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Shaping Global Production Networks through Stakeholder
Narratives: Deep Sea Mining in Pacific Island Nations

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Nicole Belle Weinkauff

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Mag. (FH) Erika Faigen MSc PhD

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Abstract

This thesis investigates how stakeholder narratives surrounding deep sea mining (DSM) shape the formation, stability, and restructuring of global production networks in critical minerals. Drawing on Coe & Yeung's (2015) GPN 2.0 framework, the study analyzes how narratives interact with dynamic drivers, risk perceptions, and modes of strategic coupling to influence DSM's contested emergence. The research draws on a multi-method approach, including literature and policy review, semi-structured interviews, and case studies of Papua New Guinea and Nauru, focusing on the firms Nautilus Minerals and The Metals Company, respectively.

The analysis identified four narrative positions: DSM as superior to terrestrial mining, DSM as an unsustainable new frontier, pragmatic views that frame it as one element in diversified supply strategies, and indigenous perspectives emphasizing sovereignty and justice. These narratives legitimize strategies and shape risk perceptions, but they also reveal the structural vulnerabilities of DSM firms as specialized suppliers lacking the power of lead firms.

The cases highlight contrasting outcomes. Nautilus Minerals in Papua New Guinea collapsed after investor withdrawal, showing how divestment can rupture network linkages and impose long-term liabilities on sponsor states. By contrast, The Metals Company in Nauru has sustained momentum through narrative framing and regulatory bargaining, yet remains exposed to similar financial, political, and reputational risks.

Overall, the findings suggest that DSM is unlikely to replace terrestrial mining, but may emerge as an additional extractive frontier that reconfigures network dependences. While narratives open or constrain entry points into global production networks, structural asymmetries in capital, power, and legitimacy continue to limit development benefits for small island states.

Zusammenfassung¹

Diese Arbeit untersucht, wie die Narrative der Stakeholder rund um den Tiefseebergbau (DSM) die Entstehung, Stabilität und Umstrukturierung globaler Produktionsnetzwerke für kritische Mineralien beeinflussen. Auf Grundlage des GPN 2.0-Rahmen von Coe & Yeung (2015) analysiert die Studie, wie Narrative mit unterschiedlichen Dynamiken, Risikowahrnehmungen und Formen strategischer Kopplung interagieren und so die umstrittene Entstehung des DSM beeinflussen. Die Forschung stützt sich auf einen multimethodischen Ansatz, der Literatur- und Politikrecherchen, halbstrukturierte Interviews und Fallstudien zu Papua-Neuguinea und Nauru umfasst, wobei der Schwerpunkt jeweils auf den Unternehmen Nautilus Minerals und The Metals Company liegt.

Die Analyse identifizierte vier narrative Positionen: DSM als dem terrestrischen Bergbau überlegen, DSM als eine nicht nachhaltige Ressourcengrenze (frontier), pragmatische Ansichten, die es als ein Element diversifizierter Versorgungsstrategien betrachten, und indigene Perspektiven, die Souveränität und Gerechtigkeit betonen. Diese Narrative legitimieren Strategien und prägen die Risikowahrnehmung, aber sie offenbaren auch die strukturellen Schwächen von DSM-Unternehmen als spezialisierte Zulieferer, denen die Macht führender Unternehmen fehlt.

Die Fallstudien zeigen gegensätzliche Ergebnisse. Nautilus Minerals in Papua-Neuguinea brach nach dem Rückzug der Investoren zusammen und zeigte, wie Desinvestitionen Netzwerkverbindungen zerstören und den Sponsorstaaten langfristige Verbindlichkeiten auferlegen können. Im Gegensatz dazu hat The Metals Company in Nauru durch narrative Rahmenbedingungen und regulatorische Verhandlungen seine Dynamik aufrechterhalten, ist jedoch weiterhin ähnlichen finanziellen, politischen und Reputationsrisiken ausgesetzt.

Insgesamt deuten die Ergebnisse darauf hin, dass DSM den terrestrischen Bergbau wahrscheinlich nicht ersetzen wird, sondern sich als zusätzliche Rohstoffgewinnungsfront entwickeln könnte, die die Netzwerkabhängigkeiten neu konfiguriert. Während Narrative den Zugang zu globalen Produktionsnetzwerken öffnen oder einschränken, begrenzen strukturelle Asymmetrien in Bezug auf Kapital, Macht und Legitimität weiterhin die Entwicklungsvorteile für kleine Inselstaaten.

¹ Translated from English to German using AI (Übersetzt mit DeepL.com kostenlose Version)

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1. Introduction

In 1875, the voyage of the HMS Challenger marked the first known discovery of deep sea minerals (Natural History Museum, n.d.). Since then, the idea of extracting these minerals for commercial use developed into a potential industry. Over the last decade, nations have been working to lower their carbon emissions and transform their energy systems to more reliable and sustainable means. Linking these two activities is the need for critical energy transition minerals to meet these sustainability targets and energy security goals (Vivoda, 2024).

The deep sea claims three main seabed mineral resources of capitalistic interest. These are cobalt-rich crusts, polymetallic nodules, and seafloor massive sulfides (Thompson et al., 2018). Almost all attention in the sphere currently is on polymetallic nodules; potato sized rocks that form on the sediment surface (4000-6000m) of the deep sea, as these are the most feasible to access and extract with current technological developments. These nodules have commercial potential due to their concentrations of metals, including nickel (1.23-1.5%), cobalt (0.2-1.5%), manganese (27-30%), and copper (1-1.4%) (Kang & Liu, 2021).

The most prominent geographical area explored for retrieval of the nodules lies in the middle of the Pacific Ocean, in the Clarion-Clipperton Zone (CCZ). The CCZ is part of, or borders, many Pacific island national jurisdictions. The International Seabed Authority (2022) estimates that the CCZ holds reserves of over 21 billion tons of polymetallic nodules. Small scale trials to mine the nodules have found that recolonization of disturbed seafloor areas would take decades, or potentially longer (Thompson et al., 2018). The estimated impact of mining the CCZ is outlined below in Figure 1, which compares the spatial scale of these impacts to familiar geographic landmarks.

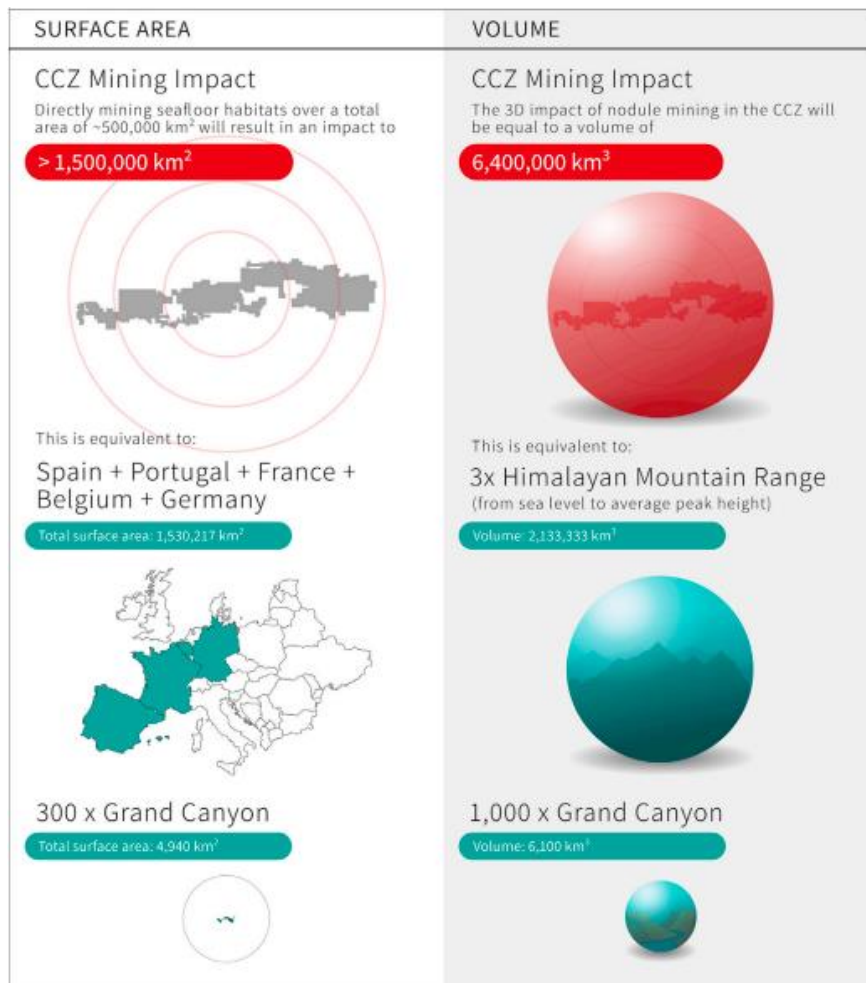


Figure 1: Comparison of the spatial scales of impacts from DSM in the CCZ with well-known features (Amon et al., 2022, p. 222)

As the technological advances in energy use and storage began to commercialize, the demand for these critical energy transition minerals started to soar above and beyond the current supply from terrestrial mines. This paved the way for regions to look further into more diverse and untapped ways of obtaining these minerals, including through deep sea mining (DSM). An overview of the timeline as DSM has developed since that first HMS Challenger mission is outlined below in Figure 2.

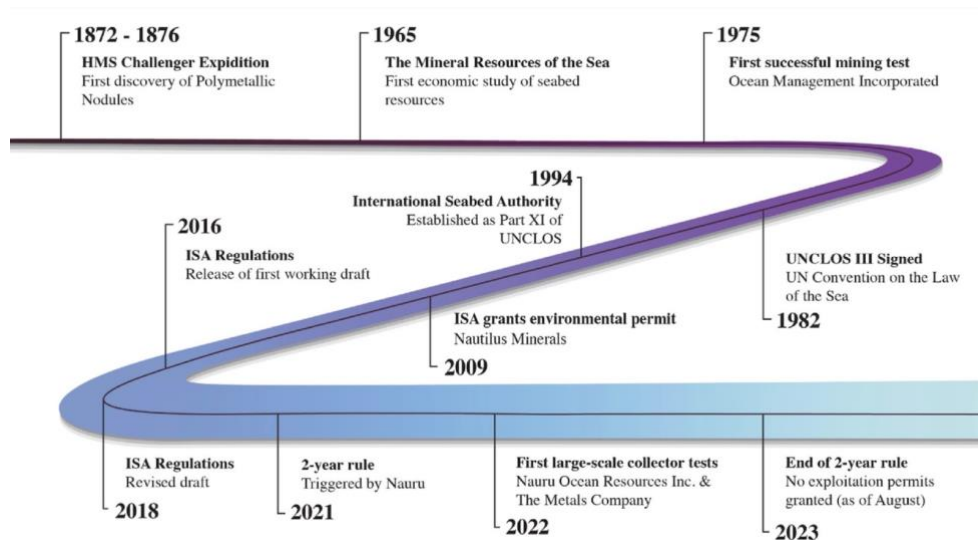


Figure 2: Timeline of the development of deep-sea mining (Deberdt & James, 2024, p.4)

DSM's emergence as a new specialized supplier within critical minerals supply chains is described as an "extremely diverse industry with a huge range of issues and political actors" (Childs, 2019, p. 119). The new form of extraction is highly contested, and the heart of the debate seems to be "the struggle to reconcile economic exploitation with ecological preservation, and this debate is anticipated to escalate" (Yu et al., 2025). There is a need to find a balance between the necessity of these minerals for technologies that can help meet national and global decarbonization goals, and the negative impacts associated with mining in a critical ecosystem needed to stabilize our climate.

Scientific studies have uncovered several potential impacts, including, but not limited to these examples. Sediment plumes from equipment roaming the seafloor can introduce heavy metals that could contaminate human seafood supply and create visual and physical barriers that could prevent organism function (Matcha, 2024). The machinery would also generate a lot of underwater noise, confusing species that use sound to communicate (Matcha, 2024). DSM is often posed as a less emissions intensive form of extraction by its supporters, yet some research shows that DSM may not reduce CO₂ emissions as expected, because it can cause damage to ocean microbes that absorb about one third of CO₂ generated on land (Farran, 2022). Additionally, a study predicts excessive daily discharge from mining ships (Hylton, 2020). With all of these examples, and that the deep sea has been critically understudied to date, it is hard to reconcile the economic benefits with the environmental concerns.

Though there has been an increase in scientific research on the topic of DSM's economic potential and environmental consequences, the conflicting interests surrounding the adoption and how they affect the emergence of DSM into the critical minerals space is understudied. This is even more pronounced at the regional level, where in-depth study of actor strategy and framing has the potential to shape industry development. This Master's thesis aims to answer the research question: How do stakeholder narratives surrounding DSM influence the formation, stability, and restructuring of global production networks for critical minerals? The aim of the research is to discover how and why narratives surrounding DSM are constructed, how they gain power, and how this power connects DSM to and shapes its position within the Global Production Network (GPN) of the critical minerals (CM) industry.

Sub-questions will then be used to trace the flow of narrative influence from the global articulation of DSM, and the associated minerals, through the institutional and spatial structuring of production networks. The first guiding question is: How are stakeholder narratives around DSM constructed and mobilized within the global discourse on critical mineral supply chains and green transitions? To guide the analysis with practical framing of the governance practices and actor strategies, the second question asks: How do the cases of Papua New Guinea and Nauru illustrate the influence of stakeholder narratives on DSM governance, value capture, and socio-political embeddedness.

The following thesis begins with a comprehensive review of the chosen conceptual lens, global production networks 2.0 and its analytical tools of drivers and strategies, delving into how these will be applied to the work. Then, in Section 3, the research design and associated methods are described in detail. Following this, Section 4 completes a comprehensive mapping of stakeholders in the critical minerals GPN. From there, Section 5 provides additional global context in regards to the CM GPN, studies of other extractive frontiers, the policy landscape, and scalar linkages. Section 6 explores the two Pacific island nation case studies of Papua New Guinea and Nauru in depth, analyzing how stakeholder narratives interact with institutional contexts and shape the positioning of DSM. Section 7 then draws the two cases together, identifying shared patterns and key divergences in how narratives influence coupling, dependency, and legitimacy. Section 8 extends this analysis to discuss what these findings reveal about the configurations and evolution of the CM GPN. The thesis concludes by reflecting on the broader implications, contributions, and limitations of applying a GPN 2.0 perspective to emerging extractive industries.

2. Conceptual Background

2.1 Theoretical Origins and Evolution of Global Production Networks

In order to fully grasp GPN 2.0, the conceptual lens that will guide this thesis, it is important to first understand the emergence of GPN 1.0 in the field of economic geography. As technological advancements, and in turn, the economy, became more and more interconnected throughout history (particularly by the 1980s) a need emerged in understanding the dynamics of these intersecting systems to gain and sustain competitive advantage. In 1993, Gereffi & Korzeniewicz launched the research field of global commodity chains (GCC). Though the GCC concept is still used today, it does have several limitations, according to Coe & Yeung (2015, p. 11), including its central focus on the commodity itself rather than the actors involved, making it hard to scale up to determine wider patterns and outcomes. Gereffi et al.'s (2005) global value chain (GVC) concept was formed to deepen the understanding of governance within supply chains, yet Coe & Yeung (2015) explain that the way place-specific institutional conditions shape firm dynamics is still underplayed. Along with these two economically centered approaches, GPN 1.0 was influenced by the actor-network theory (ANT), that emphasized shaping networks through relationships (Law, 1992).

Global Production Networks (GPN 1.0) stood out by not only trying to consider the networks themselves, but also in the attempt to reveal dynamic impacts on related territories due to the interconnectedness of the networks. It is defined as an “organizational arrangement, comprising interconnected economic and non-economic actors, coordinated by a lead firm, and producing goods or services across multiple geographical locations for worldwide markets” (Coe & Yeung, 2015, p. 1). The concept looked particularly into the value, power, and embeddedness that emerge from these connected networks and their associated regional actors (Henderson et al., 2002). However, GPN 1.0 was critiqued for its lack of ability to sufficiently explain or make causal inferences in order to fully understand the analyzed global production network.

Coe & Yeung's (2015) GPN 2.0 allows for a relational view of global production networks that goes beyond structural analysis and focuses on the existence of differential power relations and authority systems within a network and their emergent effects on various actors. From there it is easier to explain causal drivers and mechanisms that lead to value capture, along with their inherent risks, culminating in regional development outcomes. Coe &

Yeung (2015) state that the core concepts of value, power, and embeddedness remain at the foundation of the concept (p. 24), but GPN 2.0 deepens this conceptualization by theorizing the causal drivers (cost-capability ratios, market development, and financial discipline) to further understand how GPNs are configured and how outcomes vary geographically.

This is key when looking back to the research question of this thesis. Causal mechanisms are crucial in order to understand what influence actor narratives towards an impending change (DSM) in a global production network (for CM) can have on the organization of the GPN as a whole. Though it should be noted that the GPN heuristic has not typically been used to analyze narrative forms directly, GPN 2.0 specifically foregrounds causal drivers and actor strategies which make it a productive lens for additionally examining how narratives operate as part of those strategies. This makes narratives analytically relevant not only as discourse, but as a means by which actors frame legitimacy, mobilize power, and pursue strategies, all mechanisms that GPN 2.0 identifies as central to the configuration of networks and their associated outcomes. This additionality is also consistent with GPN scholarship that attempts to incorporate ethical campaigning and knowledge translation as forces that shape network coordination (Hughes et al., 2018). These concepts relate closely to the consequences of DSM arguments as well. Integrating narrative analysis into this thesis enables the ability to trace how stakeholder discourses become embedded in institutional practices and thereby influence the spatial and institutional landscape of CM production networks.

2.2 Framework Operationalization

2.2.1 GPN 2.0 Actors

Coe & Yeung (2015) express that there tends to be too much emphasis on the production functions within the value chain approach, ignoring too much the complex motivations and strategies of the different interest groups and competing institutional fragments involved in global production networks. To combat this, GPN 2.0 identifies all actors that control and produce value activity. The following analysis will build on Coe & Yeung (2015)'s GPN 2.0 three groups of economic and non-economic actors: *firms, extra-firm actors, and intermediaries*.

Firms as Actors

First and foremost, a global lead firm plays a coordination and control function within the GPN through its firm-specific power and organizational capacity in exercising market control through product and market definition (Coe & Yeung, 2015). Other firms also play a role in value activity within the GPN. These include strategic partners, who provide partial or complete solutions to lead firms, industry-specific specialized suppliers, who provide supplies to lead firms and their partners, multi-industrial specialized suppliers, who maintain and provide critical supplies, generic suppliers, who facilitate the transfer of standardized and low-value products, as well as key customers that transfer the value to lead firms through final consumption. All of this and examples are outlined in Table 1 here:

Global production network actors	Role	Value activity	Examples in manufacturing	Examples in service industries
Lead firms	Coordination and control	Product and market definition	Apple and Samsung (ICT); Toyota (automobiles)	HSBC (banking); Singapore Airlines (transport)
Strategic partners	Partial or complete solutions to lead firms	Co-design and development in manufacturing or advanced services	Hon Hai or Flextronics (ICT); ZF (automobiles)	IBM Banking (banking); Boeing or Airbus (transport)
Specialized suppliers (industry-specific)	Dedicated supplies to support lead firms and/or their partners	High-value modules, components, or products	Intel (ICT); Delphi and Denso (automobiles)	Microsoft (ICT); Fidelity or Schroders (banking); Amadeus (transport)
Specialized suppliers (multi-industrial)	Critical supplies to lead firms or partners	Cross-industrial intermediate goods or services	DHL (ICT); Panasonic Automotive (automobiles)	DHL (banking); Panasonic Avionics (transport)
Generic suppliers	Arm's length providers of supplies	Standardized and low-value products or services	Plastics in ICT and automobile manufacturing	Cleaning in banking and transport services
Key customers	Transfer of value to lead firms	Intermediate or final consumption	Other lead firms or consumers	Other lead firms or consumers

Table 1: Firms as actors in a global production network (Coe & Yeung, 2015, p. 40)

Coe & Yeung's (2015) concept outlines that a GPN must have three or more of these firm roles performed by different, independent firms. Due to the scope of this thesis, the focus will be on lead firms, strategic partners, and specialized suppliers as those with the most impact related to DSM in the GPN.

A lead firm has an asymmetric capacity to exercise corporate power, influencing the investment and decisions of other actors within the GPN in order to complete different value processes (Coe & Yeung, 2015). Global lead firms often specialize in upstream activities of R&D, as well as downstream activities like branding and marketing (Coe & Yeung, 2015). Within a GPN, firms are considered strategic partners when their relationship with global lead firms is mutually dependent. They often have firm-specific capability in offering value beyond just manufacturing production, making the relationship resemble a partnership much more closely than a generic customer-supplier transactional relationship (Coe & Yeung, 2015). Specialized suppliers fall into two categories as outlined in GPN 2.0. The first are industry-specific. Their high-value supply is dedicated to support their partner and lead firms within the same industry. For multi-industrial specialized suppliers, the goods or services tend to be intermediate, yet still critical to partners from a variety of industries (Coe & Yeung, 2015). Specialized suppliers are essential when discussing coupling points between raw materials and industry.

Extra-firm Actors

State and non-state institutions are critical actors that shape how value is organized and governed within GPNs. These can include, but are not limited to, the state itself, international organizations, labour groups, consumers, and civil society organization as outlined in Table 2 below:

Global production network actors	Role	Value activity	Areas of influence	Impact on firm activity
The state	Promotion and regulation	Ownership, industrial policies, innovations, and market rules	Capital, land, and labour markets; taxation; social and environmental concerns	Country of origin effect Different levels of state institutions Bargaining dynamics and value capture
International organizations	Global rules, agreements, and regulation	International sanctions and codes of conducts	Finance, labour, business ethics, and environment	Global
Labour groups	Firm-specific governance and extra-firm pressures	Collective bargaining	Wages and working conditions	Local, national, and international
Consumers	Buyers of final goods or services	Preferences and choices	Limited, unless through collective action	Mostly local or national
Civil society organizations	Ensuring corporate social responsibility	Lobbying and social sanctions	Ethical sourcing, gender equality, and environmental sustainability	Mix of local, national, and international

Table 2: Extra-firm actors in a global production network (Coe & Yeung, 2015, p. 47)

Again, due to scope, the later analysis will include only the most relevant extra-firm actors as it applies to DSM emergence.

The role of the state is already significantly analyzed within development literature, as many global lead firms today are state-owned enterprises or at least government-linked. However, the state as an actor and regulator of GPNs has a very different impact depending on its bureaucratic capacity and institutional legitimacy. In addition, the state as an entity is often governed at various geographical scales which can each set and enforce rules and regulations that either favor or hinder change within a GPN (Coe & Yeung, 2015). International organizations gain increasing significance as production networks become more and more intertwined across differing global jurisdictions (Coe & Yeung, 2015). Under GPN 2.0 (Coe & Yeung, 2015), civil society organizations are defined as non-state actors that have an ability to disrupt or facilitate the efficient functioning of global production networks. These can include labor groups, consumers and civil society organizations, and transnational advocacy networks. The power within civil society organizations comes from collective action where consumer preferences and views can be translated into collective pressure on particular firms and actors.

Intermediaries as Actors

As the name suggests, intermediaries of a GPN have the role of connecting multiple actors in global production networks, allowing for value activity of mutual benefit, and can be firm or extra-firm actors. Intermediaries are conceptualized into their functional role within the GPN. They are considered critical to successful operation due to their control of proprietary information enabling correct functionality within the GPN (Coe & Yeung, 2015). Examples of intermediaries include financial intermediaries, logistics providers, and intermediaries in standards, as outlined in Table 3 below:

Global production network actors	Role	Value activity	Areas of influence
Financial intermediaries	Credits, information and knowledge services	Managing financial risks and promoting new innovation and investments	Credit lines, financial advice, investment evaluations, value projections, tax strategies, etc.
Logistics providers	Connecting lead firms with their strategic partners, global suppliers, and final consumers	Efficiency, speed, and flexibility of the entire production network	Production operation, information and inventory management, and just-in-time delivery
Intermediaries in standards	Establishment, enforcement, and harmonization of protocols and codified knowledge Consultancy and information providers	Compliance, certification, and private regulation	Production (e.g. labour and environment) Consumption (e.g. quality and safety) Innovation (e.g. standardization, protocols, and interfaces)

Table 3: Intermediaries as enablers in a global production network (Coe & Yeung, 2015, p.51)

One critical intermediary when it comes to the GPN for critical minerals are standards intermediaries, who “are involved in the establishment, enforcement, and harmonization of protocols and codified knowledge and specifications in the global production of goods and services” (Coe & Yeung, 2015, p. 55). Standards intermediaries are organized by field (i.e. environmental or social/economic), form (code, label, or standard), coverage (firm, sector, or generic), key actors (businesses, NGOs, international organizations), certification process, regulatory implications, and, of course, the geographical scale (regional, national, macro-regional, or global). International standards are known to have high costs and can become a significant barrier to entry of a GPN, but are variable in their concrete realization. This is due to the variety of jurisdictions and institutional contexts the GPN might be working in (Coe & Yeung, 2015).

Overall, GPNs are constituted by actor struggle over “the construction of economic relationships, governance structures, institutional rules and norms, and discursive frames” which are “shaped by the various dynamic logics of global competition” (Coe & Yeung, 2015, p. 58). GPN 2.0 describes these configurations into two categories, strategic partnership models and lead firm-centric models. The GPN for CM can be categorized into the strategic partnership model due to the high capital intensity, state control, high concentration mid-stream, and increasing strategic partnerships downstream. As this thesis’s focus, the strategic partnership model involves a lead firm engaging with a strategic partner, crisscrossing with tangible and intangible inputs from specialized suppliers that intersect with other institutional actors.

2.2.2 GPN 2.0 Analytical Tools

Territoriality is a key concept within GPN 2.0 as it is extremely important in understanding value creation, enhancement, and retention (Coe & Yeung, 2015, p. 68). This is crucial because actors in various GPNs can be anchored in different places and regions, yet operate at multiple scales. The 2.0 version of a GPN defines *territoriality* as, “the spatial organization of global production network relations and development outcomes along with two important dimensions: the vertical dimension of global-local scales and the horizontal territorial interface” (p. 68). Within specific localities, the reconfiguration and changing governance of value activity can have diverse impacts based on the specific resource endowments, institutional settings, and growth trajectories (p. 74). This concept perfectly articulates the need to look into regional cases of DSM and how it is potentially being integrated into the GPN. Each case study’s multi-scalar linkages will be analyzed in order to show the importance of this integration into GPN outcomes.

To answer the research question, the cases will be analyzed using the GPN 2.0 *dynamic drivers* and corresponding *corporate strategies* from Coe & Yeung (2015) in order to understand network formation, coordination, and configuration within each of the case studies chosen. The first driver is *cost-capability ratio* (p. 84 - p. 94), that considers not just cost reduction in a capitalist economic view, but cost as a relative concept in combination of actor-specific capabilities. The idea is that high firm capabilities could potentially drive up costs, and firms should strive to lower this high-cost dynamic to ensure market success. When a firm exhibits a low cost-capability ratio, with high capabilities and low costs, they are considered a highly competitive industrial leader. This is due to the difficulty in achieving high value when all aspects of production take place in the home economy. A

typical cost-capability ratio for lead firms is to have high capabilities and high costs, which generally includes international production in an effort to reduce costs and get to that industrial leader ratio. Firms with low costs and declining capabilities tend to lack control in the market and could require engagement in capacity building. Finally, firms with high costs and low capability have paths of either market exit, or extensive transformation of their costs.

For suppliers, a low cost and low capability ratio means that survival is dependent on things like low wages, questionable quality, and poor working conditions. These suppliers can be easily substituted and have little power or market control. They would ideally work to improve their capabilities. On the other hand, suppliers categorized with low costs and high capabilities are seen as highly competitive and often become strategic partners of lead firms. A supplier with high costs but high capabilities can only survive if they are supplying a highly-specialized product or service, allowing for a monopolistic position in the market. In general, it is assumed that lead firms and their partners and suppliers all work independently to lower their cost-capability ratios over time (Coe & Yeung, 2015, p. 88).

Beyond the profit margins and positioning of the cost-capability ratio, *market imperative* can take a toll on firm success. This is the, “complex and negotiated outcome of the producer-consumer interface which both producers and customers are actively involved in market creation” (Coe & Yeung, 2015, p. 96). This active involvement is critical within this analysis as all economic actors within the GPN are able to create and shape the market, and their narratives are a way in which they do so. The methodology looks at market imperative in four dimensions: *reach and access*, *dominance and concentration*, *customer pressures*, and *time-to-market* (p. 95 - p. 104). Market *reach and access* can come with some reconfiguration for firms with high cost-capability ratios, and can at the consequence of those with low ratios, make the markets in ways that can allow continuous access for them. Suppliers must also take into account the competitive pressures to access markets through lead firms, as these will open doors to larger orders and better value capture. Here, extra-firm actors can be crucial in providing institutional support. Once access and reach are determined, lead firms especially will look to gain market *dominance* where they collect as much value as possible. This is the incentive for firms and their suppliers to develop or change their GPNs. *Customer pressures* must be considered across different scales. In intermediate markets, where corporate and institutional customers purchase from suppliers, market power is much higher than that of individual end consumers. However, these two forms of demand are not mutually exclusive. Within a network, the customer demands on

pricing and quality can affect the demands placed on suppliers by these firms. And these demands are known to change based on the level of maturity, i.e. a product or service becomes more widely available due to additional competition, reducing market dominance and value capture. Finally, the *time-to-market* can be crucial in market imperative when it comes to the increased initial value capture when a product is new. This can change quickly in response to extra-firm actors taking into account non-economic considerations in their purchasing decisions. The loss of this value capture can also motivate companies to address and respond to non-economic considerations in order to maintain positive market imperative.

The third and final driver is the idea of *financial discipline* (p. 104 - p. 109) where market valuation drives the choices and strategies of firms. The idea is that firms can finance their activity through capital markets instead of just through banks and financing institutions. This comes with the caveat that firms fulfill the financial objectives and terms of return on investment of shareholders. Objectively, shareholders have a number one interest, and that is higher stock prices as soon as possible, pushing firms towards short-term financial configurations of their existing operations to meet these expectations.

GPN 2.0 then uses these drivers to connect and understand strategies that corporate actors within the GPN may take (p. 129- p. 156). The first strategy outlined is internalization via *intra-firm coordination*. This strategy can help firms to navigate high risk environments. The second strategy is that of *inter-firm control*, where a firm “attempts to internalize and consolidate a high level of value activity within its highly integrated GPN” (Coe & Yeung, p. 135). This is an externalized strategy that consists of outsourcing and strong control, and does not partake in risky activities like radical and transformative innovations. The third strategy is *inter-firm partnership*, where a complete supply chain, firms, partners, and suppliers in the same GPN collaborate and co-develop together in order to compete against other groupings. Here, uncertainty is diminished, but value capture is unlikely to be evenly distributed. The final strategy within GPN 2.0 is *extra-firm bargaining*, which gives a perspective where extra-firm actors have more power in choosing how they interact with firms, which takes place as part of all of the previously mentioned strategies, where negotiation and accommodation is seen as a two-way process between actors. This bargaining is stated to achieve three outcomes; market power, proprietary rights, and social and political legitimacy.

Narratives are operationalized in this analysis as a mediating force to the drivers and strategies discussed. They shape how actors interpret competitive dynamics and inform the

strategies that they pursue. Therefore, narratives are part of the causal mechanisms through which power and legitimacy are practiced and experienced, influencing how DSM becomes positioned within the wider GPN.

2.3 Framework Limitations

All of these drivers and strategies will help to operationalize the case studies within this research. They will guide toward the why and how DSM emerging into a fully commercialized industry as a supplier of global critical minerals could influence change and other dynamics within the GPN. Though GPN 2.0 is used to better understand firms as their integrated actors with behavior that is both internally and externally shaped, the concept still has its limitations. When trying to operationalize and understand something as complex as global production, there will always be the argument that, “any theory aiming to comprehensively explain and predict outcomes for entire industries, countries, regions or the global economy as a whole should be treated as highly suspect, at best” (Ponte & Sturgeon, 2013, p. 199). This concern will always be relevant, but through the example analysis done, Neilson et al. (2018) found practical utility in the GPN 2.0 model to generate contextual understandings of firm behavior, offering insights into drivers of decision-making. The main criticism they had is that the description of dynamics and risks with a high, medium, and low scale is vague. They also found the emphasis on scale and firm-level strategies to be problematic, as it can limit comparative analysis by rejecting broader categorizations.

2.4 Conceptual Contributions

This thesis will contribute to GPN research by incorporating narrative and discourse dynamics as formative components in development of new extractive networks, looking into how they extend from those in already existing extractive industries. As argued by Hudson (2008), a GPN’s socio-ecological and socio-spatial distribution is always a mixture of intended and unintended effects and attempts to ameliorate them. He emphasizes that GPNs can allow the review of implications of the repertoire of these social choices about how, where, and what to produce, exchange, and consume. In addition, Gibson & Warren (2016) outline the need for more analysis of firms in extraction and how they adapt and transform GPNs during shifting availability and regulation of material resources. This thesis aims to add to and further develop upon this research need.

3. Analytical Approach

The research design consists of a qualitative content analysis positioned in a multi-method approach consisting of literature review, policy analysis, illustrative case studies, and semi-structured interviews. Together, these methods form an integrated framework for examining the evolving role of DSM within the CM GPN. The analysis is guided by the conceptual lens of GPN 2.0 and within this overarching lens, qualitative interpretation draws on approaches situated in both the hermeneutic and content analysis traditions as outlined in Figure 3. Constructivist Grounded Theory (CGT) represents the interpretive dimension of the research, while qualitative content analysis provides a systematic framework for organizing and presenting empirical material. Integrating these traditions allows the study to link discourse, governance, and network structure ensuring coherence between theory, data analysis, and ethical presentation of empirical material.

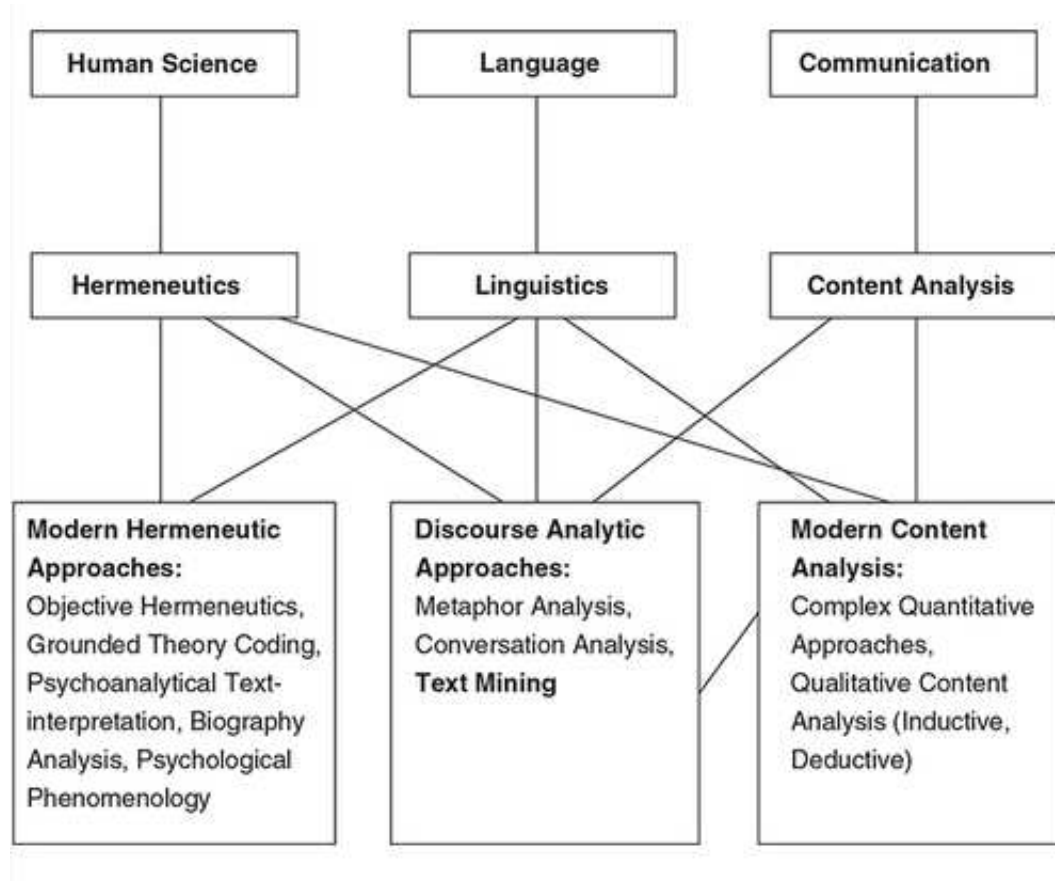


Figure 3: Approaches to Social Science Text Analysis (Mayring, 2021, p. 40)

3.1 Literature Review

The research began with a comprehensive literature review, which served as a foundation and analytical reference for the thesis, and was revisited during the research process to incorporate new insights and refine the analysis. The review was designed to map the intellectual and policy landscape in which DSM is situated, with particular attention to how the topic has been framed across disciplines and time periods.

The review process involved three steps. First, relevant academic publications were collected through database searches (Scopus and Google Scholar) using keywords such as “deep sea mining”, “critical minerals”, global production networks”, and “resource frontiers”. These keywords were chosen to capture both the thematic focus on DSM and CM, as well as the theoretical framing within GPN and frontier literature. The initial searches produced several thousand results. To manage this scope, titles and abstracts were screened to identify works with a clear empirical or conceptual focus, especially those with overlapping themes across several key words. Priority was given to peer-reviewed journal articles and highly cited conceptual papers published within the past 15 years, while older foundational works were included where relevant for conceptual background framing. During this screening, particular attention was paid to studies employing actor mapping, multi-scalar analyses, case study approaches, and reflexive or positional perspectives, as these align closely with the research question’s focus on narrative power, actor relations, and spatial configuration within the GPN. This process yielded an initial core set of approximately 80 sources for detailed review. Second, snowballing techniques were applied; references cited in key papers identified in the initial search were examined to locate additional relevant literature, ensuring more pronounced coverage of work.

The process was supplemented with policy reports, industry documents, and position papers from organizations such as the International Seabed Authority (ISA) and the International Energy Agency (IEA). These materials were included because they represent authoritative perspectives that shape policy and industrial discourse around DSM. In addition, selected media coverage was reviewed to capture how evolving public stakeholder narratives were represented and contested over time. Media sources were drawn from internationally recognized outlets (The Guardian, Reuters, BBC) and relevant industry publications to ensure credibility and balance. Together, these materials informed a review structured around three core topics of literature; (1) emergent and contested resource frontiers; (2) deep-

sea mining background and context; and (3) critical minerals value chains, networks, and markets.

The review of DSM related literature, allowed for an in-depth look into the scholarly contributions on the topic of focus up until the point of research. These contributions outline the technical, ecological, and legal dimensions of DSM, as well as the corresponding narratives used to legitimize or contest its development. As stated in the introduction, DSM has been a topic of interest since its discovery in the 1870s. Though, it is not until recently that the interest in studying and understanding deep sea minerals as a new form of extraction and input into the global critical minerals supply chain emerged. Figure 4 collates the amount of published papers referencing the key word “deep sea mining” within Scopus per year, since the first recorded input. The visual representation also poses an interesting question as to why there seems to be a spike in the 1970s, before consistently rising again in the 2000s.

The 1970s was a dynamic time involving the 1973 oil crisis exposing vulnerability in resource dependency (Bohi & Darmstadter, 1994), advances in oceanographic research, and increased government interest in non-traditional resource frontiers, such as the US beginning trial projects (Kang & Liu, 2021). During the same decade, early interest in the development of all-electric vehicles and rechargeable battery technologies began to emerge, highlighting the potential for new forms of mineral demand, particularly for battery-relevant metals (Anderman, 2004; Matulka, 2014). The principle of ‘the common heritage of mankind’ was also introduced at this time, prompting debates on benefit-sharing. All of these events postulate a greater interest in studying the topic. Throughout the 2000s, as already discussed, the renewed demand for the critical minerals found on the sea floor facilitates a rebrand of DSM as an economic opportunity to support the rise of the green economy.

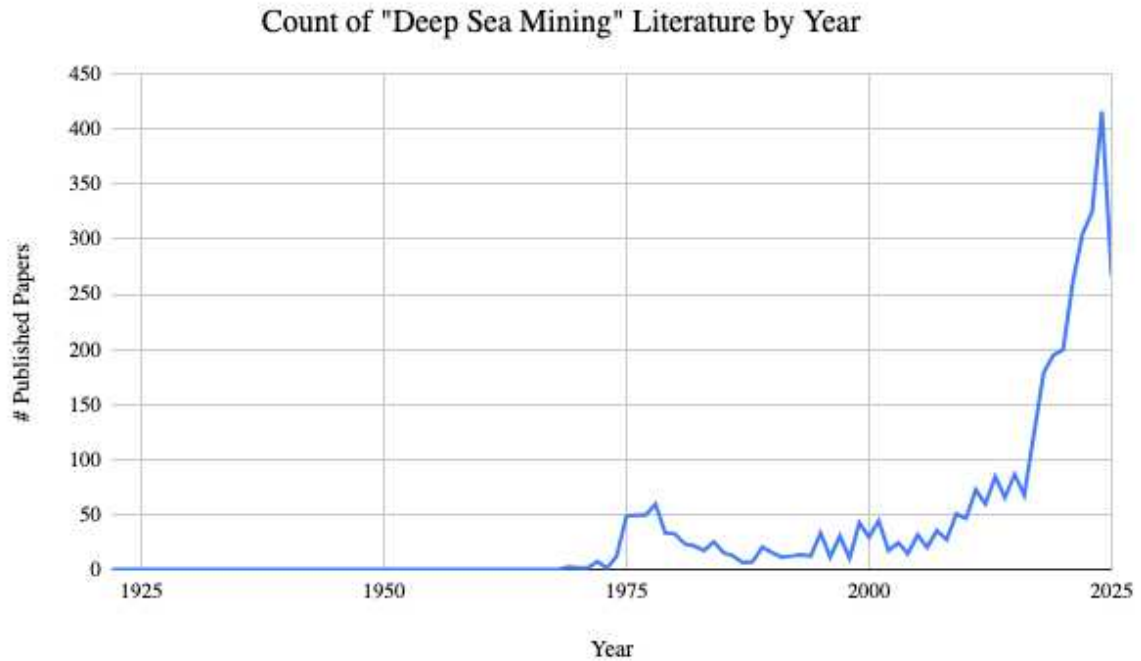


Figure 4: Count of “Deep Sea Mining” Literature by Year (Scopus, own figure)

In addition to this overview of DSM literature over time, specific papers were selected for a closer review and a more detailed understanding of key debates and conceptual framings within the field. The selection was guided by three criteria; (1) relevance to the research questions (social, political, and economic dimensions of DSM); (2) representation of diverse disciplinary perspectives (social science, economic analysis, environmental study) and (3) influence on subsequent scholarship or prominence in shaping policy and industry discourse.

For example, Carver et al. (2020) was selected for its interesting exploration into the need to further develop DSM from a social sciences perspective that takes into account social, political, and cultural relations and implications. Hallgren & Hansson (2021) was included for its look into the conflicting narratives in the green economy, sharing of DSM profits, lack of deep sea research, and the concept of leaving the minerals alone altogether. The paper called for an even further look into discussions of policy paths and regulatory processes aligning with these narratives. Sharma (2011) was chosen for its analytical view of DSM, discussing the economic, technical, and environmental issues that could hinder the development of the industry. Key themes within this literature include environmental uncertainty and limited baseline data of ecosystems and environmental impacts, the speculative nature of investment and development, and the political economy of ocean

governance. It emphasizes the uneven distribution of risk and benefit and highlights tensions that this thesis attempts to further operationalize within the following analysis.

As this thesis is from an economic geography perspective, a look into the current literature from this discipline specifically was also completed. Within economic geography, there has been limited engagement with DSM as a site where new forms of value, resource imaginaries, and spatial economic relations are being actively constructed. In 2018, John Childs advanced the field by analyzing DSM through multiple temporalities and their intersections with scale and geopolitics. And in 2022, Childs conducted a review of research that looked into the geographies of DSM, emphasizing the implications of its complex geographies. The economic side of this topic cannot be overlooked, and Folkersen et al. (2018) provide a comprehensive overview of the economic viability of DSM, outlining the research gap in economic valuation research in the deep sea that compares directly to narratives to be uncovered throughout the research.

Together, the literature review offered complementary perspectives that informed the thematic coding and framing of narratives within the study.

3.2 Policy Analysis

A key component of the research is a qualitative policy analysis, aimed at identifying regulatory gaps, conflicts, and framing across various governance levels that influence DSM's institutional development within the GPN for CM. This part of the analysis will outline international policy instruments (regional/domestic regulatory impact will be discussed as part of the case studies), with particular attention to the International Seabed Authority (ISA) as the central regulatory actor (Blanchard et al., 2023). In addition, other international bodies such as the International Energy Agency (IEA) are considered for their role in shaping global narratives and policy frameworks on CM and energy transition pathways, which indirectly inform the institutional environment in which DSM is positioned. Rather than engaging in detailed legal interpretation, the policy analysis emphasizes how these instruments are interpreted, contested, and operationalized in ways that shape actor narratives and framing.

3.3 Case Study Analysis

This stage of the methodology involves an illustrative case study analysis, building insights from the previous components to provide a situated, partial understanding of DSM

governance and contestation. This thesis looks into Pacific island nations due to their central position in geographical and political interest in the development of DSM. The Clarion-Clipperton Zone (CCZ) holds the largest known deposit of polymetallic nodules and is largely within or adjacent to Pacific island jurisdictions. Due to their constrained capabilities to harness their resource-rich waters, Pacific island nations have been the target of private DSM companies to gain sponsorship through the ISA (Aguilar, 2025). This sponsorship mechanism is examined in the subsequent analysis, as it raises broader questions regarding the ISA's mediation of environmental, social, and commercial interests. These two situations make the Pacific island nations a testbed for the emergence of DSM. The dynamics within these cases also fit well within GPN 2.0's focus on how uneven capabilities shape strategies, relationships, and value capture in an industry.

Based on the research sub-question; How do the cases of Papua New Guinea and Nauru illustrate the influence of stakeholder narratives on DSM governance, value capture, and socio-political embeddedness, the case studies will guide the analysis with practical framing of the governance practices and actor strategies. They will shed light on the motivations, narratives, and material implications of different network actors in a practical context and serve as an empirical anchor of the application of the GPN 2.0 framework.

The regional case studies of choice for this analysis are Papua New Guinea (PNG) and Nauru which were chosen for their unique but complimentary insights into the emergence of DSM in Pacific island nations. PNG represents an early and highly publicized attempt at DSM through the failed Solwara 1 project, offering insight into the consequences of weak governance, corporate overreach, and community resistance (Filer & Gabriel, 2018; Steiner, 2009). Nauru is a nation well-known for its current enablement of DSM through legal mechanisms and corporate partnerships, notably with The Metals Company (TMC), allowing for an analysis of narrative-enabled strategic coupling and anticipatory value creation (Murphy & Gard, 2025). These cases have overlapping actors and consistent local conditions (low national capability and local resentment), but with contrasting outcomes (failure versus emergence) making them ideal for analyzing how narratives operate as strategic tools within economic networks.

The cases were also selected for their personnel and institutional links that allow for continuity in tracing corporate narrative strategies across jurisdictions, showing how discursive tactics can travel and evolve. Together, the cases capture the contested terrain of DSM governance and value creation, where both resistance and restructuring are occurring.

This look into specific geographies affected by DSM developments also fills a research gap in such global discourse, which often looks holistically and not intentionally at a smaller scale.

3.4 Semi-Structured Interviews

Given the fast-paced and constantly evolving nature of DSM and CM and to further explore stakeholder perspectives and narratives around DSM and CM, the study incorporates semi-structured interviews with a diverse set of actors across the public, private, and civil society sectors. This includes representatives from governance bodies, industry actors, environmental NGOs, and advocacy groups engaged in DSM debates. This approach aligns with recent methodological reflections emphasizing the value of qualitative and interpretive methods for understanding how actors construct meaning, legitimacy, and power relations within resource governance and extractive transitions (Teixeira & Bridge, 2024). The interview process will add to the research by enabling the ability to align insights from primary data with the secondary research, strengthening the proceeding analysis and conclusions regarding DSM's role in influencing and reconfiguring the GPN.

Initial access was facilitated through a known advocate operating within the sector, with additional participants recruited based on the following coding sets and through snowball sampling. The sample size is nine interviews, allowing for in-depth exploration while maintaining analytical manageability. With participant consent, each interview was audio-recorded, transcribed, and analyzed thematically using qualitative data analysis software (MAXQDA). Coding followed Charmaz's (2017) constructivist grounded theory (CGT) and was used to identify patterns, framings, and tensions across stakeholder groups. In addition, Mayring's (2021) approach was used in managing the presentation of transcript data.

3.4.1 Interviewee Information

The nine interviews conducted from May to July of 2025 allowed for a concise look into the space. The interviews were analyzed in sets and then cross-referenced to find patterns or tensions. The first set are interviews that constituted learnings about mineral criticality, supply chains, and international input from experts working in the critical minerals field. For the second set, interviews took place with both The Metals Company and Impossible Metals, leading firms emerging in DSM. Discussions with these actors allowed an insight into the private sector's current motivations and positions. Interviews with extra-firm actors in

advocacy and economic roles helped to develop a comprehensive understanding of how the industry is currently positioned. An interview with an indigenous policy coordinator added a perspective that could not be captured through secondary sources alone. Finally, a law student was interviewed as an intermediary actor, since their contribution reflected legal expertise and knowledge production relevant to governance debates.

Coding set	Unique Identification Code (For referencing)	Organization/Focus	Actor Grouping	Interview Date	Format
CM GPN	I1	UNIDO Energy Transition Mineral Expert	International Organization	29/05/2025	In Person
	I2	UNIDO Global Alliance for Responsible and Green Minerals	International Organization	11/06/2025	Microsoft Teams
	I3	Imperial College of London Critical Minerals Supply Chain Expert	Extra-Firm (Academia)	27/06/2025	Microsoft Teams
Private Sector	I4	Impossible Metals	Firm (Specialized Supplier)	03/07/2025	Google Meet
	I5	The Metals Company	Firm (Specialized Supplier)	23/06/2025	Microsoft Teams
Anti-DSM Advocacy	I6	Sustainable Ocean Alliance Global Policy Advisor	Extra-Firm (Civil society)	24/06/2025	Microsoft Teams
	I7	Deep-Ocean Stewardship Initiative BBNJ Working Group	Extra-Firm (Civil society)	10/07/2025	Whatsapp Call
	I8	Sustainable Development Strategies Group Law Student	Intermediary (Legal/Governance)	21/07/2025	Microsoft Teams
	I9	Central Council of the Tlingit and Haida Indian Tribes Policy Coordinator	Extra-Firm (Indigenous Peoples)	08/07/2025	Microsoft Teams

Table 4: Interviewee information (own table)

3.4.2 Coding System

Interview data was analyzed using Charmaz’s (2017) constructivist grounded theory (CGT). The research question around narratives requires the ability to “move back and forth between stories and analysis” (p. 41) to create a balance while bringing human perspective to the foreground. CGT emphasizes and seeks the coexistence of multiple perspectives and offers a way to study power and inequality (p. 38 – p. 40), which is well suited in the case of contested narratives within this analysis. This framing allowed for a hybrid deductive-inductive coding system with the combined use of both inductive narrative categorization, as well as framework-driven deductive codes. The hybrid approach allowed for both operationalizing core concepts from GPN 2.0, while remaining open to themes that emerge from the narratives and positionalities of stakeholders.

Throughout the entire process, constant comparison and memo-writing took place to ensure transparency in how codes evolved throughout the analysis to remain grounded in the data. In grounded theory, analysis takes place in two phases: initial followed by focused coding.

Step 1: Initial Coding

Initial coding of interview transcripts began during the first transcription and read-through process. CGT outlines the need to engage closely with early data to identify preliminary

ideas that can be developed further in subsequent stages of coding (Charmaz, 2014, p. 114). The goal was to stick closely to the data and remain open to all possible directions it might lead. The initial codes developed and the frequency at which they were applied within all transcripts is outlined In Table 5 below:

Code	Frequency
Anti DSM	11
Pro DSM	12
Economics	32
Firms Actors	12
Extra-firm Actors	26

Table 5: MAXQDA initial coding results (own table)

In this stage, what stood out were overarching claims of position on DSM, the background information concerning viability of the industry (*Economics*), and emphasis on not only the actor groupings that the interviewees represent, but those they work closely with and discussed in their interview answers. These ground level codes allowed establishment of who is speaking, what they are saying, and what position they take.

Step 2: Focused Coding

The completed initial coding set the foundation of the analysis, but in what direction to take the path forward is determined by the focused coding. The initial codes were broken down into further nuanced codes both deductively through a GPN 2.0 lens and inductively through power dynamics and narratives. The additional set of coding did not replace the previous initial codes, but built upon them. The second set of codes developed and the frequency at which they were applied within all transcripts is outlined in Table 6 below:

Code	Frequency
Power dynamics/narratives	41
GPN 2.0 Drivers	9
Policy/Governance	34
Critical Minerals GPN	17

Table 6: MAXQDA focused coding results (own table)

The code of power dynamics/narratives evolved as a way to capture how interviewees positioned themselves in relation to DSM. Most participants expressed clear pro- or anti-DSM stances, though some, particularly critical minerals experts, articulated more nuanced perspectives that drew on arguments from both sides. It was a way to focus on the details around these discussions and answer the ‘why’ and ‘how’ of these stances. The codes of

Critical Minerals GPN and *Policy/Governance* involved a narrowing in on the greater environment surrounding the decisions and opinions discussed in the data. As seen by the number of codes included in these categories, they were significant and commonly addressed factors. Finally, the data was coded based on discussions that directly related back to the *GPN 2.0 drivers*. By combining empirical interview data with case studies, this thesis is able to apply the conceptual tools to practical contexts and thereby respond directly to the research question.

3.4.3 Presentation of Interview Material

In the analysis of this thesis, empirical material from interviews is used both in paraphrased form and through anonymized quotations. Following Charmaz's (2017) CGT, this material is not treated as objective facts, but as co-constructed accounts that help to illustrate the categories and themes developed during coding in order to form findings. Quotations and paraphrases are included selectively to exemplify patterns in the data and to give voice to the diverse perspectives of participants.

Given that this thesis is concerned with narratives and stakeholder framings of DSM, particular attention is paid to how participants articulated their experiences and positions. In this way, empirical material serves not only to substantiate the coding process but to also demonstrate how different discourses shape the governance of networks surrounding DSM.

While transcripts formed the basis of the analysis, they are not reproduced in full due to confidentiality agreements with participants. Instead, in line with Mayring's (2021) principles of qualitative content analysis, interview material is presented in the form of anonymized summaries (Appendix C) using outlined techniques such as paraphrasing, generalizing, and condensing text to reduce original material while retaining essential meaning. Selected quotes, which participants have consented to the use of, have been included to further support the analysis.

3.5 Methodological Limitations

The layered methodological approach enables a multi-scalar and multi-actor analysis of DSM's role in the critical minerals GPN. Though the research design is comprehensive for the scope of this thesis, limitations still apply. Apart from the limitations already discussed in the analytical approach, further methodological limitations are as follows.

The policy analysis was done from a discursive approach rather than through detailed legal interpretation. This could limit the conclusions about formal compliance. The semi-structured interviews are based on a small, purposefully selected sample drawn from multiple actor categories, but the limited sample size may not be fully representative of all actor views, especially from those from the case study communities. This was further exacerbated by access constraints of geographical and political barriers in the scope of this being a Master's level thesis. The study is conducted on a rapidly evolving sector during a specific time frame. The findings in this thesis only represent a snapshot of time, specifically covering the period from March to September 2025, and further developments that shift the conclusions could occur after data collection. Much of the governance in the space is shaped by the ISA, but very little of the ISA proceedings have been formally documented at a detailed level (Pickens et al., 2024) which can limit the claims made about the internal dynamics. Finally, as with all qualitative research, the researcher's positionality, background, and network access, among other factors, may have shaped the analysis.

4. Actor Mapping

Before discussing the implications of DSM and its impending emergence into the commercial world, it is necessary to first examine existing players within the GPN. The GPN for CM serves as a baseline where DSM supply would be situated once developed into a full-fledged actor category. As previously discussed, critical mineral demand is expected to grow rapidly along with the green transition, but these are only projections. Bleischwitz et al. (2018) project copper, aluminum, cement and steel consumption where saturation is reached and demand is lower than expected. Teske et al. (2016) also discuss that even with ambitious estimations, metal demand should not require seabed mining. Iceberg Research (2025), mirrors this concern stating that nickel and cobalt battery chemistries are increasingly being substituted by lithium-ion phosphate batteries, causing many terrestrial nickel mines to shut down due to weak market conditions. The claim also includes facts like land-based manganese reserves being sufficient for the next 85 years, while other metal reserves still range from 35 to 43 years of feasibility (Iceberg Research, 2025). Supply and demand is not the only motivating factor for diversifying critical mineral supplies. The nodules are also seen as a security measure in critical mineral value chains due to a geopolitical bottleneck with China at the forefront (Deberdt & James, 2024). This is cause

for concern as it can culminate in relying on limited supply chains in a politically unstable world and can limit market competition on pricing (Farran, 2022).

4.1 Firms

4.1.1 Lead Firms

Building on the conceptual framing of lead firms introduced earlier, three categories are particularly relevant to the CM GPN; (1) mining conglomerates; (2) battery manufacturers; and (3) electric vehicle (EV) makers. Mining conglomerates dominate access to raw materials and are increasingly pursuing vertical integration into refining and processing (Bridge, 2008, p. 402). Battery manufacturers exert influence over cell chemistries and technological specifications, though these standards are shaped not by firms alone but also through regulatory and standard-setting bodies working in dialogue with industry actors (Bridge & Faigen, 2022, p. 7). EV makers, meanwhile, shape both demand scale and application-driven requirements for performance and sustainability. As Bridge & Faigen (2022, p.7) demonstrate, automakers are increasingly performing lead-firm functions by structuring ties with battery producers through contracts, equity stakes, and joint ventures. Taken together, these three categories capture the differentiated but intersecting sites of power and coordination in the CM GPN.

Mining Conglomerates

Mining conglomerates occupy the upstream segment of the CM GPN where they influence supply, lobby for regulations, and invest in midstream partnerships. They are resource gatekeepers because they control reserves, refining, and trading networks. Included in this category are Glencore, one of the largest cobalt and copper traders, as well as BHP, Rio Tinto, and Vale (Leruth et al., 2022). Their lead position is evidenced through offtake agreements like the one between Glencore and Tesla (Burton & Biesheuvel, 2020) and recent large-scale investments by Rio Tinto (2024).

Battery Manufacturers

Battery manufacturers occupy a midstream position in the GPN, where they exert significant influence over material sourcing and demand dynamics through their scale and technological specifications. The world's largest battery manufacturers, including CATL, BYD, Panasonic, and Samsung SDI are headquartered in East Asia, with China playing a dominant role in both production capacity and upstream integration (Bridge & Faigen, 2022). Lead

firms exert major influence on the GPN, such as Panasonic, whose changes in battery composition specs for their Tesla partnership increase cobalt demand (Yamazaki, 2020) and Samsung SDI, whose innovations have increased demand in nickel and copper (Samsung SDI, 2025).

EV Makers

The last category of lead firms within the GPN are electric vehicle (EV) makers who lead in downstream demand for minerals, making them key actors in central orchestrations of mineral value chains. The impact here on changing market conditions is exponential, considering EV demand for one week in 2024 was greater than that of an entire year a decade before (IEA, 2025b, p. 134). This jump in EV battery demand grew by more than 25% of 2023's totals (IEA, 2025b, p. 134). Influential EV makers include Tesla, already mentioned for its extensive partnerships such as with Panasonic, Samsung SDI, and Glencore, along with Volkswagen, Ford, and Toyota (Bridge & Faigen, 2022). Some research even states that the major sector that would benefit from DSM is the automotive industry (Matcha, 2024).

4.1.2 Strategic Partners

Strategic partners within critical minerals include commodity traders and offtake partners (Trafigura) that provide financing and long-term purchase agreements, refining and processing companies (Umicore & BASF) that process raw ore into battery-grade material, engineering, procurement, and construction firms (Bechtel & Outotec-Metso) that provide equipment and infrastructure, logistics enablers (Maersk) that ensure physical continuity through transport, and financing and investments partners (IFC & BlackRock) that provide capital and risk-sharing mechanisms. This industry is unique in its need for many strategic partners due to the multitude of steps in the supply chain needed to have a fully consumable end product. As Coe et al. (2025) note, such partnerships are increasingly resourced through multi-scalar state involvement, where governments, development banks, and policy frameworks act to de-risk and enable investment in energy transition minerals. From this perspective, strategic partnerships in the CM GPN extend beyond firm-to-firm collaboration to include the public institutions and financial infrastructures that co-produce the conditions for network expansion.

4.1.3 Specialized Suppliers

One industry-specific specialized supplier example in critical minerals is Toshiba Materials that creates custom products for EV batteries through the use of manganese and copper foil (Toshiba International Corporation, 2025).

Multi-industrial specialized suppliers are actors whose outputs provide inputs to a range of sectors, in this CM case; batteries, defense, steel, and electronics. This actor category is also central to the DSM industry, which seeks to insert itself into the GPN for CM by offering polymetallic nodules as a source of multiple critical minerals. Companies such as The Metals Company (TMC) and Impossible Metals best illustrate this role. At present, no DSM company is commercially extracting minerals. Firms like TMC remain active in exploration and proof-of-concept demonstrations, while simultaneously seeking to build shareholder value and secure cash flows. Nonetheless, the strategic orientation of these companies is toward positioning themselves as future multi-industrial specialized suppliers within the CM GPN. By emphasizing their potential to provide inputs for multiple sectors, DSM firms frame their activities as the early stages of entry into the GPN, even if full-scale extraction has not yet materialized. In this sense, they occupy a role similar to junior or exploration-stage mining firms in terrestrial mining GPNs, characterized by speculative investment and the pursuit of future coupling opportunities (Nunez-Picado et al., 2022).

Understanding this attempted insertion into the GPN is central to the research and guiding questions of this thesis. Though, as discussed, the minerals in polymetallic nodules are critical to many supply chains, these firms need partnerships with specialized processing refiners to turn their ore into usable materials. With that being said, the emergence of DSM at an ambitious scale could result in the movement of these companies from specialized suppliers to strategic partners for lead firms.

4.2 *Extra-firm actors*

4.2.1 The State

The State is considered a crucial ‘gatekeeper’ role for legitimizing DSM projects found within a given country's EEZ (Childs, 2019, p. 3). In terms of ocean resources, the area between state jurisdiction and 200 nautical miles from shore is considered the outer continental shelf (OCS). States are required to enact many of the same articles in their OCS as in the Area (Matcha, 2024). In governing DSM activities in the Area, the International

Seabed Authority's capacity to enforce regulations is highly dependent on State cooperation. Regulatory roles could be required of them in the event that the State sponsors an ISA contract (sponsoring State), the State has DSM vessels registered to it (flag State), or the State has ports that will be used for docking of DSM vessels (port State) (Pickens et al., 2024). It is important to note here that there is still a dominance of developed countries in agenda setting and implementation of ocean governance. This has resulted in a "marginalization" of developing countries (Yu et al., 2025). Due to these vast differences based on geography, the role of the state will be discussed on a deeper level when addressing the specific Pacific island nation localities within the thesis case studies.

4.2.2 International Organizations

Just a few examples of independent international organizations taking a strong stance of caution on expanding extraction include World Wildlife Fund (WWF) and the Ocean Foundation. Specifically relevant for this case is their ability to develop important codes of conduct and invest time into developing frameworks of business and investment ethics. Organizations like the International Union for Conservation of Nature and Natural Resources (IUCN) have passed several resolutions and statements calling for a moratorium on DSM (IUCN, 2024) that point to a mounting resistance that could shift norms and influence national positions on the industry. The World Bank has also taken the position of a precautionary approach to DSM (World Bank, 2017) showing international finance institutions can indirectly shape development funding necessary for DSM emergence.

4.2.3 Civil Society Organizations

A prominent organization under the civil society category in the critical minerals space is the Natural Resource Governance Institute (NRGI, 2025) that supports inclusive resource governance and a just transition to sustainable economies. Many of these organizations have positions on DSM, one very formative example being GreenPeace who highlight ecological risks and also advocate for the moratorium (Greenpeace, 2025). Civil society organizations within DSM often have issues with the idea that debates within the ISA and through firm partners are centered around how to carry out mining, not on whether it should take place at all (Thompson et al., 2018). Due to the lack of transparency of the ISA, some (Ardron et al., 2018) even suggest improvements to this could be assisted by increased access to information to the public and NGOs.

4.3 Intermediaries

As noted, standards intermediaries are critical when it comes to the development of DSM. Currently, the International Organization for Standardization (ISO, 2014) creates technical and environmental management standards that are widely adopted in mineral supply chains. Also, the OECD Due Diligence Guidance for Responsible Supply Chains of Minerals serves as a de facto international standard, providing a framework for responsible sourcing. Additionally, the Initiative for Responsible Mining Assurance (IRMA, 2025) is a voluntary certification scheme that focuses on environmental and social governance in mining operations.

Industrial standards are often better enforced, and can reap major benefits for firms who become the industry standard. In order for compliance with common industrial standards to be required, certification agencies are a critical addition to the network. For critical minerals, the Responsible Minerals Initiative (RMI) is an industry-led program that provides audit standards (RMAP) for responsible sourcing (Responsible Business Alliance, 2025). Within the emerging DSM industry, no such certification agencies are developed yet. There is evidence of the International Seabed Minerals Environmental Management standards currently under development by NGOs and research consortia like the Deep Sea Conservation Coalition, pushing for independent ESG and biodiversity standards.

5. Resource Frontiers & Governance

5.1 Emergent and contested resource frontiers

This thesis builds on work that interrogates how emerging extractive frontiers are not just resource-driven, but also shaped by evolving relationships between regulation, technology, and capital. The broader literature in economic geography has addressed resource frontiers and extractive geographies, delving into how extractive regimes are analyzed as spatial projects shaped by political-economic forces (Bridge, 2009; Valdivia, 2015). More recently, GPN scholarship has begun to engage directly with the mineral and energy-transition sectors, emphasizing how states, firms, and financial actors jointly resource GPNs through multi-scalar strategies of de-risking and coordination (Coe et al., 2025). This growing engagement demonstrates that extractive frontiers are not only peripheral spaces of resource access but

also critical sites where new network configurations and forms of strategic coupling emerge. DSM has yet to be examined through these lenses.

The literature review here focused not just on geographic understanding, but also conceptualizations of the construction of opportunity and contestation by actors. A key author in this context is Gavin Bridge (2001), who explored how the nature of commodities is constructed by narratives through an examination of ‘resource triumphalism’. Particularly comparative and relevant is the rich, interdisciplinary body of work surrounding offshore extraction sectors like oil and gas that can provide parallels to strengthen the foundation and grounding of this thesis (Bridge, 2008; Bridge et al., 2013). Watts et al. (2015) built a dynamic review of how oil and gas frontiers were created based on the role of actors, infrastructure, and the state in producing extractive spaces. Kröger (2020) did some formative work on the lack of transparency in framing of new extraction under guises of sustainability, bio-economy, or the green transition that relates directly to the narratives surrounding DSM.

5.2 Critical minerals value chains, networks, and markets

Understanding the current critical minerals market as a strategic and geopolitically important framing of capitalist intent is crucial to the context of this research. The International Energy Agency’s Global Critical Minerals Outlook (2025a) projects that demand for key energy minerals will grow rapidly across all scenarios, where demand highly outranks supply. They state that to meet these exponential requirements, driven by deployment of new energy technologies, substantial investment will need to be made in new mines and refineries. Even with impending initiatives, they project copper will still be at a 30% deficit due to declining ore grades causing rising costs, paired with a slowdown in new resource discoveries (p. 7).

The existing and expected markets are heavily concentrated. For example, by 2035, the top three producing countries for nickel supply are expected to supply 85% of the market, up from 75% in 2024. In addition, Indonesia is set to see significant supply growth in both nickel and cobalt markets over the next decade (p. 97). Concentrated supply markets raise significant concerns in supply shortfall if even one supplier is disrupted. Impacts could result in not only higher prices for the raw materials themselves, but also for the technological outputs they are components of. This raises an additional risk of slower adoption of green technologies due to higher pricing. These are all key statistics and frames used by pro-DSM actors in proving the validity and necessity of the industry.

The critical minerals sourced from polymetallic nodules (cobalt, nickel, manganese, copper) are extracted as an inseparable assemblage and are governed, regulated, and marketed through overlapping global production and policy networks. As such, they constitute a single emergent entity, rather than discrete commodity chains, allowing for an integrated analysis of how DSM is being positioned within global supply strategies for critical minerals. Rather than examining DSM as a self-contained network, this research uses GPN 2.0 to investigate how competing stakeholder narratives around DSM shape its perceived legitimacy, institutional alignment, and spatial role within the evolving architecture of the global CM production network. These minerals are essential inputs in many industries, including most low-carbon technologies (batteries, wind turbines, and electric vehicles). Due to this increased demand that corresponds with overarching global and national climate targets, CM supply chains have become a major site of economic competition, industrial policy, and geopolitical maneuvering.

Other academic literature that addresses the global critical minerals market and its energy transition driver include Sen et al. (2025) who note that ongoing technological changes need to be considered as relevant demand reducers, as well as recycling to be looked at as a natural cap on demand growth. They also point out that environmental impacts will likely have a larger impact on market development through time, which is directly relevant to DSM discourse. And Calderon et al. (2024) provide a critical look at mineral demand estimates, analyzing inconsistencies in approach and results.

5.3 Governing the seabed: International Seabed Authority (ISA)

DSM, as an emerging extractive industry, is to take place within ‘The Area’ beyond any national jurisdiction, making the institutional landscape surrounding the activity complex. In section 137(2) the United Nations Convention on the Law of the Sea (UNCLOS) states that ‘All rights in the resources of the Area are vested in mankind as a whole’ and this makes the location, and the resources found within it, a part of the global commons (Farran, 2022). The Area includes approximately 54% of the ocean and is governed by the principles of common heritage of mankind (CHM) and non-appropriation. And no State is supposed to be able to claim or exercise sovereignty over any part of the Area or its resources, which are vested in mankind as a whole (Matcha, 2024).

In order to regulate any activity in the Area, most prominently DSM, the International Seabed Authority (ISA) was established as an autonomous international organization under

UNCLOS, which was adopted in 1982 and entered into force in 1994. Due to UNCLOS Article 156(2), all of the parties to UNCLOS are also member states to the ISA, amounting to 169 member states and the European Union (International Seabed Authority, 2025a). UNCLOS legally obliges the ISA to avoid “serious harm” and develop rules, regulations, and procedures (RRPs) that ensure the “effective protection of the marine environment from harmful effects” (Pickens et al., 2024). There is also a requirement to address underwater cultural heritage (UCH), which includes both tangible (shipwrecks, artefacts, human remains) and intangible (sacral and cultural values of marine environments) heritage (International Institute for Sustainable Development, 2025).

As part of this thesis, the International Seabed Authority (ISA) was analyzed in-depth for its unique power within the sphere. The ISA holds the starting lever to commercialization of DSM, as it is the entity that would approve exploitation contracts. However, this role sits in direct tension with its parallel mandate under UNCLOS to ensure protection of the marine environment, a dual responsibility that has raised concerns over conflict of interest and legitimacy (Jaeckel, 2017; Levin et al., 2020). Currently, the organization has approved 31 exploration contracts in the Pacific, Indian and Atlantic Oceans (Yu et al., 2025).

The main task of the ISA is to develop the regulations of DSM called the ‘Mining Code’ in order to define a comprehensive set of rules, regulations, and procedures (RRPs) around exploitation of minerals in the Area (Matcha, 2024). However, the ISA has encountered many roadblocks since its inception in 1994, largely due to insufficient time for discussion, divergent views amongst member states, and lack of appropriate information and inputs to progress negotiations (Pickens et al., 2024). These issues have delayed timelines for adoption of regulations and a lack of transparency has caused the ISA to lose some respect and legitimacy in the eyes of stakeholders, including member states, licensed contractors, international organizations, environmental NGOs, the scientific community, and financial actors. Though the ISA has lacked the ability to make final decisions on what full exploitation would look like, they have confirmed that no mining should occur in absence of agreed RRP.

The ISA has approved observers outside of just member states that are able to participate in deliberations, make statements or questions for the record, and even vote in cases that affect them or are within their scope of activities. Currently, the ISA hosts 28 observer states, 32 UN System organizations, and 59 NGOs as observers (International Seabed Authority, 2025b). Here, an additional discourse emerges on who is allowed in these meetings and to

add their narrative in hopes of swaying the decisions made. Critically, indigenous peoples and private sector contractors are not represented directly as observers of the ISA, creating further tensions between these relations. Private contractors participate indirectly through their sponsoring states and via submissions of data and reports. Indigenous perspectives are represented primarily through observer organizations, such as NGOs and regional advocacy networks that can either invite the communities themselves to participate alongside them at some sessions, or articulate community and cultural concerns in plenary and side-events on their behalf.

One factor of the ISA that specifically relates to value and power is that UNCLOS requires the establishment of an economic assistance fund and system of compensation from consequences of DSM emerging on existing terrestrial mining business. The idea is that there needs to be surplus value stored for the purpose of assisting a just transition for developing countries. This is due to the potential that these countries could suffer serious economic effects from a reduced price of export minerals caused by an influx of DSM minerals in the market. It is specifically aimed at preventing seabed mining from gaining a competitive advantage relative to land-based mining. An initial ISA-commissioned study found that thirteen developing states are at risk of potential adverse economic impacts as a result of this type of mining (Pickens et al., 2024). Though communities that are reliant on fish stocks for subsistence are not currently part of the debate, they could be particularly vulnerable to impacts if this form of extraction were to proceed commercially (Thompson et al., 2018).

Another form of value sharing in the hands of the ISA is the UNCLOS stipulation that resource-related activities with the Area are to be carried out for “the benefit of humankind as a whole” (International Seabed Authority, 2025a). The extent of this debate on the ISA floor has been limited to economic benefit, but many argue that the socio-economic benefits of this form of extraction may not outweigh the negative impacts (Nash et al., 2017).

For contractors applying for permits through the ISA, they have a responsibility to collect baseline environmental data of their mining site to understand and define the conditions for reporting. Because of their exclusive access to these areas and information, almost all reporting is reliant on self-verification by private companies. One example of this is Regulation 52 of the draft exploitation regulations, which places the environmental performance assessment in the hands of the company (Deberdt & James, 2024). If the economic returns are also placed exclusively in control of the private contractors, disbursement amounts and value sharing could easily be manipulated. In addition, this

distinction allows the private contractors' inputs extreme power when it comes to the development of ISA regulatory processes above that of other actors.

As stated by Yu et al. (2025), existing governance systems of the Area truly fall short of harmonizing the diverse interests of all parties involved, including political, economic, security, and ecological interests. This is where civil society organizations, with specific interests of their own, find their narrative.

5.4 International policies

The international governance of DSM is often justified in terms of the need for collective frameworks that go beyond national regulation. As exemplified by one interviewee, "It is a global issue, so you need global solutions" (I6). This reflects how industry and policy actors alike view DSM as a matter that requires coordination at the international scale, with the ISA and related institutions positioned at the center of such negotiations. Framing DSM as a global issue shapes where authority and responsibility are located, producing both opportunities and constraints. While it can legitimize coordination and open decision-making spaces for some actors, it may also concentrate authority in ways that limit others' participation. These uneven effects highlight how DSM governance emerges through interlinked but differentiated spatial interest across scales.

Beyond the ISA, it is important to examine other policies at the international level to capture the broader institutional landscape, considering how DSM is positioned in strategic policy discourse. The first is the EU Critical Raw Materials Act (CRMA) which frames CMs as strategic and essential assets and calls for diversified supply chains, explicitly stating the overdependence on foreign sources. The Act also mentioned strategic projects as critical to EU resource scarcity (European Parliament & Council, 2024). This policy acts as a demand-side driver within the GPN for CM and shows growing interest in providing institutional support for alternative CM sources. The policy also signals a legitimated space for DSM as a response to geopolitical vulnerability.

Another in-depth analysis featured is on the 2023 Agreement on the Conservation and Sustainable Use of Marine Biological Diversity of Areas Beyond National Jurisdiction. This agreement specifically looks at governance in the high seas, establishing new rules for EIAs and management tools in these areas (United Nations, 2025). For DSM projects, this agreement adds another layer of environmental oversight rules that could address issues with

self-verification by DSM contractors discussed previously. This jurisdictional overlap with the ISA shows the complex interlinkages that DSM will face once commercialized, reinforcing that DSM is not just an industrial activity, but also embedded in wider global environmental governance systems. The final organization analyzed is OECD Due Diligence Guidance for Responsible Mineral Supply Chains, which played a role in establishing international expectation for responsible sourcing with a focus on human rights, environmental protection, and conflict mitigation (OECD, 2016). Though the guidelines do not explicitly include DSM, they are widely adopted globally and the principles within are being extended to DSM discussions by various actors. Specifically, guidelines like these can be used as benchmarks in DSM debates, shaping access to downstream markets where large firms have ESG requirements and are faced with consumer and regulatory scrutiny.

5.5 Linking across scales

This thesis treats DSM as a scalar project embedded in the CM GPN. These scalar dynamics are ultimately shaped by the supranational/global scale of institutions (ISA, UNCLOS, OECD) and global lead firms previously discussed. This is outlined where decisions at the local scale (EIAs, community consent, site-level operations) reverberate at the national scale (state sponsorship, resource policy, revenue expectations) and intersect with the regional scale (Pacific island coalitions, NGOs, trade linkages). The following case studies will demonstrate how DSM and its associated local and regional narratives change the outcomes within GPN adoption.

6. Papua New Guinea & Nauru: Case Studies

This thesis takes a look at two cases within Pacific island nations, who have a unique position, and history, within the realm of DSM. This region is particularly targeted by private companies for their ability to sponsor permits in the ISA. Because these nations lack resources to undertake mining themselves, the promise of new income revenue streams is a convincing narrative to dive into the unknown of a new form of extraction. This has caused a “paradox in the Pacific”, where at the regional level, Pacific peoples’ deep connections with the ocean, understood not only as a vital source of food security and ecological balance, but also as central to their cultural identity, are widely recognized and advocated for. At the

national level, governments remain hopeful that the promising new extractive regime of DSM could alleviate some of the economic disparities they face (Farran, 2022).

The ‘No to Deep Sea Mining’ campaign released the ‘Pacific Blue Line’ statement by several Pacific regional organizations, including the Pacific Islands Association of Non-Governmental Organizations (PIANGO). This statement called for a balance between development and conservation of the ocean as well as support towards a global moratorium (Yu et al., 2025). The Pacific Network on Globalisation has also urged caution, specifically emphasizing the need for consent from Pacific communities prior to exploration beginning (Farran, 2022).

6.1 Papua New Guinea

6.1.1 Historical and Political Context

Papua New Guinea’s regulation surrounding DSM was primarily within its Mining Act of 1997 and the Environment Act of 2000. There was a gap in policy and regulation in regards to offshore mining and mineral resources specifically. Despite this, the exploration license was approved in 1997 for Nautilus, which is a company no longer in commission, to start activity in the deep sea. Early on, the process exhibited the dangers of weak environmental impact assessment (EIA) processes, as outlined by an independent NGO review of the EIA that found insufficient information, incomplete studies, inadequate risk assessments, and under-developed mitigation measures (Farran, 2022). This raised major concerns across all actors.

Upon discussion that the first commercial DSM project, Solwara 1 (Figure 5), would soon commence off the shores of Papua New Guinea (PNG), local communities, extra-firm actors, took “profound issue” with the conceptualization of DSM as a remote form of extraction. They didn’t agree with the narrative central to private firms that it has a limited temporal and spatial footprint compared to terrestrial mining (Childs, 2020). In an interview conducted by Childs (2020, p.1 20), a clan leader in the impacted area stated, “this is why this seabed mining company will be in trouble - it does not understand how us people connect to something deeper.” However, the former Minister for Mining in PNG explained their commitment to ensuring the nation’s mineral wealth was “harnessed in the most optimal and responsible way” (Chan, 2012). The government had a pro-growth argument towards DSM, despite the local backlash and its troubled history with mining.

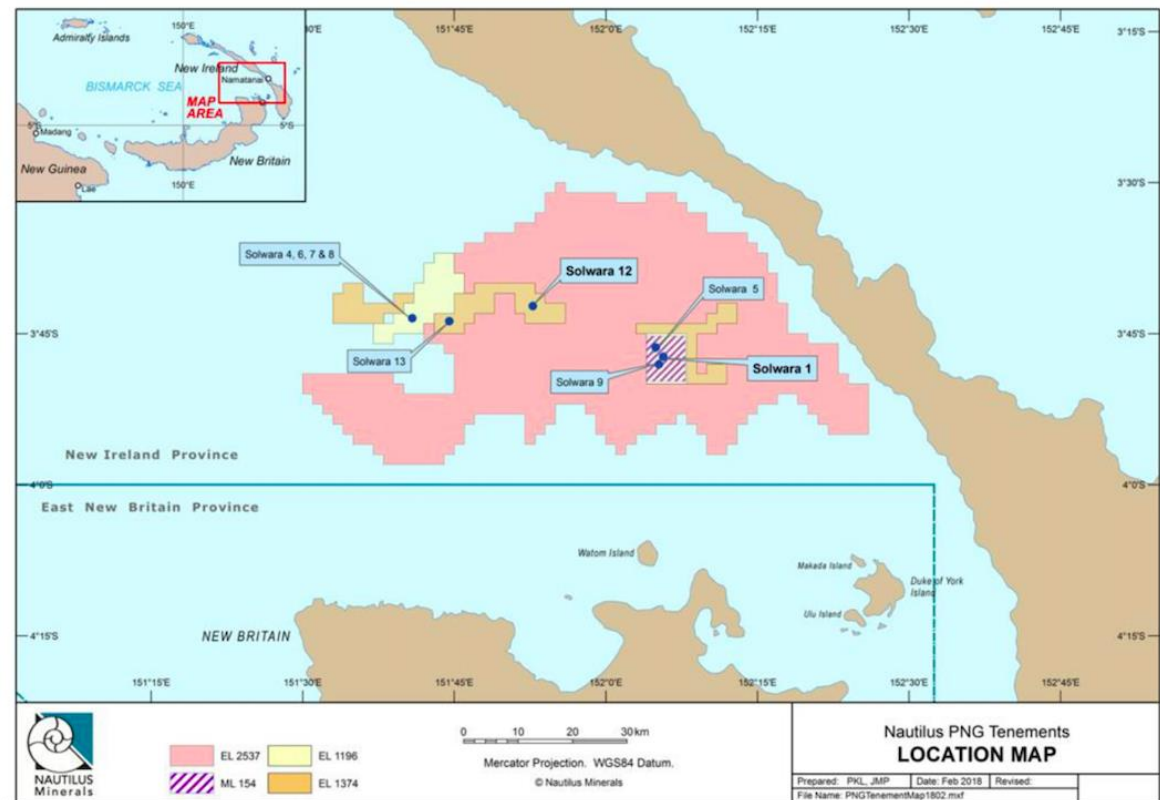


Figure 5: Solwara 1 location map (AMC Consultants Pty Ltd., 2018)

Not only were tensions rising from extra-firm actors, but Nautilus' Annual Information Forms for financial years 2015 and 2016 describe serious environmental and economic risks that rendered its Solwara 1 project a purely speculative venture. These forms describe Solwara 1 as an experiment, as both the environmental impacts and profits are complete unknowns (MiningWatch Canada, 2017). Despite this, Nautilus received the first ever exploitation DSM license in 2019. However, before any commercial extraction could begin, the company went bankrupt, leaving the PNG government in severe debt. Although large-scale mining never commenced, data collection, preparatory activities, and associated waste disposal left the marine environment damaged (Matcha, 2024). To take a look into what happened, it is first necessary to better understand the actors involved, and the GPN 2.0 dynamics and strategies at play.

6.1.2 Key Actors

Firms: In 2012, Nautilus signed a 3-year binding contract with Tongling, a state-owned Chinese copper importer. In 2015, this contract was transitioned into a take-or-pay agreement where Tongling committed to purchasing a fixed portion of Nautilus' supply (Navingo, 2012 & Navingo, 2015). Tongling, being a prominent member of a complex and

integrated global production network for these metals already, had several distinct strategic partners like China Railway Construction Corporation. As so, signing agreements with a strategic supplier like Nautilus with hopes of unusually high grades of copper was part of a larger calculated hedge on risk, spreading supply across jurisdictions and resources. They gained only if delivery actually occurred, and bore none of the risks that Nautilus held, placing them in an ideal situation.

Extra-Firm Actors: The extra-firm actors within the project were divided. PNG has an unfortunate history with mining on the island, which led to extreme mistrust in any forms of extraction. For example, Kate Murray of the Mining Justice Alliance said, “Experience with other mining projects shows us that local opposition often results in legal and/or public relations disasters for companies. In the case of Solwara 1, local opposition appears to be mounting” (MiningWatch Canada, 2017). Local communities in PNG responded by asserting their legal rights, demanding transparency, and calling for full disclosure about the potential impacts of the project (Deep Sea Mining Campaign, 2018). No matter the uproar, the industry is not dependent on direct consumption from locals, and the government continued to support DSM in hopes of economic returns and national autonomy (van Putten et al., 2023). As outlined by Childs (2019), PNG has a national history where corporations and the state are central actors within the politics of land-based resource extraction there (p. 3).

Intermediaries: The PNG government itself created the Environmental Permit (2009) and the Mining Lease (2011) without a full and public EIA in place (van Putten et al., 2023). This raises many issues when it comes to regulations and standards, as the state acted as regulator and finance intermediary where independent parties should have been involved. These EIAs, however, were commissioned to external environmental consulting firm Cardno TEC, serving as a technical standards intermediary. Once the accuracy of this EIA was questioned in the media, legitimacy was lost for the entire project, showing how impactful intermediary connection can be in GPN adoption of new entities. Overall, the network of intermediaries at play during this project failed to create sustainable legitimacy, stable finance, or community consent which are all critical for market adoption.

6.1.3 GPN 2.0 Dynamic Drivers

The first dynamic driver is cost-capability ratio, which comes from the economic ideology that cost considerations are paramount to corporate survival (Coe & Yeung, 2015). Coe &

Yeung (2015, p. 86), define the cost-capability ratio as, “the optimization process that allows firms in global production networks to achieve greater firm-specific capabilities and value capture.” When discussing in the context of DSM emergence, the driver can be framed as a balance between technological feasibility and economic cost, particularly with reference to narratives about local capabilities and reliance on foreign technology in Pacific nations. In hindsight, Nautilus Minerals in PNG constitutes a high cost, low capability ratio. The Solwara 1 project required very expensive and untested equipment and PNG itself lacked any technical expertise, experience, or supportive infrastructure, putting them in a place of high risk where they needed to co-invest high costs without any ability to manage or monitor. The imbalance triggered significant financial and operational risks, and created a narrative of dependency and vulnerability. As stated in the GPN 2.0 methodology, suppliers with a high-cost and low-capability scenario have no prospect of securing value in the GPN (Coe & Yeung, 2015). In this case, the project failed and Nautilus Minerals pulled out of the market. This analysis is “in hindsight”, because before the project failed, Nautilus Minerals’ narrative surrounding their capabilities was as a highly specialized, first-of-its-kind supplier. This pioneering approach is recycled across the industry today and noted further in the discussion section.

Along with cost and capability positioning, market imperative in terms of consumption and market access can drive firm success. As evidenced in the historical context section, there was local backlash in PNG to the emergence of this industry, but this customer pressure did not move up the chain to a point in which lead firms or institutional support was blocked. This is potentially due to the lack of relevance and mainstream understanding of the industry that is prevalent today. The narrative of economic benefit and island nation sovereignty was much more impactful when it came to investors supporting the project. Due to Nautilus securing a mining lease in PNG, distinguishing it from others who only had exploration licenses at the time (Filer & Gabriel, 2018), the company was in a fair position to secure effective time-to-market in the DSM space. If they were able to keep costs low by substantive market access aided by this early to market advantage, they might have been able to position themselves as a price-taker with a low-cost, low-capability ratio. However, in the case of DSM, production would have entered established commodity markets dominated by terrestrial mining, any pricing advantage would have remained constrained by already existing benchmark prices for these minerals. Due to the economic issues, they were never

able to prove, or provide the evidence of how future DSM could look when it comes to reach, access, or dominance in the market for CM.

Financial discipline is not only a causal driver within the GPN 2.0 framework, but also a major factor when it comes to an extractive industry with this extent of financial burden. Solwara 1, being the first of its kind, not only had high costs, but had very high uncertainty. Its listing on the Toronto Stock Exchange (TSX) facilitated early financing, allowing Nautilus to raise speculative capital for the project. Additionally, the company was able to convince the PNG government to invest roughly \$113 million with 15% equity (Cannon, 2023), selling the island a dream of economic returns and diversified portfolios.

However, their private backers were less willing to take on the risks once the project became high profile. Anglo American, a well-known mining company, divested from the company after stating that Nautilus did not match up with the company's commitments to sustainability, human rights, and environmental stewardship (Radio New Zealand, 2018). At the same time, their ship supplier canceled their contract with Nautilus and the local Community Beneficiary Area (CBA) all opposed the renewal of their license. Consequently, their stock fell by 19% (Deep Sea Mining Campaign, 2018). Even the signed offtake agreements with Tongling could not change the narrative and keep investor interest for the company. These were all major driving factors in the downfall of the project, and the company, not just the project, failed because it was no longer able to finance the equipment and other essential activities within the business model. The case shows how impactful financial discipline can be in an emerging industry. At the same time, financial dynamics cannot be separated from broader issues around environment assessments, disregard of local community backlash, and other factors discussed in shaping the project's trajectory.

6.1.4 Scalar Synthesis

At the local level, weak and contested EIAs, paired with community opposition, undermined legitimacy at the Solwara 1 project site. The PNG government nevertheless advanced permits and co-invested in the project, reflecting a disconnect between local concerns and national growth strategies. PNG's pro-DSM stance jarred the wider regional Pacific community, resulting in regional civil-society campaigns that framed DSM as a threat to oceanic identity and food security. Pacific activism was amplified through international NGO networks, scaling up local contestation into supranational governance debates at the ISA. Delays in ISA regulations and increased reputational risks raised costs and declined

Nautilus’ viability. This fed back into local ecological risks and left PNG in debt at the national scale. Overall, these scalar linkages are an example of failed strategic coupling where scalar pressures emerged from local opposition, national policies, regional advocacy, and supranational governance. These pressures garmented value capture and collapsed the project.

6.2 Nauru

6.2.1 Historical and Political Context

It is important to note that the former CEO of Nautilus founded the company DeepGreen, based in Canada. In June 2022, DeepGreen was merged with NASDAQ-listed The Metals Company (TMC), arguably the most prominent private firm in the space (Matcha, 2024). Nauru Ocean Resources Inc. (NORI) is a subsidiary of The Metals Company (TMC) and operates under the sponsorship of the Pacific island nation of Nauru at the ISA. The work done through this partnership is shown in Figure 6.

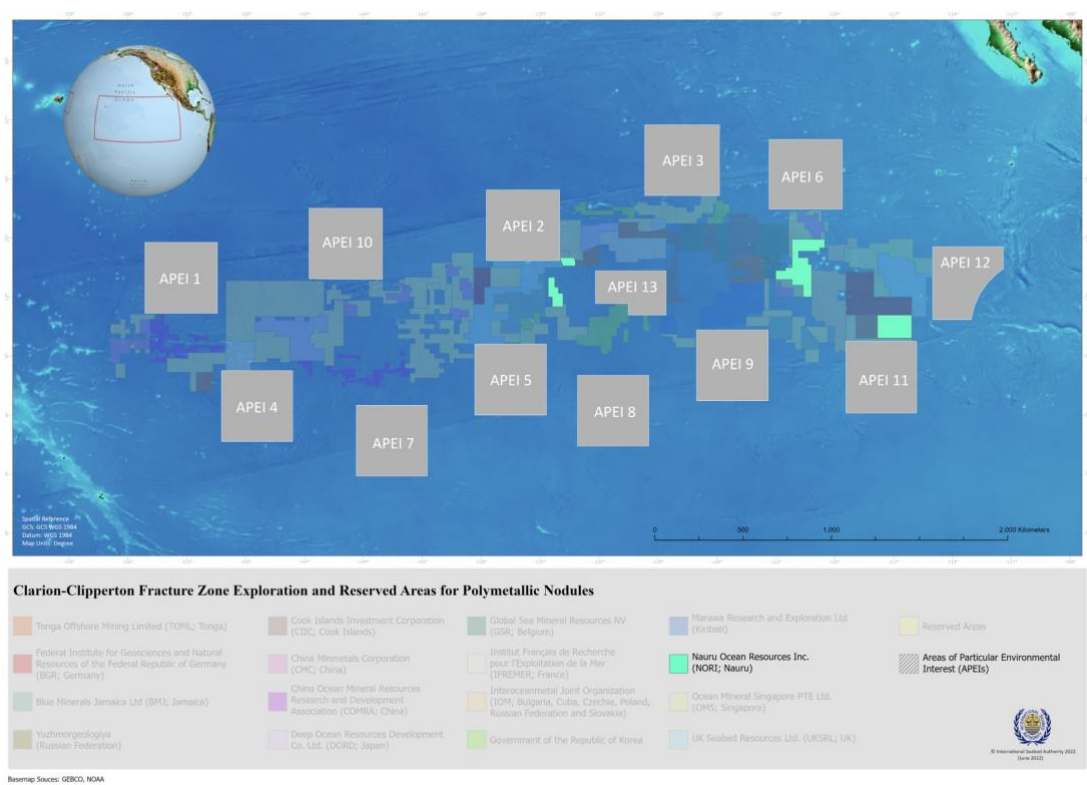


Figure 6:CCZ exploration and NORI reserved areas for polymetallic nodules (International Seabed Authority, 2025c).

Nauru frames this activity and partnership as an effort to align with the 2050 Blue Pacific Strategy for all Pacific peoples. It is communicated as an opportunity to generate economic

growth, improve livelihoods, and preserve ecosystems for future generations (Green Stock News, 2025). That being said, the narrative of Nauru's government, framing DSM as a responsible pathway to develop the blue economy, can add to the perceived legitimacy of the venture. It is worth noting that some research expresses concern that economic benefits from commercial mining for local communities may only be realized as employment opportunities and through local distribution of royalties (Thompson et al., 2018).

The most relevant project to-date for the partnership is the NORI-D Nodule Project. TMC commissioned a third-party Benchmark Lifecycle Assessment, comparing the impacts of their project with the same energy-transition metals obtained through conventional land-based production routes which reported that the TMC project performed better on all impact categories analyzed (The Metals Company, 2023b). TMC has commissioned many studies similar to this one (The Metals Company, 2024), all which seem to align with their goals and narrative, increasing legitimacy to both the public and their partners/investors. This has been brought into question by many civil society actors, including in each of the interviews with advocates within this study (I2, I6, I7, & I8).

In the PNG case, Nautilus went bankrupt, so it is important to look at the economic understanding of the TMC/Nauru initiative. Within the discourse, there is a commonly assumed concern of reporting bias in TMC's publications voiced in research as self-regulation and verification concerns (Deberdt & James, 2024) and in several interviews (I2, I6, & I8). Based on this, Iceberg Research (2025) revised some of TMC's assumptions in a more conservative manner, and found the net present value to be 111% lower than their claims (-\$721mn versus \$6.8bn). The same research body found their estimated offshore costs to be under-reported by 3.8 to 4.8 times more than claimed by their supplier, and projected costs of third-party processing to be under-reported by 57% (Iceberg Research, 2025). It will be important to dive into these economic inconsistencies when discussing the case's cost-capability ratio and financial discipline.

6.2.2 Key Actors

Firms: As TMC and Nauru are the most likely pathway to commercialized DSM currently, it is important to discuss the current position of lead firms in regards to intake of DSM supply. Many large critical minerals lead firms, like BMW Group, Samsung SDI, and Volkswagen, among others, have been signing on to a moratorium, claiming the need to pause for more research and understanding of the environmental baseline (WWF, 2025).

TMC and other private companies on the other end of this movement are combating the narrative by emphasizing that one of the tasks of exploratory mining is to undertake research (Farran, 2022). The argument is that pausing the permitting process will also pause all research, as the remote location and cost, up to \$80,000 per day (Gramling, 2014), cause significant barriers for public organizations to be able to collect the same data. From this, more concerns arise on the dangers of self-regulation and lack of auditing mechanisms, as previously discussed. TMC can use its position as a provider of scientific data to encourage actors to not sign the moratorium, pointing again to the need for public investment in deep sea research. In general, both sides rhetorically align around the need for more scientific knowledge, yet differ on who should undertake and control that research.

In 2012, Glencore signed an agreement with TMC to purchase 50% of their future nickel and copper production (Postmedia Network Inc., 2012). Today, the world's largest mining companies, and lead firms in the critical minerals GPN, seem to have a lack of general interest in DSM. Glencore and Maersk sold their stake in TMC (Iceberg Research, 2025). TMC also has a strategic partnership with Allseas, a major contractor in the global offshore energy industry, which invested heavily in supporting studies and engineering work (Allseas, n.d.). TMC is very dependent on these firm actors in order to make their business model create value. It is worth considering whether TMC holds equal strategic importance for its partners, as Allseas also has its own exploration license sponsored by Jamaica and could become a future competitor of TMC (Iceberg Research, 2025).

Extra-Firm Actors: The Nauru government is a key proponent for DSM sponsorship by their state. In their new agreement (signed June 2025) they are said to secure royalties, capacity-building, and other benefits when commercialization begins (The Metals Company, 2025). However, civil society organizations have strong opinions on this partnership. The Deep Sea Conservation Coalition (DSCC) is strongly advocating for a moratorium, and at the local level Pacific Region Civil Society Networks like the Pacific Network on Globalisation, Pacific Council of Churches, and others urge Nauru to reconsider their positions based on uncertainty and risk (Civicus Monitor, n.d.).

Intermediaries: As outlined by the PNG case, the lack of distinct intermediaries and standards authorities is a pressing issue hindering the growth and legitimacy of the industry. As a means to regulate outside of the ISA, The Metals Company has sponsored an international consortium to develop the first ESG Handbook for Marine Minerals (The Metals Company, 2023a). Again, the same concern with self-verification develops. As a

sponsor and member, The Metals Company is influencing the standards and frameworks that will then be imposed upon their activities, creating a conflict of interest that could hinder this plan for legitimacy.

6.2.3 GPN 2.0 Dynamic Drivers

The Metals Company/Nauru partnership is developing into a high-cost, high-capability ratio, considering their current phase of exploration. Though TMC is determined to sell a low-cost narrative based on lack of processing and operating costs, exponential demand, and high grade resources, evidence overwhelmingly suggests that this endeavor will be an expensive one (Dobush, 2025). The high-capability comes, again, from supplying a source with untapped potential and being the only company providing it. When it comes to suppliers with high cost, high capability, the conceptual framework suggests their spot in the market can only be secured if they become platform leaders. If not, they would need to find a way to significantly decrease costs. As mentioned, TMC is working towards proving this low-cost argument, showing their desire to move to the position of a low-cost, high-capability supplier, making them highly competitive and in the position to evolve into strategic partners of lead firms.

The market imperative of TMC can be related directly to consumer behavior and customer preferences. Extra-firm actors like NGOs and advocacy groups continue to work against the industry. Changing the narrative put out by TMC could affect the industry's prospects for legitimacy and market entry. It is known that consumers are often much more demanding on lead firms, expecting social and environmental impacts of capitalization to be as minimal as possible. In order to avoid the negative customer pressures, lead firms in the critical minerals space have signed the moratorium and put out statements claiming that they will not use minerals mined from the deep sea in their supply chains, including giants like Microsoft, Ford, and General Motors (WWF, 2025). Though TMC may have advantages in time-to-market, being the first of its kind to supply raw minerals from the seabed, the cascading customer pressures could undermine TMC's ability to secure orders from lead firms or partnerships with refiners, resulting in the inability to gain market access, failure to optimize their cost-capability ratios, and landing on the same path as Nautilus did in PNG.

As opposed to the lack of financial discipline exhibited by Nautilus in PNG, TMC in Nauru is known to have excellent narrative positioning when it comes to investor strategy. This can be exhibited by their ability to shift the value proposition of their activities based on investor

needs, specifically shown in their original framing as minerals for the energy transition, where they were targeting large climate and energy funds, to the current focus on metals, defense, and industry.

The most notable move towards appeasing investors was when, with a push from TMC, Nauru triggered the ISA's "two-year rule", which required the ISA to complete the rules, regulations, and procedures necessary to facilitate the approval of exploitation permits within two years of the request (Blanchard et al., 2023). This rule was used to effectively push the ISA to come to a decision on some kind of mining code, and to show that actors are tired of waiting. Additionally, another view of this trigger enactment is the idea that it could be a ploy to de-risk investment, ensure market confidence to shareholders, and increase funds for this capital intensive starting line. This motivation does not seem too far-fetched, as a single proposed DSM project is estimated to cost around \$11-\$12 billion with current technology (Matcha, 2024). Along with that, TMC reported that it will not raise funds for their secured vessel until rules and regulatory paths are finalized. They also recently shifted their messaging away from aggressive timelines towards a more risk adverse strategy of development and diversifying their pipeline (Junior Mining Network, 2024). This financial discipline, paired with necessary work to claim positive market imperative, can keep TMC alive long enough to be the first commercial DSM company.

6.2.4 Scalar Synthesis

Site-level pilot studies and corporate-funded environmental assessments provided necessary baseline data, but are plagued with legitimacy concerns among local communities. Nationally, the Nauru government frames DSM as a pathway to economic resilience. Their chosen sponsorship positions Nauru at odds with many regional Pacific neighbors, sparking tensions within regional civil-society coalitions that promote the moratorium. This regional Pacific advocacy, combined with the moratorium support, adds to ISA deliberations and contributes to contested legitimacy at the global scale. The ISA, as a global policy instrument, directly determines whether TMC can secure financing, maintain market access, and eventual revenue streams for Nauru. These scalar dynamics show how conditional the relationship between TMC and Nauru is. They can only embed DSM into the GPN if they align supranational legitimacy with national sponsorship and local acceptance, while navigating regional opposition.

7. Analysis

This section analyzes how DSM firms are attempting to position themselves within the CM GPN as specialized suppliers. Building on the conceptual framework outlined earlier, the analysis applies GPN 2.0's focus on corporate strategies and modes of strategic coupling to the cases of Nautilus and TMC (as well as referring material provided in interviewing Impossible Metals), as well as their state sponsors. The four themes that structure this section were derived from the empirical material through CGT, described in Chapter 3, as well as through the summarizing of transcript material following Mayring (2014).

First, financial and partnership risk is analyzed, highlighting structural vulnerabilities that have shaped firm trajectories. Second, it evaluates the strategic approaches of DSM firms, with particular attention to how corporate strategies operate when applied to specialized suppliers. Third, it turns to stakeholder perceptions of DSM's potential risks and disruptions to existing supply chains, emphasizing how contested narratives shape firm legitimacy. Finally, it analyzes the question of value capture, examining how benefits are distributed between firms and sponsoring states and what this reveals about prospects for broader development outcomes. Together, these sections demonstrate how DSM's uncertain integration into the CM GPN depend on a precarious combination of internal strategies, external alliances, and narrative legitimacy.

7.1 Financial and partnership risks

In each case, DSM firms rely on claims of technological uniqueness or first-mover advantage to legitimize their entry into the GPN. For example, Impossible Metals highlights their novel harvesting technology as innovation to distinguish themselves from competitors and TMC advertises a similar narrative, but with a greater focus on positioning itself as the first firm to commercialize seabed mining and capture market share. This positioning is used to legitimize their entry and secure investment under uncertain conditions.

The cases show how modes strategic coupling, specifically structural and functional, can be influenced by the alignment or misalignment of stakeholder narratives. For PNG, structural coupling, where external actors (Nautilus) attempt to connect the region into the GPN, failed. The close alignment of the State and Nautilus around a pro-DSM narrative did not supersede the failures discussed above. In Nauru, by contrast, the functional coupling between TMC and the State appears to be more resilient. Though structural coupling is present in terms of

the dependency created between the actors, most accurately the region is being positioned to meet wider needs of the GPN through DSM supply, providing the potential for some degree of value capture. This type of coupling will be dependent on a continuing narrative cohesion (pro-DSM) that has the potential to be destabilized by extra-firm actors and intermediaries in a similar way this happened in PNG.

The experiences of Nautilus and TMC both highlight a structural vulnerability common to incoming mining firms. Nautilus' decline accelerated after Anglo American divested in 2018, leaving the company unable to secure sufficient financing to continue developing Solwara 1. Similarly, TMC has faced setbacks as key investors reduced their exposure, reflecting broader doubts about the commercial viability of DSM. These cases underscore how emerging mining firms depend heavily on maintaining partnerships with larger corporations and institutional investors, which provide financial resources and legitimacy for de-risking further financing. When such actors withdraw, the fragile position of these firms with the GPN becomes evident.

Revisiting the GPN 2.0 dynamic drivers; cost-capability ratios, market development, financial discipline, and risk management helps to determine the viability of DSM ventures. In PNG, Nautilus' cost-capability ratio faltered due to high financial instability and failure to manage stakeholder and reputational risk, destabilizing the venture. State investment and regulation was not enough to save the project. The model Nauru and TMC use is one where legal access is supplied by the State and operational capabilities by the firm. TMC has proven successful, so far, at leveraging narrative and regulatory momentum to mitigate uncertainty and instability that may sit in their business model, continuing to attract enough investment to move forward.

These financial vulnerabilities highlight the importance of the strategies DSM firms adopt to stabilize themselves and secure a position within the GPN. The next sub-section therefore examines the corporate strategies of DSM firms through the lens of specialized suppliers, analyzing how intra-firm coordination, inter-firm partnerships, and extra-firm bargaining manifest in practice.

7.2 Strategic approaches of DSM firms

In the analysis of DSM as part of the CM GPN, it is important to analyze these positions and actions as corporate strategies through the lens of specialized suppliers rather than lead firms.

For companies like TMC, intra-firm coordination has been central to holding together diverse and uncertain activities like exploration contracts, overseeing environmental assessments, advancing technology, and managing investor relations. This tight coordination is less about commanding downstream networks and more about sustaining credibility long enough to demonstrate proof of concept and return on investment.

At the same time, DSM firms depend heavily on inter-firm dynamics. Control over partners is limited, but the attempt to stabilize dependencies is evident in TMC's reliance on Allseas for mining technology and in Nautilus's collapse after Anglo American withdrew. These dynamics underscore the structural fragility of suppliers. Inter-firm partnerships have also been a critical pathway, as DSM companies collaborate with contractors, research institutes, and potential offtake partners to pool expertise and share risks (I5). Such partnerships are enabling, but their instability highlights the precarious position of innovative suppliers trying to enter the GPN.

Finally, extra-firm bargaining is perhaps the most decisive strategy for DSM firms. TMC's sponsorship arrangement with Nauru illustrates how companies leverage favorable institutional conditions to secure access to ISA contracts. Yet, this bargaining also exposes them to wider governance struggles, including the growing call for a moratorium, which is supported by states and NGOs seeking to safeguard terrestrial industries or environmental ecosystems (WWF, 2025). DSM firms, therefore, rely heavily on institutional negotiation not only for market entry but also for social legitimacy, a challenge that remains unresolved.

Overall, these strategies highlight DSM firms' structural vulnerabilities as specialized suppliers. They lack the market power of lead firms and must instead depend on a fragile combination of internal coordination, inter-firm alliances, and institutional bargaining to solidify and sustain their position in the GPN. While the strategies help explain how DSM firms seek to manage uncertainty, their success ultimately depends on how other actors perceive DSM's risks and potential. Narratives about technological promise, cost advantages, or environmental harm play a central role in shaping stakeholder responses. The following sub-section will therefore turn to perceptions of risk and disruption among industry actors, regulators, and civil society.

7.3 Stakeholder perceptions of risk

Interviewees revealed contrasting perspectives on the risks DSM poses to existing mining supply chains if successfully implemented into the GPN. While some industry voices framed DSM as a cheaper more sustainable alternative, others questioned its ability to disrupt terrestrial mining.

One interviewee (I5) explained how TMC positions itself as having the potential to close down unethical land-based mines, specifically the ones entering the GPN in Indonesia. The interview (I5) stated their hope that the lowest price suppliers will eventually have to shut down operations, because DSM minerals will be so cost effective. Though debated, both companies position themselves in a similar light, where the materials they mine will be at a lower cost than those mined terrestrially (I4 & I5). Additionally, both interviewees (I4 & I5) discussed the example of the Australian mines that are no longer operational due to lower cost alternatives entering the market. As a result, there is a risk that firms and states with vested interests in terrestrial mining supply chains will act to strengthen and protect those ventures by blocking a shift towards DSM, for example through support for the moratorium. Both private sector interviewees (I4 & I5) mentioned this ulterior motivation towards signing the moratorium, noting that opposition to DSM may in part reflect efforts to safeguard existing terrestrial mining industries.

However, other interviewees expressed skepticism. As one interviewee put it, “If we just substitute one problem with another problem, do we get a solution? No” (I6). While DSM firms can frame their operations as transformative for supply chains, their input would only represent a very small percentage of total supply under the best production circumstances, for example around 3% of global nickel (I7). Doubling down on the lack of ability to disrupt the GPN enough for dramatic shifts like the closing of terrestrial mines. What the increased supply could do to the market is intensify competition across different sources, and depress global prices. This could actually delay reforms to injustice in the mining sector. One interviewee also echoed this sentiment stating, “We know from the history of mining operations, when the market gets competitive it’s not the bad mines that go out of business first. They just cut more corners. What you really might be doing is potentially endangering children and endangering the rainforests, because people could just cut even more corners to try to be competitive if you drive prices down” (I7). In both conducted interviews with private DSM firms (I4 & I5), it was confirmed that they have no control over this action

(closing terrestrial mines). This narrative has led to strong resistance, presumably from actors with existing vested interest in their terrestrial mine supply, including both firms and States, pointing to the lack of likelihood something like DSM could disrupt these supply chains to that extent.

While most interviewees expressed clear support for or opposition to DSM, experts in the CM field interviewed tended to adopt a more nuanced view, see both perspectives. They emphasized that projected demand for these minerals will far exceed current terrestrial supply, and that recycling schemes are not mature enough to support any time in the near future (I1, I2, & I3). This less emotional and invested perspective could be viewed as a potential supplement to existing supply chains rather than a direct competitor or substitute. This more pragmatic stance reflects the material intensity of the energy transition and suggests that, under certain conditions, DSM might gain legitimacy as a necessary additional source. These perspectives highlight that DSM's emergence is not only uncertain but deeply contested, making narrative construction a central action for firms. These narratives have the potential to shape the success or failure of GPN integration.

In addition to these dominant framings, interviewee 9 (I9) emphasized how indigenous perspectives articulate a different counter-narrative trajectory. She explained that indigenous communities work under a seven generations principle, taking into account how policy decisions can affect seven generations from now. This approach contrasts sharply with the short-term focus of firm strategies and investor timelines. Beyond critique, interviewee 9 also noted that indigenous-based solutions could contribute to maximizing co-benefits for both communities and states, suggesting that inclusive approaches grounded in indigenous knowledge systems may help address some social and ecological challenges associated with the integration of DSM. She further emphasized that traditional values and indigenous law can guide communities back to original forms of ocean protection that aim to honor both narratives and numbers. In this sense, indigenous perspectives can provide “color, context, and emotion” to the raw numbers (I9). Incorporating indigenous peoples not just as extra-firm stakeholders, but as sovereign actors with extensive, different knowledge systems and understandings of society could assist in working together towards solving conflicting issues like the ones DSM creates.

While narratives can help DSM firms secure short-term legitimacy, they do not guarantee equitable outcomes. To understand how stakeholders evaluated the distribution of benefits, the next sub-section examines the distribution of value between firms, partners, and the

Pacific island nations, highlighting how development outcomes remain conditional and uncertain.

7.4 Value Capture & Development Outcomes

The major outcome within this work is a look at the value capture trajectories, importantly, how value capture at the firm level can be translated to development outcomes at regional and national levels.

Value capture is not only important for firms like Nautilus and TMC to maintain within their operations, but is argued to be “the most important dimension in development terms” (Coe & Yeung, 2025, p.171) and is what small island nations need in order for DSM to positively affect their States. In both cases, PNG and Nauru, the promises of value capture remain contested, conditional, and uncertain, as noted by one interviewee who stated “What makes it not viable is that there is no money to be shared. You can talk all you want about how to share a pie, but if there is no pie, then that makes it irrelevant” (I7).

In terms of capital flows, DSM provides Pacific island nations the opportunity for new revenue streams, but much of the value chain for these minerals is offshore and in the hands of foreign specialized suppliers to a much larger GPN. As indicated by one interviewee, “If you're a country that has lower GDP, then anything that brings revenue, or many things that bring revenue, are quite attractive, so it's harder to have bargaining power” (I3). Profits are likely to be repatriated to foreign shareholders. These capital flows have the potential to become liabilities in the event that the speculative and volatile inflows lack financial discipline, like in the case of PNG.

The failure of PNG’s Solwara 1 project illustrates that strategic coupling does not automatically translate into development outcomes. The project is well known in the space for its failure that led to immense debt, conflict, and no long-term benefit. Nauru has stated their planned investment into an intergenerational fund (Green Stock News, 2025) to enhance value capture from DSM for future, long-term benefit. However, actual value capture is highly dependent on successful extraction, global acceptance, and ongoing market access, none of which is in a state of certainty. A key discussion here comes from the power of the firm in these contractual and benefit-sharing agreements. The regulatory terms of sponsorship agreements expect sponsor States to take responsibility for the activities of their

contracting partners, while the sponsored firms are creating the fiscal terms, structurally limiting the ability of the State to capture and reinvest value locally.

In sum, the analysis has shown that DSM firms occupy structurally vulnerable positions as specialized suppliers within the CM GPN. Their survival depends on a fragile balance of financial stability, intra- and inter-firm alliances, and extra-firm bargaining for institutional support and legitimacy. Narratives about technological innovation and first-mover advantage are central to sustaining investor confidence, yet they remain contested by stakeholders concerned about disruption to existing mining industries and uncertain developmental benefits for sponsors. Together, these findings underscore how DSM's integration into GPNs is precarious, conditional, and deeply shaded by governance struggles. The following discussion chapter builds on these insights to consider their broader implications to theory, CM markets, and the dynamics of extractive frontiers.

8. Discussion

This section interprets the findings through the GPN 2.0 framework, examining how stakeholder narratives interact with dynamic drivers, strategic coupling, and value capture trajectories to influence DSM's prospects within the CM GPN. To return to the research question; How do stakeholder narratives surrounding DSM influence the formation, stability, and restructuring of global production networks for critical minerals; the analysis shows that narratives function as both enabling and destabilizing forces. They legitimate corporate strategies, shape perceptions of risk, and inform regulatory responses, yet they also expose structural vulnerabilities and contestations that complicate DSM's entry into established supply chains.

8.1 Narratives and legitimacy

Narratives surrounding DSM can be clustered into four main perspectives; (1) pro-DSM, where a strong argument is surrounded on its superiority over terrestrial mining, (2) anti-DSM, where DSM is situated as another unsustainable resource frontier, (3) a more pragmatic view that positions DSM as one element in a diversified response to demand and policy pressures, and (4) counter-narratives rooted in indigenous perspectives that raise critical questions on sovereignty and justice.

A consistent narrative across pro-DSM discourse is that DSM is “better” for both humans and the planet than terrestrial, land-based mining. This is evidenced in the literature, where author’s like Childs state “properties of the deep-ocean are mobilised by Nautilus Minerals in PNG in order to counter narrate DSM as a more ‘sustainable’ alternative to conventional forms of terrestrial mining” (2019, p. 1). Proponents argue that terrestrial mining causes deforestation, increasing emissions, inhumane working conditions, and displacement and harm of local communities. Their position is that DSM is necessary in order to slow down expansion and close down existing terrestrial mines.

Instead DSM is likely to emerge as an additional extractive frontier, not a substitute, similar to that of offshore oil and gas, undermining the claims of a “better”, more responsible, and more sustainable industry. The temporal dimension further this: polymetallic nodules regenerate only on geological timescales, making them effectively non-renewable. Meanwhile, new research is already shifting toward alternative chemistries that may reduce reliance on these minerals specifically (Farran, 2022). Brewer (2011) reminds us, short-term gains may dissolve as strategies are outpaced by technological change, while Nixon (2011) operationalized this concept, as slow violence which “occurs gradually and out of sight, a violence of delayed destruction that is dispersed across time and space” (p. 2). It is typically not viewed as violence at all.

Beyond these polarized positions, a third narrative emerged from CM experts interviewed for this thesis, primarily analysts and policy advisors working in research institutes and international organizations, individuals situated at the intersection of research, policy, and industry practice. They acknowledged the scale of projected demand and insufficiency of terrestrial supply alone. This perspective does not uncritically endorse DSM, but frames it as a potential legitimate source material. Such narratives could position DSM inputs as part of a diversified response to global demand pressures.

Additionally, narratives can only be shaped when they are allowed to form. Indigenous communities are one actor category that is commonly overlooked in economic analyses like global production networks and commodity chains. In the case of DSM, “the emergence of deep sea mining is simultaneously a continuation of the violence of colonial relations in the region and a new threat to indigenous thought and ontologies concerning the ocean” (Childs, 2019, p.126), which is a critical and necessary perspective. The counter-narrative analyzed introduced distinctive approaches to governance where traditional values and indigenous law point toward long-standing practices of ocean protection that integrate both narrative and

numbers. In this sense, indigenous perspectives do not wholly reject DSM but reframe the debate, showing how knowledge systems outside of market logics can reshape the terms on which resource frontiers are contested. In GPN terms, these perspectives also demonstrate the potential power of indigenous communities as extra-firm actors beyond just firm action in the market.

8.2 Risk and Vulnerability

The findings also underscore how risk operates in ways consistent with GPN 2.0 conceptualization. Coe & Yeung (2015) argue that risk mitigation is not a “zero-sum process” (p. 112). In the case of DSM commercialization, firms attempt to displace risk through narratives of innovation and sustainability, yet financial, regulatory, and reputational risks remain deeply entangled across scales. Divestment, as an example seen in both cases, illustrates how financial risk becomes a governance signal, reshaping the narrative around DSM’s future commercial potential. This point encompasses the structural vulnerability of operating as a proof-of-concept venture, rather than a fully integrated extractive actor, whose future depends on either sustained partnership or eventual acquisition by larger mining conglomerates in the GPN. Also highlighted here is the vulnerability of new specialized suppliers whose survival can hinge on managing cross-scalar risks while lacking the market power of lead firms.

8.3 Strategic coupling and dependency

The GPN 2.0 approach (Coe & Yeung, 2015, p. 224) does explicitly caveat that there are numerous potential dark sides to strategic coupling within GPNs. Currently, small island nations like Nauru see a place in the global economy as a major short-term benefit to their nation’s positioning to capture value and increase development. DSM entering the GPN for critical minerals through these contracts with small island nations can entrench these nations in new dependencies on foreign firms. As discussed by Coe & Yeung (2015), “path dependency constrains - if not determines - the future development possibilities of regions” (p. 168). The concern is that private, foreign firms will use the benefits of legal and political access provided by these nations, but hinder their ability to capture full downstream value. This dependence is framed by private firms as a way for island nations to gain not only value, but sovereignty. This represents what is called a friction within the GPN, where increased risk due to ongoing political, environmental, and diplomatic tensions, complicate the functioning of their role in the GPN for CM without immediately breaking the network.

Instead this creates ongoing vulnerabilities and constraints that may limit benefits for the nations involved.

PNG represented a rupture “in which connections between global production networks and regional economies are severed, perhaps quickly or with little warning, owing to the shift in strategic priorities of lead firms or changing market conditions” (Coe & Yeung, 2015, p.169). In that case, investor withdrawal, equipment repossessions, and escalating extra-firm opposition effectively severed the connection between the network and PNG’s local economy. This rupture demonstrated how coupling can collapse suddenly, leaving the State with fiscal liabilities and reputational damage. It cannot be assumed that the same could not happen in the case of Nauru, if TMC reconfigures its strategic priorities, the market conditions shift, or regulatory stalls hinder upward movement. This needs to be critically looked at as a major impact to the GPN. Small island nations will finally be included as key players within the network, but could lack the necessary power to avoid manipulation.

These dynamics suggest that DSM may add new actors and dependencies into the GPN without substantially disrupting existing CM supply chains. While DSM could reconfigure network hierarchies and create new vulnerabilities, its contribution to overall supply is likely to remain marginal under even the most optimistic production scenarios.

Taken together, the preceding discussion shows how stakeholder narratives surrounding DSM shape how risks are perceived and managed, legitimize certain coupling strategies while destabilizing other, and influence possibilities for value capture across scales. Narratives have the power to open potential entry points into the GPN, but they cannot override structural tensions, capital limitations, or asymmetries in power and capacity. As a result, the emergence of DSM is likely to reconfigure the GPN for CM at the margins by adding new actors and dependencies rather than fundamentally transforming supply chains.

For small island nations like PNG and Nauru, the strategic use of narrative, whether to enable, resist, or reframe DSM, will continue to influence their potential position in the GPN. Though DSM may provide these states with short-term access to global markets, their capacity to capture and reinvest value locally remains structurally constrained by sponsorship agreements and the external control of production and revenue flows. DSM thus highlights both the centrality of narrative in resource frontiers and the enduring vulnerabilities created by dependency.

9. Conclusion

The case studies of PNG and Nauru demonstrate that DSM is not only a technological or industrial venture, but also a scalar project. In PNG, unresolved legitimacy at the local scale cascaded upward, undermining confidence at the regional and national levels, and feeding into supranational debates at the ISA among global actors. In Nauru, DSM's trajectory is shaped from the top down, where supranational governance sets the conditions for national action and local expectation. Together, these cases show that DSM's integration into the GPN for CM depends on how scalar linkages are aligned across local, national, regional, and supranational levels. Misalignment, as in PNG, fragments value capture and leads to failure, while conditional alignments, as in Nauru, leaves DSM's future contingent on supranational legitimacy and its translation into national benefit and local acceptance.

Reflecting on the GPN 2.0 framework, this thesis highlights four interlinked empirical dynamics: financial and partnership risks, corporate strategies of specialized suppliers, contested stakeholder narratives, and conditional value capture trajectories. These dynamics play out unevenly across scales and are deeply shaped by scalar alignments. More specifically, three indicators illustrate DSM's uneven development impacts on Pacific island economics: capital flows, organizational ecology, and knowledge/technology. Capital flows determine who captures benefits and who bears liabilities. Organizational ecology highlights how DSM introduces new firms and governance bodies, often with shallow integration into local economies. Knowledge transfer is minimal without intentional capacity building, given the highly-specialized skills required. Without targeted institutional support, DSM risks replicating patterns of foreign dependency, limited capacity, and local exclusion already seen in terrestrial mining.

Taken together, this research shows that GPNs are shaped not only by flows of capital, labor, and technology, but also by narratives that legitimate, contest, and reframe extractive frontiers. These include pro-DSM narratives of inevitability, anti-DSM critiques of ecological harm, pragmatic perspectives that position DSM as a needed supply source, and indigenous counter-narratives that foreground sovereignty, justice, and long-term stewardship. In the Pacific, state and corporate narratives frame DSM as a pathway to economic opportunity, sovereignty, and transition, while extra-firm actors emphasize ecological uncertainty and social exclusion. Even with high demand and the need for new extractive frontiers, DSM's material contribution to the overall supply chain may be too

limited to significantly alter global supply chains. Nonetheless, it could still have localized effects on supply dynamics, price signals, and geopolitical relations in specific markets.

For Pacific island states to retain the value promised to them, governance approaches could benefit from greater localization through the strengthening of local institutions that can embed and sustain capacity development. This process involves not only providing training and technical support for national agencies but also establishing or reinforcing domestic institutions capable of overseeing resource governance, enforcing regulatory standards, and coordinating stakeholder engagement. In this way, capacity building becomes effective when paired with robust institutions that enable long-term governance authority rather than continued reliance on external expertise or foreign contractors. Recommended areas of capacity development include technical, legal, and scientific expertise to enhance decision-making autonomy and reduce dependence on private firms. While such measures may not override national strategies or influence extra-firm actors, they can strengthen local leverage and power, ensuring more informed and independent governance.

Ultimately, this thesis contributes to both GPN scholarship and DSM policy debates by showing how legitimacy, narratives, and scalar alignments shape the emergence of extractive frontiers. It demonstrates that DSM firms remain structurally vulnerable as specialized suppliers whose survival depends on fragile partnerships and narrative legitimacy, raising doubts about their ability to deliver benefits. It also raises a pressing question: If DSM is unlikely to substantially alter GPNs for CM, then why accept its ecological costs? At a time when nations are committing to ambitious climate targets, the energy transition, and the protection of biodiversity (United Nations, 2025), the marginal gains of DSM may not justify the potentially irreversible impacts on ocean ecosystems.

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11. Appendices

Appendix A: Recruitment Materials

This template was used to request interviews across all stakeholder groups in this thesis. Wording was sometimes adapted to reflect the specific role or expertise of the interviewee.

Interview Request Email

Subject: Request for Interview – Master’s Research on Deep Sea Mining

Dear [Name],

My name is Nicole Weinkauff and I am currently completing a Master’s thesis in Global Change and Sustainability at The University of Vienna. My research explores how stakeholder narratives shape the governance and development of deep sea mining, with a particular focus on global production networks.

Given your expertise and role in [organization/sector], I would be grateful for the opportunity to speak with you about your perspective on deep sea mining. The interview would be semi-structured, recorded, and last approximately 30-45 minutes, and cover themes such as governance, policy, stakeholder narratives, and power. Participation is entirely voluntary and any information you provide will be anonymized unless requested otherwise.

Please let me know if you would be available for a conversation at your convenience. I would be happy to provide additional background on my research or adapt to your schedule and preferred platform.

Thank you very much for your time and consideration.

Appendix B: Semi-Structured Interview Guide

Interviews were conducted using a semi-structured approach, guided by three thematic coding sets corresponding to stakeholder groups. Questions were tailored to the interviewees' expertise and positions, but all interviews explored common themes of the wider critical minerals space, governance, narratives, and power asymmetries.

Coding Set 1: Critical Minerals and Global Production Networks

- In your view, what makes a mineral *critical* and how *critical* are the minerals targeted by DSM compared to those available on land and through recycling?
- How do you see the necessity or lack of necessity when it comes to an additional extractive industry like deep sea mining to fulfill mineral demand?
- What is your opinion on the benefits (economic gain & increased supply) versus the consequences (negative environmental impacts & conflict of ownership) of expanding the extractive industry of more forms of mining? Is it necessary?
- How do you see the role of international organizations like the United Nations (ex. ISA, UNCLOS, UNEP) in regulating global extraction of critical minerals?
- Are you aware of policies or industry efforts that promote demand reduction or decoupling rather than increased supply?
- What role do you think private companies should play in ensuring new extraction is managed ethically?
- How do you see the balance between the benefit for smaller, resource-rich countries and the large global players that want to tap into these resources for their benefit?
- Do you have any experience in the concepts of shared value of similar resources or in their distribution of value?
- What do you think about the temporal aspect of both the energy transition innovation and the use of nonrenewable resources affecting the future of critical minerals?

Coding Set 2: Private Sector

- Do you primarily function for the purpose of supplying energy transition minerals, or materials for other sectors within the global economy?
- Due to potential environmental impacts, do you see private companies setting any limits on the amount of extraction from the sea floor?
- Can you please provide insight into the economic feasibility of your business model?
- How will you manage price fluctuations within the supply chains for these minerals?
- Do you think that DSM can replace terrestrial mining if it is adopted to commercial scale?
- What models of state and regional partnerships are part of your business strategy?
- What are your thoughts on the role of the ISA in the governance of DSM?
- How do you see private sector influence, like the signing of the moratorium, on the critical minerals industry?
- How do you see the liability schemes between you and your contracted state partners?
- What steps is your organization taking to manage a just transition of DSM into the industry?

Coding Set 3: Anti-DSM Advocacy

- How have your experiences with deep sea mining advocacy shaped your views on the topic?
- In your view, how has the public narrative around DSM evolved over time?
- From your experience, what role do you think international law, or soft law frameworks, should play in regulating DSM activities?
- In your view, what different actor narratives in the space carry the most weight?
- How do you see justice in the transition to DSM, particularly in relation to small island developing states or indigenous coastal communities?

- How do you think DSM interacts with the goals of SDG 14 and ocean stewardship more broadly?
- What advocacy approaches or tools have you seen to be the most impactful in creating change within the emergence of DSM?
- In your opinion, what actors hold the most power in shaping DSM governance? Who is being left out of the decision-making processes?
- What would a just and sustainable mineral transition look like to you?

**Note: Not all questions were asked in every interview. Questions were adapted to fit the stakeholder's expertise and the flow of conversation, but the coding structure remained consistent across interviews.*

Ethical Considerations and Consent

All interviews conducted for this research followed standard ethical protocols to ensure the rights, privacy, and autonomy of participants were respected. Participation was entirely voluntary, and participants were informed that they could decline to answer any question or withdraw from the interview at any time.

Before each interview, participants were provided with general information outlining the purpose of the study, how their input would be used, and measures for confidentiality. Verbal or written consent was obtained from all participants, including permission to record the interviews for transcription purposes. All data were treated confidentially, and identifying information was anonymized in the analysis.

This approach ensured that participants could share their insights openly while maintaining full control over their contributions and protecting sensitive or proprietary information.

Appendix C: Summaries of Interview Transcripts

The following appendix presents summaries of the interview material collected for this study. In line with Mayring's qualitative content analysis (2021), the interviews were subject to a summarizing technique in which the original transcripts were systematically paraphrased, reduced, and abstracted in order to preserve essential content while omitting redundancies and sensitive details.

Full transcripts are not reproduced here because participants did not consent to their full publication. Instead, the anonymized summaries below provide a transparent account of the key themes and arguments that informed the analysis.

This approach ensures that interviewee confidentiality is maintained while still making the empirical basis of the study accessible and traceable, consistent with the Mayring's (2021) emphasis on data reduction as a legitimate method of presenting qualitative material.

1. Interviewee (I1) - UNIDO Energy Transition Mineral Expert (International Organization), 29/05/2025, In person

1.a. Summary of Interview Content

Emphasized that expected demand for CM in the energy transition will be greater than current terrestrial production capacity.

Suggested that recycling and circular economy efforts are promising but remain too underdeveloped to significantly reduce demand in the near future.

Positioned DSM as a potential supplementary supply source rather than a replacement for terrestrial mining.

Stressed that international frameworks (ISA, UN bodies) play a central role in guiding DSM development.

Indicated that governance needs to balance resource demand with environmental and social risks, especially given the global uncertainties surrounding DSM.

1.b. Code Counts (14)

Initial coding

- Extra-firm Actors = 2
- Economics = 2
- Firm Actors = 1
- Anti-DSM & Pro-DSM = 0

Focused coding

- Policy/Governance = 6
- Critical Minerals GPN = 3
- Power dynamics/narratives & GPN 2.0 Drivers = 0

2. Interviewee (I2) – UNIDO Global Alliance for Responsible and Green Minerals (International Organization), 11/06/2025, Microsoft Teams

2.a. Summary of Interview Content

Framed DSM within the broader context of CM supply chains.

Argued that future mineral demand for the energy transition will require multiple sources, and DSM is being considered as one option.

Emphasized the need to evaluate DSM not in isolation but as part of global supply chain diversification.

Stated that DSM could be positioned as a responsible alternative if developed under strong governance.

Notes that some stakeholders see DSM as offering potentially more sustainable supply chains compared to problematic terrestrial mining practices.

Pointed out that international frameworks must ensure DSM operations are transparent and aligned with sustainability standards.

Highlighted the role of institutions in balancing commercial ambitions with social and environmental safeguards.

Underscored that external stakeholders (NGOS and intergovernmental organizations) will play a major role in shaping DSM's legitimacy.

Observed that narratives around DSM are contested, with legitimacy hinging on how firms present their practices and how external actors respond.

2.b. Code Counts (13)

Initial coding

- Pro-DSM = 4
- Extra-Firm Actors = 2
- Anti-DSM, Economics, Firm Actors = 0

Focused coding

- Policy/Governance = 3
- Critical Minerals GPN = 3
- Power dynamics/narratives = 1
- GPN 2.0 Drivers = 0

3. Interviewee (I3) – Imperial College London, Critical Minerals Supply Chain Expert (Academia), 27/06/2025, Microsoft Teams

3.a. Summary of Interview Content

Emphasized the global importance of critical minerals for the energy transition

Noted that DSM is being considered primarily as a supplementary source, not a sole solution.

Pointed out that DSM should be evaluated alongside terrestrial mining and recycling to understand its place in global supply chains.

Indicated that while DSM might expand supply, economic viability remains uncertain compared to terrestrial alternatives

Suggested that countries with smaller economies may lack bargaining power in negotiation, leading to uneven benefits.

Highlighted the importance of regulatory frameworks to manage DSM responsibly.

Stressed that while international oversight is important, organizations like the UN can only do so much, and responsibility falls on states and firms

Noted that narratives around DSM often emphasize technological promise and sustainability, but these claims must be critically assessed.

3.b. Code Counts (15)

Initial coding

- Extra-firm Actors = 2
- Anti-DSM = 1
- Economics = 1
- Firm Actors = 1
- Pro-DSM = 0

Focused coding

- Critical Minerals GPN = 6
- Policy/Governance = 2
- Power dynamics/narratives = 1
- GPN 2.0 Drivers = 1

4. Interviewee (I4) – Impossible Metals, DSM (Specialized Supplier) Firm (Private Sector),

03/07/2025, Google Meet

4.a. Summary of Interview Content

Framed DSM as a sustainable alternative to terrestrial mining, arguing that the environmental and social harms of land-based extraction justify developing DSM.

Positioned Impossible Metals technology as innovative and less destructive, designed to distinguish the company from others.

Stressed that DSM minerals are cost-competitive and even cheaper in their economic models than terrestrial sources.

Noted that lower-cost DSM could pressure existing terrestrial mines, potentially forcing less efficient operations to close. But, confirmed that the company will not do anything to accelerate this, and would rely on the market in the case this does happen.

Acknowledged the high upfront costs of technology development but argued these are necessary to prove feasibility and attract investment

Acknowledged the role of recycling and other technologies but argued these cannot scale quickly enough to meet demand for the energy transition. DSM was described as part of the broader solution.

Highlighted Impossible Metals role as a unique harvesting technology and how this framing has attracting partners and investors.

Recognized the company's dependence on partnerships with contractors and financiers to scale operations.

Acknowledged the influence of external stakeholders (environmental NGOs and international institutions) in shaping the market.

Pointed out that DSM development will depend heavily on regulatory approvals and international governance frameworks. They see their position as working within these frameworks only.

Suggested that policy uncertainty increases business risk, making institutional alignment critical.

Recognized that opposition narratives (moratorium calls, NGO pressures) could slow DSM's integration into supply chains, but remained confident that the pro-DSM argument is too strong to be blocked by such factors.

4.b Code Counts (20)

Initial coding

- Economics = 8
- Firm Actors = 3
- Extra-firm Actors = 2
- Pro-DSM = 2
- Anti-DSM = 0

Focused coding

- Policy/Governance = 3
- Power dynamics/narratives = 1
- GPN 2.0 Dynamic Drivers = 1
- Critical Minerals GPN = 0

5. Interviewee (I5) - The Metals Company (TMC), DSM (Specialized Supplier) Firm (Private Sector), 23/06/2025, Microsoft Teams

5.a. Summary of Interview Content

Positioned DSM as a transformative alternative to terrestrial mining, claiming that nodules are lower cost due to the high grade and multiple metals within on rock, which could eventually make some land-based mines uncompetitive.

Suggested DSM could enable the closure of mines associated with unethical practices, particularly in regions like Indonesia. Confirmed that TMC does not have any say or action involved to facilitate this transition away from terrestrial mines, but would rely on the market to make this happen.

Framed DSM as aligned with the goals of the energy transition, stressing its necessity to meet projected exponential demand.

Argued that DSM has the potential to be cost-effective once operations scale, despite high upfront costs.

Acknowledged challenges with financing but emphasized ongoing efforts to attract investors through sustainability and innovation narratives.

Stated that competition with terrestrial mining could reduce global mineral prices, with significant ripple effects in supply chains.

Emphasized that DSM should be understood as part of the broader supply system for needed critical minerals, not as a standalone industry.

Stressed that TMC's operations rely heavily on regulatory legitimacy through ISA state sponsorship (Nauru).

Acknowledged the moratorium movement but suggested the support often reflects protection of terrestrial mining interests, as governments and firms with existing operations seek to safeguard them against competition from DSM.

Highlighted TMC's role in developing further capacities within the firm including technology development, deep ocean research, and environmental assessments.

Noted reliance on key partnerships (ex. Allseas) for technology and operational capacity.

Recognized that NGOs and advocacy groups have shaped opposition narratives, creating higher risks to their investments. TMC works to delegitimize these narratives to decrease this risk.

5.b. Code Counts (38)

Initial Coding

- Economics = 8
- Pro-DSM = 6
- Firm Actors = 5
- Extra-firm Actors = 3
- Anti-DSM = 0

Focused Coding

- Power dynamics/narratives = 8
- Policy/Governance = 5
- Critical Minerals GPN = 2
- GPN 2.0 Drivers = 1

6. Interviewee (I6) – Sustainable Ocean Alliance, Global Policy Advisor (Civil Society), 24/06/2025, Microsoft Teams

6.a. Summary of Interview Content

Stressed that DSM is not a necessity for addressing the energy transition due to the industry already innovating away from the use of these minerals.

Highlighted that alternatives such as recycling, demand reduction, and innovation in materials science should be prioritized before considering new extractive industries.

Expressed skepticism about the economic case for DSM, framing it as a high-risk and speculative venture.

Raised concerns that promises of cost-effectiveness may mask long-term environmental and social liabilities.

Strongly emphasized the importance of precautionary governance.

Advocated for a moratorium until much more robust scientific evidence is available.

Suggested that current governance frameworks (ISA, UNCLOS) are inadequate for managing DSM responsibly.

Critiques DSM's narrative of being "better" than terrestrial mining, suggesting this is misleading framing.

Pointed out that DSM risks simply adding another extractive frontier rather than solving existing problems.

Framed the industry's claims as a substitution fallacy of replacing one harmful practice with another without addressing root causes.

Highlighted the role of civil society, youth advocates, and NOGs in shifting public narratives against DSM.

Positioned advocacy networks as critical in balancing industry and state influence.

6.b. Code Counts (23)

Initial coding

- Extra-firm Actors = 6
- Anti-DSM = 2
- Firm Actors = 2
- Economics = 1
- Pro-DSM = 0

Focused coding

- Power dynamics/narratives = 6
- GPN 2.0 Drivers = 2
- Policy/Governance = 2

- Critical Minerals GPN = 2

7. **Interviewee (I7)** - Deep-Ocean Stewardship Initiative, BBNJ Working Group, (Civil Society), 10/07/2025, WhatsApp call

7.a. Summary of Interview Content

Notes that DSM is unlikely to fundamentally disrupt terrestrial mining supply chains due to its minimal supply based on total.

Suggested DSM could only supplement global mineral supply in a marginal way.

Questioned the overall economic feasibility of DSM due to high costs, technological risks, and uncertain demand.

Highlighted that cost-effectiveness claims are speculative and may not hold up in practice.

Raised concerns about whether the ISA can ensure equitable benefit-sharing schemes.

Stressed the imbalance of power between small island states and multinational firms.

Observed that DSM's momentum relies heavily on corporate storytelling to appease investors and shareholders. Argued that these narratives obscure the structural vulnerabilities of DSM ventures. Noted that investor withdrawal significantly shapes project outcomes.

Identified the critical role of advocacy networks in shaping public perception.

Pointed to the moratorium is influential in creating higher risk for DSM firms.

Warned that DSM could reproduce injustices from terrestrial mining while introducing new ecological risks.

7.b. Code Counts (25)

Initial coding

- Economics = 7
- Anti-DSM = 2
- Extra-firm Actors = 3
- Pro-DSM & Firm Actors = 0

Focused coding

- Power dynamics/narratives = 6
- GPN 2.0 Drivers = 3
- Policy/Governance = 3
- Critical Minerals GPN = 1

8. Interviewee (I8) - Sustainable Development Strategies Group, Law Student (Legal/Governance Intermediary), 21/07/2025, Microsoft Teams

8.a. Summary of Interview Content

Framed DSM as an unnecessary addition to mineral supply, arguing it will not fundamentally shift or replace terrestrial extraction.

Suggested that DSM could exacerbate existing inequalities in the GPN rather than resolving them.

Expressed skepticism about DSM's economic rationale, emphasizing speculative costs and uncertain returns.

Strongly emphasized the inadequacy of current governance frameworks (ISA, UNCLOS) for managing DSM responsibly.

Highlighted issues of transparency, accountability, and representation in ISA decision-making.

Argued that without robust environmental safeguards, DSM governance risks legitimizing harm.

Suggested narratives are being used to silence or sideline community and civil society concerns.

Pointed to advocacy campaigns and the moratorium as evidence of strong extra-firm influence on DSM legitimacy.

Consistently opposed DSM, stressing precautionary principles and long-term ecological risks.

Suggested that DSM undermines commitments to biodiversity and SDG 14.

8.b. Code Counts (17)

Initial Coding

- Anti-DSM = 4
- Economics = 2
- Extra-firm Actors = 2
- Pro-DSM & Firm actors = 0

Focused Coding

- Policy/ Governance = 4
- Power dynamics/narratives = 3
- Critical Minerals GPN = 2
- GPN 2.0 Drivers = 0

9. Interviewee (I9) - Central Council of Tlingit and Haida Indian Tribes, Policy Coordinator (Indigenous Peoples), 08/07/2025, Microsoft Teams

9.a. Summary of Interview Content

Positioned indigenous communities not just as stakeholders but as sovereign actors whose perspectives must reshape the debate.

Emphasized that indigenous perspectives frame the ocean as a living entity, not a resource frontier.

Questioned whether short-term economic gains could every outweigh the intergenerational ecological and cultural costs.

Critiqued international governance frameworks (ISA, UNCLOS) as excluding indigenous voices and knowledge systems.

Acknowledged that value can come from new extractive frontiers for indigenous communities, which is tempting for clan leaders.

Emphasized the importance of building capacity for indigenous communities so that if DSM proceeds, they are able to meaningfully participate in decision-making and benefit from value capture.

Stated that DSM decision-making risks reproducing colonial patterns of environmental and ocean governance.

Argued for recognition of indigenous law and traditional values as essential for sustainable governance.

Framed indigenous approaches as a counter-narrative rooted in the “seven generations principle,” prioritizing long-term stewardship over short-term extraction.

Suggested that indigenous voices bring “color, context, and emotion” missing from mainstream economic and technical narratives.

9.b. Code Counts (23)

Initial Coding

- Extra-firm Actors = 7
- Economics = 2
- Anti-DSM = 1
- Pro-DSM = 1
- Firm Actors = 0

Focused Coding

- Power dynamics/narratives = 6
- Policy/Governance = 5
- Critical Minerals GPN = 1
- GPN 2.0 Drivers = 0