

NAVIGATING THE PARADOX OF GREEN TECHNOLOGY ADOPTION IN THE
CEMENT INDUSTRY IN SOUTHEAST EUROPE.

by

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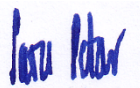
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Dedication

To my dearest husband Predrag Trpkov, your love, steadfast support, and strength carried me through every challenge of this journey. To my darling boys, Tiye and Tuene, you are my inspiration to keep striving for a better, more sustainable world, and I thank you for all the times you had to make adjustments because mum was not to be disturbed. To my mentor, Dr. Katavic, your faith in me, your wisdom, and your consistent guidance have left an indelible mark on both my work and my life.

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ABSTRACT

NAVIGATING THE PARADOX OF GREEN TECHNOLOGY ADOPTION IN THE CEMENT INDUSTRY IN SOUTHEAST EUROPE.

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This study investigates the adoption of green technologies within the cement industry in Southeast Europe (SEE), focusing on the strategic tensions and operational burdens confronting companies amid increasing demands for decarbonisation. Grounded in Institutional, Stakeholder, Dynamic Capabilities and Paradox Theories, the research analyses how cement companies, particularly in the EU member states in SEE (Bulgaria, Croatia, and Romania), manage institutional pressures, capital risk, and technology deployment in their transition toward industrial sustainability. Adopting a mixed-methods design, the study triangulates quantitative data on cement pricing, investment patterns, and emission indicators, with qualitative insights drawn from semi-structured interviews with corporate executives, industry experts, and policy stakeholders, as well as corporate sustainability disclosures. The findings reveal uneven policy enforcement, limited access to targeted green finance, and significant capability gaps in resolving strategic paradoxes and managing long-term technology integration. Companies face persistent trade-offs between short-term financial performance and long-term environmental obligations, within a risk-averse investment climate, amplified by reputational risk and stakeholder scrutiny. The analysis highlights the importance of dynamic capabilities in sensing regulatory shifts, seizing low-carbon investment opportunities, and reconfiguring core operations, as

differentiating factors among companies. A comparative trend analysis of cement prices (2015–2025) illustrates the market-level effects of decarbonisation policies and underscores the varying pace of industrial adaptation across SEE. The study concludes with clear recommendations for strengthening managerial capacity to navigate strategic paradoxes, improving governance to curtail greenwashing, and aligning national frameworks with EU climate policy alongside corporate risk-reduction priorities. In the quest for a competitive and environmentally responsible industrial transformation, the findings contribute to a deeper understanding of how sustainability transitions unfold in energy intensive sectors within emerging European markets, offering nuanced insights for corporate leaders, policymakers, and researchers on sustainability as both a source of risk and opportunity.

Keywords: Green technologies, cement industry, strategic tensions, sustainability paradoxes, decarbonisation, Southeast Europe.

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CHAPTER I: INTRODUCTION

1.1 Introduction

As societies increasingly recognise the urgency of climate change, the global imperative to reduce carbon emissions via sustainable practices is intensified. Carbon dioxide (CO₂) emissions are atmospheric discharges from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels, as well as gas flaring (Climate Watch Historical GHG Emissions (1990-2020), 2023).

CO₂ is the largest component of Greenhouse gases (GHG). Greenhouse gases refer to gasses that trap heat in the atmosphere (United States Environmental Protection Agency, n.d.). Given that Greenhouse gases differ on their radiative efficiency (ability to absorb energy) and duration in which they linger in the atmosphere (lifetime) the emission of specific gasses result in their particular global warming potential (GWP). GWP allows for all the different gasses such as methane, nitrous oxide, etc., comprising GHG emissions to be accounted in a comparable unit: the CO₂ equivalent (CO₂eq.) (Working Group 1, Intergovernmental Panel on Climate Change, 2021). Therefore, the term carbon emission is often used interchangeably with GHG emissions. The Global Warming Potential a gas is presented by the working group as:

$$\frac{\text{Amount of Energy a ton of the Gas will absorb in a given time period}}{\text{Amount of energy a ton of CO}_2 \text{ will absorb in the same time period}}$$

Through human activities emitting greenhouse gases, global warming with global surface temperatures reaching 1.1°C above 1850–1900 in 2011–2020 is now a reality. Global greenhouse gas emissions have continued to increase, with ongoing contributions via unsustainable energy use, land use, patterns of consumption and production, etc. Limiting human-caused global warming requires net zero CO₂ emissions (Core writing team, Lee H., Romero J. Climate Change 2023 Synthesis Report, 2023). Until net-zero CO₂ emissions is reached, the total carbon emissions in this decade would determine whether global warming can be limited to 1.5°C or 2°C.

Thus, with the intensification of adverse events related to climate change and the drastic emissions reduction policies for all sectors of the European economy, particularly energy, industry, transport and farming, a paradox has emerged in a form that is insufficiently examined due to its relative novelty. According to Shahzad, et al., (2022), while there are clear benefits of green technology adoption such as operational innovation, value creation and environmental preservation, substantial hurdles such as financial, market and technical constraints forestall organisations from incorporating them.

On the policy side, the European Commission has established both the green and digital transitions as key political priorities by 2030 and 2050 (Muench, et al., 2022). Multiple pieces of legislature have been implemented to support those objectives. These priorities will have long-term impact on living and working conditions. While these two concurrent or ‘twin’ transitions overlap and reinforce each other, some misalignment was identified. Digital technologies for instance can have substantial carbon footprints as in the case of data centres, which are in opposition to the objectives of the green transition.

Furthermore, on 5th January 2023, the new Corporate Sustainability Reporting Directive (CSRD) came into force with its objective of solidifying the reporting obligations for corporate disclosure of social and environmental information (Official Journal of the European Union, 2022). This reporting requirement gave the perception of sustainability being a compliance, rather than strategic issue. Companies seem to either: (a) reduce the scale/quality of production, (b) ignore or deflect the regulatory requirements as long as possible, or (c) adopt greenwashing practices. This phenomenon seems particularly prevalent in companies in energy intensive industrial sectors such as chemical production, cement production, food and beverages production, Oil & Gas refining, paper & pulp manufacturing, etc.

Cement production

Cement is an essential material that has impacted human civilisation for over a millennium. It acts as a hydraulic binder, meaning that it hardens when water is added to it. When it is mixed with water, sand and gravel it forms concrete. Concrete is the use for the majority of produced cement. Cement mixed with water, lime and sand forms the paste known as mortar (European Cement Association, 2020). Due to this unique binding properties of cement, concrete as a material is very resilient and durable, able to bear heavy loads and withstand environmental extremes. However, in the current climate reality, the impact of its manufacture on the environment cannot be ignored.

Cement production is carried out in multiple stages and it involves several actors from the quarry to the final product. Production usually entails four steps:

- i. Raw material extraction (limestone, chalk or marl) from the quarries

- ii. Processing the primary raw material with primary and secondary crushers
- iii. Clinker production through the calcination of limestone to lime and subsequent reaction with the other components of the raw material, and,
- iv. Grinding and blending with other materials

All aspects of the production process are energy intensive, particularly clinker production (European Commission Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, 2018). With global cement production requiring as much as 10.7 EJ (exajoule) of energy per year, or approximately seven percent of global industrial demand (Uratani J. M., 2023), the industry is extremely energy intensive. According to Guo et.al., (2024), CO₂ emissions from the cement industry reached 2.4 Gt in 2019, accounting for 26% of the total industrial emissions. Additionally, over 90% of countries and regions globally produce cement, and the global production of cement is increasing, especially in developing nations.

Furthermore, the industry activities affect other critical sectors at primary, secondary and tertiary levels, depending on its position on the value chains (European Commission DG Energy, 2020). Some of these industries are directly related, e.g., the construction and building sectors, whereas others are indirectly related e.g., the food/beverage production, logistics/transport, as well as tourism sectors. All these sectors are large consumers of energy, particularly the building sector. Buildings in the EU collectively account for 40% of the energy consumption and 36% of greenhouse gas emissions, which mainly stem from utilisation, construction, renovation and demolition.

The Global Concrete and Cement Association (2021), a coalition of organisations whose members account for 80% of the global cement industry volume outside of China, and the World Economic Forum launched Concrete Action for Climate supporting the delivery of net-zero products by 2050. Their primary objective is to ensure that both supply and manufacturing within the industry are in line with global climate goals, and among others, to incentivise circularity in the sector.

In every case, the private sector and technology has been marked as drivers of the transition to net zero emissions. Companies involved in activities like cement manufacturing that are reliant on substantial energy demands, face unique challenges in the form of: (a) security of supply, (b) frontloading of high costs, and (c) technical/integration. Despite these challenges, opportunities can be found in green technology adoption through innovation i.e., development of new products and services as well as value creation (Shahzad, et al., 2022), which would enable them to meet the regulatory and stakeholder requirements.

From professional observation, companies in the industrial sector in Southeast Europe seem to be grappling with compound challenges compared to their peers in other regions in Europe. In order to understand the potential for them to create value while meeting the net-zero objectives, this study would take a closer look at the cement industry to examine the ways industry players are set-up to remain competitive in light of the aforementioned challenges, along with their capacity to take advantage of any potential opportunities.

Green technologies

Green technologies refer to innovation that is focused on resource efficiency and minimisation of environmental impacts in order to mitigate and adapt to climate related challenges. They provide an alternative to traditional approaches (Barbhuiya, et al., 2024).

Types of low-carbon or green technologies deployed in the industrial sector include:

- i. Renewable energy technology such as wind, solar or geothermal, including battery management systems for energy production and storage,
- ii. Green or alternative fuels,
- iii. Carbon Capture, Utilisation and Storage (CCUS) technologies,
- iv. Energy efficiency in buildings,
- v. New and sustainable materials, and
- vi. Digital technologies and systems e.g., blockchain, AI, fibreoptic imaging, etc., for prediction, maintenance and optimisation.

When strategically deployed, green technologies can contribute to the creation and preservation of value in tangible ways.

Green technology and industry competitiveness

Examining the spill-over effects of green technology adoption on competitiveness (Selim & Salem, 2010), on potential leaps/lags in innovation, or on the pricing of end products such as real estate, would bring new insights into the industries from a perspective that has not been explored so far. The problem is that companies in energy intensive sectors like the cement industry, are having difficulties with net-zero transition (Barbhuiya, et al., 2024).

The diagram below illustrates areas in the cement production process where green technologies could be integrated to reduce production related emissions.

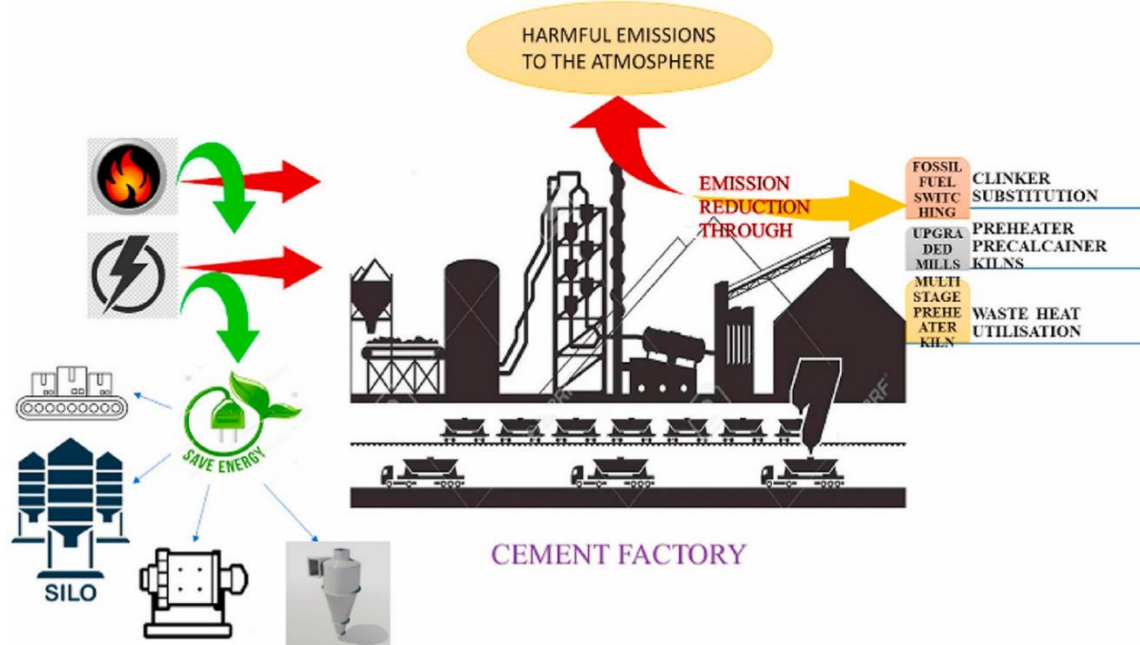


Figure 1.1 Cement manufacturing plant showing potential energy efficiency points. Image from Sahoo, N., Kumar, A. & Samsher, n., 2022. Review on energy conservation and emission reduction approaches for cement industry. *Environmental Development*, ISSN: 2211-4645, December, Volume 44, p. 100767).

Investing in green technologies aligns the cement industry with global sustainability goals and simultaneously provides tangible business benefits that could enhance competitiveness, profitability, and long-term viability (Guo, et al., 2024).

The International Energy Agency estimates that the global market for mass-manufactured clean energy technologies will be worth around USD 650 billion a year by 2030 (approximately EUR 600 billion) which is three times above the current figures. Given the strong growth of the net-zero industry globally, investing in the development and integration of green technologies (Madaleno, et al., 2022), could offer first-mover

advantage to companies and enable them to capture value beyond their current areas of activities. A major aspect of clinker production in the EU goes directly to the production of cement, not sold in the market.

Adoption and integration of various types of green technologies appear to be the obvious solution to reduce the carbon footprint and ensure long-term sustainability. Innovation in business enables the development of new products and services i.e., creates sources of competitive advantage (Shahzad, et al., 2022). Though the areas of intervention for a cement manufacturing plant to become more energy efficient i.e., greener, has been identified, the process does not seem to have gained sufficient traction in real world application. This study would attempt to understand the underlying reasons.

Macro trends driving green technology adoption

Macro trends in green or climate neutral technology refer to the dominant forces shaping the future of innovation in the field of environmental sustainability across industries and societies. Globally, particular large-scale forces have been driving economic activities for the past decade and are likely to continue to impact industries (Baah, et al., 2021). For capital and energy intensive industries, adapting to the trends is often a source of tension (Carmine & De Marchi, 2022) as the business continuity i.e., economic survival hangs in the balance if value is eroded over time due to a failure to adapt on time. The foundational macro trends affect industries in three main ways.

1. Climate change and transition to green (net-zero) economy

Companies with large carbon footprints tend to play a major role in economic development and the cement industry with its direct links to a nation's infrastructure is no

different. Since the agreement reached in December 2015 at the Conference of the Parties (COP21) in Paris, where the UN Sustainable Development Goals were adopted, political and business leaders agree that Climate Change due to human activities is the pressing issue of our time (COP 21 Paris Climate Agreement - UNFCCC, 2015).

The EU Green Deal Industrial Plan goes further to codify the necessary support infrastructure that would enable the manufacturing companies in Europe to scale up net-zero technologies in order to meet the climate targets (Communication from the European Commission, 2023). Four key trends emerging from the green transition standpoint include:

- Global agreements and policy shift to accelerate the transition to a net-zero economy. These policies and regulatory packages include incentives for green technology adoption, as well as stricter regulations on emissions and use of resources;
- Development and deployment of green technologies such as renewable energy, waste management systems, Carbon Capture, Utilisation, and Storage (CCUS) technologies that capture CO₂ from industrial processes and the atmosphere either for storage or conversion to useful products, as well as circular i.e., resource efficient economy;
- Sustainability focused management/hiring practices driven by an increased demand for transparency in corporate practices, leading to more rigorous reporting standards and the adoption of frameworks like the Task Force on Climate-related Financial Disclosures (TCFD) and the Global Reporting Initiative (GRI).

- Sustainability focused financing. The growth of green bonds, impact investing and sustainable investing, highlights the trend of alignment of financial markets with the SDGs. For this reason, Environmental, Social, and Governance (ESG) criteria are becoming essential in investment decisions. Additionally, carbon markets, carbon pricing mechanisms, and trading systems are being developed and gaining momentum as a means of incentivising emissions reductions and supporting climate-related investments.

This study builds on the knowledge that the climate goals of limiting a global increase in temperature below 2 degrees Celsius above pre-industrial levels, while taking every effort to further reduce the temperature increase to 1.5 degrees Celsius, is hinged on, among other factors, the successful transition to a net-zero economy (COP 21 Paris Climate Agreement - UNFCCC, 2015). For that to happen, it is essential for cornerstone sectors with significantly high energy intensity such as the cement industry, to be supported through their transitions to carbon neutrality via mobilising financial resources, new technology framework, capacity-building efforts, etc. However, the substantial discrepancy between declarative corporate sustainability goals, the implementation and climate outcomes, necessitate further examination particularly as it relates to resource allocation and trade-offs.

II. Digitalisation

The macro trend of digitalisation in the sphere of green technology refers to the transformative impact of digital technologies on the development, deployment, and optimisation of environmentally sustainable solutions. The economy driven by integrating

digital technologies and sustainability, is forecasted to double by 2028 with investments spanning from scaling-up current technologies, cybersecurity infrastructure, process automation and reskilling activities, forecasted to produce returns from the current four percent to fourteen percent in 2028 (Capgemini Research Institute, 2024).

Digital technologies help with measuring and controlling inputs. With automation, technologies like internet of things (IoT) could improve resource efficiency and strengthen the flexibility of systems and networks. Furthermore, energy efficient blockchain-based data management across product lifecycles and value chains support circular economy initiatives. Digitalisation enables the formation of new business, revenue and ownership models. Some key trends emerging from digitalisation in green transition include:

- Smart technologies enabling energy efficiency. IoT devices and other advanced energy management systems are deployed to optimise energy use in homes, buildings, and industries driven by the need for costs and emissions reduction.
- Sustainable urban environments i.e., Smart or Intelligent Cities: digital technologies are deployed for data analytics to improve energy efficiency, reduce emissions, and enhance the quality of life in urban areas, via smart grids, intelligent lighting systems, automated traffic control energy-efficient buildings, intelligent transportation systems, water and waste management.
- Renewable energy integration through the management of distributed energy resources such as solar panels and battery storage. Additionally, smart inverters, energy management systems and digital monitoring of energy storage solutions,

allows for flexible and resilient energy systems, increasing the reliability of renewables.

- Sustainable manufacturing practices are also boosted by digital technologies (Capgemini Research Institute, 2024) through the use of IoT, AI, and robotics to reduce waste, lower energy consumption, and optimize resource use. Additionally, digital tools are also used for product lifecycle analysis which helps manufacturers to design more sustainable products from the outset.

Therefore, the digitalisation macro trend in green technology leverages data, automation, and connectivity to impact how the sustainability goals are being achieved. However, with the rapid deployment of ICT in every sector, the Greenhouse Gas Emissions from that sector is expected to increase (European Commission: Strategic Foresight Report, 2022). Nonetheless, this trend is reshaping how green technologies are designed, implemented, and managed, driving more efficient and scalable approaches to sustainability (Kogabayev & Maziliauskas, 2017).

III. Skills demand and supply.

As new technologies, policies, and practices emerge, skills integrating sustainability and new technologies are in high demand across various sectors. This underscores the importance of continuous learning and adaptation on both demand and supply sides, as competition for talents intensifies. According to Eurostat (2024) on growth of the environmental economy, between the years 2000 and 2021, environmentally focused activities in the economy performed significantly better than the general economy

in terms of value added and employment. It grew the EU GDP by 6.0 percent, employment by 3.7 percent and gross value added by 8.3 percent.

The green transition is amplifying the requirements for new skills on all levels. Recognising this trend, the EU has set up programs for large-scale up-skilling and re-skilling of the workforce. For instance, the battery industry alone estimates it will need an extra eight hundred thousand workers by 2025 (European Commission COM 62, 2023). The capacity to attract and retain talent is directly related to the ability to maintain prosperity and attain the net-zero objectives.

To conclude, these macro trends indicate a significant global shift towards sustainability. They are driven by a combination of technological advancements, changes in policy, consumer demand, and global sustainability goals, with full recognition that green technologies are essential for addressing the environmental challenges of our time and ensuring long-term economic resilience.

Industry trends

In addition to the macro trends driving the major sectors of the economy, particular trends are also leaving a significant impact on the cement industry. They include:

- Adoption of green technologies such as systems for Carbon Capture, Utilisation and Storage (CCUS) which is still in nascent stages of deployment due to high costs and technical challenges (Barbhuiya, et al., 2024). Cement manufacturers are also attempting to reduce reliance on fossil fuels and virgin materials by using alternative fuels such as waste materials, biomass, and industrial by-products in the production process. Additionally, R&D of low-carbon cements, such as belite-

rich cement, calcium sulfoaluminate cement, and magnesium-based cements are becoming more prevalent in the industry.

- Energy efficiency improvements in the manufacturing process is also a growing trend (Guo, et al., 2024). With the integration of energy efficient practices such as optimising kiln operations, implementing heat recovery systems and upgrading equipment, the companies could reduce their carbon footprints and reduces operational costs (Barbhuiya, et al., 2024). Furthermore, a major part of clinker production in the EU goes directly to the production of cement, not sold in the market (European Commission Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, 2018). As such, cutting the clinker content in cement by substituting it with so called supplementary cementitious materials (SCMs) such as fly ash, slag, and natural pozzolans is becoming commonplace. Given that producing clinker is the most energy and carbon intensive aspect of cement manufacturing, reducing clinker content has a direct positive impact on emissions and energy use.
- Increasing demand and price of energy is another trend impacting the industry given the high energy requirements for production. Global energy-related carbon emissions grew by 1.1% in 2023, increasing 410 million tonnes (Mt) to reach a new record high of 37.4 billion tonnes (Gt). This compares with an increase of 490 Mt in 2022 (1.3%). Emissions from coal accounted for more than 65% of the increase in 2023 (International Energy Agency, 2023). According to Eurostat (2023), the construction sector contributed EUR 84 billion of value added or 23

percent to the total gross value added of the environmental economy. This activity includes energetic refurbishment of existing buildings and the construction of new energy-efficient buildings as well as noise insulation work, maintenance and repair of water networks, construction work for wastewater and waste treatment plants and sewerage systems, which all require input from the cement industry. With the increase in demand, deployment of key green technologies sets the stage to effectively curb emissions.

These industry trends reflect the imperative on the cement industry to address its negative environmental impact while transitioning towards more sustainable production methods. Understanding of drivers and paradoxes in order to foster targeted innovation, collaboration, and investment in green technologies and practices is an underlying motive for this study.

1.2 Research Problem

The cement industry involves both extractive and manufacturing activities which leaves a significant negative impact on the environment. A significant problem with corporations in the cement industry in Southeast Europe concerns the lack of integrated approach for social, economic and environmental dimensions (Poudyal & Adhikari, 2021). Poudyal and Adhikari (2021) argued that regardless of extensive research on green techniques of reducing environmental impacts of cement production, commercial implementation is still stalled and may occur only if there is a real synergy between sustainability and profitability. Moreover, the implementation will only be more rapid

when the proposed approach takes into equal consideration the multiple dimensions (social, economic, and environmental) of sustainability (Ighalo, et al., 2020).

Most of the current studies, however, prioritise environmental aspects and lack exploration into the socio-economic and governance aspects. The commercial scale up of green technologies beyond the superficial would be impossible without clear economic value to plant owners and key stakeholders such as investors, in addition to the public acceptance. ***Thus, the primary research problem is the slow uptake of green technologies in the cement industry in Southeast Europe.***

Despite its necessity and economic contribution to GDP, the cement industry faces many challenges due to environmental concerns and sustainability issues (Yi and Liu, 2022). These challenges include but are not limited to:

- the energy intensity of the industry whose needs are met primarily from fossil fuels like coal and petroleum coke, which contribute significantly to both carbon emissions and operating costs,
- natural resource intensity in the form of extreme water usage and environmental degradation from extraction of raw materials such as limestone, clay and gypsum,
- air pollution including harmful particulate matter such as nitrogen oxides and sulphur oxides which are dangerous to human health,
- high upfront costs of green technology implementation (carbon capture technologies, alternative fuels, low-carbon production methods, water conservation & recycling systems, etc.) requiring significant capital investments and continual R&D,

- lack of substitutes for clinker, which is a key ingredient and the most carbon intensive component.

Understanding the particulars of why the green technology adoption rate is slow, may uncover the aforementioned business concerns which could negatively impact the economic position of the corporations under regulatory obligation to change, and their competitive position.

This could be the underlying reason why, to appear aligned with environmental sustainability, many resort to greenwashing and other superficial actions (Barbhuiya, et al., 2024), or spend public resources on popular technologies with potentially questionable impacts. Therefore, a subordinate problem that emerges from the first, as corporations attempt to comply with sustainability directives, would be ***the trend of corporate greenwashing***.

This study will examine the problems from the perspective of threefold assumptions regarding potential inhibitors to green transition of the cement industry in the SEE region as shown in the Figure1.2. These three inhibitors may contribute to both the slow uptake and the damaging phenomenon of greenwashing in the industry, which can be observed as a discrepancy between positive public statements on sustainability on one hand, and a lack of tangible or transformative operational actions impacting existing processes, on the other. Figure 1.2 outlines the three hypotheses, based on relevant literature.

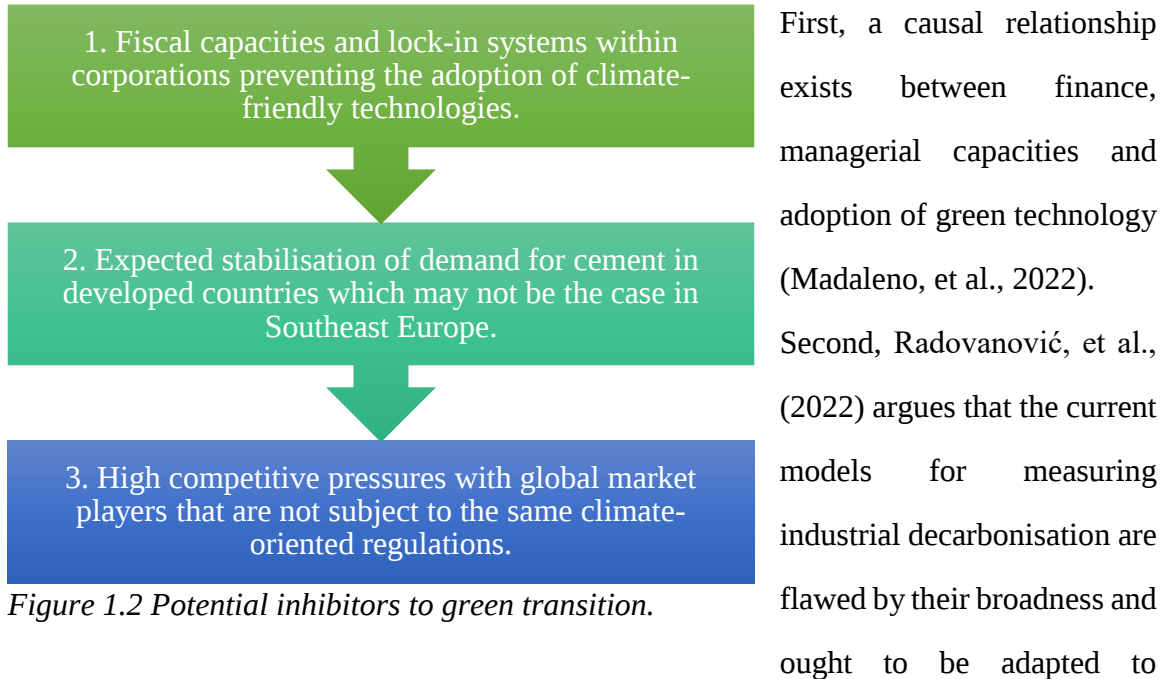


Figure 1.2 Potential inhibitors to green transition.

individual countries. Demand for cement is expected to rise in the SEE region as opposed to the stabilisation forecasted in others like Western Europe. Third, due to capital intensity, high localisation and fragmentation of the market, there is a high chance of competitive pressures influencing decision-making on green technology adoption (Uratani J. M., 2023).

Thus, a major issue in the pursuit of climate neutrality is that such extremely capital and energy intensive, heavy industries with an inherent negative impact on the environment, are either lagging in green technology adoption and CO₂ emissions reduction (Sahoo, et al., 2022), or making superficial modifications.

The issues this study would examine concern the slow uptake of green technologies in the industry could be driven by: (a) **costs of green transition** in the industry and (b) the **timeframe of green technology development, acquisition and integration**. It would also attempt to identify the contributors to the **greenwashing phenomenon** and how to curb it within the context of market and environmental forces.

Hence, to deal with this aspect of anthropogenic climate change, the paradox of green technology adoption in the cement industry is worth unentangling in order for new pathways and business models to be uncovered in the transition to net-zero industrial practices.

1.3 Purpose of Research

The purpose of this study is to explore how the green transition could significantly reduce carbon footprints in the cement industry via green technology integration, while balancing the paradoxical relationships between short to mid-term business goals, stakeholder interests, and longer-term environmental outcomes.

The focus would be in exploring the potential inhibitors of green transition in the cement industry in the SEE region, how the integration of climate friendly technologies could be accelerated, and the particular ways that overcoming the identified challenges could ensure positive outcomes for both the net-zero objectives of the industry, and the competitive position of the corporation.

Research objectives

The aim of the research is to examine the paradoxical relationship between the climate-driven urgency for industrial process reorganisation and the real costs of green technology integration.

Delving deeper, scope of this objective entails examining the capacities of management for dealing with paradoxical tensions, identifying the real costs of green transition at company level, and assessing the type of technological investments required. Additionally, other non-technology investments would be expored, alongside estimates of

the general implementation timeline of green technologies from R&D stage to full industrial scale integration, as well as the prevalence of greenwashing practices, its drivers, and effective prevention methods.

Geographical location and choice of industry

Given that cement industry actors in the region are multinational corporations, the primary location of the study would be in Croatia while still being relevant to the other countries in the region where the same company operates. The cement industry was chosen because it is the second largest multinational industry after iron and steel, and it plays an important role in global economic growth due to its impact on other vital sectors (Uwasu, et al., 2014).

While research on business and management theories abound, few are focused on interorganisational relationships and the paradoxical tensions that emerge (Fortes, et al., 2023). Research on actions and linkages between green technologies and competitive advantage within the context of the cement industry is relatively limited as many are of a narrower focus (Guo, et al., 2024). Furthermore, the cement industry is extremely energy intensive and one of the most polluting industries (The Loret Group, 2008). Between five and seven percent of the world's total emission of greenhouse gases is attributed to cement production.

Finally, there is no product to date that can be effectively substituted for cement (Selim & Salem, 2010), in the building and construction sector. Dealing with the complexity of climate change adaptation through the use of technology requires practical

and integrated approach, examined from the perspective of the corporation itself, in order to understand corporate position and optimise the relationships with key stakeholders.

1.4 Significance of the Study

Despite the prevalence of information making the case for investments in sustainable projects, and companies declarative support of green transition, there is a significant gap regarding how green technology adoption, as an aspect of the redesign of the value network in the cement industry, could impact the sustainability of both the community and corporation (Derks, et al., 2022). A positive effect of the green transition on the corporation's sustainability is assumed in the literature. However, there is insufficient empirically proven evidence that this positive effect always exists or how companies could access them through concrete actions. Instead, there is an observable sluggishness in the transition process, despite the high level of performative actions.

This study attempts to understand the corporate perspective on deep decarbonisation as a means of uncovering tools for effective management, identifying necessary multi-stakeholder actions, and elaborating on potential means of capturing value from the net-zero transition.

The cement industry is a major economic player and a rapid progression to climate neutrality has significant environmental and economic impact on industries affiliated to it on secondary and tertiary levels. Additionally, the European Commission acknowledges the varying capacities for bearing the burden of transition, which is the primary reason for the Just Transition Mechanism and associated instruments that are part of the European Green Deal investment plan to ensure that no region is left behind in the transition to a

climate-neutral economy (European Commission, 2021). An examination of the effectiveness of such policy measures from the perspective of the companies could lead to improvements in design, optimisation and deployment of such instruments.

The impact of the study could include optimisation of the energy efficiency in the industry via green technologies, reduction of greenwashing practices, pollution reduction, acceleration of innovative processes such as exploration of potential new materials and, better targeted financing of green transition.

Definition of Key Terms

- ***Business Model*** – Though there are many broad definitions of business models with some focusing on strategy and others on the firm-level actors, business models as used in this paper builds upon the definition by Osterwalder & Pigneur, (2010), as a description of the rationale by which an organisation creates, delivers, and captures value. Noting that value creation on supply-side potentially presents a paradoxical tension to meet demand-side requirements that would ensure sustainable competitive advantage, this paper examines the value chain actors, their interactions and relationships. This perspective is aligned with the findings of Fiel, (2014) where business models are said to describe the logic of value in an organisation based on how customer value is captured and created.
- ***Carbon Footprint*** – A carbon footprint is defined as the total amount of greenhouse gases emitted into the atmosphere, such as carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), expressed in equivalent tons of CO₂ (Badamasi, 2023).

- **Competitiveness** – The World Economic Forum defines competitiveness as the set of institutions, policies and factor conditions that determine the productivity levels of a given country (Cann, 2016).
- **Energy Efficiency** – Considering that reducing consumption and waste of energy across the energy system and affiliate sectors is one of the strategic objectives of the EU, the European Environment Agency, (2024) defines energy efficiency as using less energy for the same output, or increasing production with the same energy input, as well as minimising energy waste.
- **Energy Intensity** – Energy intensity is a measure of the energy inefficiency of an economy. It is calculated as primary energy consumption per unit of gross domestic product (GDP), in kilowatt-hours per US dollar (National Geographic, 2023). High energy intensities indicate a high price or cost of converting energy into GDP, while Low energy intensity indicates a lower price or cost of converting energy into GDP.
- **Greenhouse Gases** – This refers to any gas that has the property of absorbing infrared radiation (net heat energy) emitted from Earth's surface and re-radiating it back to the Earth's surface. According to Mann, (2024), the most important greenhouse gases are carbon dioxide, methane, and water vapour. To a lesser extent, surface-level ozone, nitrous oxides, and fluorinated gases also trap infrared radiation. Therefore, they all contribute to the greenhouse effect. Despite constituting a fraction of all atmospheric gases, greenhouse gases have an intense effect on the energy budget of the Earth system.
- **Green Technology (Greentech)** – Green technology, also known as Clean-Tech, or Climate technology, is an umbrella term that describes the use of technology and science to actively reduce or reverse the impact of human activities on the

natural environment. According to Williams, (2024), these technologies address health and safety concerns, in addition to boosting energy efficiency, supporting recycling, and incorporating renewable resources.

- **Green Transition** – The strategic action plan articulated in the European Green Deal that aims to tackle climate change and environmental degradation by making Europe climate neutral by 2050, through green technology, creating sustainable industry and transport sectors, while drastically reducing pollution (European Commission, 2021).
- **Innovation** – Considering the many definitions of innovation available that have been elaborated in the work of Kogabayev & Maziliauskas, (2017), innovation in the context of this paper refers to the process integrating the disciplines of science, technology, economics and management, to achieve novelty and successful commercialisation in the form of production and consumption of the output. Therefore, innovation encompasses both process innovation and technological.
- **Just Transition** – The Just Transition refers to the contributions that all EU Member States, regions and sectors have to make in order to transition to a climate-neutral economy. Given that the challenge of transition entails serious economic, environmental and social transformation of certain regions dependent on fossil fuels and carbon-intensive industries, more than others, the European Commission is helping Member States to mobilise resources and take actions to ensure targeted support for those regions and sectors (Parliament of the EU, 2021).
- **Paradox** – Paradoxes can be considered elements within or across organisations that contradict each other, but are related irrespective of whether or not the actors recognise them. As paradox concerns the persistent contradiction, tension refers

- to the negative side of business relationships, such as conflict, competition, or other crises (Fortes, et al., 2023).
- **Sustainability** – Sustainability is the practice of responsible utilisation of natural resources today, to ensure availability for future generations tomorrow (Our world in data , 2023).
 - **Twin Transition** – The European Commission laid the foundations for a comprehensive industrial strategy on 10th March 2020. This strategy aims to support the transition to a green and digital economy. Since digital technologies can provide functions that are able to catalyse the green transition, the interplay is often called “twin transition”. This is particularly urgent in sectors generating high amounts of greenhouse gas emissions, such as transports, energy, agriculture, building and construction, as well as other energy-intensive industries (Stefan, et al., 2022).

1.5 Research Questions

This study acknowledges that a transition to a net-zero economy is essential for the climate goals to be achieved (Muench, et al., 2022). For true decarbonisation to happen, cornerstone industries with significantly higher energy intensity have to be supported through their transitions (Poudyal & Adhikari, 2021).

However, the methods of implementation of the various transition strategies, the real costs, and implications of such change on business operations are unclear from the outside view. Additionally, the discrepancy between declarative sustainability goals and daily business realities requires further examination.

Primary Research Question

RQ1. How could paradoxical tensions between differing interests be managed to enable cement companies meet their net-zero targets while maintaining profitability and market competitiveness?

Secondary Questions

RQ2. How effective are the available “green” financial instruments for deep decarbonisation of industrial processes?

RQ3 What are the overt and covert costs of decarbonising the cement industry?

RQ4 How long does it take for essential green technology to move from the research and development (R&D) phase to full industrial integration and return on invested capital?

RQ5 How can corporate leaders in the cement industry assess and prevent greenwashing practices?

These questions seek to address the identified problems surrounding industrial green transition such as the true costs, the phenomenon of greenwashing, and the impact of the timing of technological transition from innovation to integration and return on investments (ROI). They will support the investigation into the interconnections between key stakeholder groups (Fortes, et al., 2023) as well as the three aspects of: (a) paradoxical tensions, (b) paradoxical thinking, and (c) paradoxical strategies/actions (Lewis, 2000), in ways that are relevant to the green transition of the cement industry in South-East Europe.

1.6 Summary

The cement industry is both an extractive and manufacturing sector, with a high capital and energy intensity, resulting in an extremely high carbon footprint. EU member countries in the SEE region are encompassed under the category of developed nations. As a result, companies within the geographical space face the accompanying regulatory constraints designed to meet the net zero objectives. However, these companies lack key resources and technologies that would support the transition, so they resort to suboptimal practices such as greenwashing.

To address the paradox of meeting short-term business objectives with long-term climate goals, as well as the tension of global competitive pressures, the research plan is for a mixed-method study to be carried out with the subsequent data processed using within case and between case analyses. Clarity in the unique challenges facing industry actors in this region could contribute to developing novel approaches or solutions that would speed up the transition to net-zero in the cement production industry, leading to positive spill-over effects in related industries such as building and construction.

CHAPTER II: REVIEW OF LITERATURE

2.1 Theoretical Framework

A preliminary review of existing literature shows that past studies have been focused on establishing the necessity and benefits of adopting measures that support sustainability goals (Muench, et al., 2022). They correctly identify the urgency and some measures that include technologies such as renewable energy generation technologies which are inherently green. However, not much information could be found from the company perspective addressing the issue at company level. Additionally, the inherent paradoxes and the systemic change that would be required are missing a holistic view (Carmine & De Marchi, 2022).

The case for public sector and institutional support for the attainment of the sustainability objectives has also been made in the existing literature (Radovanović, et al., 2022). However, a significant gap exists in articulating the role of the private sector in practical terms, particularly in industries active in the areas with enormous energy requirements, which serve as input suppliers for other foundational industries.

The built environment rests on the cement and concrete industry which is heavily dependent on the fossil fuels and has a spill-over effect on other related industries (Selim & Salem, 2010). Thus, if one would examine just the green transition of the industry without taking geographic specificities and competitive positioning into account, the current theoretical approaches could be considered inadequate (Bansal & Song, 2017). Studies on reducing the carbon footprint of cornerstone industries via green technology

adoption require a comprehensive understanding of the practicalities of green transition beyond the theoretical (Uratani J. M., 2023). Missing aspects from existing studies that would be covered by this one includes:

- How companies are managing the paradoxical tensions from net zero obligations, as well as competitive pressures with global market players currently unaffected by those regulations.
- An assessment of the impact of green technology integration on efficiency, supply chain dynamics, and cost structures, in the selected cases,
- A determination of the stakeholder influences and management approach at integration of the various aspects technological, financial, managerial, political, etc., of transitioning to net-zero.

The area of study and research questions highlight particular variables that corresponds to and integrates the postulated theories of paradoxes and stakeholders. Although trade-offs could be inevitable in the transition to net-zero, management of the environmental, social and business aspects with stakeholders, can positively impact the sustainability objective of technological integration (Gibson, 2012).

In order to clarify the adoption of green technologies as a reaction to environmental and societal pressures within the cement industry, this study employs complementary theoretical perspectives that consider both institutional field-level dynamics and strategic responses at the company level. The review that follows examines Institutional Theory, Stakeholder Theory, and their potential integration, while also reflecting on insights from Dynamic Capabilities and Paradox Theory to account for the

heterogeneity of organisations and the tensions that arise during sustainability transitions. Therefore, the conceptual framework of this study aims to balance the paradoxical tensions and by doing so, optimise the economics of sustainability in high carbon emitting industries such as in cement manufacturing. Figure 2.1 illustrates the high-level conceptual framework of the study.

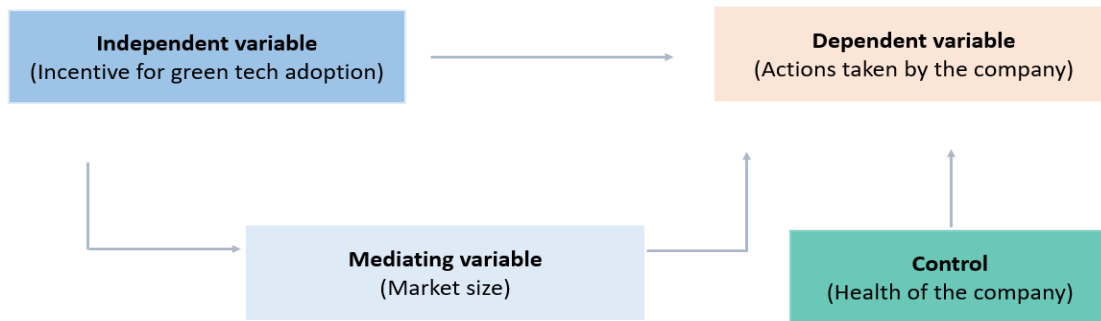


Figure 2.1 Author's illustration of the relationship between relevant variables.

The framework depicts an independent variable in the form of financial incentives/penalties, a dependent variable of corporate actions, a mediating variable of market size, as it is a determinant of both access, power and capacities, as well as a control variable in the form of the overall health of the company.

To explain the adoption of green technologies in the cement industry as a reaction to environmental and societal pressures, this study draws on complementary theoretical frameworks that encompass both institutional field-level dynamics and strategic responses at the company level. The subsequent review explores Institutional Theory, Stakeholder Theory, and their integration, while also incorporating insights from Dynamic Capabilities and Paradox Theory to address organisational heterogeneity and the tensions inherent in sustainability transitions. Table 2.1. illustrates the theoretical framework of the study.

Table 2.1 Theoretical frameworks relevant to the research.

Theoretical perspectives	Key concepts	Relevance
Institutional theory	Coercive, normative, and mimetic institutional pressures (DiMaggio & Powell, 1983; Scott, 2001).	It explains how regulatory, societal, and competitive forces influence corporate isomorphism in sustainability practices.
Stakeholder theory	Stakeholder salience (power, legitimacy, urgency), stakeholder engagement, and accountability (Mitchell, et al., 1997; Freeman & Mcvea, 2001)	It highlights the role of diverse stakeholder groups in shaping sustainability responses of companies, and emphasises managerial prioritisation of competing demands.
Dynamic capabilities theory	Sensing, seizing, and reconfiguring capabilities to respond to environmental changes (Teece, et al., 1997)	This explores the reasons why some companies outperform others in developing and deploying innovative green technologies despite facing similar institutional pressures.
Paradox theory	Tensions between competing demands (e.g., short-term profitability vs. long-term sustainability), and organisational ambidexterity (Smith & Lewis, 2011; Smith, 2014).	This explains how companies manage the inherent contradictions in pursuing both economic and environmental goals.

2.2 Institutional Theory

Institutional Theory offers a comprehensive framework for analysing the ways organisations respond to external pressures in sectors marked by significant societal

expectations and regulatory requirements, such as the green transition within the cement industry. This theory, initially articulated by DiMaggio and Powell, (1983) and further expanded by Scott, (2001), states that organisations function within institutional contexts that impose pressures to align with established norms, regulations, and practices, thus achieving legitimacy and ensuring their continued existence. In essence, Institutional Theory differentiates between three types of institutional pressures that promote organisational isomorphism¹: coercive, normative, and mimetic pressures. Each of these mechanisms is particularly important for understanding the motivations behind the adoption or rejection of green technologies by cement companies in the Southeast European (SEE) region, in light of the imperatives of environmental sustainability.

Coercive pressures

Coercive pressures emerge from formal regulations, legal requirements, and the exercise of power by state and supra-national authorities. In the SEE context, the European Union's regulatory framework, including the Emissions Trading System (ETS), industrial emissions directives, and national climate and energy plans (NECPs), imposes increasingly stringent emission reduction targets on cement producers. Companies face direct penalties, carbon costs, and the risk of exclusion from public procurement markets if they fail to comply.

These mandates create strong incentives for corporate investment in green technologies such as alternative fuels, carbon capture, and energy-efficient kilns.

¹ Organisational isomorphism refers to the process by which organisations in a similar field or industry become increasingly similar in their structures, practices, and policies due to external pressures, imitation, or professional norms.

Furthermore, funding mechanisms like the EU's Innovation Fund and the Just Transition Mechanism represent coercive financial levers by tying support to sustainability performance (European Commission, 2023).

Normative pressures

Normative pressures arise from societal expectations, professional norms, and standards disseminated by industry associations, environmental NGOs, and global governance bodies. In the cement industry, normative forces are manifested via voluntary frameworks such as the Global Cement and Concrete Association (GCCA) Sustainability Charter, ISO 14001 certifications, and Science-Based Targets Initiatives (SBTI). Companies operating in the SEE region increasingly face normative expectations from multinational clients, investors prioritising ESG criteria, and professional networks that advocate for integration of low-carbon technologies. These pressures often translate into corporate commitments to decarbonisation roadmaps and greater transparency in sustainability reporting.

Mimetic pressures

Mimetic pressures arise in contexts of uncertainty, prompting organisations to replicate the perceived best practices of industry leaders in order to uphold legitimacy and achieve competitive equality. Within the cement sector in the SEE region, companies frequently observe market leaders like Holcim, Heidelberg Materials, and Cemex, who have been at the forefront of global green investments. Local and regional rivals may imitate their approaches by embracing comparable technologies, transparency practices, and sustainability objectives, in order to mitigate reputational risks and preserve

institutional legitimacy, despite the potential for uncertain economic returns in the short term.

2.3 Stakeholder Theory

The idea that organisations require the support of stakeholders alongside their shareholders in order to exist, was initially presented by the Stanford Research Institute in 1963, establishing the concept of stakeholders (Freeman, 2010). Modern definition of stakeholder theory stipulates that:

- organisations acknowledge both internal and external stakeholders,
- stakeholders' needs and demands ought to be understood and managed, and
- effective management of stakeholders is strategic and enables the maximisation of value creation and preserving sustainability.

Thus, according to the theory, organisations should aim to generate multiple benefits for the different stakeholder groups (Mahajan, et al., 2023).

This study examines the paradoxical tension arising from conflicting or contradictory demands from various stakeholder groups (Gibson, 2012) could lead to management hesitancy in disruption of status quo, which could result in stagnation in green transition objectives requiring large investments in technologies, due to prioritisation of business-as-usual approaches.

Overview of cement industry stakeholders

Since stakeholder engagement has been shown to result in higher success rates in projects (Freeman, 2010) and securing organisational growth, identifying and managing the various interest groups becomes of paramount importance. Research findings (Baah,

et al., 2021) have shown that stakeholder pressures and green production practices had a significant impact on financial performance in manufacturing SMEs in developing countries. The key industry stakeholders and the ways they relate to each other is illustrated in the diagram below:

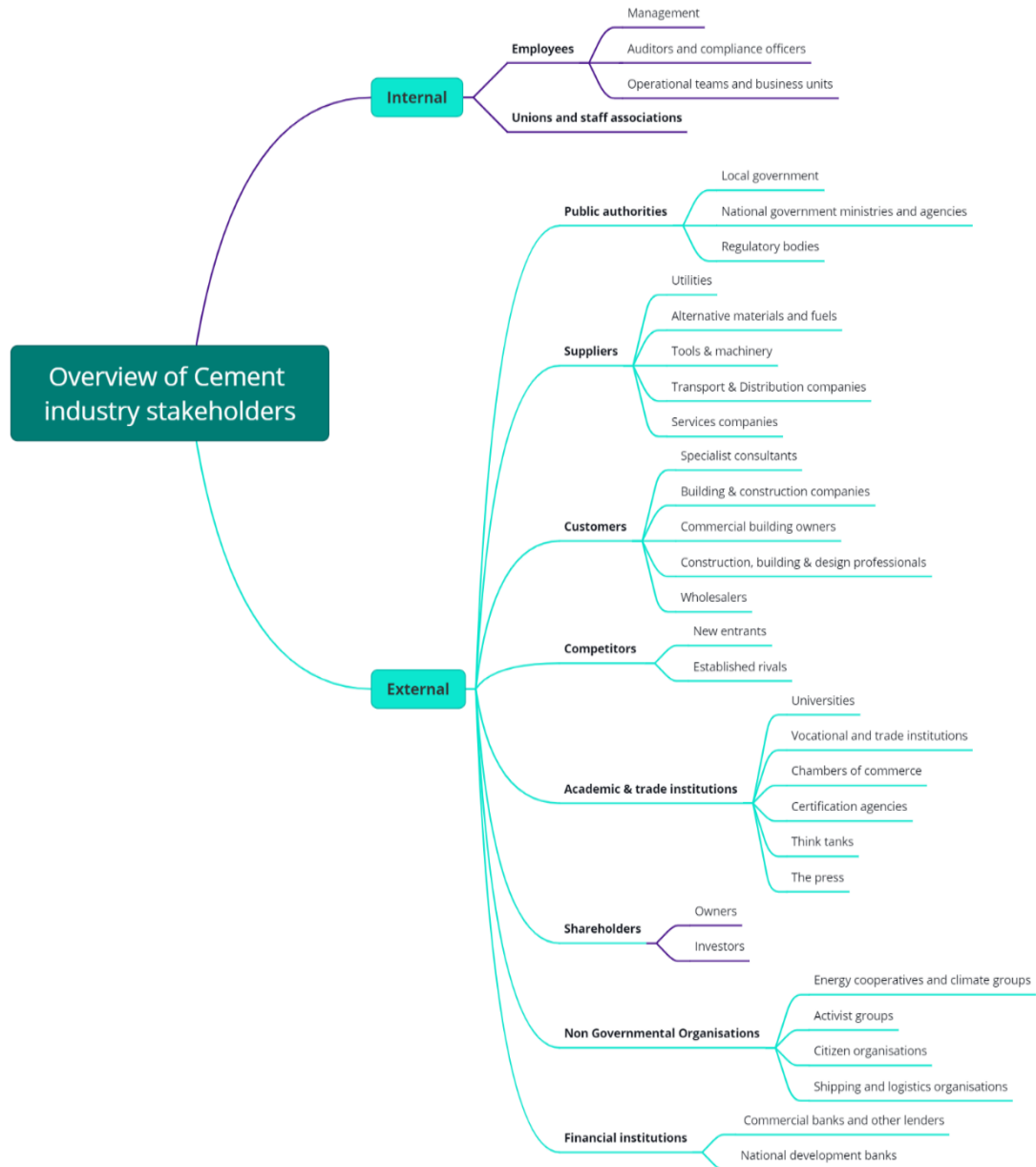


Figure 2.2. Author's diagram of internal and external stakeholders in the cement industry.

2.4 Dynamic Capabilities Theory

Dynamic Capabilities Theory (DCT) as proposed by (Teece, et al., 1997), extends the resource-based view² (RBV) of a company (Barney, 1991), by highlighting the necessity for entities to both have valuable resources and cultivate the capabilities required to adapt, integrate, and reconfigure those resources in reaction to swiftly changing environments.

The cement industry is capital-intensive, slow-moving, and exposed to regulatory and market shocks. This calls for firms to sense, seize, and reconfigure internal capabilities to adapt and survive (Tesse, 2007). This emphasis on the need for sensing and reconfiguration when adopting low-carbon technologies in regulated markets, as well as the research of (Liang, et al., 2022), on the integration of sustainable management practices with ESG to pinpoint the elements that could serve as catalysts for attaining sustainability, necessitate closer study of the Dynamic Capabilities Theory as it relates to heavy industries like cement production. In sectors experiencing significant transformation due to environmental and regulatory pressures, like the cement industry, DCT could provide a robust framework for comprehending how firms establish competitive advantage through agility and innovation.

Given that green technology adoption goes beyond asset acquisition as it involves transforming routines, retraining staff, investing in innovation, and responding to new stakeholder expectations, dynamic capabilities theory explains intra-company variance,

² The resource-based view (RBV), often referred to as the ‘resource-based view of the firm’, is a managerial framework aimed at pinpointing the strategic resources that a company can utilize to achieve a lasting competitive edge.

(Tesse, 2007) and provides insight on the reasons why some companies in the same policy context invest earlier or more aggressively in green tech.

The adoption of green technology within the cement industry encompasses more than merely acquiring equipment; it requires the establishment of organisational routines and capabilities that facilitate the effective innovation and implementation of sustainable practices. The SEE region introduces additional complexities, as companies function within institutional environments that exhibit varying levels of regulatory rigor, financial assistance, and societal expectations. The Dynamic Capabilities Theory (DCT) describes why certain companies excel in overcoming these challenges, even when faced with similar external pressures.

Sensing

Leading companies exhibit a heightened ability to monitor and interpret subtle signals within the institutional and technological landscape such as forecasting stricter EU carbon regulations, acknowledging increasing ESG demands from investors, or pinpointing feasible alternative fuels and materials. This sensing capability empowers them to proactively prepare for sustainability transitions.

Seizing

Seizing capabilities of companies refer to the mobilisation of resources (financial, human, and technological) to invest in and implement green technologies. Companies that possess robust seizing capabilities can attract green financing, establish strategic partnerships, and cultivate the internal competencies required to adopt innovations such as carbon capture and storage (CCS) or alternative clinker substitutes.

Transforming or Reconfiguring

Transformation signifies the reconfiguration of organisational processes and structures to integrate sustainability into the business model. In practice, this may involve retraining personnel, reengineering production processes, creating new supply chains for alternative fuels/materials, and institutionalising sustainability as a fundamental strategic priority.

2.5 Paradox Theory

The Paradox, defined as “contradictory yet interrelated elements that exist simultaneously and persist over time” (Smith & Lewis, 2011) has three primary characteristics: opposition, interdependence and persistence.

- i. **Opposition.** These paradoxes include organisational elements that appear logical in isolation, yet irrational when it appears simultaneously (Lewis, 2000).
- ii. **Interdependence.** The opposing elements of these paradoxes must be wholly and inextricably linked i.e., be mirror images of each other (Lewis, 2000).
- iii. **Persistence.** The tensions of these paradoxes defy definite resolutions due to persistence over a period of time (Smith & Lewis, 2011).

Companies are inherently faced with tensions (Fortes, et al., 2023), when carrying out standard operational activities. The integration of sustainability and imperative for green transition offers a specific set of additional tensions that span economic, social and environmental spheres (Hahn, et al., 2015). The paradox identified in this study, stems from the human resistance and practical obstacles that impede the integration of green technologies into standard practices in order to achieve sustainability objectives.

Paradox Theory broadly refers to seemingly contradictory elements existing simultaneously in a given case. The implication is that contrary factors often depend on each other within organisational networks and may coexist as well as interact with each other (Carmine & De Marchi, 2022).

A major challenge facing the cement industry is reducing CO₂ emissions while simultaneously meeting global demand (International Energy Agency, 2023). Better understanding of such paradox within this context would entail exploration of the impediments and challenges that organisations in the industry face in the process of adopting sustainability strategies (Sahoo, et al., 2022), along with the technologies that would enable its implementation. These tensions of paradoxical strategic transformation can be observed through corporate actions such as operational change management, financing and budgeting, technological integration, shifts in organisational culture and transaction costs brought on by process disruptions.

Furthermore, an examination of the role of governmental policies and regulations in shaping the landscape of green transition via technology adoption through both supportive and inhibitory policies could foster understanding. Most literature focus on a single level of analysis at a time, without taking the relationships between individuals vs. their organisations, as well as the organisation vs. the industry i.e., systems of which they are a part (Carmine & De Marchi, 2022). This oversight in examining the possible interconnection between paradoxical tensions, paradoxical thinking and paradoxical strategies/actions, fosters misrepresentation and limits understanding. By focusing on the interconnectivity of the elements in the system of industrial green transition, the

phenomenon can be logically explained in a way that would not be possible through mere analysis of its parts (Bansal & Song, 2017). Thus, an understanding of the paradoxical elements influencing investments in green technologies for the purpose of net-zero a.k.a. green transition, would contribute to the acceleration of the objectives, and potentially reduce the colossal carbon footprint of the cement industry.

Climate-related policies and regulations in the EU

To overcome the challenges of climate change and its associated social and environmental impacts, the European Commission championed several policy packages to manage the risks and build resilience by guiding the transition to a green and sustainable economy. The table below describes the major policies and regulations aimed at supporting EU member states in reaching that objective.

Table 2.2. Summary of the relevant guiding policies and regulations (European Commission, n.d.)

	Policy actions	Description
1.	The European Green Deal	With the conviction that economic growth should be decoupled from resource use, the EU Green Deal aims to mobilise funding and facilitate investments for the transition to a climate-neutral, competitive and inclusive economy by 2050.
2.	The Green Deal Industrial Plan	The Green Deal Industrial Plan was designed to support the scale up of manufacturing capacity for the green technologies and products required to meet the net zero climate targets of Europe.
3.	The EU Climate Law	The first EU Climate Law was adopted in 2021, outlining the target of reducing emissions by 55% till 2030,

		compared to 1990. A further target of 90% less emissions by 2040, was recommended in February 2024.
4.	Net-zero Industry Act	The Net-Zero Industry Act aims to increase the production of net-zero technologies in the EU, with boosted resilience and competitiveness.
5.	The EU Cohesion Policy	The EU Cohesion Policy is focused on strengthening the economic, social and territorial cohesion within the bloc. Given that in addition to correcting imbalances among member countries/regions, its objective is to deliver on the green and digital transition policies, €118 billion of the Policy funds have been dedicated to green transition by 2027.
6.	Fit for 55 Package	The Fit for 55 packages is a compendium of legislative proposals and amendments to existing EU legislation aimed at turning the climate objectives into law and actualise the green transition.
7.	The EU Emissions Trading System (EU ETS)	The EU ETS is the major global carbon market in support of the greenhouse gas emissions reduction policies. The System was updated to include more activities aimed at accelerating the green transition. This enables more revenue generation for reinvestment in vehicles for innovation, climate action, etc.

Financial incentives for green transition

Successful implementation of green transition initiatives requires massive upfront investments. The European Commission has mobilised significant funding avenues through multiple programs and channels in support of the deployment of low-carbon energy technologies and other solutions that increase the energy efficiency of buildings. The question remains how informed companies are of the availability of these instruments

and the ease of access to these resources. Available financial instruments (European Commission Directorate-General for Climate Action, n.d.) aimed at accelerating the green transition are illustrated in the table 2.3.

Table 2.3. Summary of the major public financial instruments in support of green transition.

	Instrument	Objective
1.	The EU Solidarity Fund	This is an instrument of support in response to disasters, particularly those related to climate. Approximately EUR €2.1 billion has made available to thirteen EU member States in the aftermath of climate disasters since 2019.
2.	Innovation Fund	This instrument supports the financing of innovative low-carbon technologies to foster solutions in support of the aim of reaching climate neutrality.
3.	The Modernisation Fund	This fund aims to support beneficiary member countries to achieve their particular climate targets and the objectives of the EU Green Deal.
4.	LIFE Climate Change Mitigation and Adaptation program	The LIFE program is constituted by four sub categories: (i) “Nature and biodiversity”, (ii) “Circular economy and quality of life”, (iii) “Climate change mitigation and adaptation”, and (iv) “Clean energy transition”. The financial allocation is designed to support the development and implementation of innovative methods of climate change response.
5.	Invest EU Program	This program leverages the EU budget guarantee to crowd in other classes of private or public investors for investments in high priority policy areas such as the green and digital transition, innovation and skills.

6.	Just Transition Fund	Supporting the transition towards climate neutrality by alleviating its socio-economic impact in the regions most affected Commission provides support to Member States having identified the territories expected to be the most negatively impacted by the transition towards climate-neutrality.
7.	The European Regional Development Fund (ERDF)	This fund supports both public and private bodies in all regions within the EU. It aims to reduce economic, social and territorial disparities via investments in targeted national or regional programs focused on industry competitiveness, green transition, sustainability, etc.
8.	Connecting Europe Facility (CEF)	This is a funding instrument aimed at promoting growth, jobs and competitiveness through a Europe-wide targeted infrastructure investment in the areas of transport, energy and digital services.

2.6 Summary

While the cement industry in other developed countries is reaching a demand plateau because of infrastructural saturation requiring only upkeep and maintenance, it is not the case for lower-income countries in the SEE region, or lagging EU member states, for whom the modernisation fund is intended (European Commission, 2021). In the latter countries, demand is increasing due to local economic specificities such as people preferring to invest their savings in real estate and a largely tourism-dependent economy (Statista, 2023).

The financial implications of net-zero transition for industrial players has neither been addressed by existing literature from the company perspective, nor from the perspective of a confluence of paradoxical tensions. Furthermore, with macro and industry trends favouring the transition, the particular actions that must be taken to create value and ensure favourable competitive positioning is needed.

Despite the allowances made in the Just Transition Mechanism, many issues such as access to timely information, convoluted processes, etc., in addition to unfavourable practices such as greenwashing, tech buzz and so on, moving the green transition process forward would require insights that would foster better management of risks, stimulate private capital and industrial optimisation. Thus, impediments to accelerated green technology adoption as it relates to competitiveness and paradoxical tensions among stakeholder groups would be investigated this study in order to determine the extent of its impact on corporate actions and outline a sustainable way forward for energy intensive industries.

CHAPTER III: METHODOLOGY

3.1 Overview of the Research Problem

The cement industry involves both extractive and manufacturing activities which leaves a significant negative impact on the environment. A significant problem with corporations in the cement industry in Southeast Europe concerns the lack of integrated approach for social, economic and environmental dimensions (Poudyal & Adhikari, 2021). Poudyal and Adhikari (2021) argued that regardless of extensive research on green techniques of reducing environmental impacts of cement production, commercial implementation is still stalled, and may occur only if there is a real synergy between sustainability and profitability. Moreover, the implementation will only be more rapid when the proposed approach takes into equal consideration the multiple dimensions (social, economic, and environmental) of sustainability (Ighalo, et al., 2020).

Given that most of the current studies, prioritised environmental aspects of the transition, lacking exploration into the socio-economic and governance aspects, combined with the fact that commercial scale up of green technologies would be impossible without clear economic value to plant owners and key stakeholders such as investors, the primary research problem became ***the factors behind the slow uptake of green technologies in the cement industry in South East Europe.***

Despite its necessity and economic contribution to GDP, the cement industry faces many challenges due to environmental concerns and sustainability issues (Yi and Liu, 2022). These challenges include but are not limited to:

- the energy intensity of the industry whose needs are met primarily from fossil fuels like coal and petroleum coke, which contribute significantly to both carbon emissions and operating costs,
- natural resource intensity in the form of extreme water usage and environmental degradation from extraction of raw materials such as limestone, clay and gypsum,
- air pollution including harmful particulate matter such as nitrogen oxides and sulphur oxides which are dangerous to human health,
- high upfront costs of green technology implementation (carbon capture technologies, alternative fuels, low-carbon production methods, water conservation & recycling systems, etc.) requiring significant capital investments and continual R&D,
- lack of substitutes for clinker, which is a key ingredient and the most carbon intensive component.

Understanding the particulars of why the green technology adoption rate is slow, may uncover the aforementioned business concerns which could negatively impact the economic position of the corporations under regulatory obligation to change, and their competitive position. This could be the underlying reason why, to appear aligned with environmental sustainability, many resort to greenwashing and other superficial actions (Barbhuiya, et al., 2024), or spend public resources on popular but suboptimal technologies with potentially questionable impacts. Therefore, a subordinate problem that emerged from the first, as corporations attempt to comply with sustainability directives, was *the trend of corporate greenwashing*.

Thus, a major issue in the pursuit of climate neutrality is that such extremely capital and energy intensive, heavy industries with an inherent negative impact on the environment, are either lagging in green technology adoption and CO2 emissions reduction (Sahoo, et al., 2022), or making superficial modifications.

The issues this study would examine concern the slow uptake of green technologies in the industry could be driven by: (a) **costs of green transition** in the industry and (b) the **timeframe of green technology development, acquisition and integration**. It would also attempt to identify the contributors to the **greenwashing phenomenon** and how to curb it within the context of market and environmental forces. Hence, to deal with this aspect of anthropogenic climate change, the paradox of green technology adoption in the cement industry is worth unentangling in order for new pathways and business models to be uncovered in the transition to net-zero industrial practices.

3.2 Operationalisation of the Theoretical Constructs

This research operationalised the theoretical constructs of Dynamic Capabilities Theory, Institutional Theory, Stakeholder Theory, and Paradox Theory into measurable and analysable dimensions to examine green technology adoption in the cement industry in South East Europe. The construct of dynamic capabilities was translated into three observable dimensions:

- sensing opportunities and threats (e.g., proactive identification of emerging and necessary green technologies and regulations),

- seizing opportunities (e.g., investment decisions in sustainable technologies and processes), and
- transforming or reconfiguring organisational processes (e.g., restructuring operations and workforce skills to align with low-carbon strategies).

Institutional pressures were operationalised as:

- coercive (e.g., compliance costs from carbon pricing and mandatory reporting),
- normative (e.g., industry standards and professional norms promoting sustainability), and
- mimetic (e.g., imitation of competitors' green initiatives).

From Stakeholder Theory, pressures and expectations were captured by mapping the salience of key stakeholders (e.g., investors, regulators, local communities, customers) and the influence of their environmental demands on corporate decision-making.

Finally, the construct of paradoxical tensions was operationalised through qualitative coding of managerial narratives that revealed trade-offs between short-term financial performance and long-term environmental goals, as well as conflicting pressures to innovate while maintaining operational efficiency.

These constructs were measured using a mixed-methods approach combining firm-level quantitative indicators such as capital expenditure on green investments, carbon intensity, and return on invested capital (ROIC). Qualitative data was derived from interviews, industry and sustainability reports to capture the underlying organisational sensemaking and strategic dilemmas. This operationalisation enabled robust empirical

testing of the theoretical propositions while preserving the contextual richness of the phenomena under study.

3.3 Research Purpose and Questions

The purpose of this study was to explore how the green transition could significantly reduce carbon footprints in the cement industry via green technology integration, while balancing the paradoxical relationships between short-term business outcomes, stakeholder interests, and longer-term environmental goals. It focused on exploring the potential inhibitors of green transition in the cement industry in the SEE region, how the integration of climate friendly technologies could be accelerated, and the particular ways that overcoming the identified challenges could ensure positive outcomes for both the net-zero objectives of the industry, and the competitive position of the corporation.

Research objectives

The aim of the research is to examine the paradoxical relationship between the climate-driven urgency for industrial process reorganisation and the real costs of green technology integration.

Delving deeper, the scope of this objective entailed examining the capacities of management for dealing with paradoxical tensions, identifying the real costs of green transition at company level, and assessing the type of technological investments required. Additionally, other non-technology investments were explored, alongside estimates of the general implementation timeline of green technologies from R&D stage to full industrial

scale integration, as well as the prevalence of greenwashing practices, its drivers, and effective prevention methods.

This study acknowledges that a transition to a net-zero economy is essential for the climate goals to be achieved (Muench, et al., 2022). For true decarbonisation to happen, cornerstone industries with significantly higher energy intensity have to be supported through their transitions (Poudyal & Adhikari, 2021). However, the methods of implementation of the various transition strategies, the real costs, and implications of such change on business operations are unclear from the outside view. Additionally, the discrepancy between declarative sustainability goals and daily business realities requires further examination.

Primary Research Question

RQ1. How could paradoxical tensions between differing interests be managed to enable cement companies meet their net-zero targets while maintaining profitability and market competitiveness?

Secondary Questions

RQ2. How effective are the available “green” financial instruments for deep decarbonisation of industrial processes?

RQ3 What are the overt and covert costs of decarbonising the cement industry?

RQ4 How long does it take for essential green technology to move from the research and development (R&D) phase to full industrial integration and return on invested capital?

RQ5 How can corporate leaders in the cement industry assess and prevent greenwashing practices?

These questions sought to address the identified problems surrounding industrial green transition such as the true costs, the phenomenon of greenwashing, and the impact of the timing of technological transition from innovation to integration and return on investments (ROI). They supported the investigation into the interconnections between key stakeholder groups (Fortes, et al., 2023) as well as the three aspects of: (a) paradoxical tensions, (b) paradoxical thinking, and (c) paradoxical strategies/actions (Lewis, 2000), in ways that were relevant to the green transition of the cement industry in South-East Europe.

3.4 Research Design

A mixed method research approach was used in this study. It allowed for a deeper exploration of the research questions by utilising a blend of qualitative and quantitative data. Since this study collected and analysed both quantitative and qualitative data, the researcher could draw more meaningful conclusions.

Since the research on the green technology adoption and competitiveness within the context of the cement industry is relatively limited (Guo, et al., 2024; Poudyal & Adhikari, 2021), a qualitative approach was an ideal research design for this study (Yin, 2009). Due to the issues that often emerge when conducting research on an under-studied topic i.e., poor operationalisation of constructs, lack of prior research to guide the development of study hypotheses, the use of only a quantitative research design in this study would most likely limit the study outcomes (Ospina, 2004; Yin, 2009). In contrast,

a primarily qualitative approach via case study (Zikmund, et al., 2013), emerged as the most likely to provide a detailed and holistic picture of the realities of green technology adoption in the cement industry.

However, given the numeric nature of business and the investment related issues the study aims to uncover, some quantitative elements would inevitably be included. In order to fulfil the objective of optimising the economics of investments in sustainable solutions within polluting industries with high carbon footprints, the quantitative research could lead to potentially finding patterns and averages, making predictions, testing causal relationships, and generalising results to wider populations.

Case Study Design

The case study is appropriate in this case because there is a need for thorough understanding of a key aspect of a critical global challenge, in its real-life context. According to Yin (2003), case studies can be used to *explain*, *describe* or *explore* events or phenomena in the everyday contexts in which they occur. His work elaborates further that the case study is an empirical investigation into a contemporary phenomenon within its practical context, using multiple sources of evidence, particularly when there are no apparent boundaries between the phenomenon and the context (Yin, 2009).

Building upon the work of Phondej (2011), the unit of analysis in this study is the relationship between the level of investigation and the subsequent analysis. Croatia has been selected as the primary country in Southeast Europe to be examined, the industry has been established as cement production, and the most appropriate participants for

interviews are senior executives and expert advisors operating in that specialised industry (Phondej, et al., 2011).

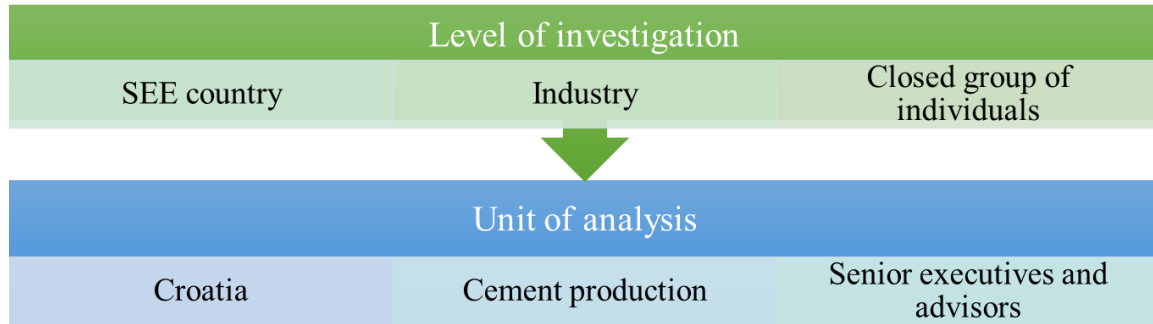


Figure 3.1 The relationship between the level of investigation and the unit analysis.

In this study, the context is the necessity for reducing the adverse climate impact (a contemporary event) of a highly essential industry, in a region of Europe where there is still a growing need for buildings and infrastructure (Radovanović, et al., 2022). The phenomenon is that some corporations in the industry seemed to be resorting to greenwashing practices, or superficial adjustments that do little to reduce their carbon footprints i.e., transition to net zero. The “why” is steeped in speculation among the various stakeholder groups, whereas the “how” is elusive.

Given the urgency of climate change mitigation and adaptation (Barbhuiya, et al., 2024), understanding the phenomenon as a means of developing relevant solutions is of utmost importance. Thus, the case study is an appropriate strategy to explain the presumed causal links among the variables.

Table 3.1 Overview of the process of determining the research design inspired by Venkatesh et al., (2016) and Yin (2009).

<i>Design steps</i>	<i>Description</i>	<i>Justification</i>
1. The context	An identified discrepancy between declarative corporate sustainability goals, the integration of disruptive green technologies and climate outcomes. Given the primary involvement of corporations active in both extractive and manufacturing activities, the role of regulators and financiers who all affect and are affected by the market, there is no clear, single set of outcomes for the investigation.	The most logical plan to answer the research questions is via a case study.
2. Design of the case study	The case study concerns the effects of decisions made by the leadership of the corporation, policymakers and investors (both institutional and private). Although these leaders seem to agree on the same overarching goal (sustainability), their perspectives, risk exposure, financial burden and pressures are vastly different. This results in paradoxical tensions and contradictory behaviours.	An embedded, single case design, with different data collection techniques, would allow the phenomenon to be examined in full operational detail.
3. Research method to best address the research questions	The study has five interrelated and multi-disciplinary research questions with a perspective that could be considered emergent in the field of green transition of heavy industries such as the cement industry which is in focus.	Mixed-methods research strategy would give a complete and diverse picture, while compensating for the weaknesses of purely qualitative approach.

Optimal Research Method

Considering the subject matter of transition to a sustainability-driven process within a corporation while maintaining or enhancing competitive position, the context calls for a qualitatively-driven research design with the addition of some quantitative elements to foster deep understanding, enhance objectivity and reliability. This approach aims to test or benchmark ideas generated from the collection of qualitative data with other numerical and financial data, while maintaining the interdependent relationship between data collection and data analysis (Hesse-Biber, et al., 2015).

Hesse-Bieber, et al. (2015) presented a distinction between qualitatively-driven and quantitatively-driven research approaches compared on several key research dimensions along a subjective-objective continuum. The table below presents their work:

Table 3.2 A comparison of qualitatively-driven vs. quantitatively-driven mixed method research approaches (Hesse-Biber, et al., 2015).

<i>Parameters</i>	<i>Qualitatively-driven</i>	<i>Quantitatively driven</i>
1. Ontology: nature of the reality	Multiple social realities	A concrete social world exists “out there.”
2. Epistemology: What can be known and who can know it	Objective of understanding multiple subjectivities. Individuals are the “experts.” Understanding human behaviours via inter-subjectivity. Absence of a definitive subject-object split in knowledge building.	Ascertaining “the truth” is the objective in order to predict and even uncover “laws” of human behaviour through objective social inquiry. Scientists are the experts.
3. Types of questions	The purpose of this research is to understand (“the what”, “the	Statement of relationship between independent and

	how” and “the why”)	dependent variable. Questions are phrased as hypotheses
4. Type of data collected	Naturalistic Settings: fieldwork, or in-depth interviews, or focus Groups Unobtrusive Data: Documents	Surveys, Experiments: Randomized Controlled Trials (RCTs) Systematic reviews/meta-analyses
5. Type of analysis	Inductive: Goal is to generate theory. Seeks out general themes/patterns in the data. Uses “thick description.” Compares and contrasts thematic data. Examples of Specific types of analyses include Grounded theory, narrative analysis, etc.	Deductive: Test out hypothesis. Explain variation in the “independent variables” by controlling the “dependent variables.” Stress is placed on statistical measurement
6. The goal	Get at a point of understanding a “process” or phenomenon	Generalise, predict and control research outcomes

Based on the above as well as the works of Yin, (2009) and Venkatesh, et al., (2016), a qualitatively-driven mixed-method approach has been determined to be the most appropriate for this study. Given the complex nature of the research questions, involving the corporation which is a semi-closed system, combining both quantitative and qualitative methods would meet the quality criteria and provide a more in-depth insight into the research questions than either method independently.

To further verify the chosen method, it was benchmarked against the seven purposes for mixed methods research presented by Venkatesh et al., (2013), which are complementarity, completeness, developmental, expansion, compensation, corroboration/confirmation, and diversity, suit the purposes of this study. The study design fits the following criteria:

- **Complementarity:** gaining viewpoints about similar experiences via interviews with management of two corporations as well as external stakeholders such as specialised advisors, financial institutions and advocacy groups,
- **Completeness:** ensuring that total representation is attained,
- **Corroboration/confirmation:** assessing the validity of inferences gained from one method through variety,
- **Compensation:** counteracting the weaknesses of qualitative method over quantitative, and,
- **Diversity:** gaining alternate viewpoints of the same experiences (Venkatesh, et al., 2016).

In light of the above, a case study design best suits the purpose of this study as it supports the goal of understanding the underlying reasons behind the prevalence of greenwashing and the lag of green technology adoption in corporations within the cement industry, despite the pressures for sustainability.

There is an apparent need for a systematic investigation that would capture the perspectives and perceptions of industry participants in order to understand the context of such complex and paradoxical phenomenon. Thus, this study would be a qualitatively led

mixed-methods research with the inclusion of quantitative data to determine risks, potential costs and trends.

3.5 Population and Sample

Population

There are three study populations: (a) organisational population, (b) internal stakeholders' population and (c) external stakeholders' population.

I. Organisational population and sample:

Population

The organisational population consists of 109 (n=109) companies in the cement industry from 10 SEE countries. A purposive sample of 3 countries (Bulgaria, Croatia and Romania) was selected for this study. Table 3.3. shows 10 countries in the SEE region. The selection criteria for firms include size, industry relevance, and willingness to participate in the research on Greentech integration.

Table 3.3. The countries in Southeast Europe in this study.

○ Albania	○ Bosnia & Herzegovina	○ Bulgaria	○ Croatia
○ Kosovo	○ Montenegro	○ North Macedonia	○ Romania
○ Serbia	○ Turkey		

The selection criteria for the three study countries include the fact that they are EU member states, have a common regulatory framework, particularly in regards to the EU Green Deal and the accompanying benefits/obligations for carbon neutrality.

The total number of cement companies in the SEE region is 109. Table 3.4. presents the number of the cement companies in the SEE region.

Table 3.4 Number of cement companies in Southeast Europe (The global cement report, n.d.)

Country	Number of companies	Country	Number of companies	Total
Albania	4	Montenegro	0	
Bosnia & Herzegovina	2	North Macedonia	1	
Bulgaria	5	Romania	10	
Croatia	5	Serbia	3	
Kosovo	1	Turkey	78	
Total	17		92	109

With the exception of Montenegro, all the cement companies have operations across the SEE region. It usually consists of a multinational corporation operating in the country via local subsidiaries i.e., individual companies registered to perform specific aspects of operations. Some of such companies operate as cement plants, concrete plants including ready-mix, grinding facilities, aggregates facilities, quarries, etc. These companies may or may not bear the exact name of the parent corporation.

The term corporation in the study refers to the multinational company at Group level, while company refers to the individual companies within the organisational population.

Sample

The purposive organisational sample was taken from the organisational population. From the total of 109 companies, the sample size is 20 (n=20) companies within the three EU member states of SEE region. They were selected because they compete under the same environment, face similar pressures, provide a unified parameter

for evaluation of the research phenomenon. Given that corporations in the cement industry are consolidated, meaning that they tend to be few in number due to acquisitions and/or corporate mergers, as well as the fact that they operate in multiple countries, several companies could fall under a single corporation. As the focus of the study is on the three EU member countries in the SEE region, the corporations active in the region are illustrated in table 3.5.

Table 3.5 Cement corporations in the three EU member states in the SEE region and the companies of their operations. (Edwards, 2019).

Country	Parent corporation	Companies
Bulgaria	1) Heidelberg Materials from Germany	i) Heidelberg Materials Devnya JSC ii) Heidelberg Materials Vulkan JSC
	2) Lafarge Holcim Group, the Swiss multinational	iii) Holcim Bulgaria AD iv) Zlatna Panega Cement AD
	3) Titan Cement Group from Greece	v) Zlatna Panega Beton EOOD
Croatia	1) Heidelberg Materials	i) CEMEX Croatia
	2) Lafarge Holcim Group	ii) Holcim Croatia
	3) CEMEX Group from Mexico	iii) Lafarge Croatia iv) NEXE Group, the sole national cement company
	4) Cementos Molins, Spain	v) Calucem d.o.o.
Romania	1) Heidelberg Materials	i) Carpatcement Holding, owned by Italcementi, a part of Hidelberg Cement Group.
	2) Lafarge Holcim Group, the Swiss multinational	
	3) Cementir Holding from Italy	ii) Heidelberg materials romania SA
	4) CEMEX Group from Mexico	iii) Holcim Romania SA iv) Lafarge Romania
	5) Titan Cement Group	v) Romcim SA

-
- vi) CELCO SA
 - vii) Cemex Romania
 - viii) Cemrom SA
 - ix) Xella ro srl
 - x) Ciment Titan
-

These enterprises are fundamental to the cement industry in South East Europe and are involved in various extents of investment in green technologies, decarbonisation strategies, and participation in the EU Emissions Trading Scheme.

The cement industry was chosen for this context as it is one of the extremely energy intensive and most polluting industries in the world (The Loreti Group, 2008). Between five and seven percent of the world's total emission of greenhouse gases is caused by cement production, which is an essential input product in building and construction sector (Barbhuiya, et al., 2024; European Cement Association, 2020). Considering its extractive and manufacturing aspects, the entire process across the value chain is both resource and energy intensive, and despite promising new innovations on the horizon, there is no product as yet that can be effectively substituted for cement to meet the material, infrastructural and building demands.

II. Internal stakeholders' population and sample

Population

Determining the exact number of executive managers in the cement industry in Southeast Europe was challenging as they vary significantly, depending on the size and scope of the company, as well as internal the organisational structure. With the current total number of 109 cement companies in the SEE region, an estimate extrapolated from

corporate reports, and some company websites show the number of executives to range between six and ten in a given corporation. Given the transnational and closed nature of the companies, it was not possible to ascertain at this point whether each executive is local to the country office, or manage local teams from the regional hubs or headquarters. To simplify the calculation of population, the base assumption is that each company has its own management unit. Thus, an average of 8 executives per company. When multiplied by the number of companies, the estimated average population is (8×109) , which is 872 executives.

The target population of internal stakeholders in the 20 companies within the three EU member states of SE Europe comprises 75 senior executive managers (*3 in ten companies, 4 in five companies and 5 in the remaining five companies, totalling 75*). They are responsible for decisions on corporate strategies which include the mode of net-zero transition, and the green technologies that would enable it.

Sample

Considering the necessity for a good and diverse sample to assure validity (Berger, et al., 2009), the study sample features a diverse range of internal and external stakeholders. The internal stakeholders comprised of six executive managers from three multinational corporations: (i) Holcim Hrvatska, a member of Lafarge Holcim, present across SE Europe, producer of Portland cement (ii) Cemex d.d., that is also operating in the non-EU region and (iii) a multinational corporation that is active across the SEE region, whose executives participated under conditions of anonymity.

These specific corporations within cement industry were selected for investigation because they met the following criteria:

- they are multinational corporations in the cement industry;
- they have operations located in the Southeast Europe, including the three EU member states Bulgaria, Croatia and Romania,
- they are engaged in green technology activities aimed at decarbonising their operations, and
- sufficient information such as annual, corporate and ESG reports are readily available.

Specific personnel within these corporations were selected because they are directly involved in the decision-making process of investing, integrating and implementing green technology initiatives within the corporate strategies. They are also well positioned to provide insight into green technology practices in the cement industry.

Two participants from each selected corporation participated in the study. They are males/females between the ages of 35 and 55 who have similar education and income levels. They hold the following positions: CFO or investment director, Head of innovations & sustainability projects, as well as Operations director. The participants were selected based on their roles, level of familiarity with the industry, and the authority they possess.

III. External stakeholders' population and sample

Population

The key external stakeholder population consists of policy makers, financial institutions, cement industry advocacy groups and industrial technology experts in SE Europe. The target population of external stakeholders is comprised of green technology consultants specialised in heavy industries including cement production. Much like the industry, expert consultancy service providers are highly specialised and operate internationally. Some cement industry consultants include Onestone Consulting in Bulgaria, PEC Consulting Group, Technic Consulting Engineering Romania, JAMCEM consultants, etc.

Industry associations serve as key intermediaries between policy makers and corporations, often mediating, serving as spokespersons and influencing policy directions. Such organisations include CEMBUREAU: the European Cement Association is based in Brussels, which is the representative organisation of the cement industry in Europe. Members of the organisation are national cement industry associations and cement companies of the European Union (except for Malta) and includes Norway, Switzerland and the UK. Croatia, Serbia and Slovakia are Associate Members of CEMBUREAU. On national level, industry associations such as Croatia Cement, carry out their work within national borders and coordinate with the international organisations.

Executive level individuals from this population are well positioned to provide the necessary insights that would address the issues under investigation. Primarily, how the

cement industry could significantly reduce their carbon footprints, while balancing the paradox of short-term business goals with longer term environmental outcomes.

Sample

The study sample of external stakeholders comprised of two innovation experts working on green technology integration in the cement industry in the Southeast Europe region, two financial institutions (an International Finance Institution (IFI), and a commercial bank), and one representative of the cement industry association. They were selected based on the insights they could provide on the paradoxical tensions and financial decision-making such as expectations of returns on investment and realistic period of stable green technology integration at scale.

Participants were solicited via a timely, formal written request to the CEO for an in-person meeting with the individuals on-site or online. Personal contacts enabled access to the leadership of such organisation. After permission had been granted by both the CEO and the participant, a field visit or video call was organised.

Visiting the participants at their premises was the most beneficial option because, in addition to reducing the transaction costs for the executive, it provided an opportunity for the researcher to observe the natural, daily operation of the company, and leave space for more organic inputs after the formal meeting is concluded. When site visits were not possible, a virtual meeting was set up as a last resort.

3.6 Participant Selection

The four phases of the participant recruitment process proposed by Berger et al. (2009) were adapted and applied in this study. These phases include: a) generating the

initial contacts by carrying out activities to identify potential participants, (b) screening to determine their eligibility, (c) informing potential participants about the study, including its risks and benefits i.e., seeking consent, and (d) enrolment and retention of eligible participants in the study.

I. Generating initial contacts

The first phase is in carrying out desk research of the company through their corporate website and press statements to identify the basic management structure, their actions and overall public approach to green technology integration. The geographical location of the management team was determined as it was important to note if the executives manage operations from the location of the plant, or in an administrative building elsewhere. Initial contacts were generated by leveraging professional contacts, accessing working groups of the industry association and attending industry events. Afterwards, a list of potential participants was drawn up.

II. Screening

The inclusion and exclusion criteria were determined in this phase, as it relates to the research objectives and who was best placed to support its achievement. The eligibility criteria were applied to the list of participants from the previous phase to the extent possible for such a relatively homogenous group, has been set up to maximise diversity.

Additionally, the researcher determined the participants to whom access is possible by leveraging existing personal and professional networks. After the final list has been drawn up, screening phone calls were made by the researcher to build rapport, instil motivation and gain soft commitment of the potential participant. During the call, the

researcher ensured that there was responsiveness to the personal objectives of the potential participant.

III. Consenting

In this phase, a detailed invitation letter containing information about the study, seeking permission and granting assurance of respect of confidentiality was drafted and sent to the CEOs of the selected organisations. Within the letter, the research objectives were clearly elaborated and assurances of efficiency such as reduced transaction costs by making site visits, clear time expectation (1 hour) and good faith approach, were emphasised.

IV. Enrolment and retention

Onboarding of participants involved coordinating with the organisation and setting the dates for the interviews, sharing the questions ahead of time so that the participants could be prepared beforehand, and reinforcing the benefits of participating in the study to incentivise the hard commitment. A thank you letter was drafted and sent after the visit and interview, with information regarding what happens next.

Regarding interview data analysis, three major steps were performed: coding the data, combining the codes into broader categories and themes/theme clusters, and interpreting the results (Creswell, 2008; Sinkovics et al., 2005). This ensures a systematic approach that could be replicated and further examined.

Ethical Assurances

Companies are the driving force behind the research. In designing the study, existing corporate privacy protection practices such as non-disclosure agreements, GDPR

regulations, etc., were kept in mind. Before the interview, a letter detailing the objectives of the research and request for meeting were sent to the CEO of the corporations. It contained sufficient information for informed consent to be made.

Some assurances included engaging in a fully transparent process at every stage, providing clear communication so that participants knew what to expect, and offering guarantees of absolute confidentiality for both company and individual participants during and after the research.

3.7 Instrumentation

The research employed a combination of quantitative and qualitative instruments to collect data in alignment with the theoretical constructs under investigation. For the quantitative component, a structured data collection template was designed to extract company-level financial and operational metrics from publicly available sources, including annual reports, sustainability disclosures, and European Investment Bank project databases. Key variables captured included capital expenditures on green technologies, carbon intensity per tonne of cement produced, and return on investment timelines for decarbonisation projects.

Regarding the qualitative component, a semi-structured interview guide was developed to evoke in-depth insights from senior executives and industry experts concerning organisational responses to institutional, stakeholder, and paradoxical pressures in the green transition. The guide comprised open-ended questions aligned with the dimensions of the theoretical framework, enabling flexibility while ensuring consistency across interviews.

Additionally, a document coding protocol was used to analyse sustainability and policy reports, applying a priori codes derived from the theoretical constructs. All instruments were pre-tested on a small sample of documents and expert contacts to ensure clarity, validity, and alignment with the research objectives, and adjustments were made accordingly. This triangulated instrumentation approach enhanced the rigor of data collection, providing complementary quantitative and qualitative evidence to support a thorough analysis.

3.8 Data Collection, Processing and Analysis

Quality data is essential for a full grasp of the phenomenon under investigation. For this descriptive case study, the researcher employed the following data collection techniques:

- i. semi-structured interviews with study participants, in addition to a qualitative inductive content analysis of multiple sources of evidence including text, images and multimedia and ESG reports on the green technology integration in the cement industry was explored;
- ii. a quantitative analysis was carried out in two formats: (a) primary data from international datasets for relevant statistical analysis, and (b) secondary data from corporate financial statements, investment reports, and business intelligence reports, was carried out to compare companies in the industry, benchmarked against their own historical performance as a means of determining value over time.

To ensure objectivity and credibility, the plan for collection, processing and analysing relevant information in line with the mixed-method design, is summarised below:

Table 3.6. Summary of analytical framework and sources of research data.

Applicable qualitative method	1. Interviews with selected participants in line with established criteria. 2. Content analysis of available secondary data from credible sources including but not limited to text, images and multimedia.
Applicable quantitative method	3. Analysis of financial data from financial statements (income statement, balance sheet, and cash flow statement), as well as investment reports, to calculate ratios that determine profitability of green technology investments. 4. Analysis of relevant datasets on industrial production, energy consumption, and environmental impact, including statistical data on CO₂ emissions, and investments in decarbonisation for cement production.

The data collection method highlights the prioritisation of bias elimination in the study via utilisation of different sources.

3.9 Research Design Limitations

The study is attempting to enhance understanding of a prevalent and subtle phenomenon in a closed, yet highly impactful industry. While this research provides valuable insights into the challenges of green technology adoption in the cement industry in South East Europe, it is not without limitations. The reliance on publicly available financial and sustainability information constrained the depth and granularity of the quantitative data, particularly regarding disaggregated capital expenditures and internal cost structures, which are often commercially sensitive and undisclosed.

Similarly, the qualitative findings, based on a purposive sample of managers and experts, may reflect context-specific perceptions, and may not be fully applicable across all companies or countries in the broader region. Considering that primary insight was derived from these executives and experts, information presented could be skewed to their subjective motivations, perspectives and experiences. This limitation is being mitigated by triangulation of data. Integrating data from other credible sources in a mixed-method approach aims to improve objectivity and assure validity.

Although the cross-sectional nature of the data also limits the ability to capture dynamic changes over time, particularly in a rapidly evolving policy and market environment. Nonetheless, as the industry is highly consolidated and not crowded, the study may be replicated in the similar geographical regions to test its reliability.

Furthermore, although the theoretical constructs were rigorously operationalised, the subjective interpretation inherent in coding qualitative data introduces potential researcher bias, despite efforts to ensure inter-coder reliability. This limitation has been mitigated in the design and sampling. Conducting onsite interviews is also a means of correcting interviewer bias as the environment is wholly unfamiliar and would lend itself well to discovery and objectivity. Additionally, other stakeholders have been included to eliminate both omission and inclusion biases of the sample. To further mitigate researcher bias, the objective of the research was considered at all times, and detailed notes were kept.

Finally, institutional and cultural differences between countries, while acknowledged, could not be fully accounted for in the comparative analysis due to

resource and time constraints. These limitations suggest that future studies might benefit from longitudinal designs, expanded samples, and closer collaboration with industry stakeholders to access more granular internal data where possible. All data in this study has been analysed and tested for confirmation bias.

3.10 Conclusion

The methodology elaborates the best approach to study a key aspect of a critical global challenge, in its real-life context. Given the particulars of the cement manufacturing industry and research objectives, a case study design was the best fit (Yin, 2009).

Furthermore, a qualitatively-driven mixed-method research approach (Hesse-Biber, et al., 2015), was determined to be the most appropriate (Venkatesh, et al., 2016), for the purpose of optimising the economics of green transition in an industry with notoriously high carbon footprint (Poudyal & Adhikari, 2021). The outcome of this study may support the efforts of the cement industry in the SEE region to manage the inherent paradoxical tensions in order to address its significant negative environmental impact while it transitions towards more sustainable production methods without sacrificing its sources of competitive advantage.

CHAPTER IV:

RESULTS

4.1 Introduction

In this chapter, the findings of the research are presented in alignment with the objectives and research questions of the study. The purpose is to understand the inhibitors to effective green transition in the cement industry in the SEE region, and to explore how industry-wide decarbonisation could be accelerated without compromising economic sustainability.

The particular ways that executives in the industry manage the paradoxical relationships between various stakeholder interests, while simultaneously balancing short-term business goals with longer-term environmental outcomes via investments in green technologies that would reduce the carbon footprints of companies, was the focus of the investigation. The necessity to manage internal and external paradoxical tensions, evident in the complex relationships compelled by the climate-driven urgency for industrial process reorganisation, which implies high upfront costs of green technology integration in core processes of cement production, in opposition to equally urgent operational needs, demand new capacities from executives. This would also necessitate an adjustment of frameworks from other stakeholder groups in order to support the net-zero transition of the highly energy intensive sector and critical input supplier of the building sector.

The findings are systematically arranged to promote clarity and coherence, systematically addressing each research question in sequence. The questions are:

- RQ1.** How could paradoxical tensions between differing interests be managed to enable cement companies meet their net-zero targets while maintaining profitability and market competitiveness?
- RQ2.** How effective are the available “green” financial instruments for deep decarbonisation of industrial processes?
- RQ3.** What are the overt and covert costs of decarbonising the cement industry?
- RQ4.** How long does it take for essential green technology to move from the research and development (R&D) phase to full industrial integration and return on invested capital?
- RQ5.** How can corporate leaders in the cement industry assess and prevent greenwashing practices?

The presentation includes both descriptive and inferential data to deliver a comprehensive overview of the findings. This chapter is dedicated exclusively to the presentation of the study's results, intentionally excluding any interpretation, which will be reserved for the discussion chapter. A transition to this analytical phase is included at the end of the results section.

4.2 Overview of Study Participants

The case study results emerged from a careful examination of the data to derive themes in response to the research questions. The primary goal of the data collection and analysis was to determine the level of harmony in the perspectives of both internal and external stakeholders regarding the essential actions for decarbonisation as well as evaluate the level of tension that might emerge from the distance between those perspectives. The data collection process resulted in 12 interviews, of which six interviews

were from internal stakeholders (i.e., employees of cement companies) and six interviews were with the external stakeholders (i.e., finance/investors, researchers, and consultants).

Profiles of the study participants

Stakeholder Categories

To address the topic of green technology integration as a key aspect of decarbonisation in the cement industry, key stakeholders whose actions influence each other were identified and selected. They are decisionmakers whose professional duties impact the state of play in the industry. Thus, their actions directly tighten or release the paradoxical tensions emergent from their differing perspectives concerning the similar objective of Greenhouse emissions reduction.

All the stakeholders have a balanced representation of gender and are EU residents. They are all middle-aged, highly educated, experienced in their respective fields, and well informed.

A total of 12 interviews, both online and face-to-face, were organised and conducted over a period of six weeks. For the internal stakeholders, six interviews were conducted with the company executives with ESG responsibilities, strategic, and operational leadership roles. In addition to the internal stakeholders, six interviews were conducted with policy makers, financial institutions, cement industry advocacy groups and industrial technology experts in the SEE region. Table 4.1. shows the main categories of criteria for both internal and external stakeholders.

Table 4.1. Categories of criteria for Internal and External Stakeholders.

Job Similarity	Demographic Similarity	Job position
○ Decision makers on finance and investment projects. ○ Contributors to corporate strategy and market development. ○ Innovation and material composition expertise. ○ Responsibility for incorporating EU directives on green transition. ○ ESG reporting responsibilities. ○ Contributors to EU investment priorities based on policy.	○ Males and Females ○ Ages 35 to 55 ○ Similar education level (university degree/master degree/doctorate) ○ Minimum of 10 years industry experience ○ Residents of the EU	○ Sustainability director ○ Project and quality control director ○ Sustainability and corporate affairs director ○ Fuels and CO2 manager ○ CFO ○ Country Head ○ Associate Professor ○ Director ○ Consultant

Internal stakeholders

Internal stakeholders i.e., participants within the companies, have ESG reporting obligations, deep market outlooks, and they design or contribute to the strategic direction of the company. In certain circumstances, strategic guidance is directed by the parent company/headquarters in western Europe, while participant stakeholders make adjustments and recommendations in line with local realities. The job titles and responsibilities span from upper middle to top management. In most cases, the operational

tasks are broader than the titles themselves convey. For instance, ESG and sustainability reporting also falls under the domain of a CFO or finance manager in some cases.

Table 4.2. shows the personal interview schedule for internal stakeholders and other statistics.

Table 4.2 The personal interview schedule for Internal Stakeholders.

Participant ID	Interview Date	Interview Duration (minutes)	Signed Informed Consent	Interview Performed
N121C	12/12/2024	50	Yes	Online
N122C	12/12/2024	45	Yes	Online
N115C	12/12/2024	75	Yes	Online
N311CR	27/12/2024	30	No	Online
N312CB	27/12/2024	30	No	Online
N411CS	15/01/2025	40	No	In person

At the behest of the companies, all but one of the interviews were conducted online, with an average duration of 45 minutes.

Demographic findings for Internal Stakeholders

The demographic findings for the six internal stakeholders reflected four key elements: gender, educational level, country of residence, and years in the industry. Table 4.3 shows the demographic statistics for internal stakeholders.

Table 4.3 Demographic statistics for Internal Stakeholders.

Participant ID	Gender	Educational level	Country of residence	Industry experience (years)
N121C	M	Bachelor's	Croatia	10.5
N122C	M	Bachelor's	Croatia	12
N115C	F	Bachelor's	Croatia	25

N411CS	M	Master's	Croatia	12
N311CR	M	Master's	Bulgaria	16
N312CB	F	Master's	Romania	10

Internal stakeholders possessed a minimum of 10 years industry experience and 25 years maximum. The three EU member states in the SEE region were reflected in the choice of participants, and with over 60 percent male and the female, the gender diversity is reflected in accordance with the realities of the industry.

External Stakeholders

External stakeholders are grouped in two categories: (a) institutional investors, project funders (Category I), and (b) academics, consultants, innovation experts (Category II). Table 4.4. shows the personal interview schedule for external stakeholders and other statistics.

Table 4.4 The personal interview schedule for External Stakeholders.

Participant ID	Interview Date	Interview Duration (minutes)	Signed Informed Consent	Interview Performed
E311X	10/12/2024	75	Yes	In person
E661X	11/12/2024	60	Yes	In person
E511X	29/10/2024	60	Yes	In person
E872X	16/01/2025	60	Yes	In person
E982XT	30/12/2024	45	No	Online
E361XT	16/01/2025	55	No	Online

Four out of six conversations with the external stakeholders were in-person, at the location of the participant. The average duration of the interviews was 59.17 minutes.

Demographic findings for external stakeholders

The demographic findings for the six external stakeholders, which included two representatives of premiere financial institutions, an innovation expert working on green technology integration in heavy industries across the SEE region (including the cement industry), an academic with expertise in new building materials, and two EU project development consultants.

The four major elements considered are: gender, educational level, country of residence, and industry experience. All of them (100%) provided the demographic information presented. Table 4.5 depicts the demographic statistics for external stakeholders.

Table 4.5 Demographic statistics for External Stakeholders.

Participant ID	Gender	Education level	Country of residence	Industry experience (years)
E311X	F	Doctorate	Croatia	20
E661X	M	Doctorate	Croatia	16
E511X	M	Doctorate	Croatia	11.5
E872X	F	Master's	Croatia	15.5
E361XT	F	Master's	Romania	11
E982XT	F	Bachelor's	Belgium	17

The external stakeholders possessed a minimum of 11 years industry experience and 20 years maximum. The gender diversity is over 60 percent female in this sample. Furthermore, 50 percent of the participants hold doctorate degrees.

4.3 Coding and Thematic Analysis

The purpose of the qualitative coding activities was to reduce the collected data (Yin, 2009). Additionally, it supports the conversion of raw data into valuable insights

via categorisation of the data into analytically useful groups. This facilitation of data interpretation enhances understanding of the complex phenomena.

The semi-structured interview format was deployed for comparability across participants



Figure 4.1. An illustration of the data of code families for interviews.

and nuanced understanding of individual perspectives. To illustrate the paradoxical tensions emergent from this disparity of perspectives, the same set of questions were posed to all participants. Figure 4.1. shows the emergent code families for: (a) the internal stakeholders i.e., corporations in cement production, (b) their external stakeholders (finance institutions), and (c) specialist service providers.

A. Codes and themes from the internal stakeholder perspective

Delving deeper, tables 4.6., to 4.10. show the data clusters from the internal stakeholder perspective, the description of context, and themes that arose from the research sub-questions. The abbreviations RQ and SQ refer to the research questions and sub-questions respectively. The sub-questions are the same for all stakeholder groups.

Table 4.6 Codes and themes for RQ1 from the perspectives of Internal Stakeholders.

RQ1. How could paradoxical tensions between differing interests be managed to enable cement companies meet their net-zero targets while maintaining profitability and market competitiveness?

Sub-question(s)	Code(s)	Description	Theme(s)
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SQ1. What aspect of stakeholder expectation impacts operations the most?	Stakeholder expectations management.	Impact: financial performance	1. Impact of the variations in the position of stakeholder groups.
		Influence: policy and regulations Interest: Market expectations of cheaper and higher quality products.	
SQ2. How does the integration of green technology affect the competitive environment?	Strategic orientation.	Economic, social and ecological sustainability.	2. Positioning sustainability at the core of modern construction.
SQ3. Is there demand for green cement that is sufficient to make the long-term investment strategically feasible?	Market opportunity.	Demand potential for green cement.	3. Balancing economic e.g., product pricing strategy, with ecological objectives.

Table 4.7 Codes and themes for RQ2 from the perspectives of Internal Stakeholders.

RQ2. How effective are the available “green” financial instruments for deep decarbonisation of industrial processes?

Sub-question(s)	Code(s)	Description	Theme(s)
SQ4. Do the companies have access to all the money allocated by	Application process.	Ease of keeping track with the different, overlapping calls, their requirements, and the	4. Impact of complex application processes on

the public funds for green transition?		convoluted process of green project calls and development. application.	
SQ5. Is private capital available at economically feasible rates?	Private capital availability	Fundraising capability on the basis of the green technology project.	5. Impediments to private financing accessibility.
SQ6. How long or how much effort does it take to prepare the project for application?	Project preparation requirements	Capacity for project preparation to be carried out in-house versus outsourcing.	6. Impediments to public financing accessibility.
SQ7. How long does it take between project proposal submission and approval?	Application timeline	Complexity of the project development requirement and evaluation process and its impact on project timelines.	7. Administrative bottlenecks and the effect on project planning and costs.

Table 4.8 Codes and Themes for RQ3 from the perspectives of Internal Stakeholders.

RQ3. What are the overt and covert costs of decarbonising the cement industry?

Sub-question(s)	Code(s)	Description	Theme(s)
SQ8. How much does it cost to develop a green technology project?	Overall costs	Estimation of the fixed and variable costs, in addition to transactional and other invisible costs as a means of determining the capital requirements of green transition in the industry.	8. Financial requirements of green transition.

SQ9. Is there a standard process guiding the choice of particular green technologies?	Technology options	Decision making process guiding the preference and choice of specific green technology i.e., pull vs. push factors.	9. Motivators behind the choice of technology.
SQ10. Is the recruitment and retraining of new employees needed?	Labour costs	The impact and associated costs of adapting the available workforce to better integrate and work with the new green technology and process change.	10. Adaptations of people and process management

Table 4.9 Codes and Themes for RQ4 from the perspectives of Internal Stakeholders.

RQ4. How long does it take for essential green technology to move from the research and development (R&D) phase to full industrial integration and return on invested capital?

Sub-question(s)	Code(s)	Description	Theme(s)
SQ11. Does the integration of chosen technologies occur without issues?	Integration issues.	Managing unpredictability and hidden costs that emerge from the process of deploying new green technology and its effects on daily operations.	11. Correlation between financial and human capacities on green technology integration process.
SQ12. What are the standard expectations of returns by investors?	Investor confidence.	Difficulty with predicting ROI due to the unpredictability of green technology project development timeline.	12. Impact of issues related to the deployment of new technology on investor confidence.

Table 4.10 Codes and Themes for RQ5 from the perspectives of internal stakeholders.

RQ5. How can corporate leaders in the cement industry assess and prevent greenwashing practices?

Sub-question(s)	Code(s)	Description	Theme(s)
SQ13. Is there an established process for determining the emissions reduction impact of a deployed technology?	Greenwashing	Industry actors may engage in greenwashing as a means of dealing with the many external pressures.	13. Lack of prohibitive measures against greenwashing practices.
SQ14. If a chosen technology turns out to be unsuitable, how easy is it to withdraw or change a particular course of action?	Course correction possibilities.	Wasted resources as a potential undesirable effect of the inability to course correct.	14. The necessity for experimentation.

For the internal stakeholders, 14 code families and 14 themes reflect 14 SQs. They were generated and recorded within the corresponding five RQs. Each SQ was represented by one code and one theme. Inputs from this stakeholder category can be summarised in three main ways:

- i. transformation is viewed as a means of strategic positioning given the regulatory and broader industry impacts;
- ii. though it is encouraging that financial instruments to support the green transition exist, the lack of customisation and speed is a major constraint; and

- iii. upfront costs are too high to be managed alongside standard costs of business operations.

B. Codes and themes from the external stakeholder perspective (category I: financial institutions)

The following tables 4.11. to table 4.14 show the data clusters from the external stakeholder perspective. They include finance institutions, as well as the description and themes that arose from the research sub-questions.

Table 4.11. Codes and Themes for RQ1 from the perspective of External Stakeholders: category I.

RQ1. How could paradoxical tensions between differing interests be managed to enable cement companies meet their net-zero targets while maintaining profitability and market competitiveness?

Sub-question(s)	Code(s)	Description	Theme(s)
SQ1. What aspect of stakeholder expectation impacts operations the most?	Stakeholder expectations management.	A stable and predictable operation is of critical importance, alongside alignment with regulations as institutional investors prioritise financing based on policy goals.	15. Maintaining high decarbonisation standards.
SQ2. How does the integration of green technology affect the competitive environment?	Innovation for competitiveness .	The rate of adoption of green technologies could be converted to market share buyers could be willing to pay more for green	16. Necessity for new business models.

		cement especially when it is tied to the ESG score.	
SQ3. Is there demand for green cement that is sufficient to make the long-term investment strategically feasible?	Demand creation.	A new crop of investors is emerging with instruments to radically disrupt the market.	17. Risk reduction in support of market expansion.

Table 4.12 Codes and themes for RQ2 from the perspective of External Stakeholders: category I.

RQ2. How effective are available ‘green’ financial instruments for deep decarbonisation of industrial processes?			
Sub questions	Code	Description	Theme(s)
SQ5. Is private capital available at economically feasible rates?	Industry attractiveness	Economic viability of green technology and other climate related investments in the cement industry.	18. Technological innovation as a means of securing investor interest.

Table 4.13. Codes and Themes for RQ3 from the perspective of External Stakeholders: category I.

RQ3. What are the overt and covert costs of decarbonising the cement industry?			
Sub questions	Code	Description	Theme(s)
SQ8. How much does it cost to develop a green technology project?	Cost structure	The ambitions of a particular company, their envisioned project size and	19. Determinants of acceptable costs of green projects.

capacity to implement all contribute the cost.

Table 4.14 Codes and Themes for RQ4 from the perspective of External Stakeholders: category I.

RQ5. How can corporate leaders in the cement industry assess and prevent greenwashing practices?			
Sub questions	Code	Description	Theme(s)
SQ13. Is there an established process for determining the emissions reduction impact of a deployed technology?	Greenwashing	Corporate integrity in disclosures and other regulatory requirements would show commitment to rethinking operations in favour of environmental sustainability.	20. Good governance and upgrade of industry practices.
SQ14. If a chosen technology turns out to be unsuitable, how easy is it to withdraw or change a particular course of action?	Course correction possibility.	It is extremely difficult to deviate from a set course because financing projects tend to be a lengthy process with various checks and balances. Projects that have secured finance based on defined parameters in an application, must be carried out to completion.	21. Consequences of green technology choice and other management decisions.

For the external stakeholders in category I (financial institutions), seven code families and 7 themes reflect seven SQs (SQs 1, 2, 3, 5, 8, 13, and 14). They were generated and recorded within the corresponding four RQs (RQs 1, 2, 3, and 5). Each SQ was represented by one code and one theme. In summary, this stakeholder category is of

the view that companies must come up with new ways of operations that are aligned with the high sustainability standards irrespective of the difficulties, as such transformation could make the industry less risky and more attractive to investors.

C. Codes and themes from the external stakeholder perspective (category II: specialist service providers)

The following tables 4.15. to 4.17 show the data clusters from the perspective of specialist service providers, as well as the description and themes that arose from the research sub-questions.

Table 4.15 Codes and Themes for RQ1 from the perspective of External Stakeholders: category II.

RQ1. How could paradoxical tensions between differing interests be managed to enable cement companies meet their net-zero targets while maintaining profitability and market competitiveness?

Sub-question(s)	Code(s)	Description	Theme(s)
SQ1. What aspect of stakeholder expectation impacts operations the most?	Economic pressures	Annual financial targets appear to be at the crux of operations. Decisions seem to be driven by shorter term operational objectives.	22. Balancing economic and environmental sustainability.
SQ2. How does the integration of green technology affect the competitive environment?	Influence of experts	Impact: lessened competitive impact due to simultaneous adoption of the same technology by industry players.	23. Herd mentality in the choice of technology to be developed and integrated.

		Influence: technical experts.	
		Interest: risk transference via public funds i.e., grants.	
SQ3. Is there demand for green cement that is sufficient to make the long-term investment strategically feasible?	Market demand	Availability of sufficient demand for green cement in the market, particularly in relation to pricing.	24. Correlation between price sensitivity and market demand for green cement.

Table 4.16. Codes and Themes for RQ2 from the perspective of External Stakeholders: category II.

RQ2. How effective are the available “green” financial instruments for deep decarbonisation of industrial processes?

Sub-question(s)	Code(s)	Description	Theme(s)
SQ4. Do the companies have access to all the money allocated by the public funds for green transition?	Dependence on grants.	Companies have access to a certain level of funding. Policy prioritisation tends to overlook the necessity for customised instruments for deep decarbonisation. Additionally, grants are often favoured over loans.	25. The potential market distortive effect of the green financial instruments.
SQ6. How long or how much effort does it	Expensive external services	Project preparation takes approximately three years.	26. Ensuring acceptable costs and quality of

take to prepare the project for application?			outputs by external service providers.
SQ7. How long does it take between project proposal submission and approval?	Project approval timeline	Approval period of submitted projects tend to exceed the allocated time by three. For instance, if the expected approval period in the call is 6 months, in reality it is likely to be concluded in 18 months due to bottlenecks at various stages of the process.	27. Administrative bottlenecks and the effect on project planning and costs.

Table 4.17 Codes and Themes for RQ4 from the perspective of External Stakeholders: category II.

RQ4. How long does it take for essential green technology to move from the research and development (R&D) phase to full industrial integration and return on invested capital?

Sub-question(s)	Code(s)	Description	Theme(s)
SQ11. Does the integration of chosen technologies occur without issues?	Technology integration issues and trouble-shooting methods.	This is always a challenging process due to compatibility of the new technology with existing infrastructure, capacities of people, etc. With new, complex processes, people tend to defer to familiar modes of work. Most common	28. Necessity for in-depth and well documented integration process management.

issues are related to technology, process and people. Thus, effective mitigation methods depend on quality data and record-keeping. Additionally, use and acclimatisation with the new technology is difficult to predict and also creates issues with proper functionality.

For the external stakeholders in category II, (specialist service providers) 7 code families and 7 themes reflect seven SQs (SQs 1, 2, 3, 4, 6, 7, and 11). They were generated and recorded within the corresponding three RQs (RQ, 1, 2, and 4). Each SQ was represented by one code and one theme.

In summary, this stakeholder category is of the view that pressures on all fronts may incapacitate companies and encourage maladaptive survival tactics. The risk of unstructured push for green technologies being driven by other experts working for both institutional (financial and governmental), and corporate sides, could lead to the development and implementation of green technologies that may be theoretically sound, but unadoptable by the market.

D. Content analysis of the secondary data

To expound on stakeholder insights, content analysis was performed in two ways: (a) analysis of qualitative secondary data such as text and multimedia from six relevant and credible industry sources, along with (b) analysis of quantitative secondary data

including financial data from published corporate financial documents of five multinational cement companies (investment reports, income statement, balance sheet, and cash flow statement), as well as the institutional investor, EIB.

Content analysis of qualitative data

A qualitative content analysis of secondary data sources involved coding and categorising textual data from six industry sources. Table 4.18 shows the data sources.

Table 4.18 Data sources utilised for content analysis of secondary data.

Data Sources	Data type	Description
CEMBUREAU (The European Cement Association)	Reports and industry publications	CEMBUREAU publishes comprehensive reports on the cement industry's sustainability initiatives. The Activity Reports highlight the industry's progress in reducing emissions and increasing the use of alternative fuels.
S&P Global	Reports	The reports provide analyses on how European cement manufacturers are reducing emissions and building business resilience, offering insights into industry commitments and strategies.
Climate Bonds Initiative	Website	The Climate Bonds Initiative discusses the financial aspects of transitioning to sustainable practices within the cement sector, including the scale of investments required to meet decarbonisation targets.
The Global Cement Report (from the	Report	The Global Cement Report provides detailed market and investment data on cement production and decarbonisation trends in Europe.

International Cement Review)		
Nature Sustainability Journal	Published articles	The study assesses various decarbonisation options for the European cement industry, providing data on the climate change mitigation potential of different strategies.
McKinsey & Company	Published industry articles	Analyses on foundational actions for zero-carbon cement, including specific ways that the cement industry could reach net-zero emissions by 2050.

Content Analysis I – Secondary data from industry publications and multimedia.

The data from these six secondary sources were processed to examine the level of alignment with the primary sources. Given the focus on the five research questions and comparison with the inputs gained from the primary sources, relevant data categories were examined and emergent themes extrapolated.

RQ1. How could paradoxical tensions between differing interests be managed to enable cement companies meet their net-zero targets while maintaining profitability and market competitiveness?

Although not explicitly labelled as a paradoxical tension, all the secondary sources agree that balancing sustainability goals and profitability is a critical challenge for cement companies. These tensions often arise from the need to balance short-term financial performance with long-term environmental commitments.

The analysis revealed **three main emergent themes** across different data categories: technology adoption, financial commitments, and stakeholder collaboration.

Table 4.19 shows the summary of findings from the content analysis of the data as it relates to RQ1.

Table 4.19 Content analysis of secondary data for RQ1.

Data category	Code	Emergent theme	Description	Freq. count
Competitive advantage	Market and demand	Tech adoption	Although mentioned in industry reports, no direct coding instances were identified for this theme across the six analysed sources (frequency 0). The topic emerged in broader strategic discussions but was not a central focus. The adoption of circular solutions in the industry is expected to result in the prevention or reduction of around 2.6 billion metric tons of CO2 emissions by 2050. This decrease in emissions, coupled with related economic advantages, may contribute as much as EUR 110 billion annually to the EBITDA of the built environment by 2050 (McKinsey & Company, 2023).	0

Sustainability goals	Investments	Financial commitments	All six sources highlighted significant investments required to meet sustainability goals. They also discussed the tension between environmental responsibility and economic viability. This challenge could lead companies to speedily develop more innovative and resilient strategies.	6
Stakeholder roles	Net-zero industry facilitation	Stakeholder collaboration	The importance of stakeholder engagement was emphasised in five out of the six sources of secondary data examined. In view of paradoxical tensions, the necessity for optimised stakeholder relations was a common point particularly with CEMBUREAU (The European Cement Association) which argued that stronger relationships would support alignment of diverse interests and enable co-creation of sustainable solutions.	5

Note. $N = 6$

RQ2. How effective are the available “green” financial instruments for deep decarbonisation of industrial processes?

Green financial and policy instruments have laid a foundation for decarbonising industrial processes in the EU and the SEE region is not exempt from such initiatives. However, in the area of deep decarbonisation, an assessment of the secondary sources reveals issues such as inconsistent policy frameworks and regulatory environments across the region, and under-investment in climate-related projects attributed to factors such as limited technical expertise, regulatory uncertainties, and insufficient private sector engagement (European Investment Bank, 2024). Table 4.20 shows the summary of findings from analysis of the data, as it relates to RQ2.

Table 4.20 Content analysis of secondary data for RQ2.

Data category	Code	Emergent theme	Description	Freq. count
Sustainability goals	Policy instruments	Efficacy of green policy and financial mechanisms	All the companies have set ambitious targets to drastically reduce their direct net CO ₂ emissions by 2030 and achieve net-zero emissions by 2050. All the secondary sources are in agreement regarding the various options for decarbonisation available. However, some periodicals in the Climate Bonds Initiative and the Sustainability Journal showed some reservations	3

about the long-term feasibility, the full environmental implications, and the climate change mitigation potential of the current options.

Note. $N = 6$.

RQ3. What are the overt and covert costs of decarbonising the cement industry?

Decarbonising the cement industry involves both overt i.e., visible and measurable, as well as covert i.e., hidden or indirect costs. Assessment of the full implications of these costs was essential to determine the investment requirements of green transition in the industry. Table 4.21 below shows the summary of findings from analysis of the data, as it relates to RQ3.

Table 4.21 Content analysis of secondary data for RQ3.

Data		Emergent		Frequency
category	Code	theme	Description	count
Costs	Capital	Financial	Substantial capital investments	3
	expenditure	requirements of green transition.	are required for low-carbon technologies, such as alternative fuels, carbon capture, and sustainable cement production methods. However, only half of the data delves into the long-term growth prospects of the technologies, while the other half focuses on the technology themselves and what they entail.	

Investments	Opportunity cost of capital	Determinants of acceptable costs of green projects	Analysis of the data reveals an expectation of dexterity with time, meaning that corporate leaders ought to allocate resources both to immediate operational efficiency in order to maintain profitability, and investing in research and development of green technologies. However, it is unclear in the data how the acceptable costs are determined and a major challenge is identifying the right project, as funds allocated to decarbonisation might divert investment from other areas.	2
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Note. $N = 6$.

RQ4. How long does it take for essential green technology to move from the research and development (R&D) phase to full industrial integration and return on invested capital?

The time it takes for essential green technologies to move from the R&D phase to full industrial integration and return on invested capital (ROIC) in the cement industry is highly varied, due to the time lag in the four phases which generally include: (i) research and development (R&D), (ii) pilot demonstration, (iii) deployment, and (iv) improved cost efficiencies after broader adoption. According to both primary and secondary data, returns

can only occur after all the stages have been completed. Figure 4.2. below shows the areas of intervention of green technologies in the cement manufacturing process, as well as the corresponding energy use and carbon footprint.

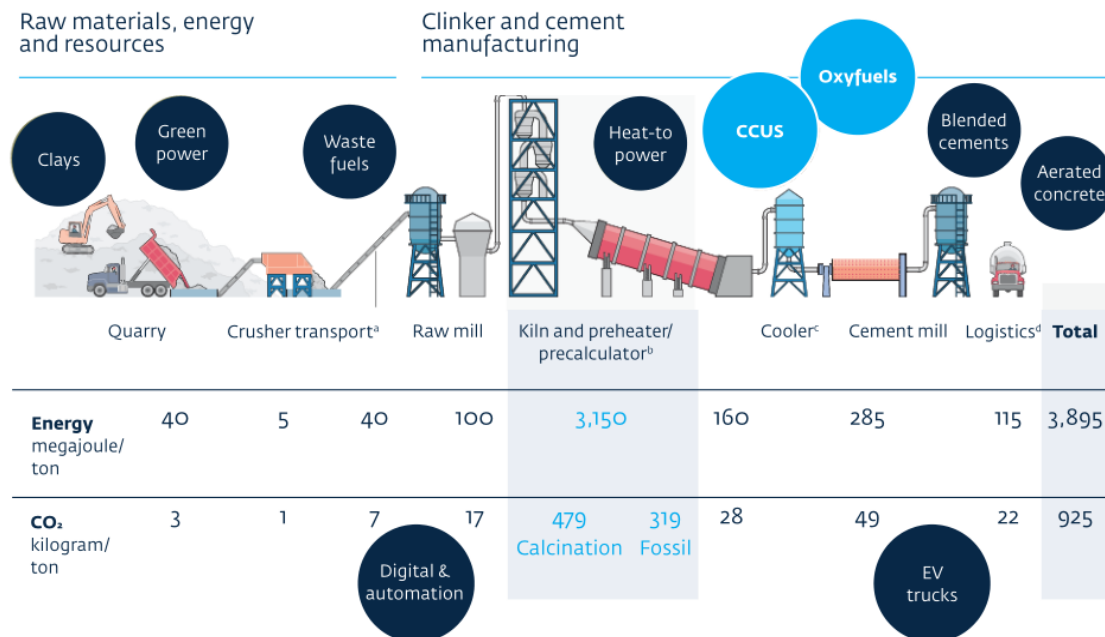


Figure 4.2. Green technologies in cement production processes.

Assumed with 1kWh/t/100m.

- Assumed global average, data from the Global Cement and Concrete Association, Getting the Numbers Right 2017.
- Assumed reciprocating grate cooler with 5kWh/t clinker.
- Assumed lorry transportation for average 200km.

Image and data source: Czigler, Tomas, Sebastian Reiter, Patrick Schulze, and Ken Somers. 2020.

"Laying the Foundation for Zero-Carbon Cement." McKinsey & Company article, May 14, 2020.

<https://www.mckinsey.com/industries/chemicals/our-insights/laying-the-foundation-for-zero-carbon-cement>.

Table 4.22 shows the summary of findings from analysis of the data, as it relates to RQ4.

Table 4.22 Content analysis of secondary data for RQ4.

Data				Frequency
category	Code	Emergent theme	Description	count
Technology adoption	Greentech	Environmental benefits of Greentech integration	Technology adoption refers to the successful integration of new technology into business processes. All (100%) of the secondary sources agree that uptake of new technologies is essential for efficiency and productivity gains, among others. However, the timeline is dependent on key factors such as technology type, financial capacity, readiness of the organisation, etc.	5
Carbon intensity	CO2 abatement	Greentech investment viability	While carbon pricing accelerate adoption, companies with higher carbon intensity will face a higher cost burden as carbon pricing increases. Subsidies, carbon pricing and green procurement mandates, accelerate adoption, while the lack of consistent regulatory frameworks slows down integration. All of these opposing aspects are present in the SEE region.	5

Note. N = 8.

RQ5. How can corporate leaders in the cement industry assess and prevent greenwashing practices?

The practice of greenwashing carries both reputational and financial risks, and could compromise the trust of stakeholders. Cement corporations, given their considerable emissions and high visibility in dialogues on environmental sustainability, must exercise caution. Table 4.23 shows the summary of findings from analysis of the data, as it relates to RQ5.

Table 4.23 Content analysis of secondary data for RQ5.

Data category	Code	Emergent theme	Description	Freq. count
Green transition risks.	Greenwashing.	Overly ambitious sustainability goals.	In addition to standard greenwashing that is visible in vague, environmental claims that are unsubstantiated, sometimes failures from unrealised goals of decarbonisation initiatives could be perceived as greenwashing as well. All of these can hurt stakeholder trust and brand value of the company.	2

Note. $N = 6$.

Content analysis of the quantitative data

Stakeholder insights from the qualitative interviews uncovered the notion that the burden of net-zero transition via green technology adoption are overwhelmingly on cement companies, particularly in South East Europe, where the local economic conditions are significantly different. The content analysis of qualitative data still left gaps

in understanding the financial aspects of green technology integration as a cornerstone of the current business climate.

For the corporate perspective to be understood, the financial pressures they face and the ways it shapes decision-making, should be clear to all stakeholders. A detailed analysis should encompass the following information amongst others:

- i. Green CAPEX – to quantify how much corporations are actually spending on decarbonisation technologies such as alternative fuels, Carbon Capture Utilisation & Storage (CCUS), electrification of kilns, etc.,
- ii. Carbon intensity per ton of cement (scope 1 emissions) – a baseline data because companies with higher carbon intensity will have a higher cost burden due to increases in carbon pricing,
- iii. Return On Invested Capital (ROIC) i.e., the payback period for Green Technologies – to quantify whether Greentech investments yield competitive returns to better assess burden,
- iv. Labour and skills costs – to quantify staffing costs such as training, recruitment needs for green transition, wage increases for specialist staff, etc,
- v. Costs of machine downtime in days – to estimate costs of non-operation due to retrofits or technological integration,
- vi. Terms of debt for financing green projects – to ascertain whether companies are using green bonds or loans, and at what rates.

- vii. Cost of compliance with environmental regulations – to quantify annual costs (in EUR) for emissions trading allowances, environmental taxes, regulatory audits and reporting.

However, given the lack of specificity in the qualitative data, the study utilised the available data to make some of the analytical estimates with the aim of delivering comparable, longitudinal financial and performance metrics at firm level, as well as sectoral aggregates.

Content Analysis II – Secondary data from corporate and investor financial documents

Table 4.24 Data sources for quantitative analysis of published corporate data.

Data Sources	Data type	Description
1. Consolidated annual reports	Financial performance data	Analysis of operational and strategic performance of the corporations via evaluation of key financial ratios.
2. Sustainability reports	Investment data	Decarbonisation focused investments such as, water optimisation technologies, Greentech integration, waste management, etc.
3. European Investment Bank (EIB)	Greentech investments	The EIB finances green infrastructure and low-carbon technologies, offering reports on investment flows in sustainability.

Financial reports used for the study are Group level and consolidated, in order to:

- a) provide an overview of the industry at its regular scale of operations, and b) to highlight potential discrepancies between the centralised strategy and local implementation.

Additionally, they are the 2025 and 2024 consolidated reports relating to performance in the most recent years, which gives a better insight into the state of affairs at large.

Some companies reported the impact of economic constraints in Europe, specifically the persistently high financing costs, and the continuous volatility in energy and raw material prices, which continue to shape construction activities and demand for building materials. The aim is to address research question three to the extent possible.

RQ3. What are the overt and covert costs of decarbonising the cement industry?

Responses to this RQ was severely limited from the qualitative data. The latest annual reports of the multinational cement companies provided a rich overview of corporate operations and market dynamics. Considering that the companies have differing classifications of their geographic locations, it was necessary to examine the data at the group level, while focusing on the cement business unit in Europe. Where possible, data specific to Southeast Europe was also examined as a sub-set of the European operations.

Themes and sub-themes in evaluation of the findings

According to Yin (2009), a theme is an idea or a concept that connect several codes through a common motif. Based on the created codes, 28 grounded themes emerged through the semi-structured interviews and the content analysis. By reviewing each of the emerged grounded themes, the researcher extrapolated five main topics surrounding the themes that represented the data cluster for the five research questions from all the stakeholder categories. Each major theme cluster contained its sub-themes. These major themes are presented in Table 4.25 and interpreted in the section on evaluation of findings.

Table 4.25 Themes and Sub-Themes in Evaluation of the Findings.

Major Themes in Evaluation of Findings
Theme cluster 1: Harmonising stakeholder priorities in sustainable decarbonisation of the cement industry.
○ Impact of the variations in the positions and perspectives of stakeholder groups. ○ Positioning sustainability at the core of modern construction. ○ Balancing economic and environmental sustainability. ○ Methods of implementing and maintaining high decarbonisation standards.
Theme cluster 2: Navigating structural barriers and leveraging strategic enablers in accessibility of green finance.
○ Impact of complex application processes on green project development. ○ Impediments to accessibility of private financing. ○ Impediments to accessibility of public financing. ○ Administrative bottlenecks and the effect on project planning and costs. ○ Reliance on external technical and specialist service providers. ○ Potential market distortive effect of green financial instruments.
Theme cluster 3: Strategic decision-making, financial readiness and organisational adaptation to green transition initiatives.
○ Determinants of acceptable costs of green projects. ○ Financial requirements of green transition. ○ Necessity for new business models. ○ Balancing product pricing strategy and ecological objectives. ○ Correlation between price sensitivity and market demand for green cement. ○ Motivators behind technology choice (herd mentality). ○ Ensuring acceptable cost and quality of outputs from external service providers. ○ Technological innovation as a means of securing investor interest. ○ Integrated and effective approaches to change management.

Theme cluster 4: Ensuring operational readiness for seamless green technology adoption.

- Correlation between financial and human capacities on green technology integration process.
- Adaptations of established people and process management.
- Risk reduction in support of market expansion.
- Impact of issues related to the deployment of new technology on investor confidence.
- Necessity for in-depth and well documented green technology integration process for effective management.

Theme 5: Governance and ethical leadership in green transition

- Good governance and upgrade of industry practices related to greenwashing.
 - Methods of implementing and maintaining high decarbonisation standards.
 - Consequences of green technology choice and other management decisions.
 - Lack of prohibitive measures against greenwashing as tacit endorsement of the practice.
 - The necessity for experimentation as a means of course correction in case a suboptimal technology is deployed.
-

4.4 Findings for the Research Questions

To explore how the green transition could be effectively managed in the cement industry in the SEE region, and how this transition, aided by key technologies could significantly reduce carbon footprints, the following specific research questions were designed:

RQ1. How could paradoxical tensions between differing interests be managed to enable cement companies meet their net-zero targets while maintaining profitability and market competitiveness?

RQ2. How effective are the available “green” financial instruments for deep decarbonisation of industrial processes?

RQ3. What are the overt and covert costs of decarbonising the cement industry?

RQ4. How long does it take for essential green technology to move from the research and development (R&D) phase to full industrial integration and return on invested capital?

RQ5. How can corporate leaders in the cement industry assess and prevent greenwashing practices?

These research questions provided the framework for determining the essential ingredients for effective decarbonisation within the unique context and markets of the SEE region.

Findings from the internal stakeholders.

Data derived from internal stakeholders i.e., executives in the cement manufacturing industry encompass all five research questions and the fourteen sub-questions.

Findings for RQ1. How could paradoxical tensions between differing interests be managed to enable cement companies meet their net-zero targets while maintaining profitability and market competitiveness?

The RQ1 sought to identify the pattern related to how opposing tensions between differing interests may be managed to enable cement production companies meet their

net-zero targets. Responses to the RQ1, through three sub-questions, provided empirical evidence on the interaction between the various forces to reveal their areas of tension.

Findings for the sub-question 1 (SQ1). What aspect of stakeholder expectation impacts operations the most? The combined data for the SQ1 yielded the theme: *Impact of the variations in the position of stakeholder groups*. The number of responses pertaining to stakeholder expectations for sustainability is shown in Table 4.26.

Table 4.26 Grounded Theme for SQ1: What aspect of stakeholder expectation impacts operations the most?

Grounded Themes	Frequency Count
1. Impact of the variations in the position of stakeholder groups	6

Note. $N = 6$

Grounded theme 1: Impact of the variations in the position of stakeholder groups. Mutual corporation-stakeholder misalignment. According to respondents' testimonies, six out of six internal stakeholders (100%) of the study participants responded that their position is misunderstood by key stakeholders (N121C, N122C, N115C, N311CR, N312CB, and N411CS). Specifically, they responded that the main stakeholder expectation that impacts operations are requirements for meeting all legislative and financial targets irrespective of market conditions. They supported their responses by arguing that market expectations are for cheaper and higher quality products, which economically does not support the costly upfront investments that green transition entails.

Findings for the sub-question 2 (SQ2). How does the integration of green technology affect the competitive environment? The combined data for the SQ2 from internal stakeholders yielded the theme of: *Positioning sustainability at the core of*

modern construction. The number of responses pertaining to the impact of green technology on competitiveness of industrial actors is shown in Table 4.27.

Table 4.27 Grounded Theme for SQ2: How does the integration of green technology affect the competitive environment?

Grounded Themes	Frequency Count
2. Positioning sustainability at the core of modern construction.	5

Note. $N = 6$

Grounded theme 2: Positioning sustainability at the core of modern construction.

five out of six internal stakeholders (83%) expressed the necessity for sustainability in the construction sector (N121C, N122C, N115C, N311CR, and N411CS). However, to the probing question of how that would be accomplished in practical terms, the financial implications emerged, with internal stakeholders' perceiving themselves as the primary recipients of all the related burdens. One out of six participants (17%) stated that sustainability is a political push that is potentially harmful to the economy as it tries to do too much at once.

Findings for the sub-question 3 (SQ3). Is there demand for green cement that is sufficient to make the long-term investment strategically feasible?

The combined data for the SQ3 yielded the theme: *Balancing product pricing strategy with ecological objectives*. The number of responses pertaining to the long-term viability of green technology investments based on marked demand for green cement is shown in Table 4.28.

Table 4.28 Grounded Theme for SQ3: Is there demand for green cement that is sufficient to make the long-term investment strategically feasible?

Grounded Themes	Frequency Count
3. Balancing price and ecological objectives.	5

Note. $N = 6$.

Grounded theme 3: Balancing product pricing strategy with ecological objectives.

According to all internal respondents, primary buyers are highly price sensitive and would favour a cheaper product above a green, more expensive one. Five out of six internal stakeholders (83%) reported that they continually monitor and adjust the prices to suit the requirements of customers (N411CS, N312CB, N311CR, N122C, N121C). They pointed out that there are hidden costs related to market preparation and consistent adjustments to internal pricing strategy, such as time, new marketing approaches, acquisition or development of new digital solutions, etc.

They argued that the current market dynamics of price competition do not support the attainment of ecological objectives, as users could simply import cheaper cement from countries without green obligations. One out of six participants (17%) stated that while more could be done to drive demand for green cement, it is a standard part of business to create markets, and the focus should be on eliminating unnecessary constraints.

Findings for RQ2. How effective are the available “green” financial instruments for deep decarbonisation of industrial processes?

The RQ2 sought to determine the effectiveness of the various available financial instruments geared towards industrial decarbonisation, and the extent to which the companies could easily access these instruments within particular timeframes, in order to achieve the objective of greenhouse gas emissions reduction in the cement industry. Responses to the RQ2, through three sub-questions, provided empirical evidence on the

ease of access to public and private capital for the development and timeline for financing the development of green technologies.

Findings for the sub-question 4 (SQ4). Do the companies have access to all the money allocated by the public funds for green transition?

The combined data for the SQ4 yielded the theme: *Impact of complex application processes on green project development; the potential market distortive effect of the green financial instruments*. The number of responses concerning access to the available green financial instruments is shown in Table 4.29.

Table 4.29 Grounded Theme for SQ4: Impact of complex application processes on green project development.

Grounded Themes	Frequency Count
4. Impact of complex application processes on green project development	4

Note. $N = 6$.

Grounded theme 4: Impact of complex application processes on green project development. Convoluting application processes and information asymmetry was indicated to be an issue to 100% of respondents. However, only 67% of participants (N115C, N311CR, N312CB and N411CS) reported that difficulties emerge throughout the application process due to the existence of various, partially overlapping calls at different times which create confusion regarding, amongst others, content, eligibility and timelines. They cite this as a major impediment to accessing public financing opportunities. Whereas, according to 33% of respondents (N121C and N122C), the application process is not supposed to be easy and the fact that there are many options is a good thing as companies have more opportunities to access funding.

Findings for the sub-question 5 (SQ5). Is private capital available at economically feasible rates?

The combined data for the SQ5 yielded the theme: *Impediments to accessibility of private financing*. The number of responses pertaining attractiveness of sustainability projects in the cement industry to private investors is shown in Table 4.30.

Table 4.30 Grounded Theme for SQ5: Impediments to accessibility of private financing.

Grounded Themes	Frequency Count
5. Impediments to accessibility of private financing.	6

Note. N = 6.

Grounded theme 5: Impediments to accessibility of private financing. 100% percent of respondents testify that investors show reluctance to investing in green technology projects in the industry for foundational reasons such as low trust in public sector services such as permits, intellectual property (IP), technology risks, uncertainty of market impacts of the technology, etc.

Findings for the sub-question 6 (SQ6). How long or how much effort does it take to prepare the project for application?

The combined data for the SQ6 yielded the theme: *Impediments to public financing accessibility*. The number of responses pertaining to accessibility of public financing instruments is shown in Table 4.31.

Table 4.31 Grounded Theme for SQ6: Impediments to accessibility of public financing.

Grounded Themes	Frequency Count
6. Impediments to public financing accessibility.	6

Note. N = 6.

Grounded theme 6: Impediments to public financing accessibility. The primary constraints of complicated application processes and information asymmetry issues are circumvented by hiring consultants and tracking the various public agencies. 100% of respondents state that the major issue with public financing is that the process lasts several years, such that by its conclusion, all estimated prices and market conditions on which the project value was based would have changed significantly.

Findings for the sub-question 7 (SQ7). How long does it take between project proposal submission and approval?

The combined data for the SQ7 yielded the theme: *Administrative bottlenecks and the effect on project planning and costs.* The number of responses related to project preparation timeline is shown in Table 4.32.

Table 4.32 Grounded Theme for SQ7: How long does it take between project proposal submission and approval?

Grounded Themes	Frequency Count
7. Administrative bottlenecks and the effect on project planning and costs.	4

Note. N = 6.

Grounded theme 7: Areas of bottlenecks from project application to conclusion. This theme encapsulates an instance of corporation-public sector misalignment. 67% of respondents stated that it takes between 2-3 years from the time of project submission to its approval, when the preparation time of 4-5 years is added, it becomes clear that a green technology project costs a minimum of 6 and maximum of 8 years before it can commence. The key bottlenecks in the process were identified in the aspects of securing

permits and environmental impact assessment. 33% (N121C and N122C) refrained from specifics, stating that they had matters under control.

Findings for RQ3. What are the overt and covert costs of decarbonising the cement industry?

The RQ3 sought to estimate the true costs of decarbonisation from the development stage to full integration. Responses to the RQ3, through three sub-questions, provided empirical evidence on the technological, human, and non-material requirements that contribute to the overall costs of decarbonisation in the cement manufacturing industry.

Findings for the sub-question 8 (SQ8). How much does it cost to develop a green technology project?

The combined data for the SQ8 yielded the theme: *Financial requirements of green transition*. The number of responses concerning the overall costs of developing a green technology project is shown in Table 4.33.

Table 4.33 Grounded Theme for SQ8: How much does it cost to develop a green technology project?

Grounded Themes	Frequency Count
8. Financial requirements of green transition.	1

Note. $N = 6$.

Grounded theme 8: Financial requirements of green transition. Respondents showed extreme reserve in dealing with the question of financial requirements with 83% refraining from providing a response on grounds of business confidentiality. On the probing question of the impact of the requirements on budgeting, a single respondent (N312CB) remarked upon financial requirements in general terms such as outsourcing,

project development, staffing, etc., avoiding specifics. The general consensus is that the requirements of green transition have a significant impact on company budgets.

Findings for the sub-question 9 (SQ9). Is there a standard process guiding the choice of particular green technologies?

The combined data for the SQ9 yielded the theme: *motivators behind technology choice*. The number of responses concerning the process of choosing to implement particular green technologies is shown in Table 4.34.

Table 4.34 Grounded Theme for SQ9: Is there a standard process guiding the choice of particular green technologies?

Grounded Themes	Frequency Count
9. Motivators behind technology choice.	5

Note. $N = 6$.

Grounded theme 9: Motivators behind technology choice. 83% of internal stakeholders cited strategic business advantages as the primary motivators behind the choice of specific green technologies. They supported their responses by arguing that without transformation of operations to more sustainable options, their long-term sustainability would be threatened. One respondent (N411CS) however, expressed the more pragmatic approach of incremental innovation and targeting technologies supported by available public funds.

Findings for the sub-question 10 (SQ10). Is recruitment and retraining of new employees needed?

The combined data for the SQ10 yielded the theme: *Adaptations of people and process management*. The number of responses related to the adaptation of human capacities and skills is shown in Table 4.35.

Table 4.35 Grounded Theme for SQ10: Is recruitment and retraining of new employees needed?

Grounded Themes	Frequency Count
10. Adaptations of people and process management	5

Note. $N = 6$.

Grounded theme 10: Adaptations of people and process management. According to 83% of respondents' testimonies, for green transition to be effective in the cement industry, established processes would require overhaul, and people would need to acclimatise themselves to new technologies, new standards and disruptions in their daily work. This presents management challenges, as "competent members of staff become temporarily incompetent and need to be quickly transitioned into new ways of working, the outcome of which is unpredictable", stated participant N311CR.

Findings for RQ4. How long does it take for essential green technology to move from the research and development (R&D) phase to full industrial integration and return on invested capital?

The RQ4 sought to determine the timeline for green project development in the cement industry given the time value of money and unpredictability of costs and other market conditions. Responses to the RQ4, through two sub-questions, provided empirical evidence on the link between technology integration, process management, and returns on invested capital.

Findings for the sub-question 11 (SQ11). Does the integration of chosen technologies occur without issues?

The combined data for the SQ11 yielded the theme: *Correlation between financial and human capacities on green technology integration process*. The number of responses concerning the technical integration process of the chosen types of green technologies into standard business operations is shown in Table 4.36.

Table 4.36 Grounded Theme for SQ11: Does the integration of chosen technologies occur without issues?

Grounded Themes	Frequency Count
11. Correlation between financial and human capacities on green technology integration process.	5

Note. $N = 6$.

Grounded theme 11: Correlation between financial and human capacities on green technology integration process. 83% of respondents see human capacity development as justifiable costs. They alluded to the fact that although justified, the costs tend to be high and often extend beyond the financial to include intangibles like transaction costs, sourcing, etc., creating management related challenges. 17% stated that it is not justified for the company to shoulder the costs, without any assurance of the employee loyalty.

Findings for the sub-question 12 (SQ12). What are the standard expectations of returns by investors?

The combined data for the SQ12 yielded the theme: *Impact of issues related to the deployment of new technology on investor confidence*. The number of responses concerning the return on invested capital (ROIC) for green technologies is shown in Table 4.37.

Table 4.37 Grounded Theme for SQ12: What are the standard expectations of returns by investors?

Grounded Themes	Frequency Count
12. Impact of issues related to the deployment of new technology on investor confidence.	2

Note. $N = 6$.

Grounded theme 12: Impact of issues related to the deployment of new technology on investor confidence. None of the respondents were willing to provide insights on standard expectations of returns by investors. In response to the probing question of cost implications of technology deployment issues, only 33% of participants (N115C and N311CR) were willing to discuss the aspect as it relates to investor expectations of returns. They listed project delays, scope creep, issues with local communities, etc., as potential commonplace problems which erode investor confidence, due to the unpredictability of the specific green project development timeline.

Findings for RQ5. How can corporate leaders in the cement industry assess and prevent greenwashing practices?

The RQ5 sought to evaluate the role of ethics and accountability in sustainability of cement manufacturing business. Responses to the RQ5, through two sub-questions, provided empirical evidence on the practice of greenwashing, reasons behind its prevalence and how it could be corrected.

Findings for the sub-question 13 (SQ13). Is there an established process for determining the emissions reduction impact of a deployed technology?

The combined data for the SQ13 yielded the theme: *Lack of prohibitive measures against greenwashing practices*. The number of responses concerning the emissions reduction effect of the deployed green technology is shown in Table 4.38.

Table 4.38 Grounded Theme for SQ13: Is there an established process for determining the emissions reduction impact of a deployed technology?

Grounded Themes	Frequency Count
13. Lack of prohibitive measures against greenwashing practices.	3

Note. $N = 6$.

Grounded theme 13: Lack of prohibitive measures against greenwashing practices. Half of all respondents expressed the necessity for specific measures to be developed to dissuade greenwashing practices. Participant N115C maintained that it would help the competitive environment if the practice would be completely eliminated because companies actually investing in green technologies and process upgrades would be distinguished from the others.

Findings for the sub-question 14 (SQ14). If a chosen technology turns out to be unsuitable, how easy is it to withdraw or change a particular course of action?

The combined data for the SQ14 yielded the theme: *The necessity for experimentation*. The number of responses concerning the potential for course correction is shown in Table 4.39.

Table 4.39 Grounded Theme for SQ14: If a chosen technology turns out to be unsuitable, how easy is it to withdraw or change a particular course of action?

Grounded Themes	Frequency Count
14. The necessity for experimentation.	6

Note. $N = 6$.

Grounded theme 14: The necessity for experimentation. All internal stakeholders reported that green technology development in highly specialised industries like cement manufacturing ought to have possibilities for course correction. They argue that the current practice of remaining with a set project for the full period even if it turns out to be the wrong choice or approach is wasteful.

Findings from the external stakeholders (categories I & II).

Data derived from external stakeholders i.e., executives from finance institutions, and providers of specialised services in the cement manufacturing industry, encompass all five research questions and the fourteen sub-questions. However, some stakeholders refrained from providing insight to certain questions, because it was beyond their scope of activities.

Findings for RQ1. How could paradoxical tensions between differing interests be managed to enable cement companies meet their net-zero targets while maintaining profitability and market competitiveness?

The RQ1 sought to identify the pattern related to how opposing tensions between differing interests may be managed to enable cement production companies meet their net-zero targets. Responses to the RQ1, through three sub-questions, provided empirical evidence on the interaction between the various forces to reveal their areas of tension.

Findings for the sub-question 1 (SQ1). What aspect of stakeholder expectation impacts operations the most? The combined data for the SQ1 yielded two themes: *Maintaining high decarbonisation standards; Balancing economic and environmental*

sustainability. The number of responses pertaining to stakeholder expectations for sustainability is shown in Table 4.40.

Table 4.40 Grounded Theme for SQ 1: What aspect of stakeholder expectation impacts operations the most?

Grounded Themes	Frequency Count
15. Maintaining high decarbonisation standards.	6
22. Balancing economic and environmental sustainability.	

Note. $N = 6$

Grounded theme 15: Maintaining high decarbonisation standards. 100% of external stakeholders in Category 1 (finance institutions) were unequivocal about the necessity to uphold and potentially increase the decarbonisation standards regardless of the potential impact on companies.

Grounded theme 22: Balancing economic and environmental sustainability. All external stakeholders also expressed the imperative for companies to maintain a balanced approach to sustainability. In response to the probing question of how to balance the expectations, responses ranged from the “necessity for goodwill and realism regarding what companies can actually do” by E311X, to the notion by E982XT, that “companies should focus more on their environmental footprints instead of profits”.

Findings for the sub-question 2 (SQ2). How does the integration of green technology affect the competitive environment? The combined data for the SQ2 yielded two themes: *necessity for new business models; herd mentality in the choice of technology to be developed and integrated*. The number of responses pertaining to the impact of green technology on competitiveness of industrial actors is shown in Table 4.41.

Table 4.41 Grounded Theme for SQ 2: How does the integration of green technology affect the competitive environment?

Grounded Themes	Frequency Count
16. Necessity for new business models.	
23. Herd mentality in the choice of technology to be developed and integrated.	5

Note. $N = 6$

Grounded theme 16: Necessity for new business models. New business models driven by technology and process innovations were deemed necessary by 67% of respondents. However, only 33% participants are confident of the potential impact of these upgraded models because the current structure is not conducive to testing these new models.

Grounded theme 23: Herd mentality in the choice of technology to be developed and integrated. 83% of external stakeholders (E311X, E611X, E511X, E361XT and E982XT) are of the view that technology choices are not based on strategic drivers, but on other market actors, whose decisions are directly related to what is eligible for public funding. According to respondent E982XT, “nothing is going to change in terms of competitive advantage if everybody is doing the same thing just to meet the minimum requirements of the taxonomy, or look cool”.

Findings for the sub-question 3 (SQ3). Is there demand for green cement that is sufficient to make the long-term investment strategically feasible?

The combined data for the SQ3 yielded two themes: *risk reduction in support of market expansion, and correlation between price sensitivity and market demand for green*

cement. The number of responses pertaining to the long-term viability of green technology investments based on marked demand for green cement is shown in Table 4.42.

Table 4.42 Grounded Theme for SQ 3: Is there demand for green cement that is sufficient to make the long-term investment strategically feasible?

Grounded Themes	Frequency Count
17. Risk reduction in support of market expansion.	
24. Correlation between price sensitivity and market demand for green cement.	3

Note. $N = 6$.

Grounded theme 17: Risk reduction in support of market expansion. 50% of external stakeholders highlighted the necessity for risk-sharing in their responses. Specifically, the need for new, green technology development to be separated from other investments that carry no expectation of internal co-financing.

Grounded theme 24: Correlation between price sensitivity and market demand for green cement. This position that green cement should be somewhat affordable is held by 50% of respondents (E311X, E982XT, and E511X). Specifically, they argued that investment prices are already so high that it made no sense to use more expensive inputs where it was not essential.

Findings for RQ2. How effective are the available “green” financial instruments for deep decarbonisation of industrial processes?

The RQ2 sought to determine the effectiveness of the various available financial instruments geared towards industrial decarbonisation, and the extent to which the companies could easily access these instruments within particular timeframes, in order to achieve the objective of greenhouse gas emissions reduction in the cement industry.

Responses to the RQ2, through three sub-questions, provided empirical evidence on the ease of access to public and private capital for the development and timeline for financing the development of green technologies.

Findings for the sub-question 4 (SQ4). Do the companies have access to all the money allocated by the public funds for green transition?

The combined data for the SQ4 yielded the theme: *the potential market distortive effect of the green financial instruments*. The number of responses concerning access to the available green financial instruments is shown in Table 4.43.

Table 4.43 Grounded Theme for SQ4: Do the companies have access to all the money allocated by the public funds for green transition?

Grounded Themes	Frequency Count
25. The potential market distortive effect of the green financial instruments.	2

Note. $N = 6$.

Grounded theme 25: The potential market distortive effect of the green financial instruments. 33% of respondents (E311X and E361XT) expressed concern about the advantages certain companies may have through access to public funding and its impact on their competitive positions. They argued that winning a grant is not entirely based on the quality of the project being developed, but on the capacities of the consultant to match the wording or requirement of the call, ability to meet the co-financing requirements, as well as the subjective impressions of the evaluators who may not have insights on the industry functioning to determine what innovation for instance means in the cement production context. Participant E982XT stated that “the focus on matching the call requirements sometimes dictates the direction the industry goes which is not ideal”.

Findings for the sub-question 5 (SQ5). Is private capital available at economically feasible rates?

The combined data for the SQ5 yielded the theme: *technological innovation as a means of securing investor interest*. The number of responses pertaining attractiveness of sustainability projects in the cement industry to private investors is shown in Table 4.44.

Table 4.44 Grounded Theme for SQ 5: Is private capital available at economically feasible rates?

Grounded Themes	Frequency Count
18. Technological innovation as a means of securing investor interest.	5

Note. $N = 6$.

Grounded theme 18: Technological innovation as a means of securing investor interest. The innovative aspect of green technologies in optimising the industry is stated as a key source of investor interest by 83% of respondents. Specifically, the potential for value creation and preservation. In response to the probing question of the reasons it was still difficult to access private capital despite positive interest in green transition, respondents argued that the core issue was in opportunity cost of capital. Participants E872X and E611X both stated unequivocally that the unattractiveness stem from the current requirement of extremely high upfront costs, high risks and patience, which do not translate into corresponding high returns.

Findings for the sub-question 6 (SQ6). How long or how much effort does it take to prepare the project for application?

The combined data for the SQ6 yielded the theme: *ensuring acceptable costs and quality of outputs by external service providers*. The number of responses pertaining to accessibility of public financing instruments is shown in Table 4.45.

Table 4.45 Grounded Theme for SQ 6: How long or how much effort does it take to prepare the project for application?

Grounded Themes	Frequency Count
26. Ensuring acceptable costs and quality of outputs by external service providers.	4

Note. $N = 6$.

Grounded theme 26: Ensuring acceptable costs and quality of outputs by external service providers. 67% of participants reported that it would be impossible to move forward with green technology development and integration without specialist service providers such as engineers, project designers, EU funds experts, legal services, etc. to support the process. While 33% emphasised the quality of the output should justify both the financial and time related costs as project preparation in the cement industry takes approximately three years.

Findings for the sub-question 7 (SQ7). How long does it take between project proposal submission and approval?

The combined data for the SQ7 yielded the theme: *administrative bottlenecks and the effect on project planning and costs*. The number of responses related to project preparation timeline is shown in Table 4.46.

Table 4.46 Grounded Theme for SQ 7: How long does it take between project proposal submission and approval?

Grounded Themes	Frequency Count
27. Administrative bottlenecks and the effect on project planning and costs.	6

Note. $N = 6$.

Grounded theme 27: Administrative bottlenecks and the effect on project planning and costs. The researcher noted a discrepancy between the respondents' expressed frustration and their willingness to communicate details on the effect of the public sector related delays and project costs. Frustrations concerning costs and public sector inefficiencies were freely expressed by all participants, whereas probing questions on specifics were deflected with general statements that it was being managed.

Findings for RQ3. What are the overt and covert costs of decarbonising the cement industry?

The RQ3 sought to estimate the true costs of decarbonisation from the development stage to full integration. Responses to the RQ3, through three sub-questions, provided empirical evidence on the technological, human, and non-material requirements that contribute to the costs of decarbonisation in the cement manufacturing industry.

Findings for the sub-question 8 (SQ8). How much does it cost to develop a green technology project?

The combined data for the SQ8 yielded the theme: *determinants of acceptable costs of green projects*. The number of responses concerning the overall costs of developing a green technology project is shown in Table 4.47.

Table 4.47 Grounded Theme for SQ8: How much does it cost to develop a green technology project?

Grounded Themes	Frequency Count
19. Determinants of acceptable costs of green projects.	2

Note. $N = 6$.

Grounded theme 19: Determinants of acceptable costs of green projects.

According to the testimonies by 33% of respondents (E311X and E982XT), major costs are determined by the type of project being developed, and include amongst others, the design, quality control and outsourcing to be in line with taxonomies.

Findings for RQ4. How long does it take for essential green technology to move from the research and development (R&D) phase to full industrial integration and return on invested capital?

The RQ4 sought to determine the timeline for green project development in the cement industry given the time value of money and unpredictability of costs and other market conditions. Responses to the RQ4, through three sub-questions, provided empirical evidence on the link between technology integration, process management, and returns on invested capital.

Findings for the sub-question 11 (SQ11). Does the integration of chosen technologies occur without issues?

The combined data for the SQ11 yielded a theme: *necessity for in-depth and well documented integration process management*. The number of responses concerning the technical integration process of the chosen types of green technologies into standard business operations is shown in Table 4.48.

Table 4.48 Grounded Theme for SQ11: Does the integration of chosen technologies occur without issues?

Grounded Themes	Frequency Count
28. Necessity for in-depth and well documented integration process management.	3

Note. $N = 6$.

Grounded theme 28: Necessity for in-depth and well documented integration process management. 50% of external stakeholders noted that cement corporations must maintain technological leadership in green innovation by investing in sustainable technologies like carbon capture and alternative fuels to reduce their carbon footprints. Furthermore, that detailed knowledge management processes are critical as input for future strategic decisions which would involve further investment in new production methods like electric-powered cement kilns or green cement technologies using alternative materials such as slag or fly ash.

Findings for RQ5. How can corporate leaders in the cement industry assess and prevent greenwashing practices?

The RQ5 sought to evaluate the role of ethics and accountability in sustainability of cement manufacturing business. Responses to the RQ5, through two sub-questions, provided empirical evidence on the practice of greenwashing, reasons behind its prevalence and how it could be corrected.

Findings for the sub-question 13 (SQ13). Is there an established process for determining the emissions reduction impact of a deployed technology?

The combined data for the SQ13 yielded the theme: *good governance and upgrade of industry practices*. The number of responses concerning the emissions reduction effect of the deployed green technology is shown in Table 4.49.

Table 4.49 Grounded Theme for SQ13. Is there an established process for determining the emissions reduction impact of a deployed technology?

Grounded Themes	Frequency Count
20. Good governance and upgrade of industry practices.	5

Note. $N = 6$.

Grounded theme 20: Good governance and upgrade of industry practices. Five out of six respondents (83%) report that current industry practices require significant upgrades in order to establish good governance models. They supported their responses by stating that transparency and accountability builds trust and bolsters the reputation which creates and preserves value in the industry.

Findings for the sub-question 14 (SQ14). If a chosen technology turns out to be unsuitable, how easy is it to withdraw or change a particular course of action?

The combined data for the SQ14 yielded the theme: *consequences of green technology choice and other management decisions*. The number of responses concerning the potential for course correction and the practical implications of the course of action set by management, as determined by the choice of technology is shown in Table 4.50.

Table 4.50 Grounded Theme for SQ14: If a chosen technology turns out to be unsuitable, how easy is it to withdraw or change a particular course of action?

Grounded Themes	Frequency Count
21. Consequences of green technology choice and other management decisions.	4

Note. $N = 6$.

Grounded theme 21: Consequences of green technology choice and other management decisions. 67% of respondents (E311X, E611X, E982XT, and E361XT) expressed the need for the burden of managerial decision-making to be noted because in cases like this, the consequences could be far reaching. They argued that senior executives should be supported more in choosing the right technologies until course correction becomes a possibility.

Findings from content analysis of the secondary data

The analysis revealed some disparities in the perspectives of the primary and secondary sources for each RQ. This section is divided in two key findings: findings from qualitative analysis of the secondary data and findings from quantitative analysis of the secondary data (corporate financial data).

Findings from qualitative analysis of the secondary data

RQ1. How could paradoxical tensions between differing interests be managed to enable cement companies meet their net-zero targets while maintaining profitability and market competitiveness?

All sources are aligned in the notion that as climate challenges intensify and the market for conventional cement encounters significant risks, the fusion of innovative thinking, technological advancements, and new business frameworks will be essential for securing a sustainable and profitable future. However, **the resistance of buyers to green cement due to cost concerns was evident in the primary sources, but not so in the secondary ones.** While the need for technology integration and the various types of technologies were described in 80% of the secondary material, most of the material was

supply focused. Consumer insights such as their requirements, or an assessment of price sensitivity was not apparent in any of the secondary data.

RQ2. How effective are the available “green” financial instruments for deep decarbonisation of industrial processes?

The efficacy of green financial and policy mechanisms in promoting substantial decarbonisation of industrial processes in South East Europe (SEE) is nuanced, as it is shaped by the distinct economic frameworks, energy dependencies, and regulatory contexts of the region. Thus, despite notable progress, numerous challenges remain. This point is fully aligned. A deviation emerged on the historical reliance on fossil fuels in the SEE region, in addition to recent geopolitical events which have enhanced the need for energy security. Secondary sources miss the **specific ways historical and geopolitical activities compound the challenges of green transition in the SEE region** and potentially create another point of tension.

RQ3. What are the overt and covert costs of decarbonising the cement industry?

Under terms of strict confidentiality, primary sources revealed some cost related issues such as the cost of compliance with environmental regulations, cost of labour and skills, etc., while references to costs in secondary sources were in general terms. Given the centrality of cost to the research, further examination was carried out using available information to estimate the cost burden and regional contexts of operations. Details are in the section on quantitative analysis of company financial data. Furthermore, across the SEE region, cement companies operate in markets with diverse regulatory maturity, varying levels of EU alignment, and uneven access to financing instruments aimed at

decarbonisation and technology. Secondary sources have a broader focus. Understanding these constraints are essential during assessment of the full implications of green transitions.

RQ4. How long does it take for essential green technology to move from the research and development (R&D) phase to full industrial integration and return on invested capital?

Some interesting insights regarding market dynamics emerged from the data. Assumption of demand for low-carbon cement, driven by ESG-conscious construction sectors, could shorten the period for ROIC. However, **primary data confirms issues with demand as the construction sector simply imports cheaper cement from other geographies.** Whereas secondary sources indicate optimism that the Carbon Border Adjustment Mechanism (CBAM), regulation by the European Union to support cleaner production practices in carbon intensive sectors, would deal with issue.

However, the Carbon Border Adjustment Mechanism (CBAM) is currently in a transitional phase that commenced in October 2023, focusing on reporting obligations for importers. Full implementation is set to start on 1st January, 2026 (European Commission Taxation and Customs Union, 2025). The implementation of CBAM is already facing many challenges such as the administrative complexity of managing emissions data across complex supply chains, trade protectionism, potential for disruption of existing cross-border electricity flows, etc.

Factors influencing the timeline of green technology dispersion include the type of technology, market dynamics, organisational readiness, financial access for scaling,

etc. Examined data show that Carbon Capture and Storage (CCS) or Alternative Clinker Materials take longer to develop and implement due to their complexity, whereas Waste Heat Recovery (WHR) systems tend to have comparatively shorter deployment timelines. Additionally, **the unwillingness of buyers to pay green premium prolongs the period for ROI.**

The technology diffusion timeline as extrapolated from both primary and secondary data is summarised in table 4.51.

Table 4.51 Estimation of technology diffusion timeline.

Stage	Standard Duration	Activities
Planning	1-2 years	Project design
Research & Development	2–5 years	Lab-scale validation, early proof-of-concept
Pilot Demonstration	3–7 years	Demonstration projects, testing under operational conditions
Commercial Rollout	5–10 years	Initial market deployment, adjustments for large-scale use
Return on Investment	10–20+ years	Broad market adoption, scale and cost efficiencies are necessary for attainment.

From the above, the timeline for essential green technology to move from the research and development (R&D) phase to full industrial integration and return on invested capital, ranges from 11 to 24 years, assuming stable market conditions.

RQ5. How can corporate leaders in the cement industry assess and prevent greenwashing practices?

Greenwashing is universally condemned. However, both primary and secondary sources appear to regard it as **a corporate integrity issue, not a business risk**. Amid the urgency to embrace sustainable methods, some companies may inflate or falsify their green credentials in order to appeal to consumers. According to a primary source, this risky strategy might consist of an excessive focus on minor sustainability efforts while essential operations remain unchanged, a divergence between articulated aims and true emissions or investment patterns, opaque ESG metrics, or a lack of external verification.

Findings from quantitative analysis of the secondary data

Corporate financial data of all the examined multinational companies show clear attempts to align plans for capital expenditures with net-zero reduction targets. The value increases year-on-year. In presentation of data, the companies applied different standards, some showing yearly figures while others skip, showing data in gaps of 3 or 5 years. Decarbonisation costs have overt and covert components. Table 4.52 shows the overt costs of decarbonisation.

Overt and covert costs of decarbonisation

Table 4.52 Examination of overt costs of decarbonisation in cement production.

Overt costs	
(Direct and measurable)	Description
1. Capital Expenditure (CAPEX)	These costs are related to the upgrade or retrofits of plants for carbon capture, alternative fuels, or electrification. For instance, the cost of a single Carbon Capture Utilisation and Storage (CCS) can be in the range of a few hundred million per facility.

2. Operational expenditure (OPEX)	These relate to increased energy costs for low-carbon processes, maintenance and operational complexity of the new technologies, human capital, etc.
3. Costa of raw material substitution	Switching to low-clinker cements or alternative raw materials generally incur higher procurement or processing costs.
4. Costs of regulatory compliance	These expenses are related to meeting emissions regulations, carbon pricing schemes, and environmental standards.
5. Costs of research and development (R&D)	Investments in innovation initiatives, new processes and technologies such as green hydrogen kilns or electrified production, as well as pilot programs.

These overt costs are often referenced by the stakeholders, and most available financial instruments e.g., grants, green bonds, etc., are geared towards supporting the companies in dealing with them. Table 4.53 shows the covert costs of decarbonisation.

Table 4.53 Examination of covert costs of decarbonisation in cement production.

Covert costs	
(Indirect or hidden)	Description
1. Organisational disruption	Costs related to changing workflows, reskilling staff, and adapting the corporate culture to new sustainability norms.
2. technological lock-in	Sunk costs and long-term inefficiency can arise from choosing the wrong technology for the particular company at the early stages. For instance, investing in CCUS instead of green hydrogen.
3. Supply chain instability	The phase out of established and predictable supply network, to source new suppliers, establish new logistics for alternative fuels or materials, and the potential instability of those new supply chains, all contribute to invisible costs.

4. Market and reputational risks	Uncertainty about the true market demand for "green cement" due to higher prices or slow adoption by end users such as in the construction sector could lead to stranded investments. Furthermore, if decarbonisation attempts turn out to be unsuccessful, or perceived as greenwashing, it can negatively impact stakeholder trust and brand value.
5. Opportunity costs	Financial and material allocations to decarbonisation initiatives might restrict investments in other business areas or activities such as competitive pricing, innovation, or market expansion.

The covert costs are much more difficult to quantify. However, they exist in many forms and have significant influence on the overall cost-effectiveness and success of decarbonisation initiatives.

Contextual insights on overt vs. covert costs of decarbonisation in the SEE Region

The main cement companies operating in this region are navigating markets with significant diversity in regulatory maturity, varying stages of EU alignment, and uneven access to decarbonisation finance and technology. The corporations and specific SEE countries include:

- Titan Cement Group (Bulgaria, Serbia, Kosovo, North Macedonia)
- Holcim (LafargeHolcim) (Romania, Serbia, Croatia)
- Heidelberg Materials (Bosnia & Herzegovina, Croatia, Bulgaria)
- Nexe Group (Croatia, Bosnia & Herzegovina)
- Cemex (Croatia, Bosnia & Herzegovina)

Table 4.54 examines the regional context as it relates to both overt and covert costs of decarbonisation of cement production.

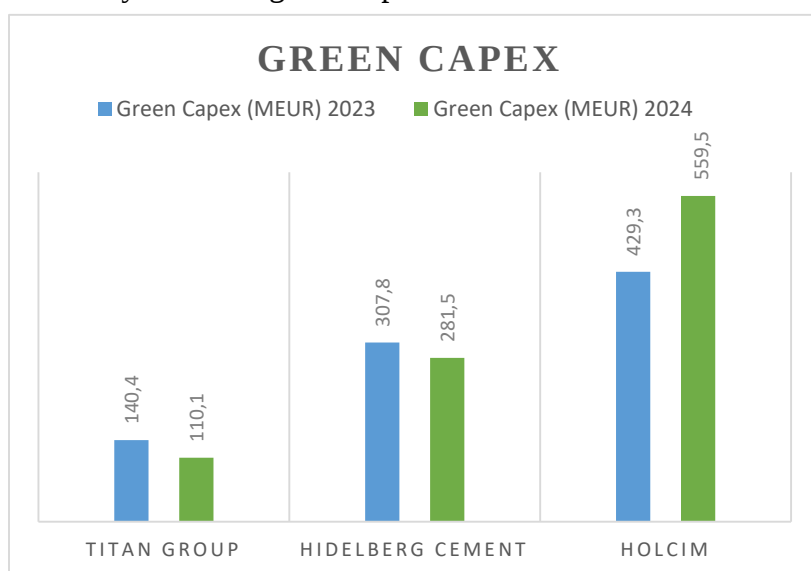
Table 4.54 Overt and covert costs in the context of the SEE region.

Cost Category	Overt costs	Covert costs	SEE context
1. CAPEX	Cost of kiln upgrades CCUS, alternative fuels, materials, etc.	Long payback periods, high financial strain on smaller players.	Many aging plants are in the region, and companies have limited access to green finance.
2. OPEX	Plant maintenance, alternative fuels translate into more expensive operations	Productivity drops during technology integration.	High variations in fuel costs, and biomass is neither widely available nor subsidised.
3. R&D & Innovation	Pilots for new technology kilns and clinker substitutes	Risk of adopting non-scalable solutions.	Local R&D is limited, so technology is often imported from parent companies.
4. Compliance & Regulation	EU ETS costs for EU members as well as carbon audits.	Policy uncertainty for non-EU countries.	Regulatory inconsistencies exist between EU and non- EU countries in SEE.
5. Staffing & Training	Hiring and reskilling for new technologies, processes, and, sustainability roles	Workforce resistance, learning curve, skills mismatch, etc.	Varying offering and quality of technical education, and variations in labour market readiness.
6. Market Readiness	Developing new, green product varieties.	Low demand for green cement due to higher prices.	Reluctance of construction clients to pay premiums for sustainability.
7. Supply Chain Adjustments	Sourcing new suppliers, securing low-carbon materials, etc.	Political risks, and unreliable infrastructure.	Limited number of green suppliers. Additionally, railways and logistics are underdeveloped.

8. Reputation & ESG	ESG reporting costs	Risk of unmet sustainability claims or greenwashing	ESG reporting is not yet widespread or mandatory in many SEE markets
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Investment trends

The green Capex classifications differ among companies, with Holcim³ classification encompassing a broader range of activities including those not eligible under EU taxonomy. Whereas green Capex related to the others are taxonomy aligned figures, which



are a percentage of income generated from taxonomy eligible economic activities. Furthermore, Holcim has been very successful in securing six grants from the EU

Figure 4.3 Green Capex across selected companies.

Source: Individual company's integrated annual reports 2024

Innovation Fund, for

CCUS projects, boosting the investment figures. The graph in figure 4.3 illustrates the share of green investments, as companies strive to honour their commitments.

³ Financial figures related to Holcim were converted to Euro based on the exchange rate on 11th June 2025.

Energy consumption and alternative fuels

Over the past few decades, the cement industry actors have allocated considerable resources towards four essential measures to curtail direct CO2 emissions. They are in the areas of thermal efficiency, fuel substitution, clinker substitution and carbon capture technologies.

Total energy consumption

The energy requirements for cement production is high. As a strategic material,

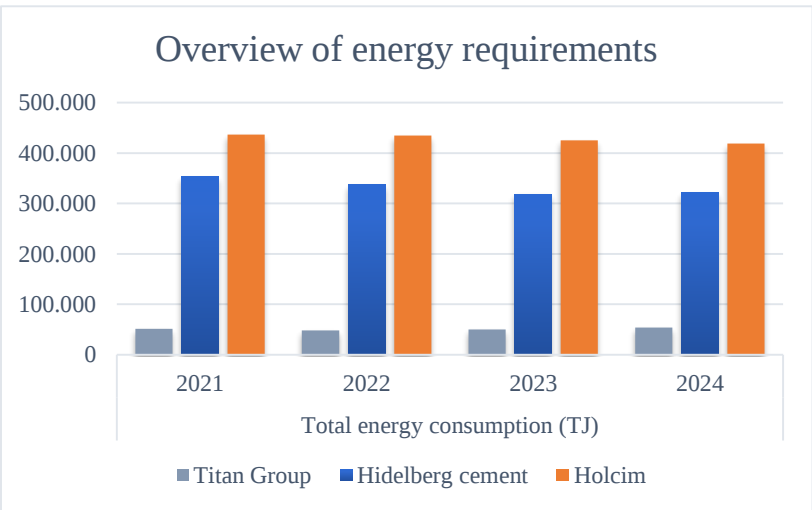


Figure 4.4 Overview of the total energy consumption of selected companies.

Source: Individual company’s integrated annual reports for 2024, 2023 and 2022.

critical for societal infrastructure, it is not an easily substituted product. All the companies used different units of measurments for their reporting of energy consumption. Some reported in Megawatt

hours (MWh), some in Terra Joules (TJ) and another in Giga Joules (GJ). For ease of comparison, all units were converted to Terra Joules. Despite the increase in effeciency measures and greener energy sources, the numbers indicate that in order to meet market demands and growth objectives, the energy requirements of production would be difficult to significantly reduce.

Alternative fuel substitution rate

Alternative fuel rate refers to the proportion of alternative fuels in the fuel mix for

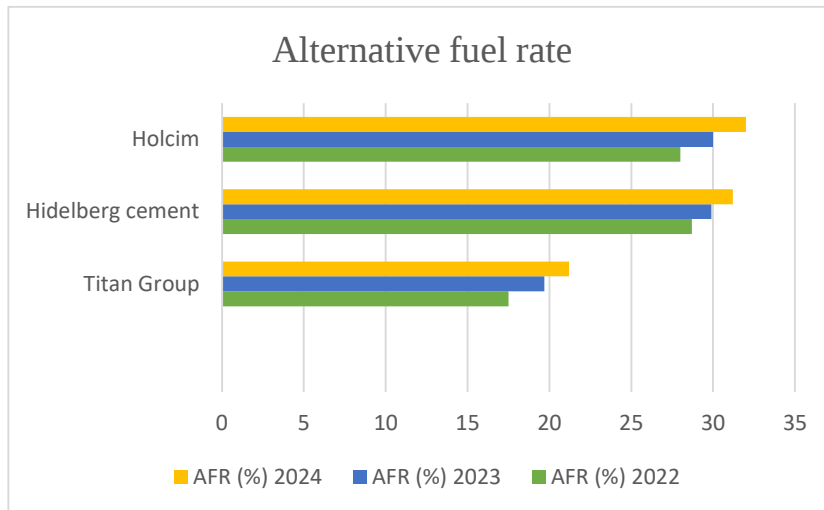


Figure 4.5 AFR of selected companies.

Source: Individual company's sustainability reports 2024 and 2023

thermal processing. It is also known as alternative fuels (AF) thermal substitution rate. It primarily pertains to residues and waste that are either not cost-effective to recycle or

cannot be recycled through any alternative methods, including processed household waste, biomass, as well as industrial by-products and waste materials.

Most companies are making investments in increasing the share of alternative fuels, as well as alternative raw materials in their production processes and the numbers have been increasing steadily year-on-year as illustrated in figure 4.6.

Clinker substitution

Clinker is the key binding agent in cement, and is fundamentally a blend of limestone, clay and minerals that have been subjected to high temperatures in a kiln, leading to their alteration. Clinker to cement ratios indicate the proportion of clinker in cement and the lower it is, the lower the CO₂ emission of that cement i.e., it shows the penetration rate of green cement in the company's production.

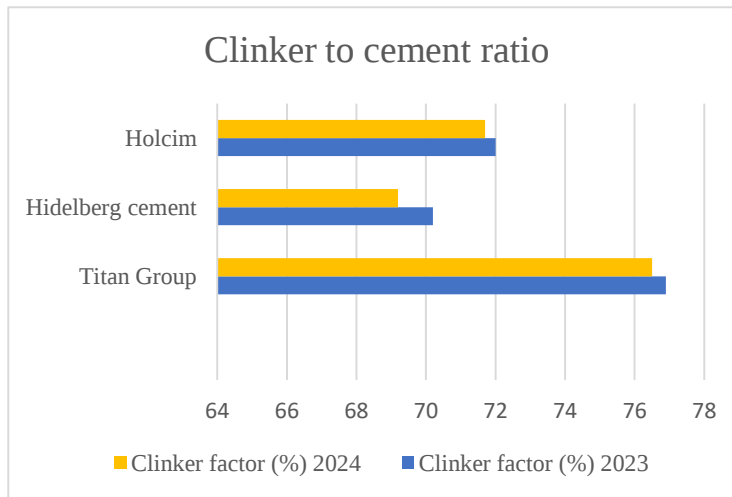


Figure 4.6 Clinker substitution ratio

Source: Individual company's sustainability report 2024.

To decrease the amount of clinker, companies increase the proportion of blast furnace slag, fly ash, and limestone in cement. Additionally, some plants incorporate alternative cement materials, including natural pozzolans or

calcined clays.

According to (Barbhuiya, et al., 2024), alternative clinker technologies are the next frontier in innovative approaches aimed at reducing the carbon footprint of cement production, as they could replace or drastically reduce the use of traditional clinker, which is the primary source of CO₂ emissions. An example of an alternative clinker technology is calcined clay-based cements, such as LC3 (Limestone Calcined Clay Cement) in which companies like Heidelberg Materials has invested.

Estimated Return on Invested Capital (ROIC) at group level

Information from the corporate financial statements (2022, 2023 and 2024) required alignment in order to be able to compare the selected companies. The formula for estimating potential return on investments (ROIC), requires the net income (also known as net profit) to be divided by the investment costs. The net income of the selected companies is outlined in table 4.55.

Table 4.55. Net income of selected industry actors.

Source: individual company's integrated annual reports for 2024 and 2023.

Net income in			
MEUR	2024	2023	2022
Titan Group	290.26	272.59	110.48
Hidberg	2,190.40	1,882.20	1,732
Holcim	3,042	3,176	3,528

The net income after taxes from the data are in accordance with the size of the companies, with the income from steady growth being used to finance operations and investments amongst others. In the income reporting, companies take currency effects into account as appreciation or depreciation of the primary currencies (EUR, USG, GBP, and CHF), affect ROIC either positively or negatively.

ROIC (Return on Invested Capital) evaluates the net operating profit of a company in relation to its invested capital, whereas ROCE (Return on Capital Employed) measures profitability of the company, considering all the capital it utilised, encompassing both debt and equity. Although both ratios offer valuable perspectives on a company's financial well-being, they emphasise distinct facets of capital efficiency. The formula for calculating Return on Capital Employed (ROCE) involves dividing earnings before interest and tax (EBIT) by the capital that has been employed.

Thus, the main differentiator is that the calculation of **ROCE is grounded in pre-tax figures, while ROIC is derived from after-tax figures**. As a result, ROCE is deemed more applicable from the company's perspective, whereas ROIC is more significant for investors, as it reflects the anticipated dividends they might obtain.

Table 4.56 ROIC of selected industry actors.

Source: individual company's integrated annual reports for 2024, 2023 and 2022.

Reported ROIC (%)	2024	2023	2022	2021
Hidberg	9.9	10.3	9.1	9.3
Holcim	11.2	10.6	9.5	8.9

Titan Group on the other hand, utilised a measurement of their capital efficiency based on a three-year Return on Average Capital Employed (ROACE).

Table 4.57 Net income of selected industry actors.

Source: individual company's integrated annual reports for 2024, 2023 and 2022.

Reported ROACE (%)	2024	2023	2022	2021
Titan Group	17.8	16.9	7.0	N/A

A company's ROCE exceeding the cost of capital, indicates that the company has efficiently used its capital to produce profits. An increasing ROCE over the years, suggests business stability making the company more attractive to potential investors.

Content analysis III – statistical data from official databases.

Analysis of relevant datasets on industrial production, energy consumption, and environmental impact, including statistical data on CO₂ emissions, and investments in actions related to decarbonisation of cement production was carried out with data from official databases containing the relevant datasets. Pricing data that was not available from the sources listed below, was extracted from other alternative sources such as business intelligence platforms, aggregated and calculated manually. Details on the data types, sources and applicability are presented in Table 4.58.

Table 4.58 Data sources for industry analysis from official databases.

Data Sources	Data type	Description
1. Statista	CO ₂ Emissions Data, cement industry data.	Analysis of statistical data on energy consumption, investments in decarbonisation and CO ₂ emissions, in cement production. Also, for the cement market in Europe.
2. International Energy Agency (IEA)	Cement industry investment trends.	Analysis of industry specific data on emissions reduction and sustainability actions, including commitments to Net Zero transition.
3. S&P Global	Cement pricing data.	Estimates for cement pricing and cement market analysis.
4. National Bureau of Statistics	Import and export data	via NACE code C23.5.1 (manufacture of cement)
4. Global Carbon Budget	CO ₂ Emissions Data.	Analysis of statistical data on CO ₂ emissions in cement production.

Findings from the analysis of statistical data

Annual CO₂ Emissions

In the context of the Net-zero emissions by 2050 target, global cement production is expected to hold steady through 2030. However, material efficiency strategies could support further reduction of CO₂ emissions from cement production. The efforts of EU cement companies to reduce their carbon footprints is evident in the data and illustrated in Figure 4.7.

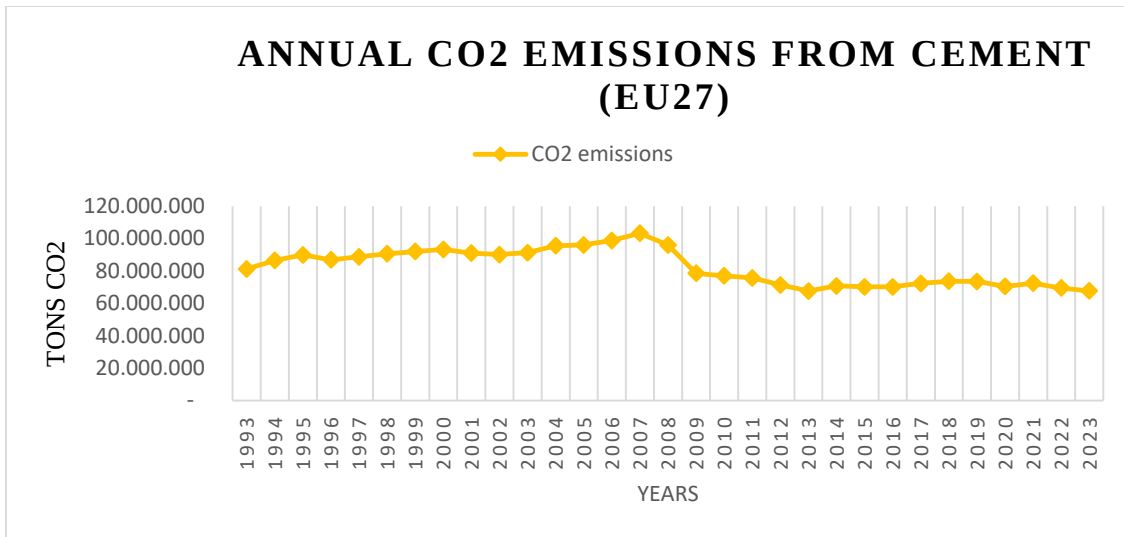


Figure 4.7 CO2 emissions trends in cement production in EU27

Data source: Global Carbon Budget (2024) [OurWorldinData.org/co2-and-greenhouse-gas-emissions](https://ourworldindata.org/co2-and-greenhouse-gas-emissions)

Looking closer at the three EU member states in the SEE region, the data shows Bulgaria and Croatia to have a significantly lower carbon footprint than Romania. Companies in these countries, on account of being EU member states, face the same obligations, despite strong variations in capacities, market size and overall impact.

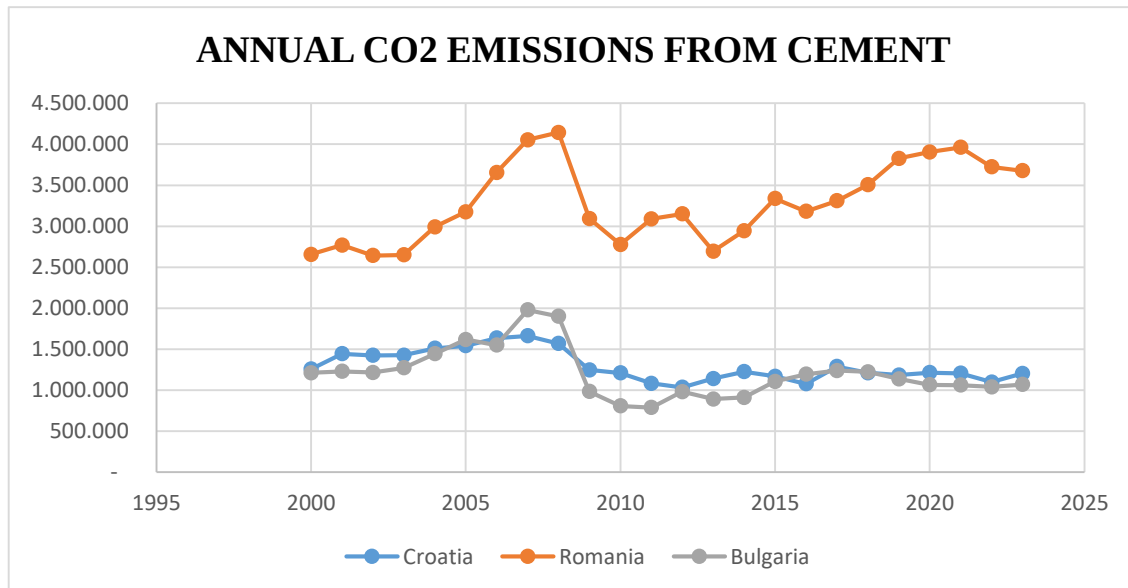


Figure 4.8 CO2 emissions trends in cement production in Croatia, Romania and Bulgaria.

Data source: Global Carbon Budget (2024) [OurWorldinData.org/co2-and-greenhouse-gas-emissions](https://ourworldindata.org/co2-and-greenhouse-gas-emissions)

The unanswered question from this data is whether the annual CO2 emissions from countries like Croatia and Bulgaria that have been relatively stable for over a decade, warrants the enormous upfront investments and long payback period for technologies like CCUS.

Cement price trends

This section presents the findings from the comparative trends in the price of cement across the three focus EU countries in the SEE region: Bulgaria, Croatia, and Romania, between 2015 and 2025. It provides a contextual foundation for analysing the financial constraints associated with green technology adoption in the cement industry in the region. Both historical and projected pricing data show a sustained upward trend across all three countries, reflecting a broader structural cost drivers in the industry.

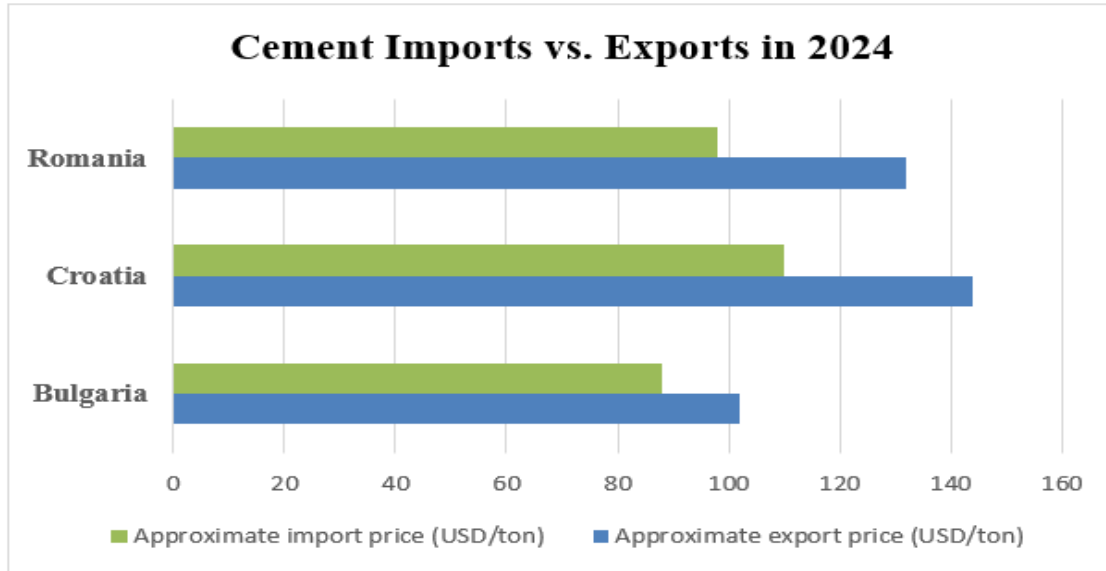


Figure 4.9 A comparison of import and export data for the three EU member states in the SEE region.

Data source: Indexbox Report: Cement - Market Analysis, Forecast, Size, Trends and Insights (2025). <https://www.indexbox.io/search/cement-price-croatia/>

Both Romania and Croatia show higher market volatility and faster growth in recent years, while Bulgaria remains below the European average for both imports and exports.

In 2024, the primary export markets for the three countries are as follows:

Bulgaria	Croatia	Romania
North Macedonia	Bosnia and Herzegovina	Hungary
Romania	Serbia	Bulgaria
Kosovo	Italy	Moldova

Some of the main factors that impact the price of cement in these countries include among others, rising input costs (coal, electricity, transport, etc.), carbon pricing and ETS compliance, logistics, and public infrastructure spending backed by EU funds.

Cement Price Trends for Bulgaria, Croatia & Romania

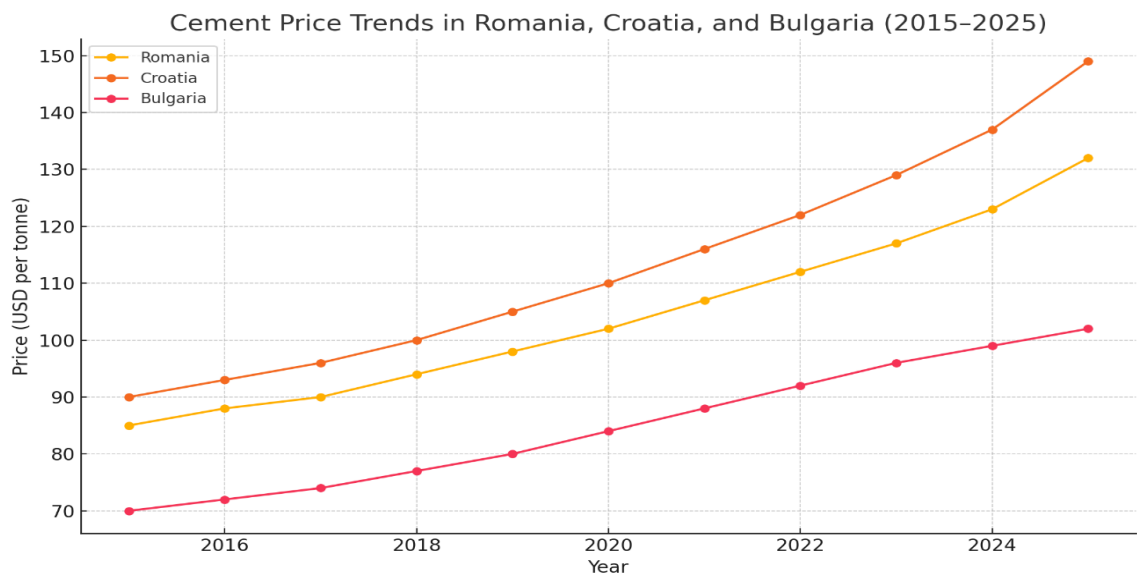


Figure 4.10 Cement industry price trend data 2015 -2025.
 Data sources: aggregated data from Eurostat – Construction Materials Price Indices, the three National Bureaus of Statistics, World Bank Commodity Markets Outlook, and IMARC Group: Cement price Report and Forecast Data (2025).
<https://www.imarcgroup.com/>

Over the last decade, the prices of cement in Bulgaria, Croatia, and Romania have seen a notable increase, indicative of wider regional inflationary trends, heightened energy and carbon expenses, and disruptions within supply chains. A detailed examination of export and import pricing indicates that:

- i. Romania has witnessed a price surge of roughly 55–65 percent, with average costs increasing from about USD80–85 per ton in 2015, to about USD132 per ton by 2025.
- ii. the most significant growth is evident in Croatia, with prices rising from an estimated USD90 per tonne in 2015, to around USD149 per ton in 2025.
- iii. Bulgaria, that is starting from a lower price point of approximately USD65–70 per ton), is projected to reach about USD102 per ton by the end of 2025, which is an increase of around 50 percent.

These developments are consistent with the EU-wide producer price index statistics⁴, which indicate an overall increase of approximately 50–70 percent in cement production costs since 2015. The projected price of cement with the integration of Carbon Capture Technologies by 2050, is about USD240 per ton. These pricing dynamics are shaped by the increasing input costs such as energy, raw materials, and emissions compliance costs under the EU Emissions Trading System (ETS). The evolution of pricing highlights the escalating cost pressures on the cement sector in the Southeast European

⁴ Note: Where precise disaggregated cement price data was unavailable, proxy indicators were used from national building material indices, adjusted by energy cost share estimates and validated through corporate disclosures.

region and emphasises the financial challenges faced by companies investing in green technologies amidst an already unstable cost landscape.

The research results provide a quantitative backdrop for interpreting firm-level investment behaviours, risk mitigation strategies, and the broader market conditions under which companies are expected to decarbonise.

4.5 Data Triangulation

To enhance the validity and credibility of the findings (Yin, 2009) on the particular challenges of green technology adoption in the cement industry in South East Europe, it was essential to triangulate three distinct, but interrelated datasets. The structure of the triangulation framework is shown in figure 4.11.

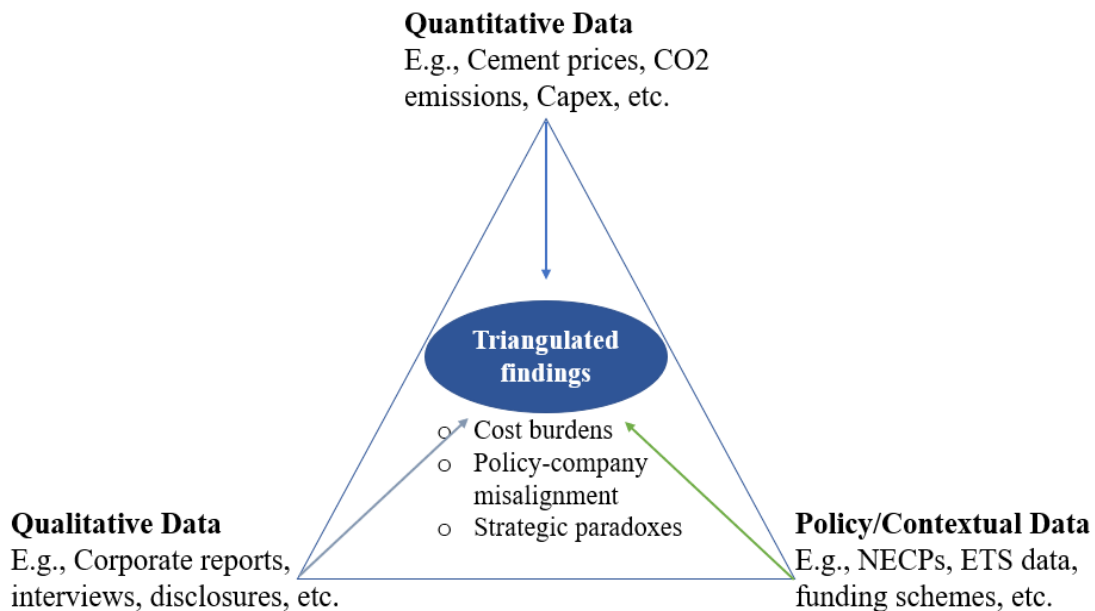


Figure 4.11 Author's representation of the triangulation framework for multi-source analysis of green technology adoption in the cement industry.

- **Stakeholder insights** from stakeholder interviews and publications aimed at determining the "why" behind observed patterns (qualitative data),
- **Financial and operational data** in order to directly assesses company-level burdens and investment patterns (quantitative data), and
- **Policy and regulatory driven instruments** that stimulate private investment responses to public policy signals, to give context to distribution of cost burdens and risk exposure (quantitative data).

The triangulation of key findings is presented in Table 4.59.

Table 4.59 Data triangulation matrix

Data source	Method	Key findings	Relation to other data
1) Semi-structured interviews with 12 internal stakeholders	Thematic analysis	Five major findings from the interviews with executives show: 1) Difficulty harmonising stakeholder priorities in sustainable decarbonisation. 2) Structural barriers negatively impact green finance accessibility; hidden costs are not taken into account. 3) Many simultaneous factors are necessary for organisational adaptation to green transition and	Qualitative insights generally support the findings from the internal stakeholders related to the necessity for stronger relationships with diverse stakeholder and interests to enable co-creation of sustainable solutions. The data also reveals expectations for firms to comply with policy directives and increase their decarbonisation efforts. However, insufficient attention was

they hinge on strategic decisions from which it is nearly impossible to backtrack e.g., choice of technology. 4) Ensuring operational and financial readiness for seamless green technology adoption is a priority, but if the choice is business survival, the shorter-term option would be chosen. 5) Governance models and ethical leadership in green transition are essential to prevent practices such as greenwashing.	paid to the complete operational and cost structure. Additionally, a phenomenon where the same tone, messaging, technologies, etc., were being used across the various reports has been noted in the qualitative sources, maintaining the focus seemingly on compliance levels and stimulation of predetermined action. Some reservations were expressed in specific secondary sources about the long-term feasibility of the currently available decarbonisation options and their climate change mitigation potential. The quantitative data indicates a taxonomy aligned Capex of around 14% of Group revenue, and staff increase of around 10% on average.
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2) Content analysis of the secondary sources: Qualitative <i>(Publications in the form of text, images and multimedia, as well as ESG reports on the green technology integration in the cement industry)</i>	Thematic analysis	Analysis showed that significant investments are required to meet sustainability goals. The tension faced by firms in balancing ESG and economic viability was identified, stating that such challenges could lead companies to speedily develop more innovative products and resilient strategies.	This insight is aligned with the quantitative data which shows a steady increase in R&D as well as other investments. The data also underscores higher fiscal risks as the share of liabilities in the form of bonds and loans are also increasing steadily, with overlapping maturities. Primary data indicate the disparity between technology development & integration timeline with financing timelines as another key area of tension.
3) Content analysis of the secondary sources: Quantitative <i>(Corporate financial and operational data; statistical data,</i>	Statistical analysis	Analysis of annual CO2 emissions in EU27 reveals a peak in 2007 and a relative plateau between 2013 and 2023. (Figure 4.7) The quantitative data show a steady increase in Greentech integration at	Some qualitative data show reservations about the long-term feasibility of the currently available decarbonisation options and their climate change mitigation potential. A slight decline in financial results is

<i>price indices, public financial instruments)</i>	company level via increases in alternative fuel substitution rates, share of renewable energy, increasing clinker factor, waste water treatment facilities and CCUS solutions. Nonetheless, the data indicates a lag in Greentech development in the SEE region.	forecasted for 2025 due to market realities. Correlation between policy strictness and adoption rates of green technologies emerged. Qualitative insights from primary data reinforces this finding of lagging SEE region, suggesting that policy and infrastructure rigidity, in addition to technological, human resource challenges as well as financial constraints, are primary sources of tension between organisations, market forces, regulators and investors. These complementary findings highlight the critical role of localisation in enabling true decarbonisation in the region.
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The data triangulation matrix presents key insights across data sources. It highlighted that organisation face significant tensions in balancing sustainability objectives with economic viability and business survival.

Structural barriers, including financing gaps, policy rigidity, and technological lock-in, continue to impede an effective green transition. Furthermore, while stricter policies are associated with faster adoption of green technologies, regional disparities underscore the need for localised and context-sensitive strategies. The findings also suggest that organisations risk prioritising compliance and standard messaging over genuine transformative change, raising concerns about greenwashing. Ultimately, large-scale investment and strategic governance are critical for credible decarbonisation, though rising liabilities point to increasing fiscal risks.

4.6 Summary of Findings

This chapter presents the key study findings. It indicated that cement companies face conflicting priorities between profit goals essential for business sustainability, and decarbonisation targets necessary for accomplishing the climate objectives. Internal and external stakeholders have differing priorities, making alignment difficult.

Decarbonisation involves urgency in both technological and process upgrades, which require high upfront costs. However, access to green finance is complex and slow. In addition, significant risk exposure in the form of currency risk, interest rate risk, credit risk and refinancing/liquidity risks, require constant monitoring, as the inability to procure the funds necessary to fulfil operational obligations, or obligations entered into in connection with financial instruments, could have dire consequences for the company.

Furthermore, besides the financial requirements, technology integration depends on human as well as material resources, rendering unpredictability to the rollout of green technologies. Finally, although there are ESG reporting standards that also apply to the cement industry, it is still possible to apply superficial environmental, social and governance claims. Corporate leaders call for better governance of the competitive landscape, while also allowing for the flexibility to backtrack from a set technological course if it happens to be unsuitable for the purpose, particularly as new ownership and business models are being explored.

4.7 Conclusion

The findings demonstrate that the adoption of green technologies within the cement industry in South East Europe remains partial and uneven, with progress strongly shaped by the intersection of institutional pressures, financial capacity, and managerial adaptability.

Quantitative analysis of data indicates that capital investments in decarbonisation technologies, though present, are modest relative to overall capital expenditures, and often rely on external support mechanisms such as EU funding and development finance. Across national contexts, the regulatory environment emerges as a key driver, with stronger policy alignment correlating with more ambitious sustainability commitments. Additionally, data from the broader EU producer price index indicates a significant rise of approximately 50–70 percent in the costs associated with cement production since 2015. This trend emphasises the increasing financial burdens on the cement sector within the SEE region, and highlights the economic challenges facing companies that are investing in green technologies within a volatile cost environment.

Qualitative insights reveal that companies face significant tensions between maintaining operational efficiency and pursuing long-term environmental goals. These strategic paradoxes are particularly acute in economies with volatile markets and underdeveloped green finance ecosystems. Managerial capabilities, particularly *sensing*, *seizing*, and *reconfiguring* competencies were found to be critical in mediating these tensions and enabling companies to respond proactively to evolving environmental demands.

Notably, the study also uncovered instances where sustainability communication outpaced substantive action, raising concerns about potential greenwashing practices in the absence of rigorous verification and governance oversight. The triangulation of data sources strengthens the reliability of these findings and highlights the differentiated pathways companies are taking toward decarbonisation. Overall, the evidence underscores the importance of aligning institutional frameworks, financial instruments, and organisational capabilities to accelerate green transitions in carbon-intensive sectors.

CHAPTER V:

DISCUSSION

5.1 Introduction

The research investigated the urgent necessity to decarbonise the carbon intensive cement industry, underscored by escalating regulatory, market, and societal pressures, within the context of operations in South East Europe (SEE). As regional economies endeavour to comply with the EU Green Deal and climate neutrality goals, cement manufacturers encounter unique challenges in adopting and integrating green technologies. These challenges are compounded by institutional fragmentation, limited financial and human resources, and increased scrutiny from investors.

The findings from the examined data highlights both the potential benefits and risks associated with such transitions such as while investments in green technology can provide long-term competitive and reputational benefits (Teece, et al., 1997), they frequently face obstacles due to governance deficiencies, technological path dependency, and the practice of greenwashing in poorly regulated settings (Lyon & Montgomery, 2015; Delmas & Burbano, 2011). This research finds itself at the convergence of these factors, investigating how cement companies in SEE manage the conflicting pressures of immediate business sustainability against long-term environmental results, factors influencing investor trust, the repercussions of suboptimal technology choice on corporate resilience and the degree to which effective governance practices can reduce the practice of greenwashing.

Utilising theories of institutions, stakeholders, dynamic capabilities, and paradoxes, the study examines how companies via their management could implement effective adaptive strategies to support them in navigating the intricate trade-offs inherent in green transitions, while maintaining credibility, legitimacy, and sustainable value creation.

5.2 Discussion of the Study Findings

The qualitative findings highlight a continuous tension between stakeholder demands for decarbonisation and the internal initiatives aimed at cost rationalisation. In the context of Paradox Theory, this tension should not be regarded as a problem to be addressed, but as a reality that requires management. Organisations that displayed significant dynamic capabilities such as actively responding to policy changes and reorganising their supply chains, were able to manage the tensions and sustain their competitive edge, while pursuing their environmental objectives. This reinforces the role of Dynamic Capabilities in resolving paradoxes.

Furthermore, the degree to which cement companies in South East Europe adopt green technologies is heavily influenced by the alignment between external institutional pressures (regulative, normative, cognitive), and multi-stakeholder expectations. Companies that encounter strong institutional mandates, e.g., the EU regulatory frameworks, and are actively engaged with significant stakeholders like financial institutions, ESG-oriented investors, and environmental NGOs, are more likely to invest in, and implement green technologies than those operating in less institutionalised settings or with low levels of stakeholder accountability.

Interpreting Findings through Dynamic Capabilities and Paradox Theory

The integration of green technologies within the cement sector of Southeast Europe (SEE) reveals a complex relationship between the development of capabilities and the inherent organisational tensions. Drawing from the Dynamic Capabilities framework (Teece, et al., 1997) the observed differences in technological adoption among companies such as Holcim Romania, Titan Cement Greece, and Nexe Group Croatia demonstrate varying levels of firm-specific abilities to identify regulatory and market pressures, seize funding and innovation opportunities, and reconfigure operational as well as technological resources. The empirical findings reveal that the adoption of green technology in the Southeast European cement sector is not simply a matter of adhering to regulations. It fundamentally relies on the dynamic capabilities of individual firms. Table 5.1 shows the integration of dynamic capability and paradox theories.

Table 5.1 Integration of dynamic capability and paradox theories.

Theoretical lens	Focus	Key concepts
Dynamic capability theory	Managing competing demands i.e., profitability vs. sustainability.	Sensing, seizing, reconfiguring.
Paradox theory	Adapting and transforming capabilities to respond to those tensions	Paradoxical tensions, acceptance, synergy.

These capabilities encompass the ability to sense, seize, and reconfigure resources in response to environmental challenges. For instance, while all cement companies faced similar external pressures, such as the EU Emissions Trading System (ETS) and escalating energy prices, or opportunities such as access to EU Just Transition funding or Innovation Fund grants, only a few such as like Holcim Croatia and Titan Cement in Greece, actively invested in alternative fuel systems and waste heat recovery, thereby deploying strategies

designed to mitigate both regulatory penalties and reputational risks and achieving notable medium-term returns on investment (ROI). This indicates a heightened ability to detect emerging sustainability trends and to seize relevant technological opportunities ahead of competitors.

On the other hand, firms such as Nexe Group and Romcim displayed a slower pace in aligning their strategies, often delaying action until there was clarity in policy or the provision of financial subsidies. This reactive approach indicates a lack of capacity for reconfiguration, particularly in the challenge of quickly redeploying capital, or retraining staff to adapt operations to new technological paradigms.

Additionally, qualitative data suggested that several firms were deficient in internal feedback mechanisms or innovation platforms, which further restricted their learning and strategic renewal which are two critical aspects of dynamic capability maturity.

From a regional viewpoint, the data also illustrate how dynamic capabilities are moulded by institutional embeddedness. Companies operating in more stable policy environments like Croatia and Romania, reported increased confidence in their green capital expenditure (CAPEX) investments and supply chain modifications. In contrast, operations in less predictable settings, such as Serbia and North Macedonia, exhibited signs of stagnation in capabilities, with their investment strategies described as “incremental” and “externally driven”. This highlights that while dynamic capabilities are constructs at the firm level, they are also shaped by the regulatory credibility and infrastructure readiness at the national level.

Despite this, the slow and inconsistent advancement of deep decarbonisation across the region indicates that dynamic capabilities alone do not fully explain the phenomenon of organisational inertia.

In this regard, Paradox Theory provides a complementary perspective, shedding light on the strategic tension that companies encounter between the pursuit of immediate cost efficiency and the need to address long-term sustainability goals (Smith & Lewis, 2011; Hahn, et al., 2015). Cement manufacturers in Southeast Europe frequently experience this as a structural paradox: the high capital intensity and prolonged asset lifespans inherent in cement production inherently restrict their ability to adapt quickly to shifts in green policy. Evidence from the qualitative data suggests that while managers recognise their climate commitments, many simultaneously resist transformative investments due to concerns about competitiveness, market uncertainty, and technological reliability, demonstrating what Paradox Theory describes as “defensive responses” to such tensions. Conversely, a subset of firms exhibits “constructive tension acceptance,” viewing green investments as strategic enablers of long-term differentiation and regulatory legitimacy not merely compliance burdens.

Therefore, the integration of these theories indicates that the successful adoption of green technologies in the cement sector of Southeast Europe is contingent on technical and financial resources, as well as on the cognitive and strategic capacity of firms to navigate and embrace the competing logics of profit and environmental sustainability.

Interpreting Findings through Institutional and Stakeholder Theory

The study's findings demonstrate that the adoption of green technology in the cement industry of Southeast Europe is largely propelled by coercive institutional pressures, particularly those linked to EU regulatory frameworks like the Emissions Trading System (ETS) and the Carbon Border Adjustment Mechanism (CBAM). Institutional and stakeholder theories naturally intersect when stakeholders are perceived as the bearers of institutional pressures. Table 5.2 shows stakeholders as agents of institutional pressure, each in alignment with one of the three institutional pillars.

Table 5.2 Stakeholders as institutional actors.

Institutional pillars	Example of stakeholder	Nature of pressure
Regulative	Regulatory bodies, EU and national government agencies, etc.	Formal rules, regulations, legal mandates e.g., ETS participation, etc.
Normative	Professional services, certification bodies, etc.	Industry best practices, social norms, professional standards such as for ESG, moral standards, etc.
Cognitive/cultural	Banks, investors, green finance platforms, NGOs, etc.	Assumptions and estimations about sustainability, risk and moral obligations.

The results indicate that stakeholders serve as a channel for institutional pressure. Regulatory bodies enforced coercive measures e.g., ETS compliance, while professional stakeholders like certification bodies and financial stakeholders, influenced normative and cognitive expectations concerning environmental performance.

Consistent with Institutional Theory, organisations pursued legitimacy through actions aligned with stakeholders, rather than solely through adherence to regulations. Nevertheless, the differences in stakeholder prominence and power across various national contexts, account for the observed inconsistent adoption patterns. This reinforces the necessity for a hybrid Institutional-Stakeholder theoretical framework, wherein the institutional landscape is influenced by the strategic roles of external entities. Table 5.3. outlines the areas of integration of institutional and stakeholder theories.

Table 5.3 Integration of Institutional and Stakeholder theories.

Theoretical lens	Focus	Key concepts
Institutional theory	Organisational conformity to norms, rules, and expectations for legitimacy and survival.	Coercive, normative, and mimetic pressures
Stakeholder theory	Companies' obligation to respond to the interests of all stakeholders who can affect, or are affected by its operations.	Power, legitimacy and urgency (including uncertainty responses)

This observation is consistent with the framework articulated by (DiMaggio & Powell, 1983) which suggests that coercive isomorphism is generated by formal rules and policies imposed by powerful institutions. For example, executives at Heidelberg Materials Romania cited the imperative to “comply with rising EU carbon pricing” as the foremost reason for their recent capital investments in waste heat recovery systems, highlighting the influence of top-down regulatory mechanisms.

Conversely, normative pressures, including industry best practices and expectations from ESG investors, were significantly less robust in SEE compared to

Western European markets. This indicates an incomplete institutional framework where coercive influences outstrip cultural or professional norms. Notably, mimetic isomorphism was observed in companies such as Nexe Group, which acknowledged replicating Holcim's innovative strategies to attract international project funding, reflecting a strategy of seeking legitimacy through imitation rather than a genuine shift towards sustainability.

In light of this, it can be said that stakeholder expectations often manifest through normative and cultural pressures, which in turn shape or reinforce the cognitive institutional environment in which companies operate. Such mimetic responses can be regarded as a mechanism by which companies navigate uncertainty about stakeholder demands.

In a nutshell, cognitive pressure is when a company internalises the widespread belief that “green technology is the future of the industry” because it has become axiomatic. Mimetic response is when a company copies the green technology investment of a competitor because of competitive uncertainty, without necessarily internalising the belief about its necessity. Whereas cultural pressure is when stakeholders expect environmentally responsible behaviour as part of societal values, and enact pressure on the company accordingly. These pressures describe the *mechanisms of isomorphism* i.e., the reasons why organisations within a given field begin to look alike.

These findings corroborate the multifaceted impact of institutional pressures and also underscore the need to refine Institutional Theory to address the disparities in regulatory capacity across regions. In environments like SEE, coercive pressures may

prevail, but in the absence of stronger normative alignment, the adoption of green practices may remain reactive rather than strategically oriented.

Discussion of Findings for the Research Questions

28 grounded themes emerged from the analysis of qualitative data. Certain patterns and relationships were obtained from the data, and further grouped into five major theme clusters for clarity. Thus, the findings for each research question are described based on the themes aligned with the cluster. Table 5.4 shows the 28 grounded themes derived from the data, juxtaposed with the cluster of major themes.

Table 5.4 The 28 grounded themes and their major theme clusters.

RQs	Themes from all qualitative data	Major theme cluster
1	○ 1. Impact of the variations in the position of stakeholder groups. ○ 2. positioning sustainability at the core of modern construction. ○ 3. Balancing product pricing strategy with ecological objectives. ○ 15. Maintaining high decarbonisation standards. ○ 16. Necessity for new business models. ○ 17. Risk reduction in support of market expansion.	Major theme 1: Harmonising stakeholder priorities for sustainable decarbonisation of the cement industry. ○ Impact of the variations in the positions and perspectives of stakeholder groups. ○ Positioning sustainability at the core of modern construction. ○ Balancing economic and environmental sustainability. ○ Maintaining high decarbonisation standards.

	○ 22. Balancing economic and environmental sustainability. ○ 23. Herd mentality in the choice of technology to be developed and integrated. ○ 24. Correlation between price sensitivity and market demand for green cement.	
2	○ 4. Impact of complex application processes on green project development. ○ 5. Impediments to private financing accessibility. ○ 6. Impediments to public financing accessibility. ○ 7. Administrative bottlenecks and the effect on project planning and costs. ○ 18. Technological innovation as a means of securing investor interest. ○ 25. The potential market distortive effect of the green financial instruments.	Major theme 2: Navigating structural barriers and leveraging strategic enablers in accessibility of green finance. ○ Impact of complex application processes on green project development. ○ Impediments to accessibility of private financing. ○ Impediments to accessibility of public financing. ○ Administrative bottlenecks and the effect on project planning and costs. ○ Reliance on external technical and specialist service providers. ○ Potential market distortive effect of green financial instruments.

	○ 26. Ensuring acceptable costs and quality of outputs by external service providers. ○ 27. Administrative bottlenecks and the effect on project planning and costs.	
3	○ 8. Financial requirements of green transition. ○ 9. Motivators behind technology choice. ○ 10. Adaptations of people and process management ○ 19. Determinants of acceptable costs of green projects.	Major theme 3: Strategic decision-making, financial readiness and organisational adaptation to green transition initiatives. ○ Determinants of acceptable costs of green projects. ○ Financial requirements of green transition. ○ Necessity for new business models. ○ Balancing product pricing strategy and ecological objectives. ○ Correlation between price sensitivity and market demand for green cement. ○ Motivators behind technology choice (herd mentality). ○ Ensuring acceptable cost and quality of outputs from external service providers.

		○ Technological innovation as a means of securing investor interest. ○ Integrated and effective approaches to change management.
4	○ 11. Correlation between financial and human capacities on green technology integration process. ○ 12. Impact of issues related to the deployment of new technology on investor confidence. ○ 28. Necessity for in-depth and well documented integration process management.	Major theme 4: Ensuring operational readiness for seamless green technology adoption. ○ Correlation between financial and human capacities on green technology integration process. ○ Adaptations of established people and process management. ○ Risk reduction in support of market expansion. ○ Impact of issues related to the deployment of new technology on investor confidence. ○ Necessity for in-depth and well documented green technology integration process for effective management.
5	○ 13. Lack of prohibitive measures against greenwashing practices. ○ 14. The necessity for experimentation.	Major theme 5: Governance and ethical leadership in green transition. ○ Good governance and upgrade of industry practices related to greenwashing.

○ 20. Good governance and upgrade of industry practices.	○ Consequences of green technology choice and other management decisions.
○ 21. Consequences of green technology choice and other management decisions.	○ Lack of prohibitive measures against greenwashing as tacit endorsement of the practice.
	○ The necessity for experimentation as a means of course correction in case a suboptimal technology is deployed.

5.3 Discussion of Research Question 1

RQ 1: How could paradoxical tensions between differing interests be managed to enable cement companies meet their net-zero targets while maintaining profitability and market competitiveness?

The major theme cluster for RQ1 is encompassed in the topic: **harmonising stakeholder priorities for sustainable decarbonisation of the cement industry**. This topic presents an overarching, macro perspective, which captures the challenge of managing diverse stakeholder positions while adhering to rigorous decarbonisation standards and preserving economic sustainability via strategic trade-offs. The degree of acceptable trade-offs becomes a matter of managerial capacity to navigate institutional pressures. The theme cluster underscores the importance of balancing environmental aspirations with the realities of business and financial considerations, acknowledging the varying interests of multiple stakeholder groups. Here, the necessity for an update of the literature related to management theory became apparent.

This cluster comprises of four grounded themes:

I. Impact of the variations in the positions and perspectives of stakeholder groups.

The positions of the stakeholders varied significantly in the study. On the side of the companies, integration of green technologies is a battle for survival brought on by climate related disruptions, as well as market expectations for cheaper and higher quality products, which economically does not support the costly upfront investments that green transition entails. With the institutional pressures, corporate actors are keenly aware of the necessity for change. Nonetheless, the upfront costs are experienced as excessively high to be managed in addition to the standard costs of business operations. Unlike the other stakeholders, only companies directly experience the covert costs of transition. Finance institutions on the other side, regard the transition as a financial and normative issue, noting that companies have full support available if the company is sufficiently bankable. Additionally, the state agencies maintain a compliance-based approach, where corporate adherence to supranational mandates is directly correlated with national adherence.

II. Positioning sustainability at the core of modern construction. Sustainability in modern construction emphasises the reduction of environmental impact alongside the enhancement of social and economic advantages. The focus on sustainability at the core of modern construction is an attempt at market correction, as there is a direct correlation between the building and construction industry shifting to green and an increase in demand for green cement. This approach encompasses the utilisation of alternative raw materials, alternative fuels, energy efficiency

improvements, etc., aimed at diminishing the carbon footprint of all the related industries. However, as input suppliers to the construction industry, some cement industry players are of the view that sustainability is a political push which is potentially harmful to the economy, as it tries to do too much at once. The colloquially known Draghi report is referenced as justification for this position. Specifically, the aspect that decarbonisation initiatives should be harmonised with economic development to guarantee that environmental objectives do not impede competitiveness (Draghi, 2024).

III. *Balancing economic and environmental sustainability.* The empirical data and literature are aligned about the necessity for corporate dexterity in managing business and sustainability objectives. Although internal stakeholders find it encouraging that financial instruments to support the green transition exist, the lack of customisation and slowness of implementation among others, are major constraints as they increase uncertainty.

IV. *Maintaining high decarbonisation standards.* Transformation is viewed as a means of strategic positioning and this position is universally upheld. However, the stakeholder groups had drastically different views on what strategic green transformation means in practical terms. External stakeholders were unequivocal about the necessity to uphold and potentially increase the decarbonisation standards regardless of the potential impact on companies i.e., further increase of institutional pressures. Whereas internal stakeholders' position was more nuanced, requiring flexibility and sensitivity to capacities.

The theme cluster for RQ1 uncovered a significant gap in positions and highlights the delicate balance between regulatory demands, business viability, and the expectations of the various stakeholder groups, who due to their differing priorities regarding the green transition exert pressures on the company in ways that affect the market, as well as the competitive environment.

5.4 Discussion of Research Question 2

RQ 2: How effective are the available “green” financial instruments for deep decarbonisation of industrial processes?

The second theme cluster for RQ2 covers the topic: **navigating structural barriers and leveraging strategic enablers in accessibility of green finance**. This topic presents an external, institution-focused perspective, which explores the systemic facilitators and challenges that influence availability and access to green finance, including the effect of established process such as eligibility, procedures, and operational mechanisms.

This cluster comprises of six grounded themes:

- I. Impact of complex application processes on green project development.*** Calls for proposals are highly anticipated and when announced create a wave of activity. With the high volume of activity, fractures in the structural framework appear in the form of unclear communication, deepening information asymmetry, system failures, discrepancies and ambiguity in interpreting the eligibility criteria, etc., contributing to processing delays. This becomes a problem due to uncertainty of project cost and timing, which impact the capacity to access financial resources

for co-financing. The study found user reported difficulties concerning the entire application process. In addition to process issues concerning specific calls for proposals, another major issue include the tendency for announcement of several, partially overlapping calls, which create confusion regarding, amongst others, content, eligibility and timelines. The process for accessing public financing is difficult, confusing, expensive, and time consuming, with no guarantee of favourable outcomes.

II. *Impediments to accessibility of private financing.* The study found the requirements of private investors to be primarily hinged on double digit returns and faster turnaround of capital. The cement industry with its legacy systems and long investment cycle for green technology projects is not considered particularly attractive by private equity investors primarily due to high opportunity costs, intellectual property (IP) issues, technology risks, low trust in timing of public sector services such as permits, etc. The underdeveloped domestic financial markets in Southeast European (SEE) countries provide a limited range of green credit lines and green bonds that are specifically designed to meet the decarbonisation requirements of industries. Concurrently, local banks often regard these projects as high-risk, primarily due to the immaturity of the technology involved, extended payback periods, and the unpredictable market demand for low-carbon cement.

III. *Impediments to accessibility of public financing.* Despite the focus on decarbonisation policies and the presence of funding mechanisms at the EU level,

cement companies still encounter considerable challenges in securing sufficient public financing for investments in green technologies. The disjointed implementation of national climate plans, coupled with discrepancies in regulatory frameworks among SEE nations, generates uncertainty regarding the long-term policy trajectory, which in turn discourages both domestic and international capital investments. Primary impediments include unpredictable timelines for calls for proposals, weak institutional capacity and administrative inefficiencies. These leave companies with the burden of shouldering the high upfront capital costs without predictable support.

IV. *Administrative bottlenecks and the effect on project planning and costs.* Related to the first theme above, this grounded theme encapsulates corporation-public sector misalignment. Administrative bottlenecks increase the cost of project development via loss of opportunity windows for market and financing due to uncertainty of turnaround time. The key bottlenecks in the process were identified in the aspects of securing permits and environmental impact assessment. On average, the timeline from project submission to its approval is between two and three years. Additionally, the project preparation timeframe is four to five years. When added together, it becomes clear that a green technology project that is financed in part via public funds, costs a minimum of six and maximum of eight years before it can commence.

V. *Reliance on external technical and specialist service providers.* This grounded theme underscores the role of diverse technical expertise as a strategic enabler for

attracting various forms of financing in order for green technology projects to be developed. However, with the high specialisation and non-repetitive need for those capacities e.g., EU funds experts, external engineering institutions, etc., companies must weigh the cost of hiring in-house versus outsourcing. Outsourcing is the usual route, but with such high supplier power as those service providers have their own priorities which may not align with the company objectives, there is still a loss of control of costs and project timeline.

VI. *Potential market distortive effect of green financial instruments.* Although green financing instruments aim to promote sustainability, their implementation may inadvertently lead to market distortions, especially in transitional economies such as those in Southeast Europe (SEE). The allocation of subsidies, preferential loans, and carbon credits through non-transparent or politically influenced processes can create an uneven competitive landscape, where firms with significant political clout or administrative capabilities reap disproportionate advantages, thereby sidelining smaller or less-connected competitors. Bigger competitors have better chances of gaining access to loans to co-finance the project and can bear the issues related to timing more so they gain the benefits of grants which in turn strengthen their competitive position. An excessive dependence on a limited range of financial instruments like EU grants, can suppress private investment by distorting risk-return perceptions, which in turn discourages long-term, market-driven financing. Additionally, the lack of standardised regional definitions of what qualifies as a “green” investment hampers comparability and transparency, which

in turn breeds investor scepticism and limits capital inflows. Stakeholders indicated that winning a grant is sometimes not based on the quality of the project being developed, but on the capacities of the consultant to match the wording or requirement of the call, the ability of the company to meet the co-financing requirements, as well as the subjective impressions of the evaluators who may not have sufficient insights on the industry functioning to determine what innovation could mean in the cement production context. Consequently, projects get financed that may not be strategically positioned to drive the industry forward. Thus, policymakers and financial institutions in SEE must navigate a complex balance between offering targeted support for decarbonisation and cultivating competitive, transparent, and efficient green finance markets that fulfil both environmental and economic goals.

The theme cluster explores the complex interplay between regulatory frameworks, financial mechanisms, and technological advancements in light of the objectives of green transition of the cement industry and the impediments to a more accessible and effective green finance ecosystem.

5.5 Discussion of Research Question 3

RQ 3: What are the overt and covert costs of decarbonising the cement industry?

The theme cluster for RQ3 is encased in the topic: **strategic decision-making, financial readiness and organisational adaptation to green transition initiatives**. It takes a more inward-facing and strategic perspective, focusing on the complexities of managerial decisions, the far-reaching consequences, and the ways it steers organisational

direction within the context of green transition and broader. The theme examines drivers of critical decision-making processes, as well as the small- and large-scale adjustments that are required to effectively implement green transition projects, such as selecting the right technologies, managing costs, restructuring people and processes, etc., and create long-term value for stakeholders.

This cluster comprises of nine grounded themes:

- I. **Determinants of acceptable costs of green projects.*** A green technology initiative must satisfy a set of criteria that encompasses environmental credibility, commercial viability, and strategic alignment to be viable for investors. The findings from the study indicate that the most robust green projects within the cement industry demonstrate: (i) a **verified emissions impact** through clearly quantified CO₂ reduction potential, primarily assessed in terms of lifecycle, and **scalability** that proves the technology is sufficiently mature for scale-up without incurring excessive operational risk. Initiatives that are merely experimental or in pilot phases often face challenges in obtaining funding unless they are explicitly categorised as R&D; (ii) **conformity with policy and taxonomy standards**, especially for EU member states, is essential. Since all projects must adhere to the EU Taxonomy for Sustainable Activities, ensuring they contribute significantly to climate objectives without inflicting substantial harm elsewhere, thereby fulfilling the ‘Do No Significant Harm’ (DNSH) principle, any misalignment in this regard can disqualify projects from consideration by numerous institutional investors.

Thus, to move forward, there is no alternative than to take on the costs of meeting the base criteria of investor requirements.

II. *Financial requirements of green transition.* As investors continue to seek competitive risk-adjusted returns, even for projects labelled as ‘green’, companies with business models that present reasonable payback periods, typically under 10 years, along with transparent cost structures and clear routes to profitability are preferred. Executives utilise all the resources at their disposal to show a healthy financial position, because there is a paradox of needing to show financial health and capacity for co-financing to be considered for access to the necessary capital required to drive the business in a mandated direction. While subsidies or carbon credits can improve the financial outlook of a company, they cannot replace a fundamentally sound business strategy.

III. *Necessity for new business models.* Green technology adoption in sectors like cement often necessitates business model innovation, not just technology substitution. Such upgrades include customised circular economy models where cement producers are exploring end-to-end carbon management services, recycled materials markets, or waste heat recovery as a service. Additionally, collaborative ecosystems are being developed via partnerships with suppliers, construction companies, and governments to create shared value chains and distribute the costs/benefits of green investments. Another area of innovation is in financing models where project finance, green bonds, or pay-per-use schemes are developed to overcome the capital intensity of green retrofits. Other novel approaches such

as initiatives to monetise CO2 reductions via carbon markets were identified in the study. However, they are all at the nascent stage, and none such initiative has been implemented at scale for the impact and results to be evident. Nonetheless, without such business model innovation, green technology projects that may be technically sound could fail to meet expectations on competitive advantage, or attract sufficient investment.

IV. *Balancing product pricing strategy and ecological objectives.* Given that cement manufacturing is a volume-based business with low margins, the prevalent strategy is on price competitiveness. The trends data confirm that the cement industry in SEE region functions within an increasingly cost-prohibitive context. The rise in cement prices, while partially indicative of inflationary trends and heightened demand, also emphasises the financial limitations that companies encounter in parallel with the requirements for environmental compliance. For companies already burdened by operational inefficiencies and constrained capital reserves, these market dynamics hinder timely investments in green technologies. The comparative analysis reveals regional variations, with Croatia having the most significant price increases, implying potentially differing fiscal pressures and investment capabilities. This uneven economic environment must be taken into account when assessing the viability and fairness of decarbonisation pathways throughout SEE. These insights directly contribute to further evaluations concerning capital investments, return-on-investment (ROI) projections, and the risk assessments that influence corporate strategies in sustainability transitions.

Unsurprisingly, internal adjustment of product price is a key area of focus for executives. Companies invest in sophisticated digital technologies and market analysis to stay atop price shifts in order to make timely adjustments. Given the sensitivity of buyers, and the impact of sales volumes on the bottom line, this is an area of investment decision-making that is usually invisible outside the boardroom of an organisation.

V. *Correlation between price sensitivity and market demand for green cement.* This theme reveals a source of pressure that is often overlooked. The primary buyers of cement are building and construction companies who have budgetary constraints and cut costs wherever possible, including materials. Thus, there would be reluctance in purchasing green but more expensive products without clear incentives. Buyers currently favour cheaper options and will import cement products from other countries without regulatory constraints of EU to keep their own costs under control. This is a major issue intended to be addressed by the Carbon Border Adjustment Mechanism (CBAM) which is expected to be fully operational in 2026.

VI. *Motivators behind technology choice.* Given that compliance with governance and disclosure requirements is mandated and is accompanied with increasing scrutiny from investors who necessitate credible ESG governance, transparent reporting, and stakeholder engagement processes as essential prerequisites for investment readiness, some companies in the industry revert to mimetic approaches to relieve the pressure. The same technologies and processes are being

implemented, creating corporate homogeneity which may lead to loss of key differentiators among organisations.

VII. *Ensuring acceptable cost and quality of outputs from external service providers.*

This theme is about quality control when sourcing services as green technology projects often involve outsourcing to various specialised organisations and institutions in areas such as engineering, IT, ESG reporting, etc. Outsourcing brings in expertise, but the company risks loss of control over the quality of output. Given the complexity of the industry, subpar deliverables could result in financial losses as well as loss of credibility. Companies manage the risk by incorporating ongoing feedback systems that encompass both quantitative measures such as timely delivery and defect rates, as well as qualitative assessments like stakeholder satisfaction. Additionally, they implement penalties for subpar performance and rewards for surpassing established targets. In a smaller market, it could lead to the scenario where a handful of credible service providers handle all the industry accounts.

VIII. *Technological innovation as a means of securing investor interest.* This theme

underscores the role of technological innovation as a strategic enabler for attracting investment. Although innovation is essential, it alone does not guarantee investor interest. Most investors are wary of ‘technology risk’, which refers to untested innovations that may fail to meet expectations. Consequently, green innovation must be integrated with a well-defined business model that illustrates market demand, value creation, and competitive advantage. Furthermore, in

addition to evidence of regulatory alignment or market indicators, such as carbon pricing or green procurement mandates, it is crucial to have comprehensive risk management strategies that address operational, supply chain, and reputational risks to mitigate the commercial adoption of the innovation. Thus, green innovation must move beyond merely proving its technical feasibility to developing a viable commercialisation strategy to attract large-scale investment.

IX. *Integrated and effective approaches to change management.* Green technology adoption in cement and heavy industries is highly disruptive as it involves an overhaul of technology, processes, culture, and strategy. Leaders are aware of what needs to change, but face challenges in how to effectively lead and control that change. An integrated approach necessitates strategic leadership, organisational learning, and disciplined execution, while also focusing on both the technical and social dimensions of the change. This is usually a slow and expensive process.

Since companies generally rely on stakeholders from the financing sector in order to bear the costs of green technology integration, this theme explores the various aspects influencing their decisions. A green technology project can attract investment when it demonstrates technological validation, economic feasibility, compliance with regulatory and ESG standards, and embedded within an innovative and credible business model. Merely having technological innovation is rarely sufficient, unless market alignment, risk management, and governance structures are also addressed. The findings show that investors are increasingly prioritise comprehensive strategies in which green technologies

enhance the overarching narrative of sustainability and competitiveness of the particular company.

5.6 Discussion of Research Question 4

RQ 4: How long does it take for essential green technology to move from the research and development (R&D) phase to full industrial integration and return on invested capital?

The theme cluster for RQ4 is encompassed in the topic: **ensuring operational readiness for seamless green technology adoption**. It takes an inward-facing and operational perspective, by examining the significance of financial preparedness and risk management beyond strategic coordination. It investigates how potential obstacles could be proactively managed to strengthen investor confidence in the deployment of green technologies, ultimately fostering long-term business sustainability.

This theme cluster comprises of five grounded themes:

- I. Correlation between financial and human capacities on green technology integration process.* Recent empirical studies and assessments from the industry consistently underscore a positive and mutually reinforcing relationship between financial and human resources in facilitating the successful integration of green technologies, especially in capital- and skill-intensive sectors like cement production. Financial resources are essential for the necessary capital investment that are required for the acquisition, implementation, and maintenance of low-carbon technologies. These typically involve significant initial costs and extended payback periods. Additionally, (International Energy Agency, 2023) noted that

without sufficient human capacity that encompass technical skills, managerial expertise, and organisational learning, these financial investments often do not yield significant operational results or provide lasting competitive advantages. Therefore, financial capacity enables investments both in hardware like carbon capture systems, alternative fuels infrastructure, etc., and soft assets like employee upskilling, change management initiatives, etc. Concurrently, human capacity influences the efficiency with which these financial investments are prioritised, implemented, and integrated into current processes. Companies with vast financial resources, but insufficient human capacities frequently face delays, budget overruns, or ineffective use of green technologies. In contrast, highly skilled teams within financially constrained organisations may find innovative solutions to their challenges, yet their effectiveness would remain limited without adequate capital. Thus, the two aspects serve as complementary facilitators of green transformation.

II. Adaptations of established people and process management. For cement companies as legacy organisations, the integration of green technology brings about considerable disruptions to the conventional paradigms of people and process management, which have traditionally been optimised for cost-effectiveness and incremental innovation, rather than for systemic transformation. **The dual pressure to mobilise financial resources, and develop human competencies, redirects the organisational emphasis towards cross-functional collaboration, agile project management, and continuous learning.** This change necessitates a re-evaluation of performance metrics, incentive frameworks,

and decision-making hierarchies in ways that facilitate long-term environmental outcomes alongside short-term operational objectives. Furthermore, resistance due to entrenched managerial perspectives or operational personnel used to established practices, can significantly hinder advancement, especially if financial limitations increase risk aversion. On the procedural side, existing standard operating procedures (SOPs) and quality control systems often require redesign to accommodate variable inputs such as alternative fuels, as well as new compliance mandates like emissions monitoring, further highlighting the necessity for synchronised human and financial capabilities.

III. *Risk reduction in support of market expansion.* Although the dominant narrative suggests that investment in green technologies mitigate long-term regulatory and market risks, for cement companies in the South East European (SEE) region, the findings indicate that the belief may be excessively simplistic and contextually weak. In principle, adherence to EU decarbonisation pathways and compliance with the CBAM should facilitate market access and bolster competitive resilience. However, the unique realities of the political and economic circumstances of the SEE region frequently diminish the risk-reduction advantages that these investments are intended to provide. This emerged in three main ways:

(i) the regulatory framework throughout Southeast Europe (SEE) is characterised by fragmentation and, inconsistent enforcement in certain instances, which is attributable to institutional deficiencies, political instability, and uneven integration into the European Union. Serbia, Bosnia & Herzegovina, and North

Macedonia are yet to become EU member states, while member countries like Bulgaria and Romania have historically fallen behind in the implementation and enforcement of the rigorous environmental regulations. This regulatory uncertainty may lead to a disconnection between the speed of green investments and the actual enforcement of policies, thereby subjecting early adopters to excessive costs without a corresponding competitive edge;

(ii) the premise that green investments lead to market growth relies on the assumption of adequate demand for green cement products, which is currently not apparent in Southeast Europe (SEE). Clients in the construction sector within this region exhibit a strong price sensitivity, and public procurement processes frequently emphasise lower costs over environmental quality, thereby constraining the commercial advantage for more sustainable products. Consequently, companies that invest significantly in decarbonisation may encounter higher unit costs without assurances of revenue increases, which arguably heightens, rather than reduces, market risk in the short term;

(iii) the capital markets and financial institutions in SEE region are relatively less developed and less responsive to Environmental, Social, and Governance (ESG) requirements compared to their counterparts in Western Europe. This situation implies that even well-defined and ambitious decarbonisation strategies may not substantially enhance companies' access to lower-cost financing or boost investor confidence. In reality, significant capital investments in uncertain or nascent technologies might be viewed as excessive exposure to speculative risks,

particularly in light of the region's already limited profit margins and ongoing structural economic difficulties.

Considering these three points collectively, there is a strong indicator that, within the SEE context, **investments in green technologies could present a risk paradox: they may mitigate exposure to long-term regulatory and reputational risks, while simultaneously heightening short- and medium-term financial and market risks.** Therefore, companies in this region bear the technical and regulatory demands of decarbonisation, as well as the specific institutional, market, and financial limitations that could diminish their potential to reduce risks.

IV. *Impact of issues related to the deployment of new technology on investor confidence.* The introduction of new and complex green technologies carries implementation risks, which include cost overruns, operational inefficiencies, and unpredictable technology performance. These factors can diminish investor confidence in the short to medium term. The extended payback periods associated with capital-intensive green technologies, along with their technological immaturity as in the case of carbon capture and storage, or hydrogen-based kilns, generate perceived financial and operational risks. Investors may view these as threats to stable cash flows and the reliability of dividends. Without effective communication of clear roadmaps, credible milestones, and strong risk-mitigation strategies regarding green investments by companies, stakeholders might perceive these initiatives as speculative rather than value-enhancing. In the context of SEE,

where financial markets are underdeveloped and investor awareness of long-term sustainability benefits is limited, these perceptions are further intensified. Investor confidence could be sustained via due diligence and strong corporate governance in order to realise the full potential for risk reduction and market expansion that is inherent in their green transition strategies.

- V. *Necessity for in-depth and well documented green technology integration process for effective management.*** Findings show that a comprehensive and thoroughly documented process for integrating green technology is crucial for effective management, as it guarantees that environmental enhancements are systematically executed and monitored. A detailed documentation and methodical approach to the integration of green technology is usually deployed by companies for support in optimising resource utilisation, minimising waste, and improving sustainability practices. Such approach to knowledge and process management is essential for maximising the advantages of green technology investment, which could ultimately result in better environmental and economic outcomes.

This theme cluster emphasises market responsiveness, alongside the critical need to align both human and blended financial capabilities by instituting well-structured and documented integration processes, with strong monitoring and tracking mechanisms to ensure effective risk management and continuous improvement in both processes and outcomes during the deployment of new green technologies. Ultimately, the evidence indicates that the successful adoption of green technology is less about the choice between financial and human resources and more about the strategic alignment and investment in

both, while recalibrating people and process management systems to foster a sustainability-oriented path.

Companies that fail to acknowledge and respond to this relationship, risk misallocating resources, and lagging behind competitors in the industrial shift towards net-zero operations. However, it also challenges the belief that the adoption of green technology unequivocally reduces risk. Rather, it postulates that regional factors may give rise to a ‘risk paradox’, in which regulatory and reputational risks are alleviated in the long run, while financial and competitive risks may escalate in the short term.

5.7 Discussion of Research Question 5

RQ 5: How can corporate leaders in the cement industry assess and prevent greenwashing practices?

The final theme cluster for RQ5 is evident in the topic: **Governance and ethical leadership in green transition and** points to the significance of ethical decision-making and the urgent requirement for more stringent accountability practices to mitigate the practice of greenwashing. Moreover, it identifies experimentation and the possibility for course correction as a vital strategy for driving innovation and ensuring the success of sustainability initiatives. It further emphasises the long-term implications of the choice of green technologies, the importance of upgrading industry standards, and the need for safeguards against misleading corporate claims regarding sustainability.

This cluster comprises of four grounded themes:

I. Good governance and upgrade of industry practices related to greenwashing.

The findings show that in the SEE region, inconsistent enforcement of the

eligibility criteria and inadequate verification mechanisms heighten the risk of greenwashing. The impacts could also be indirect in the form of funds being directed towards projects that have minimal impact on climate change, which then undermines the integrity of green finance markets. Additionally, the data supports the notion that measures aimed at relieving the pressures on companies could abate the practice of greenwashing. Good governance models, transparency and accountability, when implemented builds trust in the broader ecosystem and bolsters reputation which creates and preserves value.

II. Consequences of green technology choice and other management decisions.

Choosing the right technology should be driven by market insights instead of coercive and normative pressures. The findings revealed that some technologies are being chosen as a response to mimetic pressures, not need. Some internal stakeholders expressed the need for the burden of managerial decision-making to be noted, because the consequences of such decisions could be far reaching. They argued that senior executives should be supported more in choosing the right technologies, until course correction becomes a possibility as this could avoid scenarios where companies borrow heavily to invest in stranded assets.

III. Lack of prohibitive measures against greenwashing as tacit endorsement of the practice. This theme reveals an important yet underexplored impediment to authentic green transitions in the cement industry in SEE, is the institutional vacuum surrounding the regulation and sanctioning of greenwashing practices. The absence of clear, enforceable prohibitive measures against misleading

environmental claims can be interpreted as a tacit institutional endorsement of the practice, allowing companies to meet stakeholder and regulatory pressures symbolically rather than substantively. From an institutional theory perspective, such permissiveness reflects the normative and coercive inadequacies of governance structures that prioritise compliance optics over actual environmental performance, thereby enabling some companies to maintain legitimacy with minimal operational disruption (Meyer & Rowan, 1977). The lack of credible mechanisms for deterrence weakens investor confidence in sustainability metrics, undermines the efficacy of green financing instruments, and perpetuates the risk that suboptimal or unfitting technologies will be deployed without sufficient scrutiny.

IV. *The necessity for experimentation as a means of course correction in case a suboptimal technology is deployed.* Given the long-term nature of green technologies, the high costs and its critical role in operations, the current absence of recourse for the wrong technologies is a major issue. Sunk cost effect. For reference, all internal stakeholders reported that green technology development in highly specialised industries like cement manufacturing ought to have possibilities for course correction. They argue that the current practice of remaining with a set project for the full period even if it turns out to be the wrong choice or approach is wasteful. Thus, a viable strategic direction could be in devising resources that would assist executives in making well-informed decisions. This may encompass training initiatives tailored to specific green technologies, along with their

development and implementation processes, or promoting the exchange of knowledge among industry leaders, technology suppliers, and research organisations to investigate innovative solutions and ownership frameworks. Such approaches might enable senior executives to make educated decisions regarding the specific green technologies that correspond with the sustainability objectives of their particular organisation.

The findings for this RQ underscores that effective governance that encompasses both public and corporate sectors play a vital role in deterring symbolic compliance, and ought to implement particular measures to enable companies to course-correct when initial green technology choices do not yield the anticipated results. In the specific context of the cement industry in SEE region, enhancing governance capabilities and implementing adaptive planning strategies could serve as both a means of risk mitigation and a source of competitive advantage during the current green transition process.

CHAPTER VI: SUMMARY, IMPLICATIONS, AND RECOMMENDATIONS

6.1 Summary

This research examined the strategic and operational challenges of green technology adoption in the cement industry in the SEE region, with particular focus on the paradoxical pressures faced by companies with obligations to reconcile short-term business imperatives with long-term environmental sustainability. Figure 6.1 distills the five research questions and key associated findings into simple summations.

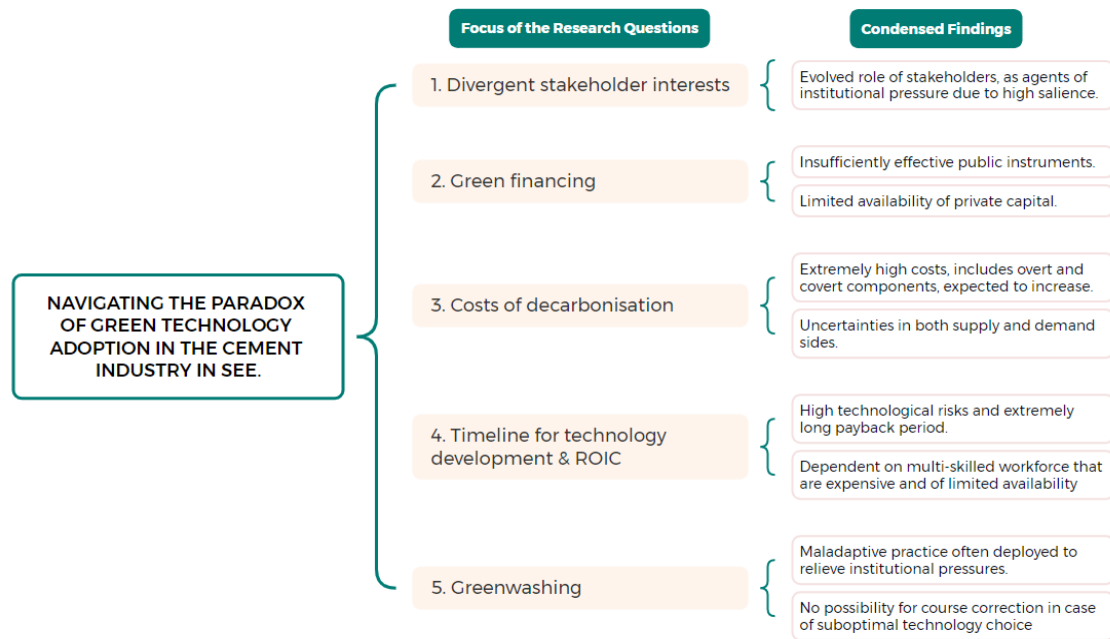


Figure 6.1 Author's diagram depicting a condensation of the RQs and findings.

Details of the theoretical and practical implications of the findings are presented in the subsequent sections. By enhancing this analysis with insights from the Institutional and Stakeholder Theories, as well as from Dynamic Capabilities and Paradox

perspectives, this research captured the diversity of company responses and the inherent tensions associated with sustainability transitions in green technologies within the cement sector of the SEE region.

6.2 Implications

The implications of this research are significant for both theoretical understanding and practical implementation. By demonstrating that the capacity of management to navigate strategic paradoxes is a key factor in the sustainable corporate growth via adoption of green technology, the study highlights the urgent requirement for continuous capacity development at the organisational level.

Regarding managers and investors, the research provides evidence that adaptive and transparent governance, along with strategic investment flexibility, can mitigate risks, enhance market positioning, and increase investor confidence in sustainability transitions. Additionally, it reveals how institutional gaps, such as the lack of effective prohibitive measures against greenwashing, could implicitly legitimise superficial sustainability claims, which could in turn undermine both corporate credibility and broader climate objectives. These findings highlight the interconnected roles of institutional contexts, organisational capabilities, and stakeholder expectations in shaping credible and effective pathways toward decarbonisation of the cement industry in the SEE region.

Implications of market dynamics and strategic pressures

The financial burden associated with green technology adoption in the cement industry in SEE must be contextualised within the broader trajectory of input cost escalation. The data showed that between 2015 and 2025, cement prices in Bulgaria,

Croatia, and Romania saw significant increases, with indicating a rise of approximately 50–70% across the three markets.

This persistent inflation in production and market prices reflects a convergence of cost pressures in the form of escalating energy prices, carbon pricing under the EU ETS, and raw material volatility. From the lens of Dynamic Capabilities Theory, these sustained price shifts demand adaptive reconfiguration of the resource portfolios of the companies, especially as they manage the dual challenge of maintaining competitiveness while meeting decarbonisation targets.

Simultaneously, institutional pressures evident in the EU climate policy mandates and stakeholder scrutiny, heighten the urgency for investment in green technologies despite unclear returns. The price trend therefore functions both as a reflection of market turbulence, and a reinforcing signal of the strategic tension faced by companies. For companies with limited financial buffers, this confluence of economic and policy-driven inflation inhibits timely adoption of sustainable practices and deepens their reliance on interim solutions rather than transformative innovation.

Policy Implications

The findings of this study have several implications for policy. First, the lack of prohibitive measures against greenwashing in Southeast Europe indicates a silent institutional acceptance of symbolic compliance, which undermines efforts toward decarbonisation. Policymakers must also recognise that weak governance distorts the competitive environment, and may also dissuade true investors who value credible ESG results. Additionally, coordinated regional policy frameworks can mitigate the risk of

uneven competitive landscapes that incentivise superficial compliance over meaningful innovation. Finally, focused public investment in skills, infrastructure, and verification capacities could improve the ability of companies to achieve policy objectives without incurring excessive risk, thereby aligning both corporate and societal interests in the transition to a greener economy.

Theoretical implications

The findings of this study broaden the scope of Dynamic Capabilities Theory to include Paradox Theory by showing that decarbonisation in a legacy-dominated industry like cement, is contingent upon more than just the adoption of technology. It demands organisational foresight, integrative learning, and skilful political navigation. By providing empirical evidence on how the net-zero transition could be accelerated in the cement industry in the SEE region via green technology integration, and how this transition could significantly reduce carbon footprints of companies, it shows the interconnectedness of both theories. The necessity to update organisational capabilities rests on the particular paradoxical tension that management considers the most strategic to reduce at a particular time.

Furthermore, the findings also expand Institutional Theory to include Stakeholder Theory by demonstrating that the adoption of green technology in the cement industry in SEE is largely propelled by coercive institutional pressures, particularly those linked to EU regulatory frameworks and that stakeholders serve as a channel for institutional pressure. Where regulatory bodies enforced coercive measures e.g., ETS compliance, financial and professional stakeholders influence normative and cognitive expectations

concerning environmental performance via financial instruments, standards, certification etc.

The integration of four strong theoretical perspectives (Dynamic Capabilities, Paradox, Institutional, Stakeholder) was essential to effectively explain the multi-level phenomena of green technology adoption in the SEE region. Using the views of both internal and external stakeholders, this study identified two major theoretical implications.

Dynamic Capabilities Theory and Paradox Theory

The integration of green technologies within the cement industry in the SEE region reveals a complex relationship between the development of capabilities and the inherent organisational tensions.

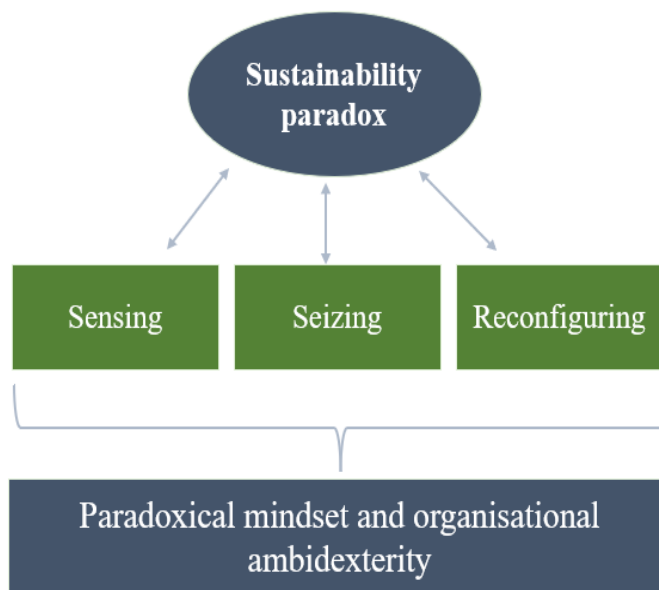


Figure 6.2 Author's diagram depicting the integration of Dynamic Capabilities and Paradox Theories.

Paradoxical mindset and organisational ambidexterity refer to the ability of companies (executives) to hold and navigate contradictory demands instead of trying to eliminate one side.

Drawing from the Dynamic Capabilities framework (Teece, et al., 1997) the observed

differences in technological adoption among companies such as Holcim Romania, Titan Cement Greece, and Nexce Group Croatia demonstrate varying levels of company-specific

abilities to identify regulatory and market pressures, seize funding and innovation opportunities, and reconfigure operational as well as technological resources.

The variability seen across different companies and countries, supports the significance of the integrated theories, and also implies a requirement to tailor the application to other sectors experiencing capital intensive, slow-paced transitions to sustainability.

The cement industry is capital-intensive, slow-moving, and exposed to regulatory and market shocks. This calls for firms to sense, seize, and reconfigure internal capabilities to adapt and survive (Tesse, 2007). The examination of the financial issues brought on by green transition, alongside the investigation of matters pertaining to internal competencies, is innovative within the theoretical context of dynamic capabilities. According to (Scarpellini, et al., 2020), dynamic capabilities mediate the ability of a company to adapt to environmental innovation pressures, particularly in heavy industries.

This research represents an initial step in a nascent area of inquiry. The empirical findings reveal that the adoption of green technology in the Southeast European cement sector fundamentally relies on the dynamic capabilities of individual firms in addition to adhering to regulations. Thus, cement corporations need to constantly update their managerial capabilities to stay viable. **Managerial capabilities in this context refers to the knowledge, skills, behaviours, and organisational routines that managers use to sense opportunities, make decisions, and implement change in response to the adoption of green technologies.** These extend management capabilities in the aspects of:

- **Sensing:** i.e., managers' ability to detect emerging environmental trends and green technology options,
- **Seizing:** the ability to mobilise resources and build coalitions to invest in and implement green projects, and,
- **Reconfiguring (aka transforming):** the ability to redesign organisational processes and structures to support sustainable innovation.

These capabilities represent repeatable managerial processes beyond mere skills, as they can be linked to specific outcomes. Therefore, improvement in this aspect implies that decisionmakers would be better equipped to navigate the various **persistent tensions** like the opposing demands of economic growth and environmental sustainability.

Institutional and Stakeholder Theory

The combination of Institutional and Stakeholder Theories enables a nuanced understanding of the interaction between external field-level pressures and internal managerial sensemaking, converge to influence the strategies that firms adopt for green technologies.

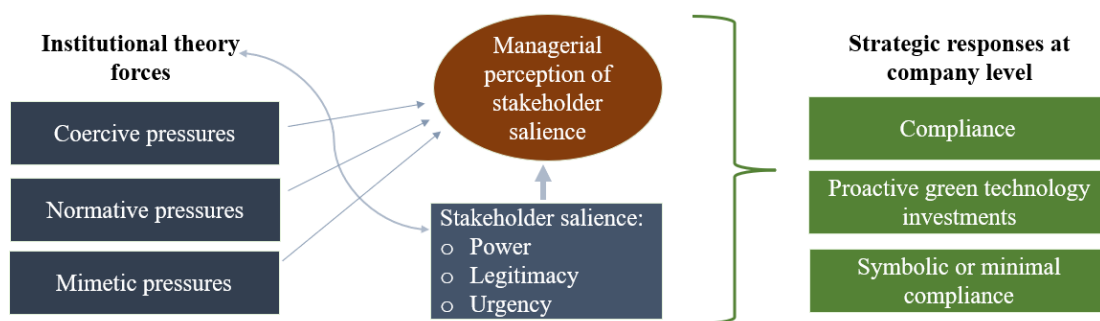


Figure 6.3 Author's diagram depicting the sources of paradoxical tensions and the integration of Institutional and Stakeholder theories

It was essential during interpretation, to make a clear distinction between institutional mechanisms and stakeholder-driven influences that inform the responses of companies to environmental sustainability challenges. The empirical evidence suggests that cognitive institutional pressures which are understood as the taken-for-granted assumptions and shared mental models regarding the inevitability and rationality of adopting green technology (Scott, 2001), are increasingly significant among cement firms in South East Europe, particularly those that are subsidiaries of multinational corporations.

However, it is important to avoid conflating these cognitive pressures with mimetic or cultural expectations from stakeholders. While cognitive pressures indicate a profound internalisation of socially constructed ‘truths’ about sustainability, mimetic responses (DiMaggio & Powell, 1983), are characterised by companies imitating perceived leaders in the industry during uncertain times, often without fully grasping the rationale behind such actions.

Similarly, stakeholder-driven cultural expectations which are grounded in societal values and norms, exert normative and reputational influences on firms, yet they are distinct from the taken-for-granted cognitive environment. These findings indicate that stakeholder salience i.e., the importance or prominence of stakeholders in a project, determined by three key attributes: power, legitimacy, and urgency (Mitchell, et al., 1997; Freeman & Mcvea, 2001), primarily operates through normative and cultural channels, which over time contribute to the shaping of the cognitive institutional field (Freeman, 2010). As a result, companies that are more exposed to the demands of powerful and

legitimate stakeholders, tend to transcend mimetic compliance, adopting green technology as a cognitively rational and strategically inevitable course of action.

Thus, another emergent notion from the research demonstrates that the more pronounced the normative and cultural expectations of stakeholders, the stronger the internalisation of cognitive institutional pressures regarding the adoption of green technology, in the context of cement companies in the SEE region. **This finding challenges the prevailing assumption in traditional institutional literature that the three isomorphic pressures are of equal strength**, and suggests the need for a regional adaptation of the theoretical framework.

Strategic paradoxes identified in the research

The study began with the aim of investigating a single paradox. However, the results revealed a total of five interconnected paradoxes that influence the implementation of green technologies within the cement industry in South East Europe, four more than was initially assumed.

First, companies navigate the tension between the ***requirements for short-term profitability and the necessity for investments in long-term environmental sustainability***, often under the scrutiny of influential stakeholders.

Second, the ***paradox of authenticity versus compliance*** arises as organisations oscillate between genuine transformation and superficial actions (greenwashing) to satisfy institutional and stakeholder demands. Third, businesses encounter the dual threats of ***innovation and market failure***, where the premature adoption of emerging technologies may lead to operational risks, while postponement risks reducing competitiveness.

Fourth, the *paradox of governance control versus flexibility* underscores the need for robust oversight and accountability to mitigate opportunistic behaviours. However, excessive rigidity can hinder the organisational agility which is essential for sustainable transformation. Finally, companies face the *paradox of increasing stakeholder expectations in the face of limited financial and managerial resources*, which intensifies internal conflicts and restricts strategic options.

Table 5.5 outlines the identified paradoxes and the corresponding theoretical perspective.

Table 5.5 The five strategic paradoxes faced by cement companies during integration of green technologies.

Paradox	Description	Theoretical perspective
Short-term vs. long-term value Paradox	The tension arising from the necessity to protect current margins and competitiveness in a cost-sensitive market i.e., business sustainability, contrasted with the imperative for costly investments in green technologies that may not yield immediate returns i.e., long term environmental sustainability. This tension is central to the sustainability paradox (Hahn, et al., 2015).	Paradox theory
Innovation risk vs. market risk Paradox	Executives face a tension between the operational and financial risks of deploying immature, unproven green technologies and the market and reputational risks of being left behind if competitors succeed at decarbonisation. (Tesse, 2007)	Dynamic capabilities theory

Authenticity vs. compliance paradox	Companies feel pressure to appear sustainable for institutional and stakeholder legitimacy to avoid reputational risk and penalties, however, genuine transformation requires deeper organisational change. It is often cheaper and faster to engage in minimal compliance or “greenwashing”. This reveals the symbolic vs. substantive action paradox (Aguilera, et al., 2021; Delmas & Burbano, 2011; Lyon & Montgomery, 2015).	Institutional theory
Governance control vs. flexibility paradox	Stronger governance is needed to curb greenwashing and enforce sustainability standards, but overly rigid rules can stifle innovation and discourage experimentation with new technologies. Managers need space to adapt and learn dynamically (Smith, 2014; Scarpellini, et al., 2020).	Dynamic capabilities theory, Institutional theory
Stakeholder expectation vs. resource constraint paradox	Companies must address rising stakeholder demands for fast progress on climate action despite limited financial and organisational resources to act at the desired pace (Fortes, et al., 2023).	Stakeholder theory

Acknowledging and adeptly managing these paradoxes through improved dynamic capabilities and institutional responsiveness would be instrumental for attaining credible, competitive, and sustainable results in this arena.

Implications for research question 1.

How could paradoxical tensions between differing interests be managed to enable cement companies meet their net-zero targets while maintaining profitability and market competitiveness?

Three key implications related to RQ1 were observed from evaluation of findings. They were related to the key aspects of stakeholder expectations that impacts operations, the effects of the integration of green technology on the competitive environment, and demand for green cement as a justification for long-term investment. These implications are derived from the sub-questions in the RQ1.

SQ1. What aspect of stakeholder expectation impacts operations the most?

SQ2. How does the integration of green technology affect the competitive environment?

SQ3. Is there demand for green cement that is sufficient to make the long-term investment strategically feasible?

The findings of this study indicated that the key aspects of stakeholder expectations that impacts operations the most, are the requirements for companies to meet all legislative and financial obligations, irrespective of market conditions. This implies that despite the high upfront costs of green technology investments, and a market that demands cheaper and higher quality products, powerful stakeholders still expect companies to deliver results that may be well beyond their capabilities.

In addition, the findings indicated that integration of the green technology impacts the competitive environment. The implication is that an increase in the demand for green cement, would be inevitable if sustainability principles are fully integrated in modern

construction. Finally, the findings of this research indicated that the viability of long-term investment depends on the stability of demand for green cement. This demand is dependent on the primary buyers i.e., building and construction companies from the region, whose high price sensitivity makes them favour a cheaper product above a green, more expensive one.

Implications for research question 2.

How effective are the available “green” financial instruments for deep decarbonisation of industrial processes?

Four key implications related to RQ2 were observed from the evaluation of findings. They were related to the companies’ access to all the financing instruments allocated by the public funds for green transition, the availability of private capital at economically feasible rates, the amount of time and effort it takes to prepare project applications, and the duration between submission of project proposals and their approval/rejection. These implications are derived from the sub-questions in the RQ2.

SQ4. Do the companies have access to all the money allocated by the public funds for green transition?

SQ5. Is private capital available at economically feasible rates?

SQ6. How long or how much effort does it take to prepare the project for application?

SQ7. How long does it take between project proposal submission and approval?

The findings of this study indicated that although the public funding is available to all, access is significantly influenced by the dynamic capabilities of individual companies. The process for accessing public financing is difficult, confusing, expensive,

and time consuming, with no guarantee of favourable outcomes. The findings also uncovered a market distortive component to the availability of public funds, as larger competitors have better chances of gaining access to loans to co-finance their projects and are better positioned to bear the issues related to timing, so they gain the benefits of the grants which in turn strengthen their competitive position. Overall, excessive dependence on a limited range of financial instruments like EU grants, tend to suppress private investment by distorting risk-return perceptions, which in turn discourages long-term, market-driven financing.

Additionally, the insufficiently developed domestic financial markets in SEE countries provide a limited range of green credit lines and green bonds that are specifically designed to meet the decarbonisation requirements of heavy industries, including cement. The industry is unattractive to private capital primarily due to the immaturity of key green technologies, extended payback periods, and the unpredictable market demand for low-carbon cement.

The findings also indicate that required resources for the project preparation are not usually available in-house due to the high specialisation, and non-repetitive need for such projects. Thus, companies must bear the costs and manage associated risks.

Finally, the research findings show that the timeline from project submission to information about the results is too long. When companies *Sense* the opportunity brought on by the grants and assess that the potential benefits are worth it to them, they decide to *Seize* the opportunity by bearing all the costs of project preparation and documentation in order to submit the paperwork on time. However, administrative bottlenecks due to weak

institutional capacities stretches the timeline beyond the opportunity window. On average, the timeline from project submission to its approval is between two and three years, during which the estimated cost of project development would have significantly changed and financing opportunities would be lost due to uncertainty of turnaround time.

Implications for research question 3.

What are the overt and covert costs of decarbonising the cement industry?

Three key implications related to RQ3 were observed from the evaluation of findings. They were related to the true costs of developing a green technology project, the existence of a standardised process guiding the choice of specific green technologies, and the necessity for recruitment of new capacities and retraining the existing ones. These implications are derived from the sub-questions in the RQ3.

SQ8. How much does it cost to develop a green technology project?

SQ9. Is there a standard process guiding the choice of particular green technologies?

SQ10. Is the recruitment and retraining of new employees needed?

The findings of this study highlighted the overt and covert costs that companies must take into account, but are partially unknown to other stakeholders. Given that investors continue to seek competitive risk-adjusted returns, even for projects labelled as ‘green’, companies with business models that present reasonable payback periods, typically under 10 years, along with transparent cost structures and clear routes to profitability are generally preferred. Furthermore, companies that invest significantly in decarbonisation may encounter higher unit costs without assurances of revenue increases, which invariably heightens, rather than reduces market risk in the short term. Therefore,

there is a paradox of needing to show financial health and capacity for co-financing to qualify for access to the necessary capital required to drive the business in the mandated direction.

In addition, the findings indicate that choice of particular green technologies are driven by institutional pressures, rather than market demand. Some companies in the industry revert to mimetic approaches to relieve the pressure, creating homogeneity which may result in loss of key differentiators among organisations.

Finally, the research showed that without sufficient human resources, that incorporate technical skills, management expertise, and organisational learning, these heavy financial investments, often do not yield significant operational results or provide lasting competitive advantages. The dual pressure to mobilise financial resources, and develop human competencies, redirects the organisational emphasis towards cross-functional collaboration, agile project management, and continuous learning. This change necessitates a re-evaluation of performance metrics, incentive frameworks, and decision-making hierarchies in ways that facilitate achieving long-term environmental outcomes alongside short-term operational objectives. The implication is that effective green transition is facilitated by the combination of financial availability and highly skilled teams.

Implications for research question 4. How long does it take for essential green technology to move from the research and development (R&D) phase to full industrial integration and return on invested capital?

Two key implications related to RQ4 were observed from the evaluation of findings. They were related to the smoothness of the integration process of green technologies and the effect of the development and integration process on the expectations of returns by investors. These implications are derived from the sub-questions in the RQ4.

SQ11. Does the integration of chosen technologies occur without issues?

SQ12. What are the standard expectations of returns by investors?

The findings of this study show that the process of developing and deploying green technologies is a long and complex one, with many challenges. It highlights the significance of full operational preparedness and risk management beyond strategic coordination. The implication is a requirement for comprehensive and thoroughly documented processes for effective management, as the only guarantee of systematic implementation and continued monitoring.

Additionally, the empirical evidence links technology integration, process management, and returns on invested capital through the factor of time. Given the high capital intensity, the long payback period, and the fact that the introduction of new and complex green technologies carries significant risks which include cost overruns, operational inefficiencies, and unpredictable technology performance, most investors are wary of both implementation and technology risks among others. Consequently, the implication is for green innovation to be integrated with a well-defined business model that clearly illustrates market demand, value creation, and competitive advantage, as well as a comprehensive risk management strategy that addresses operational, supply chain, and reputational risks that would boost the commercial adoption of the innovation.

Implications for research question 5.

How can corporate leaders in the cement industry assess and prevent greenwashing practices?

Two key implications related to RQ5 were observed from the evaluation of findings. They were related to determining the existence of a process for determining whether a deployed green technology has the expected carbon reduction effect, and the possibility of withdrawing from a set course of action if at some point in the process, a company determines that the chosen technology is unsuitable. These implications are derived from the sub-questions in the RQ5.

SQ13. Is there an established process for determining the emissions reduction impact of a deployed technology?

SQ14. If a chosen technology turns out to be unsuitable, how easy is it to withdraw or change a particular course of action?

The findings show that beyond the regulatory mandates and reporting standards, measures that are in place are insufficient to show the direct impact of certain deployed technologies. When considered that some companies' adoptions of green technology are for easing mimetic pressures, the implication for governance reforms aimed at enhancing transparency and verification standards, alongside the establishment of significant repercussions for misleading environmental information becomes an imperative. In the absence of such reforms, the institutional framework may inadvertently legitimise greenwashing as a reasonable corporate reaction to inconsistent regulatory requirements,

ultimately leading to adverse long-term effects on the credibility and effectiveness of decarbonisation initiatives.

Finally, the findings show that at the moment the possibility for backtracking from a set course for particular technology is not an option. Given its critical role in operations, the extremely high capital intensity, and the long-term nature of certain green technologies such as Carbon Capture, Utilisation and Storage (CCUS), the unavailability of course correction measures is alarming. For reference, all internal stakeholders reported that green technology development in highly specialised industries like cement manufacturing ought to have possibilities for course correction.

6.3 Recommendations for Future Research

Decarbonising the cement industry in South East Europe requires integrated approaches that align regulatory certainty, technological maturity, financial access, and corporate transparency. Considering the results and the critical analysis presented, this research offers the following six suggestions for industry professionals, policymakers, and various stakeholders aiming to promote the credible adoption of green technology within the cement industry in SEE region.

Recommendations for practical applications.

The recommendations for practical applications of the research results comprise six aspects.

1) Develop management capacities to navigate strategic paradoxes:

Organisations within the SEE cement industry should develop management competencies that directly address the inherent paradox between short-term

operational and financial sustainability and the long-term environmental goals. This necessitates: (a) cultivating a paradox mindset at leadership levels, (b) investing in scenario planning and systems thinking, and (c) fostering an organisational culture that values experimentation and iterative learning. These actions are consistent with dynamic capabilities theory, as they would improve the capacity of companies to *Sense*, *Seize*, and *Reconfigure* resources amidst competing demands.

- 2) **Adopt an adaptive, portfolio-based approach to technology selection:** To mitigate the risk of deploying suboptimal or misaligned green technologies, companies should implement an adaptive capabilities approach, testing and evaluating a portfolio of emerging technologies before scaling investments. This could be in the form of prioritising pilot programs and phased scaling rather than depending on a single path. Scenario analysis and option-value frameworks should inform technology choices, allowing the companies to adjust their course as new information emerges. This approach preserves strategic flexibility, minimises the risk of lock-in with suboptimal technologies, protects against technological obsolescence, and maintains investor confidence.
- 3) **Develop customised support for financial and human capacity-building programs:** Considering financial and human resource constraints hindering green technology integration that has been identified in the study, it is recommended that public and private financial institutions, including the European Investment Bank (EIB), design financing products and technical assistance programs that are

customised to the realities of cement companies in the SEE region. Financing products like green bonds, concessional loans and grants should be well tailored and linked to verifiable performance milestones, while workforce upskilling initiatives should be coordinated regionally to ensure the availability of qualified personnel for technology deployment and maintenance. Accessibility of such programs to manufacturers of various sizes, would control potential distortive effects and reduce some of the covert costs of transition, while ensuring that companies can effectively adopt and maintain the new processes.

- 4) **Strengthen regulatory oversight and enforcement mechanisms against greenwashing:** Regulatory bodies in the SEE region should progress beyond declarative climate commitments and implement enforceable rules against greenwashing. This involves legally defining what constitutes acceptable green claims, mandating third-party verification of sustainability disclosures, and imposing deterrent penalties on misrepresentation. Such regulatory frameworks could create the necessary coercive institutional pressures to compel companies to prioritise authentic environmental outcomes.
- 5) **Institutionalise practices of good corporate governance:** To enhance legitimacy, cement manufacturers should integrate good governance mechanisms that reinforce corporate prioritisation of long-term environmental outcomes over short-term compliance optics. This can include the establishment of independent sustainability committees within boards, clear lines of responsibility for climate strategies, incorporation of ESG related key performance indicators (KPIs) into

evaluation of management, and the implementation of a systematic processes for stakeholder engagement. Such internal normative structures can counterbalance external institutional pressures and mitigate the temptation to engage in greenwashing.

- 6) **Promote knowledge exchange and regional policy coordination:** Given the fragmented institutional landscape of the SEE region, the existing industry associations should be more active or new ones created. They could create regional platforms aimed at harmonising policy strategies, exchanging best practices, communicating the unique local challenges with other regions, and collectively capitalising on EU and international green finance opportunities. Such coordinated initiatives would reduce competitive distortions and create a level playing field that incentivises genuine green innovation over symbolic compliance.

Recommendations for future research.

The recommendations for future research based on the findings of this study concern four primary areas:

- 1) **Longitudinal investigations of the trajectories of technology adoption:** Studies could explore the evolution of green technology portfolios among cement companies over time, identifying the factors that contribute to successful or unsuccessful transitions, and evaluating the long-term performance and competitiveness implications of different strategies.
- 2) **Comparative analyses across industries and regions:** Research comparing the SEE region with others, or contrasting the cement industry with related sectors

such as steel or glass, could yield valuable insights into the institutional, cultural, and market-specific factors that influence the adoption of green technologies, as well as the reliability of sustainability claims.

- 3) **Empirical evaluation of incidence and impact of greenwashing:** Future studies should establish rigorous metrics to quantify the frequency of greenwashing practices in the cement industry of the SEE region, and examine its effects on market efficiency, investor confidence, and environmental outcomes.
- 4) **Behavioural dimensions of institutional pressures and governance:** There is an opportunity for deeper exploration into how organisational culture, leadership styles, and stakeholder dynamics influence responses to coercive, normative, and mimetic institutional pressures in sustainability transitions.

Limitations of future research

While this research enhances understanding of the strategic, financial, and governance challenges associated with the adoption of green technology in the cement sector of South East Europe, it is important to acknowledge several limitations. First, the empirical focus was geographically restricted to the SEE region and centred on a small number of companies future research could extend the analysis to include comparative regions to evaluate the generalisability of the results.

Next, although this study utilised both quantitative and qualitative data, the limited availability of longitudinal data regarding green investments and payback periods, constrained the capacity to model dynamic impacts over time. Future studies might adopt panel data methodologies to more effectively capture temporal changes.

Furthermore, this study applied Dynamic Capabilities, Paradox, Institutional, and Stakeholder theories to interpret the findings. Future research could explore alternative theoretical perspectives such as resource-based views (RBV), ecological modernisation theory, or behavioural strategy frameworks, to deepen our understanding of organisational responses to sustainability imperatives.

Finally, as this study has identified the essential role of management capacity in navigating strategic paradoxes, future research should operationalise and empirically assess managerial paradox-handling capabilities as a construct, particularly in resource-constrained, transitional economies.

6.4 Conclusion

This research has critically examined the challenges and paradoxes faced by the cement industry in South East Europe as it strives to transition towards low-carbon, environmentally friendly production under intense institutional, market, and stakeholder pressures. The findings highlight a pervasive tension between the coercive, normative, and mimetic forces driving companies towards green signalling behaviours, and the substantial investments in various technologies necessary for achieving meaningful decarbonisation outcomes. The absence of rigorous prohibitive regulations against greenwashing, coupled with insufficient financial and human resources, compromises the credibility of corporate sustainability claims, and also weakens the overarching climate policy framework.

Additionally, the risk of deploying suboptimal or unsuitable technologies poses a risk to long-term competitiveness and investor confidence. By applying institutional

theory, stakeholder theory, dynamic capabilities theory, and paradox theory, this study has illuminated the complex institutional, strategic, and organisational dynamics that influence corporate responses to green technology pressures within the SEE context.

The recommendations presented herein, advocate for a unified effort from both public and private actors to develop adaptive capacity, strengthen governance, and align incentives. Only by implementing such coordinated and credible strategies, can the cement industry in the SEE region fulfil the dual aims of business sustainability and climate accountability, thus making a meaningful contribution to the decarbonisation objectives of the region and Europe. Overall, these findings reinforce the central proposition of this study: that green transformation in carbon-intensive industries within transitional economies is contingent on both regulatory ambition and strategic alignment between market realities, governance capacity, and financial feasibility.

Contribution to knowledge

This study presents several important contributions to both the academic and practical understanding of sustainability transitions within carbon-intensive sectors. It broadened the application of Dynamic Capabilities Theory to include Paradox Theory within the context of green technology adoption, demonstrating how the capabilities of sensing, seizing, and reconfiguring, enable companies to navigate various strategic paradoxes, primarily the one between short-term business needs and long-term environmental outcomes.

Additionally, it merges Institutional and Stakeholder Theories to conceptualise and empirically validate how companies manage competing pressures, and avoid

maladaptive responses such as greenwashing. Furthermore, this study enhances the relatively underexplored literature concerning the cement industry in South East Europe providing a rare empirical account of governance gaps, managerial capacity constraints, and region-specific risks.

Lastly, it contributes methodologically by triangulating quantitative investment data, qualitative stakeholder insights, and policy analysis to offer a more holistic view of sustainability practices. Collectively, the study advances theoretical frameworks by demonstrating the interaction between institutional pressures, managerial capabilities, and sustainability outcomes, and while also informing practical applications by highlighting governance reforms and capacity-building as essential mechanisms for authentic decarbonisation.

The integration of green technologies in the cement industry across the SEE region is rapidly transitioning from an option to a strategic imperative. This shift requires companies to recalibrate their financial, operational, and managerial capabilities in order to thrive within a carbon-constrained and policy-sensitive industrial future.

REFERENCES

- Aguilera, R. V., Aragón-Correa, J. A., Marano, V. & Tashman, P. A., 2021. The Corporate Governance of Environmental Sustainability: A Review and Proposal for More Integrated Research. *Journal of Management*, January, 47(6), pp. 1468-1497.
- Baah, C. et al., 2021. Examining the correlations between stakeholder pressures, green production practices, firm reputation, environmental and financial performance: Evidence from manufacturing SMEs. *Sustainable production and consumption*, July, Volume 27, pp. 100-114.
- Bansal, T. & Song, H.-C., 2017. Similar but not the same: Differentiating corporate sustainability from corporate responsibility. *Academy of Management Annals*, Volume 11(1), pp. 105-149.
- Barbhuiya, S., Kanavaris, F., Das, B. B. & Idrees, M., 2024. Decarbonising cement and concrete production: Strategies, challenges and pathways for sustainable development. *Journal of Building Engineering*, June, Volume 86, p. 108861.
- Berger, L. K., Begun, A. L. & Otto-Salaj, L., 2009. Participant recruitment in intervention research: Scientific integrity and cost-effective strategies. *International Journal of Social Research Methodology*, 12(1), pp. 79-92.
- Capgemini Research Institute, 2024. *The Eco-Digital Era™: The dual transition to a sustainable and digital economy*, s.l.: The Capgemini Research Institute.
- Carmine, S. & De Marchi, V., 2022. Reviewing paradox theory in corporate sustainability toward a systems perspective. *Journal of Business Ethics*, Volume 184, pp. 139-158.
- Climate Watch Historical GHG Emissions (1990-2020), 2023. *Climate watch*. [Online] Available at: <https://www.climatewatchdata.org/ghg-emissions> [Accessed June 2024].
- Communication from the European Commission, 2023. *A Green Deal Industrial Plan for the Net-Zero Age*, s.l.: European Commission - COM/2023/62 final.
- COP 21 Paris Climate Agreement - UNFCCC, 2015. *United Nations Framework Convention on Climate Change*. [En ligne] Available at: <https://unfccc.int/most-requested/key-aspects-of-the-paris-agreement> [Accès le June 2024].
- Core writing team, Lee H., Romero J. Climate Change 2023 Synthesis Report, 2023. *Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, Geneva, Switzerland: IPCC.
- Creswell, J. W., 2008. *Research design: Qualitative, quantitative, and mixed method approaches*. 3rd éd. Thousand Oaks, CA: Sage Publications Inc..
- Delmas, M. A. & Burbano, V. C., 2011. The Drivers of Greenwashing. *Sage Journals*, October.54(1).

- Derks, M., Berkers, F. & Tukker, A., 2022. Toward Accelerating Sustainability Transitions through Collaborative Sustainable Business Modeling: A Conceptual Approach. *Sustainability*, 14(7).
- DiMaggio, P. J. & Powell, W. W., 1983. The Iron Cage Revisited. *American Sociological Review*, April, 48(2), pp. 147-160.
- Draghi, M., 2024. *The future of European competitiveness*, Luxembourg: European Commission.
- Edwards, P., 2019. *Global Cement*. [En ligne]
Available at: <https://www.globalcement.com/magazine/articles/1113-cement-in-central-and-eastern-eu-member-states>
[Accès le July 2024].
- European Cement Association, 2020. *European Cement Association*. [En ligne]
Available at: <https://cembureau.eu/about-our-industry/cement/>
- European Commission COM 62, 2023. *A Green Deal Industrial Plan for the Net-Zero Age*, Brussels: European Commission.
- European Commission DG Energy, 2020. *In focus: Energy efficiency in buildings*. [En ligne]
Available at: [In focus: Energy efficiency in buildings
https://commission.europa.eu/news/focus-energy-efficiency-buildings-2020-02-17_en](https://commission.europa.eu/news/focus-energy-efficiency-buildings-2020-02-17_en)
- European Commission Directorate-General for Climate Action, n.d.. *European Commission*. [En ligne]
Available at: https://climate.ec.europa.eu/eu-action/eu-funding-climate-action_en
[Accès le June 2024].
- European Commission Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, 2018. *Competitiveness of the European cement and lime sectors*, Brussels: European Commission.
- European Commission Taxation and Customs Union, 2025. *EC Taxation and Customs Union*. [En ligne]
Available at: https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism_en
[Accès le June 2025].
- European Commission: Strategic Foresight Report, 2022. *2022 Strategic Foresight Report Twinning the green and digital transitions in the new geopolitical context*, Brussels: European Commission: COM(2022) 289 final.
- European Commission, 2021. *European Commission*. [En ligne]
Available at: https://reform-support.ec.europa.eu/what-we-do/green-transition_en
[Accès le June 2024].
- European Commission, n.d.. *European Commission*. [En ligne]
Available at: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en
[Accès le June 2024].

- European Environment Agency, 2024. *European Environment Agency*. [Online]
Available at: <https://www.eea.europa.eu/en/topics/in-depth/energy-efficiency>
[Accessed June 2024].
- European Investment Bank, 2024. *Greening the financial sector - A Central, Eastern and South-Eastern European Perspective*, Luxembourg: European Investment Bank.
- Fielt, E., 2014. Conceptualising Business Models: Definitions, Frameworks and Classifications. *Journal of Business Models*, 1(1), pp. 85-105.
- Fortes, M. . V. B., Agostini, L., Wegner, D. & Nosella, A., 2023. Paradoxes and Tensions in Interorganizational Relationships: A Systematic Literature Review. *Journal of Risk and Financial Management*, 16(1).
- Freeman, R. E., 2010. The Stakeholder Concept and Strategic Management. Dans: *Strategic Management: A stakeholder approach*. s.l.:Cambridge University Press, pp. 31-51.
- Freeman, R. E. & Mcvea, J. F., 2001. A Stakeholder Approach to Strategic Management. *Social Science Research Network*, January.
- Gibson, K., 2012. Stakeholders and Sustainability: An Evolving Theory. *Journal of business ethics*, Volume 109, pp. 15-25.
- Guillaume Ricome, M. G. J. D.-R. a. I. J., 2024. Cement's carbon footprint doesn't have to be set in stone. *The future of process industries*, 10 September, pp. 3-4.
- Guo, Y. et al., 2024. A review of low-carbon technologies and projects for the global cement industry. *Journal of Environmental Sciences*, Volume 136, pp. 682-697.
- Hahn, T., Pinkse, J., Lutz, P. & Figge, F., 2015. Tensions in corporate sustainability: Towards an integrative framework. *Journal of Business Ethics*, Volume 127(2), pp. 297-316.
- Hesse-Biber, S., Rodriguez, D. & Frost, N., 2015. A qualitatively driven approach to multimethod and mixed methods research. In: S. a. J. R. Hesse-Biber, ed. *The Oxford Handbook of Multimethod and Mixed Methods Research Inquiry*. s.l.:Oxford University Press (OUP), pp. 3-20.
- Ighalo, J. O., Adeniyi, A. G. & Marques, G., 2020. *Internet of Things for Water Quality Monitoring and Assessment: A Comprehensive Review*. s.l.:Springer.
- International Energy Agency, 2023. *IEA*. [En ligne]
Available at: <https://www.iea.org/energy-system/industry/cement>
[Accès le April 2024].
- Kogabayev, T. & Maziliauskas, A., 2017. The definition and classification of innovation. *HOLISTICA – Journal of Business and Public Administration*, 8(1), pp. 59-72.
- Lewis, M. W., 2000. Exploring Paradox: Toward a More Comprehensive Guide. *Academy of management Review*, Volume 25(4), pp. 760-776.
- Liang, Y., Lee, M. J. & Jung, J. S., 2022. Dynamic Capabilities and an ESG Strategy for Sustainable Management Performance. *Frontiers in Psychology*, May, Volume 13, p. 887776.
- Lyon, T. P. & Montgomery, A. W., 2015. The Means and End of Greenwash. *Organization & Environment*, 28(2).

- Madaleno, M., Dogan, E. & Taskin, T., 2022. A step forward on sustainability: The nexus of environmental responsibility, green technology, clean energy and green finance. *Energy Economics*, 109(105945).
- Mahajan, R. et al., 2023. Stakeholder theory. *Journal of Business Research*, November.166(114104).
- Mann, M., 2024. *Encyclopedia Britannica*. [En ligne]
Available at: <https://www.britannica.com/science/greenhouse-gas>
- McKinsey & Company, 2023. *McKinsey & Company*. [En ligne]
Available at: <https://www.mckinsey.com/industries/engineering-construction-and-building-materials/our-insights/decarbonizing-cement-and-concrete-value-chains-takeaways-from-davos>
[Accès le April 2025].
- Meyer, J. W. & Rowan, B., 1977. Institutionalized Organizations: Formal Structure as Myth and Ceremony.. *American Journal of Sociology*, September, 83(2), pp. 340-363.
- Mitchell, R. K., Agle, . B. R. & Wood, D. J. J., 1997. Toward a Theory of Stakeholder Identification and Salience: Defining the Principle of Who and What Really Counts. *Academy of Management Review*, October, 22(4), pp. 853-886.
- Muench, S. et al., 2022. *Towards a green & digital future*, Brussels: Publications Office of the European Union.
- National Geographic, 2023. *National Geographic*. [En ligne]
Available at: <https://education.nationalgeographic.org/resource/sustainability/>
[Accès le April 2024].
- Ospina, S., 2004. Qualitative research. *Encyclopedia of Leadership*, pp. 1279-1284.
- Osterwalder, A. & Pigneur, Y., 2010. *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers*. s.l.:Wiley.
- Our world in data , 2023. *Our World in Data*. [En ligne]
Available at: <https://ourworldindata.org/grapher/energy-intensity>
[Accès le December 2024].
- Parliament of the EU, 2021. *Regulation (EU) 2021/1056 of the European Parliament and of the Council of 24 June 2021 establishing the Just Transition Fund*. [En ligne]
Available at: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32021R1056>
[Accès le 21 April 2024].
- Phondej, W., Neck, P. A. & Kittisarn, A., 2011. The Seven Steps of Case Study Development: A strategic Qualitative Research Methodology in Female leadership Field.. *Review of International Comparative Management*, 12(1).
- Poudyal, L. & Adhikari, K., 2021. Environmental sustainability in cement industry: An integrated approach for green and economical cement production. *Resources, Environment and Sustainability*, 4(17), p. 100024.
- Radovanović, M. et al., 2022. Decarbonisation of Eastern European economies: monitoring, economic, social and security concerns. *Energy, Sustainability and Society*, March.12(16).

- Sahoo, N., Kumar, A. & Samsher, n., 2022. Review on energy conservation and emission reduction approaches for cement industry. *Environmental Development*, ISSN: 2211-4645,, December.44(100767).
- Scarpellini, S., Marín-Vinuesa, L. M. & Aranda-Usón, A., 2020. Dynamic capabilities and environmental accounting for the circular economy in businesses. *Sustainability Accounting, Management and Policy Journal*, 11(7), pp. 1129-1158.
- Scott, W. R., 2001. *Institutions and Organisations*, s.l.: Sage Publications.
- Selim, T. & Salem, A., 2010. *Global Cement Industry: Competitive and Institutional Dimensions*, Munich: University Library of Munich, Germany.
- Shahzad, M., Qu, Y., Rehman, S. U. & Zafar, A. U., 2022. Adoption of green innovation technology to accelerate sustainable development among manufacturing industry. *Journal of Innovation and Knowledge*, 7(4), p. 100231.
- Sinkovics, R. R., Penz, E. & Ghauri, P. N., 2005. Analysing textual data in international marketing research. *Qualitative Market Research*, 8(1), pp. 9-38.
- Smith, W. K., 2014. Dynamic Decision Making: A Model of Senior Leaders Managing Strategic Paradoxes. *Academy of management Journal*, December, 57(6), pp. 1592-1623.
- Smith, W. K. & Lewis, M. W., 2011. Toward a theory of paradox: A dynamic equilibrium model of organizing. *Academy of management review*, Volume 36(2), pp. 381-403.
- Statista, 2023. *Statista*. [En ligne]
Available at: <https://www.statista.com/topics/7340/travel-and-tourism-in-croatia/#topicOverview>
[Accès le June 2024].
- Teece, D. J., Pisano , G. & Shuen, A., 1997. Dynamic Capabilities and Strategic Management. *Strategic Management Journal*, August, 18(7), pp. 509-533.
- Tesse, D. J., 2007. Explicating Dynamic Capabilities: The Nature and Micro Foundations of (Sustainable) Enterprise Performance. *Strategic Management Journal*, 28(13), pp. 1319-1350.
- The global cement report, n.d. *The global cement report, 15th edition*, s.l.: Tradeship publications Ltd..
- The Loreti Group, 2008. *Greenhouse Gas Emission Reductions from Blended Cement Production*, California: California Climate Action Registry.
- United States Environmental Protection Agency, n.d.. *EPA*. [En ligne]
Available at: <https://www.epa.gov/ghgemissions/overview-greenhouse-gases>
[Accès le June 2024].
- Uratani J. M., G. S., 2023. A forward looking perspective on the cement and concrete industry: Implications of growth and development in the Global South. *Energy Research & Social Science*, Volume 97.
- Uwasu, M., Hara, K. & Yabar, H., 2014. World cement production and environmental implications. *Environmental Development*, Volume 10, pp. 36-47.
- Venkatesh, V., Brown, S. A. & Sullivan, Y. W., 2016. VenkateshGuidelines for Conducting Mixed-methods Research: An Extension and Illustration. *Venkatesh*,

- Viswanath; Brown, Sue A.; and Sullivan, Yulia W. (2016) "GuideJournal of the Association for Information Systems, 17(7).
- Williams, A., 2024. *Forbes*. [En ligne]
Available at: <https://www.forbes.com/sites/technology/article/green-tech/>
- Working Group 1, Intergovernmental Panel on Climate Change, 2021. *Climate Change 2021: The Physical Science Basis. Contribution of Working Group 1 to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, United Kingdom and New York, NY, USA: Cambridge University Press, Cambridge.
- Yin, R. K., 2009. *Case study research: design and methods*. Fourth Edition éd. s.l.:Sage Publications Inc..
- Zikmund, W. G., Babin, B. J., Carr, J. C. & Griffin, M., 2013. *Business Research Methods*. 9th éd. Mason(OH): Cengage Learning.

APPENDIX A

INTERVIEW COVER LETTER

Dear Mr. ---,

Hope this message finds you well. My colleague ----- kindly shared your contact. I am Stephanie Trpkov a long-time competitiveness and energy sector consultant at the World Bank, where for 9 years I worked on strengthening cornerstone industries through strategic investments. As a European Commission expert on decarbonisation, and an entrepreneur, I work both on EU programs on financing energy and energy efficiency related infrastructure, and developing innovative Cleantech solutions.

Having participated in creating most of the key strategic documents in the EU and Croatia, I noticed a gap when it comes to the perspective of companies in energy intensive sectors. This formed the basis for my Doctorate in Business Thesis which is titled:

NAVIGATING THE PARADOX OF GREEN TECHNOLOGY ADOPTION IN THE CEMENT INDUSTRY IN SOUTHEAST EUROPE.

This management focused thesis is designed to come up with solutions on how cement manufacturing companies could easily deal with the competing pressures of various stakeholder interests, while choosing the right technologies for strategic competitiveness and maintaining operational efficiency. Thus, the primary research question is an exploration of how industrial actors could balance the paradoxes of stakeholder expectations, short term business goals and long-term environmental objectives that require significant upfront capital investments.

I would deeply appreciate it if you would allow for a study visit to your premises for a **30–45-minute conversation (which can be in Croatian language)** with a senior executive, responsible for investments in green technologies and plant operations. I selected your company for the study because it is a leading regional player integrating innovative green technologies at scale.

Any benefits to your company will be indirect, but potentially strategic as the study presents a unique opportunity to confidentially share your perspective on an aspect of compliance and EU priority. Attached are (i) a consent form that highlights the confidentiality principle, and (ii) the discussion topics. We can address the topic or any other inputs you wish to provide. Please feel free to contact me by phone if any clarifications are needed. Thank you so much for considering the request, looking forward to hearing from you.

With best regards,
Stephanie E. Trpkov

APPENDIX B
INFORMED CONSENT

**NAVIGATING THE PARADOX OF GREEN TECHNOLOGY ADOPTION IN
THE CEMENT INDUSTRY IN SOUTHEAST EUROPE**

You are invited to participate in a research study being conducted for a dissertation at Swiss School of Business and Management, Geneva. The study is interested in your views about how green transition could be accelerated in the cement industry and how this transition may significantly reduce carbon footprint, while balancing the paradox of stakeholder interests, short to mid-term business goals, and longer-term environmental outcomes?

You were selected because you satisfied the main categories of criteria i.e., the CEO, or plant manager, or CFO, or sustainability director on the company side, and researchers, financiers, government agencies or consultants on the stakeholder side. There is no deception in this study.

You will be asked to answer some questions during the interview process about how net-zero transition via green technology integration affects the cement industry and spills over to the building and construction sector. The interview is expected to last between 30 to 45 minutes. The following people are involved in this research study and may be contacted at any time: **Stephanie E. Trpkov**, the doctoral candidate, and **Ivica Katavic, PhD**, the dissertation mentor.

Although there are no known risks in this study, you can also choose not to answer any question that you feel uncomfortable in answering.

There are no direct benefits to you for participating in this research. No incentives are offered. The results will have applied interest that may eventually have benefits for your company and its primary and secondary stakeholders.

The data collected in this study is confidential. Your name or personal information is not linked to the data. Only the researcher in this study will see the data. You have the right to withdraw from the study at any time without penalty.

We would be happy to answer any question that may arise about the study. Please direct your questions or comments to: Stephanie E. Trpkov (stephanie@ssbm.ch; phone: +385 91 173 6286 and Ivica Katavic (ivica@ssbm.ch; + 385 99 369 5585).

Signatures

I have read the above description for *Navigating the paradox of green technology adoption in the cement industry in Southeast Europe*.

I understand what the study is about and what is being asked of me. My signature indicates that I agree to participate in the study.

Participant's Name: _____ Researcher's Name: Stephanie E. Trpkov

Participant's Signature: _____ Researcher's Signature: 

Date: _____

APPENDIX C

INTERVIEW GUIDE

Research aim

The aim of the research is to examine the paradoxical relationship between the climate-driven urgency for industrial process reorganisation and the real costs of green technology integration.

Objectives

- To explore ways that managing the paradoxical tensions could enable cement companies to meet their net-zero targets while maintaining or increasing profitability and market competitiveness,
- To determine the real costs of green transition at company level,
- To determine the type and scope of technological and other investments required to achieve net-zero objectives,
- To estimate the general implementation timeline of green technologies from R&D stage to full industrial scale integration,
- To assess the prevalence of greenwashing practices and explore effective methods of forestalling them.

	Research questions	Sub questions
1.	How could paradoxical tensions between differing interests be managed to enable cement companies meet their net-zero targets while maintaining profitability and market competitiveness?	○ What aspect of stakeholder expectation impacts operations the most? ○ How does the integration of green technology affect the competitive environment? ○ Is there a demand for green cement sufficient to make the long-term investment strategically feasible?
2.	How effective are the available “green” financial instruments for deep decarbonisation of industrial processes?	○ Do the companies have access to all the money allocated by the public funds? ○ Is private capital available at economically feasible rates? ○ How long/how much does it take to prepare the project for application? ○ How long does it take between project proposal submission and approval?
3.	What are the overt and covert costs of decarbonising the cement industry?	○ How much does it cost to develop a green technology project? ○ Is there a process for choosing particular green technologies? ○ Do they need to recruit and retrain new employees?
4.	How long does it take for essential green technology to move from the research and development (R&D) phase to full industrial integration and return on invested capital?	○ Does integration of these technologies occur without issues? ○ What are the most common issues and how are they mitigated? ○ What are the standard expectations of ROI from investors?
5.	How can corporate leaders in the cement industry internally assess and prevent greenwashing practices?	○ Is there an internal process for determining the impact of a particular technology? ○ How easy is it to withdraw or change a particular course of action?

