when doubts about the program arise, as seen in the case of the Ivory Coast: "*Because of that outbreak we also have a lot of external pressure from buyers and issues to deal with*" (P2).

5.4 Summary of Results

The Acorn program is an innovative approach to empowering smallholder farmers through participation in the VCM. Despite its efforts to produce high-quality CRUs and act as a best practice to increase the integrity of the VCM, Acorn either recognizes or faces significant challenges related to VCC quality and VCM integrity, as illustrated in Figure 12.

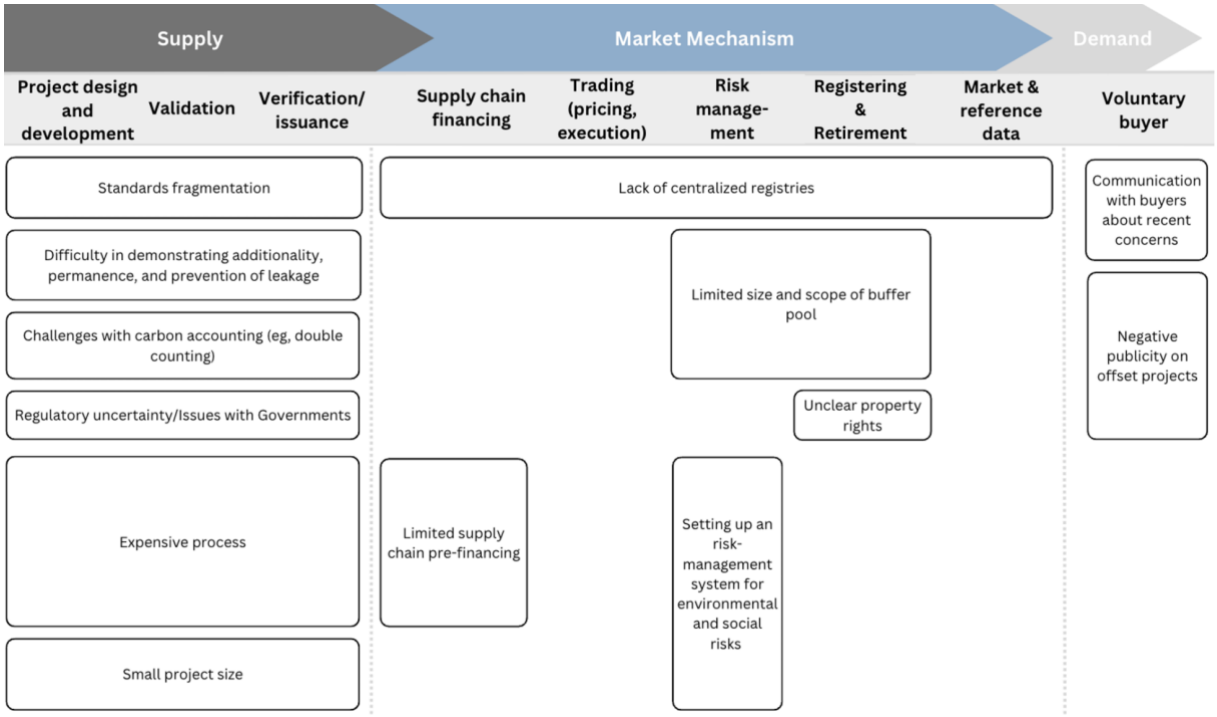

Figure 12. *Challenges for the quality of VCCs and VCM integrity according to the Acorn case study*

Note. Adapted from TSVCM (2021)

To ensure the quality of their CRUs, Acorn adopts a different approach compared to other programs. Acorns CRUs can be sold without the external validation and verification of VVBs, relying instead on an additional certification step in their project design. Factors such as additionality, permanence, and leakage are certified in the eligibility test. Third-party validation and verification are performed only when a project is chosen for its VV cycle. This has been criticized by recent articles, highlighting the lack of third-party involvement in the project.

However, Acorn uses this approach to ensure the co-benefits they provide, which are the core of the program's projects. Not only does Acorn share a significant amount of the revenues from their CRUs with farmers, but it also covers the validation and verification costs to lower the entrance barriers to the VCM. This approach is aimed at maintaining their benefit-sharing mechanism of 80:10:10. Acorn's project design is built for smallholder farmers and agroforestry. Therefore, the program is using its framework, further contributing to the high amount of quality standards in the VCM. However, this is due to their specific project design and is, according to Acorn, unavoidable. Another challenge to Acorn's CRU quality and VCM integrity is that regulatory conditions vary by country. Acorn's ongoing

conflict in the Ivory Coast over double-counting allegations highlights the complexity of this issue. Despite asking farmers about their participation in other projects during the project initiation phase, Acorn has faced scrutiny. To improve, Acorn could benefit from increased third-party involvement and refining the sampling approach of the VV cycle.

According to Acorn, the quality of the CRUs is enhanced by the closing of the large financing gap regarding smallholder farmers through Acorn's pre-financing. By setting a minimum price to ensure the income of their smallholder farmers, the program tries to ensure a fair-trading process. While Acorn settles its CRUs in its internal project registry, Acorn also suffers from the great lack of a central registry and emphasizes that this lack of transparency in the retirement process represents a crucial issue in the VCM. The current problems with its project in the Ivory Coast can also be traced back to the non-transparent retirement process in the VCM and the resulting questions about the property rights of the CRUs of Acorn. In addition to registering and retiring CRUs, risk management therefore plays an important role. Acorn’s risk management includes setting up a CRUs buffer pool, yet this might be insufficient depending on the size of to-be-replaced CRUs, as evidenced by issues in the Ivory Coast. Additionally, Acorn recognizes significant environmental and social risks, which are hard to monitor due to spatial distances between project developers and farmers.

Acorn stresses the importance of transparent market data for the integrity of the VCM. The program aims to make revenue distribution, pricing strategies, and project lifecycle details of its CRUs publicly accessible and wants to promote these practices in the VCM. The program also insists that only companies with targeted GHG emission reduction strategies can purchase CRUs, thereby attempting to increase the market's integrity.

6 Discussion

This chapter integrates the findings from the empirical section with those from the literature review. By contextualizing the empirical research results within the literature review, conclusions to the four sub-research questions will be drawn. Additionally, this chapter discusses the relevance and implications of the results.

6.1 Sub-Research Question 1

What are the main actors and mechanisms within the VCM?

The results of this thesis reveal that the VCM is a complex interplay of different actors. Generally, the main actors in the VCM can be categorized into three pillars: suppliers, service providers, and service users. The literature shows a clear distinction between the different roles of the actors that fall under these categories (Ahonen et al., 2022; Battocletti et al., 2023; S. Chen et al., 2021). However, the Acorn case study conducted shows that there can be variations, nuances, and actors taking on multiple, ambiguous roles. The results showed that Acorn simultaneously acts as a project developer, standard setter, and monitoring body. Consequently, the three pillars of actors should be viewed as guidelines, recognizing that, in practice, there are often hybrid roles depending on the project's setup. Based on the results of this research, a similar observation can be made for the definition of market mechanisms in the VCM. Figure 14 illustrates the fundamental structure of VCM market mechanisms as derived from the literature.

Figure 13. *Market mechanisms in the VCM*

Note. Adapted from TSVCM (2021)

The market mechanisms defined in this thesis provide a comprehensive overview of the VCM. However, the Acorn case study highlights the variability and flexibility within the VCM, suggesting that the above-defined mechanisms cannot be uniformly applied to VCM practice. For example, the Acorn program developed its own certification mechanism, which deviates from standard market procedures for validation and verification. This underscores the complexity and unregulated nature of the VCM, where practical implementations can vary from theoretical insights in academic literature. While the

literature provides a theoretical foundation for understanding typical VCM players and mechanisms, real-world scenarios are more context-dependent.

6.2 Sub-Research Question 2

What are the most apparent challenges in the current VCM?

The results of this thesis show that the VCM is currently facing significant challenges. Following a decline in traded VCC volume in 2022, 2023 was marked by numerous scandals and public controversies, which puts the VCM now at a crossroads. According to the literature, the VCM has the potential to make a significant contribution to closing the existing climate finance gap (WEF, 2023). However, to substantiate its claim to close the climate finance gap, the VCM would have to grow significantly. Recent scrutiny of the VCM, which has been illustrated in the literature review, has underscored core issues related to VCM integrity and the quality of VCCs, which lead to hesitation and decreased demand from buyers. The ICVCM therefore argues that if the VCM increases its integrity, the scale will follow (ICVCM, 2024). However, the Acorn case study revealed that efforts to scale up the market and enhance its integrity can sometimes be contradictory. As the market expands, its complexity increases, making it more challenging to uphold high standards of quality and integrity.

This paradox presents a significant dilemma for the VCM. On the one hand, scaling up is essential for the VCM to make a meaningful impact on climate finance. On the other hand, the increased complexity that accompanies growth could worsen already existing issues of quality and integrity. This research highlights the critical need to balance the maintenance of VCM integrity and the quality of VCCs with the demands of market growth.

6.3 Sub-Research Question 3

What mechanisms influence the quality of VCCs and the integrity of the market?

Given the importance of maintaining the integrity of the VCM and ensuring the quality of VCCs, it becomes evident how crucial it is to comprehend the market's functioning and the mechanisms that specifically affect these two pillars. Figure 14 summarizes the results of the literature review and the Acorn case study. Again, the figure by the TSVCM is used to link the relevant challenges to the

respective market mechanisms in the VCM. The **blue** boxes represent the challenges identified in the literature review, the **red** boxes highlight the challenges revealed in the Acorn case study, and the **green** boxes indicate the challenges that were evident in both parts of this research.

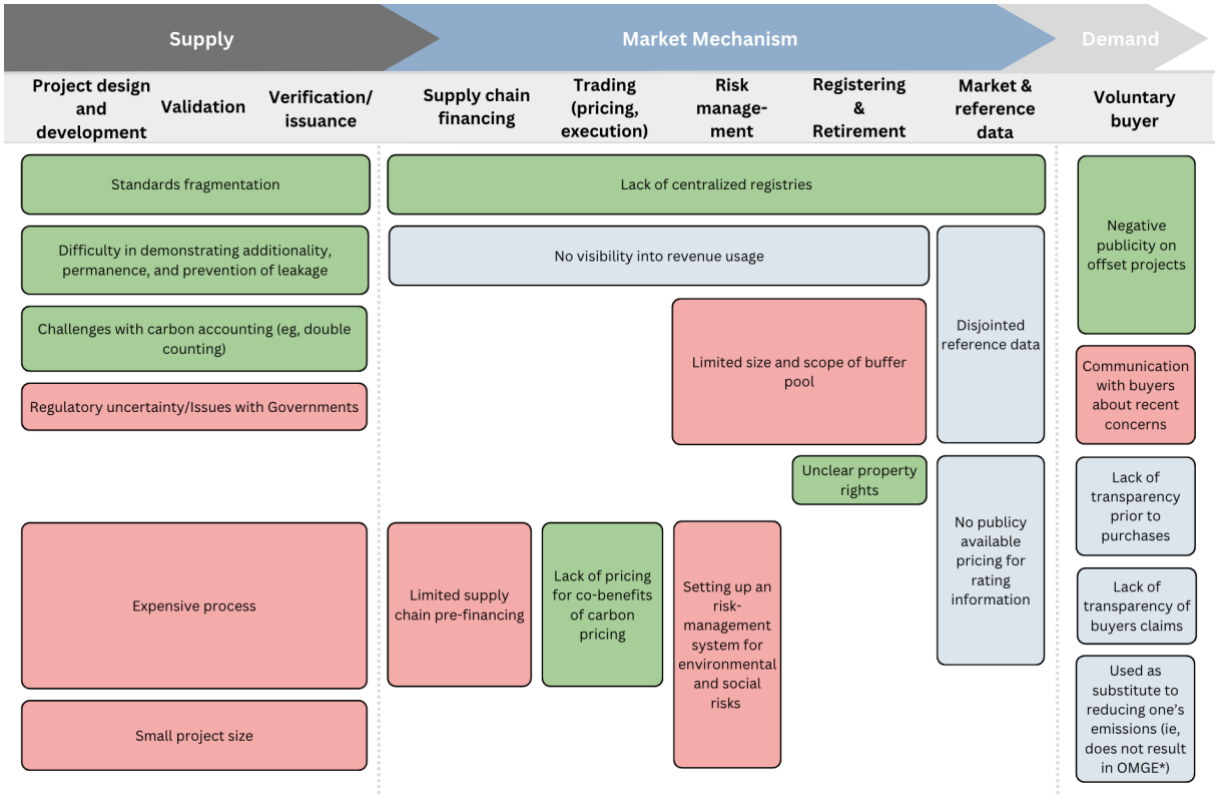

Figure 14. *Market mechanisms relevant to VCM Integrity and VCC Quality according to the literature review and Acorn case study*

Note. Adapted from TSVCM (2021)

The literature review and case study both highlighted the crucial role of the **validation** and **verification** mechanism in ensuring the quality of VCCs. These two mechanisms are essential for assessing factors like additionality, permanence, and leakage. However, significant challenges persist in the VCM regarding the establishment of a uniform standard for what constitutes a high-quality VCC. The Acorn case study also highlighted that the processes of validation and verification can be expensive, especially for projects in their early stages, which may hinder the participation of smaller entities, such as smallholder farmers, in the VCM. While an alternative approach, such as Acorn's certification mechanism, can reduce these costs, the problems in terms of ensuring the quality of the project's VCCs

remain. This emphasizes the importance of market mechanisms such as validation and verification to ensure third-party assurance of the VCCs' quality. Furthermore, the case study highlights that project development and design can affect the quality of VCCs. In the case of Acorn, engaging with governments in the project countries before the project implementation proved to be important. Insufficient interaction with governments can lead to quality issues such as double counting.

The Acorn case study also emphasized the significant relevance of **financing** in the supply chain of projects, which, among other things, can also serve as a quality and integrity feature of a project by lowering the barriers to entry into the VCM for groups that are denied access due to a lack of financial resources. While this aspect was shown in the case study, it was less highlighted in the literature, suggesting an area for further exploration. The Acorn case study also demonstrated the importance of **trade mechanisms**, especially when working with smallholder farmers. Acorn identified minimum pricing and the transparent benefit-sharing mechanism as opportunities to act as best practice, inspire other projects and thus increase VCM integrity. The interviews highlighted the need for clearer and more consistent pricing mechanisms to ensure fair compensation and market stability. Addressing these pricing challenges could significantly enhance the overall effectiveness and trustworthiness of the VCM.

Furthermore, the Acorn case study highlighted that a **risk management mechanism** is essential, especially for project developers in the Global South. This should not only take into account carbon risks but also environmental and social risks, which supports the overall observations from the literature review, indicating that there is an increasing focus on social responsibility within the VCM.

The **registering and retirement** mechanism proved to be particularly relevant for VCC quality and VCM integrity. This was emphasized both in the case study and in the literature review. The lack of a centralized register not only complicates project set-up due to a lack of information on existing projects in the region but can even lead to double counting, as in the case of Acorn. The fragmentation of the registries and the resulting lack of centralized information also points to the lack of **market** and **reference data** in the VCM. Improving VCM integrity is highly dependent on the availability of this data. While Acorn is trying to improve this situation through transparent communication, there is still a

considerable lack of information in the VCM. As a result, the VCM is perceived as lacking transparency by market participants and external parties.

The results indicate that the **demand side** is a critical market mechanism for the integrity of the VCM. Buyers not only influence the demand for VCCs but also impact overall market stability and trustworthiness. The Acorn case study highlighted the potential for projects to implement measures that ensure buyers utilize VCCs appropriately. This underscores the importance of effective communication and transparency between project developers and buyers to maintain confidence and integrity in the market.

6.4 Sub-Research Question 4

How can the existing mechanisms be used and improved to ensure the quality of VCCs and the integrity of the VCM?

The findings of this thesis indicate that to guarantee the integrity of the VCM and the quality of its VCCs, it is important to reduce the fragmentation of the VCM. In particular, the establishment of a central registry for all existing carbon projects would significantly reduce the risk of double counting. Moreover, the implementation of uniform quality standards would enhance the quality of the VCCs and the integrity of the VCM (Bai et al., 2023; Blaufelder et al., 2021; Schneider et al., 2017). Nevertheless, the case study indicates that due to the heterogeneity of projects in the market, implementing standardized quality standards may be a challenging, possibly not feasible option.

Many issues related to the different mechanisms and the resulting problems of VCC quality and VCM integrity stem from transparency shortcomings. A transparent market not only enhances the confidence of market participants but also facilitates the traceability and quality assurance of VCCs. In conclusion, both the literature and the case study underscore the need for increased transparency in all market mechanisms to improve the quality of VCCs and the integrity of the VCM (Battocletti et al., 2023; Healy et al., 2023; Ponce de León Baridó et al., 2023). However, achieving transparency is a significant challenge. The VCM involves numerous stakeholders with different and sometimes conflicting interests, while the lack of a central governing body further complicates efforts to

standardize procedures and ensure transparency. Consequently, following this research which emphasized the heterogeneity of the VCM, there is a need for joint efforts from various VCM participants to embed transparency across all market mechanisms.

7 Conclusion

7.1 Recap of the thesis

This thesis aimed to provide a comprehensive analysis of the integrity of the VCM and the quality of VCCs by examining the market mechanisms that influence these factors. Initially, an understanding of the development of the VCM and its current role in climate finance was established. To deepen this understanding, key actors and mechanisms within the market were examined (SQ1). In order to identify what currently hinders the VCM from enhancing its role in climate financing, the challenges of the quality of VCCs and VCM integrity were introduced (SQ2). The thesis aimed to understand how market mechanisms influence VCM integrity and quality of VCCS by analyzing both theoretical perspectives from academic literature and practical insights from a case study (SQ3).

Both the literature review and the case study revealed deep-rooted challenges within the VCM's mechanisms and areas for improvement (SQ4). The analysis provided by this thesis underscores the important role that market mechanisms play in ensuring the integrity of the VCM and the quality of VCCs. Market mechanisms serve as the functional elements that govern the VCM. They encompass a wide range of activities, from project design and development, validation, and verification, to supply chain financing, trading, risk management, and the registration and retirement of VVCs. While the initial goal of this thesis was to pinpoint which market mechanisms have the most impact on the quality of VCCs and the integrity of the VCM, the case study showed that this is highly context-dependent. In the case of Acorn, there is an increased focus on project development, their VV cycle and certification, supply chain financing, risk management, and registering to ensure CRU quality and the project's contribution to the integrity of the VCM. However, this emphasis might differ in other types of projects, indicating the need for a nuanced approach to evaluating market mechanisms. The research revealed

that while existing literature acknowledges the heterogeneity of the VCM, it has not yet addressed it in depth. By comparing market mechanisms from an academic perspective and an example from practice, this study highlighted the discrepancies between theoretical frameworks and real-world applications in the VCM. Overall, the thesis provides a holistic perspective on the role of VCM mechanisms in upholding VCC quality and VCM integrity (RQ).

As the introductory quote of this thesis pointed out, the window of climate action and mitigation is closing (IPCC, 2022). Therefore, the VCM has to address the challenges pointed out by this research now, so it can leverage its full potential of the VCM to global climate goals within the given timeframe. Immediate and decisive action is essential to ensure that the VCM can play its role in achieving a sustainable and livable future for all.

7.2 Recommendations for Actors in the VCM

Based on the results of this thesis, recommendations for improving the VCM integrity and the quality of VCCs can be given. It was highlighted that the lack of a centralized registry for all carbon projects significantly increases the risk of double counting. Therefore, implementing a centralized registry would enhance the transparency within the VCM. Furthermore, it would enhance the VCM's efficiency by providing accessible information on existing projects. Apart from registry data, overall market data transparency is crucial for rebuilding trust among market participants and the public, as it enables stakeholders to make informed decisions.

Because of the unregulated nature of the VCM, reducing fragmentation and enhancing data transparency relies on collaboration among the actors of the VCM. Therefore, to address the VCM's heterogeneity, there is a need for joint initiatives among different VCM participants to enhance transparency across all market mechanisms. By sharing information and best practices from various projects, participants can build a more transparent VCM. As the VCM and its projects are currently in an upscaling phase, challenges are inevitable. What counts is how the market and its participants respond to these challenges, understand their severity, and address them. Only through such proactive and adaptive approaches can the VCM fulfill its role effectively.

Further, the case study showed that the VCM can promote more benefits than only climate mitigation. In the case of Acorn, the VCM was used as a means to close a financing gap for smallholder farmers. Instead of focusing solely on the financial benefits, Acorn aims to use the VCM to further empower smallholder farmers through education and by promoting factors such as youth empowerment and gender equality. As the demand for VCCs with such co-benefits increases, all market participants should recognize that the VCM is not only about climate mitigation but can and should be seen as a comprehensive tool for sustainable development.

7.3 Limitations of the Research

In the following, several limitations of this thesis have to be acknowledged. While the combination of interviews and content analysis provided sufficient data to answer the research questions, conducting more interviews could have offered a deeper perspective on the Acorn program. Additionally, the case study focused specifically on agroforestry practices and smallholder farmers. While this narrow scope may limit the direct generalizability of the findings within the VCM, it does not make the results entirely inapplicable to other contexts. Although other projects may face unique challenges, the main insights regarding the market mechanisms are broadly relevant across different types of VCM projects. Therefore, while these findings should be applied with caution to other contexts, the underlying principles and identified market mechanisms in this research can provide valuable guidance for a wide range of VCM scenarios.

7.4 Recommendations for Future Research

Future research should focus on investigating the effectiveness of different market mechanisms in various contexts, which will provide deeper insights into how to ensure VCC quality and improve VCM integrity. The findings of this thesis highlight the need for a context-sensitive approach to evaluating the market mechanisms. One particularly promising area for future research is a comparative analysis of market mechanisms across different VCM contexts to help identify best practices and tailor strategies to specific project types and regional conditions.

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9 Appendices

Appendix A

Overview Interview Participants

Organization	Interviewees
Acorn	P1, P2
Solidaridad Network	P3
PlanVivo Foundation	P4

Appendix B

Interview Questions Guide

On Acorn

1. Could you explain the role Acorn takes within the VCM ecosystem?

Let us focus on the VCM

1. Is integrity an issue for the VCM? (Please explain)
2. What are the biggest challenges of the VCM in the nearby future concerning integrity? (Please explain)
3. Do you think Acorn contributes to integrity of the carbon market? If so, in what way?

Let us now focus on the VCC

1. Is quality an issue for VCCs? (please explain)
2. Are Acorns VCCs (CRUs) of high quality? If so, why and according to whom?
3. What sets Acorn CRUs apart from other CRUs in terms of quality?
4. What mechanisms of the VCM influence the quality of the VCC the most? (please explain)
5. What are the co-benefits of Acorns CRUs?

6. Can you explain how Acorn approaches pricing for its CRUs?
7. I would also like to ask you about the recent concerns that have been raised about the quality of the CRUs of Acorn in a project in the Ivory Coast. Could you explain the situation youre perspective?
    a. Can you explain what needs to change to avoid situations like this in the future?
8. What are the biggest challenges for Acorn in the nearby future? (Please explain)

Final part

1. Do you want to mention any issues that could contribute to my understanding of the VCM and VCCs?
2. Do you have suggestions for further reading/studying about this topic?

Additional questions for other interviewees:

1. How is your organization related to Acorn?
2. Do you think your cooperation with Acorn contributes to the integrity of the VCM? (Please explain)

Appendix C

Inductive Coding – Interviews

Theme	Sub-theme	Code	Text Fragment	Description
Acorn	Role in the VCM		*"The role of acorn is a bit ambiguous because you could argue ACORN is a project developer but on the other*	Acorn takes on an ambiguous role in the VCM.

			hand we do not execute the projects on the ground." P1	
	Conflicts of Interest		*„So also makes it sometimes difficult whether there's no another conflict of interest if you calculate it yourself how clean is that if you also sell it on the other end." P1*	Conflicts of interest can stem from the ambiguous role of Acorn.
	Strategic objectives	Smallholder empowerement	*„Our first and foremost drive is to support those problems in this transition to sustainable farming and more explicitly agroforestry." P1*	Acorns ambition is to empower smallholder farmers by adopting agroforestry practices.
		Closing financing gap	*"As a bank this is core to our DNA but it always have been difficult to finance those farmers." P1*	Acorn is an initiative from the Dutch Bank Rabobank.
Additionality	Barriers to Additionality	Issues with Governments	*„If a government once says no then you don't have the regulatory surplus you don't have the additionality at all." P2*	Issues with Governments can hinder additionality.

		Case-by-case Additionality Assessment	*„On the additionality I think it is it is also difficult case by case decision." P3*	Additionality needs to be assessed case by case.
	Additionality and Financing		*"I can say one thing that that wouldn't have happened without Acorn is the mobilizing of the financing to allow for this program to stay and grow and to buy the trees." P3*	Additionality in Acorn projects also stem from the financing, which wouldn't have reached smallholders without Acorn.
	Baseline Determination		*"Because it's very niche and then a lot of methodology in the market, when they're calculating this baseline scenario they don't take into account smallholder farmers." P2*	Baseline Determination of other standards don't take into account the specific of smallholder farmers.
Scrutiny in the VCM	Concerns about Ivory Coast Project	Attitude towards the issue	*"You cannot deny that there is a critical look on the developments in this market. But I also do think in some cases it's unfair." P1*	The interviewer thinks that in some cases the critique on the VCM is unfair.

	Recent Scandals	Attitude about Scrutiny	*"I guess it's good because people are really looking into scrutiny that put it that way and then improving every standards. But the bad side is like yes you can of course, we are business we can pause for a while but what about the farmers if you cannot generate any credits right now." P2*	The interviewee thinks that scrutiny is important to improve the VCM, but pausing the project will affect the farmers.
		Lack of problem solving	*"When the scandal appears in the registry just deregistered them and then walk away from the project they are not trying to solve the problems." P2*	When scandals appear, register just deregister the projects without solving the actual problem.
EU Regulation	Objectives of the Regulation	Ensuring quality	*"To at least ensure the quality within EU first." P2*	There is a EU regulation being developed which is supposed to ensure the quality in the regulatory scope of the EU.
		Time pressure	*"They realize if they continue doing like the phase they are*	The EU tries to establish the

			doing right now, the pace, they're never going to reach the 2050 net zero goal." P2	standard to use the VCM as a tool to reach sustainability goals.
	Issues with the Regulation		*"There's still a lot of ambiguity." P2*	The standard still needs clarification.
Supply side mechanisms	Certification		*"So certification, what we do is when the project come and then write in the document, we as the certification team do a first internal review. P2*	Acorns certification teams performs an internal review before handing it on to PlanVivo.
		Time Advantage	*"If you want to fill in and then take them six months to one year to assess, to review. And that's not really doable for our target audience." P2*	Acorn uses the certification method so the process of registering a project happens faster
	Project development	Responsibilities	*"So we do the first part of first first mile let's say and they we link up for the second mile." P3*	The local partners are responsible for the first steps of project initiation.
	Validation on Verification	Cost bearing	*"Because we also bear the validation and verification*	Acorn bears the VV costs, so the

			cost. If you want farmers to bear that, they're never going to receive any accrued revenue." P2	farmers don't have to.
		Acorn Framework	*"I think initially ACORN was founded like three or four years ago, they were trying to find first which standards are the most suitable for smallholder farmers." P2*	Acorn needed to introduce their own standard since there was no fitting standard available.
		Sampling approach	*"So because of that, we also now using this sampling strategy, every year we run the scenario to see which, how many projects are selected for validation and verification." P2*	Acorn uses a sampling approach to validation and verification.
Fragmentation in the VCM	Standards		*"Each player, if you don't like that standard you can create your own and then issue your own credits on your own registry." P2*	There is no regulation to who and how VCCs are created and registered.
	Lack of Regulation		*„But that it's still voluntary so no one is mandatory forcing you to comply with their standards." P2*	There is no body forcing VCM actors to comply

			with a certain standard.
	Heterogeneity of Projects	*"But in the VCM, there are so many different projects. Whether it's a Cookstove project in India, an avoided deforestation project in Congo, or an agroforestry project in Ghana. That all can be of a good quality." P1*	There is a lot of heterogeneity in the VCM, which makes it hard to establish an applicable quality standard to all projects.
	Need for a meta-registry	*"But what I think would what is definitely needed is a more or one uniform, a meta registry." P1*	There is a need for a meta-registry.
Free-rider Effect	Free-rider effect	*"A free- rider effects that can be created because you plant the trees and other take the benefits this really can happen." P3*	In the VCM, there can be free-riders who take advantage of already existing projects.
Importance of Integrity in the VCM	Integrity when scaling up the VCM	*"Both for ensuring that what we do is impactful and also to ensure that we have a market in a few years, credibility and integrity have to be maintained." P3*	When wanting to ensure the future of the VCM, integrity and credibility have to be maintained.

Risk Monitoring	Need for carbon, environmental and social risk assessment		*"Developing this risk monitoring system to really see not only for the carbon reversal risk but also the environmental and social risks." P2*	Acorn is establishing a risk monitoring system incorporating carbon, social and environmental risks.
Market Data	Importance of Data Transparency		*"Data transparency poses significant challenges and addressing them is crucial for the market's integrity and growth." P4*	Lack of Data Transparency is one central challenges in the VCM.
	Promoting Data Transparency		*"Then to try to promote other standards to do so as well." P2*	Acorn wants to promote other standards to be more transparent.
Nature of a project	Agroforestry	Advantages of agroforestry	*"It does not affect the yield of the farmers but actually increase the quality of the product and in the medium term, the soil health and therefore the yield." P3*	Agroforestry is a good practice that has several advantages.
		Disadvantages of agroforestry	*"The first income only comes some two years down the line. So there has to be some trust and patience." P3*	When applying agroforestry, realizing the

				income takes time.
	Technological CRUs	Uncertainty with technological CRUs	*"And you test one thing and now you think you are safe if you're buying technological carbon removal units. But in two years from now, some of those companies will go bankrupt or the cost of energy will be too high." P1*	In the VCM, issues can always appear.
Partnerships	Solidaridad		*"Well, this is a very interesting partnership. I think there is a very good complementarity between our two organizations." P3*	The interviewee thinks Acorn and Solidaridad have a complementary relationship.
	PlanVivo		*"The relationship is based on a collaborative approach to project certification and the commitment to making the benefits of the carbon market accessible to smallholder farmers." P4*	The partnership is based on a common goal.
Demand Side Mechanism	Buyer motivation		*"What I recognize is that the benefit sharing mechanism is a key trigger for buyers." P3*	The benefit sharing mechanism is an important

				motivation of buyers for buying Acorns CRUs.
	Attitudes of Buyers regarding problems	Doubts	*"Some buyers are doubting." P2*	There are buyers which are hesitant about the recent concerns.
		Neutrality	*"And then microsoft they're neutral they said this they encounter with so many this kind of things like marketing things it's not the first time they have their own way to do it." P2*	Microsoft is more neutral about recent concerns.
Scaling Up the VCM	Issues with Scaling Up the VCM	Time pressure	*"They realize if they continue doing like the phase they are doing right now, the pace, they're never going to reach the 2050 net zero goal." P2*	The VCM needs to scale up fast so it can fulfill its potential for climate mitigation.
		Maintaining Quality	*"When we are scaling so fast how can you still maintain the high quality." P2*	If the VCM scales up, maintain integrity is difficult.
	Comparison to CDM		*"So the CDM mechanism following the Kyoto protocol that had a central body. The*	The interviewee compares the CDM with the

			question is okay can a central body be the solution to safeguard that integrity issue. If that's too straight, then you also see that projects that they cannot mature cannot learn so then the market also gets stuck." P1	VCM, which was hindered to the too strict requirements.
Co-Benefits	Benefit-sharing		*"We always say to external parties of what makes Acorn different from other programming standards is that we make the benefit sharing mechanism." P2*	The benefit sharing mechanisms is the most important co-benefit of the program.
	Supply Chain Financing		*„I would say especially important are the co benefits and additionality in terms of mobilizing finance especially for smallholder farms and climate mitigation." P3*	The mobilization of finance is an important factor for Acorn.
Trading	Need for transparent Practices	Trading	*"Either it is a cash distribution or it is a mobile payment and we are looking at creating also wallets virtual wallets." P3*	Acorn is aiming to improve the payment processes to the farmers.

		Pricing	*„For voluntary carbon market unless they are willing to disclose the price, then you can only gather like fraction of information." P2*	Information about pricing is limited in the VCM.
	Fair Pricing		*„Because if you have offer at the lower price who will be sacrificing the end: it's the farmers, because they get less." P2*	When lowering prices, farmers are the ones suffering the most.
	Transactions		*"We also do direct sales only because we don't want a middleman to participate." P1*	Acorn does OTC sales to avoid middleman.

Appendix D

Deductive Codes from Literature Analysis

Theme	**Sub-Theme**	**Code**	**Description**
Factors Constituting VCC Quality	Environmental Integrity	Additionality	Ensuring projects provide environmental benefits beyond what would have occurred without them.
		Leakage	Preventing the displacement of emissions to other areas.
		Permanence	Addressing the risk that carbon sequestration benefits may not be permanent.

		Double Counting	Avoiding the same VCC being counted more than once.
	Socio-Economic Factors	Co-Benefits	Amount of benefits created through a VCM projects besides the revenues from VVCs.
Factors influencing the Integrity oft the VCM	Fragmentation	Fragmentation of Registries	Lack of Integration between different registries, also one with the compliance market.
		Fragmentation of Standards	A multitude of standards exists, creating ambiguity about what constitutes a high-quality credit.
	Market Data	Insufficient Data and Information Disclosure	Lack of availability and transparency of data from VCM participants such as project developers or standards.
	Claims of Buyers	Transparency and Accuracy of Corporate Claims	Inaccuracy and lack of transparency of corporate sustainability claims.

Appendix E

Deductive Coding – Interviews

Theme	**Sub-theme**	**Code**	**Text Fragment**	**Description**
Quality of VCCs	Environmental Integrity	Additionality	*„To begin with a project undergoes an Eligibility Assessment to determine if a*	For Acorn, Additionality is determined

			project is suitable for Acorn and meets the requirements set out in the Acorn Framework by assessing the project design.“ P2	through its eligibility test
		Permanence	*„Permanency with agroforestry […] is not necessarily the highest.” P3*	For the practice of agroforestry, permanency is an important issue.
		Leakage Prevention	*„It depends on the on the location you have areas where there is a higher risk application other geographies there is a lower risk“ P3*	For Acorn, leakage is highly dependent on the area where the project is located.
		Double Counting	*„So it's like with the ivory coast issue so someone already claimed in the beginning but they are not transparent then at certain point in time then you discover oh you're actually overlapping and you're doing double counting“ P1*	Double counting is a transparency issue.
	Socioeconomic Factors	Co-Benefits	*“We always say to external parties of what makes Acorn different from other programming standards is that*	The co-benefits of Acorns CRUs are what sets Acorn apart from other programs.

			we make the benefit sharing mechanism." P2	
Integrity of the VCM	Fragmentation	Fragmentation of Registries	*„You have to really start digging deep to find where they are active and I think they're an overarching body also really can be of help." P1*	Acorn recognizes a need for a meta registry.
		Fragmentation of Standards	*"There's no this kind of label only labeling the small folder standards." P2*	When a project like Acorn is really niche, there is no standard that is fitting to the project.
	Market Data	Insufficient Data and Information Disclosure	*"It's the transparency in general, when, where and by whom the carbon is being sequestered and creating the transparency to the level of a buyer. And for every carbon removal unit, you can see how this has been developed." P1*	Acorn tries to ensure transparency through disclosing detailed information on their CRUs.
	Claims of Buyers	Transparency and Accuracy of Corporate Claims	*"Because Microsoft is one of our biggest buyers they also ask to apply to comply to certain standards so that's also in a way that's forcing us to merge to the*	Buyers are holding Acorn accountable.

			high integrity carbon standards so to say." P2	

Appendix F

Declaration of Originality Master's thesis

By signing this statement, I hereby acknowledge the submitted Master's thesis titled

The Role of Market Mechanisms in Upholding Quality and Integrity in the Voluntary Carbon Market

to be produced independently by me, without external help.

Wherever I paraphrase or cite literally, a reference to the original source (journal, book, report, internet, etc.) is provided.

I declare to also have finalized the SDG statement for this thesis (available in the MSc. thesis document folder on the Intranet).

By signing this statement, I explicitly declare that I am aware of the fraud sanctions as stated in the Education and Examination Regulations (MSc-EER 2023-2024) of SBE, Maastricht University.

Place:	40822 Mettmann, Germany
Date:	21.06.2024
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Appendix G

Sustainable Development Goals (SDG) Statement

Through the research conducted for this Master's thesis, I seek to contribute to one or more of the 17 SDG(s) set forth by the United Nations (https://www.undp.org/sustainable-development-goals). Specifically: SDG 13.

Explanation: This thesis aims to contribute to "Sustainable Development Goal (SDG) 13: Climate Action - Take urgent action to combat climate change and its impacts" by improving the functioning of the VCM. The VCM has the potential to be a significant climate mitigation tool, not only by contributing to global climate financing (Target 13.a) but also by enhancing the resilience of vulnerable groups and regions (Targets 13.1 and 13.3). As this thesis demonstrates, VCM projects can bring financial benefits to less developed, climate-vulnerable regions while increasing awareness and education about climate change impacts and protective measures. Enhancing the quality of VCCs, ensuring the integrity of the VCM, and supporting the market to regain its former strength will significantly bolster its effectiveness in achieving SDG 13.