Railway construction in Africa: material and carbon footprints across global supply chains

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Large-scale railway construction has in recent years been promoted as a key element of development strategies across Africa, most notably through the African Unionâ€™s Agenda 2063 and the proposed African Integrated High-Speed Rail Network (AIHSRN). While rail transport is often considered low-carbon in operation, far less is known about the environmental and economic implications of railway construction itself, particularly when upstream supply chains are considered at national and international scales. This knowledge gap limits the ability of policymakers to assess the full resource and emissions impacts of transport infrastructure investment and its interaction with trade and industrial development. The primary research question addressed in this paper is: How can railway construction be explicitly represented in African multi-regional inputâ€“output (MRIO) models, and what does this imply for its material footprint, carbon footprint, and reliance on international supply chains?

Existing global MRIO databases represent construction as a single aggregated sector, obscuring the distinct production structure and material composition of specific infrastructure types such as railways. As a result, MRIO-based analyses are currently unable to distinguish railway construction from other construction activities. Methodologically, this study develops a sector disaggregation approach to introduce an explicit railway construction sector into African MRIO tables. Using the OECD Inter-Country Input-Output (ICIO) database, the construction sector in African economies is split into railway and non-rail components using production recipes that approximate the intermediate input structure of railway construction.
These recipes are informed by detailed Chinese railway construction inputâ€“output data, reflecting the prominent role of Chinese firms, technologies, and contractors in recent African railway projects. To ensure consistency with African conditions, the disaggregation is complemented by engineering data on material requirements and rail design standards drawn from completed and planned railway projects in Africa. These data are sourced from international development agencies (such as JICA and the World Bank), African national infrastructure ministries, and technical documentation from major rail corridors.
Eleven African economies are represented in the ICIO database. Our analysis focuses on recent railway construction case studies in these countries. Case studies are selected based on three criteria: (1) Temporal alignment, restricting the sample to countries where large-scale railway construction (e.g. standard-gauge or high-speed rail) was active during the ICIO base years; (2) Data availability, prioritising projects with accessible Bills of Quantities or Environmental Impact Assessments to calibrate production recipes to African engineering contexts; and (3) Technological diversity, contrasting different project archetypes (such as Chinese-led freight rail in Sub-Saharan Africa and European-led passenger rail in North Africa) to examine how international supply-chain structures affect total material and carbon intensities.

The resulting disaggregated MRIO framework is used to estimate the upstream material and carbon footprints associated with railway construction activity and to trace their domestic and international supply-chain origins. The analysis highlights the relative contributions of key material inputs, notably steel and cement, the geographic distribution of embodied emissions, and the degree of import dependence embedded in railway investment.
While the study is ongoing, preliminary expectations guiding the analysis are that railway construction is substantially more material- and carbon-intensive than average construction activity

and that a large share of its environmental footprint is generated outside African economies through imported intermediate inputs. At the same time, domestic production of basic materials is expected to contribute significantly to total impacts in several countries, highlighting potential linkages between infrastructure investment, industrial structure, and low-carbon development pathways.

The novelty of the research lies in providing one of the first explicit representations of railway construction within African MRIO models and in demonstrating a transferable infrastructure sector disaggregation method applicable beyond rail to other large-scale infrastructure types. By embedding infrastructure construction directly into MRIO tables, the approach advances the capacity of inputâ€“output analysis to evaluate infrastructure-driven environmental pressures and trade dependencies. Substantively, the study contributes a baseline framework for assessing the environmental and supply-chain implications of transport infrastructure investment in Africa and creates a foundation for scenario-based analyses of railway expansion.