

Exposing Forced Labor in the Global Supply Chain of Carbon Steel, and in the Supply Chain of Components Used in Belt and Road Initiative Projects

Report

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This report presents research on forced labor in the global supply chain of carbon steel, and in the supply chain of carbon steel components commonly used in the construction of infrastructure projects funded through China's Belt and Road Initiative. ICF prepared this report according to the terms specified in its contract with the U.S. Department of Labor. The research team would like to express sincere thanks to all the parties involved for their support and valuable contributions.

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GLOSSARY

Basic oxygen furnace: A specialized steelmaking vessel in which high-pressure oxygen is injected into a mixture of molten iron, recycled steel, and chemical additives to create refined steel by removing impurities. Basic oxygen furnaces are typically situated within integrated steel mills, receiving molten iron directly from the facility's blast furnaces. This process is also referred to as the basic oxygen process.

Belt and Road Initiative: A Chinese infrastructure and development program launched in 2013 that aims to build overland and maritime trade connections through investments in roads, rail, ports, and other infrastructure projects across Asia, Africa, and beyond.¹

Blast furnace: The primary furnace used in integrated steel mills to transform iron ore pellets and other iron-rich materials into liquid iron. These large furnaces are designed to operate continuously, producing molten iron that flows directly to basic oxygen furnaces for conversion into steel.

Carbon steel: The most basic form of steel—an iron alloy in which carbon is the main alloying element (typically 0.3–2% carbon by weight). Distinguished from specialty steels like stainless steel by having minimal amounts of other elements besides iron and carbon.

Country of melt and pour (steel): This term identifies where steel is initially created and solidified, encompassing two key steps: first, where raw materials are melted into liquid steel in a steelmaking furnace, and second, where that molten steel is cast into its initial solid form. This solid form may be either a semifinished product (such as an ingot, bloom, slab, or billet) or a finished steel product. The location of these processes is typically documented on standard mill test certificates that accompany steel products.

Crude steel: The initial form of steel, produced by processing pig iron. Typically, further refining is required to produce downstream steel products.

Direct reduced iron: A form of processed iron produced by removing oxygen from iron ore through a chemical reaction, rather than through traditional melting. This process uses reducing gases (typically hydrogen and carbon monoxide derived from natural gas, synthetic gas [syngas], or coal) to convert iron ore into pure iron while keeping it in solid form. The resulting product can be used as a raw material in various steelmaking processes, including in electric arc furnaces.

Electric arc furnace: A furnace that produces molten steel by heating input materials (primarily scrap iron or direct reduced iron) with electric arcs generated by carbon electrodes.

Ferrous: Refers to a material containing or consisting primarily of iron (including steel).

Flat steel: Steel products like sheets and plates produced by rolling steel through rollers. Commonly used in automotive manufacturing, appliances, and construction.

Long steel: Steel products like beams, rails, and rods that are long and linear in shape. Primarily used in construction and infrastructure projects.

Metallurgical coal: A specialized grade of coal with high carbon content used to make coke for steelmaking. Distinguished from thermal coal used for power generation.

¹ Initially termed “One Belt, One Road,” the program's name was later changed to the Belt and Road Initiative to better reflect its expanding scope (Syarif, 2023).

Pig iron: The product of smelting iron ore, generally in a blast furnace, which can either be in liquid/molten or solid/cast form when consumed in steelmaking. The liquid form of pig iron is often referred to as “hot metal” or “crude iron.” It contains a high percentage of carbon and is used as an intermediate product in the production of steel.

Standard gauge railway: Railway infrastructure built to a standardized track width (4 ft 8.5 inches, or 1,435 mm between rails). Term commonly used to refer to several Chinese-funded railway projects in Africa, including the Mombasa–Nairobi Standard Gauge Railway in Kenya.

Steel: An alloy of iron and carbon.

Scrap metal, externally sourced: Recycled metal materials obtained from sources outside a facility’s own operations. This category encompasses three main types of scrap: pre-consumer scrap generated during manufacturing processes at other facilities; post-consumer scrap recovered from products that have reached the end of their useful life, such as recycled automotive steel; and processed scrap that has been professionally shredded, analyzed for composition, and custom-blended to meet specific alloy requirements. These materials can be sourced from any external supplier, including other metal production facilities (even those under the same corporate ownership) as well as downstream manufacturers. This definition distinguishes externally sourced scrap from internal scrap that is generated and recycled within the same facility.

Scrap, internally sourced: Internal scrap (also called runaround, home, turnaround, or in-house scrap) refers to metallic material that is recycled within the same facility in which it was generated as scrap during production processes. Since this material never leaves the facility and is directly reused as production input, it typically does not impact the facility’s overall material accounting—the amount of raw materials coming in versus finished products going out remains unchanged. For example, trimmed edges from steel sheet production that are collected and re-melted in the same plant would be considered internal scrap.

ABBREVIATIONS

BRI	Belt and Road Initiative
DRI	direct reduction of iron
GFSEC	Global Forum on Steel Excess Capacity
IMIP	Morowali Industrial Park
KCJB	Jakarta-Bandung High-Speed Railway
KII	key informant interview
ILO	International Labor Organization
MOU	Memorandum of Understanding
PPE	personal protective equipment
psi	per square inch
SGR	Standard Gauge Railway
TEU	twenty-foot equivalent unit
UFLPA	Uyghur Forced Labor Prevention Act
XUAR	Xinjiang Uyghur Autonomous Region

EXECUTIVE SUMMARY

CONTEXT

The global steel industry has undergone significant transformation in the past few decades, with China emerging as the dominant producer, accounting for more than half of both global steel production and global steel exports (World Steel Association, 2024b). This dominance has implications for infrastructure development worldwide, especially for projects funded through China's Belt and Road Initiative (BRI). Through the BRI—an overarching development and investment initiative named² after the historical Silk Road trade routes linking China to Europe and the Middle East—China has provided loans and equity funding to countries all over the world for investments in roads, rail, ports, and other infrastructure. Since its launch in 2013, the BRI has channeled more than \$1 trillion in Chinese investment into infrastructure projects across 150 member countries, making it one of the largest development initiatives in history (Wang, 2024). These large infrastructure projects have required large volumes of steel components, many of which have been sourced from China.

Over the past decade, global observers and human rights organizations have intensified their scrutiny of labor conditions in supply chains, with particular focus on forced labor risks in Chinese manufacturing (Murphy et al., 2022; Sheffield Hallam University, 2022, 2023). This attention has grown following documented systematic labor rights violations in China's Xinjiang Uyghur Autonomous Region (XUAR), a region that hosts a substantial part of the country's steel production capacity. The convergence of China's role as both the world's largest steel producer and the primary funder of infrastructure development in many developing economies has made understanding labor conditions in the steel supply chain for BRI projects increasingly important for policymakers and development practitioners.

OBJECTIVES OF THE STUDY

This qualitative study aimed to provide a sectoral overview of the role of forced labor in the global production and international trade of carbon steel. To this end, this report presents an overview of the processes by which carbon steel is manufactured and processed, an overview of the global carbon steel supply chain, a review of major stakeholders in this supply chain, and a discussion of the risks and evidence of forced labor present in the global carbon steel sector as a whole.

In particular, this study aimed to examine the risks of forced labor in the supply chain of carbon steel components commonly used in the construction of infrastructure projects funded through the BRI. To provide further context to findings regarding the supply chain of carbon steel goods used in BRI-funded infrastructure projects, this study presents case studies of the carbon steel supply chain in two countries: Indonesia and Kenya. These countries host significant BRI-funded infrastructure projects and have significant domestic steel industries.

The study aimed to:

- Document evidence of forced labor in steel production and supply chains.
- Map key risk factors and examine how procurement practices may enable or constrain the use of forced labor.
- Analyze how BRI project structures and financing arrangements influence labor conditions.
- Identify specific downstream products and supply chain segments at greatest risk.

² Initially termed “One Belt, One Road,” the program's name was later changed to the Belt and Road Initiative to better reflect its expanding scope (Syarif, 2023).

To this end, this study was designed to answer the following research questions:

- What are two to three common infrastructure-relevant downstream goods made from carbon steel alloys that were used in the BRI projects addressed in the case study countries?
- Is carbon steel used in BRI-funded infrastructure projects generally manufactured in-country or imported (from China or elsewhere)?
- What evidence is there of China exerting influence in the BRI host countries' domestic production of steel and the development of the local steel industry within the case study countries?
 - To what extent can we identify and quantify the proportion of the carbon steel used in BRI-funded projects that is (a) imported from China, (b) imported from countries other than China, and (c) sourced from domestic producers?
- Are there accounts of forced labor indicators in the supply chains of carbon steel likely to have been used in BRI projects in the case study countries?
 - Where are the indicators of forced labor in the supply chain of carbon steel for BRI projects found in the context of the case study countries?
 - Are there accounts of forced labor indicators in recruitment and use of workers for construction activities that use goods produced from carbon-based steel?

METHODOLOGY

This study applied a mixed-methods approach, which included an extensive review of secondary literature, reviewing industry and international trade data (from UN Comtrade, World Steel, and other sources), and conducting key informant interviews (n=30) with industry representatives and experts, government officials, and civil society representatives in both case study countries and around the world. Data collection took place between July and December 2024.

The research team faced significant challenges in securing key informant interviews, despite extensive outreach efforts. Significant numbers of candidates failed to respond to outreach or declined to be interviewed. Of those who did respond, many expressed hesitation about discussing labor conditions in the steel sector, particularly regarding Chinese production. Industry stakeholders were especially difficult to engage, with several explicitly declining to participate due to concerns about sharing potentially business proprietary supply chain information. To address this challenge, the research team conducted additional rounds of outreach to potential respondents and expanded the pool of potential interviewees through snowball sampling.

KEY FINDINGS

Study findings suggest that significant forced labor risks exist throughout the BRI steel supply chain, with concerns in projects located in countries with limited regulatory capacity. The following key findings emerged:

Supply Chain Structure and Procurement: BRI financing agreements—the agreements governing the terms under which funding is allocated and projects are completed—generally mandate or favor sourcing materials from Chinese suppliers, even when capable domestic producers exist. These sourcing provisions, combined with tied financing models that generate unsustainable debt burdens for host countries, have created conditions conducive to labor exploitation. Limited supply chain transparency and inadequate oversight mechanisms have allowed labor abuses to persist.

Production-level Labor Violations: This study documented evidence of forced labor in the supply chain of steel and steel components made in steelmaking facilities in the XUAR and elsewhere in China.³ Multiple indicators of both involuntary work and coercion have also been reported in Chinese-operated facilities in the case study countries. Limited transparency and restricted access to production facilities hinder independent verification of labor conditions. Further, this study found evidence of labor violations in the domestic supply chain of steel and steel components made in both case study countries. In Indonesia, domestic steel facilities showed systematic labor violations, with workers reporting excessive overtime, unsafe conditions, and wages below the legal minimum. Kenya's domestic steel sector, though smaller, exhibited similar issues, with industry experts describing widespread use of informal labor, inadequate safety measures, and worker confinement on factory premises.

Project Implementation Issues: This study found evidence of serious labor violations in the construction of BRI-funded projects in both case study countries. At Indonesia's Morowali Industrial Park, investigators documented 30 worker deaths between 2019 and 2023 due to unsafe conditions. Workers regularly faced 12+ hour shifts without adequate rest or compensation. Living conditions were severely substandard, with just 3 toilets provided for every 2,500 workers. In Kenya's Standard Gauge Railway project, local workers have reported physical abuse, systematic discrimination, withheld wages, and forced overtime.

Structural Risk Factors: The study identified several systemic issues that enable labor exploitation, including the following:

- Host country regulatory capacity rarely matches the scale and complexity of BRI projects.
- Steel companies and construction firms commonly use labor subcontracting to evade worker protections and union representation.
- Limited transparency requirements allow violations to go undetected.
- Lack of effective grievance mechanisms leaves workers without recourse.

These findings demonstrate that forced labor risks exist throughout the BRI steel supply chain, from initial production in China through project implementation throughout the world. The combination of mandatory Chinese sourcing, weak oversight mechanisms, and economic pressures creates conditions in which labor exploitation can flourish. Although individual projects show varying degrees of risk, the structural issues identified suggest that these problems are likely widespread across BRI infrastructure development.

CONCLUSION AND RECOMMENDATIONS

The combination of tied financing, opaque supply chains, and systematic labor rights evasion creates conditions in which worker exploitation can flourish without effective oversight or accountability. There are no easy solutions, but several key recommendations emerged from the research.

Recommendations:

To Other Governments:

Other governments should take several concrete steps to strengthen oversight of forced labor risks in BRI steel supply chains:

³ Of note, Chinese steel produced outside the XUAR may still have Uyghur Forced Labor Prevention Act implications due to supply chain connections with either XUAR-based facilities or transferred Uyghur forced labor.

- Governments should enhance international cooperation through targeted capacity building programs for labor inspectorates in BRI recipient countries. This could include technical assistance for developing digital tracking systems, training on investigating forced labor indicators, and support for cross-border coordination of enforcement efforts. Programs should focus particularly on strengthening oversight capacity in countries that host major BRI infrastructure projects.
- Government agencies should support alternative infrastructure financing models that avoid creating excessive debt burdens or procurement requirements for countries looking to invest in infrastructure projects. Technical assistance should be provided to help countries evaluate financing options and negotiate agreements that preserve procurement sovereignty and support fair market-based business practices in international markets. In addition to provisions protecting economic sovereignty of borrower countries, these alternative infrastructure financing models should also include provisions establishing strong labor standards that will foster a level playing field and providing guidance to facilitate monitoring and compliance.

To Industry:

Private sector actors involved in steel production and procurement should implement several key reforms:

- Steel producers and manufacturers should develop comprehensive traceability systems that track steel inputs from raw material sources through final product delivery. These systems should document not only country of origin but also specific manufacturing locations and labor conditions at each production stage. Digital tracking tools and blockchain solutions could help ensure data integrity throughout complex supply chains.
- Industry actors should conduct due diligence investigations to actively identify, document, and remediate existing labor abuses in their steel supply chains, while establishing preventative measures and regular monitoring to protect against future violations, especially when sourcing from regions with documented forced labor risks.
- Companies should create detailed protocols for identifying forced labor risks, including clear procedures for conducting supplier audits, verifying labor conditions, and responding to red flags. These protocols should align with international standards like the International Labor Organization's forced labor indicators while being adapted for steel industry-specific contexts.
- Effective grievance mechanisms must be established and made accessible to workers throughout the supply chain. These should include multiple reporting channels (phone, web, in-person), protection for whistleblowers, and transparent processes for investigating and remedying complaints. Mechanisms should be available in workers' native languages and account for literacy barriers.

To Host Country Governments:

BRI recipient countries should implement several reforms to better protect workers and strengthen domestic oversight:

- Labor inspection frameworks should be strengthened through increased staffing, enhanced authority, and improved technical capacity. This should include specialized training for inspectors on steel industry operations and common forced labor indicators. Digital tools should be provided to support more efficient inspection processes and data collection.
- Countries should support tax incentives for workforce development programs and technical assistance to meet international labor standards. Strong labor protections should be built into any industry initiatives.

- Specialized labor monitoring units should be created for large infrastructure projects, with authority to conduct regular inspections and enforce labor standards. These units should have direct reporting lines to senior government officials and adequate resources to maintain consistent oversight throughout project implementation.
- Mechanisms for reporting labor violations should be strengthened through protected channels and strong penalties for retaliation. This should include anonymous reporting options, legal aid for workers pursuing complaints, and meaningful sanctions for employers found to have violated labor standards.
- Finally, countries should ensure that infrastructure financing agreements maintain sovereign control over procurement decisions and labor oversight. This includes carefully evaluating financing terms, preserving the right to source from domestic suppliers, and maintaining authority to enforce national labor laws, regardless of project funding source.

I. INTRODUCTION

This report presents findings from a preliminary study examining evidence of forced labor in the global supply chain of carbon steel components used in infrastructure projects funded by China's Belt and Road Initiative (BRI).

The BRI, launched in 2013, is a massive global infrastructure development program aimed at building overland and maritime trade connections between China, Asia, Europe, Africa, and beyond. With more than \$1 trillion in Chinese investment to date across 150 member countries, the BRI has become one of the largest development initiatives in history (Jie & Wallace, 2021; McBride et al., 2023).

As the BRI has expanded in scale and scope, concerns have grown regarding the labor conditions in the supply chains of goods used in the construction of infrastructure projects funded through the BRI, as well as in the construction of those projects. China's own steel industry, which supplies a significant portion of the steel used in BRI projects, has faced allegations of forced labor, particularly in the Xinjiang Uyghur Autonomous Region (XUAR) (Murphy et al., 2022; Sheffield Hallam University, 2023). Meanwhile, reports suggest that some BRI construction projects in host countries have been marred by exploitative labor practices (see Sections 3.4, 4.1, and 4.2).

In this context, this study aimed to provide an overview of the role of forced labor in the global production and trade of carbon steel, particularly carbon steel used in BRI-funded infrastructure projects. More broadly, it was designed as a preliminary exploration of the ways in which supply chain-focused mixed-methods research tools can be used to examine labor issues across projects funded through the BRI.

To this end, this report includes a detailed description of the production process of carbon steel and carbon steel downstream goods; an overview of the global carbon steel production and supply chain; a description of the current state of the BRI, including its current scale, recent trends, and its impacts on the carbon steel sector; and a presentation of primary and secondary evidence containing reports of forced labor in the global steel supply chains serving BRI projects. It then explores how these dynamics have played out in two case studies examining countries that have received significant BRI-related infrastructure investment and loans: Indonesia and Kenya. Each case study examines the local carbon steel sector, evidence of labor exploitation in local carbon steel supply chains, and labor conditions in the supply chains and construction of two BRI-funded projects in each country (the Jakarta-Bandung High-Speed Railway [KCJB] and Morowali Industrial Park [IMIP] in Indonesia and the Standard Gauge Railway [SGR] and Port of Mombasa in Kenya).

The study found significant indications of forced labor at multiple points in BRI steel supply chains, from raw material mining to component manufacturing to project construction. Procurement models that mandate sourcing from Chinese suppliers, combined with financing arrangements that generate unsustainable debt burdens for host countries, have created conditions conducive to labor exploitation. Limited supply chain transparency and inadequate oversight mechanisms have allowed labor abuses to persist.

2. METHODOLOGY AND STUDY IMPLEMENTATION

This study served as a preliminary investigation into how established supply chain research methodologies could be adapted to examine labor conditions in materials procurement for BRI projects. Using carbon steel as a test case, the research explored approaches for documenting labor risks in complex international supply chains serving major infrastructure initiatives. The study's findings offer

insights both about labor conditions in steel production and about methodological approaches for investigating BRI supply chains more broadly.

2.1 STUDY OBJECTIVE AND RESEARCH QUESTIONS

This qualitative study aimed to provide a sectoral overview of the role of forced labor in the global production and international trade of carbon steel. To this end, this report presents an overview of the processes by which carbon steel is manufactured and processed, an overview of the global carbon steel supply chain, a review of major stakeholders in this supply chain, and a discussion of the risks and evidence of forced labor present in the global carbon steel sector as a whole.

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The study aimed to:

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- Analyze how BRI project structures and financing arrangements influence labor conditions.
- Identify specific downstream products and supply chain segments at greatest risk.

This study was guided by the following research questions:

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- Is carbon steel used in BRI-funded infrastructure projects generally manufactured in-country or imported (from China or elsewhere)?
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2.2 DATA COLLECTION

The research team used three primary data collection methods.

First, the ICF research team conducted extensive desk research, examining more than 400 secondary sources, including academic literature, investigative journalism, industry reports, and government

documents. This review focused particularly on labor conditions in steel production and processing, BRI project implementation, and international trade patterns. Further, the research team conducted a review of existing literature on the structure of the steel industry.

Second, the research team analyzed trade data from multiple sources, including UN Comtrade, national customs databases, and shipping records, to map steel flows between producing and consuming countries. This analysis focused particularly on carbon steel products used in infrastructure and construction.

Third, researchers conducted 30 key informant interviews (KIIs) with industry experts, government officials, civil society representatives, and other stakeholders knowledgeable about steel supply chains and labor conditions. Of these 30 KIIs, the ICF research team conducted 10 interviews with experts and stakeholders in the United States, Europe, and Asia, and in-country partners conducted the remaining interviews with steel industry stakeholders and experts in Kenya (n=10) and Indonesia (n=10). Interview guides were developed in consultation with the U.S. Department of Labor and drew upon research instruments and interview guides used in previous ICF-led studies of forced labor.

2.3 MEASURING FORCED LABOR

This study uses the definition of forced labor contained in International Labor Organization (ILO) Convention 29: “The term forced or compulsory labor shall mean all work or service which is exacted from any person under the menace of any penalty and for which the said person has not offered himself voluntarily.” The study operationalizes this definition of forced labor according to the guidelines provided in the 20th International Conference of Labor Statisticians *Guidelines Concerning the Measurement of Forced Labor* (2018) and the ILO’s *Hard to See, Harder to Count* (2024). According to the guidelines, a case of forced labor requires performing work that is both involuntary and under the threat or menace of a penalty.

This study uses the following indicators of involuntary work:

- Forced recruitment
- Deceptive or fraudulent recruitment
- Hazardous or degrading working conditions
- Onerous working hours or work schedule
- Degrading work-related living conditions
- Abuse or manipulation of debt
- Inability to terminate employment

The study uses the following indicators of coercion:

- Physical or sexual violence
- Restrictions on workers’ movement
- Abuse or manipulation of debt
- Withholding of wages
- Retention of identity documents
- Threat of loss of housing or land provided by employer

2.4 CHALLENGES, LIMITATIONS, AND FUTURE RESEARCH DIRECTIONS

2.4.1 Challenges

The research team faced significant challenges in securing KIIs, despite extensive outreach efforts. Significant numbers of candidates failed to respond to outreach or declined to be interviewed. To address this challenge, the research team conducted additional rounds of outreach to potential respondents and expanded the pool of potential interviewees through snowball sampling.

ICF researchers tasked with conducting KIIs with global steel industry stakeholders and BRI experts outside of Kenya and Indonesia ultimately contacted more than 45 potential key informants, but even after extensive follow-up, only 10 ultimately participated in interviews. In-country research partners also received many refusals to participate and non-responses to invitations.

These issues with response rate appeared to stem from several factors. Many potential respondents cited competing time commitments or did not respond to multiple contact attempts. Others expressed hesitation about discussing labor conditions in the steel sector, particularly regarding Chinese production. Industry stakeholders were especially difficult to engage, with several explicitly declining to participate due to concerns about sharing potentially business proprietary supply chain information. In addition to these issues with securing qualitative interviews, there were also data access restrictions that made it so that the research team was not able to delve as deeply into the supply chain of steel goods made in China and shipped to BRI host countries as would have been ideal. Although macro-level trade data indicate major trade flows of steel goods between China and BRI host countries, China has not published shipping data since 2018.

2.4.2 Limitations

This limited interview sample and the lack of access to shipping data creates some constraints on the study's findings. Although the interviews conducted provided valuable insights, they may not fully represent the range of perspectives and experiences across the industry. The relatively small interview sample particularly affects the study's ability to make broad conclusions about industry-wide practices or to capture detailed information about specific supply chains. Further, the lack of publicly available shipping data made it impossible for the research team to conduct detailed direct tracing of steel products exported from China. However, the information gleaned from the 30 KIIs that were conducted for this study, when combined with trade data analysis and extensive documentary research, still offers important insights into labor conditions and supply chain dynamics.

2.4.3 Future Research Directions

The methodological insights gained through this pilot study can help inform more targeted and extensive research into labor conditions in BRI supply chains going forward. Future studies may benefit from focusing on specific regions or supply chain segments, allowing more time for stakeholder engagement, and developing new strategies for data collection and verification.

3. FINDINGS

3.1 DEFINITION AND PRODUCTION PROCESS

3.1.1 Product Description

Carbon steel is the most common type of steel, distinguished from other varieties by its primary alloying element: carbon. All steel contains some carbon, but carbon steel specifically contains between 0.05% and 2.5% carbon by weight, with other elements present only in small quantities. This differs from other

specialized forms of steel, such as stainless steel, which contains significant chromium and nickel, or alloy steels, which contain substantial amounts of other metals like nickel or molybdenum (Colás & Totten, 2016).

Carbon steels are typically classified into three main categories based on their carbon content: low-carbon or “mild” steel (containing up to 0.25% carbon), medium-carbon steel (containing 0.25–0.60% carbon), and high-carbon or “tool” steel (containing 0.60–2.5% carbon or more) (ScienceDirect Topics, 2025).

Low-carbon steels are softer and less wear-resistant than higher-carbon steels, but they are also more pliable and easier to weld. As such, low-carbon steels are commonly used in downstream applications in which high hardness or wear resistance is not required, and their high ductility allows for lower-cost manufacturing methods such as cold-forming or stamping. Common applications for low-carbon steel include automotive body panels, steel piping, wires, food cans, and consumer appliance parts.

Medium-carbon steels offer a balanced combination of strength and ductility. These steels respond well to heat treatment processes, allowing their mechanical properties to be optimized for specific applications, though they are somewhat more challenging to weld than low-carbon steels.

Medium-carbon steels are frequently employed in applications requiring moderate wear resistance and strength, while still maintaining some degree of formability. Common applications for medium-carbon steel include railroad tracks, crankshafts, axles, gears, heavy-duty machinery parts, and agricultural equipment in which the material must withstand repeated stress and moderate wear conditions.

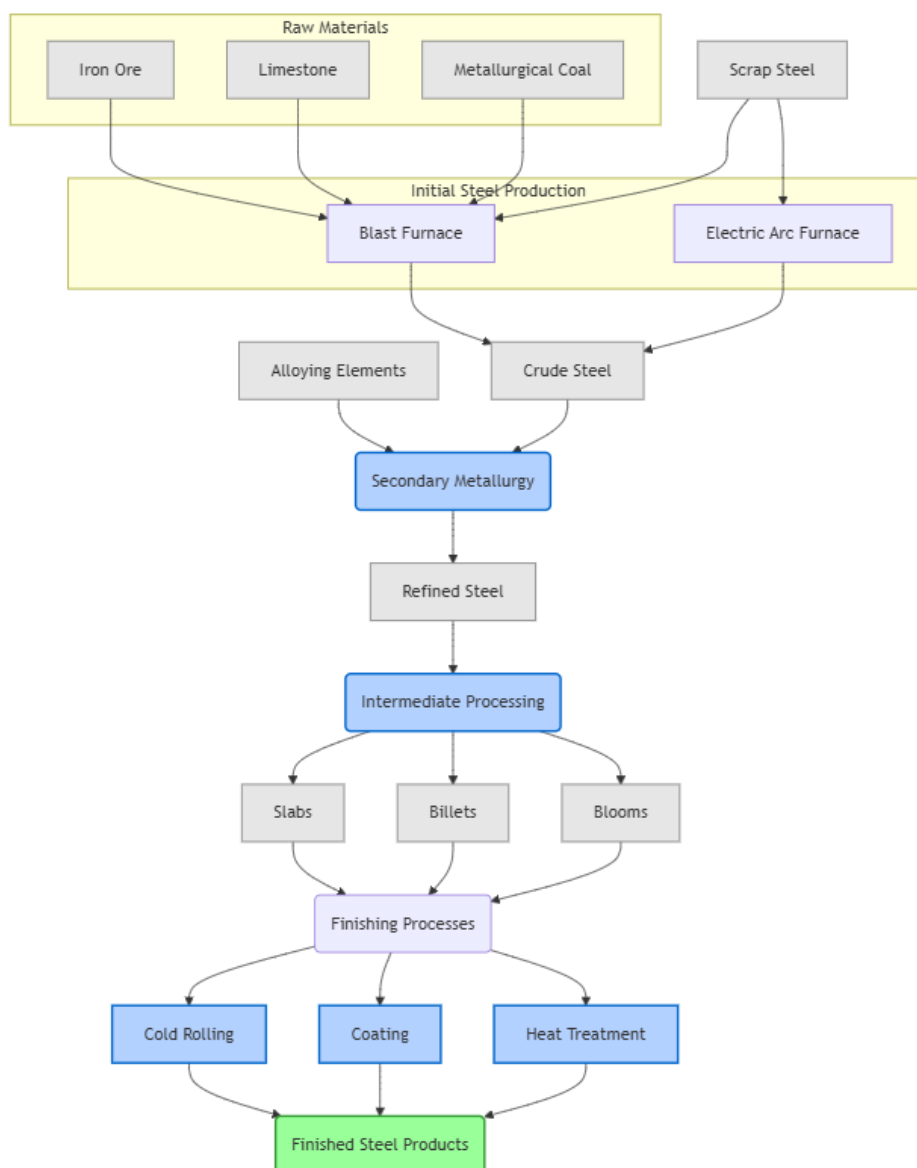
High-carbon steels possess superior hardness and wear resistance compared to their medium- and low-carbon counterparts, but they are also more brittle and significantly more difficult to weld and form. These steels respond exceptionally well to heat treatment processes, allowing them to achieve very high hardness levels, though this comes at the cost of reduced ductility. Due to their excellent wear resistance and ability to maintain a sharp edge, high-carbon steels are predominantly used in applications requiring these specific properties. Common applications for high-carbon steel include cutting tools, drill bits, springs, high-strength wire, woodworking tools, and knives in which maximum hardness and wear resistance are essential, despite the increased manufacturing complexity and cost.

Carbon steels become more difficult, and thus more expensive, to produce and to manufacture into downstream applications as their carbon content increases. This is in large part due to the physical structure of carbon steels. In carbon steel, carbon atoms essentially “fill in the gaps” between iron atoms in the steel’s crystal lattice, effectively hindering the movement of the metal’s grains when it is placed under mechanical stress. This significantly increases its hardness but also makes it more prone to cracking under mechanical stress. As such, more care, precision, and energy are required to form higher-carbon steels into specific shapes for downstream use. Furthermore, if the carbon atoms and iron atoms are not relatively evenly distributed, clusters of carbon atoms can gather, forming stress points that further weaken the overall metal. This clumping tendency increases as the relative carbon content increases and can occur not only in the initial production process but also during any subsequent heating and cooling. As such, precise temperature and mechanical controls must be followed when hot-forming or welding with higher-carbon steels to prevent cracking or weak points in the steel components being made.

3.1.2 Carbon Steel Production Process

Carbon steel production is a multi-stage process that includes multiple rounds of melting and cooling of iron and other trace minerals (Naoum & Conniff, 2023).

Figure 1. Steelmaking process



Source: ICF.

3.1.2.1 Input Goods

Carbon steel can be produced through two primary methods and requires some combination of key raw materials: iron ore, metallurgical coal (also known as “coking” coal), and limestone, or scrap steel (Allanore & Krol, 2024).

3.1.2.1.1 Iron Ore

The primary input for most steel production is iron ore. There are three main commercial grades of iron ore, with grading determined based on iron content: high-grade ores (containing greater than 67% iron by volume), medium-grade ores (58–62% iron content), and low-grade ores (containing less than 58% iron) (Seetharaman, 2013). The iron content and impurity levels of iron ore used in the steelmaking process directly impact its efficiency, environmental footprint, and production costs. This is in large part

because the lower the iron content in the input iron ore, the more of that ore is needed to extract the same amount of iron, leading to higher energy usage in mining, transportation, and processing stages like crushing and grinding, ultimately impacting the overall cost of steel production.

Nearly all of the global production of iron ore is ultimately used in steel production, and while it is mined in more than 50 countries around the world, iron ore varies widely in both quality and composition across global deposits (U.S. Geological Survey, 2024). The current leading global producers of iron ore—Brazil, South Africa, and by far the largest producer Australia—all have significant and accessible deposits of high- and medium-grade iron ore (Pistilli, 2024). Many other countries, including the three countries central to this study—China, Indonesia, and Kenya—contain notable deposits of medium- and lower-grade iron ore.⁴ The higher production costs associated with extracting and processing low-grade iron ore, combined with a recent downturn in global iron prices, have led existing iron mines to shut down and hindered the development of any new extraction efforts.⁵ That said, there are some indications that extraction and trade in low-grade iron ore may become increasingly important to global supply in the near future. Depletion of higher-grade iron ore deposits, growing political pressure in many countries to diversify critical mineral supply chains, and new technological advancements in steelmaking that have reduced the cost of ore processing and enabled the production of high-quality steel using lower-quality ore have all led to increased interest in exploration of lower-grade iron ore deposits (Baskaran, 2024; Geoscience Australia, 2023; Ling et al., 2024). In interviews conducted for this study, for example, multiple steel industry stakeholders in Kenya mentioned renewed government and industry interest in restarting iron ore mining in southern Kenya (Taita Taveta County).

Given the prevalence of reports of labor exploitation and dangerous working conditions in iron mining in China, in countries from which China imports high-grade iron ore, and in countries hosting BRI-funded projects, if mining activity targeting lower-quality iron ore deposits does in fact increase, this may be an important supply chain to monitor in future studies on labor conditions in the supply chain of goods used in BRI-funded projects (AFP, 2018; Tian et al., 2022; United States Department of State, 2022; Xinhua News Agency, n.d.).

3.1.2.1.2 Metallurgical Coal

Metallurgical or “coking” coal is a specialized grade of bituminous (or “soft”) coal, characterized by its high-carbon content (around 80% carbon by weight), low levels of sulfur, and low levels of non-combustible materials (also called “ash”) (SGS Mineral Services, 2013; U.S. Energy Information Administration (EIA), 2025). To be used in the steelmaking process, metallurgical coal is first processed into metallurgical coke.

Metallurgical coke is a hard, sponge-like mass consisting of nearly pure carbon. It is produced by heating metallurgical coal at high temperatures in an oxygen-free chamber to evaporate off any of the coal’s volatile components. During this heating process, the remaining material softens, liquefies, and then re-solidifies into coke (Federal Steel Supply, 2016).

In terms of global trade, Australia dominates the global market for metallurgical coal, accounting for more than half of global exports in 2023, more than three times the exports supplied by the next largest exporter of metallurgical coal, the United States (Russell, 2024). In terms of overall production,

⁴ Although Kenya does host some high- and medium-grade iron ore deposits, such as those in Ikutha in Kitui District, most of its deposits seem to be lower-grade, such as those in Marimante in Meru District and Macalder in South Nyanza (“Kenya’s Metallic Minerals,” 2018; Mutembei et al., 2014). Indonesia also has some medium-grade iron ore deposits, found in South Kalimantan and Central Sulawesi, but these are limited in size, and the rest of the country’s iron ore deposits are of a much lower grade (Rochani & Anugrah, 2008).

⁵ China saw the closure of more than 1,500 low-grade iron ore mines in 2015 alone (Basov, 2015; Jamasmie, 2015).

however, China is the world's largest producer of metallurgical coal, producing an estimated 490 million metric tons in 2023, an increase of 3.6% over the previous year (CoalNewswire, 2024).

Given the prevalence of labor violations and dangerous working conditions in coal mining in China, and in countries hosting BRI-funded infrastructure projects (see Section 3.4.1.1, Iron Ore Mining), if mining activity targeting lower-quality iron ore deposits in these and other countries around the world does in fact increase, this may be an important supply chain to monitor (Di et al., 2022; Reuters, 2021; Tian et al., 2022).

3.1.2.1.3 *Limestone*

Limestone (CaCO_3) acts as a flux in the steelmaking process, helping remove impurities. Although limestone is widely available globally, the steel industry requires high-purity grades with specific chemical compositions (Seetharaman, 2013). Major global exporters of steel-grade limestone include the United Arab Emirates, Oman, Malaysia, Vietnam, and Iran (Jain & Sharma, 2024).

3.1.2.1.4 *Scrap Steel*

Although it is not strictly a raw material, recycled or “scrap” steel constitutes an important input in modern steelmaking. Almost every steel plant includes scrap steel as part of its mix of input materials. In addition to being a ready source of already refined input iron, the scrap steel acts as a heat regulator by absorbing excess heat generated during various stages of steel production (Çiftçi, 2023).

3.1.2.2 *Initial Steel Production*

The transformation of raw iron ore into carbon steel can be accomplished through one of two kinds of facilities: blast furnaces and electric arc furnaces.

In a blast furnace, the steelmaking process begins by loading pulverized iron ore, coke, and limestone into the top of the furnace. As these materials move downward, superheated air is blasted in from the bottom at temperatures around 2,000°F. This superheated air causes the coke to ignite, generating additional heat and releasing carbon. Much of this released carbon acts as a “reducing agent” (a chemical reactant that functions to remove oxygen from a given mixture), converting iron oxide into pure iron (Seetharaman, 2013). Much of the rest of the carbon that is released during the ignition of the coke combines with the iron, creating a liquid metal containing about 4% carbon—a substance referred to as “pig iron.” The limestone particles facilitate this process by bonding with unwanted elements like silica and aluminum oxide, forming a liquid called slag that floats on top of the molten iron. This slag is regularly drained off, taking the impurities with it. The molten iron is then tapped from the bottom of the furnace and transported to the next stage of steelmaking, in which its carbon content is reduced to create steel (Seetharaman, 2013).

This molten pig iron is then transferred to a basic oxygen furnace, in which high-purity oxygen is blown into the metal to further reduce carbon content and create steel (Seetharaman, 2013). An electric arc furnace works quite differently. Instead of using coke and limestone, it primarily uses recycled steel (scrap) as its raw material, though it can also use directly reduced iron made from iron ore. The process begins by loading this metal into a large, bowl-shaped furnace. Then, enormous electrodes are lowered into the furnace, creating electrical arcs that generate temperatures up to 5,400°F, melting the iron into a liquid pool. During this process, operators can add specific minerals and elements to achieve the exact chemical composition they want. They can also inject oxygen or add limestone to help remove unwanted elements (Seetharaman, 2013).

These two steelmaking techniques have several important benefits and drawbacks. Facilities that employ a blast furnace tend to operate it as continuously as possible to minimize energy loss associated with restarting and reheating the furnace equipment. Large blast furnaces require significant infrastructure,

personnel, and startup costs, but the equipment required is relatively low-tech, and, once running, the furnaces can produce tremendous volumes of steel at relatively low operating costs.⁶ Further, their continuous operation model provides for stable production schedules, provides for even heating (which reduces the risk of imperfections in the steel produced), and allows for relatively simple automation of a number of steps in the steelmaking process (Seetharaman, 2013).

That said, blast furnace steelmaking has significant drawbacks. Although blast furnace steelmaking requires far less electrical power than arc furnace steelmaking, blast furnace steelmaking produces significantly more greenhouse gasses, particularly carbon dioxide. Further, although they allow for relatively easy adjustment of the specific form of steel being made through changes to the input mixture, because of the high energy costs associated with restarting a blast furnace once it has been shut off, they are only cost effective to operate if they have a constant supply of input materials and there is sufficient demand to warrant continuous steel production (Seetharaman, 2013).

Electric arc furnace steelmaking facilities are more flexible, given that they are designed to operate in batches and can be started and stopped as needed. Arc furnaces are also more flexible in terms of production volume and the types of steel they can produce. Further, although they are much more electrical power-intensive, they are generally considered more environmentally friendly, particularly when they are operated using some degree of renewable energy. In the absence of available renewable sources of power, however, these environmental benefits are blunted. Further, at the time of writing, electric arc furnaces are limited in their capacity to accept raw iron ore as an input (Seetharaman, 2013). Recent technological advancements in a process called direct reduction of iron (DRI), however, have begun to allow arc furnaces to be more useful in the primary production of steel, in addition to the recycling or re-smelting of scrap steel (Ling et al., 2024).

DRI is a metallurgical process by which iron ore pellets (iron ore crushed into a powder whose grains are around 10–20 mm) are converted from iron oxide into pure iron without having to be heated to their melting point. In other words, DRI is a way to produce iron directly from ore without going through a traditional blast furnace process in which the iron melts completely. In DRI, the iron ore powder is preheated to around 800°C using reformed natural gas, driving off moisture to make the ore more reactive. The heated iron oxide powder is then exposed to reducing gasses (generally a mix of hydrogen and carbon monoxide, both of which are derived from natural gas), which bond to the oxygen in the iron oxide powder, converting it to pure iron. The resulting product, called direct reduced iron or “sponge iron” is pure enough to be used as a feedstock for steelmaking in electric arc furnaces.

The advent and spread of DRI in steelmaking supply chains has significantly enhanced the usefulness and versatility of electric arc furnaces as alternatives to traditional blast furnaces in steelmaking facilities. DRI provides a cleaner, more consistent iron input when compared to traditional scrap metal inputs, allowing facilities relying on arc furnaces to produce higher-grade steels (such as stronger medium- and high-carbon steels) that were previously only possible to produce using integrated blast furnace equipment. This synergy between DRI and electric arc furnaces has been particularly important in regions with access to low-cost natural gas (for DRI production) but limited scrap availability, such as the Middle East and parts of Asia. It has also become increasingly relevant as steel producers seek to reduce their carbon footprint, since DRI and arc furnace equipment can produce similar qualities and quantities of steel with lower emissions than the traditional blast furnace-basic oxygen furnace route, especially when using natural gas or hydrogen as the reducing agent (International Iron Metallurgical Association, 2019; Ling et al., 2024; ScienceDirect, 2024). According to one steel industry trade group,

⁶ Steelmaking using smaller blast furnace equipment is possible. This option can reduce startup costs, but smaller blast furnaces do not benefit as much from economies of scale, and their lower mass can make them less energy efficient over time.

the share of global steel production produced using electric arc furnaces is expected to grow sharply from 28% at present to upwards of 40% by 2030 (Aboura, 2024).

3.1.2.3 *Intermediate Processing*

The transformation of raw steel into intermediate products follows different paths, depending on facility capabilities and final product requirements. In integrated steel plants, continuous casting machines directly convert liquid steel into semi-finished forms like slabs, blooms, or billets (Guthrie & Isac, 2022). These machines rapidly cool the steel through water-cooled copper molds, producing continuous strands that are cut to desired lengths. This process, which has largely replaced older ingot casting methods in most steelmaking facilities, improves yield and energy efficiency while reducing labor requirements (Guthrie & Isac, 2022).

In plants that use the older bottom-pour machinery—less common currently but still relatively common in countries with developing steel industries that still rely on significant numbers of older plants, such as Indonesia and Kenya—liquid steel is poured into static molds to form ingots, which then require additional processing steps, including primary rolling or forging to create intermediate products (Srinath Viswanathan et al., 2008). This method offers certain advantages for specialized products, but it generally requires more energy and labor per ton of finished product (Srinath Viswanathan et al., 2008).

3.1.2.4 *Downstream Product Manufacturing*

The production of finished carbon steel products involves multiple specialized processes, depending on the intended application. Downstream steel products are primarily categorized into four categories:

Semi-finished: Steel materials that have undergone initial processing, such as slabs, blooms, and billets, which are used in the building blocks for other steel products, including those defined as flat products, long products, and pipes and tubes.

Flat Products: Produced by rolling semi-finished steel through rollers to produce flat sheets, strips, and plates. These are most often used in the automotive, appliance and machinery manufacturing, construction, and food packing industries.

Long Products: Steel products typically produced by rollers that are long and linear and typically come in the form of bars, rods, rails beams, and angles. They are typically used in construction (e.g., rebar or structural steel beams and columns), railroad tracks, manufacturing, and energy (e.g., wind turbines).

Pipe and Tube: Steel items typically produced through welding to form hollow cylindrical shapes. Downstream uses include in the oil and gas, plumbing, construction (e.g., scaffolding, framework), and automotive industries.

A more detailed description of steel production follows.

The first step in transforming raw steel (carbon steel or otherwise) into usable products is hot rolling. In hot rolling processes, steel is heated to approximately 1,700°F and passed through successive sets of rotating rollers sets that gradually shape it into its intended shape and dimensions while maintaining necessary mechanical properties (EnduraSteel, 2023a).

Structural steel components (commonly referred to as “long steel” products), such as I-beams, channels, and spars that form the skeleton of most large buildings, bridges, and other structures, generally achieve their final shape directly from the rolling process, requiring minimal additional processing before use in construction. Sheet and plate products (commonly referred to as “short steel” products), crucial for

various infrastructure applications, undergo a similar process of graduated hot rolling that decreases thickness while increasing length (EnduraSteel, 2023b).

After hot rolling, some steel goods undergo further shaping through a process called cold rolling. Cold rolling occurs at room temperature and improves dimensional accuracy and surface finish while also increasing strength. High-strength sheet products for building panels and decking systems, for example, are commonly cold rolled, allowing them to span greater distances at smaller thicknesses than hot-rolled sheets would be capable of (EnduraSteel, 2023a).

Other steel goods undergo a range of further manufacturing processes, including welding, reinforcing, or pulling. Precision bars and small structural sections undergo cold drawing or cold finishing to achieve exact dimensions and improved surface quality (Eaton Steel Bar Company, 2024). Heavy wall pipes and smaller steel pipes, used for energy transmission and the transmission of water, are created by forming steel plate into cylindrical shapes and welding the seams (YENA Engineering, 2021). Rebar, used to reinforce concrete structures, is pulled and further heated and cooled through specialized rollers to create the characteristic deformation patterns that enhance concrete bonding (EnduraSteel, 2024).

Finally, depending on the specifications required for a given downstream use, some steel products undergo further treatment processes, such as heat treatment to relieve residual stresses, coating processes to apply corrosion protection, or welding to achieve more complex shapes (EnduraSteel, 2023c). Box girders for long-span bridges and built-up columns for high-rise buildings, for example, are created through the precise welding of steel plates and shapes to form enclosed sections with optimal structural efficiency. Welded wire mesh, used to provide distributed reinforcement to concrete slabs and walls, is welded into specific configurations designed to provide tensile strength (CalWire, 2024).

3.1.2.5 Specific Uses of Carbon Steel in Infrastructure Projects

In infrastructure projects, specific grades and forms of carbon steel serve distinct purposes based on their mechanical properties and performance requirements. The most common uses of building components made using carbon steel are in structural components such as beams, columns, and trusses (Three D Metals, 2022).

3.1.2.5.1 Structural Components

Structural steel components primarily use low-carbon steel grades, typically containing 0.15–0.25% carbon. These grades provide an optimal balance of strength, weldability, and cost-effectiveness. The most commonly used specifications include ASTM A36 steel and ASTM A572 Grade 50 steel.

ASTM A36 steel (0.25% carbon maximum) serves as the standard grade for structural shapes such as I-beams, channels, and angles. This grade offers a minimum yield strength of 36,000 pounds per square inch (psi), making it suitable for most building and bridge construction applications. Its excellent weldability and formability allow for efficient fabrication and field assembly (Intsel Steel West, 2022).

ASTM A572 Grade 50 steel (0.23% carbon maximum) represents a higher-strength option, with a minimum yield strength of 50,000 psi. This grade finds extensive use in modern infrastructure projects in which weight reduction and improved performance are priorities, such as in long-span bridges and high-rise buildings (Beshert Steel Processing, 2024).

3.1.2.5.2 Reinforcing Steel

Reinforcing steel (rebar) typically uses low- to medium-carbon grades, with carbon content ranging from 0.25% to 0.40%. The primary specifications include ASTM A615 Grade 60 rebar and ASTM A706 Grade 60 rebar.

ASTM A615 Grade 60 rebar contains approximately 0.30–0.35% carbon and provides a minimum yield strength of 60,000 psi. This grade dominates the concrete reinforcement market in North America, offering an optimal combination of strength, ductility, and cost-effectiveness. It serves in applications ranging from highway bridges to building foundations (Harris Supply Solutions, 2024).

ASTM A706 Grade 60 rebar, while similar in strength to A615, contains slightly lower carbon content and additional controls on chemical composition to enhance weldability. This grade is particularly important in seismic regions in which structural ductility and weldability are critical design considerations (Portland Bolt, 2024).

3.1.2.5.3 Plate and Sheet Products

Steel plate and sheet products, essential for various infrastructure applications, use different carbon contents based on their intended use. The primary specifications in this category include ASTM A283 Grade C plate and ASTM A516 Grade 70 plate.

ASTM A283 Grade C plate (0.24% carbon maximum) serves in general purpose applications in which moderate strength and excellent formability are required. This grade commonly appears in storage tanks, culverts, and general fabrication applications (Octal Steel, 2024).

ASTM A516 Grade 70 plate (0.27% carbon maximum) is used in pressure vessel applications, such as storage tanks and pipeline components. Its controlled manufacturing process ensures good-notch toughness and weldability, critical for maintaining structural integrity under pressure and varying temperature conditions (RFP Pipes and Fittings, 2024).

3.1.2.5.4 Infrastructure-Specific Applications

Different infrastructure sectors require specialized carbon steel products. Bridge girders, for example, are commonly made using ASTM A572 or A709 steel, both of which are selected for their high tensile strength and strength-to-weight ratio. Railroad rails, by contrast, are often made from higher-carbon steels like A499 or A996 that provide greater wear resistance and resistance to deformation. Components designed to allow for deformation and weathering, such as guard rails placed along roadsides, commonly use softer, low-carbon steel that is then galvanized to improve weathering resistance (World Steel Association, 2024a).

Water infrastructure applications demand specific grades of carbon steel optimized for their unique requirements. Water transmission pipelines predominantly use API (American Petroleum Institute) 5L Grade X42 to X70 steels, in which carbon content is precisely controlled to achieve an optimal balance between strength and weldability necessary for reliable fluid transport. Storage tanks in water systems typically employ either A283 Grade C or A516 Grade 70 plate steel, with the selection depending on the specific pressure requirements of the installation. Water treatment plant components generally use low-carbon steel grades, chosen specifically for their superior fabrication flexibility, which allows for the complex shapes and configurations often required in treatment facilities (Smith Group, 2024).

Energy infrastructure relies heavily on specialized carbon steel grades engineered for demanding applications. Transmission towers are constructed using high-strength low-alloy steels, in which carbon content is carefully controlled to achieve optimal strength-to-weight ratios essential for these tall structures. Underground pipelines in energy systems employ API specification steels that must meet rigorous requirements for both strength and toughness to ensure safe and reliable energy transport. Substation structures throughout the energy grid typically use galvanized A36 or A572 Grade 50 steel, selected specifically for its ability to provide the long-term durability necessary in these critical installations (Federal Steel Supply, 2022).

Each of these applications requires specific processing methods, quality control measures, and often specialized coating systems to ensure long-term performance in service. The selection of appropriate carbon steel grades and forms significantly influences both initial construction costs and long-term maintenance requirements for infrastructure projects.

3.2 SUPPLY CHAIN FINDINGS

3.2.1 Overview of Global Steel Production and Supply Chain

The global steel industry is a cornerstone of industrial development and infrastructure growth, with carbon steel production being particularly vital to construction and manufacturing sectors worldwide. In 2024, global crude steel production reached 1,882.6 million tonnes, representing a 0.8% decrease from 2023 levels (World Steel Association, 2025). China continues to dominate global production, accounting for 53% of world steel production in 2024, followed by India at 7.9% and Japan at 4.4% (World Steel Association, 2025).

The steel industry employs more than 6 million people directly worldwide, with millions more in supporting industries (International Labour Organization, 2023). Labor costs typically represent between 20% and 25% of total production costs for integrated steel mills, although this varies significantly by region and production method (OECD, 2023).

The industry has undergone significant technological transformation in recent decades, with increased automation reducing labor requirements in primary production, while specialized fabrication continues to require substantial skilled labor (International Labour Organization, 2023).

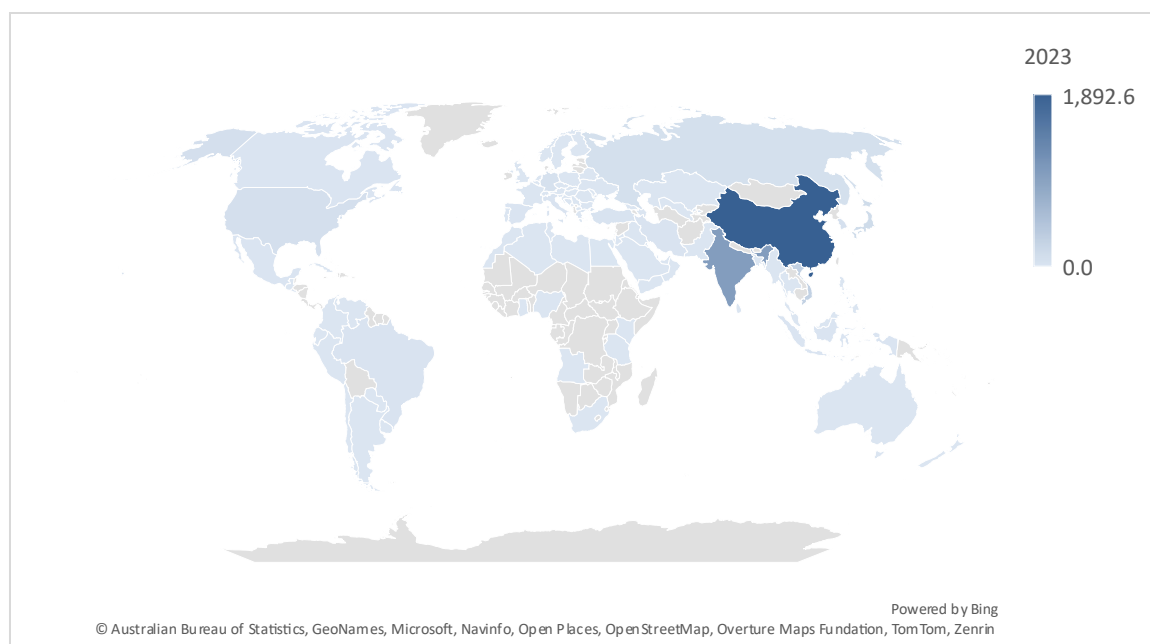
3.2.2 Carbon Steel Production

There are no official, publicly available estimates of the size of global carbon steel production. With some exceptions, however, the largest producers of crude steel⁷ are also likely to be the largest producers of carbon steel. According to the World Steel Association, China was the largest global producer of crude steel in 2023, producing as much as the next 30 global steel producers combined (World Steel Association, 2024b).⁸

⁷ Crude steel and “raw steel” are industry terms used to refer to semi-finished steel products that can be refined into carbon steel or other steel products.

⁸ According to World Steel, China produced 1892.6 million metric tonnes of crude steel in 2023, while the next 30 largest steel producers collectively produced just 1814.5 million metric tonnes that year (World Steel Association, 2024b).

Figure 2. Global steel production by country, 2023 (in million metric tonnes)



Source: World Steel Association, 2024b

Global steel production is highly concentrated, with the top 15 steel companies accounting for approximately 33% of global production (World Steel Association, 2023). Consolidation within steel production has been driven by a variety of factors, including, but not limited to, economies of scale, technology requirements, and the need for capital investment in modern production facilities. However, the downstream fabrication sector remains relatively fragmented, with numerous small and medium-sized enterprises serving local markets (OECD, 2023).

Steelmaking facilities that rely on blast furnace equipment remain dominant globally, accounting for 70.8% of production in 2022, and electric arc furnace production represented 29.2% (World Steel Association, 2023). These proportions, however, vary significantly by region. In the United States, electric arc furnace production accounts for approximately 71% of total steel production, and in China, blast furnace-basic oxygen furnace production dominates at around 90% of total output (American Iron and Steel Institute, 2023). Newer facilities in both Kenya and Indonesia have begun to adopt arc furnace equipment for a proportion of their steel production, but the majority of the steelmaking capacity in both countries rely on basic oxygen furnaces (Commodity Inside, 2024; Swastika & Hasan, 2024) (industry KIs).

3.2.2.1 International Trade in Steel and Steel Products

International trade in carbon steel products is substantial but complex, with various tariffs, anti-dumping measures, and other trade policies affecting international trade patterns. In 2022, global steel exports reached 395.8 million tonnes, with China being the largest exporter, representing 17% of global exports at 67.3 million tonnes (World Steel Association, 2023). Exports of carbon steel in various forms

amounted to \$249 billion in 2023, a decrease of 17.2% from the previous year but still 28% above 2019 levels (UN Comtrade).⁹

The two most traded categories of carbon steel products—flat hot-rolled steel 600 mm or more in width (HS 7208) and flat hot-rolled steel 600 mm or more in width that has then been cold rolled (HS 7210)—together have accounted for around or above half of world exports by value each year since 2019. During that same period, China was the top exporter of each of those two categories of steel sheets, followed by other major steel-producing countries such as Japan, Germany, South Korea, and Belgium. Both these categories of carbon steel goods have a variety of uses, ranging from car bodies and home appliances to parts and rail ties, but cold-rolled steel sheets are generally used more for precision parts and equipment, and hot-rolled sheets are used more for infrastructure and construction, such as support beams and railroad ties.

Global steel import patterns are closely tied to economic growth and infrastructure development. The World Steel Association (2023) projects steel demand to grow by 2.3% in 2024, driven primarily by infrastructure investment in developing economies and recovery in manufacturing sectors. This growth is particularly pronounced in regions with significant infrastructure initiatives, such as the BRI, which the World Bank (2023) estimates will require more than 200 million tonnes of steel products through 2027.

3.2.2.2 *China's Role in the Global Steel Supply Chain*

China is by far the world's largest producer of crude steel and largest exporter of steel products. In 2023, its steel output was more than 1 billion tonnes, or nearly 54% of the global total, according to data compiled by the World Steel Association, a non-profit industry body headquartered in Brussels (World Steel Association, 2024b).¹⁰ The next largest producer, India, only accounted for 7% (World Steel Association, 2024b). No other country accounted for more than 5% and, outside of the top 10 producers, the rest of the world together produced just 15% (World Steel Association, 2024b).

“China has been greatly expanding and becoming the world's largest steel-producing nation, and certainly for ... they've been over half the global steel production for probably the last four or five years, at least.”
—Steel industry group representative

Recent data showed that as of 2023, steel production and exports from China were almost back to 2015 levels (Zhang, 2024). Based on data from the China Iron and Steel Association and the National Bureau of Statistics, China's crude steel output over January–November was likely to reach 951 million metric tonnes, up 16 million metric tonnes from the previous year (Zhang, 2024). That said, rising steel exports from China may not necessarily be indicative of a strong domestic steel industry, but rather suggest faltering domestic demand. The increasing exports are partly due to weakness in China's domestic demand for steel, influenced by significant shifts in property markets and infrastructure projects. In early 2024, China's central government ordered public infrastructure projects to be slowed or halted in 12 Chinese provinces with particularly high levels of local debt, leading to lower steel demand in these regions (S&P Global, 2024). Despite this drop in demand, Chinese steel manufacturing facilities have been unable to reduce production accordingly, as newly commissioned steelmaking facilities need to maintain high production levels to keep costs low and generate cash flows through economies of scale (S&P Global, 2024).

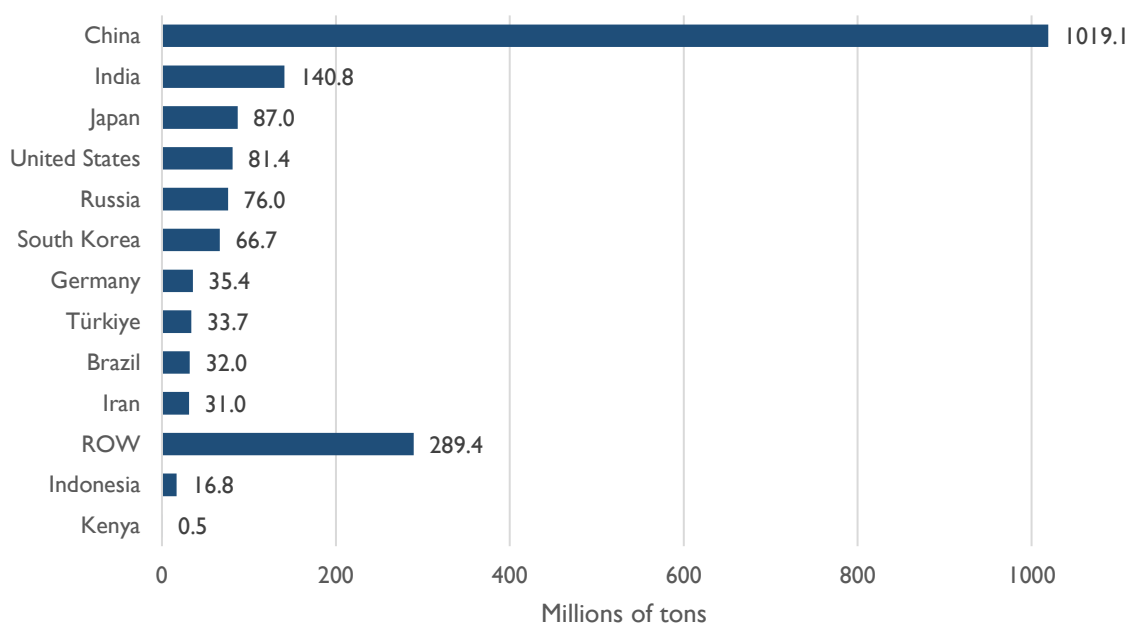
Of note, the output of both case study countries examined in this project increased in 2023. Indonesia's 2023 steel production was estimated at 16.8 million tonnes, nearly double the amount it produced in

⁹ Most of the carbon steel is classified under 1 of 12 HS codes at the 4-digit level (HS 7206–HS 7217). See Appendix 2. Note, this figure does not include exports of items and articles manufactured from carbon steel (HS 73), such as tubes, pipes and containers for fuel.

¹⁰ These figures represent total crude steel production.

2019 (World Steel Association, 2024b). Kenya’s output was 450,000 tonnes, or 12.5% greater than 4 years earlier but still near the bottom globally (World Steel Association, 2024b).

Figure 3. Crude steel production, 2023



ROW=rest of world; the value associated with this entry is the sum of crude steel production by all countries not listed
Source: World Steel Association, 2024b

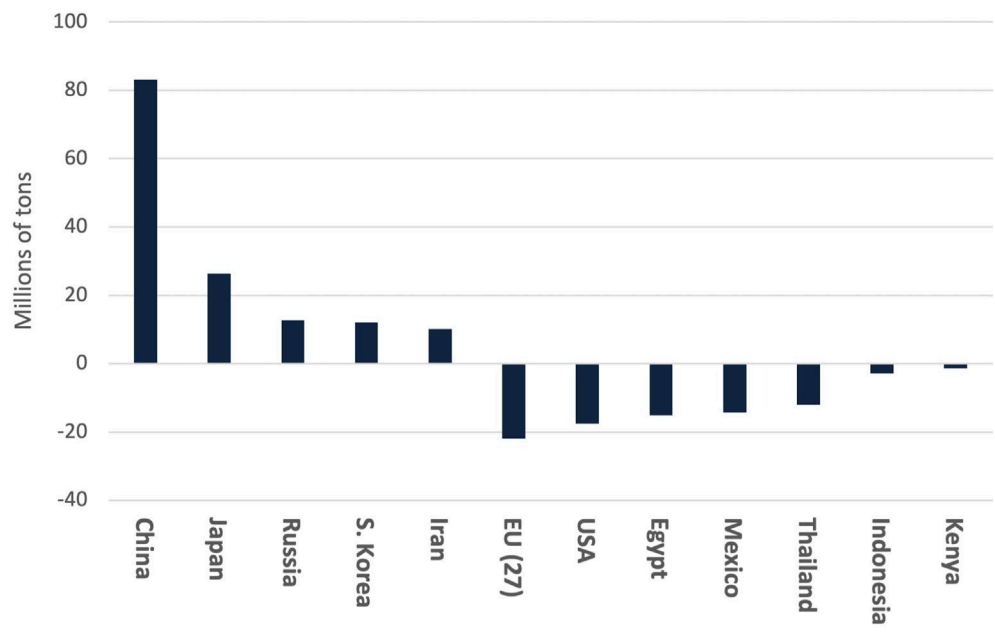
The estimated volume of crude steel output traded globally, based on an estimated continuous casting ratio of 93%, was equal to 24.7% of production, a slight rise from 22.6% in 2022. Since the “steel crisis” of 2016, when an economic downturn in China led to excess Chinese steel flooding international markets, the Organization for Economic Cooperation and Development has convened the Global Forum on Steel Excess Capacity (GFSEC) (Global Forum on Steel Excess Capacity, 2024). Despite its efforts to reduce the distortions caused by the problem, the GFSEC still forecasts excess capacity to expand until at least 2026 (Global Forum on Steel Excess Capacity (GFSEC), 2024). In one of its latest reports, the GFSEC cited “Government interventions and other non-market factors” in China as two of the main factors prolonging the situation (Global Forum on Steel Excess Capacity (GFSEC), 2024). It also noted that subsidized investments by Chinese state-owned enterprises— some of which could be classified as part of the BRI—into Southeast Asia are not relieving downward pressure on prices and industry profits worldwide (Global Forum on Steel Excess Capacity (GFSEC), 2024).

At the same time, the steel trade has been impacted by actions taken by economies that are both major steel producers and steel importers—most notably, although not solely, the United States and the European Union. The United States has imposed higher tariff rates on Chinese steel and aluminum imports based on the results of a Section 232 investigation.¹¹ As of early 2024, the Section 232 tariffs,

¹¹ A Section 232 investigation refers to a probe conducted by the U.S. Department of Commerce under the Trade Expansion Act of 1962 to determine if certain imports threaten national security. In 2018, following such an investigation, the United States imposed global 25% tariffs on steel imports and 10% on aluminum imports, citing that excessive imports posed a threat to domestic production capacity deemed vital for national defense and critical infrastructure (U.S. Department of Commerce, 2018). These tariffs were maintained with respect to China and combined with other trade measures such as duties imposed under Section 301 of the Trade Act of 1974, resulting in a cumulative average tariff of 47.5% (as of April 19, 2024) on steel imports from China to the United States as part of broader efforts to address what the United States considered unfair trade practices and protect domestic steel industries (Bond et al., 2024).

combined with Section 301 duties and various other trade remedies, including anti-dumping duties and countervailing duties, have increased the average tariff of steel imports from China to the United States to 47.5% (Bond et al., 2024). The European Union, for its part, has also acted, setting quotas for steel imports and increasing the out of quota tariff rates, with only a small number of minor producers given exclusions (GlobalTradeAlert.org, 2018).

Figure 4. Net global exports of crude steel, 2023



Source: World Steel Association, 2024b

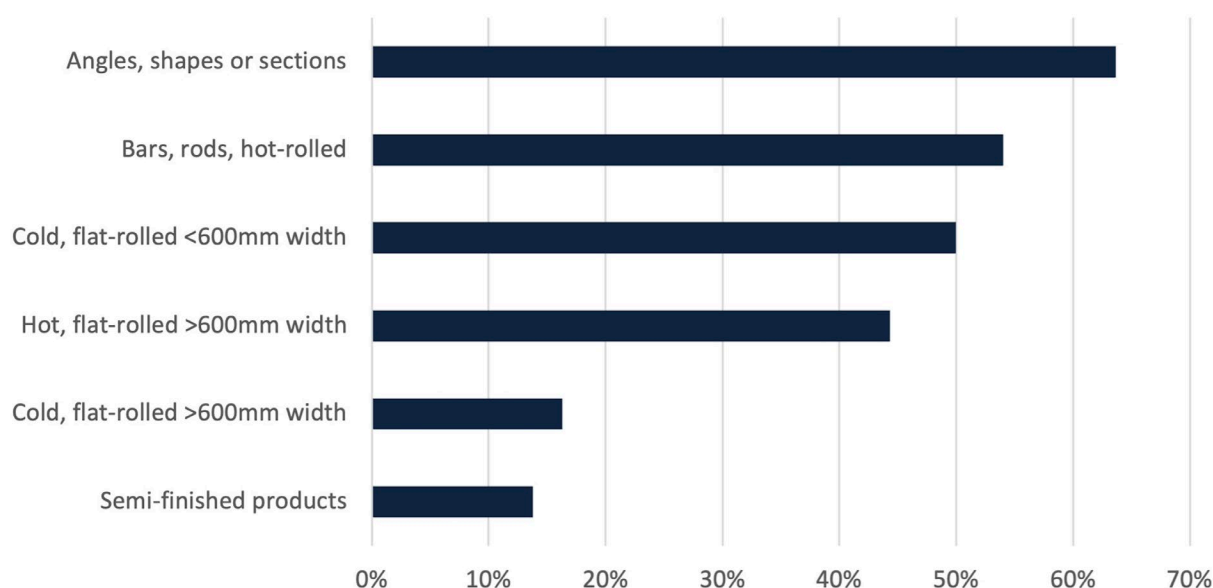
3.2.3 Trade in Steel Between China and Case Study Countries

3.2.3.1 Indonesia

Measured by output and capacity, Indonesia’s steel industry is far more advanced than Kenya’s. Nevertheless, it still needs imports to meet demand.

Meanwhile, China’s share of Indonesia’s steel imports has risen in step with China’s share of global steel exports. In 2019, in value terms, China’s share was 11%. By 2023, that figure was 28%. For Indonesia’s primary carbon steel imports, however, China’s share is greater. In cold-rolled steel (HS 7210), it was 50% in 2023; in hot-rolled steel, it was 44%.

Figure 5. China's share of Indonesia's primary steel imports



Source: UN Comtrade, ICF calculations

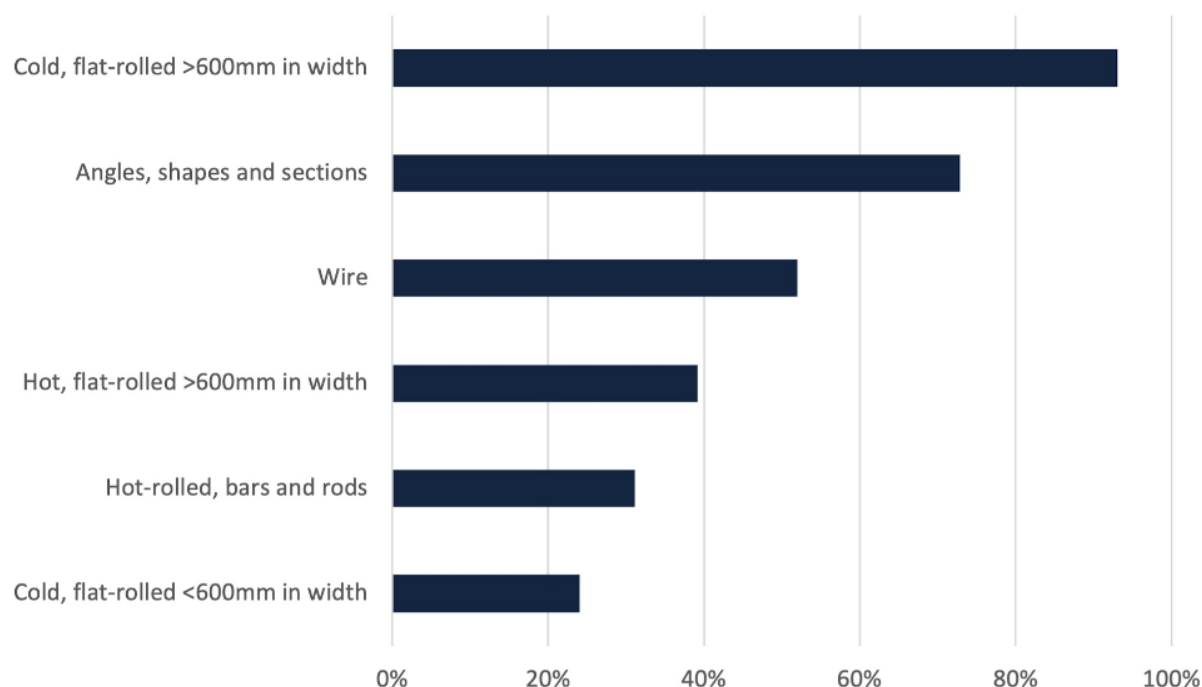
3.2.3.2 Kenya

Kenya's steel industry is still in its infancy. Domestic production has been relatively flat, ranging between 400,000 to 450,000 tonnes for the past 5 years.

Kenyan steel imports from China have continued to increase, both in absolute terms and as a share of total domestic consumption. From \$80 million in 2019, they rose to \$289 million in 2022 before declining to \$249 million in 2023. China's share of Kenya's steel imports ranges from just 24% in cold-rolled flat steel less than 600 mm in width to 93% of cold-rolled flat steel greater than 600 mm in width. In between, China had a 39% share in hot-rolled flat steel, Kenya's largest category of carbon steel imports (UN Comtrade).¹²

¹² Of note here, UN Comtrade is missing the volume amounts for key four-digit HS codes. This precludes calculating China's share of Kenya's imports of carbon steel by weight. In particular, volumes are not available for HS 7208, the largest category by value of carbon steel goods imported to Kenya from China.

Figure 6. China's share of Kenya's primary carbon steel imports



Source: UN Comtrade, ICF calculations

3.3 POLICY INITIATIVE FINDINGS: BRI

3.3.1 Background and Overview

The BRI, first announced in 2013 by President Xi Jinping, is conceived as a transformative infrastructure and development program with a two-pronged approach: building overland connections to Europe reminiscent of the historical Silk Road,¹³ while simultaneously developing maritime connections through investments in roads, rail, ports and other infrastructure (McBride et al., 2023).¹⁴ Initial participation in the program was limited, with only eight countries joining in the first year, including Mongolia, Cambodia, Pakistan, and Afghanistan. By the conclusion of 2016, membership had reached only 27 nations. The incorporation of the BRI into the Communist Party of China constitution in October 2017 marked a significant turning point, as it signaled the initiative's status as an enduring policy rather than a temporary program (Xinhua News Agency, 2017). Following this institutional commitment, participation expanded rapidly, with membership more than doubling from 55 to 116 countries in 2018 alone (Belt and Road Advisory, 2018).

3.3.2 Current Scale and Geographic Distribution

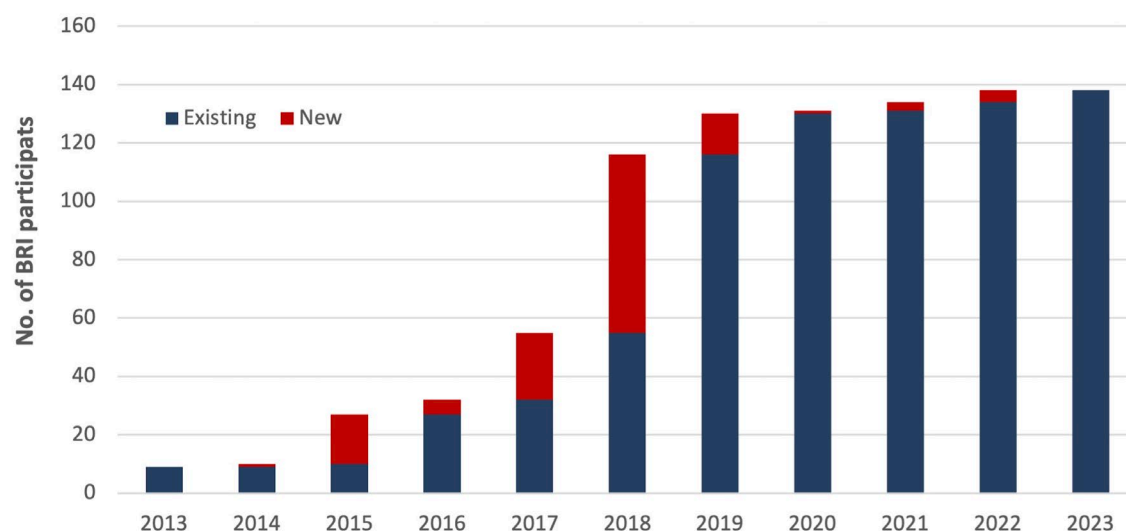
As of 2024, the BRI had achieved remarkable scale, reaching 150 member countries that collectively represent approximately two-thirds of the world's population and whose collective gross domestic

¹³ The historical Silk Road was a vast network of trade routes connecting East Asia and the Mediterranean between roughly 130 BCE and 1453 CE. Named for the lucrative Chinese silk trade, which flourished along its length, the route facilitated the exchange of goods, technologies, religions, cultures, and ideas between China and regions that included Central Asia, the Indian subcontinent, Persia, Arabia, and Europe. The Silk Road was not a single path but rather a complex web of land and maritime routes that evolved over time (Hansen, 2012; Hook, 2022; R. K. Mishra, 2020).

¹⁴ Initially termed "One Belt, One Road," the program's name was later changed to the Belt and Road Initiative to better reflect its expanding scope (Syarif, 2023).

product accounts for nearly half the global economy (Zhang, 2024). Although estimates of the value of Chinese BRI-related investment and lending since the program’s inception vary, most estimates place the total amount at just more than \$1 trillion,¹⁵ a figure that includes more than \$600 billion in construction contracts and more than \$400 billion in non-financial investments (Wang, 2024).¹⁶

Figure 7. BRI member country totals, by year



Source: McBride et al., 2023

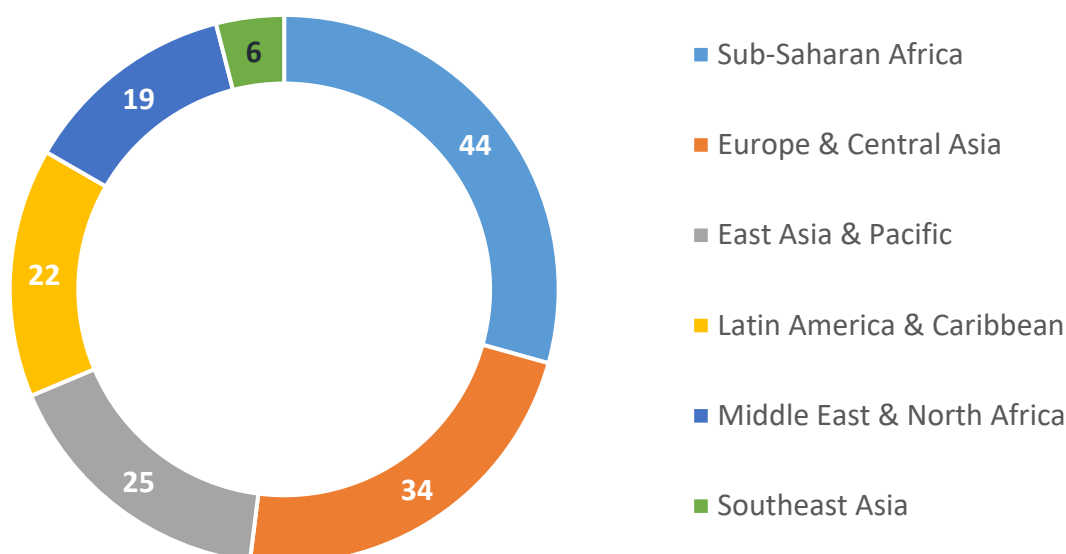
The geographic distribution of BRI participants now spans almost every region of the globe. In line with the BRI’s initial framing as a tool to revive historical trade connecting China to Europe overland through Central Asia, its membership now contains 34 countries that were once connected to the historical Silk Road. These now represent, however, only a fraction of current participation. Sub-Saharan Africa has emerged as a key focus area, although investment levels vary significantly among participating nations. Similar variation exists in East Asia and the Pacific, where participation numbers include smaller island nations like Vanuatu and the Cook Islands. Latin American engagement presents a more complex picture—while several countries have received BRI investments, many regional governments maintain a cautious stance.¹⁷

¹⁵ It should be noted here that there is a good deal of debate over what categories of foreign development funding should be considered “BRI-related.” Generally, this term is understood to refer to funding coming directly from the Chinese government as well as financing or export credits issued by the country’s EXIM Bank and the China Development Bank—both of which have been described in Chinese state communications as vital pillars of the BRI program. Direct funding of development projects associated with the BRI from the Chinese government has been relatively small, amounting to only 75 projects worth a total of \$22 billion paid for out of a designated “Silk Road Fund” (The State Council Information Office of the People’s Republic of China, 2023). Substantial foreign development funding issued through the EXIM Bank and China Development Bank began almost a decade before the announcement of the BRI, leading one set of analysts to describe the BRI as less a new program and more of a “rebranding of Chinese export finance to create a coherent narrative that could encompass wider diplomatic and strategic goals” (Freeman & Tugendhat, 2023).

¹⁶ In the context of foreign development funding, a “non-financial investment” refers to an investment that involves providing resources, expertise, or support other than direct financial capital, such as transferring technology, training local workforce, building capacity within institutions, or providing technical assistance, aimed at fostering long-term development in a recipient country.

¹⁷ Some initiatives in South America, particularly those focused on electric vehicle battery supply chains, align more closely with traditional foreign direct investment patterns than core BRI objectives

Figure 8. Number of countries participating in BRI, by region, as of 2023



Source: McBride et al., 2023

It should be noted, however, that discussions of BRI “membership” do not tell the complete story of Chinese foreign funding activity relating to this program. Although each BRI member country’s participation in the program has been formalized through either a Memorandum of Understanding (MOU) or cooperation agreement,¹⁸ these agreements are neither formal treaties nor guarantees of funding. Indeed, many member countries’ participation in the program remains nominal, with these agreements functioning more as endorsements than active project commitments. Among the BRI members in Sub-Saharan Africa, for example, many have received little or no Chinese development investment, as have many of the small island nations (such as Vanuatu and the Cook Islands) in the Latin America and Caribbean region. This dynamic became particularly evident in 2023 when 19 countries experienced a complete cessation of BRI funding and others, including Italy, allowed their MOUs to expire without renewal (Wang, 2024).¹⁹

Further, even among countries that have seen received significant investment from China after a conclusion of an MOU or cooperation agreement mentioning the BRI, it is unclear whether that funding should properly be considered BRI-related. For example, Chinese investments aimed at developing supply chains of critical minerals used in electric vehicle batteries in Latin America—including copper in Peru and lithium in Argentina, Chile, and Mexico—are commonly included in discussions of BRI-related investments, but as the link between these mineral investments and the themes of connectivity and trade infrastructure is tenuous at best, these projects might more accurately categorized simply as foreign investments separate from BRI (Roy, 2025).

¹⁸ Cooperation agreements are more general in their terms and tend to be more joint statements of an intent to cooperate in the context or goals of the broader BRI program. MOUs are agreements that commonly contain similar language regarding general cooperation, but also include more specific provisions, such as descriptions of specific projects that may be developed with China’s assistance (Nolan & Leutert, 2020).

¹⁹ Although Kenya was one of the countries that saw its planned future BRI-related funding totals drop to zero in 2023, Kenyan leaders presented a number of proposals for additional BRI-related funding during the 2023 BRI annual forum (Griffith Asia Institute, 2024; Igunza, 2023).

3.3.3 Recent Trends and Strategic Shifts in the BRI

The BRI has undergone three fundamental transformations in recent years that have significantly reshaped its implementation approach and impact.

3.3.3.1 *Shift Toward Greater Reliance on Equity Financing vs. Debt Financing*

BRI financing has undergone a significant transformation over the past decade, shifting from predominantly debt-based models to increased equity financing. Initially, BRI projects were largely funded through loans provided by Chinese state-owned banks to recipient countries, with these countries taking on debt obligations that required repayment with interest, regardless of project outcomes (Jie & Wallace, 2021). Under this debt financing model, the borrowing nation retained ownership of the infrastructure but also shouldered all financial risks, while China primarily acted as a creditor. High-profile examples of this approach include the \$8 billion China-Laos Railway, in which Laos took on debt equivalent to nearly a third of its gross domestic product, and Pakistan's Gwadar Port development under the China-Pakistan Economic Corridor, which initially involved billions in loans that significantly increased Pakistan's external debt burden and raised concerns about the country's long-term ability to meet these obligations (Deng, 2024; Mahtani & Huiying, 2023).

Equity financing, by contrast, involves direct investment in which entities take ownership stakes in projects, sharing both risks and potential returns (Investopedia, 2024). This approach provides several strategic advantages for both host countries and Chinese stakeholders. For BRI host countries, equity financing reduces sovereign debt burden and balances risks more equitably between Chinese investors and local stakeholders, as Chinese partners now have direct financial incentives in project success rather than guaranteed loan repayments regardless of outcomes. For the Chinese government, greater reliance on equity financing helps address persistent criticism about burdening developing nations with unsustainable debt loads. For Chinese companies, the equity model imposes greater discipline on investment decisions, as they must take a longer-term view of project viability. This has already begun reducing the number of economically questionable “white elephant” projects receiving funding (Jones & Hameiri, 2020). On the other hand, equity financing is not without strategic disadvantages for host countries. Although financing major infrastructure projects through Chinese equity funding may reduce the cost to host countries, and thereby reduce the sovereign debt burden associated with them, such a financing model requires countries to formally grant some degree of influence and control over those projects to Chinese state and quasi-state entities.

Reliance on equity investment as a source of BRI investment model became increasingly evident in the late 2010s, as multiple BRI host countries reported loan repayment difficulties, resulting in growing criticism of Chinese investments as “debt-trap diplomacy” (Monyae & Chapotera, 2023). By the end of 2018, equity financing accounted for 9% of overall BRI project funding (He, 2020). In 2021, that had increased to 31%, and in 2023, equity investments surpassed 50% of total BRI investment for the first time (Wang, 2023). This transition represents more than a simple change in financing structure—it signals a fundamental shift in how China approaches BRI project risk and sustainability.

For recipient countries, equity financing helps alleviate the immediate burden of large loan payments, particularly for projects that may take years to generate sufficient returns. This shift has proven especially important in the context of rising global interest rates and increasing concerns about debt sustainability in developing nations (Moses et al., 2022).

3.3.3.2 *Shift Toward Smaller Projects and Diversification of Project Type*

At the 2023 BRI annual forum, President Xi formally announced a strategic pivot away from massive infrastructure projects toward what he termed “small and beautiful” initiatives (Tan, 2024). This announcement formalized a trend that was already evident in project metrics—the China BRI

Investment Report 2023 revealed that the average size of BRI construction projects had decreased by 22% from their 2017 peak (Wang, 2023).

Observers have suggested that this downsizing reflects multiple strategic considerations for China and Chinese state-owned enterprises, including managing reputational risk associated with high-profile project failures, responding to China's tightening financial resources, and permitting more diversified investment across a broader range of countries and sectors while reducing exposure to any single project. The shift has also enabled better alignment with local development needs and capacities, as smaller projects prove easier to integrate into existing systems and typically allow for greater local participation (Yeung, 2024).

Infrastructure development remains a cornerstone of the BRI, but the nature and scale of these projects have evolved significantly. Traditional large-scale “hard infrastructure” projects like major railways, mega-ports, and massive power plants that characterized the early BRI have given way to more targeted, moderate-sized infrastructure investments. Rather than developing entirely new port complexes, recent projects like Indonesia's Kuala Tanjung Port and Tanzania's Dar es Salaam Port expansion have focused instead on modernizing specific terminals or upgrading existing facilities with improved logistics systems (CDR Essential Intelligence, 2024; Pant et al., 2021; Yusuf et al., 2023).

The initiative has simultaneously diversified beyond traditional transportation and energy infrastructure into digital technology, renewable energy, healthcare, and agricultural sectors. Alongside traditional infrastructure projects, China has increasingly emphasized technological connectivity projects, including 5G networks, undersea and overland fiber-optic cables, and other digital infrastructure, under the heading of the Digital Silk Road (Heeks et al., 2024).²⁰ These digital infrastructure projects serve multiple strategic incentives. They require less capital investment than traditional physical infrastructure while offering potentially higher returns and strategic influence, and they offer Chinese technology companies like Huawei and ZTE that have faced restrictions in Western markets an alternative outlet for expansion (Kadi, 2019). Further, they also help advance China's standards-setting agenda in emerging technologies while creating new channels for digital connectivity with BRI partners (He, 2022).

In the renewable energy sector, BRI investments have shifted noticeably toward green technology, including the Cauchari Solar Park in Argentina and large wind farms in Kazakhstan and Uzbekistan, all of which were financed through mixed equity and debt arrangements, with Chinese companies maintaining significant ownership stakes (Betancourt, 2024).

3.3.3.3 *Project Type Evolution*

The BRI has undergone a substantial evolution in the types of projects it prioritizes. In South and Southeast Asia, there has been a dramatic decline in coal-fired power generation projects, with approximately 90% of proposed coal projects cancelled since 2021 (Flowers, 2023).

In the energy sector, China has redirected investment toward renewable projects. Although this partly addresses the overcapacity issues facing China's solar cell industry, it also aligns with global sustainability goals and helps improve the BRI's environmental image (Bega & Lin, 2025). This shift demonstrates how the evolution in project types reflects both practical economic considerations and broader strategic objectives.

²⁰ The Digital Silk Road has been characterized variously as a distinct initiative, an offshoot of BRI, or a new category within it, but its growing prominence reflects China's strategic emphasis on technological leadership (Heeks et al., 2024).

3.3.4 China's Impact on Global Steel Trade and Production

3.3.4.1 Overall Steel Market Dynamics

China's dominant position in global steel production has influenced BRI implementation and international market dynamics. The GFSEC projects that Chinese excess steel capacity will continue to grow at least through 2026 (Global Forum on Steel Excess Capacity (GFSEC), 2024).

"Since the slump in the Chinese economy, and because China has such a large steel production capacity, [...] they try to unload the overproduction to third countries."

—Steel industry expert

The Forum specifically identifies Chinese government interventions and non-market factors as key drivers of ongoing market distortions, with subsidized investments by Chinese steel state-owned enterprises into Southeast Asian BRI projects contributing to persistent downward pressure on global prices (Global Forum on Steel Excess Capacity, 2024).

"They've slowed down the rate of growth in their domestic steel production capacity. But what, what has been very noticeable during that time is that Chinese investment in steel production outside of China that does seem to be particularly tied to Belt and Road projects has been growing."

—Steel industry trade group representative

3.3.4.2 Steel Sector Specifics

Two categories of flat-rolled steel have consistently accounted for around half of world exports by value since 2019: flat, hot-rolled steel 600mm or wider (HS 7208) and cold-rolled steel of similar width (HS 7210) (UN Comtrade).

China leads exports in both categories, followed by Japan, Germany, South Korea, and Belgium. These products serve distinct markets. Cold-rolled steel typically goes into precision parts and equipment, and hot-rolled steel is more commonly used in infrastructure and construction applications like support beams and railroad ties.

3.4 LABOR FINDINGS: LABOR EXPLOITATION IN STEEL SUPPLY CHAINS STEEL GLOBALLY, AND IN CARBON STEEL USED IN BRI-FUNDED PROJECTS IN PARTICULAR

3.4.1 Evidence of Labor Exploitation and Forced Labor Indicators in the Production of Carbon Steel Goods

3.4.1.1 Raw Material Extraction

3.4.1.1.1 Iron Ore Mining

Iron ore mining operations across several countries have raised significant labor rights concerns. In Brazil, inspections at the Mina do Pico mine uncovered serious labor violations, with more than 300 workers subjected to exhausting working hours and degrading conditions, leading to one of the country's largest steel companies (Vale) being added to Brazil's "dirty list" of companies found guilty of having labor conditions analogous to slavery (Brazil Ministry of Labor and Employment, 2024; Mining.com, 2024).

A report on South African mine workers covering workers extracting a variety of minerals, including iron ore, found that mine workers face persistent challenges related to exposure to harmful substances, frequent workplace accidents, and inadequate living conditions (Quiroz et al., 2024).

In China, concerns about forced labor in iron mining have led to action from U.S. authorities, resulting in at least three Chinese iron mining companies (Baowu Group Xinjiang Bayi Iron and Steel Co., Ltd., Western Gold Co., Ltd., and Xinjiang Jinbao Mining Co., Ltd.) being added to the Uyghur Forced Labor Prevention Act (UFLPA) banned list (U.S. Department of Homeland Security, 2025).

Although not considered a significant a global exporter of iron ore, Mexico has also seen troubling reports in its iron mining sector. Sources from Colima and Michoacán have reported that criminal organizations have directly taken control of some iron ore mining operations, particularly those shipping to Asia. These groups operate outside national security-related export restrictions, and their involvement has become a significant driver of regional conflict (Crisis Group, 2024). The labor conditions in these operations are unknown.

3.4.1.1.2 Limestone Quarrying

Recent years have also seen a number of concerning reports of unsafe working conditions and other exploitative conditions in the supply chain of limestone used in steelmaking in China. Steelmaking firms in China generally rely heavily on limestone sourced domestically from mines in the Shandong, Hebei, and Anhui provinces, but also reportedly supplement domestic sources with limestone imported from nearby countries like Vietnam and Malaysia. Although not as prevalent as reports of labor rights violations in iron ore or coal extraction, there have been a number of reports of accidents and unsafe working conditions in limestone mining in China (Gan, 2016; Xinhua, 2016), Malaysia (Arif, 2022, 2023; Franco & Barker, 2024; Malay Mail, 2013), and Vietnam (Hưng, 2024; VietNamNet Bridge, 2011).

3.4.1.1.3 Coal Mining

The coal mining sector also presents significant labor rights concerns in both China and Indonesia.

China's coal mining industry has faced scrutiny over alleged use of state-sponsored forced labor schemes, particularly of Uyghur and other Muslim ethnic minorities in the XUAR. Coal mined in China is included on the U.S. List of Goods Produced by Child Labor or Forced Labor for the use of forced labor (United States Department of Labor, 2024). There have been reports of workers being coerced into labor through detention, threats, and restricted freedom of movement. Reports of poor and hazardous working conditions, including frequent instances of landslides and explosions in which mine workers are injured or killed, have also raised human rights concerns (Global Times, 2022; Hayley, 2023; Hayley et al., 2023; Reuters, 2023; Xu, 2023). Multiple reports describe systematic labor transfer programs moving workers from rural areas to mining regions (Wormington, 2024). These programs operate through government-affiliated recruitment channels and have faced scrutiny regarding the degree of worker voluntariness. Documentation indicates that some workers face restricted mobility and limited ability to decline participation or seek alternative employment.

“The part where the risk [of labor abuses] is the highest is at the mining stage for, let's say, well, coal products.”

—Steel sector non-governmental organization representative

Indonesia's coal mining industry, particularly in the East Kalimantan region, has faced numerous challenges related to worker safety (Werner et al., 2024). Research has uncovered evidence of companies manipulating data on work accidents and potential hazards, raising serious concerns about transparency and worker protection (Sultan et al., 2024).

Similar allegations have arisen in the coal mining and charcoal production sectors of other countries around the world. In Colombia, for example, investigations have documented hazardous and degrading working conditions in various mines, including the prominent Cerrejón mine (Harrison, 2021). Workers have reported serious safety concerns and poor working conditions, leading to calls for improved

oversight and worker protections (Butler, 2012; CNV International, 2024; Weber et al., 2023). In Brazil, there have been a number of reports that workers in Maranhão have been subjected to forced labor in the production of charcoal used by local steelmakers (Osava, 2020).

Kenya's coal mining industry is much smaller and less developed than those in Indonesia and China, although recent years have seen increased interest in developing the country's coal reserves as a source of energy (Kariuki & Kuria, 2021; Matelski, 2019). The ICF research team was unable to identify any reports of forced labor or other major labor abuses in Kenya's coal mining sector. That said, recent efforts to expand coal mining in Kenya, particularly in the Kitui and Mui Basin regions, have seen significant resistance from local communities, citing concerns about the environmental, social, and health impacts of opening new mine sites (ActionAid, 2015; Matelski, 2019; Wanyonyi, 2018; Willy & Elmawi, 2021).

3.4.1.2 Steel Production in China

Recent research has identified significant risks of forced labor in global steel supply chains, particularly in production from certain regions (Global Slavery Index, 2024; Prince et al., 2020). A 2023 Sheffield Hallam University report documented systematic use of forced labor in steel production in the XUAR, finding that major steel producers participate in state-sponsored labor transfer programs in which workers face restricted movement and the inability to refuse work (Murphy et al., 2022; Sheffield Hallam University, 2022, 2023). That same study found that Chinese steelworkers' wages are often withheld or subjected to illegal deductions, and their living conditions are poor and often controlled by employers. The report estimated that approximately 9% of China's steel production capacity is located in the XUAR, representing about 4.8% of global steel production capacity (Murphy et al., 2022; Sheffield Hallam University, 2022). Given China's role as the largest steel exporter globally, this creates significant risks for international supply chains.

3.4.2 Risk of Forced Labor in the Global Supply Chain of Carbon Steel Broadly

Given the evidence of indicators of forced labor at various stages in the production process of carbon steel, much of the global supply of carbon steel is at risk of having been produced with forced labor. This risk is particularly pressing, given the dominance of Chinese steelmaking in the global carbon steel supply chain (discussed in Section 3.2.2.2, China's Role in the Global Steel Supply Chain) and the ample evidence of forced labor and other labor abuses at various stages in the supply chain of Chinese-made steel (discussed in the previous sections).

The ability to trace steel from production through end use remains limited (although industry stakeholders interviewed for this study reported that industry groups in the United States and Europe have made significant efforts to improve supply chain tracing), creating challenges for identifying and addressing labor exploitation.

"Steel is a widely traded commodity, and there's a constant of debate, like, when it comes into the United States, where's that steel really from? Because often we see steel being exported from China to third countries, getting either further processed or at least re-labeled, and then being shipped on to other countries."

—Steel industry trade group representative

Steel products often pass through multiple intermediaries before reaching end users, with limited documentation of origin beyond immediate suppliers (OECD, 2023). This is particularly true for steel used in infrastructure projects, in which materials may be sourced through multiple tiers of contractors and suppliers. Industry initiatives to address forced labor risks include enhanced supply chain due diligence, third party auditing programs, and transparency requirements for suppliers. However, the

effectiveness of these measures remains limited by challenges in verification and enforcement, particularly in regions with restricted access for independent monitors.

3.4.3 Risk of Forced Labor in the Supply Chain of Carbon Steel Components used in BRI-Funded Projects

Although the specifics of BRI financing agreements are generally not made public (Schroeder, 2023), experts have long suspected that they often include explicit or implicit procurement provisions that favor Chinese-made goods and materials (Ghossein et al., 2018).²¹

A 2019 World Bank study documented significant increases in infrastructure-related imports from China among BRI recipient countries in the years immediately following project approval (World Bank, 2019). This pattern has continued in recent years. According to 2024 S&P Global research examining Chinese customs data, steel exports to BRI partner countries have grown substantially, with Malaysia and Indonesia seeing year-over-year increases of 38% and 28%, respectively, in 2023 (Ni & Singh, 2024).²² Although the precise provisions of procurement requirements likely vary across agreements, the consistent growth in Chinese exports to BRI countries, particularly in construction materials like steel, suggests a systematic link between project financing and sourcing decisions.

As discussed previously, there is considerable evidence of forced labor and other labor abuses in China's coal, iron ore, and steel sectors, and, as a result, much of China's steel output is at risk of having been made with forced labor at one or another point in the supply chain. Attempts to parse this risk by tracing the supply chain of specific steel goods are complicated by the complexity and opacity of that supply chain. Macro-level trade data indicate major trade flows of steel goods between China and BRI host countries, but detailed direct tracing is limited because China has not published shipping data since 2018.

3.4.4 Evidence of Labor Exploitation and Forced Labor Indicators in the Construction and Operation of BRI-Funded Projects

3.4.4.1 *The BRI and Chinese Labor*

In addition to evidence suggesting that agreements structuring many BRI-related projects include either implicit or explicit requirements to source materials from China, there is also evidence of a similar pattern in the use of Chinese labor. Although also difficult to confirm, given the opacity of these agreements, Chinese firms' use of Chinese labor—in both support and managerial roles—has long been a concern of host country governments and local advocacy groups. These concerns are often framed in terms of a worry that the promised positive economic externalities of large BRI financed infrastructure projects, such as increasing employment of local labor, increasing wages, and upskilling the workforce, will be reduced if Chinese contractors rely too heavily on Chinese labor and input goods (Hillman & Tippet, 2021; Weng et al., 2021). These concerns have been the focus of protests and other forms of

²¹ An early criticism of the BRI was that, more than a policy of engagement, development aid, and diplomacy, it was formulated as an economic strategy for absorbing the excess capacity that had built up across a range of state-directed industries in China, most prominently—but far from limited to—steel and steel products (CKGSB, 2016). That criticism has grown louder as the initiative has expanded (Tran, 2024).

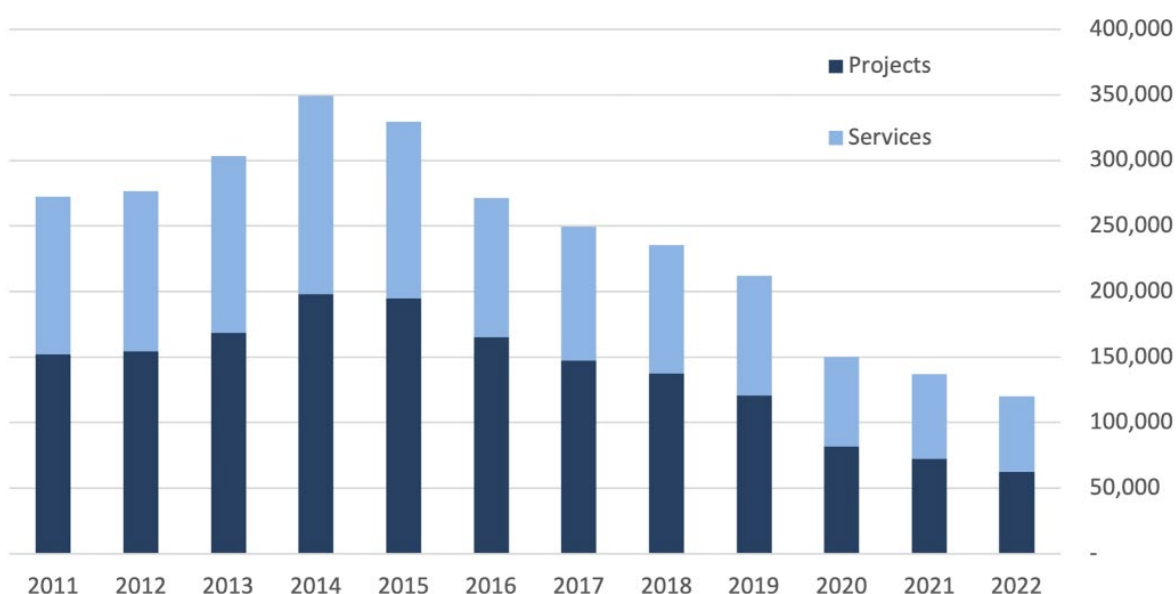
²² Although many BRI project agreements include requirements to procure construction components from Chinese manufacturers, analyzing the impact of these requirements on trade flows remains challenging. The sourcing of Chinese steel for BRI projects from Chinese steel companies should not necessarily be interpreted as an effort to offload excess production capacity at below-market prices. As S&P reports, although China's steel sector faces pressure to export excess capacity, particularly to developing markets with lower trade barriers than the United States and the European Union, Chinese construction firms may have sound business reasons for choosing Chinese suppliers. Beyond any procurement requirements in project agreements, these firms often have existing relationships with Chinese suppliers and may prefer working with manufacturers who understand Chinese construction standards and practices (Ni & Singh, 2024). Thus, the dominance of Chinese steel in BRI projects likely reflects a combination of both policy requirements and practical business considerations.

civil unrest, as well as violence directed toward the Chinese workers (Martorano et al., 2021). Even in authoritarian countries, like Kazakhstan, Kyrgyzstan, and Tajikistan in Central Asia, where dissent is often repressed before it can be expressed, there have been actions that rulers have not been able to ignore (Castillo, 2024; Jardine et al., 2019; Schulz, 2021). More broadly, a regional survey in Southeast Asia found that 64.5% of respondents were worried about China's influence (Seah et al., 2024).

The scale of Chinese overseas labor migration has grown dramatically since the 1990s, reflecting China's expanding global economic presence and the internationalization of its workforce. According to official Chinese statistics, the number of Chinese workers stationed abroad has increased nearly twentyfold over 3 decades, from 57,900 workers in 1990 to almost 1 million in 2018–2019 (H. Chen, 2022; Halegua & Ban, 2021).²³ This expansion was particularly pronounced in the construction sector, which accounted for approximately 40% of overseas Chinese workers in 2021 (Halegua & Ban, 2021). A number of sources have reported, however, that the number of Chinese overseas workers fell sharply at the beginning of this decade, dropping to around 600,000 in 2022 due in large part to pandemic-related disruptions (H. Chen, 2022).

According to data issued by China's National Bureau of Statistics, presented in Figure 9, the number of Chinese workers in Africa (including workers on contracts for specific projects plus those working in services) peaked at around 350,000 in 2015 and has fallen each year since (China Africa Research Initiative, 2025).

Figure 9. Chinese laborers in Africa, 2011–2022



Source: China Natural Bureau of Statistics, China Africa Research Initiative

That said, there is reason to suspect that actual numbers of Chinese overseas workers are higher than these estimates suggest, given that these estimates do not account for undocumented Chinese workers (H. Chen, 2022). Reporting continues to suggest that Chinese nationals continue to migrate to BRI countries for temporary work on projects, and that many of these workers face working conditions so hazardous or exploitative as to meet any number of indicators of forced labor (China Labor Watch, 2022; U.S. State Department, Office to Monitor and Combat Trafficking in Persons, 2022).

²³ The growth trajectory shows significant acceleration in the early 2000s, with the workforce nearly doubling between 2000 and 2010, from 424,900 to 846,600 workers (Halegua & Ban, 2021).

3.4.4.2 *Exploitation of Both Local and Chinese Migrant Laborers Working on BRI-Funded Construction Projects*

Reports from multiple countries have documented concerning patterns of labor exploitation on construction projects funded through the BRI. A number of reports have documented issues of discriminatory treatment against local workers. In Tajikistan's highway construction projects, for example, reports suggest that local workers have been subjected to harsher treatment than Chinese employees while being forced to work overtime without compensation and with inadequate safety measures (Rozanskij, 2021). In addition, Kyrgyz construction workers employed by Chinese-owned Sinzyan-Basin Ltd. on the Bishkek-Torugart roadway improvements reported facing discriminatory treatment, as well as unsafe conditions, inadequate protective equipment, and forced overtime (Business & Human Rights Resource Centre, 2011). Ecuadorian construction workers employed in the construction of Ecuador's Coca Codo Sinclair hydroelectric dam project reported being mistreated and discriminated against by Chinese managers (Casey & Krauss, 2018; Vallejo et al., 2018). And there have been similar allegations of discriminatory treatment against local workers, further documented in the case study sections, in connection to BRI projects in Kenya and Indonesia (see Sections 4.1 and 4.2).

Other reports have emphasized how Chinese migrant workers frequently encounter their own set of exploitative practices. China Labor Watch has documented extensive evidence of abuses targeting Chinese workers abroad, including deceptive recruitment tactics, illegal fees, mandatory deposits, restrictions on personal freedom, and threats of violence to prevent workers from leaving or reporting abuses (China Labor Watch, 2022, 2024a, 2024b; Kuo & Chen, 2021a). Recruitment of Chinese labor to work on BRI-funded projects abroad commonly involves predatory agencies that misrepresent working conditions and compensation to potential workers (Halegua & Ban, 2021). Once deployed overseas, these workers often find themselves in vulnerable positions with limited ability to return home. A survey of Chinese construction workers in Cambodia, for example, found that 57% of respondents reported that their employers confiscated and held their passports (Hillman & Tippet, 2021). The conditions these workers face often violate even China's own regulatory requirements for overseas labor (Kuo & Chen, 2021b). Chinese workers have also increasingly become targets of local frustration and suspicion, further complicating their already precarious situations in host countries and creating additional vulnerabilities. These issues are particularly noteworthy, given that they occur within Chinese-funded projects, highlighting the complexity of protecting worker rights in transnational contexts in which enforcement mechanisms may be limited or unclear.

The sheer number of reports of labor mistreatment on BRI-related project worksites, however, points to a more fundamental issue beyond discrimination between worker groups: the systematic undermining of labor rights affecting all workers involved in BRI construction. As Franceschini (2020) concluded from research in Cambodia, "Chinese-owned construction sites in Cambodia are grounded in a labor regime as exploitative as those in mainland China," creating environments in which both local and Chinese workers suffer from inadequate protections and rights. In Cambodia's Sihanoukville Special Economic Zone, both Chinese and local construction workers have experienced deceptive recruitment practices, unsanitary housing conditions, hazardous work environments, and wage theft. Although Chinese workers received higher wages when paid, both groups endured similar patterns of labor exploitation.

This pattern reveals that the erosion of labor standards appears integral to the BRI business model rather than incidental to it. As Azeem and Akbar (2024) document, "Chinese investors exploit loopholes in the national labor law regime at all levels—legislation, implementation and adjudication—by mostly hiring contract labor, ignoring safety and social security, and discouraging and undermining trade unions." By systematically undermining worker protections and rights, these companies not only directly harm workers of all nationalities but also threaten to permanently degrade labor standards in host countries. The evidence demonstrates that although discrimination exists in many contexts, the more

significant problem is how Chinese companies involved in these projects actively work to lower labor standards, resulting in exploitation that crosses national boundaries and affects all workers involved in BRI construction.

4. CASE STUDIES

Indonesia and Kenya represent instructive case studies for examining forced labor risks in BRI infrastructure projects, as they exemplify different stages of industrial development and distinct approaches to BRI engagement. Indonesia, as Southeast Asia's largest economy and the world's 14th-ranked steel producer, demonstrates how even countries with substantial domestic manufacturing capacity can face significant labor rights challenges in BRI projects (World Bank, 2024; World Steel Association, 2024b). Kenya, with its more limited industrial base but strategic location as East Africa's primary maritime gateway, illustrates how BRI projects can reshape local labor markets and supply chains in emerging economies. Together, these countries provide insight into how BRI-related labor risks manifest across different economic and regulatory contexts.

Kenya and Indonesia are particularly instructive case studies for examining the evolution of BRI implementation, as they host projects representing both the early large-scale infrastructure focus and more recent strategic shifts in the initiative.

Indonesia exemplifies this transition with its portfolio of BRI investments. While the KCJB demonstrates the ambitious, large-scale transportation infrastructure typical of the BRI's early phase, the IMIP aligns with newer BRI priorities. IMIP reflects the initiative's shift toward industrial capacity development and resource security, focusing on value-added production rather than just raw infrastructure. As a specialized nickel processing facility with significant equity investment rather than pure debt financing, IMIP showcases China's evolving approach to more targeted, economically sustainable projects.

Kenya's portfolio also spans this evolution. The SGR represents the earlier BRI model of massive transportation infrastructure with heavy debt financing, and the Port of Mombasa renovation exemplifies the more recent "small and beautiful" approach. The port project's more modest scale focuses on upgrading existing facilities rather than building from scratch, and its strategic emphasis on trade facilitation rather than landmark construction aligns with the BRI's current direction toward projects with clearer economic returns and lower debt burdens.

Together, these countries provide insight into how BRI investments have adapted from headline-grabbing megaprojects to more strategically focused interventions that balance economic sustainability with China's commercial interests. This transition makes their experiences relevant for understanding BRI implementation across various economic and regulatory contexts worldwide.

The documented patterns of labor exploitation and worker rights violations in these countries' BRI projects reveal structural issues likely present throughout the BRI supply chain. Both countries have established labor protection frameworks and some domestic manufacturing capacity, yet they still struggle to enforce standards and protect workers in BRI projects. This suggests that even countries with stronger regulatory systems may face similar challenges in overseeing BRI project labor conditions. Furthermore, the interactions among Chinese financing, procurement requirements, and labor management practices observed in these cases provide valuable insights into how forced labor risks may manifest in other BRI recipient countries, particularly those with limited regulatory capacity or high unemployment rates.

4.1 INDONESIA

4.1.1 The Supply Chain for Carbon Steel Infrastructure Components in Indonesia: Domestic Production and Chinese Imports

Indonesia's carbon steel supply chain represents a complex mix of domestic production and significant Chinese imports, with the latter playing a dominant role, particularly in BRI-funded infrastructure projects. The country ranks 16th globally in steel production, with output reaching approximately 16.8 million tonnes in 2023, nearly double its 2019 production (World Steel Association, 2024b). China is Indonesia's most important trading partner. In 2023, China accounted for approximately 30% of all imports to Indonesia, amounting to over \$65 billion in total (Dataweb, 2024).

"Indonesia's steel needs still rely heavily on imports, accounting for about 30–40% of total demand."

—Representative, Indonesian steel trade group

Indonesia's domestic steel industry faces significant challenges competing with Chinese imports, despite government attempts to protect local production through import restrictions and quotas (Karim, 2024).

"There are restrictions and quotas on imports. However, domestic demand is high, and certain products, like seamless pipes, are not yet manufactured locally. This creates delays for projects that rely on these materials."

—Indonesian steel distributor

Aside from any contract provisions that require or allow for greater use of Chinese-produced steel and steel products, Indonesian steel industry stakeholders interviewed for this study reported that domestically produced steel is often more expensive than Chinese imports, despite identical specifications, creating market pressures that favor imported materials.

"The problem in Indonesia is that sometimes the price of locally produced plates is higher than those from China, even though the specifications and sizes are the same."

—Indonesian steel distributor

To the extent that Chinese steel is produced with forced labor inputs, it becomes difficult for domestic steel industries that do not use forced labor to compete on price. The price differential has led to reduced use of domestic production capacity and increased dependence on imports.

4.1.2 Evidence of Labor Exploitation in the Supply Chain of Carbon Steel Infrastructure Components in Indonesia

The sourcing and production of steel for BRI projects in Indonesia presents a complex picture of labor exploitation risks, both in domestic production and through imported materials. Indonesia has attempted to build domestic steel manufacturing capacity, but evidence from industry stakeholders suggests that a sizable portion of steel components used in BRI projects, particularly for major infrastructure, continues to be imported from China. Multiple expert sources confirm this pattern. A non-governmental organization representative with knowledge of the construction of the KCJB project interviewed for this study noted that even basic components like bolts were generally imported, with only simpler elements like rail bearings and hooks being produced locally. This observation is corroborated by two Indonesian subject matter experts interviewed for this study, who both pointed to the predominant use of Chinese steel in high-speed rail construction. A representative of an Indonesian steel trade group, while cautious about providing specific figures, stated that imports constitute a substantial portion (30–40%) of the overall market for steel components in Indonesia.

Given the ample evidence of labor abuses at various stages in the supply chain of Chinese-made steel and downstream steel components (discussed in Section 3.4.1, Evidence of Labor Exploitation and Forced Labor Indicators in the Production of Carbon Steel Goods), there is reason to believe that carbon steel components imported from China or made from steel smelted in China are at risk of having been made with forced labor.

As for those carbon steel components made in Indonesia or made from steel smelted in Indonesia, recent investigations have uncovered concerning evidence of labor exploitation in Indonesia's steel production supply chain as well.

Of particular concern are the conditions reported at facilities like the Delong Industrial Park, where stainless steel manufacturer Jiangsu Delong Nickel, which cosponsors PT Obsidian Stainless Steel in a joint venture with state-owned Xiamen Xiangyu Group, operates. Workers at these facilities have reportedly been subjected to severe restrictions on their freedom of movement, including being confined to worker dormitories, denied access to essential medical care, and forced to work 12-hour shifts under hazardous conditions (Kuo & Chen, 2021b). They also described how local Indonesian steel workers are discriminated against in steel facilities owned and operated by Chinese interests and placed at a disadvantage when it comes to competing with Chinese labor.

“Despite having the same job positions, local workers often face lower bargaining power because of Indonesian policies that make local labor cheaper in the face of foreign investments.”

—Representative, Indonesian steel worker trade union

These concerns are particularly relevant to Indonesian steel plants operated or financed by Chinese interests. A prime example is the PT Dexin Steel Indonesia project, constructed by the China Minmetals Corporation, which stands as Indonesia's most technologically advanced and largest steel plant (MySteel, 2023; Yunxiao, 2023). The project's significance is underscored by its scale: once fully operational, it is expected to become Indonesia's primary carbon steel production facility, creating employment for more than 5,000 local workers and generating tens of thousands of additional jobs throughout the local upstream, midstream, and downstream industries. The project reached a significant milestone with the opening of its Phase I operations on September 19, 2023.

4.1.3 Evidence of Labor Exploitation in BRI-Related Infrastructure Projects and other Major Downstream Uses of Carbon Steel Products in Indonesia

A review of extant literature and data from interviews with industry experts and insiders conducted for this project reveals a number of allegations of abuses in some BRI projects in Indonesia. These include claims of poor working conditions, inadequate safety measures, and disparities in treatment between Chinese and Indonesian workers (Hillman & Tippet, 2021). In industrial parks like IMIP, there have been reports of long working hours, exposure to hazardous materials, and limitations on workers' rights to organize. However, it is important to note that the severity and prevalence of these issues vary across projects and sectors.

4.1.4 The Bandung Railway: Evidence of Forced Labor in the Supply Chain of Carbon Steel Components or Construction Labor

The KCJB project, Southeast Asia's first bullet train, began operations in October 2023 after experiencing multiple delays (H. Chen, 2023). Construction began in 2018. Spanning approximately 86 miles, the KCJB links four stations from East Jakarta to West Java and reduces travel time between Jakarta and Bandung—an arts and cultural hub—from 3 hours to around 40 minutes. Also named WHOOSH, which stands for “time saving, optimal operation, reliable system” in Bahasa Indonesia, its all-electric trains generate no carbon emissions and travel at speeds of up to 217 miles per hour

(H. Chen, 2023). It is also built to withstand Indonesia's sometimes capricious climate and is equipped to deal with earthquakes, floods, and other emergencies, according to officials (H. Chen, 2023).

Figure 10. Map of Indonesia showing Jakarta-Bandung High-Speed Railway



Source: Wikimedia Commons (Creative Commons), https://commons.wikimedia.org/wiki/File:Java_High-speed_Rail_Indonesia.svg

The supply chain of some of the carbon steel components used in the construction of the KCJB reveals significant concerns regarding labor conditions and transparency, both in the production of steel components and in construction activities. Although local suppliers were used for many components used in the KCJB's construction, including cement, signaling and electrical equipment, and some steel components, the specialized carbon steel rails required for the project were sourced from China (China Report ASEAN, 2023).

“Most of the steel for the high-speed railway came from China. Chinese contractors prioritize their own products. Even if local production is involved, it’s usually for less critical components like reinforcement bars. Key materials are primarily imported from China.”

—Indonesian steel distributor

The KCJB project required 279.4 km of main line rails, 28.9 km of station line rails, and 79 groups of fork rails, all of which were supplied and produced by Pansteel Group Co Ltd, a subsidiary of China's Ansteel Group (Subari, 2021).

“It was initially predicted that local steel would be used, but that didn’t happen. To my knowledge, most of the steel was directly imported from China.”

—Expert, KCJB

Information on the sourcing of these rails, and other materials used in this project, was scarce, but one Indonesian source indicated that these rails were produced in 50-meter sections in a Pansteel facility in China's Sichuan province, transported by rail to a port facility in Fangcheng, China, and then transported to Indonesia by sea with the assistance of China Electric Construction Group Co Ltd (Subari, 2021). Upon arriving at KCJB staging sites, these 50-meter rail sections were welded into 500-meter-long rail sections and then transported by specialized rail cars for laying. The construction of the 142.3 km railway line ultimately took 1,168 of these 500-meter-long steel rail sections to complete (Prasetyo, 2023).

Although the technical specifications and production quality were heavily emphasized in project documentation, there is notably limited transparency regarding labor conditions in the production process.

The project's labor structure showed a ratio of between 1-to-4 and 1-to-7 Chinese to Indonesian employees during construction (China Report ASEAN, 2023). This provided significant local employment (approximately 51,000 jobs), but questions remain about working conditions and labor standards enforcement. The project has faced criticism for limited safeguard policies and inadequate oversight of working conditions (China Report ASEAN, 2023).

“The participation of local communities in the workforce is very low. Most of the workers are brought in from China. Local residents generally work only as manual laborers, while strategic positions are filled by foreign workers.”

—Expert, KCJB

Construction of the railway has raised several labor-related concerns, including multiple worker deaths alleged to have resulted from unsafe working conditions and inadequate worker protections (Yuniar, 2022a, 2022b). Further, the project has been criticized on environmental and social grounds, particularly for failing to obtain buy-in and account for “obtain[ing] free, prior, informed consent of the communities that currently live along the proposed rail route” (China Dialogue, 2020; Paendong, 2020; Utama, 2024). Environmental organization Wahana Lingkungan Indonesia documented cases in which construction methods led to damage to nearby homes and contaminated water sources (X. Chen et al., 2024). These issues suggest insufficient attention to both worker and community safety standards.

4.1.5 Morowali Industrial Park: Evidence of Forced Labor in the Supply Chain of Carbon Steel Components or Construction Labor

IMIP presents particularly concerning evidence regarding labor conditions and safety standards in BRI-related steel production. As the world's largest nickel processing plant, IMIP has transformed a former fishing village into a major industrial hub, employing more than 200,000 workers, but this rapid development has been accompanied by serious labor rights issues (Liljas, 2024).

Figure 11. Map of Indonesia showing Morowali Industrial Park



Source: Mapcreator.io, ICF

Documentation reveals a pattern of severe safety incidents and labor violations. In 2023, three Chinese workers filed human rights complaints over “inhumane working conditions,” citing breathing difficulties, memory loss, and heart problems (Yuniar, 2023a). Workers reportedly faced shifts exceeding 12 hours without adequate rest or overtime compensation, working in conditions of thick smoke and dust (Idrus, 2023). The scale of these issues is significant—more than 42,000 Chinese migrant workers were employed in Indonesia in 2022, many at IMIP.

A December 2023 fire at one of the nickel plants killed 13 workers (9 Indonesians and 4 Chinese) and injured 46 others. Subsequent worker protests demanding closure of smelters until a full investigation could be completed were rejected by site officials (Bustan, 2023). The Central Sulawesi Mining Action Network, an Indonesian environmental group, documented 30 deaths at IMIP from 2019 to 2023, all related to poor health and safety standards (Bustan, 2023).

According to informants interviewed for this project, workers in smelting facilities in IMIP continue to face various labor abuses, including workplace safety violations, inadequate training and personal protective equipment (PPE), and excessive overtime:

“The working conditions in ... Morowali are still poor. While the government talks about added value for national income, the reality on the ground is different. Some common violations include a lack of safety guarantees for workers. The safety standards applied are very minimal. For example, work areas with high risks are not supported by adequate safety equipment, including PPE. Companies often force workers to operate in hazardous areas without sufficient risk mitigation. Even the work tools used are often unfit for

purpose and pose a risk of workplace accidents. Our trade union believes that productivity should not only depend on workers' skills but also on the quality of tools provided by the company."

—Representative, Indonesian steel worker trade union

"The real wages received by workers are often insufficient to meet the high cost of living in Morowali. As a result, workers endure extended working hours in the form of overtime."

—Representative, Indonesian steel worker trade union

Working conditions at IMIP have been documented as severely substandard. Labor unions reported in 2022 that some facilities had only 3 "open-style" toilets per 2,500 workers, far below Indonesia's regulatory requirement of 1 toilet per 15 workers (IndustriALL, 2022a). Despite union demands, these conditions remained unaddressed (IndustriALL, 2022a). The rapid population growth in the area, with more than 100,000 new residents arriving in just a few years, has overwhelmed local infrastructure and public services.

"We found that workplace safety in Morowali is far from adequate. The companies are primarily focused on maximizing nickel production for industrial needs, with little attention paid to worker welfare."

—Representative, Indonesian labor union

The evidence suggests systemic failures in protecting worker rights and safety at IMIP. The combination of dangerous working conditions, excessive hours, inadequate facilities, and limited worker protections indicates significant forced labor risks in the facility's operations. These concerns are amplified by the apparent lack of effective oversight or enforcement of labor standards.

4.2 KENYA

4.2.1 The Supply Chain for Carbon Steel Infrastructure Components in Kenya: Domestic Production and Chinese Imports

Over the last decade, Kenya's steel industry has seen a number of significant changes, most notably a sharp growth in domestic production capacity for many types of steel goods and steps toward reliance on domestically sourced iron ore.

"Local manufacturers are doing a good job producing various grades of steel bars. The demand is so high that 90% of the people, including Chinese companies, buy from local manufacturers. No one is importing steel bars, binding wires, BRC [British Reinforced Concrete] meshes, or nails—they are all sourced locally. For steel plates, if the thickness is up to six or eight millimeters, we buy locally, as well as small-rolled angles and channels. This accounts for about 10 to 15% of our total production, depending on the job."

—Engineer, Kenyan steel fabrication firm

As noted by industry stakeholders interviewed for this project, Kenya's steel sector has evolved from being primarily a secondary producer that imported steel billets to becoming increasingly involved in primary steel production. Today, Kenya's steel producers now produce a wide range of finished steel components commonly used in infrastructure, commercial, and home construction, including rebar, angle bars, channels, I-beams, flat bars, and C-sections, as well as wire rods that can be further processed into various wire products such as chain links, barbed wire, and wire meshes.

That said, these advances have largely been limited to the production of low-carbon or "mild" steel. Low-carbon steel is more affordable than high-carbon steel and is employed in a variety of downstream uses in construction, automotive, manufacturing, household items, and food packaging (such as cans). As of the time of writing, Kenya's domestic production capacity for high-carbon, stainless, or other specialty

steels remains extremely limited.²⁴ As such, Kenya's market for specialty steel goods such as high-grade carbon steel and stainless steel is dominated by imported materials.

"No, there's no difference apart from high-carbon steel, like tool steel. They're not produced in Kenya; they're imported, like stainless steel. There's no company that produces stainless steel."

—Engineer, Kenya Railways Corporation

An engineer with experience overseeing the construction of major infrastructure projects reported:

"Carbon steel consumption is mainly for construction materials like D-form bars, which are a major component here. ... Most of the materials we use are imported, as the local production capacity is limited. Companies like Tononoka, Doshi, and Athi River Steel manufacture on a medium scale, but anything beyond that is imported. We import nearly 99% of our carbon steel plates and other high-grade materials from overseas since local manufacturers do not produce them."

—Engineer, Kenyan steel fabrication firm

The engineer goes on to say that on major infrastructure projects:

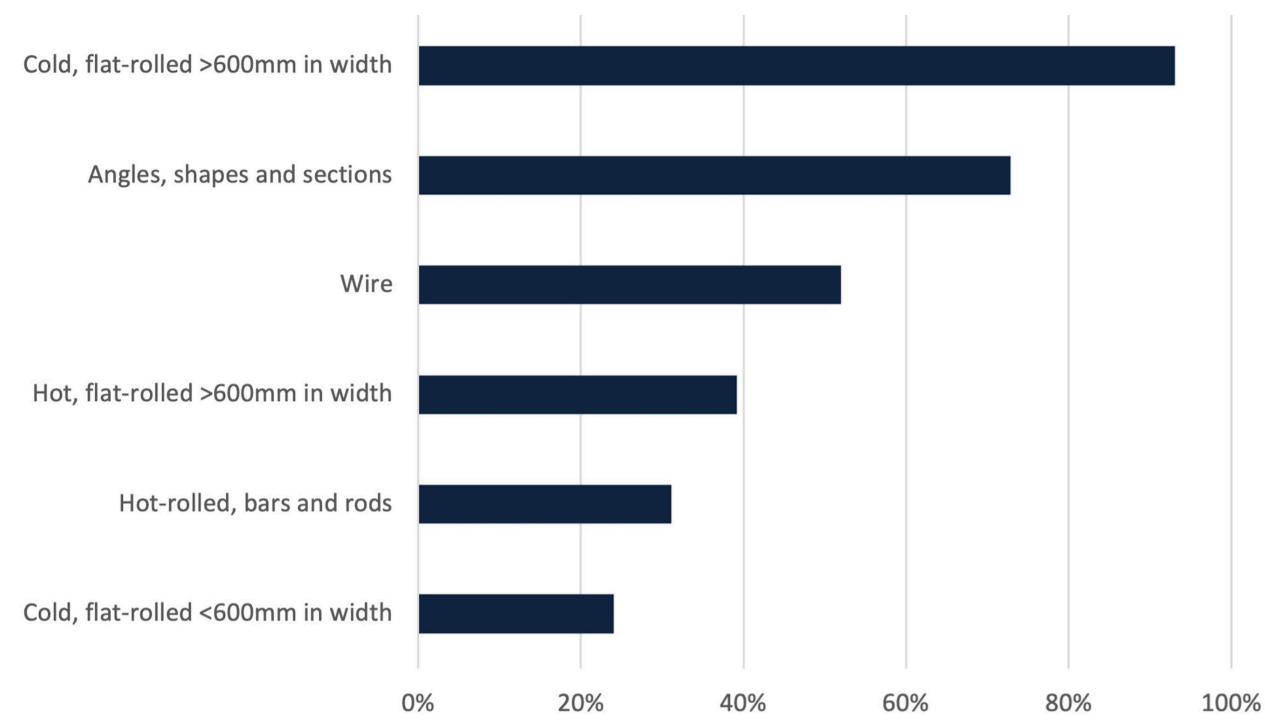
"The grade of the material is crucial, especially for carbon steel, where yield strength matters a lot. For most projects, about 60% of the [steel] material is imported because local production cannot meet the required specifications immediately. ... We import a lot from China because their quality is good. Previously, we imported from Romania and Ukraine for larger beams, but now China offers a better price."

—Engineer, Kenyan steel fabrication firm

According to trade data and sector stakeholders interviewed for this study, most of these specialty steel imports to Kenya come from China.

²⁴ Although major local manufacturers like Tononoka, Doshi, and Athi River Steel have made some inroads into production of high-carbon, stainless, or other specialty steels, their output remains quite limited.

Figure 12. China's share of Kenya's primary carbon steel imports



Source: World Steel, 2024

Domestic production is primarily focused on secondary conversion, with companies either purchasing scrap metal for melting or importing billets for conversion into finished products. Major local manufacturers like Devki Steel, Tononoka Steel, and Athi River Steel operate at medium scale but struggle to meet demand for high-grade carbon steel and stainless steel products.

The country has identified potential iron ore deposits in regions like Taita Taveta, but mining operations remain limited, with most raw ore being exported rather than processed domestically due to high processing costs and logistical challenges.

The supply chain for large infrastructure projects in Kenya, such as the BRI-funded SGR and Port of Mombasa, demonstrates particularly high import dependence. Industry representatives argue that some materials are sourced locally, but evidence suggests that specialized components and high-grade steel products are predominantly imported from China, often as a condition of project financing arrangements.

Project financing often dictates procurement patterns, as evidenced by observations from port authority officials:

“In our case, we have most of the funding from the Japanese, Chinese, or the Government of Kenya. ... When it comes to the Chinese, their model is different. These bring in raw materials, which they then fabricate locally.”

—Engineer, Kenya Ports Authority

This pattern of tied financing and procurement has raised concerns about the development of domestic production capacity and the long-term sustainability of Kenya's steel industry.

4.2.2 Evidence of Labor Exploitation in the Supply Chain of Carbon Steel Infrastructure Components in Kenya

The steel industry in Kenya exhibits several concerning patterns regarding labor conditions. Industry participants describe working conditions as fundamentally challenging, with widespread issues related to safety, compensation, and job security. Sector experts report significant labor issues in Kenyan steel facilities, with persistent problems that include inadequate protective equipment, insufficient wages, and unreliable transportation to work sites.

“Certainly, there’s no good working environment there. There are always complaints of lack of PPEs, poor wages. And sometimes they don’t have transport to the mining areas, so they have to walk, or they’re carried by lorries at the back of lorries. So, there are always issues. Sometimes they’re not paid on time. They have to wait, and you know, the way the job is very demanding. You wake up in the morning, you overwork, there’s no overtime. So, there are a lot of issues surrounding that place especially on employment of locals.”
—Kenya steel industry expert

“Despite the provisions of the law, like the one on PPEs, which clearly states that employers should provide PPEs to employees, some employers still ignore that. So, for us, it is our duty to ensure that it’s being enforced where we have members. But where we don’t have members, we aren’t able to enforce it.”
—Representative, metal workers union

Other industry insiders mentioned instances of steel industry workers being confined to factory premises through the night.

“If you go to places like Kariobangi Industries or even in Thika or the Industrial Area, you’ll find conditions where staff are locked up overnight in the workplace, with no escape. It has happened several times. So, it is not forced labor per se, because they are adults and they are working, but the conditions are very unsafe—you’re locked up in the factory.”
—Engineer, Kenya Railways Corporation

Multiple informants interviewed for this study reported that Kenya’s steel sector has seen an increase in the use of labor subcontracting, and that this practice has further eroded worker protections and collective bargaining agreements. Union representatives describe a systematic pattern in which companies turn to outsourcing specifically to avoid labor obligations. As explained by one union representative:

“Outsourcing works like this: an employer doesn’t want to deal with employees directly, so they recruit someone who owns a company, and they have an agreement that this person will supply employees.”
—Representative, metal workers union

This practice has led to significant wage disparities. Companies with collective bargaining agreements offer wages 30% above the legal minimum, while outsourced workers typically receive only the minimum wage. The impact on union representation has been severe, as one representative noted regarding Devki Steel Mills:

“When they saw that we were fighting for employees’ rights, demanding good pay and working conditions, they decided to outsource their core business.”
—Representative, metal workers union

Safety concerns are particularly acute in the industry, with multiple documented serious incidents. Industry sources report that steel mills are “known for being hazardous.” One particularly severe incident involved a worker falling into molten steel at a facility in Thika:

“About a year ago ... we had an incident in Thika where a worker fell into molten steel. It took a long time for them to stop production ... it’s so hot that even the intervention measures take hours to stop production.”

—Engineer, Kenya Railways Corporation

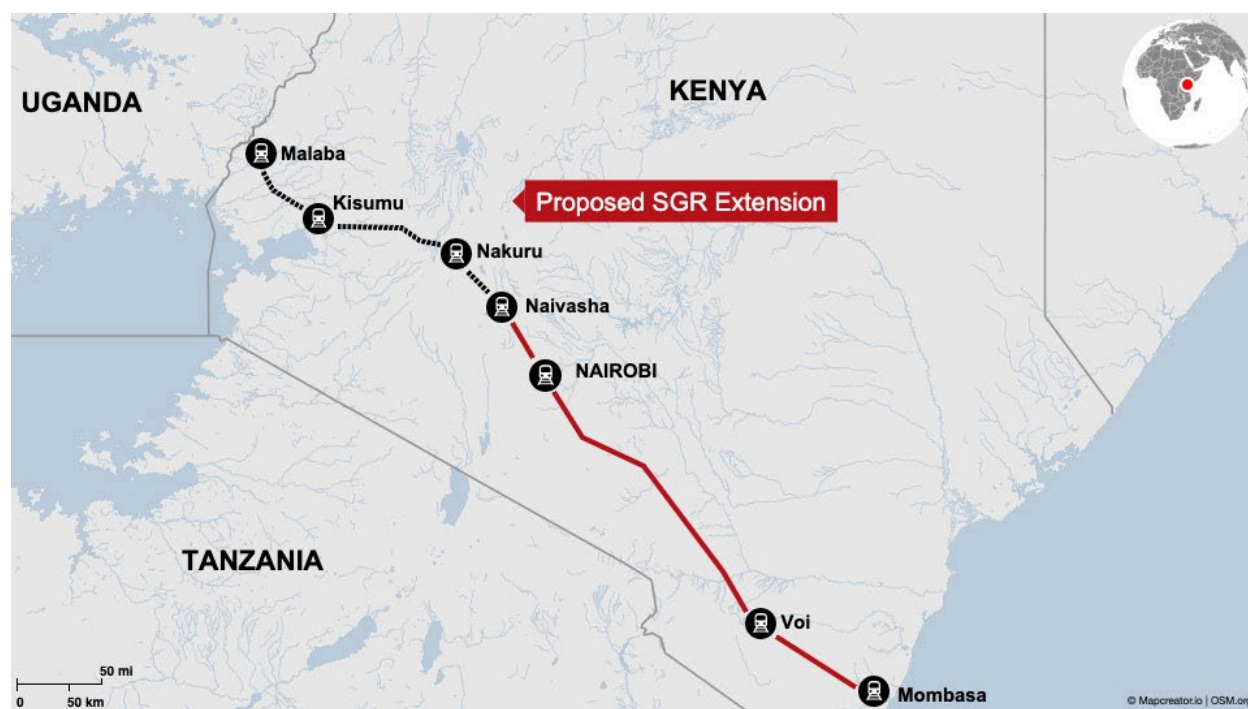
The economic pressures facing the industry have exacerbated these issues. Companies have significantly reduced their workforces while expecting remaining employees to handle increased workloads without corresponding compensation. One facility reported reducing its workforce from 1,200 to approximately 320 workers, noting that “fewer workers are doing more work,” despite only a recent 5% salary increase. The high unemployment rate in Kenya compounds these issues, because workers feel unable to refuse unsafe conditions or excessive workloads due to limited alternative employment options.

Government oversight remains inconsistent and often ineffective. Although Kenya has established regulatory frameworks through the Labor Act of 2007 and Occupational Health and Safety regulations, enforcement is sporadic. One industry source interviewed for this study indicated that labor inspections of steelmaking facilities typically occur only in response to specific complaints or pressure from advocacy groups, noting that inspectors “just come and check. ... I’m not sure how often it happens. I think it can also happen on demand, like when there are complaints from pressure groups.” Many companies rely on voluntary International Organization for Standardization certification for safety standards rather than government oversight, creating a self-regulation system that lacks external accountability.

4.2.3 Standard Gauge Railway: Evidence of Forced Labor in the Supply Chain of Carbon Steel Components or Construction Labor

The SGR project, which began construction in 2014 and completed its first phase in 2017, connecting Nairobi to the port of Mombasa, represents Kenya’s largest infrastructure project to date, costing approximately \$3.8 billion (Taylor, 2020). The second phase, to extend the rail line into Uganda, never materialized as both countries struggled to pay down BRI debts to China. Although initial project agreements stipulated that 40% of materials should be sourced locally, evidence suggests that the majority of steel components were imported from China, where serious forced labor concerns exist in steel production (The East African, 2015). The Chinese contractor, China Road and Bridge Corporation, initially pushed to source steel from outside Kenya, claiming that local suppliers did not meet specifications, although some local sourcing did eventually occur (The East African, 2015).

Figure 13. Map of Kenya showing Standard Gauge Railway



Source: China Global South Project (2023)

Information regarding the sourcing of steel components used in the construction of the SGR in both secondary literature and interviews with industry insiders conducted for this project was contradictory. When asked about the sourcing of carbon steel components for the SGR, a Kenyan engineer with knowledge of procurement practices in large infrastructure projects in Kenya claimed that nearly all of the steel used for the SGR was imported as a finished product. A Kenyan steel company insider, however, dismissed this notion as an “absolutely wrong and irresponsible statement,” claiming instead that “all the steel [used in the SGR] was locally produced” and, indeed, all major infrastructure projects in the country (including those that were funded in large part through the Chinese BRI-related funding, such as the SGR, the expressway, and the Port of Mombasa) used “a hundred percent locally produced steel” (Official, Kenya Association of Manufacturers). Later in the interview, however, this interviewee acknowledged that “there are certain types of steel that they would want to import because they aren’t made in the country” (Official, Kenya Association of Manufacturers).

Despite these conflicting reports, it is reasonable to assume that the majority of the medium- and high-carbon steel components required for the construction of the SGR were imported from China. Given the above finding that Kenyan steel facilities are, as yet, unable to produce high-carbon or specialty steels in any substantial amount, it is unlikely that they were sourced locally. Evidence from both secondary sources and interviews with Kenyan steel industry stakeholders suggests that China has been and remains the leading source of carbon and other specialty steel components to Kenya (Wissenbach & Wang, 2017).

As outlined in the previous section, there are also reasons to be concerned about the risk of forced labor or other labor abuses in the supply chain of those steel components used in the construction of the SGR that were sourced from local Kenyan suppliers and those that were sourced from China. Further, there is reason to be concerned about labor conditions in the supply chain of the iron ore and coal used in the production of Kenyan steel. The Kenyan iron mining sector has seen high-profile

allegations of unsafe working conditions, and like many other forms of mineral extraction in the country, the iron ore supply chain includes a growing number of artisanal and small-scale miners, according to recent secondary sources and interviews with industry stakeholders conducted for this study (Mkanyika, 2019; Njumwa et al., 2024).

Labor exploitation concerns extend to the construction phase of the SGR project itself. Workers have reported severe mistreatment, including physical abuse, unpaid overtime, withheld pay, and other forms of abuse or mistreatment at the hands of Chinese supervisors (Mwakio, 2015; The Citizen, 2021). One worker described how “sometimes, we would be made to lie down and whipped thoroughly and there was nothing any of us could do since we needed the jobs so we could feed our families” (Kirui, 2019). Workers also reported being denied days off while working extra hours in harsh weather conditions, with inadequate safety measures and below-market wages that sparked strikes in 2016 (Kuo, 2016; Mwakio, 2015). These issues have been exacerbated by the stark disparities between Chinese and Kenyan workers in the project’s labor structure. Reports indicate that Chinese workers received preferential treatment in terms of working conditions, disciplinary procedures, and workplace privileges, creating a two-tier system that disadvantaged local workers. Kenyan workers have reportedly been subjected to systematic discrimination, including segregation on staff vehicles and bathroom facilities, punishment for not performing menial tasks they were never hired to do, and discriminatory application of fines—Kenyan workers would be penalized for activities like smoking or using mobile phones on cargo trains while Chinese workers reportedly engaged in the same behaviors with impunity (Goldstein, 2018; Michael Musyoka, 2018; Wafula, 2018; Wilson-Andoh, 2022). These practices raise serious concerns about compliance with international labor standards and Kenya’s domestic labor laws.

The financial structure of the SGR project illustrates how debt obligations can create systemic pressures that increase the risk of labor exploitation. Kenya’s total debt for the SGR project has grown to approximately \$4.7 billion, creating significant financial strain on the country’s budget (Kell, 2023; Soy, 2023). This debt burden has intensified pressure on project managers to cut costs wherever possible, with labor expenses representing one of the few variable costs that can be readily adjusted during implementation. Economic analysis reveals that the SGR has consistently operated at a loss since its inception, reporting a cumulative deficit of more than \$200 million between 2017 and 2022, further amplifying the pressure to minimize operating expenses (Council on Foreign Relations, 2021). The connection between Kenya’s debt obligations and labor exploitation represents a broader pattern seen across BRI projects globally. The financing structure creates a self-reinforcing cycle: high debt levels necessitate cost minimization, which leads to labor exploitation, which in turn undermines project sustainability and exacerbates financial challenges. Without addressing the underlying debt dynamics and creating stronger oversight mechanisms, the risk of forced labor and other exploitative practices will likely persist in current and future BRI-funded infrastructure projects in Kenya.

4.2.4 Port of Mombasa: Evidence of Forced Labor in the Supply Chain of Carbon Steel Components or Construction Labor

The Port of Mombasa represents a critical piece of Kenya’s infrastructure and a key strategic asset in the competition for regional trade dominance in East Africa. As East Africa’s largest and most sophisticated port facility, it handles more than 2 million twenty-foot equivalent units (TEUs) annually and serves as the primary maritime gateway for not only Kenya but also Uganda, Rwanda, Burundi, South Sudan, Somalia, and parts of Tanzania, Ethiopia, and the Democratic Republic of Congo (Jing, 2024; Kenya Port Authority, 2025). The port’s significance extends well beyond Kenya’s borders, making it a focal point for Chinese BRI investment in the region.

The China Road and Bridge Company has implemented several major projects at the port since 2010, including the construction of Berth 19 (completed in 2013), Berths 20 and 21 (completed in 2016), and the Kipevu Oil Terminal (completed in 2022) (Dredging Today, 2011; Moraes, 2022; Reuters, 2018).

These expansions have increased the port's annual container handling capacity from just under 700,000 TEUs in 2010 to just more than 2 million TEUs by 2023 (Kenya Port Authority, 2025; Reuters, 2011).

The Port of Mombasa expansions should be understood within the broader regional context of port development and competition. China's simultaneous investment in Tanzania's Bagamoyo Port project (\$10 billion) and involvement in the development of Lamu Port in northern Kenya (part of the \$25 billion LAPSET corridor) represents a strategic positioning in the region's maritime infrastructure (A. Mishra, 2021; Muchira, 2022). This has created a competitive dynamic between East African nations for Chinese investment and regional trade dominance. By controlling financing for multiple competing port facilities across East Africa, China has effectively positioned itself to benefit, regardless of which port emerges as the dominant regional hub (Krishna, 2024).

These port infrastructure developments are intrinsically linked to the SGR, creating what Chinese and Kenyan officials frequently refer to as an "integrated transport corridor." And as with the SGR, the expansion of the Port of Mombasa has significantly contributed to Kenya's Chinese debt burden. While the SGR has received more public attention regarding debt concerns, the port projects have added substantially to Kenya's overall BRI-related obligations. By 2023, Kenya's debt to China for port-related infrastructure had reached approximately \$6.3 billion, combining both direct port investments and associated landside infrastructure (Kell, 2023). This debt obligation has created significant fiscal pressure, with port revenues increasingly directed toward loan repayments rather than further infrastructure development or operational improvements.

The Mombasa port projects have also operated within the same procurement framework as the SGR, with similar implications for steel sourcing and labor conditions. Although some basic steel components were sourced locally, specialized components such as the high-grade steel piling sheets for the berth walls were manufactured in China and shipped to Mombasa.

The port's development has also been affected by government austerity measures, which have impacted both procurement and labor conditions. A key informant noted that procurement activities had been suspended since July 2024 due to government spending restrictions, stating:

"From July to date, we have not spent any money due to the government austerity measures."

—Engineer, Kenya Ports Authority

These financial constraints have created additional pressure on working conditions and labor rights.

The port's operations involve substantial steel consumption for various infrastructure components, including docks, cranes, and loading structures. As noted by one official:

"Indeed, at the port, we consume a lot of steel. We use it widely in constructing docks, cranes, and other loading and unloading structures. Its strength supports the heavy loads and stress these structures endure daily."

—Engineer, Kenya Ports Authority

However, the concentration of steel fabrication in Chinese-controlled facilities raises concerns about transparency and oversight of labor conditions in the supply chain.

4.3 ANALYSIS OF FORCED LABOR INDICATORS IN INDONESIAN AND KENYAN BRI PROJECTS

An analysis of documented conditions in Indonesian and Kenyan BRI projects reveals multiple indicators of both involuntary work and coercion, suggesting significant forced labor risks in the carbon steel

supply chain. The evidence from both countries demonstrates how project structures and management practices create conditions that align with established forced labor indicators.

In Indonesia's IMIP, several indicators of involuntary work are clearly documented. Workers faced hazardous and degrading working conditions, with three Chinese workers filing human rights complaints over "inhumane working conditions" that led to breathing difficulties, memory loss, and heart problems (Yuniar, 2023b). The working conditions included exposure to thick smoke and dust, and severely inadequate facilities—just 3 "open-style" toilets provided for 2,500 workers (IndustriALL, 2022b). A documented pattern of workplace fatalities provides further evidence of hazardous working conditions—with 30 deaths tracked between 2019 and 2023 related to poor health and safety standards (Bustan, 2023). The December 2023 incident in which 13 workers (9 Indonesian and 4 Chinese) were killed and 46 were injured in a fire, followed by management's rejection of workers' demands for temporary closure pending safety investigations, further demonstrates the hazardous conditions (Bustan, 2023). Workers endured onerous working hours, regularly exceeding 12-hour days without adequate rest periods or overtime compensation. The coercive elements at IMIP included effective restrictions on workers' movement through the structure of the industrial park system.

In Kenya's steel industry, involuntary work indicators are evident in both manufacturing and construction contexts. Hazardous and degrading working conditions are widespread, with union representatives reporting "no good working environment" and persistent inadequate protective equipment. The practice of workers being "carried at the back of lorries" to worksites demonstrates degrading conditions. Workers face onerous schedules, particularly following workforce reductions that left "fewer workers doing more work" without corresponding compensation increases.

Coercive practices in Kenya's steel sector include the systematic withholding of wages. As one union representative explained regarding outsourced workers:

"You'll see now, without a CBA [collective bargaining agreement], an employer will just do whatever they want. You'll see now an employee can be unpaid ... most of these outsourcing companies are even paying employees below the minimum wage."

—Representative, metal workers union

Coercive practices also include restrictions on workers' movement. As mentioned previously, industry insiders mentioned instances of steel industry workers being confined to factory premises through the night. There are also reports of physical violence. Workers involved in the SGR construction project have reported physical abuse, including being whipped.

In both countries, the structure of BRI project financing and management creates conditions that enable these forced labor indicators to persist. The tied financing model, which typically requires the use of Chinese contractors and materials, reduces transparency and complicates oversight. The resulting opacity in supply chains makes it difficult for local authorities to effectively monitor and enforce labor standards. Furthermore, the economic pressures created by project debt obligations—such as Kenya's \$4.7 billion SGR debt—create incentives to minimize labor costs through practices that align with forced labor indicators.

4.4 IMPLICATIONS OF INDONESIAN AND KENYAN FINDINGS FOR FORCED LABOR RISKS IN BRI PROJECTS GLOBALLY

The documented labor issues in Indonesian and Kenyan BRI projects reveal patterns that likely indicate broader systemic risks across the BRI supply chain globally. The evidence from both countries

demonstrates how project financing structures, procurement patterns, and labor management practices create conditions conducive to worker exploitation and forced labor.

The evidence from Indonesia and Kenya suggests several key risk factors likely present in other BRI recipient countries:

- First, the tied financing model common to BRI projects creates inherent conflicts between project completion and labor protection. When project funding is contingent on using Chinese contractors and materials, there are strong incentives to minimize costs through labor exploitation. This pattern is evident in both Indonesian and Kenyan projects, in which financial pressures consistently led to deteriorating working conditions.
- Second, the opacity of supply chains and limited oversight capability of host countries creates opportunities for labor exploitation. In both Indonesia and Kenya, government regulators struggled to effectively monitor working conditions in Chinese-operated facilities. IMIP's serious safety violations and the SGR's discriminatory practices both persisted despite nominal regulatory oversight.
- Third, the use of labor subcontracting to evade worker protections appears to be a systemic practice. In Kenya, steel companies explicitly used subcontracting to undermine union representation. Similar patterns of avoiding direct employment relationships appear in Indonesian projects.

These findings suggest that BRI projects around the world likely face significant forced labor risks, particularly in countries with limited regulatory capacity and high unemployment. The combination of tied financing, opaque supply chains, and systematic labor rights evasion creates conditions in which worker exploitation can flourish without effective oversight or accountability.

5. CONCLUSION AND RECOMMENDATIONS

This study proposed a preliminary approach to examining forced labor risks on steel and steel components used in BRI infrastructure projects, through case studies in Indonesia and Kenya. Through analysis of trade data and stakeholder interviews, combined with exploratory case studies of BRI projects in Indonesia and Kenya, the study identified significant forced labor risks at multiple points in the supply chain—from raw material extraction through steel production and construction.

The evidence suggests that forced labor risks in BRI steel supply chains stem from both structural factors and specific practices. The tied financing model common to BRI projects, which typically requires sourcing materials and labor from Chinese contractors, reduces transparency and complicates oversight. Extant literature documents the high risk of forced labor in steel production in China. In addition, China stopped reporting shipping data in 2018. In combination with a variety of contracting and business practices, the resulting opacity makes it difficult for observers to effectively monitor labor standards. Even if there were government support of enforcing labor standards, the economic pressures created by project debt obligations create incentives to minimize labor costs through practices that align with multiple forced labor indicators.

These dynamics were particularly evident in both case study countries. In Indonesia's IMIP, systematic safety violations, excessive working hours, and degrading conditions resulted in multiple worker deaths and serious injuries. Kenya's SGR project saw widespread reports of discriminatory practices, withheld wages, and physical abuse of local workers. In both cases, the combination of tied procurement, limited oversight capacity, and economic pressure from project debt created conditions in which labor exploitation could persist despite nominal regulatory frameworks.

The findings suggest that many steel components used in BRI infrastructure are at risk of being produced with steel that was produced using forced labor. Reporting has documented evidence of indicators of forced labor at multiple points in the supply chain of Chinese-made steel, and there have been reports of significant labor issues in the supply chain of steel produced in facilities in BRI recipient countries like Indonesia and Kenya.²⁵

These risks often overlap and are difficult to quantify, highlighting the complex nature of labor issues in BRI supply chains. While there are no quick fixes, various stakeholders can take pragmatic steps to reduce these risks and reform BRI procurement practices for the long-term benefit of workers, businesses, and host countries.

Recommendations:

To Other Governments:

Other governments should take several concrete steps to strengthen oversight of forced labor risks in BRI steel supply chains:

- Governments should enhance international cooperation through targeted capacity building programs for labor inspectorates in BRI recipient countries. This could include technical assistance for developing digital tracking systems, training on investigating forced labor indicators, and support for cross-border coordination of enforcement efforts. Programs should focus particularly on strengthening oversight capacity in countries that host major BRI infrastructure projects.
- Government agencies should support alternative infrastructure financing models that avoid creating excessive debt burdens or procurement requirements for countries looking to invest in infrastructure projects. Technical assistance should be provided to help countries evaluate financing options and negotiate agreements that preserve procurement sovereignty and support fair market-based business practices in international markets. In addition to provisions protecting economic sovereignty of borrower countries, these alternative infrastructure financing models should also include provisions establishing strong labor standards that will foster a level playing field and providing guidance to facilitate monitoring and compliance.

To Industry:

Private sector actors involved in steel production and procurement should implement several key reforms:

- Steel producers and manufacturers should develop comprehensive traceability systems that track steel inputs from raw material sources through final product delivery. These systems should document not only country of origin but also specific manufacturing locations and labor conditions at each production stage. Digital tracking tools and blockchain solutions could help ensure data integrity throughout complex supply chains.
- Industry actors should conduct due diligence investigations to actively identify, document, and remediate existing labor abuses in their steel supply chains, while establishing preventative measures and regular monitoring to protect against future violations, especially when sourcing from regions with documented forced labor risks.

²⁵ UFLPA creates a rebuttable presumption that goods produced wholly or in part with inputs from the XUAR are produced with forced labor and therefore prohibited from importation into the United States. UFLPA also mandates a list of entities that use forced labor or are otherwise connected to labor and human rights violations in the region. Kenyan and Indonesian manufacturers and exporters using Chinese steel inputs produced by entities in the XUAR or entities on the UFLPA Entity List are thus prohibited from being imported into the United States.

- Companies should create detailed protocols for identifying forced labor risks, including clear procedures for conducting supplier audits, verifying labor conditions, and responding to red flags. These protocols should align with international standards like the ILO's forced labor indicators while being adapted for steel industry-specific contexts.
- Effective grievance mechanisms must be established and made accessible to workers throughout the supply chain. These should include multiple reporting channels (phone, web, in-person), protection for whistleblowers, and transparent processes for investigating and remedying complaints. Mechanisms should be available in workers' native languages and account for literacy barriers.

To Host Country Governments:

BRI recipient countries should implement several reforms to better protect workers and strengthen domestic oversight:

- Labor inspection frameworks should be strengthened through increased staffing, enhanced authority, and improved technical capacity. This should include specialized training for inspectors on steel industry operations and common forced labor indicators. Digital tools should be provided to support more efficient inspection processes and data collection.
- Countries should support tax incentives for workforce development programs and technical assistance to meet international labor standards. Strong labor protections should be built into any industry initiatives.
- Specialized labor monitoring units should be created for large infrastructure projects, with authority to conduct regular inspections and enforce labor standards. These units should have direct reporting lines to senior government officials and adequate resources to maintain consistent oversight throughout project implementation.
- Mechanisms for reporting labor violations should be strengthened through protected channels and strong penalties for retaliation. This should include anonymous reporting options, legal aid for workers pursuing complaints, and meaningful sanctions for employers found to have violated labor standards.
- Finally, countries should ensure that infrastructure financing agreements maintain sovereign control over procurement decisions and labor oversight. This includes carefully evaluating financing terms, preserving the right to source from domestic suppliers, and maintaining authority to enforce national labor laws, regardless of project funding source.

APPENDIX I: REFERENCES

- Aboura, Y. (2024, September 10). Blast furnace to EAF transition: Navigating challenges and market gaps. *Steel Hub*. <https://www.steelhub.com/magazine/blast-furnace-to-eaf-transition-navigating-challenges-and-market-gaps/>
- ActionAid. (2015, November). Coal mining disrupts people's livelihoods in Mui basin, Kenya. *Center for International Environmental Law*. <https://www.ciel.org/reports/upholding-human-rights-bridging-gender-environment-divide/coal-mining-disrupts-peoples-livelihoods-in-mui-basin-kenya/>
- AFP. (2018, June 7). Rescuers save 23 workers trapped in China mine. *Taipei Times*. <https://www.taipeitimes.com/News/world/archives/2018/06/07/2003694486>
- Allanore, A., & Krol, A. (2024, June 28). Steel. MIT Climate Portal. <https://climate.mit.edu/explainers/steel>
- Arif, Z. M. (2022, March 21). Rescuers identify possible spot where victims are buried under landslide at limestone quarry. <https://www.nst.com.my/news/nation/2022/03/781907/rescuers-identify-possible-spot-where-victims-are-buried-under-landslide>
- Arif, Z. M. (2023, September 5). Keramat Pulai quarry claims fourth life this year as limestone crushes worker to death. <https://www.nst.com.my/news/nation/2023/09/951277/keramat-pulai-quarry-claims-fourth-life-year-limestone-crushes-worker>
- Baskaran, G. (2024). Partnering with Middle Eastern countries to boost U.S. minerals security. <https://www.csis.org/analysis/partnering-middle-eastern-countries-boost-us-minerals-security>
- Basov, V. (2015, September 17). True giants of mining: World's top 10 iron ore mines. *MINING.COM*. <https://www.mining.com/true-giants-of-mining-worlds-top-10-iron-ore-mines/>
- Bega, F., & Lin, B. (2025). China's Belt & Road Initiative wind energy cooperation: Wind of change for the Chinese energy finance? *Renewable and Sustainable Energy Reviews*, 208, 115069. <https://doi.org/10.1016/j.rser.2024.115069>
- Belt and Road Advisory. (2018, December 24). *Belt and Road top 10 of 2018: What happened?* Belt and Road Advisory. <https://beltandroad.ventures/beltandroadblog/belt-and-road-top-10-in-2018-what-happened>
- Beshert Steel Processing. (2024). *ASTM A572 Grade 50 steel sheet & plate*. <https://www.beshertsteel.com/steel-sheet-and-plate/astm-a572-grade-50/>
- Betancourt, M. (2024, March 7). *Can the Belt and Road go green?* Eos. <http://eos.org/features/can-the-belt-and-road-go-green>
- Bond, D. E., Spak, G., Mayorga, M., & Saccomanno, I. (2024). *Biden Administration announces new measures to protect US steel, aluminum, and shipbuilding industries*. White & Case LLP. <https://www.whitecase.com/insight-alert/biden-administration-announces-new-measures-protect-us-steel-aluminum-and>
- Brazil Ministry of Labor and Employment. (2024). *Cadastro de Empregadores que tenham submetido trabalhadores a condições análogas à de escravo (Registry of employers who have subjected workers to conditions analogous to slavery)* (No. Portaria Interministerial MTE/MDHC/MIR nº 18). Brazil Ministry of Labor and Employment. https://www.gov.br/trabalho-e-emprego/pt-br/assuntos/inspecao-do-trabalho/areas-de-atuacao/cadastro_de_empregadores.pdf
- Business & Human Rights Resource Centre. (2011, June 9). *Bishkek-Torugart road builders employed by Chinese company Sinzyan-Basin Ltd. protest against discrimination and abuses of their labour rights [Kyrgyzstan]*. Business & Human Rights Resource Centre. <https://www.business-humanrights.org/en/latest-news/bishkek-torugart-road-builders-employed-by-chinese-company-sinzyan-basin-ltd-protest-against-discrimination-and-abuses-of-their-labour-rights-kyrgyzstan/>
- Bustan, T. (2023, December 24). *Fire at Chinese-owned Indonesia nickel smelter kills 13 workers, injures 46*. Benar News. <https://www.benarnews.org/english/news/indonesian/indonesia-nickel-plant-fire-13-killed-12242023103115.html>
- Butler, C. (2012, March 23). *Solidarity Center—Visiting mine workers observe troubling conditions in Colombian coal mines and surrounding communities*. Solidarity Center.

- <https://www.solidaritycenter.org/visiting-mine-workers-observe-troubling-conditions-in-colombian-coal-mines-and-surrounding-communities/>
- CalWire. (2024). *Reinforcing concrete slabs: A guide to welded wire mesh*. CalWire. <https://cawire.com/the-essential-guide-to-reinforcing-concrete-slabs-with-welded-wire-mesh/>
- Casey, N., & Krauss, C. (2018, December 24). It doesn't matter if Ecuador can afford this dam. China still gets paid. *The New York Times*. <https://www.nytimes.com/2018/12/24/world/americas/ecuador-china-dam.html>
- Castillo, N. (2024, August 19). *CPC | In much of Central Asia, perception of China declines*. Caspian Policy Center. <https://www.caspianpolicy.org/research/central-asia/in-much-of-central-asia-perception-of-china-declines>
- CDR Essential Intelligence. (2024, November 5). The Belt and Road Initiative 2025 | Indonesia. *CDR News*. <https://www.cdr-news.com/cdr-essential-intelligence/belt-and-road-initiative/indonesia/>
- Chen, H. (2022, November 29). *Report: Chinese workers abroad trapped in state-sponsored projects*. Axios. <https://www.axios.com/2022/11/29/chinese-workers-overseas>
- Chen, H. (2023, October 1). *Indonesia launches Southeast Asia's first bullet train*. CNN. <https://www.cnn.com/travel/article/indonesia-first-bullet-train-china-funding-intl-hnk/index.html>
- Chen, X., Hutahaeen, M., & Tobing, I. N. (2024, July 2). *A ground-breaking railway: Is the Jakarta-Bandung High-Speed Railway a game-changer for Indonesia?* The European Financial Review. <https://www.europeanfinancialreview.com/a-ground-breaking-railway-is-the-jakarta-bandung-high-speed-railway-a-game-changer-for-indonesia/>
- China Africa Research Initiative. (2025). *Data: Chinese workers in Africa*. China Africa Research Initiative at Johns Hopkins University's School of Advanced International Studies. <http://www.sais-cari.org/data-chinese-workers-in-africa>
- China Dialogue. (2020, August 4). *Indonesia: Jakarta-Bandung high-speed rail line faltered amid floods, poor management and environmental concerns*. Business & Human Rights Resource Centre. <https://www.business-humanrights.org/en/latest-news/indonesia-jakartabandung-high-speed-rail-line-faltered-amid-floods-poor-management-and-environmental-concerns-2/>
- China Labor Watch. (2022). *Trapped: The Belt and Road Initiative's Chinese workers*. China Labor Watch. https://media.business-humanrights.org/media/documents/Trapped_-_The-Belt-and-Road-Initiatives-Chinese-Workers-I_Hi3J4zj.pdf
- China Labor Watch. (2024a, March 1). *Assessing CCP's role in labor rights abuse: Overseas party building work in SOEs*. China Labor Watch. <https://chinalaborwatch.org/assessing-ccps-role-in-labor-rights-abuse:-overseas-party-building-work-in-soes/>
- China Labor Watch. (2024b, June 28). *Forged in silence—The untold stories of Chinese workers at Indonesia's nickel plants*. China Labor Watch. <https://chinalaborwatch.org/forged-in-silence-the-untold-stories-of-chinese-workers-at-indonesias-nickel-plants/>
- China Report ASEAN. (2023, November 9). *The Jakarta-Bandung High-Speed Railway will create job opportunities and drive economic development along the route*. <https://www.prnewswire.com/apac/news-releases/the-jakarta-bandung-high-speed-railway-will-create-job-opportunities-and-drive-economic-development-along-the-route-301983509.html>
- Çiftçi, B. B. (2023). *Raw materials*. World Steel Association. <https://WorldSteel.org/steel-topics/raw-materials/>
- CKGSB. (2016, June 14). *Solving the prickly issue of overcapacity in China*. CKGSB Knowledge. <https://english.ckgsb.edu.cn/knowledge/article/solving-the-prickly-issue-of-overcapacity-in-china/>
- CNV International. (2024). *Colombian government promises to listen to the mine workers*. Labour Observatory for a Just Transition in the Coal Supply Chain. <https://justtransition.cnvinternationaal.nl/articles/news/colombia-government-promises-listen-to-mine-workers>
- CoalNewswire. (2024). *China's met coke production in 2023*. The Coal Trader. <https://thecoaltrader.com/chinas-met-coke-production-in-2023/>

- Colás, R., & Totten, G. E. (2016). *Encyclopedia of iron, steel, and their alloys* (online version). CRC Press.
- Commodity Inside. (2024). Steel production capacity in Africa—Iron making and steelmaking. *Commodity Inside*. <http://commodityinside.com/reports/african-steel-production-capacity/>
- Council on Foreign Relations. (2021, March 25). *Belt and Road in Kenya: COVID-19 sparks a reckoning with debt and dissatisfaction*. Council on Foreign Relations. <https://www.cfr.org/blog/belt-and-road-kenya-covid-19-sparks-reckoning-debt-and-dissatisfaction>
- Crisis Group. (2024, May 24). *The generals' labyrinth: Crime and the military in Mexico*. <https://www.crisisgroup.org/latin-america-caribbean/mexico/106-generals-labyrinth-crime-and-military-mexico>
- Deng, Y. (2024, December 16). Fulfilling promises for the China-Pakistan economic corridor | GJIA. *Georgetown Journal of International Affairs*. <https://gjia.georgetown.edu/2024/12/16/13728/>
- Di, H., Ali, S., & Lu, Y. (2022). Defining the primary work stress factors of Chinese coal miners—A mixed-methods study. *International Journal of Environmental Research and Public Health*, 19(21), 14593. <https://doi.org/10.3390/ijerph192114593>
- Dredging Today. (2011, July 15). Kenya: CRBC starts USD 66.74 million berth project in Mombasa. *Dredging Today*. <https://www.dredgingtoday.com/2011/07/15/kenya-crbc-starts-usd-66-74-million-berth-project-in-mombasa/>
- Eaton Steel Bar Company. (2024). *Cold rolled steel bar—Cold finished steel bar*. Eaton Steel Bar Company. <https://www.eatonsteel.com/cold-finished-steel-bar.html>
- EnduraSteel. (2023a, April 7). *Hot rolled vs. cold rolled steel*. Endura Steel. <https://endura-steel.com/hot-rolled-vs-cold-rolled-steel-definitions-differences-and-history/>
- EnduraSteel. (2023b, May 6). *A journey through the steel rolling process*. Endura Steel. <https://endura-steel.com/a-journey-through-the-rolling-process-how-rolled-steel-takes-shape/>
- EnduraSteel. (2023c, August 11). *Different types of steel treatment*. Endura Steel. <https://endura-steel.com/different-types-of-steel-treatment/>
- EnduraSteel. (2024, May 31). *Complete guide to using rebar to reinforce concrete*. Endura Steel. <https://endura-steel.com/complete-guide-to-using-rebar-to-reinforce-concrete/>
- Federal Steel Supply. (2016, June 22). *How does coke and coal play into steel making?* <https://www.fedsteel.com/insights/how-does-coke-and-coal-play-into-steel-making/>
- Federal Steel Supply. (2022, May 27). *Steel's impact on US infrastructure*. <https://www.fedsteel.com/insights/steels-role-in-the-us-power-infrastructure/>
- Flowers, S. (2023, November 9). *China's Belt and Road Initiative turns away from coal*. Wood Mackenzie. <https://www.woodmac.com/blogs/the-edge/china-belt-road-initiative-turns-away-from-coal/>
- Franco, A., & Barker, J. (2024, June 27). *Watch giant sinkhole open up under soccer park after mine collapse*. Arizona Daily Star. https://tucson.com/news/nation-world/watch-giant-sinkhole-open-up-under-soccer-park-after-mine-collapse/article_c0dff9bc-f43e-5da5-809e-d050a3ba68fc.html
- Freeman, C., & Tugendhat, H. (2023, October 26). *The Belt and Road Initiative: A key pillar of the global community of shared future—The Third Belt and Road Forum for International Cooperation*. U.S. Institute of Peace. <https://www.beltandroadforum.org/english/n101/2023/1010/c124-895.html>
- Gan, N. (2016, June 29). *Four Chinese quarrymen killed by carbon monoxide poisoning inside cave*. South China Morning Post. <https://www.scmp.com/news/china/society/article/1983129/four-chinese-quarrymen-killed-carbon-monoxide-poisoning-inside>
- Geoscience Australia. (2023, December 19). *Iron ore (Australia)* [Text]. Geoscience Australia. <https://www.ga.gov.au/scientific-topics/minerals/mineral-resources-and-advice/australian-resource-reviews/iron-ore>
- Ghossein, T., Hoekman, B., & Shingal, A. (2018, December 20). *Public procurement in the Belt and Road Initiative*. World Bank Blogs. <https://blogs.worldbank.org/en/trade/public-procurement-belt-and-road-initiative>
- Global Forum on Steel Excess Capacity. (2024). *Global Forum on Steel Excess Capacity*. Global Forum on Steel Excess Capacity. <https://www.steelforum.org/>

- Global Forum on Steel Excess Capacity. (2024). *Steel exports, trade remedy actions and sources of excess capacity*. Global Forum on Steel Excess Capacity. <https://steelforum.org/gfsec-steel-exports-trade-remedy-actions-and-sources-of-excess-capacity.pdf>
- Global Slavery Index. (2024). *Modern slavery in China*. Walk Free. <https://www.walkfree.org/global-slavery-index/country-studies/china/>
- Global Times. (2022, July 24). *Working group sent to investigate Gansu coal mine collapse that kills 10, injures 7*. Global Times. <https://www.globaltimes.cn/page/202207/1271232.shtml>
- GlobalTradeAlert.org. (2018, July 19). *Intervention 61213: EU: Extension of definitive safeguard measure on imports of steel products*. GlobalTradeAlert.Org. <https://www.globaltradealert.org/intervention/61213/safeguard/eu-extension-of-definitive-safeguard-measure-on-imports-of-steel-products>
- Goldstein, J. (2018, October 15). Kenyans say Chinese investment brings racism and discrimination. *The New York Times*. <https://www.nytimes.com/2018/10/15/world/africa/kenya-china-racism.html>
- Griffith Asia Institute. (2024, February 5). *China Belt and Road Initiative (BRI) investment report 2023*. Griffith Asia Insights. <https://blogs.griffith.edu.au/asiainsights/china-belt-and-road-initiative-bri-investment-report-2023/>
- Guthrie, R. I. L., & Isac, M. M. (2022). Continuous casting practices for steel: Past, present and future. *Metals*, 12(5), 862. <https://doi.org/10.3390/met12050862>
- Halegua, A., & Ban, X. (2021, January 25). Legal remedies for China's overseas workers. *Made in China Journal*. <https://madeinchinajournal.com/2021/01/25/legal-remedies-for-chinas-overseas-workers/>
- Hansen, V. (2012). *The Silk Road*. OUP USA.
- Harris Supply Solutions. (2024). *A615 rebar—ASTM A615 grade reinforcing bar*. <https://www.harrissupplysolutions.com/a615-rebar-astm-a615-grade-reinforcing-bar.html>
- Harrison, A. (2021). "We are going to kill you." A case study in corporate power left unchecked. *Global Witness*. <https://en/blog/we-are-going-to-kill-you-a-case-study-in-corporate-power-left-unchecked/>
- Hayley, A. (2023, June 4). Landslide at mine in China's Sichuan province kills 19. *Reuters*. <https://www.reuters.com/world/china/landslide-chinas-sichuan-province-kills-14-leaves-5-missing-2023-06-04/>
- Hayley, A., Lv, A., & Hayley, A. (2023, November 27). Mine accidents surge in China's top coal province as producers raise output. *Reuters*. <https://www.reuters.com/world/china/mine-accidents-surge-chinas-top-coal-province-producers-raise-output-2023-11-27/>
- He, A. (2020). The Belt and Road Initiative: Motivations, financing, expansion and challenges of Xi's ever-expanding strategy. *Journal of Infrastructure, Policy and Development*, 4(1), 139. <https://doi.org/10.24294/jipd.v4i1.1180>
- He, A. (2022). *The Digital Silk Road and China's influence on standard setting* (No. CIGI Papers No. 264). Centre for International Governance Innovation.
- Heeks, R., Ospina, A. V., Foster, C., Gao, P., Han, X., Jepson, N., Schindler, S., & Zhou, Q. (2024). China's digital expansion in the Global South: Systematic literature review and future research agenda. *The Information Society*, 40(2), 69–95. <https://doi.org/10.1080/01972243.2024.2315875>
- Hillman, J., & Tippet, A. (2021, July 6). *Who built that? Labor and the Belt and Road Initiative*. Council on Foreign Relations. <https://www.cfr.org/blog/who-built-labor-and-belt-and-road-initiative>
- Hook, G. D. (2022). China's Silk Roads. In L. R. Kurtz (Ed.), *Encyclopedia of violence, peace, & conflict (third edition)* (pp. 562–570). Academic Press. <https://doi.org/10.1016/B978-0-12-820195-4.00117-5>
- Hung, Đ. (2024, December 31). *Dust, vibrations, crop failure due to the impact of stone mining activities*. Lao Dong. <https://news.laodong.vn/xa-hoi/khoi-bui-rung-chan-mat-mua-vi-anh-huong-cua-hoat-dong-khai-thac-da-1443065.lido>
- Idrus, P. G. (2023, March 3). *Workers at Chinese-owned Indonesian nickel plant file complaint over working conditions*. Benar News. <https://www.benarnews.org/english/news/indonesian/indonesia-china-labor-complaint-03032023122641.html>

- Igunza, E. (2023, October 16). *Kenya seeks more Chinese loans at “Belt and Road” forum despite rising public debt*. AP News. <https://apnews.com/article/kenya-china-loans-economy-belt-road-debt-97e352532bf5db3bc40a7370116f4410>
- IndustriALL. (2022a, March 8). *Urgent need to stop mine accidents at Indonesia Morowali Industrial Park*. IndustriALL. <https://www.industrialall-union.org/urgent-need-to-stop-mine-accidents-at-indonesia-morowali-industrial-park>
- IndustriALL. (2022b, March 8). *Urgent need to stop mine accidents at Indonesia Morowali Industrial Park*. IndustriALL. <https://www.industrialall-union.org/urgent-need-to-stop-mine-accidents-at-indonesia-morowali-industrial-park>
- International Iron Metallurgy Association. (2019, November 14). *Direct reduced iron (DRI)*. International Iron Metallurgy Association. <https://www.metallics.org/dri.html>
- Intsel Steel West. (2022, February 14). *Grade guide: ASTM A36 steel*. Intsel Steel West. <https://www.intselsteelwest.com/grade-guide-astm-a36-steel/>
- Investopedia. (2024). *What is equity financing?* Investopedia. <https://www.investopedia.com/terms/e/equityfinancing.asp>
- Jain, P. K., & Sharma, G. (2024). Limestone—A review with special reference to the iron and steel industry. In K. Randive, A. K. Nandi, P. K. Jain, & S. Jawadand (Eds.), *Current trends in mineral-based products and utilization of wastes: Recent studies from India* (pp. 169–176). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-50262-0_13
- Jamasmie, C. (2015, March 27). *Chinese miners keep digging for iron ore despite most losing money*. MINING.COM. <https://www.mining.com/chinese-miners-keep-digging-iron-ore-despite-losing-money>
- Jardine, B., Blake, A., Arnsdorf, I., Kessler, G., Rodriguez, S., Alfaro, M., Tucker, B., Vazquez, M., Somasundaram, P., Diamond, D., Roubein, R., Weber, L., & staff, W. P. (2019, October 16). *Analysis | Why are there anti-China protests in Central Asia?* Washington Post. <https://www.washingtonpost.com/politics/2019/10/16/why-are-there-anti-china-protests-central-asia/>
- Jie, Y., & Wallace, J. (2021, September 12). *What is China’s Belt and Road Initiative (BRI)?* Chatham House. <https://www.chathamhouse.org/2021/09/what-chinas-belt-and-road-initiative-bri>
- Jing, D. (2024, March 25). *BRI in my eyes | Belt and Road Initiative in Kenya*. Belt and Road Portal. <https://eng.yidaiyilu.gov.cn/p/0Q6ETRIH.html>
- Jones, L., & Hameiri, S. (2020). *Debunking the myth of “debt-trap diplomacy”: How recipient countries shape China’s Belt and Road Initiative*. Royal Institute of International Affairs. <https://www.chathamhouse.org/sites/default/files/2020-08-25-debunking-myth-debt-trap-diplomacy-jones-hameiri.pdf>
- Kadi, T. H. E. (2019, June 5). *The promise and peril of the Digital Silk Road*. Chatham House. <https://www.chathamhouse.org/2019/06/promise-and-peril-digital-silk-road>
- Karim, M. F. (2024, November 20). *Indonesia’s economic relationship with China needs a course correction*. East Asia Forum. <https://eastasiaforum.org/2024/11/20/indonesias-economic-relationship-with-china-needs-a-course-correction/>
- Kariuki, D. W., & Kuria, J. M. (2021). Coal-Key energy resource for the future in Kenya? A review. *International Journal of Advanced Research*, 3(1), 72–85. <https://doi.org/10.37284/ijar.3.1.319>
- Kell, F. (2023, May 30). *Kenya’s debt struggles go far deeper than Chinese loans | Chatham House – International Affairs Think Tank*. <https://www.chathamhouse.org/2023/05/kenyas-debt-struggles-go-far-deeper-chinese-loans>
- Kenya Port Authority. (2025, January). *KPA achieves major milestone*. <https://www.kpa.co.ke/Pages/KPA-Achieves-Major-Milestone.aspx>
- Kenya’s Metallic Minerals. (2018, December 23). *Mining & minerals Kenya blog*. <https://miningandmineralskenyablog.wordpress.com/2018/12/23/kenyas-metallic-minerals/>

- Kirui, D. (2019, June 2). *African workers report cases of assault, discrimination by their Chinese supervisors*. The Epoch Times. <https://www.theepochtimes.com/world/african-workers-report-cases-of-assault-by-their-chinese-supervisors-2947560>
- Krishna, S. (2024, November 11). *Significance of Mombasa Port for Chinese outreach in Africa*. Observer Research Foundation. <https://www.orfonline.org/expert-speak/significance-of-mombasa-port-for-chinese-outreach-in-africa>
- Kuo, L. (2016, August 3). *Kenyan rail workers are protesting against their Chinese employer for a raise—To \$5 a day*. Quartz. <https://qz.com/africa/749177/kenyan-rail-workers-are-protesting-against-their-chinese-employer-for-a-raise-to-5-a-day>
- Kuo, L., & Chen, A. (2021a, April 30). *Overseas Chinese workers for Belt and Road projects exposed to risks of forced labour and human trafficking, China Labor Watch finds*. Business & Human Rights Resource Centre. <https://www.business-humanrights.org/en/latest-news/overseas-chinese-workers-for-belt-and-road-projects-exposed-to-risks-of-forced-labour-and-human-trafficking-report-finds/>
- Kuo, L., & Chen, A. (2021b, May 1). *Chinese workers allege forced labor, abuses in Xi's 'Belt and Road' program*. Washington Post. https://www.washingtonpost.com/world/asia_pacific/china-labor-belt-road-covid/2021/04/30/f110e8de-9cd4-11eb-b2f5-7d2f0182750d_story.html
- Liljas, P. E. (2024, April 11). *Cheap coal, cheap workers, Chinese money: Indonesia's nickel success comes at a price*. The Guardian. <https://www.theguardian.com/world/2024/apr/11/cheap-coal-cheap-workers-chinese-money-indonesias-nickel-success-comes-at-a-price>
- Ling, J., Yang, H., Tian, G., Cheng, J., Wang, X., & Yu, X. (2024). *Direct reduction of iron to facilitate net zero emissions in the steel industry: A review of research progress at different scales*. *Journal of Cleaner Production*, 441, 140933. <https://doi.org/10.1016/j.jclepro.2024.140933>
- Mahtani, S., & Huiying, O. (2023, October 12). *China's promise of prosperity brought Laos debt—And distress*. Washington Post. <https://www.washingtonpost.com/world/interactive/2023/laos-debt-china-belt-road/>
- Malay Mail. (2013, July 19). *One killed, 10 injured in Johor quarry blast*. Malay Mail. <https://www.malaymail.com/news/malaysia/2013/07/19/one-killed-10-injured-in-johor-quarry-blast/497371>
- Martorano, B., Iacoella, F., Metzger, L., & Sanfilippo, M. (2021, June 15). *Areas in Africa with more Chinese-backed projects were more likely to experience protests*. The Conversation. <http://theconversation.com/areas-in-africa-with-more-chinese-backed-projects-were-more-likely-to-experience-protests-162137>
- Matelski, M. (2019). *Who's in the driving seat? The interplay between advocacy organisations and local communities resisting coal mining in rural Kenya*. *Third World Quarterly*, 1–17. <https://doi.org/10.1080/01436597.2024.2428334>
- McBride, J., Berman, N., & Chatzky, A. (2023, February 2). *China's massive Belt and Road Initiative*. Council on Foreign Relations. <https://www.cfr.org/backgrounder/chinas-massive-belt-and-road-initiative>
- Michael Musyoka. (2018, August 21). *The truth about SGR toilets meant for Chinese only [PHOTOS]*—Kenyans.co.ke. Kenyans.Co.Ke. https://www.kenyans.co.ke/news/26179-truth-about-sgr-toilets-meant-chinese-only-photos?fb_comment_id=1589433361136656_1589644604448865&page=1
- Mining.com. (2024, June 7). *Brazil adds vale to so-called "dirty list" after contractor subjected workers to slave-like labour*. MINING.COM. <https://www.mining.com/brazil-adds-vale-to-so-called-dirty-list-after-contractor-subjected-workers-to-slave-like-labour/>
- Mishra, A. (2021, June 1). *A Chinese-built port in the Indian Ocean: The story of Kenya's Lamu port*. Observer Research Foundation. <https://www.orfonline.org/expert-speak/a-chinese-built-port-in-the-indian-ocean-the-story-of-kenyas-lamu-port>
- Mishra, R. K. (2020). *The 'Silk Road': Historical perspectives and modern constructions*. *Indian Historical Review*, 47(1), 21–39. <https://doi.org/10.1177/0376983620922431>

- Mkanyika, L. (2019, January 15). *Taita Taveta iron mining firm workers go on strike*. Business Daily. <https://www.businessdailyafrica.comhttps://www.businessdailyafrica.com/bd/corporate/companies/taita-taveta-iron-mining-firm-workers-go-on-strike-2234870>
- Monyae, D., & Chapotera, K. (2023). China's Africa debt trap question: Ethiopia and Kenya infrastructure case studies. In B. Ndzendze & D. Monyae (Eds.), *Perspectives on Africa-China infrastructural and industrial cooperation* (pp. 209–228). Springer International Publishing. https://doi.org/10.1007/978-3-031-38395-3_12
- Moraes, C. (2022, February 1). *CCCC completes construction of New Kipevu oil terminal in Mombasa, Kenya* | ConstructAfrica. <https://constructafrica.com/news/cccc-completes-construction-new-kipevu-oil-terminal-mombasa-kenya>
- Moses, O., Gormley, L., & Springer, C. (2022). *China's paid-in capital: Identifying and analyzing China's overseas development investment funds*. Working Paper No. 025; Boston University Global Development Policy Center. https://www.bu.edu/gdp/files/2022/11/GCI_WP_025_ODIF_FIN.pdf
- Muchira, N. (2022, April 29). *China pushes for implementation of Tanzania's Bagamoyo Port*. The Maritime Executive. <https://maritime-executive.com/article/china-pushing-for-implementation-of-tanzania-s-bagamoyo-port>
- Murphy, L., Salcito, K., Uluyol, Y., & Rabkin, M. (2022). *Driving force: Automotive supply chains and forced labor in the Uyghur region*. Sheffield Hallam University. <https://www.shu.ac.uk/-/media/home/research/helena-kennedy-centre/projects/driving-force/driving-force-auto-supply-chains-and-ufl-apr23.pdf>
- Mutembei, P. K., Naftali, T. M., & Jackson, W. M. (2014). Iron enrichment in laterites soils from selected regions in Kenya using magnetic separation. *IOSR Journal of Engineering*, 4(3), 42–48. <https://doi.org/10.9790/3021-04364248>
- Mwakio, P. (2015, March 12). *Standard digital news - Kenya: Standard Gauge Railway workers down their tools over poor pay*. The Standard. <https://web.archive.org/web/20150312155325/https://www.standardmedia.co.ke/article/2000150057/standard-gauge-railway-workers-down-their-tools-over-poor-pay>
- MySteel. (2023, September 20). *Indonesia Dexin Steel Phase I expansion project completed*. <https://english.chinaisa.org.cn/do/cn.org.chinaisa.view.Column.d?column=9&article=34416>
- Naoum, K. de, & Conniff, M. (2023, November 12). *All about high-carbon steel*. Xometry. <https://www.xometry.com/resources/materials/high-carbon-steel/>
- Ni, S., & Singh, S. (2024, January 19). *Belt and Road Initiative: Steel demand from key countries echoes surge in Chinese exports*. S&P Global Commodity Insights. <https://www.spglobal.com/commodityinsights/en/market-insights/blogs/metals/011924-bri-steel-demand-from-key-countries-echoes-surge-in-chinese-exports>
- Njumwa, J. Z., Nyame, F. K., Ofori, B. D., Ibrahim, K., & Makindi, S. M. (2024). On the margins of the mining economy: Occupational health and safety in artisanal scale gemstone mining in the Mwatate-Voi area, Taita Taveta County, Kenya. *East African Journal of Environment and Natural Resources*, 7(2), 99–116. <https://doi.org/10.37284/eajenr.7.2.2404>
- Nolan, J., & Leutert, W. (2020, October). *Signing up or standing aside: Disaggregating participation in China's Belt and Road Initiative*. Brookings. <https://www.brookings.edu/articles/signing-up-or-standing-aside-disaggregating-participation-in-chinas-belt-and-road-initiative/>
- Octal Steel. (2024). *ASTM A283 Grade C and D steel plate specification—Octal steel*. <https://www.octalmetals.com/astm-a283-grade-c-d-plate/>
- Olander, E. (2023, May 29). *The Kenyan government apparently is unaware China doesn't finance railways in Africa anymore*. The China-Global South Project. <https://chinaglobalsouth.com/2023/05/29/the-kenyan-government-apparently-is-unaware-china-doesnt-finance-railways-in-africa-anymore/>

- Osava, M. (2020, March 5). *Slavery modernises, adapts to stay alive in Brazil*. Inter Press Service. <https://web.archive.org/web/20200306092308/http://www.ipsnews.net/2020/03/slavery-modernises-adapts-stay-alive-brazil/>
- Paendong, M. W. (2020, December 8). *Indonesia: Jakarta-Bandung rail project criticized for failing to account for social impacts*. Business & Human Rights Resource Centre. <https://www.business-humanrights.org/en/latest-news/indonesia-jakarta-bandung-rail-project-criticized-for-failing-to-account-for-social-impacts/>
- Pant, H. V., Saha, P., & Observer Research Foundation (Eds.). (2021). *Mapping the Belt and Road Initiative: Reach, implications, consequences*. Observer Research Foundation.
- Pistilli, M. (2024, November 4). *Top 10 iron ore-producing countries (updated 2024)*. https://investingnews.com/daily/resource-investing/base-metals-investing/iron-investing/top-iron-producing-countries/?utm_source=nasdaq&utm_medium=syndication
- Portland Bolt. (2024). *ASTM A706*. <https://www.portlandbolt.com/technical/specifications/astm-a706/>
- Prasetyo, W. A. (2023, January 21). *Proses Pengelasan Rel Kereta Cepat Jakarta-Bandung Sepanjang 500 Meter Selesai*. Republika Online. <https://republika.co.id/berita/rot9tt467/proses-pengelasan-rel-kereta-cepat-jakarta-bandung-sepanjang-500-meter-selesai>
- Prince, S., C.deBaca, L., & Thatcher, C. (2020, October). *Design for freedom*. https://www.designforfreedom.org/wp-content/uploads/2020/10/DesignforFreedom_FullReport_L.pdf
- Quiroz, D., Stravens, M., French, L., Xhali, M., Hatting, S., & Rajeevan, C. (2024). *The South African mining sector—Labor rights in transition*. CNV International. https://www.cnvinternationaal.nl/_Resources/Persistent/f/0/3/2/f0320c5e206d7a12eb6b554728faad69d660390c/CNVI-0442%20The%20South%20African%20Mining%20Sector%20-%20Labour%20rights%20in%20transition%20mineral%20mining%20Profundo%20DEF.pdf
- Reuters. (2011, May 4). *Kenya's Mombasa port 2010 cargo volume up 12 pct*. Reuters. <https://www.reuters.com/article/business/finance/kenyas-mombasa-port-2010-cargo-volume-up-12-pct-idUSJOE7430G2/>
- Reuters. (2018, September 13). *China's CCCC wins \$398 million contract to build Mombasa oil terminal*. Reuters. <https://www.reuters.com/article/business/chinas-cccc-wins-398-million-contract-to-build-mombasa-oil-terminal-idUSKCNILT2OX/>
- Reuters. (2021, April 11). *Xinjiang coalmine accident traps 21—China state media*. Reuters. <https://www.reuters.com/world/china/21-miners-trapped-after-xinjiang-coal-mine-accident-china-daily-2021-04-11/>
- Reuters. (2023, February 24). *China coal mine death toll rises to six, 47 missing*. Reuters. <https://www.reuters.com/world/china/china-coal-mine-death-toll-six-47-missing-rescue-resumes-2023-02-24/>
- RFP Pipes and Fittings. (2024). *Exploring the properties and uses of ASTM A516 Gr. 70 plate*. <https://www.hicplates.com/blog/exploring-the-properties-and-uses-of-astm-a516-gr-70-plate/>
- Rochani, S., & Anugrah, R. I. (2008). *The current status of iron minerals in Indonesia*. *Indonesian Mining Journal*, 11(2), 1–17.
- Roy, D. (2025, January 10). *China's growing influence in Latin America | Council on Foreign Relations*. Council on Foreign Relations. <https://www.cfr.org/background/china-influence-latin-america-argentina-brazil-venezuela-security-energy-bri>
- Rozanskij, V. (2021, March 12). *Tajik workers revolt against Chinese “slave owners.”* PIME Asia News. <https://www.asianews.it/news-en/Tajik-workers-revolt-against-Chinese-'slave-owners'-52581.html>
- Russell, C. (2024, February 22). *Metallurgical coal is the commodity world's quiet performer*. Reuters. <https://www.reuters.com/markets/commodities/metallurgical-coal-is-commodity-worlds-quiet-performer-russell-2024-02-22/>

- Schulz, D. (2021, April 7). *CPC | Anti-China protests held in several Kazakhstani cities*. Caspian Policy Center. <https://www.caspianpolicy.org/research/energy-and-economy-program-eep/anti-china-protests-held-in-several-kazakhstani-cities>
- ScienceDirect. (2024). *Direct-reduced iron—An overview*. ScienceDirect Topics. <https://www.sciencedirect.com/topics/engineering/direct-reduced-iron>
- ScienceDirect Topics. (2025). *Carbon steel—An overview*. <https://www.sciencedirect.com/topics/engineering/carbon-steel>
- Seah, S., Lin, J., Martinus, M., Fong, K., Aridati, I., Thao, P. T. P., & Chee, D. (2024). *The state of Southeast Asia: 2024 survey report*. ISEAS - Yusof Ishak Institute. <https://www.iseas.edu.sg/centres/asean-studies-centre/state-of-southeast-asia-survey/the-state-of-southeast-asia-2024-survey-report/>
- Seetharaman, S. (Ed.). (2013). *Treatise on process metallurgy, volume 3: Industrial processes*. <https://shop.elsevier.com/books/treatise-on-process-metallurgy-volume-3-industrial-processes/seetharaman/978-0-08-096988-6>
- SGS Mineral Services. (2013). *Coal ash*. <https://www.sgs.com/-/media/sgscorp/documents/corporate/brochures/sgs-min-wa294-coal-ash-en-11.cdn.en.pdf>
- Sheffield Hallam University. (2022). *Steel sector forced labour* [Text/html]. Automotive Supply Chains and Forced Labor in the Uyghur Region. <https://www.shuforcedlabour.org>
- Sheffield Hallam University. (2023). *Products made with forced labor in the Uyghur region* (No. Issue Brief 3). Sheffield Hallam University.
- Smith Group. (2024). *Steel's vital role in water infrastructure projects*. <https://smithgroup.ae/f/steels-vital-role-in-water-infrastructure-projects>
- Soy, A. (2023, October 13). *China's Belt and Road Initiative: Kenya and a railway to nowhere*. <https://www.bbc.com/news/world-africa-67101736>
- S&P Global. (2024, January 26). *Daily update: January 26, 2024*. S&P Global. <https://www.spglobal.com/en/research-insights/articles/daily-update-january-26-2024>
- Srinath Viswanathan, Apelian, D., Donahue, R. J., DasGupta, B., Gwyn, M., Jorstad, J. L., Monroe, R. W., Sahoo, M., Prucha, T. E., & Twarog, D. (2008). *ASM handbook. 15: Casting*. ASM International.
- Subari, W. A. (2021, September 30). *Kisah Pengangkutan Rel Baja Kereta Cepat Jakarta-Bandung dari Tiongkok*. <https://mediaindonesia.com/ekonomi/436616/kisah-pengangkutan-rel-baja-kereta-cepat-jakarta-bandung-dari-tiongkok>
- Sultan, M., Setyadi, D., Ramdan, I. M., & Haviluddin, I. (2024). Preventing practices of manipulating accident data in the coal mining sector using mobile applications in East Kalimantan, Indonesia. *Journal of Health Science and Medical Research*, 20241075. <https://doi.org/10.31584/jhsmr.20241075>
- Swastika, A. B., & Hasan, K. (2024). *Indonesia iron and steel's full potential hinges on low-carbon technologies*. Centre for Research on Energy and Clean Air. https://energyandcleanair.org/wp/wp-content/uploads/2024/12/EN-Report_CREA_Indonesia-iron-and-steels-full-potential-hinges-on-low-carbon-technologies.pdf
- Syarif, A. (2023, December 9). *Belt and Road Initiative's new approach and what it means for Chinese investments in Indonesia*. The Conversation. <http://theconversation.com/belt-and-road-initiatives-new-approach-and-what-it-means-for-chinese-investments-in-indonesia-218438>
- Tan, S. L. (2024, July 31). *China's evolving Belt and Road Initiative in Southeast Asia*. IISS. <https://www.iiss.org/online-analysis/online-analysis/2024/07/chinas-evolving-belt-and-road-initiative-in-southeast-asia/>
- Taylor, I. (2020). *Kenya's new lunatic express: The Standard Gauge Railway*. *African Studies Quarterly*, 19(3–4).
- The Citizen. (2021, April 5). *Kenya's standard railway project stalls over strike*. The Citizen. <https://www.thecitizen.co.tz/tanzania/news/africa/kenya-s-standard-railway-project-stalls-over-strike-2521782>

- The East African. (2015, January 31). *Tax threat to SGR as Chinese contractor rejects local cement, steel*. The East African. <https://www.theeastafrican.co.ke/tea/news/east-africa/tax-threat-to-sgr-as-chinese-contractor-rejects-local-cement-steel-1332174>
- The State Council Information Office of the People's Republic of China. (2023, October 10). *The Belt and Road Initiative: A key pillar of the global community of shared future*. The State Council Information Office of the People's Republic of China. http://www.scio.gov.cn/zfbps/zfbps_2279/202310/t20231010_773734.html
- Three D Metals. (2022, December 21). The benefits of using carbon steel in construction. *Three D Metals*. <https://threedmetals.com/blog/the-benefits-of-using-carbon-steel-in-construction/>
- Tian, J., Wang, Y., & Gao, S. (2022). Analysis of mining-related injuries in Chinese coal mines and related risk factors: A statistical research study based on a meta-analysis. *International Journal of Environmental Research and Public Health*, 19(23), 16249. <https://doi.org/10.3390/ijerph192316249>
- Tran, H. (2024, April 9). Breaking down Janet Yellen's comments on Chinese overcapacity. *Atlantic Council*. <https://www.atlanticcouncil.org/blogs/econographics/sinographs/breaking-down-janet-yellens-comments-on-chinese-overcapacity/>
- United States Department of Labor. (2024). *2024 list of goods produced by child labor or forced labor* (p. 116). United States Department of Labor. https://www.dol.gov/sites/dolgov/files/ilab/child_labor_reports/tda2023/2024-tvpra-list-of-goods.pdf
- United States Department of State. (2022). *Human rights report 2021—China*. <https://2017-2021.state.gov/report/custom/3756d296dd/>
- U.S. Department of Commerce. (2018, February 16). *Section 232 investigation on the effect of imports of steel on U.S. national security*. <https://www.commerce.gov/issues/trade-enforcement/section-232-steel>
- U.S. Department of Homeland Security. (2025). *UFLPA entity list*. U.S. Department of Homeland Security. <https://www.dhs.gov/uflpa-entity-list>
- U.S. Energy Information Administration (EIA). (2025). *Glossary*. <https://www.eia.gov/tools/glossary/index.php>
- U.S. Geological Survey. (2024). *Iron ore—Mineral commodity summaries 2024*. <https://pubs.usgs.gov/periodicals/mcs2024/mcs2024-iron-ore.pdf>
- U.S. State Department, Office to Monitor and Combat Trafficking in Persons. (2022). *Forced labor: The hidden cost of China's Belt and Road Initiative*.
- Utama, A. (2024). *China's global footprint | Fear, hope, disappointment linked to Indonesia-China rail project*. Voice of America. <https://projects.voanews.com/china/global-footprint/english/projects/infrastructure/transportation/fear-hope-disappointment-linked-to-indonesia-china-rail-project.html>
- Vallejo, M. C., Espinosa, B., Venes, F., López, V., & Anda, S. (2018). *Evading sustainable development standards: Case studies on hydroelectric projects in Ecuador* (No. GEGI Working Paper 019). Boston University Global Development Policy Center.
- VietNamNet Bridge. (2011, May 4). *Police charge owners of quarry after 18 die*. VietnamNet Global. <https://vietnamnet.vn/en/police-charge-owners-of-quarry-after-18-die-E6473.html>
- Wafula, P. (2018, July 7). *Revealed: SGR workers treated badly by Chinese masters*. The Standard. <http://www.standardmedia.co.ke/article/2001287179/revealed-sgr-workers-treated-badly-by-chinese-masters>
- Wang, C. N. (2023, August 1). *China Belt and Road Initiative (BRI) investment report 2023 H1 – Green Finance & Development Center*. <https://greenfdc.org/china-belt-and-road-initiative-bri-investment-report-2023-h1/>
- Wang, C. N. (2024, February 5). *China Belt and Road Initiative (BRI) investment report 2023 – Green Finance & Development Center*. <https://greenfdc.org/china-belt-and-road-initiative-bri-investment-report-2023/>

- Wanyonyi, M. K. (2018). *Implications of coal mining on environmental rights of local communities in the Mui Basin, Kitui County – Kenya* [Thesis, University of Nairobi]. <http://erepository.uonbi.ac.ke/handle/11295/104932>
- Weber, G., Cabras, I., Peredo, A. M., Yanguas-Parra, P., & Prime, K. S. (2023). Exploring resilience in public services within marginalised communities during COVID-19: The case of coal mining regions in Colombia. *Journal of Cleaner Production*, 415, 137880. <https://doi.org/10.1016/j.jclepro.2023.137880>
- Weng, L., Xue, L., Sayer, J., Riggs, R. A., Langston, J. D., & Boedhihartono, A. K. (2021). Challenges faced by Chinese firms implementing the ‘Belt and Road Initiative’: Evidence from three railway projects. *Research in Globalization*, 3, 100074. <https://doi.org/10.1016/j.resglo.2021.100074>
- Werner, T. T., Toumbourou, T., Maus, V., Lukas, M. C., Sonter, L. J., Muhdar, M., Runting, R. K., & Bebbington, A. (2024). Patterns of infringement, risk, and impact driven by coal mining permits in Indonesia. *Ambio*, 53(2), 242–256. <https://doi.org/10.1007/s13280-023-01944-y>
- Willy, M., & Elmawi, O. (2021, August 13). *Kitui coal mining project is a disaster in the making—The elephant*. <https://www.theelephant.info/analysis/2021/08/13/kitui-coal-mining-project-is-a-disaster-in-the-making/>
- Wilson-Andoh, P. (2022, May 18). *China’s Belt and Road Initiative in Kenya—Foreign Policy Research Institute*. <https://www.fpri.org/article/2022/05/chinas-belt-and-road-initiative-in-kenya/>
- Wissenbach, U., & Wang, Y. (2017). *African politics meets Chinese engineers: The Chinese-built Standard Gauge Railway Project in Kenya and East Africa* (No. 2017/13). China Africa Research Initiative (CARI), School of Advanced International Studies (SAIS), Johns Hopkins University.
- World Bank. (2019). *Belt and Road economics: Opportunities and risks of transport corridors*. World Bank. <https://www.worldbank.org/en/topic/regional-integration/publication/belt-and-road-economics-opportunities-and-risks-of-transport-corridors>
- World Bank. (2024). *The World Bank in Indonesia* [Text/HTML]. World Bank. <https://www.worldbank.org/en/country/indonesia/overview>
- World Steel Association. (2025, January 24). December 2024 crude steel production and 2024 global crude steel production totals. *World Steel.Org*. <https://WorldSteel.org/media/press-releases/2025/december-2024-crude-steel-production-and-2024-global-totals/>
- World Steel Association. (2024a). Steel in transport. *World Steel.Org*. <https://WorldSteel.org/steel-topics/steel-in-transport/>
- World Steel Association. (2024b). *World Steel in figures 2024*. <https://WorldSteel.org/data/world-steel-in-figures-2024/>
- Xinhua. (2016, August 17). *NW China limestone mine fire kills 12 -*. Xinhua. http://www.xinhuanet.com/english/2016-08/17/c_135606505.htm
- Xinhua News Agency. (n.d.). *23 rescued, 2 remain missing in NE China iron-mine blast*. Retrieved January 14, 2025, from http://www.xinhuanet.com/english/2018-06/06/c_137233813.htm
- Xinhua News Agency. (2017, October 24). *“Belt and Road” incorporated into CPC Constitution—Xinhua*. Xinhua News Agency. http://www.xinhuanet.com/english/2017-10/24/c_136702025.htm
- Xu, M. (2023, February 24). China’s coal mine accidents rise amid push for higher production. *Reuters*. <https://www.reuters.com/markets/commodities/chinas-coal-mine-accidents-rise-amid-push-higher-production-2023-02-24/>
- YENA Engineering. (2021, April 13). Steel pipes: Everything you need to know. *YENA Engineering*. <https://yenaengineering.nl/steel-pipes-everything-you-need-to-know/>
- Yeung, C. (2024, March 19). *China’s Belt and Road: The transition to small and beautiful*. Asia Pacific Foundation of Canada. <https://www.asiapacific.ca/publication/china-belt-and-road-initiative-10-years-later>
- Yuniar, R. W. (2022a, December 20). *Two Chinese workers killed and four others injured due to derailment during construction of the Jakarta-Bandung high-speed railway*. Business & Human Rights Resource Centre. <https://www.business-humanrights.org/en/latest-news/two-chinese-workers-killed-and->

- four-others-injured-due-to-derailment-during-construction-of-the-jakarta-bandung-high-speed-railway/
- Yuniar, R. W. (2022b, December 20). *Worker deaths revive safety concerns in Indonesia's China-backed rail project*. South China Morning Post. <https://www.scmp.com/week-asia/politics/article/3203975/chinese-worker-deaths-indonesia-rail-site-raise-fresh-safety-concerns-belt-and-road-project>
- Yuniar, R. W. (2023a, March 3). Chinese workers 'suffering' in Indonesia's nickel factories, complaint says. *South China Morning Post*. <https://www.scmp.com/week-asia/people/article/3212109/indonesias-nickel-sector-under-scrutiny-chinese-workers-allege-inhumane-working-conditions>
- Yuniar, R. W. (2023b, March 3). Indonesia's nickel sector under scrutiny as Chinese workers allege inhumane working conditions. *South China Morning Post*. <https://www.scmp.com/week-asia/people/article/3212109/indonesias-nickel-sector-under-scrutiny-chinese-workers-allege-inhumane-working-conditions>
- Yunxiao, X. (2023, October 23). *China Minmetals Corporation strives for high-quality collaboration results under the BRI*. State-Owned Assets Supervision and Administration Commission of the State Council. http://en.sasac.gov.cn/2023/10/23/c_16101.htm
- Yusuf, S. D., Omojorla, V., Umar, I., & Loko, A. Z. (2023). Implementation of a 220v AC overload and high voltage monitor alert system with auto shut down. *International Journal of Engineering and Modern Technology*, 8(5), 32–40. <https://doi.org/10.56201/ijssmr.v8.no1.2022.pg32.40>
- Zhang, J. (2024). *What is the future of China's Belt and Road Initiative?* (GIS Reports). Geopolitical Intelligence Services. <https://www.gisreportsonline.com/r/what-is-the-future-of-chinas-belt-and-road-initiative/>

APPENDIX 2: HS CODES

Product	HS code	HS definition
Iron and steel	72	Iron and steel
	7201	Pig iron and spiegeleisen in pigs, blocks, or other primary forms
	7202	Ferro-alloys
	7203	Ferrous products obtained by direct reduction of iron ore and other spongy ferrous products, in lumps, pellets, or similar forms; iron having a minimum purity by weight of 99.94%, in lumps, pellets, or similar form
	7204	Ferrous waste and scrap; remelting scrap ingots of iron or steel.
	7205	Granules and powders, of pig iron, spiegeleisen, iron or steel
	7206	Iron and nonalloy steel in ingots or other primary forms (excluding iron of heading 7203)
	7207	Semifinished products of iron or nonalloy steel
	7208	Flat-rolled products of iron or nonalloy steel, of a width of 600 mm or more, hot-rolled, not clad, plated or coated
	7209	Flat-rolled products of iron or nonalloy steel, of a width of 600 mm or more, cold-rolled (cold-reduced), not clad, plated or coated
	7210	Flat-rolled products of iron or nonalloy steel, of a width of 600 mm or more, clad, plated or coated
	7211	Flat-rolled products of iron or nonalloy steel, of a width of less than 600 mm, not clad, plated or coated
	7212	Flat-rolled products of iron or nonalloy steel, of a width of less than 600 mm, clad, plated or coated
	7213	Bars and rods, hot-rolled, in irregularly wound coils, of iron or nonalloy steel
	7214	Other bars and rods of iron or nonalloy steel, not further worked than forged, hot-rolled, hot-drawn or hot-extruded, but including those twisted after rolling
	7215	Other bars and rods of iron or nonalloy steel
	7216	Angles, shapes and sections of iron or nonalloy steel
	7217	Wire of iron or nonalloy steel
	7229	Wire of other alloy steel
Iron and steel	73	Articles of iron and steel
Railway rails	7302	Railway or tramway track construction material of iron or steel, the following: rails, check-rails and rack rails, switch blades, crossing frogs, point rods and other crossing pieces, sleepers (cross-ties), fish-plates, chairs, chair wedges, sole plates (base plates), rail clips, bedplates, ties and other material specialized for jointing or fixing rails

Notes on HS mapping: Carbon steel is the most basic form of steel, an iron alloy in which carbon is the main alloying element (typically 0.3–2% carbon by weight); it is distinguished from specialty steels like stainless steel by having minimal amounts of other elements besides iron and carbon. Exhaustively,

carbon steel and carbon steel articles are included under HS headings 72 and 73; globally, a majority of carbon steel is classified under one of the 12 4-digit level HS codes (7206–7217). Construction projects, like those in this study, tend to use long steel products, typically produced by rollers that are long and linear, and typically come in the form of bars, rods, rails beams, and angles. These carbon steel products are typically used in construction (e.g., rebar or structural steel beams and columns), railroad tracks, manufacturing, or energy (e.g., wind turbines). Specific product definitions and HS mapping can vary. Based on available data, this study used industry norms to track carbon steel in BRI projects.

APPENDIX 3: GLOBAL EXPORTERS

Top 10 Global Exporters of Iron and Steel, 2021–2023

Exporting country	Annual exports, by value (FOB USD)			Percentage of global exports		
	2021	2022	2023	2021	2022	2023
China	\$ 65,008,616,725	\$ 74,003,010,403	\$ 68,987,773,121	12	14	15
Germany	\$ 32,859,189,385	\$ 37,771,894,420	\$ 32,753,903,930	6	7	7
Japan	\$ 34,633,393,241	\$ 35,033,221,109	\$ 30,543,539,511	6	7	7
Indonesia	\$ 20,943,799,989	\$ 27,823,548,257	\$ 26,704,566,922	4	5	6
South Korea	\$ 27,930,508,045	\$ 28,108,455,687	\$ 25,725,964,625	5	5	6
Belgium	\$ 21,834,896,236	\$ 25,337,816,762	\$ 21,013,175,229	4	5	5
United States	\$ 18,690,722,288	\$ 21,114,737,606	\$ 20,501,178,331	3	4	5
Italy	\$ 19,159,302,986	\$ 21,153,125,575	\$ 17,055,049,018	4	4	4
Netherlands	\$ 18,848,976,264	\$ 20,323,658,509	\$ 16,401,432,908	4	4	4
France	\$ 18,065,295,155	\$ 19,135,504,496	\$ 15,685,730,474	3	4	3

Source: UN Comtrade, 2024 (HS 72)

Top 10 Global Exporters of Articles of Steel or Iron, 2021–2023

Exporting country	Annual exports			Percentage of global exports		
	2021	2022	2023	2021	2022	2023
China	\$ 92,706,259,106	\$ 106,708,800,508	\$ 97,165,851,241	26	28	26
Germany	\$ 34,083,307,693	\$ 34,735,789,666	\$ 37,084,894,719	10	9	10
United States	\$ 19,337,998,922	\$ 22,087,223,149	\$ 22,758,043,823	5	6	6
Italy	\$ 21,473,830,088	\$ 22,827,758,836	\$ 22,518,623,600	6	6	6
Poland	\$ 11,209,929,472	\$ 12,102,685,305	\$ 12,088,879,119	3	3	3
Spain	\$ 9,318,800,354	\$ 10,580,761,696	\$ 11,162,382,607	3	3	3
South Korea	\$ 9,797,999,319	\$ 11,787,099,162	\$ 10,878,993,296	3	3	3
Netherlands	\$ 10,362,272,777	\$ 10,687,637,585	\$ 10,781,989,934	3	3	3
Türkiye	\$ 8,801,101,050	\$ 10,533,234,364	\$ 10,051,285,088	2	3	3
Mexico	\$ 8,101,296,964	\$ 10,067,593,551	\$ 9,865,913,419	2	3	3

Source: UN Comtrade, 2024 (HS 73)

APPENDIX 4: FINAL RESEARCH INSTRUMENTS

INTERVIEWER CERTIFICATION OF RESPONDENT CONSENT

READ THE FOLLOWING STATEMENTS TO THE RESPONDENT AND ANSWER ANY QUESTIONS THE INDIVIDUAL MAY HAVE. DO NOT BEGIN THE INTERVIEW UNTIL ALL QUESTIONS HAVE BEEN ADDRESSED AND THE INDIVIDUAL HAS AGREED TO PARTICIPATE IN THE STUDY.

Hello, my name is [ICF team member name]. I am a researcher from ICF, a private research and consulting company. I am talking with people about labor conditions in the global supply chain of carbon steel projects used or likely to be used in large infrastructure projects funded through China's BRI program. These conversations are designed to inform an analytical report that I and my team are putting together on this topic.

Confidentiality:

Your confidentiality and privacy will be protected throughout the research process. Interview notes from this conversation will be anonymized, stored securely, and will only be accessed by our research team.

Attribution:

In general, any information drawn from our conversation that we decide to include in our report will either be included without attribution or attributed using a general moniker (e.g., "steel industry expert").

If there are particular quotes or data points for which we believe it would be useful to provide direct attribution, we will contact you to ask for your consent.

No matter your choice, the above data storage practices apply.

Voluntary Participation:

Your participation in this study is voluntary. If you choose to talk with me, you can choose not to answer some questions or end the interview at any time.

The interview will take about 30-45 minutes.

I will answer any questions that you have about the study before we begin. Do you have any questions about the study? If you have any questions in the future, or if you later change your mind and do not want us to include the information you provided in our study, you may contact me at mack.eason@icf.com.

Do you agree to participate in this interview?

Interviewer Certification of Consent

My signature affirms that I have read the verbal informed assent statement to the respondent. I have answered any questions asked about the study, and the respondent has agreed to be interviewed.

___ Respondent agreed to be interviewed

___ Respondent did not agree to be interviewed

Print Interviewer's Name _____

Interviewer's Signature/Thumbprint _____

Date _____

I would like to ask your permission to record this interview. The recordings will be kept safely and not shared, before being transcribed and then destroyed. The transcribed notes will not contain any names or information that will identify you. May I record the interview to **facilitate my recollection**? (If yes, switch on the recorder).

___ YES

___ NO

Key Informant Interview Unique ID Number: _____

BRI KEY INFORMANT INTERVIEW PROTOCOL

Interviewer instructions:

Foster a dynamic conducive to gathering good data. The interview should have the relaxed feel of a conversation. Set the tone by using a slow pace in your speech.

Ask one question at a time. Give the respondent ample time to reflect and fully respond before moving to the next. Try not to interrupt, and don't answer on their behalf.

If the respondent agrees to be recorded, give them your full attention. Make note of any follow-up questions you want to remember to ask, but otherwise focus on the respondent rather than your paper.

Probe for more depth, particularly when responses are brief. Use phrases such as, "Tell me more about that" and "Can you give me an example?" Aim to get specific instances, in considerable detail, whenever possible.

You do not have to ask each question verbatim, but at least broach all the topics covered that are relevant to the key informant. If a respondent makes clear they have no knowledge of that topic, move on to the next. Adapt the flow and questions to make them relevant to the respondent.

For each item, ask the general question first, and then probe the sub-items that have not been addressed spontaneously.

Introduction Questions (KIs):

- Could you please tell me your role and what you focus on?
 - Is there other experience you have in the steel industry?
- Can you describe your organization's work directly in the steel industry?
 - PROBE FOR WHAT KIND OF ACTIVITIES IN THIS AREA DO YOU AND YOUR ORGANIZATION UNDERTAKE?

Supply Chain Theme General:

- Could you please tell how steel sector works in Kenya/Indonesia/China?
 - What laws and regulations are central to operations in the steel industry?
- How important is the steel industry to Kenya/Indonesia/China
 - How important is the artisanal sector compared to the larger-scale sector?
 - What has/have been the most significant change(s) to the industry in the last few years? Please explain.
- Have there been any recent socio-political events that have impacted the supply chain? Please explain.
 - How have they impacted your company?
- Who are the major stakeholders and influencers in the steel industry?

Production:

- Could you please describe the production process of steel from the beginning to the end? Where does your company become involved in that process?
 - How are these goods transported from one location to the next? How does your company transport / receive the good?
- After smelting, what processing occurs in Kenya/Indonesia?

- What about specifically in Kenya/Indonesia? Where are the main processing areas (PROBE FOR GEOGRAPHY)?
- What goods (including bi-products and downstream goods) are produced in-country?
- Of these, which are the most common (or produced)?
- Are these consumed domestically or for export? Please explain.
- Is there a list of production sites or processing facilities in Kenya/Indonesia? How would we be able to access it?
 - Probe if participant is willing to share the information of who to contact to get access.
 - Do you have a list of production sites that are a part of your supply chain? Tell me more about how that list is updated / maintained?
 - Do you have a list of production sites or processing facilities that you sell to? Tell me more about how that list is updated / maintained.

Tracing and Due Diligence:

- What types of products does steel from China/Kenya/Indonesia end up in? (PROBE FOR BOTH INTERMEDIARY GOODS AND FINISHED/END GOODS)? (IF APPLICABLE: Which of those goods does your company make?)
- How might one track steel made at a particular point through the domestic supply chain?
 - Could you walk us through how your company does this?
 - Is there a point in the supply chain where you anticipate tracking would no longer be possible? (probe for specifics on what stakeholder the traceability ends with, ex: intermediary buyer, exporter, etc.)
 - (SPECIFIC PROBE) When does the mixing of steel from different sites occur, how does mixing occur?
- What oversight is being conducted by the government when it comes to labor standards within the steel industry and its supply chain. How does this impact your company?
 - PROBE FOR SPECIFICS ON WHAT THE INITIATIVES ARE AND WHO IS PROMOTING THEM (E.G. GOVERNMENT, INTERNATIONAL CORPORATIONS, DOMESTIC COMPANIES))
 - What about any supply chain traceability initiatives specifically? Please explain the stakeholders involved, including your own company.
 - What are the different certifications available for companies in the supply chain and how common are they?
 - How are these certifications monitored / approved and is your company a part of any of them? If so, please explain how you got approved and how you are monitored for compliance.
- What due diligence initiatives does your company participate in to monitor labor conditions on the (site type) you source from?
 - (IF NOT ANSWERED IN PREVIOUS QUESTION) What supply chain or industry certifications does your company current have? Can you please explain the process involved in obtaining the certification(s) and how you are monitored for compliance?
 - Are you actively working to obtain any additional certifications in the near future? Please tell me more about that.

Sourcing Questions for Buyers

- Where do you source your steel from?
 - PROBE (geographical region, names of sites, etc.) PROBE SPECIFICALLY FOR SAMPLE AREA
 - Please explain your sourcing process (buying method, transportation process, etc.)

- Do you keep the steel you buy from each source separate and at what point do you combine steel from multiple sources? Please explain.
- How often do you source steel from these places?
 - Are there times of the year when this changes? Please explain.
 - How do you determine how much you buy from a source?
- (IF NOT COVERED PREVIOUSLY) Who are your primary buyers domestic and/or international of (downstream good)?
 - PROBE (regions, companies, countries, specific industry)

Post Export Questions

- How would you describe the role of steel exports from Kenya/Indonesia in the global trade of steel?
 - What are some international markets?
 - Are there any recent changes (emerging/declining) in these markets? (PROBE FOR COUNTRIES AND/OR COMPANIES)
- Who are the major players / stakeholders in Kenya/Indonesia that import steel from China? Please explain.
 - Who are the major exporters and importers involved in this? Can you describe in what product form the good is exported to Kenya/Indonesia?
 - Are you aware of situations where the importing company in Kenya/Indonesia is formally connected to the exporter in China? (PROBE FOR CONTRACTS, OWNERSHIP, PART OF SAME LARGER COMPANY, ETC)
- Do BRI projects in Kenya/Indonesia produce steel domestically?
 - How have changes in domestic production impacted/changed imports of steel?
 - At what stage do steel imports become mixed with domestically produced steel?
- Does the downstream use of steel imported from China differ from the downstream use of domestically produced steel?

Labor Questions

- What is your overall impression of working conditions in the steel industry?
 - What are the main issues you are aware of? (PROBE FOR FORCED LABOR IF NOT STATED)
- What can you tell us about labor standards in the steel industry, especially when it comes to harvest/extraction sites?
 - What are the primary concerns across the industry when it comes to labor standards?
 - How are labor standards enforced at your workplace and who enforces them?
- During which stages of the steel supply chain are risks for (forced labor) most prevalent?
 - What are the risk factors at each stage?

Conclusion:

- Could you suggest any organizations or individuals that are well informed about the steel supply chain or BRI projects in the industry that we could interview?
 - (IF APPLICABLE BASED ON RESPONDENT TYPE: PROBE IF THE INDIVIDUAL HAS ANY ADDITIONAL REPORTS OR DATA THEY ARE ABLE TO SHARE SUCH AS ANY LISTS MENTIONED IN QUESTION 9)
- Is there anything else you'd like to add?