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Proactive approaches towards the phase-out of the PFAS family:

The PFAS Movement status and a multi-national automotive enterprise towards hazardous chemicals phase-out.

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Abstract

The pervasive issue of Per- and polyfluoroalkyl substances (PFAS) motivated the research for this master's thesis. During a previous professional experience at a chemical consultancy, insights were gained into the Registration, Evaluation, Authorization, and Restriction of Chemicals (REACH) regulatory requirements, which informed the foundation of this study. PFAS are recognized for being highly toxic to both humans and the environment, and the impending REACH PFAS Restriction aims to phase out this entire family of chemicals within the EU. However, the final decision on the complete phase-out of PFAS, often referred to as "forever chemicals," is still pending. This regulatory uncertainty and the active PFAS Movement pose significant challenges and opportunities for industries, particularly multinational enterprises operating across different regulatory landscapes.

This thesis focuses on the adaptation strategies of a multinational automotive enterprise to the upcoming ECHA's PFAS Restriction. It explores their current knowledge, approaches, and awareness of hazardous chemicals within their global supply chain. Additionally, the study examines the status and feasibility of the PFAS Movement in the absence of fully enforced regulatory measures.

Methodologically, this case study involved analyzing the REACH PFAS Restriction status and conducting interviews with stakeholders across different management levels within the enterprise. It also involved key observations from the Helsinki Chemicals Forum 2024. The framework for analysis was derived from literature reviews and insights from the Helsinki Chemicals Forum. Furthermore, the United Nations Global Framework on Chemicals (GFC) provided a comprehensive basis for addressing the research questions, focusing on strategic objectives related to legal frameworks, institutional mechanisms, capacities among key actors, partnerships and collaboration, and integration into decision-making processes.

The findings reveal that the PFAS Movement depends heavily on legal frameworks, specifically REACH, for effective chemical phase-out. Multinational enterprises need help aligning their global operations with EU regulations, particularly the lack of PFAS reporting and management practices that vary per region. The study underscores the importance of cross-sectoral collaboration, internal enterprise capacities, and proactive measures for successful PFAS management and phase-out. Practical policy and industry implications include integrating decision-making processes and transparency in hazardous chemical management. Recommendations for future research highlight the necessity of exploring the financial feasibility of PFAS alternatives, the identification of PFAS in supply chains, and strategies to avoid regrettable substitutions.

Keywords: PFAS, Hazardous Chemical Restriction, REACH, Multinational Automotive Industry, Global Supply Chain Management

Executive Summary

Background and Introduction

The persistent environmental and health hazards posed by per- and polyfluoroalkyl substances (PFAS) have required comprehensive research and regulatory measures. This master's thesis investigates the implications of the impending REACH PFAS Restriction, which aims to phase out the entire family of PFAS chemicals within the European Union (EU). During previous professional experience at a chemical consultancy, the author gained substantial knowledge about the Registration, Evaluation, Authorization, and Restriction of Chemicals (REACH) regulations, specifically concerning the classification, labeling, and packing of chemicals. This thesis leverages that knowledge to understand the broader implications of PFAS restrictions, mainly focusing on a multinational automotive enterprise's adaptation strategies.

PFAS are widely recognized for their high toxicity to humans and the environment. The REACH PFAS Restriction is set to phase out these "forever chemicals" in the EU in the coming years, although the final decision is still pending. The PFAS Movement and the upcoming regulatory restrictions create uncertainties, challenges, and opportunities for enterprises. These changes necessitate thoroughly examining the industry's readiness to adapt and comply with new regulations, especially for multinational enterprises operating in different regulatory environments.

Research Objectives and Questions

The primary objective of this thesis is to explore how a multinational automotive enterprise will adapt to the upcoming ECHA's PFAS Restriction. The research aims to assess the company's current knowledge, approach, and awareness of hazardous chemicals in its global supply chain. Additionally, it investigates the status and feasibility of the PFAS Movement in the absence of fully enforced regulatory measures. Two main questions guide the research:

1. What are the current challenges and status of the PFAS Movement from different stakeholders' perspectives?

2. How will a multinational automotive enterprise phase out PFAS and adapt to the upcoming REACH PFAS Restriction in their products, processes, standards, and business approach when cross-functioning with industries around the globe?

Methodology

The methodology employed in this research is an exploratory qualitative case study focusing on a multinational automotive enterprise to understand its adaptation strategies in response to the upcoming REACH PFAS Restriction. The study design involved a comprehensive analysis of the REACH PFAS Restriction status and in-depth interviews with various stakeholders within the enterprise, including individuals from diverse management levels and geographical locations. This approach allowed for a nuanced understanding of the enterprise's management plans, adaptation strategies, and environmental practices when complying with hazardous chemicals in diverse jurisdictions while operating globally.

The analytical framework for this study was derived from extensive literature reviews and insights gained from the Helsinki Chemicals Forum. The new United Nations Global Framework on Chemicals (GFC) was also utilized to provide a structured basis for addressing the research questions. This framework emphasizes two strategic objectives: the

Establish legal frameworks, institutional mechanisms, and capacities for the safe management of chemicals and enhance implementation through effective resource mobilization, partnerships, and integration into decision-making processes.

The research process involved qualitative data collection through interviews and document analysis. Thematic coding was used to inductively organize the data, while a deductive approach was applied to assess each theme against the most recent topics related to the research. The study also integrated the five key aspects derived from the two strategic objectives of the GFC, which include legal frameworks, institutional mechanisms, capacities among key actors, partnership and collaboration, and integration into decision-making processes. These aspects were essential in analyzing the research questions and understanding the challenges and strategies related to the PFAS phase-out.

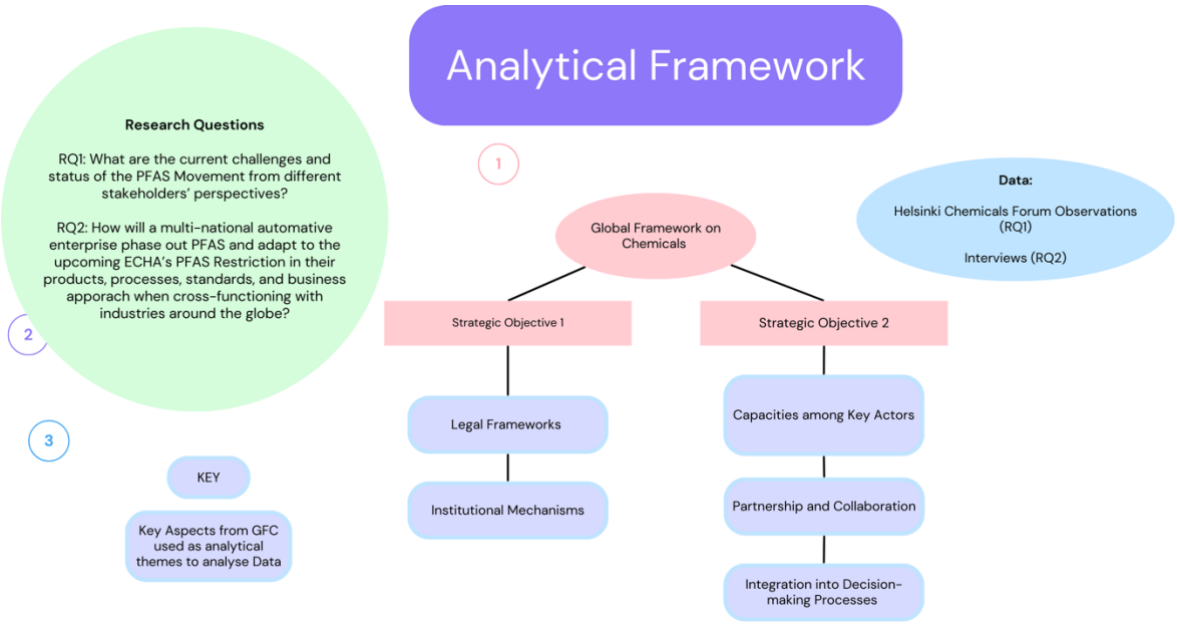

Figure 0-1: Analytical Framework

Source: Author's own.

Key Findings

- Challenges and Status of the PFAS Movement:

⇒ The PFAS Movement heavily relies on legal frameworks like REACH to ensure safer chemical management. Despite PFAS not being universally included in legal frameworks, organizations like ECHA target PFAS as hazardous chemicals.

⇒ The pending REACH PFAS Restriction creates uncertainties for multinational enterprises, particularly in aligning global operations with EU regulations.

⇒ Cross-sectoral collaboration and proactive measures are crucial for effective PFAS management and phase-out. Stakeholders advocate for transparency and knowledge sharing for successful international cooperation and partnerships.

- Adaptation of Multinational Automotive Enterprise:

⇒ The enterprise identified minimal PFAS presence in one specific product and is acting to address this, although other environmental priorities exist.

⇒ Suppliers' lack of mandatory PFAS reporting complicates the enterprise's efforts to assess PFAS usage in their global supply chain.
⇒ The enterprise employs various strategies to stay updated with regulatory changes, including collaboration with external organizations and an internal sustainability council.
⇒ Effective internal and external collaboration, transparency, and proactive measures have positioned the enterprise to anticipate and comply with new regulations.

Practical Implications

For practitioners in the industry sector, it is essential to integrate lower management roles into decision-making processes concerning hazardous chemicals like PFAS. Transparency and collaboration within enterprises and with external stakeholders can foster voluntary disclosure and safer chemical management. For policymakers, implementing PFAS testing and offering support through institutional mechanisms can facilitate smoother transitions for industries facing new regulations.

Recommendations for Future Research

Future research should focus on understanding the transition stages of companies within and outside the PFAS Movement, identifying PFAS in supply chains, and exploring the financial feasibility of PFAS alternatives. Additionally, studies should examine suppliers' behavior, their proactive measures to report PFAS, and strategies to avoid regrettable substitutions.

Conclusion

This thesis comprehensively analyzes the challenges and opportunities posed by the upcoming REACH PFAS Restriction and the active PFAS Movement. By examining the adaptation strategies of a multinational automotive enterprise, the research highlights the critical role of collaboration, transparency, and proactive measures in managing hazardous chemicals and ensuring compliance with evolving regulatory requirements.

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Abbreviations

PFAS – per and poly-fluoroalkyl substances

GSC – Global Supply Chain

HCF/The Forum – Helsinki Chemicals Forum

The enterprise – The multi-national automotive enterprise

GFC – Global Framework on Chemicals

REACH – Registration, Evaluation, Authorisation, and Restriction of Chemicals

ECHA – European Chemicals Agency

GS Council/The Council – Global Sustainability Council

OEMs – Original Equipment Manufacturers

CSRD – Corporate Sustainability Reporting Directive

EU – European Union

UN – United Nations

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1 Introduction

Our interconnected world has no easy path to follow when restricting human-created per and poly-fluoroalkyl substances (PFAS). These substances, also known as "forever chemicals" due to their bioaccumulation and high persistence in degradation, consist of a diverse conglomerate of thousands of chemicals (Pensyl, 2023). PFAS can be found from the Tibetan Mountain Ranges to the Arctic Circle (Ray, 2022). These chemicals have been used in various products since the 1940s, but it was not until the 1990s that their toxicity levels became public knowledge despite incomplete disclosure. (Gaber et al., 2023).

The extreme remediation costs, along with the damaging affectation on humans and the environment, arose in the last decades, finding that PFAS serves as a direct cause of numerous health diseases when ingested. Forever chemicals have been linked with testicular cancer, kidney cancer, ulcerative colitis, thyroid disease, and pregnancy-induced hypertension, among other diseases (Sarratos, 2021)(Gaber et al., 2023). Currently, there is minimal information on the toxicity levels of this family of substances (Ray, 2022).

In present times, PFAS have been used in an open range of appliances, such as Teflon (non-stick and lubrication cookware), cosmetics, impermeable or water-repellent fabric, food packaging, medical devices, automotive, military equipment, industrial manufacturing, electronic devices, and fire-extinguishing foam. They became highly used due to their resistance capacity and the solid-repellent effects on oil and water, as well as on textiles and coating products ("PFAS Explained - US EPA," 2023). These chemicals adhere to livestock food, dairy products, soil, drinkable and groundwater, and even human breastfeeding milk and umbilical cord blood (Sarratos, 2021).

The international relevance of the DuPont contamination cases pushed the United States (US) to act on more public testing, with more cases arising throughout the decades (Ray, 2022). The most employed and researched chemicals are perfluorooctane sulfonic acid (PFOS) and perfluorooctanoic acid (PFOA), primarily identified from their persistence and alarming, dangerous effects on the environment and humans (Pensyl, 2023). The gravity of this issue persists, and around 90% of pregnant women in the US are liable for PFAO and PFOS exposure (Gaber et al., 2023). Around 15 million Americans are continuously affected by PFAS leakage through tap water (Pensyl, 2023).

PFAS relies on the regulating interest of nations and how different problems or solutions could arise from banning such utilized chemicals, as they are contained in an extended variety of niches, and the alternative chemicals that could supplement PFAS do not include a formal toxicology report yet, just as the PFAS family (Spyrakis & Dragani, 2023).

The REACH PFAS Restriction continues in the evaluation process and will not be enforced until several years later (*Next Steps for PFAS Restricition Proposal - ECHA*, 2024). Companies do not have a chemical regulatory scheme to follow when assessing PFAS and must implement internal chemical management strategies (Pensyl, 2023). The current PFAS Movement has been an active platform for companies, institutions, organizations, and practitioners to raise their concerns and act on the forever chemicals (International Chemical Secretariat, 2021).

1.1 Problem definition

During my MESPOM internship, I had the opportunity to conduct it with a chemical consultant. I learned about the Registration, Evaluation, Authorization, and Restriction of

Chemicals (REACH) regulatory requirements for the classification, labeling, and packing of chemicals. I want to use this knowledge gathered for my thesis, learning the general restriction of PFAS to comprehend how a restriction process is done and how the European Chemicals Agency's (ECHA) regulatory updates are published.

PFAS are found to be highly toxic to humans and the environment. The REACH PFAS Restriction will phase out the entire PFAS family in the EU in the coming years. The final decision to remove these forever chemicals is still awaiting. The PFAS Movement has created external changes in the industry sector toward the PFAS phase-out. The pending restriction of PFAS and the active approach of the PFAS Movement can generate uncertainties, challenges, and possibilities for enterprises, and there might be different considerations from authorities, institutions, stakeholders, and practitioners.

REACH is actively assessing the PFAS family, and companies will be pushed to adopt new measures and alternatives. In the case of multi-national enterprises, uncertainties can arise when these industries reside in different parts of the globe, as to which extent they must comply with the EU and whether these new requirements and methods are implemented throughout the enterprise or only for their industries based in the EU.

Lately, disclosing the ongoing evaluation of the ECHAS's Committee for Risk Assessment (RAC) and the Committee for Socio-economic Analysis (SEAC) opinions has provided better justification for the next step of PFAS in the EU. This also leaves uncertainties on the next step for companies with direct or indirect contamination of PFAS and its approach, defining the chemical ban's position and the industry sector's approach.

1.2 Aim and Research Questions

My thesis aims to research a multi-national automotive enterprise on how they will adapt to phase out PFAS from any products or processes, their current knowledge, approach, and awareness of hazardous chemicals in their global supply chains, as well as research the status of the PFAS Movement and its feasibility when lacking regulatory capacities and comprehending the impact of EU hazardous chemical restrictions upon organizations and the private industry sector.

The following research questions were formulated:

RQ1: **What are the current challenges and status of the PFAS Movement from different stakeholders' perspectives?**

RQ2: **How will a multi-national automotive enterprise phase out PFAS and adapt to the upcoming REACH PFAS Restriction in their products, processes, standards, and business approach when cross-functioning with industries around the globe?**

1.3 Delimitations and Scope

The case of selecting a multinational automotive enterprise was derived from previous contacts in Mexico who hold professional services with this enterprise, as well as past working experiences with chemical regulations and their transition to new products. These experiences also support connecting with organizations and experts related to chemicals and PFAS. In this specific case, the scope of the research was delimited to this exact enterprise and practitioners and organizations within the chemical and PFAS realm.

1.4 Ethical Considerations

Researcher honesty and personal integrity. There will not be any external organization funding my research; for this, the flow of the study, findings, and conclusions will not be affected by external funding. No external party has the authority to influence the findings or decisions of the thesis.

Ethical responsibilities to research subjects include consent, confidentiality, and courtesy. Any eligible participant will be informed of the type of involvement and will always be able to withdraw at any given moment from the interviews without any obligation. I will address any issues arising during the research, minimize disadvantages, and surveil the entire research.

What may the findings be used for? The outcome of the research seeks to provide knowledge and not do any harm. Always be aware of the privacy, dignity, and respect of the individuals, and communicate the limitations of the findings with respect.

Handle, store, and make available data records. The information gathered will be safeguarded, protecting the privacy and confidentiality of the participants and ensuring that any sensitive data is assessed according to the ethical thesis guidelines. The empirical data that is collected will be stored in password-locked private devices.

2 Literature Review

This literature review assesses the current academic knowledge of the PFAS chemical compound family. It will provide a broader comprehension of the PFAS family and the regulatory measures taken to phase out PFAS in the European Union. It will also briefly describe the policy challenges in the EU, regulatory updates on PFAS, and a deeper explanation of the PFAS Movement.

2.1 PFAS Chemical Composition

The term PFAS is used to shorten the whole family, which consists of some 12,000 chemicals (Spyrakis & Dragani, 2023). The present terminology of PFAS is general, an organic definition in chemistry terms, simply guiding authorities and stakeholders to obtain practical comprehension of the chemicals (*Reconciling Terminology of the Universe of Per- and Polyfluoroalkyl Substances: Recommendations and Practical Guidance*, n.d.)(Spyrakis & Dragani, 2023).

The OECD Chemicals and Biotechnology Committee formally defines PFAS as: "…fluorinated substances that contain at least one fully fluorinated methyl or methylene carbon atom (without any H/Cl/Br/I atom attached to it), i.e., with a few noted exceptions, any chemical with at least a perfluorinated methyl group (–CF3) or a perfluorinated methylene group (–CF2-) is a PFAS" (*Reconciling Terminology of the Universe of Per- and Polyfluoroalkyl Substances: Recommendations and Practical Guidance*, n.d.).

This definition only clarifies the coherency and consistency throughout the compounds; simply, it only seeks to explain the separation of PFAS from non-PFAS compounds, leaving the specific working scopes to the users and the activities applied. It does not establish that the PFAS family shares the same compound properties, appliances, hazardous exposure, or risks (*Reconciling Terminology of the Universe of Per- and Polyfluoroalkyl Substances: Recommendations and Practical Guidance*, n.d.). Individual users' activities and specific working scopes can set the hazardousness classification.

The compounds of chemicals are categorized between short and long chains; PFAS consists of a fully (per) or partially (poly) fluorinated carbon chain. The length of these chains describes the properties that impact the conduct of the substance over the environment, its toxicity, and accumulation levels ("Portal on Per and Poly Fluorinated Chemicals," 2023).

When categorizing PFAS, there is a discernment between short and long-chain compounds. The long-chains are known as PFOA and PFOS, with derivative compounds perfluoro carboxylic acids (PFCAs), perfluoro alkane sulfonic acids (PFSAs), and perfluorobutane sulfonic acid (PFHxS), all classified as toxic, bio-accumulative, and bio-persistent chemicals ("Portal on Per and Poly Fluorinated Chemicals," 2023). The United States conducted a representative blood serum testing, resulting in 99% of their population carrying PFAS in their blood (Ray, 2022). European authorities evaluate that if no enforcement is applied, 4.4 million tons of PFAS can remain on for the upcoming 30 years on our planet ("ECHA Publishes PFAS Restriction Proposal," 2023).

2.2 REACH PFAS Restriction

The Registration, Evaluation, Authorisation, and Restriction of Chemicals (REACH) is a regulation of the European Union, enforced in 2007, and was established to increase measures that protect the environment and human health from chemical risks. This regulation also promotes competitiveness within the chemical industry and advocates implementing alternative

methods to conduct hazard assessments of chemical substances (*Understanding REACH - ECHA*, n.d.).

Companies play the leading role by complying with the REACH regulation. Their responsibility relies on ensuring the identification and risk management of their substances. They must provide safety information about their chemicals (*REACH Regulation - European Commission*, 2024). When risks are not managed, authorities restrict the substances, and substitution must be done for the most hazardous chemicals (*Understanding REACH - ECHA*, n.d.).

Since 2014, several EU countries, including the European Commission and the ECHA, have recognized the presence of PFAS registration within the ECHA's database and have started conducting regulatory measures. Due to the vast number of PFAS, only the highest urgency PFAS have been regulated (*Per- and Polyfluoroalkyl Substances (PFAS) - ECHA*, n.d.).

REACH decided to act on the PFAS family substances by proposing a complete restriction of the entire family of hazardous chemicals, also known as the 'universal PFAS restriction' ("PFAS Restriction") (Wietor, 2024). The restriction procedure has been exhaustive and began with the PFAS Restriction proposal in 2023. In March 2023, a six-month Committee's Opinions open consultation was initiated. ECHAS's Committee for Risk Assessment (RAC) and the Committee for Socio-economic Analysis (SEAC) prepared the proposals' scientific evaluation and reviewed the comments from organizations, stakeholders, and individuals ("ECHA Publishes PFAS Restriction Proposal," 2023).

Although the REACH PFAS Restriction is not the first, other restrictions have mitigated some PFAS compounds. The Stockholm Convention focused on Persistent Organic Pollutants (POPs) and restricted PFOS and PFOAS from the PFAS family, and REACH also restricted PFOA, C9-C14, PFHxS, PFHxA, and fire-fighting foams (Wietor, 2024).

The PFAS Restriction differs from other individual bans due to the encompassing of the entire PFAS family. This restriction contemplates two assessment options: i) a complete ban with an 18-month transition period, and ii) a complete ban with an 18-month transition period with a specific time of 5 or 12-year derogation. The derogation period gives companies essential use time to continue using these chemicals until the end of their specific-time transition period (FPP4EU, 2023).

In March 2024, ECHA announced that its two scientific committees, RAC and SEAC, would continue evaluating the PFAS Restriction proposal due to the many comments received during the consultation process (Federal Institute for Occupational Safety and Health, 2024). Due to this continuous evaluation process, no official date has been set for the application of the PFAS Restriction, and the current updates from ECHA regarding this matter are on hold, awaiting the final opinions from the two scientific committees to present them as soon as possible to the European Commission. The following months of June and September 2024 are set to discuss two committee meetings regarding the comments on metal products manufacturing, textiles, leather, packaging, and petroleum and mining. (*Next Steps for PFAS Restriction Proposal - ECHA*, 2024) In the meantime, no further regulatory guidance has been disclosed.

2.3 PFAS Regulatory Challenges

The current dilemma in the EU is how to ban the PFAS family correctly to ensure social and economic protection. Although the environment is a priority, restricting all PFAS substances could be costly for businesses' adaptation and remediation (Wietor, 2024).

The European Commission adopted the Chemicals Strategy for Sustainability in 2020. This strategy adds to a relevant part of the EU's zero pollution ambition, a fundamental commitment to the European Green Deal (*Chemicals Strategy for Sustainability - ECHA*, n.d.). The European Green Deal is a growth and development strategy that aims to protect the environment and achieve climate neutrality across the EU by 2050. It underscores diverse policies and actions to accomplish a clean transition from funding, regulation, innovation, and dialogue integration to meeting the goals of the Paris Agreement (*The European Green Deal - European Commission*, n.d.).

The Chemicals Strategy for Sustainability has set an action plan to ban the most harmful chemicals, contemplating the PFAS family as a hazardous threat and promoting its effective phase-out unless for essential usage (*Chemicals Strategy for Sustainability - ECHA*, n.d.). In order to achieve this, the Chemicals Strategy for Sustainability set a regulatory roadmap (see Annex 1)(*Helsinki Chemicals Forum*, 2024) that portrays their current regulatory transitions. The PFAS Restriction is located on the preparation and adoption from its proposal phase. This is strictly caused by the ongoing evaluation process with the two scientific committees, as a complete assessment of the comments must be done before reaching another regulatory phase (*Next Steps for PFAS Restriction Proposal - ECHA*, 2024). The most recent estimation for a PFAS Restrictions application will not be until 2029, giving time for industries to prepare, adjust, and transition (*Helsinki Chemicals Forum*, 2024). However, this is not a specific date set by the Chemical Strategy for Sustainability; it is an estimation derived from the current regulatory procedure of the PFAS Restriction (*Chemicals Strategy for Sustainability - ECHA*, n.d.).

Other legal frameworks have been enforced in the meantime, such as the new Corporate Sustainability Reporting Directive, which requires large companies to report their social and environmental risks (European Parliament, 2022), as well as the new Corporate Sustainability Due Diligence Directive, which promotes sustainable and responsible corporate behavior across the value chain (*Corporate Sustainability Due Diligence - European Commission*, n.d.); the new Global Framework on Chemicals that promote the safer management of chemicals and fosters collaboration across sectors ("Global Framework on Chemicals," 2024); and the EU's Chemical Industry Transition Pathway, which is a roadmap created to guide the transition to safe and sustainable chemicals (*EU Chemical Industry Transition Pathway*, n.d.). All the previously mentioned support and alignment with the European Green Deal (*The European Green Deal - European Commission*, n.d.), although the PFAS Restriction is still in the evaluation process, none of these legal frameworks can contemplate the entire PFAS family. They can provide bases for hazardous chemicals assessment, safer management of chemicals, and collaboration for sharing knowledge and data, which serve as reasonable initial steps to assess PFAS if needed. At the same time, they support the Green Deal's ambitions as the Chemicals Strategy for Sustainability does, envisioning the inclusion of the entire PFAS family in the future.

2.4 PFAS Movement

Supply chains have become a key pillar in our current lifestyles, as we have created an intricate dependency on them (Yeoh, n.d.). In 2020, the COVID pandemic taught the world that when uncontrollable external forces act upon humans, we can do little to nothing alone. Several worldwide problems have arisen in recent years, such as wars, economic recessions, and the global pandemic. These issues showed the vulnerability of companies and, more specifically, reflected on their supply chains (Xu et al., 2023).

Supply chains have learned through these implications how to adapt to nature's forces and fulfill the customers' demands (Ivanov, 2022). Despite that, everything comes with a cost, and for companies, their most significant setback was supply chain disruptions, which is an issue that must be mitigated at all costs (Xu et al., 2023). On the verge of these ongoing issues, policy

markers are continuously enforcing regulations on companies and directly on the supply chains. The requirements for sustainability reporting have changed the activities of the industrial sector for the better, as enterprises are conducting holistic approaches to sustainability requirements (Ike et al., 2019). Incorporating holistic approaches in supply chains is a sign that capabilities are firmly harnessed (Arda et al., 2023), and by including proactive approaches, companies can position themselves not only one step ahead of the competition but of the regulations as well (Zhou et al., 2024).

The PFAS family has posed a new threat to supply chains, and companies that harness holistic and proactive approaches can react much faster to these issues, which can disrupt the supply chain and affect its overall performance (Arda et al., 2023). Companies are more proactive toward preventing and remediating issues that threaten their supply chains. The PFAS Movement, established by the International Chemical Secretariat ("ChemSec") in 2020, (*PFAS Movement*, n.d.) has driven unprecedented change from the private sector by developing its databases, such as the SINLIST, where companies can check which chemicals to avoid; the ChemScore, a sustainability ranking for the most significant chemical products; ChemSec's Marketplace, where companies can find safer alternatives from hazardous chemicals, and the PFAS Guide, a platform that helps companies identify PFAS in their products and processes (International Chemical Secretariat, n.d.-b).

Even though ChemSec established the PFAS Movement in 2020, intending to build a network that can act together to tackle PFAS, it currently encompasses much more than that and has built on a more significant network (International Chemical Secretariat, 2021). Other organizations have also decided to act against PFAS, developing programs, webinars, databases, sector groups, etc., such as Change Chemistry, a network of organizations with more than 100 companies aiming to make sustainably safer chemistry throughout the marketplace (Change Chemistry, n.d.); FluoroProducts and PFAS for Europe ("FPP4EU"), a sector group of the European Chemical Industry Council, dedicated to providing a space for exchange and discussion between producers, importers, other parties, and user of PFAS (FluoroProducts and PFAS for Europe, n.d.); and Enhesa Product Intelligence, that promotes safety in product and market access to decrease the risk of non-compliance (Enhesa, n.d.).

The PFAS Movement pushed for a much more profound approach to tackling PFAS, and the concept itself has evolved into an entire movement that drives diverse organizations, businesses, and companies to work for the same outcome: the phase-out of PFAS. The organizations mentioned above have stepped in and proacted toward any upcoming restriction on these forever chemicals, supporting businesses to appoint and plan any practices and approaches that can be implemented before more global restrictions arise to regulate PFAS.

Research Design, Materials, and Methods

This section presents the framework used to analyze the RQs. It has been derived from observations made during the Literature Review and insights from the Helsinki Chemicals Forum. The new United Nations Global Framework on Chemicals (GFC) is analyzed and detailed to justify its adoption. This new framework focuses on two strategic objectives synthesized into five key aspects directly related to the RQs.

2.5 Research Design

Utilizing up-to-date approaches is essential to adequately addressing the RQs. The Global Framework on Chemicals—For a Planet Free of Harm from Chemicals and Waste encompasses various aspects, such as hazardous chemicals exposure in the global supply chain, stakeholder engagement, and sustainable management strategies, that comprehensively address this research topic ("Global Framework on Chemicals," 2024).

To date, scholars have yet to publicly explore and evaluate the effectiveness of strict regulations on the GSC, the current practices of major corporations, and optimal methods for phasing out hazardous chemicals from the supply chain. HCF experts discussed the GFC's strategic objectives as a basis for sound targets for effective chemical phase-out from the supply chain, among other plans (*Helsinki Chemicals Forum*, 2024).

The GFC established five strategic objectives and 28 targets, guided by the Rio Declaration on Environment and Development and 13 different United Nations statutes from declarations, plans, agendas, and codes. In this case study, the twenty-eight targets are not included, as the UNEP's "indicators for tracking progress in reaching targets" are yet to be determined ("Global Framework on Chemicals," 2024), and the provisions are being continuously developed (Carlini et al., 2024). These strategic objectives are set to report and monitor the progress and impact of implementing the GFC. However, the aim is not to analyze its effectiveness but to answer these RQs. Only two of the five strategic objectives are assessed by adapting the research authors' analytical framework (Figure 2) due to relevance and similarities with the RQs. To operationalize the analytical process, the author established five key aspects derived from the two strategic objectives, which are set to analyze the RQs.

The two selected strategic objectives are stated as follows ("Global Framework on Chemicals," 2024):

1. "Legal frameworks, institutional mechanisms, and capacities are in place to support and achieve the safe and sustainable management of chemicals throughout their life cycle."
2. "Enhanced implementation occurs through increased and effective resource mobilization, partnerships, cooperation, capacity-building, and integration into all relevant decision-making processes."

The five key aspects consist of i) Legal Frameworks, ii) Institutional Mechanisms, iii) Capacities among key actors, iv) Partnership & Collaboration, and v) Integration into decision-making processes. These five key aspects (Table 1) are challenges the policy and industry sector must address to assess hazardous chemicals effectively, ensure safer management, and protect the environment, industries, and society. They converge with the current literature review to address companies' uncertainties when phasing out hazardous chemicals and shed light on how restrictions and regulations affect them. They aim to promote effective chemical management and its adaptability to new tools and instruments. In addition, they focus on multisectoral engagement, building a connection among all sectors and including social and environmental

matters that are pivotal for effectively managing chemicals while constantly adapting to industry changes ("Global Framework on Chemicals," 2024).

Key Aspects	Description
Legal Frameworks	Legal frameworks are the set of regulations, laws, codes, etc. that rule our political, socio-economic environment. These appply to a particular region, country, continent or worldwide. They are set to regulate our activities and guarantee our safety (Conti & Peruginelli, 2021).
Institutional Mechanisms	These are different mechanisms such as guidelines, rules, practices and processes that are coordinated by insittutions, sometimes institutions apply as the mechanism itself as it can provide guidance, support, and collaboration acrros sectors and promote stakeholder engagement ("Global Framework on Chemicals," 2024) (Agrawal et al., 2021).
Capacities among key actors	Capacities are the internal and external of resources, from skills, platforms, integrated groups, activities, and knowledge that can be implemented by actors ("Global Framework on Chemicals," 2024).
Partnership & Collaboration	Cross-sectoral agreements, networks, mechanisms for cooperation, that are key for capacity-building, and coordination among stakeholders to contribute and build strong relationships ("Global Framework on Chemicals," 2024).
Integration into decision-making processes	The inclusion of different stakeholders into the process of proactive decision-making that promote solutions, express considerations, enhance management practices and create cross-sectoral partnerships ("Global Framework on Chemicals," 2024).

Table 1. Five key aspects

Source. Author's own

From the Literature Review, there is uncertainty about new regulations and restrictions, such as the PFAS Restriction, which can disrupt the entire GSC if not assessed correctly. Although big enterprises have established internal strategies and targets reflected in their Corporate Sustainability Report and other legal frameworks, they are not forced to detail the challenges and best approaches for chemical compliance and the methods for an effective chemical phase-out throughout the GSC. This remains an internal transition that companies must fulfill at their professional expense and knowledge.

The new Global Framework on Chemicals aims to provide comprehensive guidance to large corporations on assessing hazardous chemicals in their operations. This framework outlines the necessary steps companies should take, while it does not necessarily reflect the actual practices companies currently implement in the real world ("Global Framework on Chemicals," 2024). The research does not aim to track the progress of implementing it.

The five key aspects offer a comprehensive approach to effectively track and manage progress regarding the vision, "Our vision is a planet free of harm from chemicals and waste for a safe, healthy, and sustainable future." This vision aligns with the framework's title, "For a Planet Free of Harm from Chemicals and Waste," and the two strategic objectives mentioned ("Global Framework on Chemicals," 2024). The five key aspects align with the research questions, aim, and problem definition, focusing on assessing hazardous chemicals within the policy and industry sectors. In this case study, the key aspects serve as a roadmap to determine a company's current position and understand which approaches and practices can be implemented to address ongoing challenges. It also provides an overview of the company's historical management of chemicals throughout the global supply chain. Additionally, it covers policy changes and decisions related to phasing out hazardous chemicals and PFAS.

This case study aims to delineate and understand the challenges faced during business transitions, the impact of strict regulations, and the best practices to adopt when dealing with these issues. The findings are centered on the implications of an upcoming chemical restriction on a multi-national enterprise's global supply chain and the response of this enterprise toward chemicals phase out. ("Global Framework on Chemicals," 2024). This Measurability structure categorizes the research practitioners (interview participants and HCF experts' observations) as indicators that uncover insight into the current challenges and improvements made by the company and the PFAS Movement. The GFC adopting the qualitative exploratory research design aligns with the study's aim of providing diverse real-life practices and suggestions to other enterprises for effective chemical phase-out, as well as sharing knowledge to policymakers on what are the current companies' challenges to build more considerate and conscious policy decision-making. Strict regulation, in this case, the upcoming REACH PFAS Restriction upon a big enterprise, acts as a direct catalyst that can influence and disrupt its global supply chain.

This research design also follows an exploratory qualitative research approach; although it is set in a specific context, the research process is also conducted through the exploratory approach. The lack of literature between the GSC and chemical phase-out and the status of the PFAS Movement due to the pending PFAS restriction enforcement provides space for using diverse data sources. Qualitative research with an exploratory design serves as a tool to gather multiple data sources when a topic lacks knowledge, then inductively organize through thematic coding and deductively assess each theme to enhance and incorporate additional data from the most recent issues related to this research (Creswell & Creswell, 2018).

The RQs are designed to analyze the perception of two categories of practitioners involved in restriction effects and chemical phase-out in the GSC: i) practitioners involved within the enterprise, ii) practitioners that advise and aid with external perspectives (i.e., organizations, agencies, enterprises). These are two primary data sources in the research: enterprise interviews and the perspective of external practitioners' support, which define the effect of strict regulation over a big enterprise and the best approaches for chemical phase-out.

Data classification was compiled by interviews and forum panels, following a purposeful sampling design. This concentrates on selected individuals with experience or knowledge of this research topic, applying a snowballing strategy to identify individuals with similar characteristics, positions, or interests (Palinkas et al., 2015). The criteria for selecting this characteristic enterprise were defined by previous professional relations in one of their industries based in northern México, and the candidates were chosen by a selected sampling of their roles within the enterprise. The external practitioner's perspectives were selected by observations related to the research in the Helsinki Chemicals Forum Panels.

This is demonstrated through an analytical framework shown in Figure 1, strengthening the rationale for the novel **Global Framework on Chemicals**.

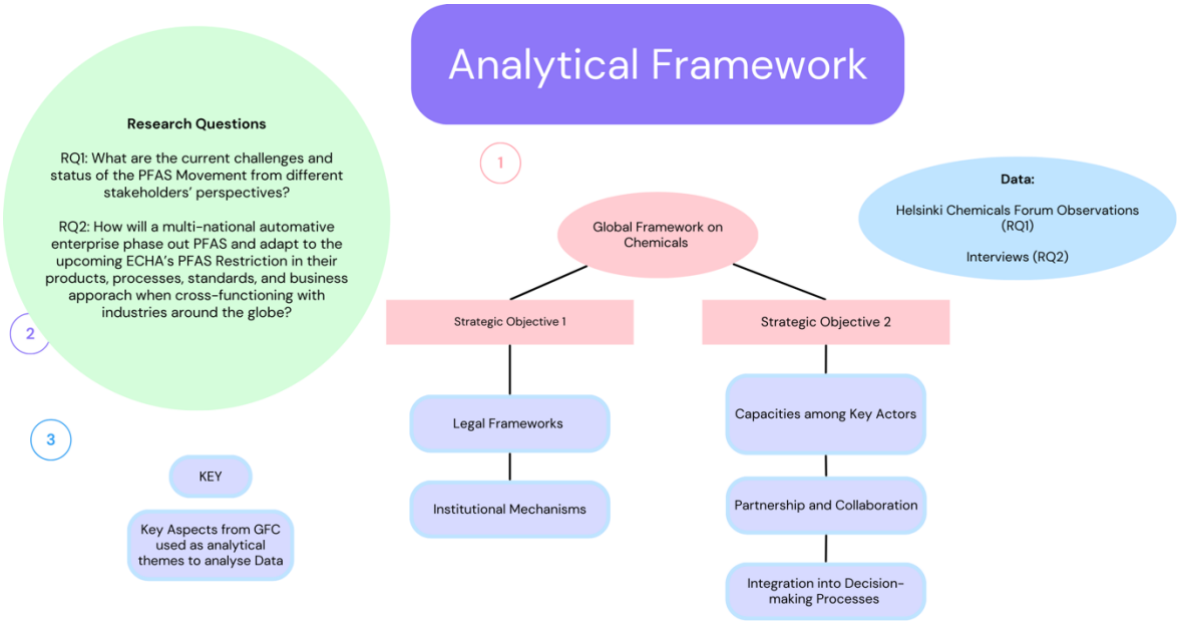

Figure 2: Analytical Framework

Source: Author's own

2.6 Data collection

2.6.1 Literature Review

The literature review was done in two parts. The initial literature review was a systematic SCOPUS search. The keywords used were Global Supply Chain, PFAS, Hazardous Substances, Hazardous Chemicals, Substances of Very High Concern, REACH, Chemical Regulation, Chemical Legislation, PFAS Restriction, PFAS Movement, Holistic Approach, Technical Approach, Proactive Approach, Resilience, Sustainability, Supply Chain Disruption, Regrettable Substitution, Substitution Planning, Chemical Phase Out, and PFAS Phaseout.

The selected articles were those related to managing global supply chains, past legal cases related to and including PFAS, chemical regulatory updates, and PFAS restriction proposals.

The excluded articles focused on financial aspects of the global supply chain, PFAS lawsuits, DuPont, 3M, chemical industry polluters, and PFAS alternatives.

The initial review needed more relevant literature due to the absence of cases related to the phase-out of hazardous chemicals from the GSC and the pending PFAS restriction adaptation. To address this, an additional literature review was conducted using a snowball/citation method of the existing relevant papers, which focused on the ongoing regulatory updates and similar practices in the GSC related to sustainability, green initiatives, and health and safety approaches. This approach allowed the incorporation of various academic articles and more diverse sources of information from grey literature to enrich the literature review. Using the citation method, broader themes were developed on the scope, and specific research gaps were identified based on the HCF panels' key observations.

2.6.2 Helsinki Chemicals Forum

The HCF enhanced the research material from the need for more literature. Data was compiled from the opening keynotes and the subsequent panels. The Forum consisted of three keynotes and five panels. The primary approach to gathering data was based on the explorative design and approach to develop an analysis and compilation of key insights related to this case study. The HCF experts comprised diverse, relevant roles within organizations, institutions, agencies, big enterprises, ministries, and civil servants. (i.e., ECHA, European Commission, UNEP, REACH, OECD, ChemSec, Enhesa, Change Chemisty, CEFIC, and Apple, amongst more). This enriched the research by adding different perspectives from experts within the related chemicals sector, but with a wide range of expertise in other areas, comprising twenty-five top experts from all continents representing various stakeholders.

The HCF observations aim to refine the information and provide a detailed description of upcoming regulatory changes. These changes include the nuanced REACH PFAS Restriction, the role of the new UN Global Framework on Chemicals in managing chemicals throughout their lifecycle safely within global supply chains, substitution planning to create regulatory certainty and investments, and Transition Pathways for Sustainability.

Previously established in the Forum, the HCF experts are divided into panels. Following this categorization process allows more flexibility in analyzing experts' observations while maintaining ethical considerations. The Panels shown in Annex 2 are divided into five panels, each with a different topic. Some of them are supported by preliminary-related Keynotes that briefed and enriched several Panels. In addition, the Theme simplifies the analytical process and succinctly describes the panel's topics. The Position and organization describe the panelists involved.

2.6.3 Interviews

The interviews were conducted with internal and external stakeholders. The internal stakeholders are part of a multinational automotive enterprise; the external stakeholders are an external client and a chemical expert from an independent non-profit organization. This enterprise focuses on manufacturing products such as sealing and fluids for terrestrial vehicles and other areas where the same product development has opened new market opportunities. The interviews aimed to analyze in depth the current practices and challenges an enterprise with a well-positioned market must face when conducting chemical phase-out and chemical compliance while addressing the effect of strict regulations and restrictions upon their GSC and considering the perspectives of different stakeholders within the enterprise, with the support of an external client, providing an outside lens to analyze the enterprise approaches within clients, as well as including the perspective of an expert from a chemical independent non-profit organization to analyze the uncertainties other companies have at present that can relate with this enterprise.

The interview questions (Annex 3) were semi-structured and tailored to each participant. Internal and external stakeholders' interviews were adjusted to their position and role within their enterprise and field of expertise. All interviews encompassed different dimensions or themes that the participants decided to share and were relevant to the data collection. These interviews followed an exploratory approach to augment the scope of the research, although always followed by the themes from the Literature review; this refined the stakeholders' perspective, covering their different roles with similar topics to address diverse research gaps.

Ten interviews were conducted to analyze this research. Eight were held within the multinational automotive enterprise, one with one of the enterprise's clients and one with an independent non-profit organization.

The participants within the enterprise were selected after extensive research on the enterprise departments, roles, and committees. After a formal request, the requested individuals were provided through a contacts list. These participants share a direct nexus within different areas and groups dedicated to managing chemicals, including decision-making, risk management, chemical compliance, and product development. Within the enterprise eight participants, three sub-groups were established to describe their roles and specify each one's area. There are cross-sectoral hierarchy roles distributed along the enterprise. It was vital to allocate the participants in groups for a less intricate and more detailed data analysis. The external stakeholder interviews were selected through a more explorative context. One interview was held with a direct client of the enterprise, an automobile manufacturer with a critical position in the market, contacted through LinkedIn. The last participant was approached through the snowballing method as part of a non-profit organization with independent resources, focused strictly on the PFAS phase-out movement from enterprises, and is a crucial organization supporter of the HCF. Table 2 presents all the interviewing participants for this research.

Name	Role	Sector
S1	Director of Human Resources & Former Global Sustainability Council Lead	Global Sustainability Council
S2	Chief Manufacturing Officer & Global Sustainability Council Lead	Global Sustainability Council
S3	President Global Sealing & Global Manufacturing	Global Sustainability Council
R1	Chief Accounting Officer & Enterprise Risk Management	Enterprise Risk Management
R2	Global Manager of Chemical Compliance	Global Chemical Compliance
M1	Vice President of Global Mixing	Management of Mixing and Sealing Strategy
M2	Plant Manager Mixing	Management of Mixing and Sealing Strategy
M3	Sealing Strategy	Management of Mixing and Sealing Strategy
E1	Director of Environment and Innovation	External Stakeholders
E2	Senior Chemicals and Business Advisor	External Stakeholders

Table 2. Participants' classification for interviewing.

Source. Author's own.

2.7 Data analysis

The Literature found during the SCOPUS search and snowballing method was sorted into five emerging themes for the Literature Review. These themes included PFAS Composition (which gives more information on PFAS, their hazardous potential, etc.), the PFAS Movement, REACH, Policy Challenges, and PFAS in the Industrial Sector. Furthermore, other relevant and related literature found were later incorporated into the analysis of the findings to triangulate interview data.

For the interviews and HCF Observations, qualitative content analysis was applied to the data collected, utilizing the analytical framework (Figure 2). RQ1 was grounded in the HCF panel experts' analysis of the literature. In RQ2, four sub-groups were formulated to highlight the difference between roles and their relation to the specific enterprise sectors; the classification of the interviews consisted of i) Global Sustainability Council, ii) Global Chemical Compliance & Enterprise Risk Management, iii) Management of Mixing and Sealing Strategy, and iv) External Stakeholders.

To answer the RQs, the analysis of the present literature, the HCF, and the interviews were reviewed through the GFC's Measurability structure ("Global Framework on Chemicals," 2024). This structure analyzes the RQs through the structure of the five key aspects. In this, the five key aspects are the delineated areas to fulfill or accomplish while also being challenged to elucidate, and each practitioner contributes to these key aspects. At the same time, the UNEP's indicators for tracking progress in implementing the GFC are yet to be determined ("Global Framework on Chemicals," 2024). The "key indicators" are derived from the HCF experts' observations and the enterprise's participant's answers for tracking progress and monitoring ("Global Framework on Chemicals," 2024). These indicators show stakeholders' real-life approaches, challenges, and future internal strategies and display the harnessing of the two strategic objectives from the GFC while being adapted to the enterprise's present transitions and the overall status of the PFAS Movement.

Two Measurability structures (Table 3) were applied for the two categories of practitioners (HCF experts' observations and interviews). To answer RQ1, only the Measurability structures with the HCF experts' observations are needed, suitable for the policy trajectory of the PFAS Movement and the composition of RQ1. It is analyzed separately due to the difference in practitioner categories. To answer RQ2, the Measurability structures with the participants' interviews were applied. The perspectives of internal and external stakeholders within the interviews display the differences between industry sectors while merging them to enrich findings. The Measurability structure strategy is followed to maintain a fluid analysis; this is to compare and revise the ongoing regulatory changes, new approaches, and challenges for chemical phase-out with the current results from the enterprise's real-life approach.

Vision	"Our vision is a planet free of harm from chemicals and waste for a safe, healthy and sustainable future"				
Key aspects	Legal Frameworks	Institutional Mechanisms	Capacities among key actors	Partnership & Collaboration	Integration into decision-

					making processes
Key indicators	(participant's name or HCF panel, if applicable)	(participant's name or HCF panel, if applicable)	(participant's name or HCF panel, if applicable)	(participant's name or HCF panel, if applicable)	(participant's name or HCF panel, if applicable)

Table 3. Measurability structure template.

Source. Author's own.

2.8 Limitation

The data gathered from the interviews with stakeholders can face different barriers, as the case only centers around one specific company, and the selected individuals are the primary source of input within the company. The key observations gathered from the HCF can also face some barriers. However, different practitioners were involved in the panels, and this observation were grounded only in the topics discussed in the five panels of the Forum. The Global Framework on Chemicals is a new framework established in the year this thesis was written; this can create uncertainty regarding the unknown effectiveness of this framework. Due to time and information constraints, Strategic Objectives B, C, and D from the Global Framework on Chemicals are left out. This also considers that the information is only based on two out of five strategic objectives. Lastly, the indicators for tracking progress from the GFC cannot be implemented due to the pending classification of these indicators, while their status will be determined soon.

3 Analysis and Findings

This chapter presents the empirical results from the analysis conducted on the two groups of practitioners (interview participants and HCF experts' observations). The five key aspects address each RQ. The first section covers the overall status of the PFAS Movement according to the actors involved (RQ1). The second section reviews the position of the multi-national automotive enterprise phasing out PFAS from their global supply chain (RQ2). The five key aspects aim to contribute as filters to display the position and perspective of diverse actors involved with hazardous chemicals and, in some cases, in PFAS.

3.1 Chemical regulations and PFAS Movement status

RQ1: **What are the current challenges, status, and vision of the future of the PFAS Movement from different stakeholders' perspectives?**

3.1.1 Legal Frameworks

In the specific case of this research, the PFAS Movement depends on the PFAS Restriction to move forward with an effective chemical phase-out from industries. Although the PFAS family is not included in legal frameworks, ECHA has targeted these forever chemicals as a threat and considered them hazardous. The PFAS Movement currently relies on different legal frameworks focused on the sound management of hazardous substances ("Global Framework on Chemicals," 2024) . Several legal frameworks encompass hazardous chemicals as a subject of management and reporting. These chemical legislations provide support and envision stakeholders for the next steps for PFAS in the future.

Despite regulatory advancements, the Classification, Labelling, and Packaging (CLP) tool (*CLP Legislation - ECHA*, n.d.) , a component of the REACH regulation, was identified as a foundational element for future chemical legislation and control of hazardous chemicals. P3 discussed that the REACH PFAS Restriction remains pending due to the critical importance of ensuring that regulatory changes balance environmental protection, economic prosperity, and digital advancements. This careful consideration is particularly relevant given recent global challenges, such as ongoing wars and the COVID-19 pandemic (Xu et al., 2023) , which highlighted vulnerabilities in existing supply chains—stressing the need for legal frameworks that can adapt to changing conditions while ensuring the safe management of chemicals.

Observations from P1 revealed a significant global disparity in chemical legislation, with approximately 100 countries currently lacking any form of chemical regulation (International Chemical Trade Association AISBL, 2020). This gap underscores an urgent need for establishing legal frameworks to manage chemicals effectively, as these countries cannot handle hazardous chemicals. At the same time, it emphasizes the need for consistency and predictability in legislation to foster innovation and effectively manage global supply chains. Several P1 experts underscored that a stable regulatory environment is essential for businesses to plan and innovate within a clear legal context.

P1 also focused on the critical need for enhanced chemical regulation, which can be assessed mainly through the recently adopted Global Framework on Chemicals. This framework shifts the focus from EU-centric regulations to a more comprehensive international approach, engaging diverse stakeholders, including Member States, intergovernmental organizations, the private sector, and civil society. The Global Framework on Chemicals aims to standardize and enhance chemical safety practices globally ("Global Framework on Chemicals," 2024).

Regarding classifying PFAS as substances of very high concern, P4 discussed significant implications for managing and regulating SVHC. The stringent measures for SVHC in the Chemicals Strategy for Sustainability (*Chemicals Strategy for Sustainability - ECHA*, n.d.) advocate for phasing out all use except essential ones, which are directly relevant to PFAS, given their classification as SVHCs due to their persistence, bioaccumulation, and toxicity (Gaber et al., 2023). Another legal framework that sets a precedent for phasing out hazardous chemicals. This strategy supports restricting and eliminating PFAS from consumer products, the GSC, and industrial processes.

Furthermore, P3 warned that PFAS contamination costs will exceed the phase-out costs if not addressed promptly, highlighting the urgency of addressing PFAS pollution (International Chemical Secretariat, 2023, p. 12). The potential economic and environmental consequences of inaction must be avoided, underscoring the imperative for companies not to conduct business if there is a lack of knowledge on its SVHC and policymakers to prioritize PFAS management and phase-out efforts. By leveraging tools like the CSRD criteria report, companies can more effectively identify and manage hazardous classes of chemicals. Integrating environmental criteria into corporate reporting supports resource mobilization and partnerships by promoting transparency and accountability in chemical management practices ("Global Framework on Chemicals," 2024).

Back on a global scale, P3 reviewed some relevant international initiatives that illustrate other approaches to chemical regulation. Canada's recent reforms emphasize a risk-based assessment of substances rather than a one-by-one chemical approach. This shift, covered under the Chemicals Management Plan (CMP), (Canada, 2006) includes risk assessment, risk management, and focusing on substances of highest concern (SVHCs in the EU), promoting a holistic and systematic approach to chemical management. Japan's Chemical Substances Control Law (CSCL) was also discussed, particularly its requirement for pre-market evaluation of new chemical substances. This law (*CSCL (Chemical Substances Control Law) (METI)* , n.d.) mandates government evaluation of biodegradability, bioaccumulation, and persistence before new chemicals can enter the market. Such pre-market evaluations ensure that only chemicals meeting safety standards are allowed. The EU Transition Pathways (*EU Chemical Industry Transition Pathway*, n.d.) were highlighted as crucial in transitioning to a green and digital economy for industrial ecosystems. These pathways, supported by companies, do not introduce new roadmaps but continue to build on existing regulations.

3.1.2 Institutional Mechanisms

The Forum emphasized a crucial 2030 target from the new GFC, expecting governments to have developed appropriate institutional capacities, legal frameworks, and training programs in chemical risk prevention and clinical toxicology ("Global Framework on Chemicals," 2024).

The evolving role of the European Chemicals Agency (ECHA) and its initiatives to enhance chemical safety through proposals of regulatory frameworks was mentioned throughout P2. A significant development was the evolution of ECHA in 2021, which included the creation of a partnership for the Assessment of Risk from Chemicals. This partnership aims to strengthen the assessment and management of chemical risks, accentuating diligent institutional mechanisms and capacities (ECHA: Strategy Statement 2024-2028, 2024). ECHA's proactive role is critical in providing and compiling different opinions on proposals for restricting hazardous chemicals (*Per- and Polyfluoroalkyl Substances (PFAS) - ECHA*, n.d.). P2 highlighted that these opinions are pivotal for ensuring that legal frameworks are adaptable and effective in managing chemical risks throughout their life cycle.

In addition, ECHA's Strategy Statement for 2024-2028 aims to deliver agreed actions on risk and hazard assessments by working with other EU institutions, providing data and advice to the Commission, the European Parliament, and the Council to support the development of EU policy, and engaging with pertinent EU agencies, Member States, and stakeholders to align for the effective implementation of recent legal requirements (ECHA: Strategy Statement 2024-2028, 2024). This remarks the commitment to enhancing chemical safety through this institutional mechanism.

3.1.3 Capacities among key actors

Different key actors harness different capacities depending on their roles. Some capacities are shared, others are kept private, others are used across various sectors, and others only function in specific niches.

From the observations in P1 and P2, actors shared the common knowledge of implementing database platforms and catalog information as capacities to build external cross-sectorial collaborations. One P1 actor added that the drivers of change are those working in the supply chain and acknowledged that it is crucial to identify the information requested by each actor and create pragmatic systems to unlock this information as different chemical compounds constantly transit the supply chain.

During P1, a key actor from one of the biggest electronic manufacturing enterprises worldwide provided information on its current capacities and actions taken to address them. The actor detailed its enterprise's measures to phase out PFAS and benchmark within different industry sectors. Implementing internal restrictions and efforts to ensure suppliers meet these standards, with the release of its white paper on PFAS, created a compliance chain effect between its suppliers, as the suppliers of their suppliers immediately took action to understand and meet the new requirements. It was a reaction to building new relationships with new suppliers to develop new materials and technologies. This example demonstrates how large companies can drive change and push others to follow sustainable requirements apart from legal frameworks, exemplifying the private sector's role in advancing chemical safety (International Energy Agency, 2019). Another capacity is set on its new chemical database, showing how companies can support the global chemical market by maintaining control and transparency with suppliers, as this database can delve deeper into chemical compositions to avoid regrettable substitutions.

According to another P1 actor, the Global Framework on Chemicals can improve transparency within and across value chains by reinforcing the basics, such as Safety Data Sheets (SDS), and ensuring governments implement the Global Harmonisation System (GHS) in all relevant sectors. ("Global Framework on Chemicals," 2024) Another essential capacity is the development of an EU Common Data Platform for Chemicals, which aims to expedite risk management, assessment, and mitigation processes by leveraging actors with new capacities (European Commission, 2023).

ChemSec, an independent organization focused on phasing out PFAS, currently merging environmental objectives with a business perspective, underscored the importance of integrating sustainability into corporate strategies through capacity-building efforts (International Chemical Secretariat, 2024a). This organization developed the ChemScore 2023 platform that evaluates companies based on their hazardous product portfolio, management and transparency, development of safer products, and involvement in controversies, as it serves as a valuable tool for clients seeking to assess and mitigate chemical risks, including those associated with PFAS (International Chemical Secretariat, 2024b). Chemscore contributes to the advancement of sustainable chemical management practices.

Insights from Japan's supplemental actions for safer chemical management accentuate the relevance of voluntary management, data tools, and international cooperation for capacity-building. Harmonizing chemical management practices across countries is critical to leveraging industries globally, as exemplified by initiatives like the ASEAN-Japan Chemical Safety Database. This free database includes relevant information on chemical regulation, GHS classification results, risk and hazard assessments, and building transparency between countries (Association of Southeast Asian Nations, 2024).

3.1.4 Partnership & Collaboration

Proactive measures from effective partnerships are needed to ensure that PFAS and other hazardous substances do not surpass limits that can harm the environment and society and, in this case, disrupt global supply chains.

Based on crucial observations in the Forum, stakeholders have acted and expressed their concerns regarding a transparent chemical and industry network that works in cross-sectoral environments. Collaboration between legislators, industry, academia, and NGOs is crucial for adopting regulations and promoting innovation, particularly in chemical and product alternatives and substitution.

Insights from P3 display the example of Australia's Industrial Chemicals Introduction Scheme (AICIS) approach to addressing regulatory chemical data gaps, such as PFAS, through transparent decision-making from policymakers and collaborating with industries to create more sound chemical databases and avoid the absence of chemical data (*Australian Industrial Chemicals Introduction Scheme (AICIS)*, 2024).

The newly adopted Global Framework on Chemicals contains collaboration tools. The framework aims to extend the focus from the EU to an international framework and remarks on the involvement of all stakeholders, including Member States, intergovernmental organizations, the private sector, and society, as these collective actions are highlighted to leverage substance substitution planning ("Global Framework on Chemicals," 2024). Regulator-to-regulator exchanges, agreements for hazard assessment comprehension, and transparent information exchange are essential for international collaboration.

In P1, one key stakeholder from the private sector emphasized that the PFAS Movement must keep the momentum on substitution ambition, cooperation, and leadership, encouraging other stakeholders to focus on these matters rather than on profit margins. It highlighted the need for collaboration, awareness, and a multi-sectorial approach. ECHA's strategy statement for the next five years (2024-2028) (ECHA: Strategy Statement 2024-2028, 2024) reiterates a new approach to sharing input, involving more partners and legislators to ensure a fluid understanding of chemical regulations. ECHA involves actors from different sectors, as shown in the more than 4,400 organizations, companies, and individuals that submitted relevant comments and specific information on the PFAS Restriction proposal in 2023 (*Per- and Polyfluoroalkyl Substances (PFAS) - ECHA*, n.d.).

From an organizational approach, ChemSec's collaboration with over 60 investors denotes effective collaboration and partnerships when assessing hazardous chemicals (International Chemical Secretariat, 2021). ChemSec has worked closely with investors and appreciated their comments, which has enhanced its credibility and support for the transition. This includes developing tools like the SIN List (*SIN List*, n.d.) and the PFAS Guide ("PFAS Guide," 2023). These tools aim to identify hazardous chemicals and the PFAS family within the GSC and

around companies for effective phase-out and contribute to collaboration across ChemSec's investors.

3.1.5 Integration into decision-making processes

The involvement of diverse chemical and industry sector stakeholders in different decision-making processes is critical to preserving human health and the environment ("Global Framework on Chemicals," 2024). Decision-making processes are needed to enrich and access relevant chemical and environmental information. Integrating stakeholders into decision-making can enrich with new sources of data and information, developing accessibility of information and refining with more informed decisions. Facilitating more informed decisions and actions in different sectors and from diverse stakeholders can endorse public awareness and accessibility across the industry and chemical sectors ("Global Framework on Chemicals," 2024).

Key observations from P1 concerning decision-making processes focused on proactive initiatives by international entities and industry leaders to enhance chemical management. Several stakeholders stressed the need for global sector dialogues to prioritize and bring supply chain actors together from the initial steps of the processes. Essential steps to enable effective decision-making include considering actors with different roles in diverse sector strategies, developing coordinated actions, and enhancing expertise, resources, and influence (ECHA: Strategy Statement 2024-2028, 2024). These critical steps allow the inclusiveness of all actors in the supply chain, with trust building and engagement between sectors for effective transitions from hazardous chemicals. P1 experts mentioned that companies should consider and implement involving stakeholders from different industries that possess relevant knowledge or expertise from the beginning steps of the process. Companies should consider effective and sustainable measures, enhancing implementation through cooperation and capacity-building ("Global Framework on Chemicals," 2024).

ECHA's strategy statement for the next five years (2024-2028) includes an enhanced approach to transparency when sharing input, involving more stakeholders and legislators to ensure a fluid apprehension of chemical regulations, refining policy enacting and decision-making through the lens of optimal data, knowledge, and competence use (ECHA: Strategy Statement 2024-2028, 2024).

One key actor from a big electronic enterprise emphasized the importance of obtaining input to ensure that regulations are practical, achievable, and meaningful. Another essential aspect mentioned was the harmonization within the regulatory community for decision-making, transitioning from managing hazardous chemicals to promoting safer chemistry. This key actor from P1 added that policymakers must balance chemical restrictions with efforts to innovate and develop more sustainable current practices. Raising awareness across all sectors, not just the chemical industry is crucial for effective and safe chemical management ("Global Framework on Chemicals," 2024).

Chemical-related panels with experts like the HCF and chemical organizational initiatives, such as the PFAS Movement (Chem Sec, Change Chemistry, FFP4U), support the relevance of stakeholders in raising their voices and considering the input provided. Several organizations, such as ChemSec, FPP4EU, Enhesa, and Change Chemistry, have established campaigns and discussion forums, spread awareness, and informative webinars on managing hazardous chemicals, incorporating actors into their decision-making (*PFAS Movement*, n.d.)(Change Chemistry, n.d.)(FluoroProducts and PFAS for Europe, n.d.). The PFAS Movement has been built upon the partnership, cooperation, and integration of actors related to this hazardous

chemical family to reach for their concerns and include them for more transparent conditions for better comprehension, identification, classification, and phasing out of PFAS (*PFAS Movement*, n.d.).

3.2 Industry approach towards hazardous chemicals and PFAS phase-out

RQ2: **How will a multi-national automotive enterprise phase out PFAS and adapt to the upcoming REACH PFAS Restriction in their products, processes, standards, and business approach when cross-functioning with industries around the globe?**

3.2.1 Legal Frameworks

One of the GS Council's leading roles is adopting legal frameworks related to its corporate and industrial activities while disclosing its sustainability initiatives, strategies, and objectives to collaborate with suppliers and countries. The enterprise conducts these aspects by implementing and disclosing its CSR, considering its central assessment and reporting scheme, and any other directives or regulations for compliance. This enterprise has several advantages over other competitors due to its historical and automotive manufacturing positioning, harnessing legal frameworks and capacities in place to address the overall sustainability aspects.

S1 acknowledged that the enterprise must comply with worldwide regulations due to the establishment of its industries in diverse countries, such as the US, China, Mexico, and Brazil. In addition, according to S1, the materiality assessment from its CSR sets the relevance of the targets and the voice of customers, suppliers, and employees. However, the participant mentioned that PFAS issues are minor compared to the others in the CSRD materiality assessment (International Chemical Secretariat, 2024-a). This does not diminish its relevance but does hold different priorities within the enterprise. Still, complying with regulations for the CSRD from sustainable and financial materiality assessment is a priority. Even though PFAS is not considered a primary target of current regulations (International Chemical Secretariat, 2024-a), S2 states that if strict regulations are enacted, the enterprise will be focused on complying.

S3 recognized that "requirements, restrictions, and regulations are set to mitigate adverse impacts, such as PFAS. It is not a debate or question to meet a requirement; it is key: with the CSRD to disclose, but not just that, also feasible support to deliver on those aspirations and objectives." However, the enterprise has different priorities, allocating a relevant part of financial capital for health and safety to protect employees, customers, and the community.

The CSRD is one framework where the enterprise allocates more than enough effort. The new EU CSRD recently required double materiality assessments covering environmental and financial risk (*Corporate Sustainability Reporting - European Commission*, n.d.), with R1 mentioning that "now, it is a balance, while the enterprise is still continuously improving its methodology for making assessments." R1 noted that a sanction code does not exist for the PFAS family, but this matter is not a compromise. The enterprise's notion of legislation is applied directly to knowing when to act, and environmental and chemical risks are considered entirely seriously.

REACH has been present within the enterprise, and R2 has followed the REACH regulation since it was proposed in the early 2000's. R2 added the example of hazardous substance DEHP (*Di(2-Ethylhexyl)Phthalate (DEHP)*, n.d.) when, in 2011, the enterprise phased out this chemical classified as SVHC, being able to adjust efficiently. R2, M2, and M3 also recognized that REACH is the crucial regulatory base to follow when strict chemical regulations arise.

R2 complemented that the classical way to transition from hazardous chemicals in the GSC is to complete the deadline to transition. A new regulation is set in place, and follow the same process before the deadline. The present way to transition occurs even before the regulation is enforced. Global Chemical Compliance, in collaboration with the product development and sales departments, reaches out to diverse stakeholders to raise awareness, prepare, and phase out with more than enough time. R2 included that there is no PFAS in the sealing systems, but "in fluids, we are working on it," explaining that there are no reporting requirements for PFAS and no supplier information. The enterprise knew they had PFAS, one way or another, with substitutions in mind, and suppliers were also working on it.

M1 explained that the biggest challenge derived from more strict sustainability requirements from legal frameworks is the cost of products. In recent years, this challenge has been leveraged by explaining to the customers, who are now more knowledgeable about the renovations. Although there is no gratification on additional costs, they must be paid to advance and be sustainable. E1 recognized that the EU chemical regulations are forward-thinking by anticipating future regulation of substances. This provides time for industries to prepare and be several years ahead before the regulation is enforced. Including that compliance comes with a cost, but it is never as much as the risk of disruption from unpreparedness, as it is vital to be one big step ahead of legislation.

E2 mentioned that enforcing the REACH PFAS Restriction also creates business opportunities for other sectors to develop alternatives and substitutions. One key aspect of the PFAS restriction is that regulating these substances will avoid financial risk for companies, as it is difficult for companies to quantify the use of these substances. R2, E1, and E2 consider that beginning with internal mapping and identifying substances can keep them a step ahead before the restriction occurs. E2 reiterated not to substitute PFAS with another PFAS, as this can deliver a more regrettable substitution, but to understand which approaches are safe and sustainable, as the PFAS Restriction, when enforced, can control and keep away industries from regrettable substitutions (Maertens et al., 2021). Lastly, M2 expressed the need for different frameworks, initiatives, and strategies to develop safer products since regulation burdens companies, and it also sets financial and business opportunities to transition to safer, cleaner, and sustainable solutions for the short and long term.

3.2.2 Institutional Mechanisms

Diverse institutional mechanisms can leverage an enterprise's activities, such as chemical and environmental management.

S2 commented that the new SEC platform (U.S. Security and Exchange Commission, n.d.) from the US is one example of institutional mechanisms created to share some of the challenges of doing business today: data reporting, developing an automated system, disclosure of climate-related risks for the company, and the specific challenge today of pulling new teams together and ensuring they comply.

When asked about diverse mechanisms, S3 shared that some governments support grants to develop sustainable products, and the enterprise looks for funding and support on the development side, as it helps those leverage. The enterprise must compete, which is a risk and a decision plan between continuous growth and sustainability. This falls into place with his comment that the enterprise wants to push to new technologies when new restrictions set more strict sustainability requirements. Some governments set institutional mechanisms to support the enterprise, while regulations enforce requirements that ensure the management of chemicals

while protecting the actors within the enterprise. S3 added that government grants and strict compliance with legal frameworks strengthen their internal objectives.

R2 and E1 shared that through the International Material Database System (IMDS)—a German automotive database in which every supplier of materials must report to conduct business in the automotive industry—all enterprises from the vehicle sector started disclosing PFAS in their products and traced suppliers (*IMDS | International Material Data System*, n.d.). Another addressed institutional mechanism is the Automotive Industry Action Group (AIAG). The enterprise has been a member of this organization since its foundation. In this organization, automotive industry members cooperate to reach general global standards for quality assurance, supply chains, and CSRD issues (*Corporate Sustainability Reporting - European Commission*, n.d.). R2 commented that the enterprise counts with one subcommittee of chemical compliance at AIAG and joined with several top-tier suppliers in the automotive industry. R2 noted that AIAG advised on PFAS several years ago, while no member knew where the PFAS Restriction was directed. AIAG and OEMS helped to voice the enterprises' demands and concerns about PFAS, such as whether a substitution could be achieved, how and when it could be achieved, and whether it is private for each company.

3.2.3 Capacities among key actors

An enterprise's internal capacities can be found among its key actors and its reaction to harnessing these advantages, tools, capabilities, and opportunities provided by the enterprise. Companies can leverage and support their transition to safer chemicals management, inclusivity of stakeholders, enhanced cross-sectoral engagement, and effective decision-making if their capacities are used effectively and grounded in the enterprise's position.

S1 states that one key enterprise advantage is that it "does not have to start from ground zero and can respond quickly." By having the structure to approach their raw materials, they can plan and prepare how to respond and report much faster than a company starting on the journey of the automotive industry. Another advantage is that this enterprise consistently focuses on sustainable sourcing of substances. Using their capacities to develop a supplier code of conduct in 16 different local languages, they keep reporting as simple as possible for clear global communication. This supplier code of conduct is set to maintain transparency between the GSC and the enterprise.

Participant S2 stated, "The Global Sustainability Council keeps the capabilities and capacities ahead of the game and keeps the team focused on the goal when strict regulation is upcoming." The GS Council centers on the ever-changing restrictions and its more stringent requirements, as it drives the enterprise to conduct secondary meetings to develop action plans and avoid risk. Complementing that the enterprise's main 'sustainability capacity' is the establishment of its Global Sustainability Council, as S2 added, "When the Council sets priorities, systems, and strategies, they apply to all regions."

S2 recognizes that new regulations will leave its products behind if the enterprise does not continue to innovate. PFAS is one more chemical to substitute out of the many that have arisen, and more will come. Developing internal sustainability guidelines has helped map the supply chain and internal terms and conditions with suppliers, including its go-forward suppliers, who must follow the enterprise's strategies.

Participant R1 shared, "Government authorities do come in to ensure we meet legal requirements." Internal and external legal counsel has also followed its establishment in significant regions to provide support. In addition, R2 used a regulatory data platform from a

United Kingdom-based firm that focuses on environmental, sustainability, and global regulatory services for data accessibility on chemical legal requirements worldwide. R2 also used the enterprise's Component Content Management System (CCMS) database (Rutten, 1996) . It included all the Enterprise Resource Planning (*Enterprise Resource Planning*, 2014) data to communicate with suppliers and identify and phase out DEHP substances (*Di(2-Ethylhexyl)Phthalate (DEHP)*, n.d.)from their raw materials. Although there has been a capacity step up with implementing different data platforms for chemical management, the enterprise also counts on an environmental team that solves environmental issues, mitigates impact, and conducts effective resource allocation. The current challenge for the environmental team is found in sites along the GSC, allocating much of this team's capacities towards cleaning responsibilities of the GSC-impacted sites.

The enterprise shares technical information with its OEMs (Goswami et al., 2022) to avoid hazardous materials. M3 mentioned that the enterprise commonly tries to have close alternatives along with OEMs due to its market positioning. If not possible, it uses its capabilities to look for other options around the globe. This differs from when a product is developed within the enterprise. In this case, a formal assessment of the country's regulations is conducted to ensure the development of a new product meets the regional and international requirements. M3 added that there are three fundamental differences in the enterprises' requirements. i) Legal and ii) customer requirements for strict compliance, and iii) internal enterprise requirements that keep all three together. These internal requirements are shared in its CSR, which contains its benchmark and goals based on the customer and legal requirements.

E1 and R2 shared that their enterprises implement the IMDS (*IMDS | International Material Data System*, n.d.) as mentioned in 5.2.2 Institutional Mechanisms. This is a general requirement for the automotive industry to be able to conduct business. Suppliers report their activities and disclose material data sheets to obtain new knowledge on substances and product composition.

3.2.4 Partnership & Collaboration

The enterprise considers that one important challenge when collaborating with different stakeholders occurs when a government or other entities speed up their requirements. This also uplifts transparency among all sectors, and S3 commented on the necessity of being transparent with suppliers for beneficial partnerships. The suppliers also try to meet the same high standards despite the different regulations and requirements while maintaining the same consistency in doing business around the globe. S3 mentioned that "everyone holds the same high standards" to mitigate environmental and financial risks, follow government regulations, and always comply with them.

Internal collaboration in the enterprise is found in different sectors. For the Global Sustainability Council, if there is a solid plan, a review is set once a quarter each year, but weekly meetings might occur if needed. Separate teams on specific topics work to board all the enterprise's relevant sustainability and environmental aspects. S2 complemented that the board of directors is deeply engaged with the enterprise, and the Council meets with them once a year to take the right actions.

S2 commented that "restrictions and more strict requirements are ever-changing, which drives secondary meetings to develop action plans and avoid risk." With the Global Sustainability Council, there is a peer focus on sustainability. Now, certified areas with sustainability and subject matter experts leading the inter-teams are robust, as these experts help keep these areas one of the company's top priorities. S2 added that "the entire global supply chain is focused on

sustainability, and they have a goal now to map all suppliers, keeping an eye on purchasing areas to ensure suppliers are also leading to sustainability."

About M2, several plants based in Canada and Europe have the same processes, but the internal strategies might differ. Its bases are equal, with Key Performance Indicators (KPIs) (Harlow, n.d.)and due diligence processes(*Corporate Sustainability Due Diligence - European Commission*, n.d.) in every plant. M2 shared that the materials team, for example, takes a technical approach to keep ahead of regulations. It usually receives advice (3-5 months, one year) and works after its first notification, never waiting until the deadlines.

In addition, M2 explained that difficulty levels are shared between changing old products and developing new products is more complicated. They shared empirical evidence that raw materials were unavailable in the COVID-19 pandemic stages. This disruption pushed the entire enterprise to change, reflecting to customers the possibility of change with its products (Xu et al., 2023). Through the years, its stakeholders understood that this disruption could be overcome. This is with significant collaborative tasks and responsibilities to improve overall aspects. M2 highlighted that it could be costly. However, more sustainable products were developed by spending significant partnered effort within different departments and roles, such as quality validation, engineering approvals, product development, and more. M2 added that the most effective approach to phase out hazardous chemicals and PFAS is treating everyone globally, using previous collaboration schemes learned from past externalities schemes to work efficiently and sustainably across sectors.

M3 described no cooperation between competitors, but the enterprise is a member of different associations (AIAG, n.d.) that set standards for all competitors and push them to stay above the compliance limits. Not only strict regulation and self-improvement but also the associations' support, driving for new products, go as a current to support the industries.

According to M3, materials containing PFAS are directly used in Europe, and its OEMs comprehend that. Supply Chain security in advance is critical, as it allows different stakeholders to know which materials or hazardous substances are forbidden and avoid risk. Anticipating future steps and developments together and meeting new requirements as they become stricter is a continuous task. The enterprise envisions that all internal sectors meet sustainability requirements in its CSR while working with OEMs to ensure products meet the standards. M3 added that the PFAS Movement and its restriction are new topics but, for some years, have been known as substance movements that require a total phase-out.

Participant R2 enunciated that cooperation across the GSC is the primary approach for tackling hazardous chemicals—and PFAS in the future. R2 added that the key challenge was reaching upper management sectors within the company, as other priorities were at stake. It was not until the sales team got involved that more stakeholders within the enterprise noticed and acted upon these concerns. R2 included that more internal training, experience involvement, cross-sectoral decision-making, and precise information delivery must be enhanced to solve these issues. Another challenge explained by R2 is monitoring which restrictions will be set in place and when. Unsurprisingly, some substances can be restricted from being used in a product or derogated (FPP4EU, 2023) it is just a matter of preparing to phase them out with time. Nevertheless, another challenge commonly arises when the enterprise finishes substituting one substance, and more often, another restriction is enforced, forcing it to replace another substance.

R2 conveyed that, from the automotive industry's approach in general, the phase-out of PFAS will not be fulfilled at a specific date but a piece at a time, reiterating that stakeholders cannot

ignore this issue and should start looking for similar products, conduct active listening, and collaborate more with suppliers. Complementing that, soon, there could be concerns that suppliers do not report PFAS, although PFAS limits are lower than .1%. It is not wrong not to report this –at the present time– it should be done for transparency (*Per- and Polyfluoroalkyl Substances (PFAS) - ECHA*, n.d.).

From a holistic approach, S1 identified that no stakeholder can face environmental issues alone. Collaboration with new teams, internal and external cooperation throughout the GSC, upstream and downstream, and government bodies mandating enterprises are needed to protect global supply chains.

S3 noted that to eliminate PFAS, the customers, OEMs, and vehicle producers must stand behind this issue, demand it on their supply base, and be consistent with the implementation, or not everyone will do it, with the example of VW and Volvo, that lead the change (Volkswagen AG, 2024). S3 stressed that stakeholders need the industry and chemical sectors to set objectives, establishing them on a set date or near future. S2 comprehends the difficulty of governments in driving change. Still, it acknowledges the industry and chemical sectors' responsibilities to set the expectations, as there are resources, capacities, associations, and proactive measures to drive these changes.

From the perspective of Participant E1, collaboration is key. Still, a challenge arises in requirements for suppliers, as this chain of suppliers follows a long path in which its suppliers must ensure other suppliers also comply through the chain. E1 commented, "One key challenge of PFAS is that there are no reporting requirements, so there is no general information from their suppliers." Stressing that everyone needs to use a proactive approach –a less costly and more sustainable approach–as a complete phase-out from the automotive industry will take time, and the initial step is identifying whether you have these hazardous substances within your products and processes, with suppliers being crucial for a successful GSC phase-out. Within E1's enterprise, different responsibilities are allocated, from product development to relationships with suppliers, to ensure efficient communication and transparency; as many of its products result from supplier innovation, the enterprise must ensure all stakeholders are on the same path.

E2, from an external stakeholder perspective, mentioned a positive movement along the phase-out of the forever chemicals. Still, the main concern is that clients need to know if their products contain PFAS. The clients' and more stakeholders' uncertainty has created a much more engaged community and has driven changes inside and outside enterprises. The financial risk of changing products is a revolving topic within its organization and clients; E2 expresses that regulation is not only a problem or burden for companies but also sets financial and business opportunities to transition to safer, cleaner, and sustainable short- and long-term solutions.

3.2.5 Integration into decision-making processes

Stakeholders are incorporated in all decision-making processes that enhance sector partnerships and networks. These processes must support the enterprise in achieving sound chemical management and protecting the environment from hazardous chemicals.

There is a diverse presence on their GS Council. S1 detailed that many enterprise leaders are based in the US, incorporating international voices from around the globe. Stakeholders from Europe are included, as most of the regulatory changes occur on the European continent. This enterprise has adapted to communicate in 16 different local languages, keeping transparency and comprehension as simple as possible for effective communication. From the S1's

description, the GS Council is responsible for executing the sustainability strategy and creating sub-strategies. Each member of the Council is responsible for their material topic area to checkpoint the execution of the action plans, initiatives, regulatory changes, and impacts to their strategy.

S3 recognized that suppliers "also deliver feasible support on those aspirations and objectives" regarding the enterprise's role towards sustainability and safe chemical management. This achieves sound chemical management by incorporating external stakeholders that support the vision and act on it beyond compliance ("Global Framework on Chemicals," 2024).

Previously mentioned in 5.2.4 Partnership and Collaboration, S3 highlighted the need for the industry and chemical sectors to set some objectives for the PFAS phase-out, as governments present difficulties driving chemical regulatory change. A proactive approach is needed by the industry and chemical sectors, working together and conducting strategic decision-making to guide the following steps and set feasible expectations for the PFAS phase-out. S3 reiterated that the resources, capacities, associations, and proactive measures cannot be driven if different actors do not get involved and decide how to conduct effective changes.

M1 emphasized the enterprises' approach toward chemical compliance, as they must "always upgrade internal requirements to be ahead of the law." This means that all the necessary measures, such as strategic decision-making, must occur before regulations are enforced.

R2: Cooperation was central to tackling hazardous chemicals and PFAS from the GSC. Reaching upper management within the company was only possible once the sales strategy got involved.

From 5.2.4 Partnership and Collaboration, R2 noted that internal collaboration along the GSC is crucial to eliminating hazardous chemicals and PFAS in the future. R2 complemented that establishing proper contact with upper management sectors within the company was more accessible once the sales team cooperated and supported reaching upper management. Reiterating from 5.2.4 Partnership and Collaboration, decision-making integration from different enterprise sectors and experience involvement must be applied to overcome these issues.

E1, from an external stakeholder position, mentioned that decision-making processes regarding hazardous chemicals occur in different sectors but find common ground with upper management levels to understand all the comments within areas to address financial risk while meeting sustainability standards.

E2 mentioned that big enterprises should set positive examples in decision-making, showing industrial and policy sectors that a community is behind in finding solutions and being concerned about this. Some companies have moved ahead of regulation, and regulation can take more robust measures as big companies adapt to change. The example E2 has seen is that companies do not consider as a critical aspect the financial risk of changing products when they have the means to conduct changes, as there is no regulation, holistic measures drive the entire approach, and the goal is to stand out and be better before regulations. Then, after changes are implemented, companies can focus on the financial aspects. If they are acting now, they are aware of their position and capacities and actively conduct decisions that try to positively impact their companies as stakeholders make sharp decisions to change components and substances without holding back.

4 Discussion

This research has added more knowledge on the status and present challenges of the PFAS Movement to comprehend the next proactive steps the industry and chemical sector must consider. This study also leverages more information about industrial practices beyond chemical compliance derived from the awaiting REACH PFAS Restriction by sharing insights about the perspectives of a multi-national automotive enterprise with activities on their supply chain at a global scale.

Companies still need to be aware of the current measures that must be applied to the PFAS family case. The reactions to these uncertainties are focused on this study following a holistic approach, which drives proactive measures toward chemical phase-out (Arda et al., 2023). More companies have decided to join explicitly or privately the PFAS Movement, a concept built on action beyond chemical and environmental compliance. Different approaches from different stakeholders have been set in place to address these hazardous substances. The automotive industry considers the PFAS family a threat, and several stakeholders have decided to act. Moreover, companies, institutions, independent organizations, and practitioners from different sectors have joined the PFAS Movement and expressed their eagerness to phase it out effectively.

The PFAS family has driven a Movement (International Chemical Secretariat, 2024a) that has manifested strongly in the industry and chemical sectors. Such Movement has benchmarked many companies to act upon PFAS throughout their companies; this movement has created a share of data and knowledge, transparency, and investments, spread cross-sectoral awareness, and incorporated different actors into their decision-making and collaboration across various sectors. The movement supports the relevance of stakeholders in raising their voices and considers the input provided to enrich the community for a faster PFAS identification, classification, and phase-out (International Chemical Secretariat, 2021).

The findings from this research are relevant to all actors involved in manufacturing products and processes that contain PFAS and other hazardous chemicals. It also provides considerations for policymakers to reflect on the current concerns and uncertainties that the industry sector has regarding the status of the PFAS Restriction and the holistic and technical approach toward these hazardous chemicals.

This enterprise has a set of different priorities above the PFAS phase-out. It has more environmental responsibilities and priorities than just hazardous chemicals, and relevant financial resources are allocated to protecting employees, customers, and the community. PFAS is not the main chemical under regulation and inspection, as the enterprise's business position has led to other issues to deal with and tackle. However, in PFAS matters, they act beyond regulatory compliance.

The company acknowledges the presence of PFAS and its harmful effects but must also deal with other environmental aspects highlighted in its CSR. Other automotive enterprises have similarly shared their priorities regarding other environmental and sustainability issues such as climate change, supply chain management, product safety and quality (Baxter, n.d.), product environmental performance, reduction of CO2 emissions (*Mazda Sustainability Report 2023*, 2023), sourcing of raw materials, and allocating resources for effective risk management (Volkswagen AG, 2024).

The actions taken by this company can be accomplished because they apply a holistic approach (Arda et al., 2023) and have a solid historical and strategic positioning in the automotive industry (Georgescu & Georgescu, 2023), giving them the advantage to explore different techniques on

how to treat and manage these chemicals and prepare for potential future restrictions. The considerable size and capital of the company enable it to have specific divisions that can focus on exploring how to deal with PFAS while also managing other environmental and sustainability requirements from the CSRD and diverse existing regulations from different regions (Hånell et al., 2023).

There is room for more research regarding proactive approaches of enterprises from the industry sector related to hazardous chemicals, specifically PFAS. The interviews showed that there is also a bottom-up proactive sentiment to act beyond chemical regulatory compliance, as enterprises, like in this case study, an automotive enterprise, make efforts for themselves and far beyond what is legally required.

Previous literature focuses primarily on top-down legislation and institutional mechanisms to enforce chemical restriction ("Global Framework on Chemicals," 2024); it does not contemplate other approaches that can fulfill chemical requirements, as strict regulation sets the tone for companies to report and conduct safe chemical assessments (*Understanding REACH - ECHA*, n.d.). The interviews showed that there is a different approach when addressing hazardous substances and specifically PFAS, as when enterprise employees develop direct and indirect proactive behaviors across their sectors, this can be reflected in the enterprise's proactive measures in this case study (Zhou et al., 2024), acting beyond compliance and collaborating with stakeholders for safer chemical management measures.

Proactive approaches mean that multi-national enterprises are more environmentally inclined than previously thought, showing forward thinking and good practices for risk mitigation in businesses. These are established by developing collaborations with stakeholders across different industry sectors, the inclusion of institutional mechanisms and external stakeholders like their suppliers and the community, implementing decision-making inclusion from various stakeholders, sharing knowledge and data suppliers and institutional mechanisms, and developing more training skills (Hånell et al., 2023) This enterprise certainly englobes key proactive measures to safely manage chemicals ad eventually conduct a PFAS phase out across the GSC as the suppliers reporting capacities on the forever chemicals are none.

More research needs to be done on risk mitigation and assessment regarding PFAS substances and the collaborative approaches with suppliers to begin reporting PFAS, as it is vital to building transparency across all suppliers involved in their GSC.

More needs to be known about the impacts of hazardous chemicals and PFAS on other industries. To understand the various approaches from different industries, an assessment of their engagement with proactive behaviors must be conducted; this can show smilers and build connections for other industry sectors to follow similar actions beyond chemical compliance to avoid regrettable substitutions, enhance resource mobilization, and build transparency (Hånell et al., 2023).

This research's scope is limited to only the chemical and industry sectors and one multi-national automotive enterprise. A more comprehensive assessment of the automotive industry should be conducted to enhance its scope and support the industry sector, as this limits the generability of the findings for other industries.

Another fundamental limitation is the absence of the concrete REACH PFAS Restriction. However, several legal frameworks encompass hazardous substances and can include the PFAS family when restricted, as the absence of the PFAS restriction leaves regulatory gaps. Therefore, many statements and ideas are conditional and more hypothetical now with the current regulations and proactive approaches. A different theoretical approach could be implementing

the PFAS Restriction –when enforced– as a concrete benchmark to assess progress toward PFAS phase-out and create more academic and established text and theory that analyzes this substance mitigation.

As little has been analyzed in the academic realm, I had to implement my theoretical framework to explore this topic. This framework was based on the UN's Global Framework on Chemicals—For a Planet Free of Harm from Chemicals and Waste (GFC).

The GFC requires more development, as the Measurability structure set to measure the key indicators has net to be used in the international scene but only displayed and in continuous development. The explorative design in this thesis was made to adapt two of the five strategic objectives from the GFC, in which they serve as a structure to answer the RQs, while these objectives currently are not focused on PFAS. This can also affect the outcome of the RQs as the room to interact with these forever chemicals is very much limited. The PFAS Restriction must be enforced first to ensure it can be formally assessed through the GFC. Despite this, the two strategic objectives perceive hazardous chemicals and the actions of companies, institutions, and organizations as key to mitigating harmful chemicals. PFAS will be one more family of substances added to this regulatory realm in the future.

In the Helsinki Chemicals Forum, many panels and topics discussed direct and indirect matters related to the thesis topic. However, much information had to be excluded as it was not within the scope of this research – with many angles and aspects to consider about this problem, such as substitution planning, sustainable product development, the circularity of products containing hazardous substances, the impact of enforcement and implementation of different national chemical legislations and restrictions, and the use of economic instruments for chemical management (*Helsinki Chemicals Forum*, 2024).

5 Conclusions

***RQ1*: What are the current challenges and status of the PFAS Movement from different stakeholders' perspectives?**

The PFAS Movement relies on legal frameworks to ensure safer chemical management and depends on the REACH Regulation to restrict the PFAS family. This provides an effective chemical phase-out from the GSC and, overall, in industries. Although the PFAS family is not included in legal frameworks, ECHA still targets PFAS as hazardous chemicals.

The REACH PFAS Restriction remains in the final reviewing stages and enforcement process due to the relevance of ensuring the regulatory changes balance environmental protection, economic prosperity, and digital advancements. This is mainly driven by the ongoing global challenges that have exposed the GSC in recent years.

Not all countries currently possess legal frameworks or institutional mechanisms to address hazardous substances, not contemplating PFAS chemicals. However, several legal frameworks encompass hazardous chemicals as substances for management and reporting. The new GFC focuses on standardizing and promoting safer chemical practices worldwide, encourages collaboration among all sectors, contemplates management approaches to hazardous chemicals and promotes transparency and knowledge sharing between stakeholders. Since its foundation, ECHA has been the critical institutional mechanism for regulating PFAS. Other organizations, such as s ChemSec, Enhsesa, etc., are focused on phasing out PFAS.

Other enterprises' capacities are established to support PFAS identification, management, and phase-out. Some well-known companies used their capacities to deal with these issues, and most internal chemical database platforms were programmed to work with suppliers. Companies, public institutions, and organizations develop other common chemical database platforms. These databases include the PFAS substances.

The PFAS Movement's central pillar is the cross-sectoral collaboration of diverse stakeholders. These stakeholders are involved publicly or privately in this movement and are taking proactive measures to eliminate PFAS. Stakeholders encourage and request collaboration across sectors, from regulator-to-regulator exchanges to stakeholder inclusion in decision-making, more agreements for hazard assessment comprehension, and transparent information exchange to achieve successful international cooperation and partnerships.

The GFC supports cross-sectoral collaboration and can be used as a framework for guidance and cooperation when addressing PFAS in the future. Different organizations (ChemSec, etc, are also well-established in dealing with chemical pollutants. They also serve as institutions to share data and information and align with partnership approaches to assess PFAS the safest way possible.

***RQ2:* How will a multi-national automotive enterprise phase out PFAS and adapt to the upcoming REACH PFAS Restriction in their products, processes, standards, and business approach when cross-functioning with industries around the globe?**

The case study enterprise recognized the presence of PFAS in one specific product with minimal toxicity levels and is acting on it. Due to other environmental issues and targets to accomplish, there are different priorities. They allocate relevant financial resources for the health, safety, and environment department to protect employees, customers, and the community. It is uncertain if its suppliers use PFAS due to the lack of reporting requirements, as suppliers do not need to

disclose PFAS. They have closely followed REACH since its foundation and always comply with this regulation.

The focus is the CSRD as its primary tool for sustainable and financial materiality assessment and reporting schemes. These schemes disclose the company's performance and impacts and contemplate any other relevant directives or regulations that require compliance.

Collaboration with different organizations has been a standing base for the enterprise to keep up-to-date with regulatory changes and be able to conduct proactive approaches. They also collaborate internally within its areas, having committees, teams, and groups to ensure all areas meet sustainability requirements. They have shared some responsibilities by working closely with their suppliers and pushing their OEMs for constant product development that complies with the CSRD. To address sustainability issues adequately across the enterprise, they established a Global Sustainability Council, which is responsible for executing the sustainability strategy and creating sub-strategies if needed; each member is accountable for their material topic area to checkpoint the execution of the action plans, initiatives, regulatory changes, and impacts to this strategy.

Reaching upper management from lower managerial roles was challenging, but collaboration between other areas and groups has effectively expressed matters to upper managerial roles. Decision-making integration from different enterprise areas and experience involvement must be applied to overcome these issues.

The enterprise has taken advantage of its capacities, benchmarking its historic position of having a solid foundation structure to approach issues and report effectively. They have established internal enterprise requirements that align with legal and customer requirements. Another critical capacity is the enterprise's ability to harness several database platforms for transparency, knowledge sharing, products, and chemical content and reporting across the entire automotive industry sector, not only grounded to their suppliers. These capacities have positioned the company to be one step ahead of regulations and be able to act beyond compliance.

Collaboration with external stakeholders from different organizations and suppliers has been a standing base for the enterprise to keep up-to-date with regulatory changes and be able to conduct proactive approaches. They also collaborate internally within its areas; some responsibilities are allocated across groups, teams, committees, and a Global Sustainability Council. All stakeholders know hazardous substances and PFAS, sharing alignment despite diverse role distribution, from upper management to lower and different hierarchical roles.

From the external stakeholders' perspective, integration into decision-making processes regarding hazardous chemicals occurs in different sectors but finds common ground with upper management levels to understand all the comments within areas to address financial risk while meeting sustainability standards. The role of enterprises with PFAS falls into proactive and holistic measures that drive the entire approach, intending always to be better and ahead of the regulations.

Both external stakeholders and the enterprise align when addressing the main concern: suppliers and other external stakeholders need to know if their products contain PFAS. This uncertainty has actively created a community within the industry sector that drives internal and external changes for enterprises.

5.1 Practical policy and industry implications

The practical implications of this research can be reviewed into two groups: i) practitioners from the industry sector involved directly or indirectly with PFAS, and ii) policymakers concerned and involved with the PFAS Restriction.

For group i) practitioners from the industry sector involved directly or indirectly with PFAS, the recommendations are grounded in developing more integration of lower management roles into decision-making processes regarding hazardous chemicals and the PFAS family. With this, upper management levels can strengthen internal cooperation and allocate more resources to safer chemical management. Building transparency corridors between internal areas of enterprises and external stakeholders, as the PFAS chemicals are not classified into reporting directives, internal development of tools with suppliers can create more trust and partnership, which, if done correctly, can drive for voluntary disclosure of PFAS.

For group ii) policymakers concerned and involved with the PFAS Restriction, the key recommendations are based on the current position of the PFAS Restriction. There must be an implementation of testing PFAS to avoid more regrettable substitutions, as the industry sector cannot do this alone; with government incentives and initiatives through institutional mechanisms, the substitution planning of chemicals can be open for diverse sectors. The depth of PFAS is yet to be known. Even with a PFAS Restriction enforced in the future, the assessment for testing more potential diseases, more profound comprehension of the PFAS toxicity levels, financial costs of PFAS substitution, and the circularity of products with PFAS - if, after testing, the hazardous levels are not harmful to the planet–must be regulated. This ensures that not only are PFAS restricted, but remediation strategies are set subsequently to support the industry sector instead of financially affecting them with more enforced substitution and phase-out requirements. Policymakers are bound to act now, as the industry sector is moving capacities and capabilities to target these issues.

From a brief comparison of both RQ1 and RQ2, following the five key aspects to analyze these research questions, there is a clear understanding from the enterprise and the PFAS Movement organizations to tackle PFAS at all costs. The enterprise's proactive measures show that although there is no present collaboration with any of the PFAS Movement organizations, they do share general knowledge and practices to tackle hazardous chemicals and, in this case, PFAS. While the enterprise also differs from the PFAS Movement's priorities to tackle PFAS, as this company currently focuses on much more environmental, sustainability, and chemical issues than just the forever chemicals, this displays that companies face several problems simultaneously. When a global restriction arises, they must adapt quickly and efficiently, revolving into the matter that policymakers must develop more sound policies to support companies, as when enterprises fulfill the transition and phase out of certain hazardous chemicals, a new restriction will arise and oblige them to transition if they want to continue conducting business. Both RQs converge when acknowledging that companies face much bigger environmental tasks than just the PFAS phase-out. Still, they prioritize the eradication of PFAS and stress the need for proper PFAS regulation to avoid any further regrettable substitutions and transparent supply chain practices among suppliers.

5.2 Recommendations for future research

The areas and recommendations for future research include more research on companies within and outside of the PFAS Movement to understand at which transition stage several sectors are located and how companies position themselves in the PFAS phase-out, as these measures are taken through proactive approaches.

More research should be done on identifying PFAS around the supply chain, especially across suppliers, and practitioners should conduct studies on holistic and proactive measures for voluntary PFAS reporting.

Another area of research could be the financial costs companies have to face when developing products that do not contain PFAS, whether it is financially feasible, as not all companies have the same financial capital, and whether the PFAS Restriction will get some companies out of business and how this could be tackled. In addition, there also needs to be more research focused on understanding the composition of products and their processes in the global supply chains by studying the behavior of suppliers and their proactive approaches and reporting requirements; this is to identify PFAS hazardous levels in products and find if they are subject of product circularity.

Finally, the following steps must be analyzed more deeply to avoid the regrettable substitution of PFAS. Some companies' approaches are beyond chemical compliance. They act with their financial capital and own initiatives, not using regulatory requirements. This can elucidate internal company requirements and be a potential tool for policymakers when addressing PFAS disclosure in the future.

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Text style 'Bibliography item.'

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Appendix

5.3 Annex 1. Regulatory Roadmap

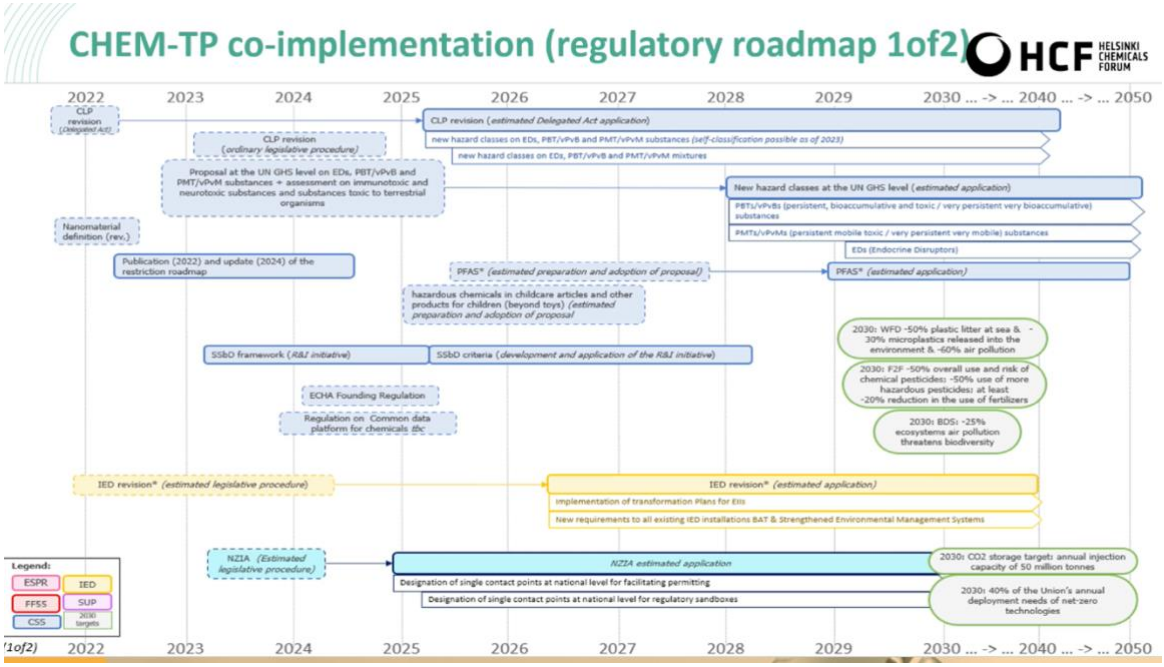

Figure 1. Regulatory Roadmap

Source. Helsinki Chemicals Forum (*Helsinki Chemicals Forum*, 2024)

5.4 Annex 2. Helsinki Chemicals Forum Panels

Name	Panel	Keynote (if applicable)	Theme	Position and organization
P1	How does the new Global Framework on Chemicals influence the global supply chain to manage chemicals safer during the whole product lifecycle?	Personal reflections from the ICCM-5 and perspectives on the new Global Framework on Chemicals	GFC for safer chemical management	• President of ICCM-5 (Federal Ministry for the Environment, Germany) • Chemicals Legislation Manager (CEFIC and ICCA) • Associate Director (Toxics Link) • Environmental Technologies Smarter Chemistry Lead (Apple)

				• Chief of Chemicals & Health branch (UNEP)
P2	How can substitution planning help to create regulatory certainity, promote investments in safer alternatives and speed up the substitution of the most harmful chemicals?	What will be the future role of ECHA under the EU's revised set chemicals regulations	Substitution planning	• Expert, Sustainable Economic Unit (Ministry Economic Affairs Belgium) • (DUCC) • Expert, Substitution planning (ChemSec) • Executive Director (Change Chemistry) • Senior expert at European Commission (REACH Unit)
P3	Learnings from changes to the chemicals legislation elsewhere (US, Canada, Australia, Japan)	Chemicals policy at crossroads – achievemetns and challenges for the future Commission	Chemical legislation transtions	• Assistant Administrator (OCCSPP) • Senior Legislative Policy Advisor, and Director General (Enviroment and Climate Change Canada) • Executive Director (AICIS) • Director of chemical safety office (Chemical management policy divison Japan) • Director of submissions and interaction (ECHA)
P4	Increasing the Use of Economic Instruments for Chemicals Management		Economic Instruments	• Corporate Chief Economist • Director Centre for Future Chemical Risk Assessment and Management (University of Gothenburg) • Sustaianble Chemicals Unit, DG ENV

				(European Commission) • Principal Administrator, Environment, Health, and Safety Program (OECD)
P5	Are Transition Pathways for Sustainability demonstrating how industrial sectors can achieve both the EU's chemicals and industrial strategies?		Transition Pathways	• Deputy Director General (CEFIC) • Chemicals Management Advisor (Eurometaux) • Senior Business and Investor Advisor (ChemSec) • Director, DG GROW (European Commission) • Managing Editor Europe (Enhesa)

Table 2. Helsinki Chemicals Forum Panels

Source: Author's own

5.5 Annex 3. Interview Questions

- This enterprise has settled in different countries and regions, and its branches and suppliers might do the same due to contracts, agreements, and cost-efficient processes. How do you ensure effective internal management systems and strategies in diverse regions despite the different working cultures, values, and principles?
- It is key for companies to avoid financial and environmental risks when phasing out hazardous chemicals. How do these enterprise stakeholders conduct effective resource allocation and mitigate adverse impacts (in this case, PFAS or any past chemical ban) that can threaten the Global Supply Chain and the entire business?
- From internal decisions with managers and engineers to external decisions with suppliers. What considerations must the Global Sustainability Council take when mitigating environmental and financial risk while complying with regulations? (with any past restrictions and currently with PFAS).
- How has the Global Sustainability Council encouraged and improved enterprise management capabilities when strict laws are upcoming? (e.g., PFAS Regulation, eco-design, efficient and sustainable products.)
- How does the Global Sustainability Council work between areas (risk mitigation/assessment, CRR/CSR, product development) to ensure all comply?
- What are the financial challenges of constant investment in innovative and more sustainable products? Is there any chance of applying for funds or projects in different countries?

- What are the challenges of developing sustainable products when new restrictions often arise that set more strict sustainability requirements for these manufactured products?
- When a chemical restriction arises and hazardous chemicals are identified in the supply chain, what are the initial steps in the decision-making process of diverse stakeholders to avoid further risks in the supply chain?
- How do the enterprise stakeholders mitigate adverse impacts (in this case, PFAS) that can threaten the entire business? (Examples include reducing emissions, developing sustainable products, and avoiding hazardous chemicals.)
- What are the most effective internal practices when a chemical restriction can affect the supply chain?
- How does the enterprise conduct a substitution plan for chemicals and products when strict regulation is upcoming? (past chemical restriction and PFAS Restriction)
- From the enterprise's international relevance and regarding your position, what are the best practices and advice (holistic approach) for the automotive industry to prepare and eliminate PFAS from the Global Supply Chain?

5.6 Annex 4. Interview Consent Form

RESEARCH CONSENT FORM

Master Thesis

Lund, Sweden

Purpose of Research

Guillermo Sicairos Fernandez guillermo@mespom.eu +30 9641553113

This study focuses on environmental business management through policy adaptation. The research aims to explore the business adaptation of a multi-national enterprise through its global supply chain approach when phasing out PFAS via REACH PFAS Restriction. For it to comprehend how strict regulation in one part of the world can affect or benefit the global supply chain.

Processing of personal data and the legal basis: The personal data collected during this interview is solely for the purpose of academic research for a Master's thesis. It will be securely stored for the duration necessary to complete the research and the subsequent drafting of the thesis.

Confidentiality & Anonymity: The data provided by the participant that is collected voluntarily will be considered strictly confidential and will not be given to others without written permission from the participant. The participant will be anonymised in all resulting texts.

Right of Refuse, Discontinue or Withdrawal: The participant has the right to discontinue or decline the participation in the research anytime he/she/they feel to do so, including during potential follow-up interviews. Furthermore, the participant has the right to withdraw consent at any time.

Access: The participant has the right to gain access, request correction or deletion of personal data or limitation to processing of data concerning the data subject. Additionally, the participant has the right to file a complaint about how the personal data is used.

Participant's Signature:

Date: