### Research

# Business diplomacy in practice: challenges in the semiconductor industry's sustainable supply chain

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## Abstract

The rapid technological evolution, combined with the widespread dissemination of digital devices, has significantly increased the demand for semiconductor chips, highlighting the industry's vital role in globalisation. The semiconductor industry stands at the forefront of technological innovation and economic development, yet it grapples with significant sustainability and supply chain management challenges. Alongside growing sustainability demands within the supply chain, monitoring the semiconductor supply chain faces considerable challenges. Companies typically employ business diplomacy to navigate shifts in the global business environment. By examining the sustainability reports of 19 semiconductor firms selected from the S&P Global Sustainability Yearbook 2024, this research enhances our understanding of how semiconductor companies implement business diplomacy strategies to improve the sustainability of the supply chain by underscoring the critical interrelationship between environmental considerations, social issues, operational efficiency, and strategic international relations with key corporate stakeholders. It also contributes to the theoretical framework of supply chain management and sustainability within the semiconductor industry by illustrating the business diplomacy strategy associated with stakeholder risk management.

**Keywords** Business diplomacy · Sustainable supply chain · Semiconductor · Strategic management · Stakeholder engagement · Risk management

# 1 Introduction

In the context of accelerated technological advancement, semiconductor chips have established themselves as the foundational elements of contemporary digital infrastructure. These diminutive yet highly efficacious components are indispensable across a diverse array of applications, encompassing consumer electronics, telecommunications, artificial intelligence, and defence systems [28, 76]. Consequently, the semiconductor industry has emerged as a pivotal contributor to economic growth and innovation, thereby influencing global supply chains and geopolitical dynamics [45]. Notwithstanding its critical importance, the industry is increasingly susceptible to disruptions and serious risks, primarily attributable to its intricate supply chain architecture, the intensifying interconnectedness of global economies and prevailing geopolitical tensions [11, 38]. The COVID-19 pandemic has exacerbated these challenges, disrupting the procurement of essential raw materials, causing a notable decline in trade, destabilising global trade networks and compromising the interconnectivity among nations involved in semiconductor manufacturing [65].

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Ensuring business continuity and protecting international interests has gained prominence, highlighting the critical role of business diplomacy in fostering cooperation among industry stakeholders [3]. Organisations have increasingly adopted business diplomacy as a strategic mechanism to navigate uncertainties and uphold operational stability [45]. Business diplomacy is the implementation of diplomatic strategies within the corporate sphere to assist organisations in addressing intricate international challenges [4]. It encompasses essential activities such as stakeholder engagement, reputation management, and lobbying—fundamentally crucial for promoting sustainable business practices and enhancing corporate resilience [26]. In the semiconductor industry, wherein supply chains extend across multiple nations [37] and involve a diverse range of stakeholders—including governmental entities, non-governmental organisations, and local communities—business diplomacy's role is paramount. Nevertheless, the predominant focus of contemporary research on business diplomacy remains largely on large-scale enterprises across various industries, including mining (Valderrey et al. 2021), biotechnology [59], and the oil and gas sector [34], where interactions with governmental entities and non-market factors are both direct and frequent. Simultaneously, there exists a paucity of studies investigating corporate diplomacy within cross-border supply chains, and nearly none have undertaken a rigorous examination of the semiconductor supply chain, an industry characterised by significant fragmentation, vulnerability to political influences, and pronounced impact from sustainability standards and strategic trade policies.

Effective collaboration among entities is vital for addressing pressing sustainability issues, encompassing resource scarcity and environmental impacts [27, 87]. Sustainable supply chain management (SSCM), which plays a fundamental role in helping companies achieve their sustainability goals, has become a challenging area for both industry and academia, and is currently a hot research topic that has yielded numerous results from a variety of approaches. [47]. Empirical evidence suggests that firms implementing SSCM practices are more likely to realise a competitive advantage and achieve sustainable long-term growth [61]. Recognising the strategic importance of sustainability, corporations are progressively initiating measures to minimise environmental harm while concurrently generating value for their stakeholders [105]. However, businesses cannot rely solely on internal operational tools for a supply chain to achieve true sustainability. Still, they must actively interact and coordinate with external factors, especially institutions, sustainability standards, the local community and other stakeholders' expectations. In this context, business diplomacy is an important intermediary between operations and the institutional environment, helping businesses adapt and shape the conditions for sustainability implementation across the entire supply chain [24, 55]. The convergence of business diplomacy, sustainable business practices, and supply chain management has become increasingly prominent in contemporary discussions surrounding global commerce, particularly within the semiconductor industry. Effective business diplomacy is essential for facilitating collaborations among diverse stakeholders, including governmental agencies, non-governmental organisations, and local communities, in the semiconductor sector, characterised by its extensive and multifaceted global supply chains. Such collaboration is crucial for addressing sustainability challenges, particularly resource scarcity and environmental impacts exacerbated in high-tech manufacturing contexts [27, 87].

Although scholars in the field justify the role of business diplomacy, as it emphasises the enhancement of engagement with key stakeholders within a firm's supply chain, the research pertaining to business diplomacy in the supply chain remains underexplored. Our research aims to contribute to reducing this knowledge gap.

The aim of this article is to examine how business diplomacy is practised within the sustainable supply chains of the semiconductor industry. Specifically, it seeks to answer the following research question:

- Which are the key stakeholders in the semiconductor industry's sustainable supply chain?
- How do semiconductor companies manage stakeholders for their sustainable supply chain in the sense of business diplomacy?

## 2 Literature review

This chapter summarizes some previous studies relevant to business diplomacy and sustainable supply chain management, including critical comments and highlighting gaps in the knowledge base on which the study is based.



#### 2.1 Business diplomacy for non-market strategy

Business diplomacy is defined as the application of diplomatic principles and frameworks within business contexts that enable organisations to navigate complex international landscapes effectively [4]. The current complex nature of the foreign business environment is influenced by multiple stakeholders who generate numerous demands and challenges for firms operating within the markets and shaping ecosystems [18]. In this context, firms are regarded as diplomatic actors who contribute to formulating beneficial diplomatic strategies not only for the firm but also for the nation with which they are associated [13].

Business diplomacy is not merely perceived as a corporate channel for communication or advocacy. Its objective extends to the creation and maintenance of positive relationships with stakeholders based on a win–win solution between firms and other stakeholders [43]. The ultimate outcome is the establishment of social goodwill, which provides legitimacy and a social license to operate [59] through established bonds and earned trust from the society [74]. Once being accountable in the host market, a long-term network will offer long term success for the company [40].

Business diplomacy has emerged as a vital component of international relations, management, and corporate social responsibility (CSR). It entails strategic engagement with stakeholders to advance corporate interests while addressing societal challenges [27, 102]. Closely related to business diplomacy, it integrates insights from international relations, CSR, and corporate communication [93, 53, 94]. Westermann-Behaylo et al. [100] argued that business diplomacy assists companies in navigating complex political and social landscapes, balancing profit motives with contributions to peace and stability. Additionally, Ingenhoff and Marschlich systematically review business diplomacy and political CSR, clarifying their theoretical and practical intersections [50]. The increasing involvement of businesses in diplomatic processes has gained significance, particularly in response to global crises such as the COVID-19 pandemic. Ramadan and Anggraeni [69] highlight how government has increasingly engaged business actors in diplomacy to promote national economic recovery.

Business diplomacy is vital for achieving sustainability and sustaining competitive advantage in sectors with intricate supply chains, such. Engaging effectively with governments and regulatory bodies assists businesses in aligning their practices with international sustainability standards while securing favourable trade agreements [93, 94]. Business diplomacy also improves reputation management, bolstering investor confidence and nurturing long-term partnerships [26]. The capacity of firms to navigate international relations through diplomatic strategies enables them to mitigate operational risks and advance industry-wide sustainability initiatives [27]. Empirical studies highlight the strategic significance of business diplomacy for multinational enterprises (MNEs). Henisz [35] stressed that MNEs must cultivate dynamic capabilities to respond effectively to evolving geopolitical contexts. Delgadillo et al. [97] emphasise that proactive engagement with non-business stakeholders can result in favourable outcomes in foreign markets. Additionally, Kesteleyn [44] demonstrated how Belgian multinationals employ public–private partnerships in economic diplomacy to shape state policies. Marschlich and Ingenhoff [50] contended that fostering strong diplomatic relationships enhances organisational legitimacy, facilitating smoother operations within diverse regulatory environments.

In order to implement diplomatic strategies, a variety of business diplomacy tools have become increasingly integral components of a firm's international management strategy. Numerous studies have systematically categorised these tools into essential functional groups, with the objective of optimising the firm's capacity to engage with and influence the host institutional environment [35, 78]. Stakeholder engagement tools, such as the cultivation of personal relationships and stakeholder dialogue platforms, occupy a pivotal role in fostering trust and attaining a social license to operate [27, 50, 103]. This facilitates the maintenance of open and regular communication channels, which have been recognised as a prerequisite for businesses to effectively manage stakeholder expectations. Additionally, policy advocacy and networking tools constitute another critical group of resources. Firms routinely employ policy advocacy and government support strategies to sway institutional decisions and secure a conducive operating environment [26, 32]. Furthermore, business intelligence tools, including non-market risk analysis and market monitoring, enable organisations to identify the risks of supply chain disruption stemming from geopolitical fluctuations or emerging environmental policies [15, 27]. In light of the increasing necessity for global businesses to engage with sustainable development goals, particularly in relation to sustainable supply chains, CSR Integration tools such as the implementation of social projects and participation in sustainability initiatives play a vital role in enhancing legitimacy and fortifying institutional co-creation capacity [50, 93, 94, 100].

While business diplomacy has been extensively theorised as a strategic capability for multinational corporations (MNCs) to navigate non-market environments [26, 27], empirical studies regarding the application of this concept across specific industries remain fragmented and unsystematic. Nevertheless, certain scholars have conducted studies at the



industrial level in sectors such as mining, biotechnology, energy, and pharmaceuticals, which are significantly influenced by political factors, sustainability demands, and public scrutiny [59, 73, 75, 82]; (Valderrey et al. 2021). These investigations underscore the business diplomatic capacity of firms, which is emerging not solely as a risk-response instrument but also as a mechanism for institution building, legitimacy construction, and the promotion of sustainable supply chains. The case of Areva, which operates mining activities in Niger, illustrates a multi-round negotiation process in which host governments leverage commodity price fluctuations and geopolitical considerations to enhance their bargaining power. Areva, in turn, employs community dialogue and social development agreements as soft power to preserve long-term exploitation rights [82]. In the context of the GMO controversy in Mexico, biotechnology companies have engaged in business diplomacy to lobby and influence policy discourse and public opinion through sponsorship of scientific research, collaboration with state actors, and participation in national forums [59]. Salvi and Ruël [75] demonstrate that the Enel case in Chile integrates diplomacy into stakeholder mapping, community investment, and environmental, social, and governance (ESG) partnerships with local governments, thereby assisting businesses in accessing new markets and creating sustainable value.

## 2.2 Sustainable supply chain management

Sustainable supply chain management (SSCM) is a multidisciplinary approach that has been examined in the literature from the perspectives of business sciences, engineering sciences, environmental sciences, and social sciences, sometimes also examining the connections between these fields. Sustainable Supply Chain Management (SSCM) is a crucial element of achieving corporate sustainability by integrating environmental, social, and economic factors into supply chain operations [12]. The Triple Bottom Line (TBL) framework highlights the necessity for businesses to adopt practices that balance profitability with environmental care and social equality [49, 104]. Importantly, despite the acknowledged significance of SSCM, existing research frequently separates these dimensions instead of embracing a comprehensive approach, which emphasises the need for a more integrated perspective [52]. Taking into account all the characteristics of supply chains and sustainability, Ahi and Searci [2] defined SSCM as the integration of economic, environmental, and social considerations into procurement, manufacturing, and distribution processes to meet stakeholder needs and improve an organization's profitability, competitiveness, and flexibility. The introduction of SSCM practices is influenced by external drivers, such as pressure from customers, suppliers, or competitors, and internal drivers, such as the commitment of senior management [66]. Paul et al. [60] consider top management support to be the main driver of sustainable supply chain management, which primarily brings about progress in the area of innovation.

Organisations that align their supply chain strategies with sustainability goals experience enhanced risk management, improved operational performance, and strengthened relationships with stakeholders [30, 48, 68]. Empirical evidence shows that organisations adopting SSCM practices often gain a competitive advantage while simultaneously enhancing overall business performance. Firms that actively reduce their environmental footprint and promote social responsibility are more likely to build stronger brand loyalty and attract investment [61, 105]. Research indicates that businesses operating in emerging markets, particularly benefit from sustainability initiatives, as these efforts bolster resilience and adaptability in volatile environments [11]. Furthermore, SSCM is fundamentally linked to process innovation and long-term profitability. Delgadillo et al. [97] argue that organisations engaged in proactive sustainability efforts are better positioned to navigate regulatory challenges and global supply chain disruptions.

Despite its advantages, the implementation of SSCM faces several considerable challenges, including high initial costs, regulatory inconsistencies, and resistance to change. Many organisations struggle with the inherent trade-offs between short-term profitability and long-term sustainability, particularly in sectors marked by narrow profit margins [39]. Moreover, misalignment among stakeholders—suppliers, manufacturers, and policymakers—can hinder progress, as these parties may have differing priorities [10]. A key challenge is the lack of a standardised framework for assessing sustainability performance. In certain industries, clear guidelines are available, however, many sectors depend on fragmented and inconsistent metrics, making practical evaluation of progress more difficult [96]. To address these issues, companies must adopt collaborative approaches, advocate for robust regulatory frameworks, and integrate sustainability considerations into their core corporate strategies.

Planning is essential in sustainable supply chain research, which includes sustainable product, technology, and process design, infrastructure and supply chain planning, and innovation [48, 81]. Economic efficiency is an important consideration when implementing sustainable supply chains, and planning plays a key role in achieving triple sustainability performance [46]. Manufacturing, including green manufacturing, licensing and outsourcing, lean philosophy, quality performance improvement, and certification and standardization, also improves financial and sustainability performance in the long term

[21, 106]. SSCM publications related to logistics examine inventory management, sustainable distribution, market management, reverse and green logistics, and waste management [81, 83], often in the context of circularity [70, 76, 108]. In terms of supply planning and procurement, it is important to examine resource management, procurement, supplier management, and supplier codes of conduct [81]. Sustainable best practices should be implemented within companies, especially if their resources are limited [51]. It is essential to minimize costs, waste, and environmental impacts [70].

The incorporation of digital technologies has significantly transformed sustainable supply chains, boosting transparency and operational efficiency. Innovations such as big data analytics, blockchain technology, and artificial intelligence enhance decision-making by enabling real-time tracking, waste reduction, and predictive analytics [25, 67]. For instance, blockchain has been widely adopted to ensure ethical sourcing and traceability, particularly within industries subject to stringent regulatory oversight [57]. These findings suggest that leveraging technological advancements is not merely an option but a vital necessity for organisations aiming to achieve sustainability in supply chain management.

Significant growth is expected in semiconductor manufacturing due to increasing demand from the industrial, consumer electronics, and automotive sectors, which poses a particularly significant environmental challenge due to high chemical consumption and the generation of hazardous chemical waste [21, 37]. Initiatives that integrate recycling, sustainable product design, and safe disposal practices play an important role in the disposal of electronic waste (e-waste), as does avoiding poor product quality that jeopardizes customer confidence and corporate reputation [83]. In addition, the significant energy consumption, water use, and greenhouse gas emissions associated with semiconductor manufacturing are also a concern in the sector [90]. Not only environmental risks but also ESG-related risks in general are important for companies in the industry [38], and ESG is becoming increasingly strategic for semiconductor manufacturers [22]. TSMC, one of the leading semiconductor manufacturers, has made significant efforts to recycle and reuse chemical acids in collaboration with its suppliers [37]. Practical initiatives can also be examined from the perspective of stakeholder importance to identify good practices [90]. At the same time, the complexity of the semiconductor industry's supply chain requires increased transparency and information sharing to avoid risks and maintain the trust of stakeholders such as investors and consumers [17].

A significant proportion of publications in the field of sustainable supply chain management focus on logistics, supply planning and procurement, and quality performance, while less researched topics in SSCM include ethics and social responsibility, with sub-topics such as human resources and rights, humanitarian activities. The connection between sustainable value chains and business diplomacy is infrequently addressed in the existing literature. Although most research and models on sustainable supply chain management (SSCM) focus on the consequences of practices, practical professionals have pointed out their importance [29]. Although most research and models on sustainable supply chain management (SSCM) focus on the consequences of practices, companies' participation is primarily driven by relational and moral motivations, and companies that demonstrate a high level of moral commitment generally perform better than those driven by amoral considerations [62]. Information management and communication, dialogue, cooperation, coordination, and contribution (6C) also play an important role within management information systems, as does stakeholder management [81]. In the supply chain of electronic products, stakeholder cooperation also plays a critical role in achieving optimal results in reverse logistics [92] in promoting sustainable life cycle management [83] and in information sharing between policy makers and industry stakeholders [70], involving non-governmental organizations and academia [79].

The relationship between sustainable value chains and business diplomacy is rarely discussed in the literature. Defining business diplomacy as the relationship between a global company and its numerous non-business partners and external stakeholders, Van Gorp [98] highlights that local industry and international standards are important building blocks of sustainable development chains and emphasizes the role and potential of civil society movements. To our knowledge, no previous study has simultaneously examined the relationship between business diplomacy and sustainable supply chain management with a focus on the semiconductor industry, thus filling a gap in the literature. The aim of this research is to highlight the role that business diplomacy can play in developing sustainable supply chains by evaluating best practices in semiconductor companies.

## 3 Research method

#### 3.1 Research design

This study employed the qualitative research method to thoroughly explore the business diplomacy strategies and sustainability practices of the semiconductor industry. According to Denzin and Lincoln [23], qualitative research facilitates



a deeper understanding of the context, significance, and motivations behind corporate strategies, which is especially crucial when evaluating issues pertaining to corporate governance and multi-stakeholder relations. Furthermore, as Yin [107] observed, qualitative research is a powerful tool for analysing content from corporate documents, assisting in uncovering hidden trends and strategies that companies utilise to maintain their supply chains. The use of sustainability reports as the primary data source is also supported by Bowen [16], who emphasised that document analysis provides insights into organisational strategies without directly interfering with corporate operations. In this case, Qualitative analysis methods were employed to extract information from corporate reports for the purpose of identifying key stakeholder groups within the sustainable supply chain of the semiconductor industry, as well as to examine the business diplomacy tools utilised by companies to engage each of these groups.

### 3.2 Data collection and analysis

The data for this study were gathered by examining the 2023 sustainability reports of 19 leading semiconductor companies ranked in the Semiconductors & Semiconductor Equipment category of the S&P Global Sustainability Yearbook 2024 (S&P Global, n.d.). These reports provide insights into companies' sustainability strategies, stakeholder management and supply chains, including stakeholder engagement tools and practices. Furthermore, these companies represent global semiconductor businesses with strong sustainability strategies. And they are expected to provide rich data on the sustainable supply chain management models and business diplomacy tools these companies employ.

S&P Global is recognised as the leading organisation globally in financial and sustainability ratings, renowned for its corporate assessment methodologies that adhere to international standards concerning governance, environment, and society (ESG) (S&P Global, n.d.). In particular, the Sustainability Yearbook produced by S&P Global is founded upon the Corporate Sustainability Assessment (CSA) methodology, which is a comprehensive corporate sustainability evaluation system characterised by its depth and standardisation. The CSA methodology encompasses a thorough assessment framework that amalgamates self-reported data with information obtained from external sources, thereby ensuring objectivity and reliability. The CSA methodology possesses several logical characteristics, including industry-specific customisation featuring 62 distinct sets of questions tailored for each sector and a multidimensional evaluation encompassing ESG. An additional analytical component addresses media and stakeholder feedback (MSA) with a stringent data verification process.

This secondary data source reflects the companies' commitment and strategy in implementing sustainable development goals. Bowen [16] asserts that document analysis is an effective research method for collecting information from corporate reports without directly intervening in an organisation's internal operations. The coding process was executed employing thematic analysis, grounded in the theoretical principles of business diplomacy and sustainable supply chain management. Based on a guided approach, the analysis was conducted using the literature, which served as the initial guideline for developing the first codes (Armstrong 2021). The process is conducted through an iterative and ongoing comparison between data and theory. Text segments within the relevant sections of reports are meticulously extracted and transferred into an Excel spreadsheet, subsequently assigned a double code comprising two components: the stakeholder designation (e.g., employee, supplier, customer, government, etc.) and the category of diplomatic tool employed (e.g., Supplier Code of Conduct, ESG Investor Dialogue, Stakeholder Engagement Survey, etc.). Each combination of codes signifies a particular practice of the enterprise in engaging a stakeholder through the utilisation of a specific diplomatic tool. Finally, the codes were compiled and organized into large thematic groups (themes). The two principal themes addressed are key stakeholders in the semiconductor industry's sustainable supply chain and business diplomacy tools for a sustainable supply chain in the semiconductor industry, which are emphasized as key topics in the results section. Figure 1, as shown below, demonstrates the coding process.

Figure 1 shows that the analytical process was carried out in two main stages. In the first stage, initial codes were established based on a thorough theoretical overview of business diplomacy, sustainable supply chains, and non-market strategies. The extracted and processed codes included diplomatic tools and stakeholder classifications. In the second phase, these codes were consolidated and refined by analysing 19 sustainability and integrated reports from semi-conductor companies. This synthesis of theory and practice led to the discovery of new codes, as illustrated in Fig. 1, resulting in two primary themes. Credibility is achieved through a continuous comparison of theoretical codes with empirical evidence, supplemented by cross-coding performed by both authors to reduce subjective bias. Transferability is enhanced by contextualising the semiconductor industry, a global sector marked by complex stakeholder structures heavily influenced by institutional, geopolitical, and sustainability challenges. As a result, the analytical framework of this research applies to similar industries, including energy, high-tech, and other transnational supply chains.



Fig. 1 Coding process. Source: own creation

In order to mitigate these risks and improve the reliability of the analysis, this study employed a cross-referencing strategy that utilised independent industry reports. Moreover, to enhance the validity of the study, the findings from the sustainability report will be cross-referenced with relevant academic literature and industry reports to verify the accuracy of the data and to provide a basis for further expansion of the research using interview and questionnaire methods to achieve triangulation [16]. The cross-referencing process entails a systematic comparison of the diplomatic tools and stakeholders delineated in the corporate report with the patterns and practices observed in the industry report.

## **4** Results

#### 4.1 Key stakeholders in the semiconductor industry's sustainable supply chain

Numerous stakeholders play a key role in ensuring transparency and accountability while minimising negative impacts on the environment and society in semiconductor companies' sustainable supply chains. These stakeholders directly influence companies' reputational capital, business models, and production chains in an industry significantly impacted by environmental concerns, such as semiconductors.

Semiconductor companies identify a relatively analogous core stakeholders, which includes suppliers, employees, customers, shareholders/investors, academic institutions, government and industrial associations, business partners, local communities, NGOs and other stakeholders (see Table 1).Generally, suppliers, employees, customers, shareholders/investors, academic institutions, government and industrial associations are the stakeholders that semiconductor



companies prioritise for engagement. The business partners, local communities, NGOs and other stakeholders are the least engaged stakeholders.

Firstly, raw materials and component suppliers are critical, as the semiconductor industry relies on rare resources such as silicon, rare earth elements, and speciality chemicals [8]. Without stringent controls on raw material sourcing, over-mining can cause severe environmental damage and exacerbate issues related to conflict minerals [84]. Therefore, supply chains must uphold responsible mining standards, reduce carbon emissions, and implement recycling solutions to optimise resource use [9, 41].

In 19 sustainability reports, the industry and each company's environmental impacts have been clearly defined, adhering to regulatory frameworks in their operating destinations.

Table 1 outlines the interrelationships among stakeholders involved in developing sustainable supply chains. Notably, employees, suppliers, and the government play the most prominent roles in their engagement within the supply chain.

This prioritisation is justifiable as employees represent the internal resources that dictate success or failure, customers serve as a significant source of revenue and technology partnerships, and investors provide capital and are anticipated to guide the strategic direction. Numerous companies like Powerchip Semiconductor Manufacturing Corp reports favourable outcomes from engaging this group, as evidenced by high customer satisfaction scores ([64], p. 17). Consequently, these companies can provide comprehensive technical support and fast response mechanisms to ensure compliance with strict sustainability standards, such as environmental protection and social impact, in the development of new products. For employee engagement, Powerchip Semiconductor Manufacturing Corp ([64], p. 17) and Phison Electronics Corp ([63], p. 41) showed the employee feedback response rate is 100%. This rate demonstrated the importance of employees in this industry owing to the stringent technical requirements, the necessity for ongoing innovation, and the limited availability of highly gualified human resources. Organisations emphasise internal engagement initiatives, talent cultivation, and the establishment of a sustainable corporate culture to preserve and enhance this vital resource. Employees are directly engaged in optimising the energy efficiency of chips, enhancing semiconductor packaging technology to minimise e-waste, and developing manufacturing processes that consume less water and fewer toxic chemicals. Furthermore, semiconductor engineers and scientists are instrumental in driving innovation and the transition to green technology, such as employing renewable energy in wafer manufacturing and designing more energy-efficient chips for AI and cloud computing applications. In most cases among the sampled companies, employees receive training to effectively utilise new technologies and acquire knowledge of sustainability through training programmes or related events. This approach enables employees to assist in reducing greenhouse gas emissions, allowing these companies to maintain a low level of scope 3 emissions.

Data analysis from 19 semiconductor companies worldwide indicates a significant transformation in the manner in which these companies conceptualise and respond to the involvement of customers within sustainable supply chains. From this viewpoint, companies are actively positioning customers as institutional actors rather than only perceiving customers as mere end users or ordering parties. Specifically, customers are presented in the data as two-way strategic partners: they engage in audits, periodic inspections, and satisfaction surveys, while also contributing to technological innovation through co-development and exerting increased pressure for compliance with cross-border ESG standards. For instance, PSMC, UMC, and TSMC have established systems for regular dialogue with customers regarding supply chain risks, product quality, and process improvement. Numerous companies also provide detailed metrics on loyalty scores [9], or measuring methods for customer satisfaction like Net Promoter Scores and Customer Effort Score [58]. This phenomenon illustrates a means of business diplomacy via collaboration throughout the value chain, where the customer serves as the central focus of the organisation behaviour.

In the semiconductor industry's sustainable supply chain, investors and shareholders play a pivotal role in shaping development strategies, ensuring transparency, and upholding environmental, social, and governance (ESG) commitments. They provide the capital necessary to propel innovation and manufacturing expansion, serving as a monitoring force that creates pressure for companies to adhere to sustainability standards. Additionally, investors and shareholders require companies to demonstrate their return on assets, as semiconductors may need to make aggressive investments to meet the market's demands for green transitions. A mutual understanding among companies, investors, and shareholders are standard practices in the semiconductor sector, aimed at constructing a dialogue with investors and shareholders to help them comprehend the corporate values linked to social and environmental considerations.

Other partners in this path of innovation and R&D, which are considered necessary in the network of semiconductors, are universities, research institutes and academic institutions. Academia and universities are home to leading scientists and experts conducting fundamental and applied semiconductor research. Through research projects, they develop new

Table 1 Stakeholders in the sustainable supply chain of semiconductor companies

Company/stakeholder	Suppliers	Customers	Employees	Sharehold- ers/inves- tors	Academic institu- tions	Government Indust associ tions	ial Business 1- partners	Local commu- nities	NGOs Other stake- holder	s l
Advantest	×	×	×	×	×	×	×	×	×	I
ams OSRAM	×	×	×	×	×	×	×	×	×	
ASE Holdings	×	×	×	×	×	×	×	×	×	
ASM International	×	×	×	×	×	×	×	×	×	
ASML Holding N.V	×	×	×	×		×	×	×	×	
Infineon	×	×	×	×	×	×	×	×		
Vanya technology corporation	×	×	×	×	×	×		×		
ON Semiconductor Corporation	×	×	×	×	×	×		×	×	
<sup>2</sup> hison Electronics Corp	×	×	×	×	×		×		×	
<sup>2</sup> owerchip Semiconductor Manufacturing Corp	×	×	×	×	×	×	×	×		
Renesas Electronics Corporation	×	×	×	×	×	×		×		
30HM Co., Ltd	×	×	×	×		×				
5K hynix Inc	×	×	×	×	×	×	×	×		
5TMicroelectronics N.V	×	×	×	×	×	×		×	××	
Faiwan Semiconductor Manufacturing Company Limited	×	×	×	×	×	× ×	×			
Tokyo Electron Limited	×	×	×	×	×	×	×	×	×	
United Microelectronics Corporation	×	×	×	×	×	×	×			
vanguard international semiconductor corporation	×	×	×	×	×	×	×	×	×	
<b>MIN Semiconductors Corp</b>	×	×	×	×	×	×	×			
Souces: Own compilation										



materials, advanced manufacturing processes and improved circuit design, contributing to improved performance and reduced environmental impact in semiconductor manufacturing. Investing in R&D helps manage risk, enhance sustainability, and drive new product development and improved manufacturing processes. For example, Infineon launched research projects with research institutes at a wide European scale or built a specialised campus for Jiangnan University to train future engineers.

Another example is that SK hynix [85] has an intensive industry-universities program while this company's employees engage with students as mentors or incubators for youth entrepreneurial students via SPARK programs. These companies tend to attract talents from university campuses mostly. In the same vein, WIN and Vanguard International Semiconductor Corporation [101] have other approaches through industry-academia partnerships. They tend to initiate joint exclusive research programs for new advantageous technologies. Moreover, investing in future talent via sponsorship and scholarships is another measure to access and secure high-quality human resources while the world is witnessing a shortage in the industry. These are examples of approaching business partners for innovation and non-business partners, such as academic institutions, for technological advancement and talent attraction. These actions lead to creating the industrial network and ecosystem to connect stakeholders that support the sustainable development of the semiconductor industry. Building a network of connections and cooperation between businesses, research and education organisations, and government agencies creates a collaborative environment. In this sense, academia provides a scientific basis for formulating policies and strategies for the sustainable development of the semiconductor industry.

This argument underscores the importance of these stakeholders in contributing to a sustainable supply chain. In general, upholding sustainability will be pushed through governmental regulations and laws on several green incentives. This argument underlines the cruciality of the government in this chain via creating alliances or collaborations. These alliances were formed based on the market orientation via many formats. STMicroelectronics ([86], p. 151) collaborated with the local government on joint sustainable development of the industry: "Our Beijing site (China) signed a three-year memorandum of understanding with the local government in Pengshui to cooperate on sustainable development". In the same vein, Renesas ([71], p. 47) used the same approach to engage with the government: "Renesas joined the "Water Project" in February 2022 as part of its ongoing efforts to conserve water resources. The "Water Project" was launched by the Ministry of the Environment of Japan as a public-private partnership initiative to increase commitment to maintain or restore a healthy water cycle based on the Water Cycle Basic Law that took effect in 2014". Some of them will rely on governmental subsidiaries such as ROHM. Or ASM International will join an association which could help it raise its voice or advise the policy-making decision. However, the typical impacts of governmental actors will be on suppliers of these companies by setting related regulations. In the semiconductor industry's sustainable supply chain, suppliers are crucial in ensuring the continuity and efficiency of the entire global supply system. They provide the raw materials and components necessary for the manufacturing process and directly influence the supply chain's environmental, social, and economic aspects. Ams OSRAM integrates its suppliers' compliance capabilities into their Business Continuity Management. Similarly, ASE Holdings certifies its business continuity by acquiring ISO 22301. These are a few examples of the significance of suppliers in the environment. In terms of governance, the environmental aspect of sustainable supply chains highlights the crucial role of company suppliers, particularly those providing raw materials and components. The semiconductor industry depends heavily on rare materials, including silicon, rare earth elements, and speciality chemicals. The extraction and production of these materials can lead to detrimental environmental effects, such as air and water pollution, as well as the depletion of natural resources. Consequently, adopting sustainable extraction methods and efficient waste management practices is vital. Without stringent controls on the provenance of raw materials, over-mining can inflict significant environmental damage and exacerbate issues, such as conflict minerals. Therefore, the supply chain must enforce standards for responsible mining, reduce carbon emissions, and implement recycling solutions to optimise resource utilisation.

Table 1 illustrates that establishing a comprehensive supply chain for the semiconductor industry necessitates that suppliers actively adhere to environmental and social standards. Suppliers also play a role in mitigating risks associated with disruptions in the global supply chain. In the semiconductor sector, interruptions in the supply of raw materials can impact the entire production and distribution cycle. Fostering trustworthy and transparent partnerships between suppliers and manufacturers enhances their ability to adapt to market and business environment fluctuations. In this industry, suppliers encounter challenges due to the stringent requirements for pure raw materials, specialised components, and compliance with sustainability standards. Consequently, leading companies have instituted regular supplier assessment systems and have encouraged collaborative programs aimed at mitigating environmental and social risks within the supply chain. In practice, Infineon [41] has established a supplier code of conduct system that imposes ethical standards on its suppliers, and the corporation will assist any supplier experiencing difficulties in transitioning to an

inclusive and environmentally friendly process. For TSMC [89], this company also creates joint development programs to establish incentives for material production processes that are in line with Hsieh et al. [37]. All 19 semiconductor corporations regarded their suppliers as key stakeholders in decarbonising their production chains. In this context, each semiconductor company will require its suppliers to comply with the specific company's due diligence and auditing systems concerning environmental impacts.

While suppliers focus intensely on semiconductors, employees are recognised as a vital link in the sustainable supply chain. As a high-tech industry, semiconductors necessitate a workforce with extensive expertise in materials, circuit design, manufacturing processes, and quality control. Meanwhile, supply chain management teams are responsible for ensuring suppliers comply with ESG standards, from the origin of minerals to the working conditions at semiconductor factories worldwide. Furthermore, employees also play a crucial role in fostering a sustainable corporate culture, from adhering to ethical codes and safeguarding employee rights to participating in environmental protection initiatives within the workplace. In the semiconductor industry's sustainable supply chain, employees are the driving force behind operating and innovating technology and play a central role in assisting companies in addressing social issues, such as human rights and business ethics. Given the nature of an industry with a global supply chain, upholding fair labour standards, ensuring safe working conditions, and protecting employee rights are fundamental elements in building a sustainable supply chain. Table 1 also illustrates the companies' efforts to maintain a safe and healthy workforce, both within the companies and in the context of their suppliers. Several guidelines, which encompass international standards such as the United Nations Universal Declaration of Human Rights, the UN Global Compact, the UN Guiding Principles on Business and Human Rights, and the International Labour Organization, have been instrumental in guiding the ethical conduct of these companies [1, 7, 91]. Regarding business ethics, semiconductor companies must ensure transparency and accountability throughout the supply chain, from mineral sourcing to factory manufacturing conditions [84]. One of the greatest challenges is the issue of conflict minerals, where critical materials such as tantalum, tin, tungsten, and gold (3TG) can be mined from areas marked by severe human rights violations. To address this, these companies adopt the Responsible Business Alliance (RBA) standard, which requires suppliers to provide transparent information about the origin of raw materials and comply with rigorous ESG auditing processes. In addition, a "Zero Tolerance" policy against exploitative labour, discrimination, or unethical practices is enforced throughout the supply chain [41, 95, 99]. Other cases have demonstrated their strict adherence to business ethics through policies and monitoring systems designed to prevent human trafficking, child labour, or any form of modern slavery [6, 101], which are well-recognised issues in global supply chains across all industries [14, 42]. Another employee-related issue is workplace harassment, which is prohibited in any supplier, company, or partner context [72, 86]—business diplomacy plays a sophisticated role in maintaining positive engagement between employees and companies. This approach aids these companies in crafting an open dialogue agenda with transparent information and investing in training and welfare policies to foster a fair and sustainable working environment while enhancing their competitiveness in the global market. Selected organisations, such as the ILO or UN Compass, uphold international standards in their reports to publicly disclose their contributions towards improving working conditions. This initiative advocates for compliance with local regulations concerning the social aspect of sustainability. Additionally, they ensure their supply chains adhere to sustainability principles by requiring their partners and suppliers to follow the company's code of conduct. This represents a significant exercise of bargaining power through business diplomacy. So far, selected companies have established triangular relationships for diplomatic engagement strategies involving government, suppliers, and employees.

Figure 2 illustrates the relationship among three sites where governmental actors typically exert regulative influence, resulting in shifts in business policy towards suppliers and employees. The connection between employees and companies signifies a mutually beneficial situation. Stakeholders highlighted in orange are predominantly engaged, whereas those highlighted in green exhibit minimal engagement. Furthermore, Fig. 2 underscores the nature of two-way engagement for each stakeholder. While the government issues national policies, companies will respond by engaging with stakeholders, including suppliers, customers, employees, and academic institutions, in terms of communicating requirements and providing support to those in need. Conversely, other stakeholders, such as partners, NGOs/IGOs, and local communities, are addressed solely through one-way communication like announcements, without any deeper engagement strategies. However, other stakeholders also have their role to ensure a resilient and sustainable supply chain. Along with other stakeholder engagement, partnerships for technology, research & development (R&D) also play an essential role in finding optimal solutions for sustainable semiconductor manufacturing. This partnership category assists semiconductor companies in extending their research to innovation for environmental conservation and innovative advantages, which gives each company a new positioning. R&D and innovation programs or summits are approaches that semiconductor companies use to establish partnerships with customers, manufacturers, and suppliers for product





Fig. 2 The relationship between the company and stakeholders. Source: Own creation

life cycle assessment and green product development. It is noticeable that semiconductors seem to develop their new products conforming with the ISO 14000 family of standards [41], such as ISO 14064-1 Greenhouse Gas Inventory for reducing greenhouse gas emissions or ISO 14067 Carbon Footprint International Standard [56]. Their policies will adhere to ISO 14001 Environmental Management System and 45001 Health and Safety Management System.

The result shows that the stakeholders that are most actively and systematically engaged include suppliers, employees, investors, and industry associations. The primary objectives of engaging with these groups are to manage supply chain risks, enhance operational efficiency, and fulfil financial expectations from the capital market. Leading companies widely utilise various business diplomacy tools such as the Supplier Code of Conduct, employee well-being programs, ESG Investor Days, and membership in specialized associations. In contrast, the engagement with local communities, non-governmental organizations (NGOs), academia, and non-supplier business partners is considerably limited. Communication with the community often occurs sporadically through charitable CSR activities, which lack strategic sustainable development initiatives. Relationships with NGOs and academia are primarily short-term or incidental and are not yet integrated into the innovation ecosystem or the establishment of social legitimacy.

Stakeholders with direct influence on the supply chain which has an impact on finance are employees, suppliers, and investors. These stakeholders are engaged more proactively and profoundly than indirect stakeholders such as communities, NGOs, and academia. This distinction underscores a management mindset concentrated on optimizing short-term benefits rather than fostering long-term sustainable capacity.

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It is evident that companies exhibiting strong performance often implement multi-stakeholder and multi-channel engagement strategies, employing appropriate business diplomacy tools for each stakeholder group and establishing continuous feedback loops (stakeholder feedback loops). Conversely, businesses that underperform primarily restrict engagement to supplier compliance or periodic financial reporting, lacking efforts for two-way dialogue or meaningful community engagement. Consequently, semiconductor companies must proactively and systematically enhance their engagement strategies towards stakeholders with low engagement. This approach is essential not only to address the growing demands for ESG compliance but also to improve risk resilience, sustain long-term competitiveness through innovation and new technology development with academic institutions and non-supplier business partners. In this way, a resilient and sustainable supply chain is transparently maintained within the current context of uncertainty in globalization.

#### 4.2 Business diplomacy tools for a sustainable supply chain in the semiconductor industry

Business diplomacy is a strategy used by businesses to establish and maintain relationships with international stakeholders, promote business interests and build a positive image in the global market. Effective application of business diplomacy tools not only enhances competitiveness but also helps businesses adapt flexibly in the volatile international business environment. In the case of the semiconductor industry, a sophisticated diplomatic strategy is essential as the industry is usually caught in the middle of global competition.

Based on the reports the following business diplomacy tools were identified: strategic partnerships and alliances, networking and lobbying, regulatory compliance, CSR and sustainability initiatives, codes of conduct, stakeholder dialogues, and ESG disclosures.

Establishing strategic partnerships and alliances is the dominant tool when 19 companies engage with governments or their partners. Nanya Technology Corporation ([56], p. 164) "cooperated with government departments to provide the Company's venues for local farmers to display and sell their own products, provide direct purchase opportunities for farmers to increase farmers' profits and income, and promote the concept of responsible consumption". In the same vein that Renesas ([71], p. 47) participated jointly with the government in "the "Water Project" in February 2022 as part of its ongoing efforts to conserve water resources. The "Water Project" was launched by the Ministry of the Environment of Japan as a public–private partnership initiative to increase commitment to maintain or restore a healthy water cycle based on the Water Cycle Basic Law that took effect in 2014".

Networking and lobbying are two critical tools in business diplomacy, helping businesses expand relationships, increase influence and promote strategic interests. Networking is establishing and maintaining relationships with partners, customers, governments and international organisations, facilitating access to information, cooperation opportunities and support in the global business environment. Meanwhile, lobbying aims to influence legislators and government agencies to influence policy decisions in a way that benefits businesses, often through meetings, research funding or participation in industry associations. Powerchip Semiconductor Manufacturing Corp ([64], p. 7) suggested "proposing policies to the government that cover land, water, electricity, and human resources that are relevant to industrial competitiveness and support environmental sustainability". Twenty-one companies also mentioned organising many events, meetings, and individual interactions per investors' requests to apprehend the strategic pathway of green investment. The intensive implementation of investor/shareholder relationships and engagement describes the significant impact of investors in this semiconductor industry by voting rights and navigating voice during meetings. However, the opinions of investors or shareholders regarding these companies' green investments or green transitions are not clearly defined. However, several companies, such as Nanya, Infineon or ASML, communicate their strategies regarding technological innovation, climate risks and social due diligence requirements to their investors and shareholders to advocate for their support of investment continuity. Particularly, Nanya and ASE Holdings also distinguished the difference between regular and institutional shareholders and the distinctive approaches to each type of shareholder. ASML has organised many ESG investor conferences, showcases, and sustainability surveys to raise investors' awareness of sustainability investment and ESG practices [9]. The nature of business diplomacy is to influence, negotiate or advocate for the companies' investment value creation strategies as investors fund the companies' activities. To this end, companies need to publicly disclose business and operational activities to gain trust and support and attract more investment from shareholders and investors. Large and institutional investors increasingly require semiconductor companies to integrate sustainability goals into their business strategies, from reducing carbon emissions in wafer manufacturing to ensuring that their supply chains are free of conflict minerals. In addition, shareholders, through their voting rights at general meetings, can directly influence essential decisions such as investing in clean technology, improving manufacturing processes, and



implementing transparent ESG reporting. Several examples for communicating intensively about sustainability status to investors are TSMC, STMicroelectronics and Nanya via conferences, reports or individual direct communications. These engagement strategies facilitate prompt support from investors to invest in strategic environmental protection for stable and responsible supply chains.

Another tool for ensuring a sustainable supply chain is regulatory compliance, which involves business diplomacy to engage with a company's stakeholders, ensuring that their partners comply as well. Compliance helps minimise legal risks, enhance brand reputation, and maintain positive relationships with governments, investors, and global customers. This protects business interests and contributes to promoting sustainable development within the supply chain. United Microelectronics Corporation [95] emphasises its commitment to credibility through the declaration of "maintaining the highest ethical standards and professional competence, and strictly requires its employees and business partners to abide by the applicable anti-corruption and anti-bribery laws and regulations irrespective of where business is conducted". Another example is that STMicroelectronics ([86], p. 6) requires its "suppliers to implement the Responsible Business Alliance (RBA) standards and encourage ISO and OHSAS certifications to address ethics, social, environmental, health, and safety risks. We participate in the Responsible Minerals Initiative." The activities undertaken by these companies to ensure their compliance with international standards and national law imply a significant impact of this diplomatic tool on sustaining the supply chain.

CSR and sustainability initiatives play a crucial role in the diplomacy of businesses, as companies implement these initiatives to earn public trust and legitimacy. SK hynix ([85], p. 22) requires the achievement of "all planned targets by enhancing ESG management capabilities and fostering mutual growth with suppliers." Moreover, United Microelectronics Corporation ([95], p. 31) aims to gain "public trust through business integrity and ethics; the Company fulfils its corporate social responsibility and achieves sustainable development." Numerous environmental and social sustainability initiatives have been launched, such as ASE Holding ([7], p. 185), which concentrates on "Community Development, Charitable Care, Emergency Assistance, and Cultural Development to engage with the local communities where we operate and to promote a more diverse and inclusive society," or Advantest ([1], p. 38), which has "laid out biodiversity conservation initiatives in accordance with The Advantest Group's Guidelines of Action for Biodiversity." In this context, when effectively implemented, CSR and sustainability initiatives not only benefit society but also contribute to the long-term growth of the business through enhanced reputation and strong relationships. Joint research programmes also fall into this category. By collaborating with research institutions, universities, and international partners, businesses can share resources, reduce R&D costs, and accelerate technological innovation. These programmes not only assist in improving products and services but also support businesses in meeting sustainability standards, complying with international regulations, and expanding their network of strategic relationships. This approach has been extensively adopted by many semiconductor companies.

Industry leaders typically engage more comprehensively with the entire stakeholder ecosystem. Business Diplomacy tools, such as codes of conduct, stakeholder dialogues, and ESG disclosures, have demonstrated effectiveness in fostering trust for sustainable supply chains. Nonetheless, a distinction will be made regarding the manner in which these companies utilise diplomatic tools. STMicroelectronics employs numerous tools to engage with their key stakeholders, thereby fostering an environment conducive to open dialogue. Similarly, Infineon Technologies categorises stakeholders into layers; the diplomatic tools employed to communicate with each layer serve distinct purposes in building trust within business operations. However, certain companies, such as Phison Electronics and Powerchip Semiconductor Manufacturing Corp, only engage in open dialogue with stakeholders who have a direct impact on their business activities. The remaining stakeholders will be informed through diplomatic announcements.

However, when comparing practices between companies, a clear differentiation emerges in the manner and degree of implementation of business diplomacy tools to build sustainable supply chains. Specifically, enterprises such as STMicroelectronics, Infineon Technologies, onsemi, and Phison Electronics demonstrate outstanding capabilities in systematically implementing business diplomacy tools. These companies take proactive measures to formulate a Supplier Code of Conduct and conduct regular sustainability assessments for 100% of their key suppliers. Furthermore, they establish direct communication channels with investors through events such as "Investor Days," which concentrate on sustainable development strategies, while incorporating internal programs such as "Voice of the Employee" to uphold elevated levels of employee engagement. Additionally, these companies devise CSR initiatives that are aligned with their core competencies, including the promotion of STEM education and the reduction of carbon emissions in local communities. In contrast, corporations such as Vanguard International Semiconductor (VIS), PSMC, and Nanya Technology primarily exhibit minimal engagement in compliance activities. Evaluations of suppliers are contingent upon fundamental standards such as RBA Compliance, and these organisations lack comprehensive programs aimed at the development



of long-term sustainability capabilities. Communications with shareholders frequently emphasise periodic financial reporting, with minimal focus on long-term Environmental, Social, and Governance (ESG) strategies. Local community initiatives typically involve sponsorships or charitable contributions, rather than fostering strategic connectivity initiatives to enhance the sustainability of the value chain.

In general, multinational enterprises exhibit a propensity to engage stakeholders in a more proactive, strategic, and innovative manner than regional companies, which are similarly influenced by external compliance requirements. This distinctly underscores the importance of business diplomacy as a crucial internal capability in the development of sustainable supply chains.

## 5 Discussion

The efforts of the companies examined show that the building a sustainable supply chain is an urgent requirement for businesses, including suppliers in the semiconductor industry, as previous authors have also pointed out [83, 90]. In this way, the supply of raw materials will not be disrupted due to noncompliance with national regulations and the demands of social and environmental stakeholders. From this observation, business diplomacy assumes its role in harmonising business interests with social interests. Every stakeholder has a distinct role in the sustainability of the global supply chain. In a sustainable semiconductor supply chain, suppliers, employees, customers, shareholders/investors, governments and academic institutions play a key role while industrial associations, business partners local communities, NGOs/IGOs also contribute significantly to sustainable development, as previously noted by Schultz et al. [79], and Rani et al. [70]. Similar to other industries [39], semiconductor companies cannot focus solely on profits, they must also consider longterm environmental, social, and governance impacts to maintain their position in an industry increasingly pressured for sustainability. The results shows the importance of collaboration between semiconductor companies and stakeholders that aligns with studies of Tosarkani and Amin [92], Singh et al. [83] and Hsieh et al. [37]. The results are consistent with the findings of the study conducted by Paulraj et al. [62], which asserts that companies must demonstrate a high moral level of commitment and engagement with stakeholders and their values within the supply chain. Practitioners may infer from this outcome that stakeholder engagement has broadened to include various types of stakeholders who possess the potential to create opportunities or assist in safeguarding companies from non-market risks. This perspective is further corroborated by the findings of Schultz et al. [79] and Bui [17]. Nonetheless, this paper has empirically demonstrated that the level of engagement varies significantly among companies, with stakeholders being only partially engaged, except in rare instances. As this industry is gaining momentum and is particularly influenced by geopolitical factors, a comprehensive engagement strategy is imperative to reduce the complexity in the market. The Semiconductor Industry Association [80] and Capgemini Research Institute [19] underscore the significance of trust within the supply chain to achieve sustainability. In particular, Capgemini Research Institute [19] advises that establishing an ecosystem of partnerships with all stakeholders is necessary to ensure a sustainable supply chain and mitigate any risks related to disruptions.

Suppliers are pivotal in the semiconductor industry's sustainable supply chain, providing the raw materials and components needed to produce chips and microchips. Critical materials such as silicon, rare earths, chemicals, and precious metals (such as gold, tantalum, tin, and tungsten) are often sourced from various countries, some of which risk human rights violations or unsustainable mining practices. Therefore, suppliers must ensure the continuity of raw material supply and commit to complying with environmental, social, and governance (ESG) standards. This research is in line with Kesteleyn et al. [44] and Saner et al. [78] that adhering to these standards helps to minimise risks and ensure that the production process does not harm the environment or local communities. Semiconductor companies tend to implement a business diplomacy strategy through dialogues to make ethical business conduct compulsory. Several influential tools, such as demands or due diligence, have been employed to ensure social and environmental sustainability throughout the value chain, which was implied by the research of Doh et al. [24] and Egea et al. [26]. This underlines the importance of the labour force in the sustainable supply chain, which is directly involved in implementing sustainability initiatives within the industry. To maintain a sustainable working environment, companies must ensure workers' rights, apply high labour safety standards, and promote diversity in the workforce [5, 36]. Selected semiconductor companies strongly emphasise social issues they and their partners and suppliers must address—investors and shareholders increasingly pressure them to fulfil their ESG commitments. Green investment funds and financial institutions will only invest in companies with clear sustainability strategies. This research also highlights the alignment with the research of Sidibé and Saner [82] and Bui [17] as these incentives compel companies to be more transparent in reporting their environmental impact, setting emission reduction targets, and investing in green technology to attract capital.



# 5.1 Theoretical implications

In this study, business diplomacy emerges as an essential and theoretically significant approach to building and managing sustainable supply chains in the semiconductor industry. This research demonstrates that business diplomacy underscores the role of enterprises as entities that not only seek profit but must also fulfil their responsibilities to stakeholders and promote sustainable values throughout the supply chain. The interconnection between semiconductor companies, employees, regulatory bodies, and suppliers is clarified within the semiconductor industry. This study contributes to multi-stakeholder management within business diplomacy theory [88] through the triangular relationships and the company. It implies that the success of a business diplomacy strategy is pre-defined by the industry, whether it is focused or not. The semiconductor industry is competitive not only at the micro level but also at the macro level, signifying global competition. Many business diplomacy studies have overlooked this industrial factor. This research also emphasises the organisational behaviour that will dictate the success of the business diplomacy agenda [50, 88]. Only when organisations, such as semiconductor companies, recognise their impacts on society and their contributions to the sustainable supply chain will their business diplomacy strategy focus on sustainability.

Another factor that warrants attention is associated risks. These reports evidently show that risk analysis constitutes the majority of a report, including risks arising from each stakeholder. Scholars of business diplomacy should consider this. As long as stakeholder risks are significantly involved in business activities, companies should strive to address them by engaging diplomatically with those stakeholders.

Figure 3 illustrates the role of business diplomacy in the process of engaging with key stakeholders. Business diplomacy facilitates the enhancement of trust-based cooperation among businesses through various mechanisms, including codes of conduct, stakeholder dialogues, CSR or sustainability initiatives, ESG disclosures, as well as influential tools such as regulatory compliance, strategic partnerships and alliances, networking, and lobbying. These business diplomacy tools foster deeper engagement with external stakeholders, including suppliers, governmental entities, and local communities, in order to identify and manage risks while fostering harmony with the internal working environment of employees who also play a significant role in contributing to a sustainable supply chain.

The findings derived from the present study substantiate and substantially augment the theory of business diplomacy as articulated by Saner et al. [78]. They demonstrate that global enterprises require not only technical and managerial competencies but also the capacity to navigate non-market environments through interactions with governments, civil society, and international organisations. Furthermore, the findings of the study reinforce the argument posited by



Fig. 3 The relationship of business diplomacy, stakeholder engagement and management, risk management. Source: Own creation



Henisz et al. [35] that strategic engagement with stakeholders not only enhances legitimacy but also has the potential to yield substantial long-term market and non-market returns. Companies such as Infineon, TSMC, and ASML exemplify that effective diplomatic strategies not only serve to mitigate ESG risks but also facilitate access to preferential policies and large-scale public–private partnerships.

The study substantiates this perspective within the semiconductor industry, which is notably susceptible to geopolitics, supply chain risks, and sustainability regulations. Therefore, business diplomacy is no longer considered an additional tool but has evolved into a strategic capability. Hence, this study conceptualises business diplomacy through a risk-based perspective and examines how companies incorporate business diplomacy into non-market risk forecasting and mitigation strategies strategy. This study provides empirical support for the existing literature regarding the conceptualisation of business diplomacy. Nevertheless, the interaction between business diplomacy and the concept of sustainable supply chains at the industrial level requires further elaboration to enhance the theory of supply chain sustainability, which extends beyond operational risks and logistics to include non-market risks and opportunities in relation to the strategising of business diplomacy. In the same vein, while the ESG model focuses on reporting compliance standards, the findings recommend reconceptualising sustainability actions of firms by integrating the diplomatic behaviour.

#### 5.2 Managerial implication

Business diplomacy also allows businesses to develop strategic partnerships with financial institutions, sustainable investment funds and regulatory agencies to respond to financial and compliance risks. This study agreed with Saner's [77] and Pantoja's [59] research that they formalise the industrial demands, which are sensitive in the host countries, and translate them into risks. This study examines the topic on a risk basis, similar to the approaches taken by [38], and [17]. Therefore, risks can be foreseen. In the event of conducting a sustainable supply chain, disruption risk due to natural disasters, geopolitical fluctuations, or grand challenges, business diplomacy plays its role as an approach to closely coordinate with partners and governments to seek alternative solutions and ensure business continuity. Given that leadership commitment is essential [60, 66] for sustainable supply chain management, this study provides several managerial insights, as outlined below:

- Maintaining transparent dialogue and establishing risk management mechanisms through business diplomacy: This action helps businesses improve their comprehensive risk management capabilities by associating with multi-stakeholder perspectives. This helps minimise the negative impact of risks and increases trust and support from shareholders, investors, customers and the community [17, 33, 54], thereby creating a solid foundation for sustainable supply chain development. For instance, in this study, selected companies avoided regulatory compliance risks by acquiring international standard certifications aligned with national law. This action could serve as a value contribution to market acceptance [32]. In short, the relationship between risk and business diplomacy is constituted based on a win-win situation, in which business diplomacy plays a role as a strategic tool to help businesses identify, minimise and manage risks in sustainable supply chains, thereby protecting reputation, optimising operational efficiency and ensuring long-term sustainable development. On the other hand, legitimacy will be approved and transferred to companies that can handle all stakeholders' demands. Thereby, they could align comprehensive risks with business operations. In a business environment increasingly dominated by non-market factors such as climate change, environmental policies, and geopolitical tensions which could generate many risks, the study results show that business diplomacy is emerging as a core management capability for semiconductor corporations to shape and maintain sustainable supply chains. This finding aligns with the view of Saner et al. [78], who argued that today's global businesses need to develop cross-functional diplomacy capabilities to maintain operational effectiveness in a complex world. This study was conducted in accordance with best practices evaluated by S&P Global in the semiconductor industry. Therefore, this study may serve as an empirical and practical consideration for companies within the industry to enhance their risk management systems and diplomatic strategies, thereby ensuring the adaptation of resilient supply chains in response to extreme events.
- Institutionalisation of the business diplomacy function: this action was backed by Saner et al. [78] by establishing a dedicated business unit responsible for diplomatic external relations, and this study emphasises the significance of business diplomacy, it is noted that this business unit may overlap with other functional offices such as public relations or market research. In this context, the recommendation of a high-level or senior official for institutionalising business diplomacy at the firm level is advisable. Another step in institutionalisation involves the standardisation of proactive diplomatic processes to establish multilateral partnerships with stakeholders aimed at mitigating poten-



tial risks and reactive diplomatic actions in the event of conflicts or extremity cases which could cause disruption in the supply chain. Prompt diplomatic interventions will ultimately contribute to the reduction or alleviation of risks, thereby ensuring a sustainable supply chain.

- Multilateral diplomatic engagement: this study advocates for the strategic implementation of multilateral diplomatic engagement with stakeholders through a proactive methodology. For example, these semiconductor enterprises have been actively involved in global initiatives such as RE100 and the United Nations Global Compact (UNGC), which facilitate the establishment of an effective and influential communication channel for the promotion of favorable policy frameworks. Ultimately, to establish a robust strategic alliance, organisations must develop cross-functional diplomatic competencies and sustainability training programs for management and operational teams to bolster their capacity to address non-market risks, particularly in politically sensitive regions.

KPMG [31], Capgemini Research Institute [19] and Semiconductor Industry Association [80] implies that participation in industrial and trade associations will create an open dialogue and communication with necessary stakeholders to ensure the flow of market intelligence which dictate a resilient and sustainable supply chain. From this empirical point of view, diversification and intensification of business diplomatic tool suitable for each stakeholder group are advised. This recommendation intends to a two-way open communication and to avoid only announcement from one side which could lead to the non-market risks. These implications not only contribute to enhancing adaptability and supply chain stability but also play a crucial role in fostering sustainable competitiveness for enterprises in the long term.

# 6 Conclusion

In summary, this analysis highlights the crucial relationship between business diplomacy, and sustainable supply chain management. This academic exploration of their interconnections contributes to the ongoing discourse regarding the transformation of business practices in response to contemporary challenges. The role of business diplomacy has recently gained more attention in international business practices and the development of management theory. In particular, this study was conducted based on a sensitive industry, which is semiconductors. From social and environmental elements, semiconductor is an energy and water-intensive-used industry with a complex manufacturing process. The companies in this industry are strictly subject to regulations while engaging in social actors is an added value. Business diplomacy is vital in building sustainable supply chains in the semiconductor industry, where globalisation, supply chain complexity, and geopolitical factors increasingly impact. According to this research, the stakeholder groups that hold a pivotal role in the sustainable development strategies of a supply chain encompass suppliers, employees, customers, governmental bodies, and academic institutions, all of which engage in open and reciprocal dialogue. In contrast, industry associations, business partners, NGOs/IGOs, and local communities appear to lack sufficient focus. It is noteworthy that companies not only recognise stakeholders but also implement appropriate specialized diplomatic strategies effectively demonstrating their proactive approach in shaping institutional relationships via codes of conduct, stakeholder dialogues, CSR or sustainability initiatives, ESG disclosures, regulatory compliance, strategic partnerships and alliances, networking, and lobbying.

This study contributes to three principal lines of research. First, it enhances the understanding of business diplomacy by offering a practical toolkit within a debatable industry, instead of being confined to prior conceptual classifications [78]. Second, it augments stakeholder theory by illustrating how firms execute engagement strategies that are differentiated based on the power and influence of each stakeholder group. Third, it integrates sustainable supply chain management and non-market strategy theory, demonstrating that business diplomacy serves a dual role: acting as both a strategic capability and an institutional coordination mechanism to enhance a sustainable and resilient supply chain in intricate geopolitical contexts [35].

# 7 Limitations and future research direction

While this study offers valuable insights into the role of business diplomacy in the promotion of sustainable supply chains, it is important to acknowledge certain limitations. Firstly, the research relied predominantly on secondary data derived from the integrated reports, ESG reports, and sustainability reports of 19 significant semiconductor companies, which may not comprehensively represent the informal or context-specific practices of business diplomacy. The absence of



access to primary data from senior managers could have diminished the profundity of the analysis regarding internal strategic drivers.

Moreover, the CSA methodology of S&P Global Ranking has limitations, including its reliance on self-reported data, potential biases related to enterprise size, and the absence of field surveys. While verified, the Corporate Sustainability Assessment (CSA) significantly depends on data supplied by businesses, which introduces the potential for information bias or "greenwashing." Additionally, size bias emerges as a limitation, as larger enterprises with greater resources are more capable of preparing data, thereby increasing their likelihood of attaining higher scores relative to smaller businesses. Moreover, the CSA heavily relies on document and media analysis, which restricts the scope of on-site evaluations. This may potentially result in self-reporting bias or exclude unreported factors.

Secondly, although the thematic analysis method is pertinent for exploratory purposes, it remains subjective in its interpretation; consequently, the results may be susceptible to research bias or influenced by the manner in which each company articulates its findings.

In order to enhance the comprehension of this subject matter, prospective research may explore the following avenues. Firstly, there is a necessity for more comprehensive qualitative research, including semi-structured interviews with ESG managers, external affairs directors, and heads of supply chains, to gain a deeper understanding of the mechanisms and strategic drivers that underpin business diplomacy. Secondly, the theoretical implication shows the possibility of business diplomacy as a moderating or controlled variable which affects the sustainable supply chain. In this sense, quantitative research may be undertaken to assess the impact of business diplomacy capabilities on specific performance outcomes, including financial performance, supply chain flexibility, and supplier ESG compliance. Lastly, cross-regional comparative studies, such as those contrasting Europe, East Asia, and North America With the variation of the country context, companies will need specific proper diplomatic strategies. This type of research would facilitate the identification of the influence exerted by institutional, cultural, and political contexts on the manner in which companies engage in business diplomacy.

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#### Declarations

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