Due diligence in electronics and vehicle manufacturing

Electronics and vehicle manufacturing requires the procurement of raw materials, refinement of those raw materials for use in manufacturing, manufacturing component parts and assembly of the final product. This case study focusses on risks and impacts caused during the manufacturing and assembly stage. Given that the nature of manufacturing for both electronics and vehicles are extremely similar, and the risks and supply chains are often shared, this study considers both industries together, but could be relevant to other industries, such as renewable energy supply chains.

Key characteristics of electronics and vehicle supply chains

Market landscape

The electronic and vehicle manufacturing (EVM) sectors represent critical pillars of the global economy in terms of value added, employment, innovation, export and growth (OECD, 2024[1]; 2024[2]).[1] These industries are increasingly converging as vehicles become more computerised and electrified, creating new competitive dynamics where traditional boundaries between consumer electronics, semiconductors, and automotive manufacturing blur. This convergence has accelerated with the rise of electric vehicles (EVs), autonomous driving technologies, and smart mobility solutions, prompting established players in the US, Europe, Japan and Korea to adapt while creating opportunities for newcomers, particularly in the US, the People's Republic of China and Vietnam.

Supply chain resilience has become a central focus following recent disruptions, particularly in semiconductor manufacturing where shortages severely impacted vehicle and electronics manufacturing worldwide. This has prompted governments to invest heavily in domestic production capabilities. Simultaneously, manufacturers are increasingly prioritising sustainability throughout their operations, with commitments to carbon neutrality, circular material flows, and responsible sourcing driving innovation in manufacturing processes and product design (Dechezleprêtre et al., 2023[3]).

The economic significance of these sectors extends far beyond direct manufacturing, creating vast ecosystems of suppliers, service providers, and complementary industries that collectively employ millions worldwide. These industries also serve as crucial engines for technological advancement, with their massive research and development investments driving progress in areas ranging from battery technology and artificial intelligence to advanced materials and manufacturing techniques.

Looking forward, the electronic and vehicle manufacturing landscape faces transformative shifts from multiple directions. The transition to electric mobility continues to accelerate, reshaping automotive supply chains and manufacturing requirements. Emerging technologies like artificial intelligence and advanced robotics are revolutionising product development and production processes. Meanwhile, geopolitical tensions and sustainability imperatives are pushing companies to reconsider globalised production models in favour of more regionalised approaches.

Supply chain characteristics

EVM supply chain structure

Electronics and vehicle manufacturing (EVM) supply chains are complex, diverse, and often very large (in terms of number of suppliers) and very long (in terms of number of stages from raw material to final product). Generally speaking, EVM supply chains include four main phases:

- **Phase 1: Extraction and production of raw materials** such as mining minerals, drilling and extraction of oil and gas, and farming and forestry of agricultural products.
- **Phase 2: Processing and refining of raw materials** such as smelting and refining minerals; refining oil and gas for chemical manufacturing to produce rubber, plastics, paints and dyes; and processing agricultural products to be used in fabric and leather components of products.
- **Phase 3: Manufacturing of components** including batteries, semiconductors, screens, casings, vehicle chassis, body panels, engines, seats, interior trims, lighting, tyres, wheels, etc.
- **Phase 4: Final product assembly** of the vehicle or electronic product.

The topics covered in this paper specifically concern human rights, labour, corruption and environmental risks related to manufacturing and final assembly (i.e., phases 3 and 4).

Figure 1. Simplified vehicle supply chain

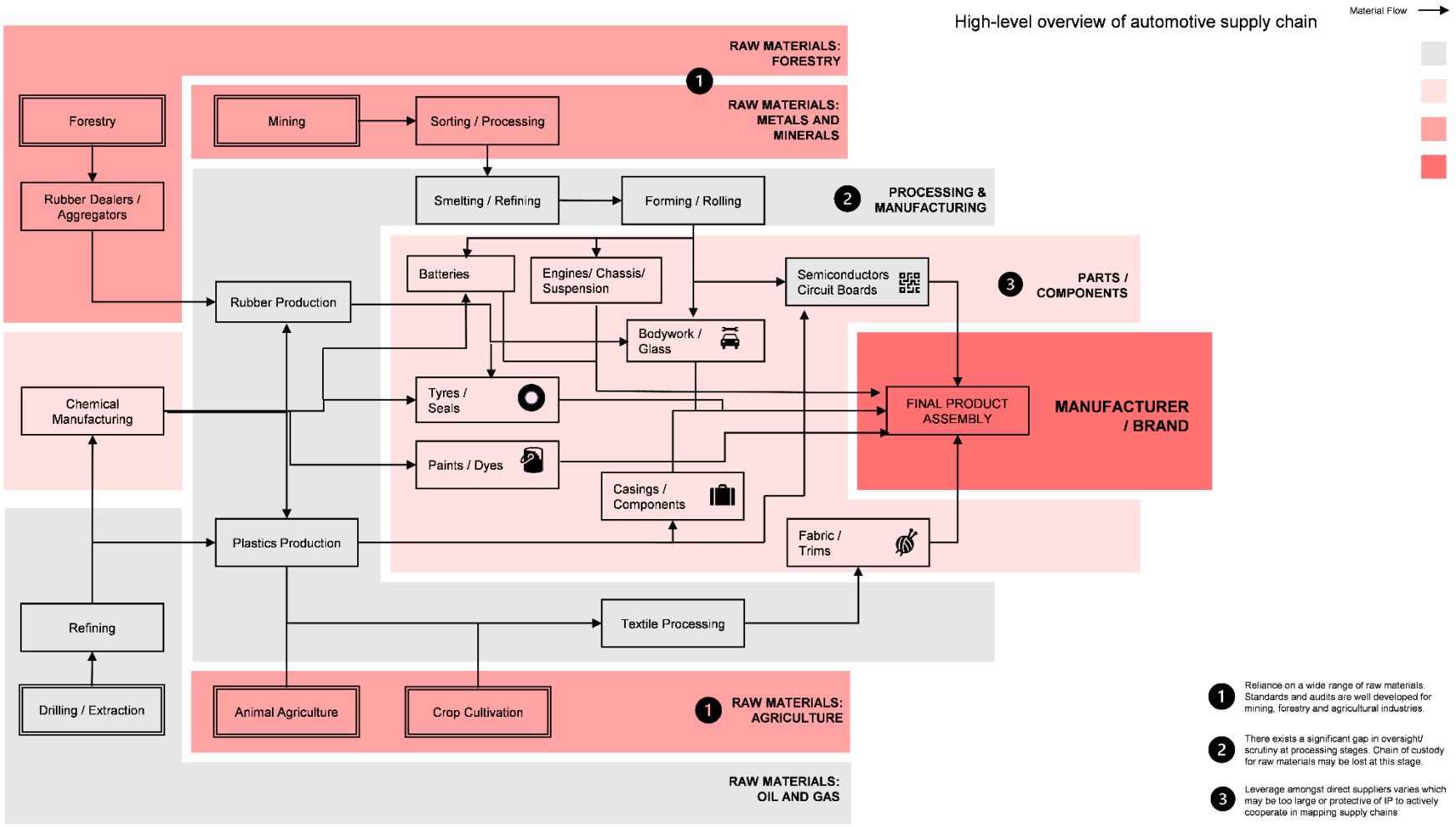
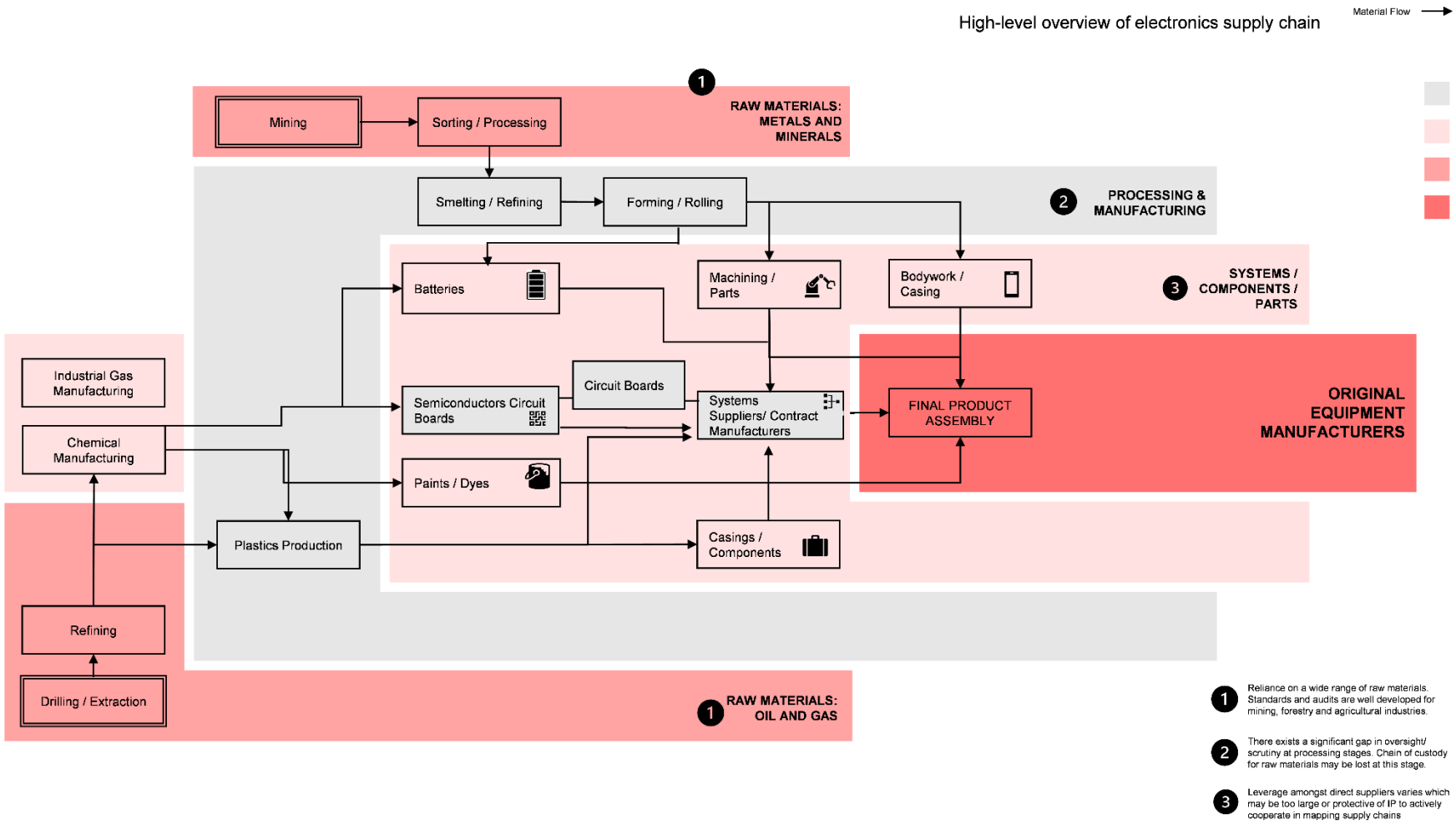


Figure 2. Simplified electronics supply chain



While some components are shared between different EVM supply chains (e.g. semiconductors, screens and batteries), the majority of supply chains vary significantly in terms of size and complexity. **Likewise, many electronics and vehicles are highly technical and specialised and most products use a wide array of materials, each with multiple components with their own complex supply chains.**

By way of example, an average vehicle has an estimated 30 000 component parts made of approximately 50 raw materials. In interviews with stakeholders for the development of this paper, one automotive company reported mapping over 500 suppliers for its batteries alone. Electronics companies reported similar numbers, with some interviewees estimating over 10 000 tier-one suppliers for their products. Interviewees also stated that supply chains were getting longer and could span up to ten tiers.

EVM supply chains are generally non-linear. Companies have various buying and partnership relationships and do not operate within predefined brand-supplier-sub-supplier relationships. Companies can hold multiple positions in the EVM supply chain, from original equipment manufacturer, original design manufacturer, to original brand manufacturer. As an example, a company might produce semiconductors for use in consumer products or manufacturing machinery of other companies while also producing its own consumer products.

Production models and workforce profile

Production models in EVM supply chains are highly flexible and include short product lifecycles, lasting only 3-18 months, with high seasonal peaks. This in turn requires a highly flexible workforce with suppliers in some jurisdictions reliant on migrant and/or temporary workers, and reports and interviews noting high risks of forced labour in certain jurisdictions.

The workforce is reportedly typically low-skilled in middle and lower tiers of the EVM supply chain (i.e. where raw materials are transformed into usable component parts and early in component part manufacturing). One interviewee referred to the combination of specialist technical machinery, automation, and low-skilled workers. As products advance through the EVM supply chain, the factories, workers and machinery tend to become increasingly sophisticated, though this varies by product.

Factories tend to be large, employing between 10 000 and 50 000 workers. Female worker representation in the electronics factories ranges from 60% to 90%, depending on the country of operation. About 80% to 85% of the workers in the electronics sector are in the assembly line processes and most of these assembly line workers are women. Male workers are generally assigned to fabrication and maintenance related tasks, which are higher and better paid positions. Such workforce characteristics may entail unique risk profiles and gendered impacts, such as sexual harassment and sexual and gender-based violence.

Salient impacts associated with the sector[2]

The most likely and severe risks related to EVM manufacturing and assembly reported by interviewees and flagged in research include the use of **forced labour and child labour, exposure to hazardous chemicals, undermining of collective bargaining, low wages and excessive overtime** (US Department of Labor, 2024[4]; UNICEF, 2020[5]; Electronics Watch, n.d.[6]; UN OHCHR, 2018[7]). While this list can inform individual company due diligence efforts, it is non-exhaustive. Each company is expected to identify its priority risk areas based on its individual circumstances, including risks not listed here.

Infringements on human rights, notably the use of forced labour and child labour

Forced labour and child labour are significant risks in EVM supply chains in multiple jurisdictions. These risks can manifest themselves in a variety of ways depending on the source (e.g. passport retention, recruitment related debt, and forced overtime). The sector relies heavily on the use of migrant workers and

temporary workers who may be at heightened risk of forced labour such as through deceptive recruitment practices. There are also reports of forced labour facilitated through government-led labour and student worker programmes (ILO-OECD, 2023[8]).

Failures to provide safe and healthy working environments, including harmful exposure to hazardous chemicals

Exposure to hazardous chemicals was consistently flagged as a high risk in interviews across all stakeholder groups and in desk research. Chemicals used as solvents and degreasers in electronics production are documented to be linked to cancer, reproductive and developmental toxicity, blindness and kidney failure, damage to the nervous system, harm to bone marrow, miscarriage, liver damage, irritation to eyes, skin, nose, throat and the respiratory system. Per- and Polyfluorinated Substances (PFAS) or "forever chemicals" are reportedly used in semiconductor manufacturing (ILO, 2021[9]). Workers may not be aware of the hazards of the chemicals they work with, preventing them from taking adequate measures to protect themselves.

Risks to rights of workers, including to establish or join trade unions, engage in collective bargaining, and wages and working hours outside of the framework of government policies and applicable international standards

In the automotive sector, older automotive OEMs and brands in Europe and North America continue to have strong levels of unionisation. However, interviewees noted that new market entrants, in particular EV manufacturers, can be more often union-opposed and pursue anti-union policies in their own operations.

Within the electronics sector, the risks to rights to join trade unions or engage in collective bargaining are high and unionisation is generally considered to be low. The situation is further compounded by a reliance on migrant and temporary workers. Irregular status and structural barriers (e.g. tying the workers' ability to stay or leave a country to a visa sponsored by their employer) affect their participation in unions in the industry according to the UN Report on Rights to Freedom of Peaceful Assembly and of Association (United Nations General Assembly, 2016[10]). Some electronics companies are beginning to engage with unions, and there may be a trend towards stronger unionisation. However, global framework agreements between companies and trade unions are rare and there are no sectoral agreements and initiatives such as those in the garment and footwear sector (e.g. the International Accord for Health and Safety in the Garment and Textile Industry, ACT on Living Wages).

There is a history of union busting within both sectors, where companies reportedly hire specialised firms to target unions. Interviews and desk research noted that risks of low wages and excessive overtime are also common. These issues are often linked to low unionisation, temporary and migrant workers, and seasonal peaks. In some factories, wages and bonuses may be tied to excessively high production targets or long working hours. Workers may face the loss or delay of the wages or bonus promised to them if they do not meet those targets.

Environmental impacts linked to disposal of hazardous chemicals, water management, and greenhouse gas emissions

High levels of water usage, pollution and greenhouse gas emissions are reported at nearly all stages of the EVM supply chain. This is further compounded by a strong reliance on fossil fuels within electricity grids across Asia, where most electronics and automotive manufacturing is based. Stakeholders noted that semiconductor and battery manufacturing may be the highest risk segments of EVM supply chains given their long and complex manufacturing processes and their increasing demand.

Bribery and corruption linked to large scale investments in host countries, favourable tax conditions, and relaxed oversight of operations

Interviews and desk research indicate a broad range of circumstances where this risk presents itself, such as payments to regulators to avoid investigations on operations or taxes, payments to safety inspectors on manufacturing sites, and payments to government officials to approve or support large investments or mergers with local companies.

Key considerations for due diligence

Challenges

Lack of leverage and visibility

For due diligence purposes, EVM supply chains are characterised by a limited visibility over the supply chain beyond tier-one and lack of transparency of due diligence information. These dynamics can stem from:

- intense competition for suppliers and specialised manufacturing processes (e.g., advanced semiconductors)
- high protection of intellectual property rights for innovation and technology (e.g., risks of economic espionage, hacking and trade secret theft result in supply chain disruptions)
- possible anti-competitive concerns (e.g., interviews indicated perceptions that supply chain cooperation may risk violating competition laws)
- regulation that may prevent due diligence information from passing along the supply chain (e.g. data governance laws that restrict or limit the type of information that can be transferred in or out of manufacturing countries)
- geopolitical and national security considerations related to certain products (e.g. policies that limit semiconductor manufacturing in specific countries due to the use of advanced semiconductors in, inter alia, weapons and intelligence gathering technology).

The power dynamics within EVM supply chains are marked by high barriers to market entry, high levels of rapid innovation and significantly reduced options for sourcing alternatives. Leverage within EVM supply chains varies greatly depending on the role and buying relationship a specific company has. Companies, particularly the large consumer facing brands, may not have the same ability to cascade responsible business conduct (RBC) expectations up the supply chain to their suppliers and sub-suppliers as is common in other sectors. Companies in the middle of the supply chain sometimes have more power than the buyers who rely on them for their products. **Those companies that produce the materials, parts or components that the market needs hold the most leverage.**

There is a high number of public buyers in EVM supply chains. **Despite the high value involved in public contracts, procurement bodies may still face limitations in the leverage that they can exert as there may be a limited number of suppliers that can fulfil the technical specifications required for their orders.** One interviewee from civil society remarked that public procurement bodies may have “sunk costs” (i.e., costs of investment over several years in a specific technology and reliance upon it), which in turn reduces their leverage.

Private and public buyers can work to increase their leverage, including through outreach from senior management, commercial incentives and collaborative approaches. Moreover, individual purchasing practices play a significant role in mitigating adverse risks and impacts in the EVM supply chain. For instance, order fluctuations and seasonal demand cycles, coupled with aggressive price

negotiations and low margins, can exacerbate supply chain vulnerabilities and force suppliers into unsustainable production regimes. This may, in turn, increase the likelihood of compromised labour standards.

High levels of disruption

EVM supply chains are currently experiencing high levels of disruption caused by a range of factors with a high level of interdependency. These include:

- geo-political shifts, including related to trade and national security
- new regulation and market requirements related to supply chain due diligence and sustainability more broadly, and combating forced labour specifically
- shifting reliance on sourcing, including raw material sourcing, away from certain jurisdictions
- rapid innovation and the race to secure supply of the most advanced and critical technology (e.g. batteries and semiconductors)
- disruption of "traditional" industries due to new technology (e.g. electric vehicles and artificial intelligence).

While there is a history of collaboration in EVM supply chains to identify and address risks linked to raw materials (e.g. through industry initiatives aimed at identifying and auditing smelters and refiners in mineral supply chains), interviewees reported a lack of initiatives at the manufacturing and assembly phase to help provide greater visibility on risks and actors beyond tier-one of EVM supply chains. However, the basis for developing an industry-wide collaborative effort exists, notably through initiatives such as the Responsible Business Alliance and the Drive Sustainability Initiative.

Opportunities

Tailoring policies and management systems to account for EVM risks

Interviewees noted that RBC policies and management systems in EVM supply chains are generally tailored toward mineral supply chain due diligence and due diligence of own operations and tier-one suppliers. This is likely in response to years of existing legislation, industry and market self-regulatory efforts, and civil society activism related to mineral sourcing. However, interviewees also stated that there are significant gaps with regards to knowledge of EVM risks and actions taken to address those information deficiencies.

In line with the *OECD Guidelines for Multinational Enterprises on Responsible Business Conduct* (MNE Guidelines) (2023[11]), company policies should include commitments to conduct risk-based due diligence to address all RBC issues throughout their supply chains and business relationships, including component manufacturing and final product assembly (see MNE Guidelines, Ch. II Commentary, para 17). Likewise, internal management systems may need to be updated to allocate appropriate resources to due diligence. These specific actions and others are described in more detail in the *OECD Due Diligence Guidance for Responsible Business Conduct* (Due Diligence Guidance) under Step 1 (OECD, 2018[12]).

Initial scoping of EVM risks and in-depth assessments

Step 2 of the Due Diligence Guidance notes that companies should conduct due diligence by first carrying out a high-level desk-based scoping exercise to identify those areas of the business where potential or actual impacts are likely to be most severe[3] and/or most likely. This can include reviewing credible publicly available reports, information from complaints mechanisms, and engaging with relevant experts (OECD, 2018, pp. 25-28, 61-73[12]).

Box 1. Scenario: Initial risk scoping and in-depth assessments

A fictional vehicle manufacturer, FairCar Automotive, is conducting desk research and basic stakeholder outreach to determine whether products they manufacture or that are in their supply chains are associated with particular risks. FairCar reviews publicly available reports about RBC risks associated with vehicle manufacturing and discusses these issues with practitioners and NGOs researching these issues. This initial scoping indicates FairCar's battery supply chains are likely to be associated with more significant risks than its other components.

At this juncture, it is unlikely that FairCar will have detailed information on specific sub-suppliers to commence a detailed assessment of its battery supply chain. Rather, they would first seek to gather additional information on where its batteries are manufactured, mapping the higher-risk stages of the supply chain for these products and the quality and nature of any due diligence carried out by high-risk sub-suppliers. Only then can FairCar move on to prioritise individual business relationships for in-depth assessment and action.

A determination of which risks are most significant will be context specific. Therefore, the Due Diligence Guidance recommends that companies should engage with relevant stakeholders on how to prioritise and publicly communicate the rationale for this prioritisation. Given the prevalence of risks involving child and forced labour in EVM supply chains, as well as worker health and safety, companies may want to prioritise engagement with workers' groups, international and local civil society organisations focused on these issues and representatives of affected communities. Publicly communicating the rationale behind how prioritisation decisions are made and why is important for establishing trust and credibility in the enterprise's due diligence approach. In some cases, prioritisation may also be informed by legal obligations.

Increasing leverage and visibility

Where companies do not have sufficient leverage with their business relationships and may struggle to gather relevant supply chain due diligence information, they should take steps to increase their leverage. Strategies for increasing leverage are described in the Due Diligence Guidance Step 3 (OECD, 2018, pp. 19, 51-53; 77-81[12]). These include:

- Developing and sharing a common set of RBC requirements with suppliers. Similarly, companies sourcing from the same supplier may use their combined leverage to encourage the shared suppliers to implement effective corrective action measures with due consideration for competition law (e.g., setting joint timelines for corrective action and jointly conducting or sharing supplier assessments, corrective action plans, and progress reports using common metrics).
- Establishing RBC-linked incentives in the supply chain, for example by integrating RBC expectations into supplier contracts; putting in place measures to require or support direct suppliers (tier-one) in their assessments of sub-suppliers (tier-two); increasing orders or giving prospective orders to suppliers that perform well in relation to quality of production and RBC.
- Collaborating at a sector-wide or regional level to identify and engage suppliers that operate at common control points in the supply chain. Companies may join geographic or issue-specific initiatives that seek to prevent and mitigate adverse impacts in the areas identified (e.g. country or sector roundtables, multi-stakeholder initiatives and on-the-ground programmes).
- Participating in dialogs with a variety of stakeholders who can share information on supply chains, risks, and risk mitigation best practices.

Given the difficulty in engaging suppliers beyond tier-one in EVM supply chains and the lack of leverage reported by many interviewees, many of the risk mitigation actions may be difficult to achieve for individual companies, including even large multinational enterprises. **Companies may wish to seek support through collective action and multistakeholder initiatives dedicated to supporting responsible business conduct or targeted at specific issues** (OECD, 2018, pp. 19, 51-53[12])**.** Examples of such initiatives include the Clean Electronics Production Network (CEPN), the Drive Sustainability Initiative, the Global Battery Alliance (GBA), and the Responsible Business Alliance (RBA). These initiatives promote dialog among businesses and stakeholders in EVM supply chains and work to develop common solutions to supply chain due diligence challenges such as standardised supplier questionnaires, risk information databases, and commonly accepted audit requirements. Companies are expected to review and act on the information generated from collective efforts.

Disengagement as a last resort to address risks

RBC standards are above all tools for enabling continuous engagement, including in high-risk areas, and only call for disengagement from business relationships as a last resort after failed attempts at mitigation, where the enterprise deems mitigation not feasible or because of the severity of the adverse impact (OECD, 2023[11]) Ch. II Commentary, para 25); (OECD, 2018, pp. 80-81[12]). In these situations, enterprises should comply with national laws, international labour standards and the terms of collective bargaining agreements. It is important that companies make sure that suppliers are given sufficient notice.

In instances where impacts are severe and likely and it is not possible to carry out adequate due diligence, an enterprise may determine that mitigation is not feasible and decide to disengage. For example, where risks related to a certain manufacturing segment of the supply chain are well documented through publicly available information but companies sourcing from these areas are prevented from obtaining any information regarding such risks related to their specific suppliers, taking action to address them becomes challenging. Such opacity could conceivably lead to the need to suspend sourcing or disengage. In these circumstances, companies should also document and report on their best efforts to gather information and mitigate risk.

However, the current degree of geographic concentration in EVM supply chains makes disengagement practically difficult in some contexts. This is particularly true of certain EVM components such as batteries and semiconductors. A key consideration in EVM supply chains for disengagement therefore includes how crucial the supplier or business relationship is to the company. Decisions to disengage can also consider the legal implications of remaining in or ending the relationship, how disengagement might change impacts on the ground, as well as the potential social and economic adverse impacts related to the decision to disengage.

Where a company decides to stay engaged despite failed attempts at mitigation, a determination that mitigation is not feasible or the severity of the adverse impact, companies may consider reporting the situation internally, continuing to monitor the business relationship, for example, through maintaining a knowledge database, and revisit their decision to continue the business relationship where circumstances change or as part of the company's long-term strategy. The company may consider also reporting publicly and to relevant stakeholders (e.g., government officials or business relationships) on:

- best efforts to gather information or prevent and mitigate an impact
- the decision not to end the business relationship
- how this decision aligns with their policies and priorities
- what actions are being taken to attempt to apply leverage to mitigate the impacts
- how the business relationship will continue to be monitored in the future.

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Notes

[1] The information presented in this case study is based on 14 interviews with selected stakeholders across government, business and civil society carried out by the OECD and Due Diligence Design, followed by group consultations as well as desk research. It does not aspire to be an exhaustive stocktaking of all EVM impacts and due diligence responses.

[2] During interviews, stakeholders were asked which issues under the scope of the MNE Guidelines that they encountered as part of their due diligence processes. In the case of non-industry stakeholders (i.e. government, worker and civil society representatives), they were asked to identify what risks they believed to be most significant and to share desk research.

[3] The significance of an adverse impact is understood as a function of its likelihood and severity. Severity of impacts will be judged by their scale, scope and irremediable character:

- Scale refers to the gravity of the adverse impact.
- Scope concerns the reach of the impact, for example the number of individuals that are or will be affected or the extent of environmental damage.
- Irremediable character means any limits on the ability to restore the individuals or environment affected to a situation equivalent to their situation before the adverse impact.

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