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Critical Raw Material supply chains - the Key to a Twin Transition?

A critical analysis of the
European Critical Raw Materials Act of 2023

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Abstract

The thesis investigates how the problem of Critical Raw Material supply chains is represented within the European Critical Raw Materials Act of 2023. Bacchi's 'What's The Problem Represented To Be' approach has been adapted and utilised to explore what aspects of these supply chains are problematised. By highlighting how the problem of supply chains is represented, this research aims to uncover what political, social and environmental implications are not mentioned and by extension, silenced within this European Critical Raw Materials Act. The application of the Sociotechnical Imaginaries framework highlights the factors included in the desired future of a twin transition fuelled by critical raw materials disseminated through the European Critical Raw Materials Act and thereby promoted by the European Commission and the European Union. However, this analysis also shows that the plan that is set in place by the European Critical Raw Materials Act to reach a twin transition pertains weaknesses and shortcomings for addressing import dependency, supply chain vulnerability as well as social and environmental implications.

Key words:, Critical Raw Material Supply Chain Vulnerability, Import Dependency & Geopolitics, Twin Transition, Critical Materials Extraction Impact, European Critical Raw Materials Act

Words: 9602

List of Abbreviations:

Artisanal small-scale miner **(ASM)**

Critical Raw Materials **(CRM)**

European Commission (**EC)**

European Union **(EU)**

European Critical Raw Materials Act **(ECRMA)**

European Raw Materials Alliance **(ERMA)**

Five Eyes Critical Mineral Alliance **(FVEY CMA)**

Minerals Security Partnership **(MSP)**

Multinational corporations **(MNC)**

Sociotechnical Imaginaries **(STI)**

The Democratic Republic of Congo **(DRC)**

United Kingdom **(UK)**

United States **(US)**

What's the problem represented to be (**WPR)**

Table of contents

1. Introduction

On the 14th of September 2022, Ursula von der Leyen, the President of the European Commission (EC) presented her annual State of the Union Speech. During this speech, she addressed numerous concerns and challenges that face the European Union (EU). One of the main takeaways is her deliberation upon threats to the Union's energy security, autonomy, and sovereignty, namely the importance of abolishing the EU's dependency on Russian fossil fuels. Ursula von der Leyen further stressed the importance of green energy, investing in the renewable energy sector and finally securing a sustainable supply of critical raw materials (CRMs). These materials are fundamental components for numerous green energy technologies such as electric vehicles as well as wind and solar power (IEA, n.d). Various stakeholders have their own definition of CRMs, the EC defines them as: "[...] indispensable for the EU economy and a wide set of necessary technologies for strategic sectors such as renewable energy, digital, space and defense" (European Commission [a], n.d.). One of the EU's current goals is to attain climate neutrality by 2050, thus the EU is now shifting itself from a dependency on Russian fossil fuels to a sustainable autonomous energy supply sustained by critical raw materials (COM/2022/289, final, p.1).

This shift also represents the EU's envisioned transformation to attain a twin transition. Incorporated in the European Green Deal and the EU's Digital Strategy, the twin transition includes the forward-looking push towards the green and digital transition and hence, is seen as a 'twin' transition due to the capacity of the two to reinforce each other (COM/2022/289, final). According to the EU's 2022 Strategic Foresight Report, for this transition to be successful, the securement of robust supply chains of CRMs will be paramount (ibid.).

It is worth noting that the EU stands for 25 percent of the global consumption of CRMs although it produces less than 3 percent of the global supply, meaning that the Union is currently dependent on importing CRMs (Regeringskansliet, 2020, pp.88-89). China is the biggest supplier of these materials globally and also is the main exporter to the EU (see Figure 1). Ursula von der Leyan stresses the importance of: "[…] avoid falling into the same dependency as with oil and gas" (Von Der Leyan, 2022; EC, 2023). She proposes new partnerships as well as new strategic projects within the supply chain and finally, the European Critical Raw Materials Act (ECRMA). Given the importance of CRMs for a twin transition and the announcement of the ECRMA, this

study will critically analyse how the problem of CRM supply chains is represented within the aforementioned act.

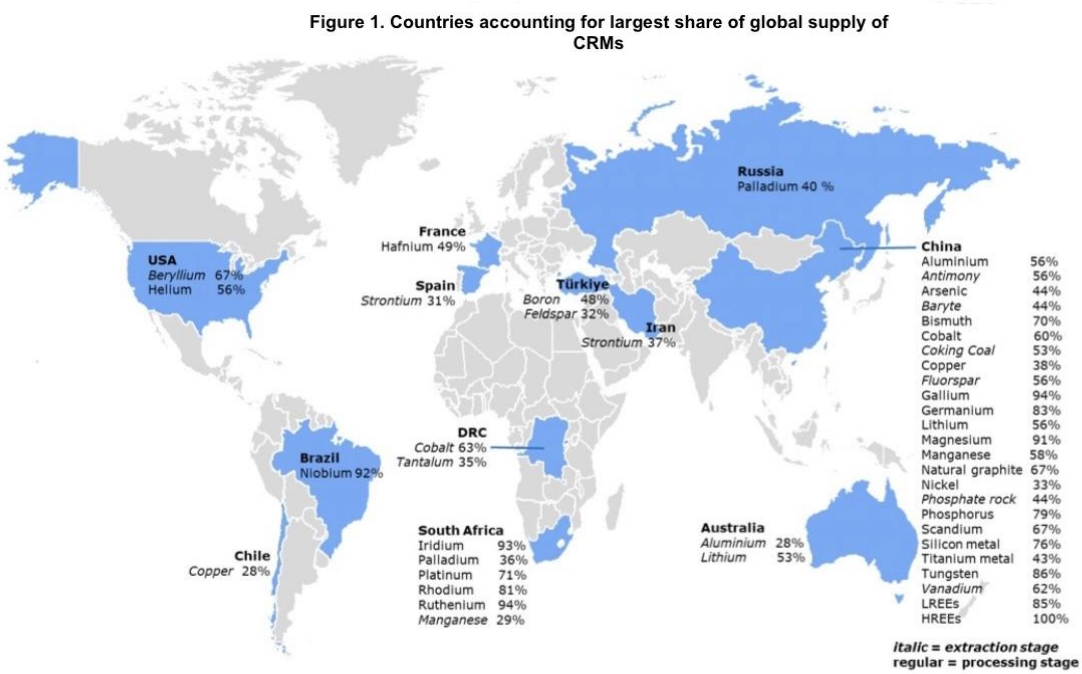

Figure 1. Presents the countries accounting for the largest share of global supply of CRM. It is worth noting that only two EU countries are on the map as the holders of the largest supplies of only two CRMs (hafnium and strontium) whereas China holds 25 CRMs.

Source: Grohol et al. (2023, p. 10)

1.1. Research problem, research aim, and research questions

As mentioned in section 1., green energy technologies for a twin transition require a robust supply of CRMs. Securing a stable supply chain of CRMs is strained by numerous factors. The relevant thematic literature discusses vulnerable supply chains, geopolitical competition as well as the negative social and environmental impacts of CRM extraction. Therefore, the EC's desired future of a twin transition fuelled by CRMs may come at the cost of numerous political, social, and environmental implications. Given these implications, this thesis aims to critically analyse the ECRMA and uncover the silences in regards to the political, social and environmental implications of CRM supply chains.

The following research questions have been established to obtain the objectives of this study.

1. How are the supply chains of Critical Raw Materials problematised with the EU's Critical Raw Materials Act?
2. What are the silences of this problematisation in regards to the social, political and environmental implications of Critical Raw Material supply chains?

By scrutinising the silences within the problem representation of CRM supply chains, we can uncover what political, social and environmental implications and risks are not addressed or mitigated within the ECRMA. Therefore, by critically analysing how the EC problematises CRM supply chains and furthermore, what it does not problematise, our analysis highlights the shortcomings and weaknesses of the proposed pathway to a twin transition fuelled by CRMs.

1.2. Relevance of the topic

In 2019, the EU released the European Green Deal (COM/2019/640, final), an accord consisting of numerous ambitious climate goals, including the intention to become the first carbon neutral continent by 2050 (ibid). The pursuit of a carbon neutral future will be fueled by a sustainable green energy transition utilising energy technologies including solar panels, wind turbines, and electric batteries (European Commission, 2023). A common denominator for the aforementioned energy systems is the necessity of critical minerals and materials for their composition (United Nations, 2021). In order to achieve a carbon neutral future fuelled by renewable energy, the World Bank (n.d) predicts that the demand for CRMs will increase by 500 percent by 2050. Beyond the increasing demand for these materials, securing a stable supply of CRMs faces numerous difficulties. As will be discussed in section 2., supply chains are considerably vulnerable to external shocks, political instability, and resource nationalism, furthermore the strategic value of CRMs has contributed to the establishment of regional mineral alliances that are intensifying global competition for sustainable supply chains of CRMs. Looking beyond the political significance of the growing demand and value of CRMs, the extraction of these materials also has numerous environmental and social consequences. The aforementioned challenges to CRM supply chains and the social and environmental implications will be further deliberated upon in section 2.1. In light of the vulnerable nature of CRM supply chains, the geopolitical significance as well as the negative implications of CRM extractions, pursuing a

twin transition fuelled by these materials may result in numerous political, social and environmental consequences.

1.4. Delimitations and Scope

The time frame for our research and data sample is set following the 2022 State of the Union speech by the president of the European Commission**.** Within her speech, Von Der Leyen emphasises the geopolitical significance of energy politics, the importance of shifting from Russian fossil fuels, investing in the renewable energy sector and lastly, to secure a sustainable supply of CRMs. Followingly, this speech announced the commencement of the European Critical Raw Materials Act, a legislative proposal with the intention to secure sustainable supply chains of CRMs (COM/2023/160, final). Beyond the thematic significance of CRM supply chains in contemporary political discourse, this proposal represents the EU's first regulatory framework that addresses supply risks and shortages of CRMs (COM/2023/160, final).

Considering the significance of this topic, this thesis will focus on the green energy sector in relation to the twin transition. As this sector is highly reliant on a sustainable supply of CRMs and therefore also interrelated to the attainment of a twin transition, we have chosen to delimit our focus to only this particular sector in order to obtain a more thorough analysis. This thesis will also not discuss the impacts on the energy sector associated with Russia's war on Ukraine, while this can be seen as relevant, it is beyond our scope in regards to the aims and research questions of this thesis.

2. Background

The following section will discuss the thematic discourse behind the supply chains of CRMs. We will examine the empirical literature on supply chains, covering the geopolitical significance of CRMs, the vulnerability of CRM supply chains, CRM application in a twin transition as well as the social and environmental implications that CRM supply chains can create. It is worth noting, the relevant literature in the subsections below is considerably extensive and therefore solely a few examples and cases will be raised. The sample of the cases discussed are included due to their prevalence within the academic discourse as well as their relevance within the specific scope of this study.

2.1. CRM application in a twin transition

The EC's desired future of a twin transition emphasises the synergy between a green and digital transformation, in which the simultaneous transitions can mutually reinforce each other (European Commission, 2022). A crucial element in achieving this transition is green energy technologies as these technologies would benefit the pursuit of the EU's climate objectives and support the energy needs of the digital sector (COM/2022/289, final, p.2). The EC explains that a sustainable supply of CRMs is a decisive factor in order to attain a twin transition (ibid, p.8). Green energy technologies such as batteries, wind and solar energy require CRMs within their composition, including materials such as copper, cobalt and lithium (IRENA, nd). It is worth noting, there are other numerous CRMs fundamental for green energy technologies beyond those previously mentioned, additionally, the amount of materials required vary depending on the green energy technology in question.

Scholars such as Kalantzakos (2023, p.3-5) stress the fragility of climate objectives that are reliant on green energy technologies, as the assembly of these technologies are occurring too rapidly when taking into consideration the vulnerable nature of CRM supply chains. Considering the dependency on CRMs for green energy technologies, disruptions within the supply chain could therefore potentially have a severe impact for a twin transition.

2.2. Factors influencing the vulnerability of CRM supply chains

Considering the importance of CRMs for green energy technologies and additional strategic sectors, the demand for these materials is rapidly accelerating (IRENA, nd). This increasing demand influences the supply chains of CRMs in numerous ways. Firstly, many countries with extensive reserves of CRMs are located in less developed states, and within these states, a wave of resource nationalism is transpiring (Dou et al, 2023, pp.9-10). Resource nationalism is a term that is both conceptual and vague, Pryke (2017, pp.474-475) defines it as the: "[...] various forms of state involvement in the extraction, processing and sale of natural resources". Resource nationalism diminishes the power of multinational corporations (MNC) by imposing regulations on the ownership of MNCs, as well as raising taxes and royalties (Dou et al., 2023, p.9). This form of economic nationalism stemming from the growing global strategic value of CRMs has intensified the vulnerable nature of supply chains (ibid, p.9).

Other factors such as political instability may influence the supply chains of CRMs, notably if immense concentrations of CRMs are located in countries suffering from political instability. Such a scenario increases the risk of disruptions with the global supply chains of CRMs (Yu et al, 2021, p4-7; Brown, 2018, pp.207-208).

An additional factor that influences the supply chains of CRMs is external market shocks, an example is the COVID-19 pandemic that brought about backlashes in globalisation (Giese, 2022, p.2-3). One example of this is China, a major exporter of processed CRMs. During the pandemic China imposed numerous restrictions in order to combat the spread of COVID-19, this resulted in numerous supply shortages in the global market, including CRMs (ibid, pp.1-2).

2.3. Geopolitical significance of CRM supply chains

The necessity for CRMs in green energy technologies and other strategic sectors highlights the geopolitical significance of these materials. It is worth noting, the geopolitical significance of CRMs is extensive, as they are fundamental components for several strategic sectors. Therefore, this subsection will solely cover the geopolitical significance of CRM supply chains in the context of green energy technologies and a twin transition.

Firstly, numerous mineral alliances have been established with the intention to secure a sustainable supply of CRMs. One example of such an alliance is the Five Eyes Critical Mineral Alliance (FVEY CMA) consisting of the United States (US), United Kingdom (UK), Australia, New Zealand and Canada (Shiquan and Deyi, 2022, p.3). Dou (et al., 2023, p.6) explains that one of the main objectives of the FVEY CMA is to: "[...] counter China's dominance of the supply chain", he continues by explaining how such growing global competition for sustainable CRM supply chains between geographic regions demonstrates a surge of regionalisation which may intensify geopolitical tensions.

Whilst the EU imports CRMs from numerous countries, China is currently the EU's largest importer (Grohol et al., 2023, p. 7). China holds the largest share within the global supply of 25 CRMs, including copper, cobalt and lithium, all three of which are essential for green energy technologies (ibid., p. 10). In light of the EU's current dependency on Chinese imports of CRMs, the desired future of a twin transition is arguably dependent on this supply from China.

2.4. Social implications of CRM supply chains

The social implications of CRM supply chains are often related to the extraction of these materials. A frequent example mentioned is labour rights of artisanal miners (ASM) in the Democratic Republic of Congo (DRC). As of 2022, the DRC accounts for circa 70 percent of the global supply of cobalt (Garside, 2023). ASM within the cobalt mining sector of Congo is correlated with child labour, human rights violations and endangering public health due to pollution and unsafe working conditions (Mancini, 2021, pp. 2-3). Whilst literature on the social implications of CRM supply chains frequently raises concerns in the global south, the extraction of CRMs has also inferred social implications in European countries, such as Sweden. Haikola and Anshelm (2016, p.7-9) describe how mining operations in Northern Sweden contribute to the exploitation of minority groups, notably the Sami. This exploitation is contextualised by land grabbing by mining companies in territories where Sami reindeer herdsmen operate (ibid). Both of these empirical examples highlight various social implications that arise within the supply chains of CRMs. The example of the Sami contextualised that the detrimental implications of CRM extraction does not solely occur in the global south.

2.5. Environmental implications CRM supply chains

Scholars highlight numerous implications of CRM extraction and supply chains, ranging from deforestation, land and water pollution as well as extraction causing detrimental damage to ecosystems and biodiversity (Bebbington et al., 2018, pp.1-2). An example frequently discussed in the academic literature is the lithium extraction in Chile.

The extraction of the CRM lithium has considerable environmental implications. Lithium extraction operations are frequent in the Salar De Atacama desert in Chile, where this extraction method is "[...] reported to harm soils and contaminate the air, poisoning fish and killing livestock" (Beales et al., p.21). Furthermore, lithium extraction also requires immense amounts of water and has drained 65 percent of water reserves in the Salar De Atacama region.

3. Theoretical Framework

This thesis will build upon the sociotechnical imaginaries (STIs) framework proposed by Janasoff and Kim (2015). This theoretical framework will be used to understand and identify how the problem of CRM supply chains is represented to be within the ECRMA in regards to the twin transition. Furthermore it will be used to showcase the weaknesses that the desired twin transition entails. We are exploring the created vision of a particular desired future, more specifically the sustainable green energy and digital transition that is rooted in the securement of CRMs supply chains. This framework will be helpful in order to understand how the framing and narration within the ECRMA is potentially showcased as something desirable - as a way to imagine a different future with CRMs. The envisioned future can be identified as the future of the European Union's autonomous sovereignty of energy that is attained through a twin transition. As we will see, this thesis identifies the EU's desired future as one that attains a twin transition, in which the securement of CRM supply chains is paramount.

The framework of sociotechnical imaginaries was initially conceptualised and defined by Janasoff and Kim (2007). Their first definition of STIs was limited to only nation-states. However, STIs were redefined to a more inclusive definition that accounted and articulated to do justice to the complexities of dimensionalities and temporalities that truly signify the term. Therefore, the STIs in this paper will be used and understood as: "collectively held, institutionally stabilised, and publicly performed visions of desirable futures, animated by shared understandings of forms of social order attainable through, and supportive of, advances in science and technology" (Janasoff and Kim, 2015, p. 4). In line with the literature, we understand STIs as desired futures that are rooted in collective, institutional beliefs, values and ideologies that fall in line with the structures and operations of society, and can therefore be achieved by social and technological advancement and innovation.

There is a distinction between imaginaries and sociotechnical imaginaries. An imaginary can be understood similarly to the definition above, where a shared understanding of a particular social order is based on subjective cultural values and perceptions that are envisioned and strived for. However, sociotechnical imaginaries hold a deep rooted focus on society and technology.

Here the relationship between society and technology is incorporated within the desired futures and contain elements of development in both spheres, such as science, technology, cultural values and political institutions (Janasoff and Kim, 2015, pp. 19-21). There is an emphasis in STIs on the role of technological advancement and change coupled with social progression that is essential for attaining an envisioned future of progress. This connection to technology is seen as key in the conceptualisation of the term sociotechnical imaginaries - implying that technology and its further development and innovation is needed for development itself (Janasoff and Kim, 2015, p. 19).

Imaginaries and STIs are not physical entities per se but rather the constructions that emerge through imaginations of desired futures that are commonly shared and arise from institutions and groups. A comprehensible way of understanding STIs is to view them as infrastructures and road maps of plans that are required in order to realise a favourable future (Miedzinski et al., 2022). Therefore, in this thesis, the STIs identified encompass the desired future of attaining a twin transition, in which the securement of CRM supply chains is key. This therefore relies on technological innovations and advancement as well as political institution expansion and management to reach a climate neutral future.

It also has to be noted that the definition of STIs entitles the word 'desired' due to the grounding of sociotechnical futures being embedded in visions of positive social progress. This means that STIs promote certain pathways over others and can thereby shape choices and actions. Furthermore, it has to be understood that an adverse effect can take place i.e. a future that is not desirable. However, such an outcome usually happens when there is a failure to accomplish certain social interventions and technological innovations (Janasoff and Kim, 2015, pp. 4-5).

In this sense, sociotechnical imaginaries have the political and social power to shape and determine public expenditures, technological design as well as the justification of inclusion or exclusion of who will be the beneficiaries of given change (Janosoff et. al., 2007, p. 1). Given the deep rooted political salience of imaginaries like this, there exists a certain kind of inevitability of risks as well as instabilities that are associated with the realisation of a 'desired' future (ibid.). Janasoff and Kim (2015, p. 28) argue that in order to understand the operations of sociotechnical imaginaries within given policies, language can be explored for framings of risk and benefit and therefore also the: “[...] attitudes toward regulation and the market, and visions of technologically mediated progress or failure and backsliding”.

STIs encode, both at once, a descriptive narration of attainable futures, as well as a prescriptive one of the kind of future that ought to be attained. Meaning that in this respect, they dictate what ought and ought not to be within a given society (Janasoff and Kim, 2015, p. 4.) This theory thus allows us to examine and reflect on the depths of transformations to sustainability by looking at how such a transformation can be implemented in a way that is equitable and acceptable, while also inquiring about how meanings are created (Janasoff and Kim, 2015, p. 21).

4. Methodology and Research Design

The following section outlines the research method, clarifying the methodological approach and justifying its applicability for our research question and analysis. Subsequently, the limitations of our research method will be discussed.

This study applies the 'What's the Problem Represented to be' (WPR) method first proposed by Carol Bacchi (2009). Her approach recognises that policies are established in response to a problem. Whilst the policy may not specify it as such, it indirectly signifies a need of remedying something and therefore is implying a problem (ibid, IX). Bacchi's approach facilitates the means to critically analyse policies through a series of questions. These questions will act as a guiding tool for our analysis, each key question will be discussed in section 4.1. The WPR approach provides insight to the consequences that a policy may unintendedly impose. Bacchi explains that by creating policies, one may implicitly give shape to problems rather than to react to them (ibid, p.1). Additionally, scholars such as Osborne (1997) scrutinise policy creation and formulation, describing that in order to formulate a policy, a stage of problematisation is required (ibid, p.174). Osborne further clarifies that through problematisation: "[...] by positing an issue as a particular sort of issue, a range of factors must be simplified" (ibid, p. 175). Considering the issue of giving shape and the potentiality of problem simplification, the WPR approach will provide a framework to investigate how the problem of CRM supply chains is represented by the ECRMA, and what silences are identifiable of that particular problematisation in regards to the social, environmental and political implications.

Bacchi's (2009) approach consists of six questions, although not all of which will be utilised for this thesis. Certain questions have been excluded considering the lack of applicability to our specific research area, aims and research questions. The three of Bacchi's questions that have been selected for our analysis have been adapted to the research questions and aims of this thesis, the adaptations can be found in Table 1.0 below. Furthermore, an overview of each question and its purpose will be clarified in the next section (4.1.). The excluded questions are not included in the table below, nor will they be elaborated upon in the next section.

As mentioned in section 1.1, this thesis investigates how the supply chains of CRM's are problematised by the EC and to investigate the silences in regards to the political, social and environmental implications of these supply chains. In order to do so in a coherent manner, each question will be discussed separately throughout the analysis also in relation to our research questions. Two categories have also been created that make up the subsections within the analysis. Firstly, vulnerable supply chains and import dependency reflect the political implications. Secondly, the social and environmental implications are discussed together, seeing as they are mainly referred to simultaneously with the ECRMA.

WPR Questions in use	**Adapted Questions**
Q.1 What is the problem represented to be in a specific policy?	What is the problem of CRM supply chains represented to be in the European Critical Raw Materials Act?
Q.2 What presuppositions or assumptions underlie this representation of the problem?	What deep-seated assumptions underlie this representation of the problem in the European Critical Raw Materials Act?
Q.3 What is left unproblematic in this problem representation where are the silences? Can the 'problem' be thought about differently?	What are the silences within the problem representation of supply chains of CRMs in regards of the political, social and environmental implications?

Table 1. Shows the methodological questions of inquiry that will be proposed in the for the analysis of the Critical Raw Minerals Act

4.1. WPR Questions

As discussed in section 1.1. Bacchi argues that policies are established in response to a problem, our first question concerns what the implied problem is and how it is represented, therefore our analysis begins by investigating how CRM supply chains are problematised within the European Critical Raw Materials Act, 2023.

Subsequently, our second question builds upon our analysis of the first question, by highlighting the perceptions that underpin how the problem is represented in the ECRMA. This entails questioning what assumptions are made and that which are taken for granted. This reflection enables the identification of conceptual logics that highlight the problem representations found in question one. To clarify, Bacchi (2009, p.5) defines conceptual logic as: "[...] the meanings that must be in place for a particular problem representation to cohere or to make sense". Additionally, Bacchi (ibid, pp.6-7) explains that policies are conveyed through language. Whilst policy brings about 'meaning creation', investigating how that meaning has been established in the first place is useful in order to identify assumptions that underpin specific problem representations. The benefit of this question is twofold. As mentioned above, it allows us to identify conceptual logics that highlights why particular aspects of CRM supply chains are problematised. Secondly, by recognising the assumptions behind the problem representation, we can uncover limitations as to how the problem is represented within the ECRMA. These limitations partly refer to simplified problem representations, but also the silences in terms of that which is not problematised within the act. Both of these limitations will be discussed in the following paragraph.

Our third question scrutinises the silences as to how a problem is represented and questions what has not been problematised in the ECRMA. The silences partly represent that which is not included or problematised, but also limitations and the simplified ways a problem is conceptualised , meaning that a particular representation may only present one aspect or nuance of a problem (Bacchi, 2009, p.13). In order to scrutinise the silences within the problem representation, we will examine a broad range of literature within the thematic discourse of CRM supply chains. To find such literature, we used key terms such as; mineral extraction consequences, social and environmental implications of mineral extraction, and CRM vulnerable supply chains. Following this initial search, we used the snowballing method to acquire more

sources that have been referenced within the primary source. This literature review will act as a basis to highlight the limitations within the problem representation and thereby the political, social and environmental implications that are not addressed.

4.2 Limitations

The European Critical Raw Materials Act of 2023 is currently a proposal and is not a ratified legislation, this may pose some questionability as to the reliability of the findings of this research. However, considering the fact that it has been proposed by the EC, it can still be seen as valuable to look at as any potential changes that could be implemented after the ECRMA has been ratified can highlight if the problem representations of CRMs have changed compared to the first version. Furthermore the ECRMA represents the perceptions on how the EC problematises the supply chain of CRMs and thus decreases the concerns of validity.

This thesis has chosen to focus on the energy sector within the twin transition fuelled by CRMs. As the chosen focus entails the investigation of the political, social and environmental implications, it does not consider these implications relate to other strategic sectors that are dependent on CRMs, such as aerospace or defence. Nevertheless, the energy sector is the most relevant sector for the attainment of a twin transition and thus justifies our chosen scope.

5. Analysis

The analysis consists of three main parts, the problem representation of CRM supply chains, assumptions that underlie that particular problem representation and finally the silences in regards to how the problem is represented. Each part of the analysis will firstly discuss vulnerable supply chains and import dependency, and subsequently the social and environmental implications. Section 5.1 encompasses our analysis and a discussion of how the problem of CRM supply chains is represented within the ECRMA. These findings answer our first research question: How are the supply chains of Critical Raw Materials problematised with the EU's Critical Raw Materials Act? Section 5.2 and 5.3 covers the assumptions that underlie the problem representation and the silences in regards to how the problem is represented. Both sections are interrelated as the identified assumptions allow us to recognise silences, limitations

and simplifications as to the political, social and environmental implications of CRM supply chains. The silences are also partly based upon the findings of section 5.1, as we scrutinise limitations and the simplified ways the problem may be conceptualised. Additionally, for certain findings the identified silences go beyond the limitations within the problem representation. Therefore the findings from section 5.2 and 5.3 answers our second research question: What are the silences of this problematisation in regards to the social, political and environmental implications of Critical Raw Material supply chains? All sections of the analysis continuously address the STI of a twin transition.

5.1. Problem representation of CRM supply chains

Within the EU's Critical Raw Materials Act, there are numerous variations of how the problem of supply chains of CRMs is represented. This ranges from implicit and explicit deliberations on the vulnerability of supply chains, import dependence as well as social and environmental considerations. In this section two categories of the problem representation are discussed. Firstly, vulnerable supply chains and import dependency, as in the ECRMA, vulnerable supply chains are consistently referred to as a result of CRM import dependencies. Secondly, the environmental and the social consequences are frequently addressed in tandem, therefore they are also discussed together throughout the analysis. By addressing both categories separately, we can more clearly present the different dimensions as to how the problem of supply chains is represented in the ECRMA. Therefore the goal of section 5.1 is to explore the answers to our first research question: How are the supply chains of Critical Raw Materials problematised with the EU's Critical Raw Materials Act?

5.1.1. Vulnerable supply chains and import dependency

The vulnerable nature of CRM supply chains is frequently problematised within the ECRMA, it also addresses the necessity of CRMs for a green energy transition and therefore how the vulnerable nature of supply chains may disrupt the EU's single market and competitiveness. The ECRMA also claims that: "[…] without a secure supply of critical raw materials, the Union will not be able to meet its objectives for a green and digital future" (COM/2023/160, final, p.1). The ECRMA raises diverse factors that cause these disruptions, partly the global exposure to events

such as the COVID-19 pandemic and Russia's war on Ukraine (ibid, pp. 9-10). These external disruptions and the vulnerable nature of CRM supply chains are on numerous occasions referred to as a result of structural dependencies on imports from a short list of third countries. One example of this is the EU's dependency on China, which is mentioned in the ECRMA on several occasions. Firstly, 97 percent of the EU's magnesium, which is needed for electrical wiring purposes, comes from China (ibid, p.1). This puts in focus the reliance that the EU has created. Secondly, 60 percent of the world's supply of cobalt, a fundamental mineral in batteries, is refined in China. This import dependency is contextualised as a problem in the act with the following citation: "There are precedents of countries leveraging their strong position as suppliers of CRMs against buyer countries, for instance through export restrictions" (COM/2023/160, final, p.1). The ECRMA continues by stressing how the demand for materials such as cobalt will increase and as a result: "[…]many countries have adopted policies to actively secure their supply of critical raw materials, increasing resource competition." (ibid, p.1) The report describes that such strategic dependencies could prompt further vulnerabilities in regards to the EU's import of CRMs. Beyond mentioning that the EU is dependent on imports from a limited number of third countries, an explicit stated objective of the CRM act is to: "diversify the Union's imports of raw materials" (ibid, p.60).

As mentioned above, CRM supply chains have the potential to disrupt the EU's internal market. The ECRMA also addresses current limitations in monitoring supply chain risks of CRMs, highlighting that there are discrepancies between EU's member states in terms of their capacity to anticipate supply chain disruptions. This discrepancy is a result of two factors. First, certain EU member states have not established structures or frameworks that identify CRM supply chains risks and therefore cannot communicate these disruptions to companies. Second, certain companies do not have the resources to invest in monitoring programes that track potential risks within CRM supply chains. The problem representation of CRM supply chain risk monitoring is therefore twofold - not all member states have sufficient frameworks to monitor these risks and, not all private companies have the ability to track these risks due to their financial capacity.

5.1.2. Social and environmental implications

It has to be noted that certain problem representations can come across as contradictory, and these contradictions will be discussed in section 5.3.2., in order to clarify the silences in regards to how the problem is represented. Therefore, the actual implications of the problem representation will not be deliberated upon within this section, as the main goal is to explain how the problem representation itself is represented.

The ECRMA addresses that social as well as environmental implications may arise from CRM extraction and processing. However, the specific implications that extraction and processing may have is not deliberated upon within the ECRMA. Rather it acknowledges that the potential social and environmental implications will be addressed through compatible regulations and directives that are referred to within the ECRMA. To contextualise, the ECRMA is compliant with the Conflict Minerals Regulation (2017/821), including due diligence policies that address human and labour rights along the value chain. The ECRMA is also consistent with other EU policies aiming to mitigate environmental consequences including the Directive on Environmental Impact Assessment (2011/92) and Directive of the European Parliament and of the Council on Water Policy (2000/60). To clarify, the ECRMA does not elaborate on how these regulations and directives can mitigate social and environmental impacts, however this will be addressed in the problem representation silences in section 5.2.2.

CRMs that are bought by the EU often hold sustainability certifications regarding their production and the supply chain they come from. The ECRMA mentions that the EC should further empower the recognition of these certificates. Both public and private enterprises that are a part of CRM supply chains can attain a certification that proclaims the sustainability of their operations. There is an emphasis on the necessity of a framework for certifications that can accurately assess the sustainability of the supply chain of CRMs that cover: "[…] including environmental protection, human rights including labour rights and business transparency, and which contain provisions for independent third party verification and monitoring of compliance" (COD/2023/160, final, p.14). Yet at the same time, the ECRMA discusses that the certification schemes have limitations in determining the sustainability of CRM supply chains and in their production and processing. The ECRMA describes that these certification schemes have the

potential to create confusion regarding the authenticity of the claims made about the sustainability of CRM supply chains in which these enterprises operate.

5.1.3. Sociotechnical imaginary of the twin transition

In this study we identify the STI disseminated by the ECRMA as the attainment of a twin transition fuelled by CRMs. This STI is promoted by the EC and the EU. The identification of how the problem of CRM supply chains is represented to be within the ECRMA, can allow us to understand the specific particularities of factors that need to be realised in order to attain such a future. The specific factors of the envisioned future of a twin transition were identified from the problem representation. More factors and particularities of the envisioned future will be elaborated upon from assumption identification in the next section (5.2.) in relation to the second research question. As the problem representation of CRM supply chains state the challenges that the EU needs to correct to attain a twin transition. This is how the following factors that are a part of the STI were identified.

The envisioned future is seen as one in which the EU has eliminated any structural import dependencies of CRMs and therefore does not rely on China or for that matter any third countries for imports. The EU therefore accomplishes a successful CRM supply chain diversification plan and secures a strong position within the global supply chains of CRMs. Furthermore, by imposing monitoring of CRM supply chain risks it will be able to anticipate any supply chain disruptions and therefore will be able to manage its internal market accordingly to ensure that the Union's market stays stable and is resistant to shocks.

The specific social and environmental aspects of the twin transition are seen to encompass specific mitigation processes that will ensure a high level of environmental and social protection of any repercussions that CRMs, their extraction, and processing might result in. In addition, the twin transition attainment views that the EU will be able to promote sustainable sourcing of CRMs. Additionally it aims for both public and private corporations to advance sound environmental and social actions through certification schemes that will be able to promote a higher level of transparency of CRM supply chains (COM 2023/160).

5.2. The assumptions that underlie the problematisation of CRM supply chains

The problem representations of CRM supply chains discussed in the previous section contain underlying assumptions which are implied within the ECRMA. These assumptions are essential to understand the limitations of the problem representation in regards to silences and problem simplification. Therefore, this section investigates the basis of these assumptions to lay out the groundwork for section 5.3 in which we identify the silences and limitations of the problem representation of CRM supply chains. This section also highlights the STIs that are presumed and disseminated through the ECRMA. With this in mind, section 5.2., seeks to identify the assumptions of the desired future in which CRM supply chains are seen as essential to attain a twin transition. Thus, this section contributes to answering the question: What are the silences of this problematisation in regards to the social, political and environmental implications of Critical Raw Material supply chains?

5.2.1. Vulnerable supply chains and import dependency

Considering the problem representation of vulnerable supply chains disrupting the internal market and deterring the attainment of a green and digital future, this problematization assumes that a sustainable supply of CRMs is decisive for the EU's strategic interests and economic prosperity. CRMs are perceived as the ultimate catalyst in achieving a twin transition. As demonstrated in the previous section, the ECRMA states that: " [...] without a secure supply of critical raw materials, the Union will not be able to meet its objectives for a green and digital future" (COM/2023/160, final, p.1). This takes for granted that a stable supply of CRMs is decisive to secure a twin transition. The sociotechnical imaginary that the ECRMA promotes can thus be identified as one that envisions the twin transition as the desired future, in which the ECRMA also acknowledges the integral role that CRM supply chains play in the realisation of this kind of future transition. The commonalities in these assumptions highlight the overarching assumption that the sustainable social and technological pathway that the EU is aiming to attain, should be seen as the best option.

The problem representation analysed in section 5.1.1. includes structural dependencies on a small number of third countries. Resource rich states can use their access to CRMs as a leveraging tool. This can increase resource competition and with it a rise in demand. These problematisations share certain similarities in terms of what assumptions are made. There is an assumption that the demand for CRMs will continue to intensify and that this intensification will further accelerate resource competition. Additionally, by creating new partnerships, the ECRMA quotes: "[...] to diversify sources of raw materials supply by further integrating the EU's raw materials value chains with those of resource-rich third countries […]" (COM/2023/160, final, p.2). Therefore, by diversifying its supply of CRMs, the ECRMA assumes that the EU can mitigate the potential disruption stemming from accelerated resource competition, demand and vulnerable supply chains. Given this, the ECRMA further assumes that the cooperation of third party countries and stakeholders along the supply chain will assist in creating sustainable supply chains of CRMs for the EU. Finally, considering the growing geopolitical significance of CRMs, the problem representation of the EU's current important dependency assumes the necessity of strengthening the EU position within the global supply chain of CRMs. This therefore points to the STIs in which the EU has to establish a secure position within CRM global supply chains. This is therefore envisioned to be attained through partnering with third party countries that are considered as allies as well as resource rich.

China is referred to multiple times within the ECRMA, however it is also indirectly referred to when addressing the opposing relationships to countries that are seen as allies (ibid, pp. 1, 63) There exist assumptions that the EU will be able to stop its import dependency from China and therefore that it will be able to secure a stable procurement of CRM supply chains elsewhere with countries that are seen as more strategically aligned with EU's objectives and interests. In light of Bacchi's argument that policies are indirectly signifying the necessity of remedying something. The EU's problematisation in regards to (that above) highlights how the EU's desired future of a twin transition is not riddled with structural dependencies, in this case that the EU's imports of CRMs are not dependent on China or other countries.

5.2.2. Social and environmental implications

The social and environmental assumptions identified below entail ambitious assumptions in terms of mitigating the social and environmental implications of CRM supply chains, therefore

the assumptions will be scrutinised and elaborated upon in section 5.3.2. highlighting what the ECRMA does not problematise, takes for granted and simplifies.

Within the ECRMA there are several assumptions on the basis of which the policies, legislations and directives referenced in the proposal can adequately mitigate and enforce the protection of both environmental and social repercussions within the supply chain of CRMs. Another assumption is that the legislative policies, such as the Conflict Minerals Regulation (2017/821), Directive on Environmental Impact Assessment (2011/92) and Directive of the European Parliament and of the Council on water policy (2000/60), mentioned previously, consistent with the ECRMA will be sufficient in ensuring that the various stakeholders within the supply chain will comply with the EU's policies. Similarly, there is an assumption that across CRM supply chains the EU can promote and integrate ethical actions that could address human rights including labour conditions. It can be seen that the EU is promoting a certain type of STI which envisions that socio-environmental protection and further industrialisation can be reconciled and thus can support one another.

Another assumption that the ECRMA makes is that the EU can ensure the free movement of CRMs within its single market and at the same time safeguarding the environment (COM/2023/160, final, p. 2, 4, 13,). This is thought to be done by improving CRM circularity and overall sustainability. This assumption presumes that CRM circularity can be improved with new technological innovations in order to prolong CRM life span and increase their recyclability.

Moreover it can be seen that the ECRMA assumes that the social and environmental risks that are associated with both the extraction and processing of CRMs lie beyond the EUs geographical borders and thus take place elsewhere. This assumption also holds that CRM extraction will increase extensively, however the EU will not be impacted by such upscale as the Union imports the majority of its CRMs.

5.3. Silences within the ECRMA problem representation of CRM supply chains

The silences and the limitations that are identified in this section stem from the problem representation of CRM supply chains, they are also based on the assumptions made within the problem representation. Additionally, in order to identify the silences in regards to the political, social and environmental implications of CRM supply chains, relevant literature within the discourse of CRM supply chains is examined. This literature review provides a comprehensive understanding of what implications are discussed within the thematic discourse, the findings of which pinpoint silences within the ECRMA and potential problem simplifications as to how the problem is represented. Therefore the silences in this section highlight the shortcomings and simplifications as to how the CRM supply chains are represented within the ECRMA, and with it the imperfections and weaknesses of the created STI. The aim of this section seeks to provide answers to our second research question: What are the silences of this problematisation in regards to the social, political and environmental implications of Critical Raw Material supply chains?

5.3.1. Vulnerable supply chains and import dependency

By examining the problem representation of vulnerable supply chains and import dependencies within the ECRMA, it is notable that certain risks and concerns are not being mentioned, or problematised for that matter. Therefore, there exist certain limitations as to how the problem is represented to be in regards to the political implications of supply chains of CRMs.

The ECRMA does not explicitly discuss the fact that CRMs are finite. The very fact that CRMs are not endless (Martins and Castro, 2020 p. 417) puts into question the sustainability of the objectives and adequacy of the ECRMA considering its objective: “[...] to ensure the EU’s secure access to critical raw materials, while incentivising the development of sustainable supply sources" (COM/2023/160, final, p.60) This may be problematic considering the findings in section 5.2.1 where we discussed how the ECRMA assumes that CRMs are fundamental to the EU’s internal market as well as achieving its environmental objectives. By not acknowledging

that CRMs are finite, the ECRMA may arguably only present a short term solution of the EU's internal market and put into question the feasibility of the EU's environmental objectives fuelled by CRMs. Furthermore, this kind of action plan for reaching a desired future of a twin transition puts the actual development of EU's countries at risk (Martins and Castro, 2020 p. 417)

Additionally, there are numerous factors that may influence the instability and vulnerability of CRM supply chains which are not addressed in the ECRMA. Several geographic areas with high concentrations of CRMs suffer from political instability that can further exacerbate the vulnerability of CRM supply chains (Brown, 2018, pp. 207-209). Such instability may result in MNCs being reluctant to invest in mining operations, political turmoil may also cause temporal interruptions in CRM extraction, both of which contribute to supply chains of CRMs being vulnerable (ibid). There are other unproblematised factors of CRM supply chain vulnerability and diversification. Amongst these, the sustainability of supplies can be identified in which the diversity of minerals is restricted by geological occurrence (Brown, 2018, pp. 214-215). This means that certain CRM can only be found in very particular geological areas. Furthermore, the ECRMA does not address that CRM supply chain diversification may not be possible in regards to certain CRM due to them being geologically bound to specific areas. To contextualise, the case of rare earth elements (REEs), which are seen as CRMs by the EU can be brought to light. China currently dominates the global world market as the majority of REE can be found within the country's geographical borders. It currently supplies 100 percent of heavy REEs and 85 percent of light REEs to the EU (Grohol et al. 2023, p. 10). REEs are crucial for low-carbon and renewable energy technologies as they are used in electric vehicles, generators, wind turbines, semiconductors amongst others (Ferreira and Critelli, 2022, p.63). Similar cases can be made about other CRMs, yet nonetheless this highlights the central flaw in CRM supply chain diversification plan - that while this may be possible to some extent, it puts into question whether diversification partners can secure a sufficient amount of CRMs in light of the rapidly growing demand.

Another indirect silence, in terms of the limited nuance in a conceptualisation of a problem relates to the simplification of the implications that the growing global competition of CRMs may have on geopolitical tensions between geographic clusters. The ECRMA briefly mentions how: "[...] the risk of supply disruptions is increasing against the background of rising geopolitical tensions and resource competition" (COM/2023/160, final, p.1). The ECRMA does

not address the formation of mineral alliances such as the European Raw Materials Alliance (ERMA) or the Minerals Security Partnership (MSP) consisting of EU member states such as Sweden, France and Germany, but also other states including the UK and the US. As discussed in section 2.1.3 , scholars such as Dou (et al., 2023, p.6) refer to these mineral alliances as a form of regionalisation that may further intensify tensions between the geographic clusters. In light of Dou's (ibid) findings, these alliances that several EU countries are a part of could intensify geopolitical tensions, such tensions are presented as a factor that contribute to supply disruptions. Therefore, individual member states' pursuit of sustainable supply chains through participation in mineral alliances could exacerbate the growing geopolitical tensions even further while also contributing to the damaging of supply chain stability.

5.3.2. Social and environmental implications

The ECRMA acknowledges the existing potential of environmental and social repercussions, while the ECRMA states that this can be mitigated through existing policies and their legislative acts which align with the proposal the question still arises - is that actually the case? By taking a closer look at what each directive indicated in the proposal addresses, it can be understood there are no regulations that cover all environmental and social impacts within CRM supply chains. This can be highlighted through the Conflict Minerals Regulation (2017/821) mentioned in section 5.1.2.. This regulation requires companies within the EU to ensure that the import of 3TG minerals (tin, tungsten, tantalum and gold), also known as 'conflict minerals', are responsibly sourced. This requirement is in place to ensure that the minerals do not come from high-conflict areas that could support armed groups or criminals (European Commission [b], n.d.). This EU directive only covers three strategic minerals (gold is not on the CRM list), whilst the list of CRMs includes 34 minerals as recognised by the EU in the proposal. Furthermore, this reflects that the ECRMA does not put forward clear guidelines regarding supply chain management, meaning that there are no clear governing mechanisms in place that can enforce sustainable and responsible sourcing throughout the whole supply chain.

Similar silences and limitations apply to the other directives mentioned in the ECRMA. The Environmental Impact Assessment (2011/92) requires public and private projects, that relate to construction and extraction of mineral resources, to carry out an assessment of environmental

effects before carrying out a project. As this directive only applies to EU member states, companies that are based outside of the EU are thus not required to comply with such impact assessments prior to project implementation.

A corresponding argument can be made about the Directive of the European Parliament and of the Council on water policy (2000/60). The aim of this directive is to put in place a framework for: "[…] the protection of inland surface waters, transitional waters, coastal waters and groundwater" which can ensure the prevention and mitigation of water deterioration in said water categories (Directive 2000/60). However, once again as this is an EU directive, this applies only to the member states of the EU. As the EU imports the majority of its CRMs water deterioration is not affected in the EU but rather in third party countries where the extraction and processing takes place. Environmental consequences in regards to water pollution amongst other associated impacts that arise with water pollution such as soil deterioration, air contamination, biodiversity degradation can be seen in Chile (Beales et al, p.21). Chile is one of the main EU's supplier of Lithium (Grohol et al. 2023, p. 10) and as lithium extraction requires immense amounts of water it has drained 65 percent of the water reserves in concentrated regions within the country and polluted remaining water streams used both by humans and livestock (Beales et al, p.21).

5.4. STIs exposure of silences

The overall discoveries in the analysis showcase that the desired future of a twin transition in which CRM supply chains are the key, have contradictions, limitations and pose questions about the 'desirability' of the kind of future the ECRMA. The theoretical framework of STIs call to attention that given the deep rooted political salience of STIs like the desired attainment of a twin transition produced and disseminated by the EC and as an extension the EU, there exists a certain kind of inevitability off risks as well as instabilities that are associated with the realisation of a 'desired' future (Janosoff et. al., 2007, p. 1). These risks and instabilities have been highlighted through our analysis and from this analysis it is evident that the silences within the questionably sustainable securement of CRM supply chains for the EU are not deliberated upon. We have identified that many limitations, silences and unproblematised areas within the problem representation of CRM supply chains both in the political and the social, environmental fields. All limitations, silences, simplifications and unproblematised areas can be seen as weaknesses

and shortcomings of the CRM supply chains that the ECRMA sets out for the current plan to attain the envisioned twin transition.

6. Conclusion

The main objectives of this thesis were to explore the problem representation of critical raw material supply chains within the ECRMA in order to identify the silences in regards to the political, social and environmental implications that supply chains can result in. In order to investigate the problem representation and its silences, we adapted three key questions of Bacchi's (2009) 'What the problem represented to be' approach to systematically scrutinise the problem representation of CRM supply chains within the ECRMA. Furthermore, the Sociotechnical Imaginary framework by Janasoff and Kim (2015) allowed us to uncover the weaknesses and the shortcomings of the proposed pathway to attain a twin transition.

The analysis consistently discussed two categories of implications. Vulnerable supply chains and import dependency which encompasses the political implications and subsequently, the social and environmental implications were discussed collectively. Starting with the political, we identified four main problem representations: vulnerable supply chains disrupting the EU's single market; structural dependencies exacerbating vulnerabilities; the increasing global demand and strategic value of CRMs has resulted in numerous states enforcing protectionist policies; finally, that certain EU member states do not have adequate measures to monitor CRM supply chain risks. The two identified problem representations in regards to social and environmental implications are: that CRM supply chains can have social and environmental impacts; that certification schemes have limitations for providing accurate authenticity insurance about said sustainability claims.

The problem representation in the ECRMA allowed us to highlight limitations, unaddressed risks and silences. For our category of vulnerable supply chains and important dependency, we identified that: CRM supplies are not explicitly declared as finite; the influence that political instability in CRM rich countries has on supply chains is not addressed; the challenges in diversifying imports of CRMs are simplified; the potentiality that EU member states involvement in mineral alliances can intensify resource competition that ultimately may perpetuate vulnerable supply chains is not considered. For the silences in regards to the social and environmental implications, we have identified that ECRMA does not address and therefore

cannot mitigate all social and environmental impacts that take place either as a direct or indirect result of CRM supply chains; that most environmental and social consequences of CRM extraction and processing take place outside of the EU therefore the sustainability of CRM supply chains cannot be ensured outside of EUs borders.

Whilst we acknowledge the importance of sustainable supply chains of CRMs for the attainment of the twin transition, it is of utmost importance to address the silences highlighted in this thesis in order to ensure that the pathway to a twin transition is actually politically, socially, and environmentally sustainable.

6.1. Avenues for future research

Considering that the European Critical Raw Materials Act is currently a proposal, the final document, after it has been ratified, may provide slightly different problem representations of CRM supply chains as well as silences in regards to the political, social and environmental impact of these supply chains. Therefore building upon this research and conducting a critical analysis on the ratified ECRMA could provide further beneficial findings. Furthermore, altering the scope to focus on the problematisation of CRM supply chains of other strategic sectors such as defence and aerospace could also illuminate additional silences of the implications of CRM supply chains in the context of the aforementioned sectors. This thesis investigated the political, social and environmental implications of supply chains, by delimiting the thematic focus to one of the aforementioned fields could allow for a detailed examination. On a final note, the topic of CRM supply chains of the European Union opens up a variety of cross sectional and longitudinal studies that could examine the sustainability throughout the entirety of the supply chain. Further investigations along the supply chain could shed light on more specific political, social and environmental repercussions.

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