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Construction Raw Materials in India and Indonesia

Market Study and Potential Analysis | Final Report

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ABOUT THIS REPORT
This report presents the final results of a study on construction raw material value chains in two metropolitan areas in India and Indonesia.
This study is a product of BGR's sector project "Extractives and Development", which is implemented on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ). The set up and the implementation of the study have been coordinated and accompanied by Hannah Maul.
For more information please visit: www.bmz.de/rue/en

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COVER PHOTO
Jörg Böthling / visualindia.de – Hard working women at a granite stone quarry in India.

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Acronyms

ASM	Artisanal and small-scale mining
BEE	Bureau of Energy Efficiency
BIS	Bureau of Indian Standards
C&D waste	Construction and demolition waste
DFM	District Mineral Foundation
DGMC	Directorate General of Minerals and Coal
ECBC	Energy Conservation Building Code
EIA	Environmental Impact Assessments
EPA	Environment Protection (Amendment) Act
EUR	Euro
FCA	Forest Conservation Act
FSI	Floor Space Index
GDP	Gross domestic product
GRIHA	Green Rating for Integrated Habitat Assessment
IBM	Indian Bureau of Mines
IDR	Indonesian Rupiah
INR	Indian Rupee
LPJK	National Construction Services Development Board
LSM	Large-scale mining
MEMR	Ministry of Energy and Mineral Resources
MoEFCC	Ministry of Environment, Forest and Climate Change
MoHUA	Ministry of Housing and Urban Affairs
MMDR	Mines and Minerals (Development and Regulation)
MoMSME	Ministry of Micro, Small & Medium Enterprises
M-sand	Manufactured sand
NBCI	National Building Code of India
NCT	National Capital Territory of Delhi
NCR	National Capital Region of Delhi
NGT	National Green Tribunal
OBC	Other backward castes
OHS	Occupational health and safety
PEPs	Politically exposed person
PPE	Personal protective equipment
SC	Supreme Court of India
SCST	Scheduled casts and scheduled tribes
SIPB	Rock Mining Permit
USD	US Dollar

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1. Introduction

Industrial minerals and construction raw materials make up 84% of mineral production across the globe. The price and value of most construction raw materials on global markets is comparatively low, exports are limited, and foreign direct investment is low. For this reason, they are often classed as 'low-value' materials and receive relatively little attention compared with higher value per volume minerals such as precious metals. However, construction raw materials are a high-value sector. As they are typically used in the region or country they are produced in they have the potential to significantly contribute to the local economy and poverty reduction. The quarrying and mining of construction raw materials in developing countries provides many low-skilled jobs. Next to the positive effects for the local economy, the construction raw materials sector is prone to risks due to its widely informal character. This includes health and safety risks, child labour, and adverse environmental impacts (Franks 2020; Hilson 2016). Also the greenhouse gas (GHG) impacts related to the construction raw materials sector are significant. Over 50% of GHG emissions are related to materials production, consumption and end-of-life management, and that will further rise in the next decades (OECD 2018).

The importance of non-metallic minerals – which include construction raw materials – is going to increase in the coming decades. The OECD estimates that global materials use is projected to more than double between 2011 and 2060, from 79Gt to 167Gt. Non-metallic minerals represent around half of that. Their use is projected to rise from 35Gt in 2011 to 82Gt in 2060. In India, the infrastructure boom is already coming to an end, but nonetheless materials use in the country is projected to grow from 6Gt in 2011 to 23Gt in 2060, accompanying economic growth (OECD 2018).

The construction industry is the largest consumer of raw materials globally (World Economic Forum (WEF) and The Boston Consulting Group 2016), Constructed objects account for 25-40% of total global carbon emissions. There are trends of transitioning towards a low-carbon construction industry (IFC and CPLC 2018). The OECD projects recycling of materials to become more competitive in comparison to the extraction of primary materials, due to technological developments and changes of the relative prices of production inputs (OECD 2018).

Construction consists mainly of residential housing (38%), transport, energy, and water infrastructure (32%), institutional and commercial buildings (18%), and industrial sites (13%). In developing countries, the construction industry can account for more than 8% of GDP (v. 5% in developed countries). Currently, more than 100 million people are working in construction around the world. The industry is expected to undergo significant growth in the coming years (World Economic Forum (WEF) and The Boston Consulting Group 2016). The projected growth between 2018 and 2023 was 4.2% per year. Urbanisation and population growth drive this increase, with an estimate of 75% of the infrastructure that will be in place in 2050 still having to be built (IFC and CPLC 2018). Demographic changes are not the only megatrend that needs to be observed in order to understand changes in the construction value chain. Other factors are the availability of energy, digital and technological developments and climate change mitigation (De Groote and Lefever 2016).

As this report is written in early 2021, it is important to consider the impacts of the COVID-19 pandemic on the construction sector and value chain. The construction sector has experienced contraction and negative effects on labour in much of the world in 2020 and 2021. In some countries, the construction sector was considered crucial and kept open, while in other countries the sector was shut down during country lockdowns. In some cases, the sector was opened as one of the first after lockdown measures were relaxed. The impacts of these disruptions are most severe for small and medium-sized enterprises (SMEs) who are facing liquidity issues and the risk of bankruptcy. These businesses rely on financial support, stimulus or relief packages to recover. Additionally, construction raw material supply chains have been disrupted

by the pandemic, which has led to delays in material delivery and increased prices (in particular for imported material). Labour shortages have also affected the value chain as many migrant workers returned home, as seen for example in India in spring 2020. Informal workers, who represent the majority of the sector's workforce, were particularly vulnerable to effects from the pandemic, as they often do not have access to sick leave, social protection, or enough savings to stop working to protect their and their family's health. The post-pandemic recovery on the other hand presents opportunities to improve certain aspects of the construction and construction raw materials sector. Efforts to reduce GHG emissions for example are often a key part of COVID-19 responses, and the pandemic has shown the risks and downsides of informal labour markets and precarious work as well as a reliance on imports. All of these can be lessons learned for building a more sustainable and resilient construction sector and construction raw material value chain which works for workers, small businesses, communities, and the environment (ILO 2021). The specific impacts of COVID-19 in the two countries of interest are elaborated on in the chapter on value chain barriers.

TABLE 1 – INDIA: PRODUCTION OF QUARRYING MATERIALS 2017-18 (IN TONNES) (INDIAN MINERALS YEARBOOK 2019)

Material	Production
River sand (2016-17)	228,610,000
Limestone	340,417,000
Quartz	3,950,605
Marble	14,028,976
Clay	not available
Feldspars	4,270,245
Granite	6,366,127
Kaolin	8,744,864

Note: Production data for minor minerals is collected at a state-level and not all state data was reported to the Ministry. The data is therefore likely an underestimation and not all materials are covered.

TABLE 2 – INDONESIA: PRODUCTION OF QUARRYING MATERIALS 2018 (IN M^3) (BPS 2019)

Material	Legal Entity	Home Business	Total
Sand	8,534,989	242,669,943	251,204,932
Stone and Andesite	16,423,074	39,186,513	55,609,587
Gravel	3,754,173	9,778,523	13,532,696
Limestone	3,487,433	3,769,297	7,256,730
Quartz	1,218,160	385,749	1,603,909
Marble	132,254	3,662	135,916
Clay	2,147,873	724,736	2,872,609
Feldspars	288,203	–	288,203
Granite	11,278,346	–	11,278,346
Kaolin	526,297	–	526,297

Considering the growing importance of construction raw materials and industrial minerals in the economy, their environmental and social impacts, and their potential to contribute to local development and poverty reduction, the Federal Institute for Geosciences and Natural Resources (BGR) commissioned this study under the title 'raw materials construct metropolises'. Its objectives are to gain a better understanding of the value chain barriers, opportunities, and potentials of locally produced construction raw materials in the metropolitan areas of New Delhi, India, and Surabaya, Indonesia. The focus lies on urban areas and their surroundings (with a radius of around 100-150 km). Construction raw materials are typically high volume and low value, and transport costs are high. They are therefore mostly extracted close to the locations of processing, manufacturing, and construction. The study aims at understanding and analysing the construction material value chains, including aspects such as current conditions and impacts of extraction and recycling, processing, and manufacturing as well as transport, and analysing obstacles and the potential for greater local value addition for local development, as well as the climate change impact of those value chains. The focus of the study lies on sand and gravel, crushed rock, dimension stone, gypsum, limestone, clays, brick, and cement.

The report starts with a brief overview of the methodology and limitations of the research, and proceeds with the two country case studies: India and Indonesia. Each case study will begin with a country overview and an introduction into the selected metropolitan area. Subsequently they describe the value chains from production to transport, processing, manufacturing and use in construction of a select number of materials, describing the current situation, processes and actors, and social and environmental impacts. The following value chain analyses provide information on production volumes and value, demand and consumption, prices, taxes and retribution, salaries, import and export, depending on data availability. Due to the different data availability for the two countries, the case studies do not match entirely in terms of content and structure. This also reflects two very different contexts and construction raw materials value chains. After the country case studies follows the analysis of value chain barriers. The report closes with the potential analysis and a short conclusion.

2. Approach and methodology

The research was carried out in two phases due to restrictions caused by the COVID-19 pandemic. The first phase took place between March and June 2020 and consisted of desk-based research, secondary data analysis and remote interviews with government representatives and value chain actors. It resulted in a preliminary report which provided an overview and basic understanding of the construction raw material sectors in India and Indonesia, with a specific focus on New Delhi and Surabaya. During this desk-based phase, the most interesting materials for each region in terms of importance and potentials were selected as the focus of the report.

In order to close some of the data gaps that resulted from the first phase, in the second phase between December 2020 and February 2021, local researchers in New Delhi and Surabaya undertook field research interviewing actors along the supply chain and from government agencies. 53 people in India and 18 people in Indonesia working in mining, processing, manufacturing, trading, transportation, and construction as well as NGOs and politics were interviewed. The locations of the respective interviewees in India span Delhi NCT, Rajasthan, Haryana, and Uttar Pradesh. In Indonesia they include Surabaya, Mojokerto Regency, Pasuruan Regency, Sidoarjo Regency and Magetan Regency in East Java. The market research followed detailed questionnaires and covered the following aspects:

- Types and origins of construction raw materials
- Production, transport, processing, manufacturing, and end usage in the construction sector
- Actors in the value chain
- Value chain barriers and opportunities
- Lessons learned from previous projects in the field of climate neutral production and processing of construction raw materials
- Legal and regulatory frameworks

The research team complemented these findings with further remote expert interviews, secondary data analysis and literature review where appropriate, including government statistics.

For a comprehensive list of interviewees, see Annex 1.

Based on the findings from the market research, the team developed recommendations regarding potentials for increased value addition. The approaches were developed in a workshop to take advantage of the expertise and learnings of various team members.

Limitations

The research results are limited and compromised by a number of factors. First, the construction raw material sector is still understudied, despite growing recognition of its importance in local economies. The secondary material available was therefore limited to some academic publications, NGO and media reports. These publications predominantly cover social and environmental impacts of material extraction and rarely take a value chain perspective. Second, the COVID-19 pandemic and related travel restrictions meant that the field work could not be conducted as initially planned. Taking advantage of a slight loosening of restrictions in both countries, local researchers resident in New Delhi and Surabaya were hired instead to undertake interviews with value chain actors and government officials, all while observing COVID-19 rules. Despite a certain easing of restrictions however, the data collection process was time

consuming and characterised by difficult access to interlocutors. Third, government officials – in particular in India – were reluctant to speak to the researchers and to share data without official permission from the central government. Fourth, many value chain actors, in particular larger operators, were also reluctant to share information, in particular quantitative data with regards to production, purchase and sales volumes, prices, salaries, and profits. Consequently, the report cannot make generalised sector-wide estimates and the field data collection focuses more on smaller operators. Fifth, given the limitations on primary data collection, results on supply chain mechanisms, value chain barriers and potentials cannot be seen as being exhaustive. Sixth, the access to interviewees and secondary data was highly divergent between India and Indonesia (with less information being available for the latter) which is why the two report sections do not cover exactly the same issues.

3. India

3.1. Country overview

About 34% of India's population lives in urban areas[1] (UN, 2019) an increase of about 3% since the 2011 Census (The Hindu 2018); this trend is expected to grow and by 2025 it is estimated that more than 525 million Indians, or 37% of the country, will be living in urban areas. Government responses to this shift have included the "Housing for All" scheme under which 60 million houses are to be built by 2022, including 20 million houses in urban areas (IBEF 2020a). To achieve this target India will need to construct 43,000 houses per day until 2022 (IBEF 2020b). This growth of the housing stock is complemented by the growth of India's infrastructure as the country plans to spend 1.4 trillion USD (1.2 trillion EUR)[2] on infrastructure through its "National Infrastructure Pipeline" in the next five years (IBEF 2020b). 18% of this amount is expected to go towards roads (IBEF 2020c). This growth would have the potential to make India the third largest construction market globally, after China and the US (IBEF 2020b). By 2030 the construction sector is expected to contribute 15% to the Indian economy (IBEF 2020b) and become the country's third-largest sector in terms of FDI inflow while the real estate market is forecasted to reach 1 trillion USD (840 billion EUR) (IBEF 2020a).

Delhi itself has been experiencing one of the fastest urban expansions in the world making it the world's second most populous urban agglomeration with a predicted population of 37.2 million people by 2028 (Economic Times 2019). As a result, Delhi's housing and infrastructure development sector has been seeing an exponential growth in budget allocation by the Government, reaching 460 million EUR in 2019-2020, with half of it being proposed for development works in informal settlements (ET Realty 2019). The budget is used to create urban infrastructure such as water supply and sewerage facility, provide affordable housing and increase the availability of low cost 'pucca' houses for the poor and lower-middle class people, develop the road infrastructure as well as develop group housing societies and regularise unauthorised colonies (ET Realty 2019).

As construction depends on a vast number of entrants (from machinery to raw materials and labour, as well as the services supporting those) its indirect footprint in the economy is even more significant both through direct and indirect job creation. The downside however is that the construction sector and its supply chains also create negative social, environmental and governance impacts commensurate to the size of the sector.

In response to the rapid urban growth of Delhi and its neighbouring areas and to facilitate land use and infrastructure planning and monitoring across different states under India's federal system, the National Capital Region (NCR) was established as a central planning region centred upon the National Capital Territory (NCT) of Delhi and including districts[3] from the states of Haryana, Uttar Pradesh, and Rajasthan (Figure 1).

The data collection underlying this report was initially centred within a 150km radius from Delhi NCT to reflect the common understanding that construction raw materials are bulky and thus sourced locally. This selected area covered the NCR and some adjoining

[1] A figure that does not include the semi-urban sprawls located in proximity to the metropolises (interview with Prem Mahadevan).

[2] All currency values in this report are expressed in their original and converted into Euro, using the Oanda currency converter on 19 March 2021 at https://www.oanda.com

[3] Under India's federal system each state is composed of Districts, this in turn are composed of sub-districts, sometimes referred to as tehsil (the Hindi term).

Figure 1 — **Delhi's population trends (Economic Times 2019)**

Rising population

How the population of Delhi, Central NCR and NCR has grown in the past 20 years

National Capital Territory (NCT) of Delhi

1,483 sq km

2001 13,8 mn

2011 16,8 mn

2021* 23 mn

* Projection

Central National Capital Region plus NCT

3,483 sq km

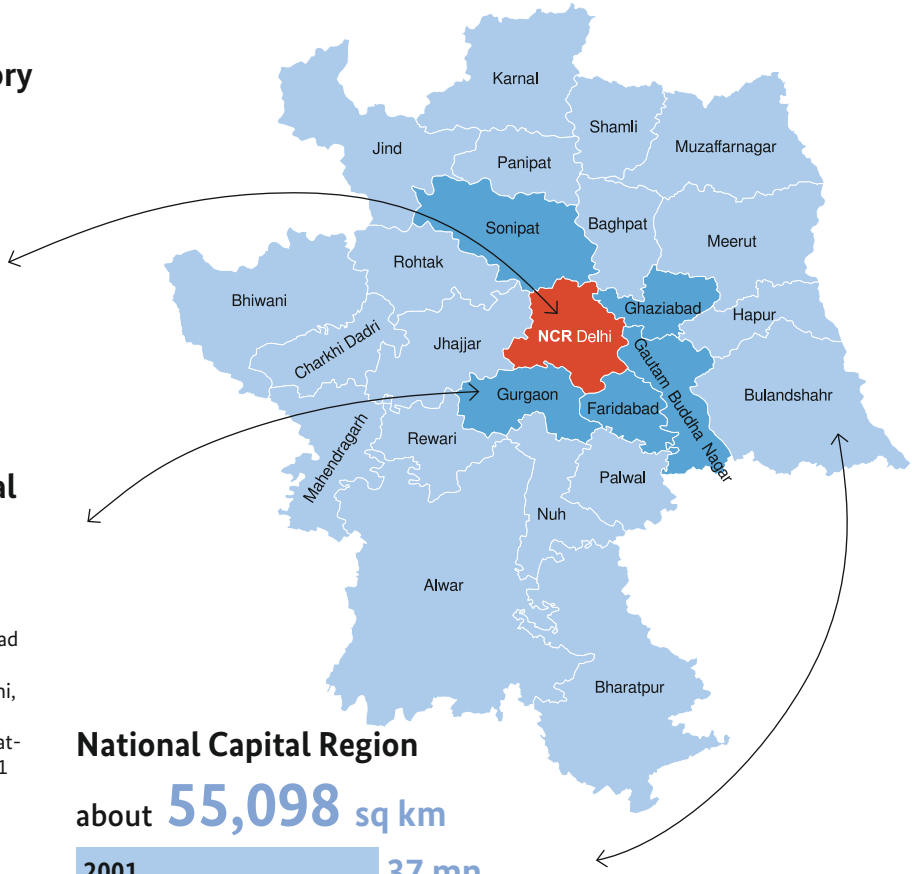
Central National Capitel Region is spread over 2,000 sq km, comprising nearby regions of Delhi such as Ghaziabad-Loni, Noida, Gurgaon-Manesar, Faridabad-Ballabhgarh, Bahuadurgarh and Sonepat-Kundli, as defines in Regional Plan 2021

2001 16,8 mn

2011 22,2 mn

2018* 29 mn

*2021 projection is not available



National Capital Region

about **55,098 sq km**

2001 37 mn

2011 46 mn

2021* 64 mn

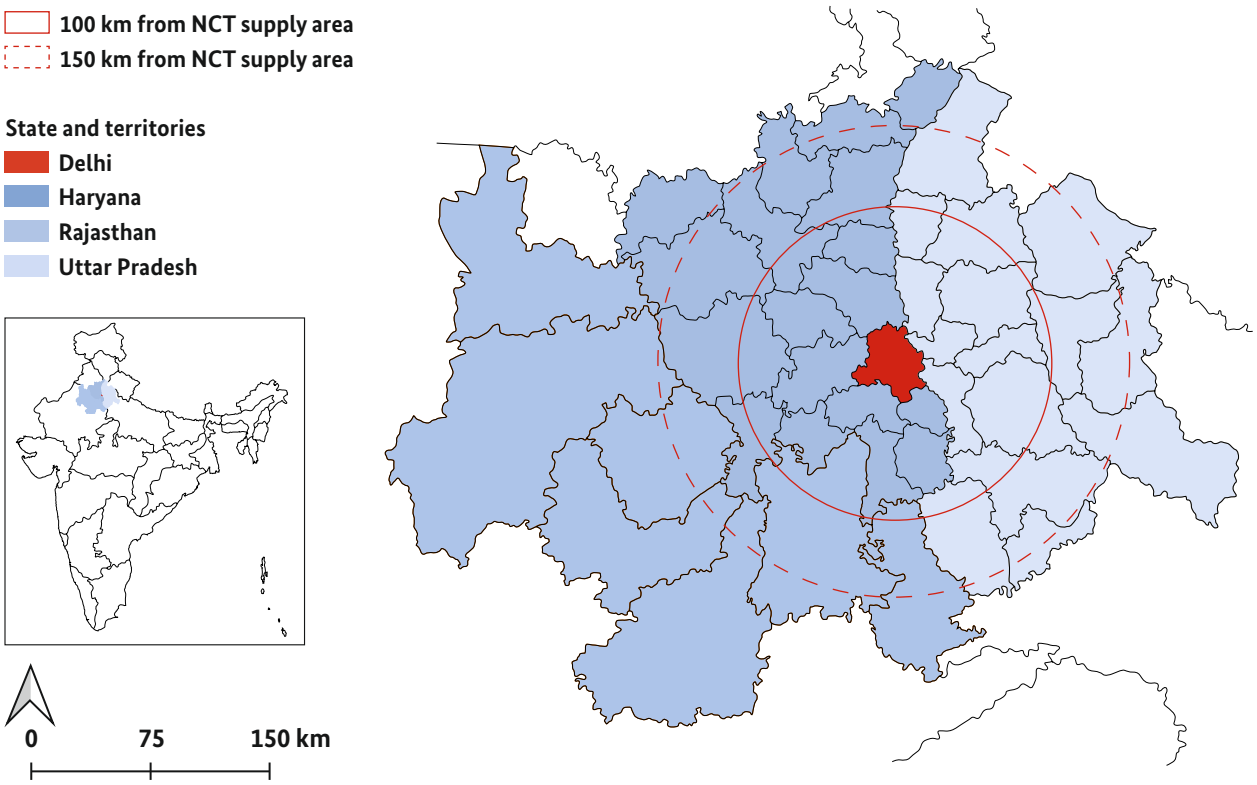
*Projection

NCR includes Baghpat, Bulandshahr, Gautam nBuddh Nagar, Ghaziabad, Hapur, Meerut, Muzaffarnagar, Shamil, Bhiwani, Faridabad, Gurgaon, Mewat, Jhajjar, Jind, Karnal, Mahendragarh, Palwal, Panipat, Rewari, Rohtak, Sonipat, Alwar, Bharatpur

districts. During the course of this research, it has emerged that certain construction raw materials are sometimes sourced from as far away as 600 km or more from Delhi. Due to this finding the supply area considered by this report was expanded to the remaining districts of Haryana and Rajasthan and the Western districts of Uttar Pradesh.

This focus on the state level is central to the understanding of production conditions as the materials under the purview are all considered "minor minerals" under India's mineral resources management framework which classifies minerals into "major" and "minor" minerals. Major minerals, which includes all metallic and energy minerals as well as diamonds and minerals with key industrial applications (such as graphite, fluorite, perlite or asbestos) are regulated and legislated upon by the Federal Government and its agencies. For minor minerals, these tasks are assumed by the individual states in which they are located. states thus have authority over the regulation, administration, licensing, mining, and taxation of minor minerals. And while a general applicable legal framework for the mining sector that is composed of environmental, social, and labour regulations as well as certain impact compensation mechanisms exist at the national level, their appli-

Map 1 — **Delhi NCT area of supply**



cation in the minor mineral sector is the responsibility of the individual states; and generally, most of the day-to-day administration of minor minerals takes place at the district level. The production of data on the mineral sector also falls under the responsibility of the different state authorities and as an unfortunate consequence, information on minor minerals and their extraction is neither centralised nor standardised and presents significant gaps.

In states that are relevant for this research the agencies in charge of minor minerals oversight are the Mines and Geology Department of Haryana, the Department of Mines and Geology of Rajasthan, and the Directorate of Geology and Mining of Uttar Pradesh. In the case of Delhi NCT, no single authority responsible for mineral resources could be identified[4]; even though the Delhi Minor Mineral Rules of 1969 place the sector's responsibility under the Director of Industries[5] no indication of these responsibilities could be found, and other official sources indicate that sand mining leases are granted by the Revenue Department (MOEFCC 2016).

Both rule implementation and monitoring as well as data generation suffer from a lack of capacity at the state and district levels. In 2015 a major reorganisation of mineral classification took place with the promulgation of the Mines and Minerals (Development and Regulation) Amendment Act (MMDR) 2015. With it, 31 erstwhile major minerals with key applications in the construction sector became minor minerals. This transition of minerals under the jurisdiction of individual States appears to have taken various States by surprise. States have approached the Central Government to seek support from the Indian Bureau of Mines (IBM) claiming they did not have sufficient capacity to shoulder these expanded responsibilities. In response to these requests the Central Government agreed to a transitory role for IBM for 2 years in order for States to build up their capacity, this period was then extended for a further 2 years, until May 2019 (GOI 2017). These capacity issues persist to this day and are also found in the other stages of construction material supply chains as will be seen in the following sections of this report, leading to significant negative environmental, social, and governance impacts.

[4] Based on research, document consultation and stakeholder interviews.

[5] A detailed keyword research on the Department of Industries of Delhi (http://pgc.delhi.gov.in/) with terms such as "mining lease", "mining", "sand", "stone", etc. has not returned a single result.

3.2. Value chain overview and analysis

While Delhi's construction raw material supply chains vary in terms of the commodities traded, market conditions, actors involved and levels of formality, a number of commonalities have been identified by our research:

1. With the exception of the cement supply chains (which are largely formalised), the majority of the sector operates somewhere on the continuum between full formality and informality or even illegality, in Indian parlance the sector is "unorganised" and cannot be seen through a strict formal vs. informal lens. To paraphrase and extend ICC and CUTS' (2018) analysis of the mining sector, construction supply chains are characterised by a predominance of small companies that do not fully comply with the applicable regulations mainly due to chaotic regulatory hurdles, corruption, governance failure, and a lack of oversight. Coupled with financial and technological constraints this leads to supply chains where limited compliance with regulations becomes a necessary business advantage.

2. With the exception of cement manufacturing plants and their captive limestone mines, there is limited vertical integration between the different stages of material transformation and its final usage on a construction site;

3. No exclusive relationships or closed pipe supply chains have been observed. Despite some ongoing relations, mostly localised in the upstream, supply relations are relatively fluid and can change depending on the market. No mention has been made of future supply contracts (where material would either be paid in advance or a future delivery at an established price would be agreed upon) either, even though supply chains suffer from seasonal supply/price variations;

4. While transporters can generally be found between each stage of the supply chain their involvement is limited to the provision of transport services. No indication of transporters taking ownership of the material could be found during this study. Ownership always remains with the seller or the buyer;

5. There are no known significant physical marketplaces for the construction raw materials under our scope. Commodities are traded through direct contact between supply chain stages.

THE CONSTRUCTION RAW MATERIALS SUPPLY CHAIN

The following section will present an overview of the supply chains of various construction raw materials, from production to processing and manufacturing, transport and trade to end usage in the construction sector.

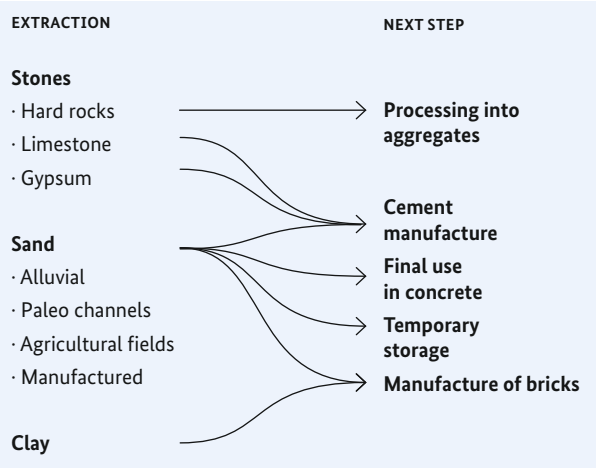
PRODUCTION

India's construction raw material supply chains are currently overwhelmingly dominated by virgin materials extracted from quarries, fields and rivers. Recycled material currently only accounts for a limited supply of the construction sector value chains.

While they are in every sense different stages from a value chain perspective, there is nevertheless some overlap between the extraction and the processing/manufacture steps as ownership of the material might not change between these stages, as typically:

- Limestone is predominantly extracted from mines that belong to cement manufacturers;
- Clay bearing soil extraction is part of brick manufacturing; and,
- Stone crushing can be conducted on the quarry by those also involved in extraction.

Figure 2 — Extraction and follow up steps of stones, sand and clay



Information collection in the sector is complicated by differences in the nomenclature of minor minerals between States, as well as high informality rates in the sector. Delve (2019) estimates that up to 80% of the Indian ASM sector is characterised by informality, although the word unorganised would likely be a better representation of it; a predominance of the unorganised sector that reflects the state of the Indian rural economy at large. This lack of information on production translates into a lack of information on livelihoods generated by the sector, the limited information available pointing to a sector employing vast numbers of the rural poor. Delve (2019) for example estimates based on official numbers that ASM quarries provide livelihoods to more than 10 million Indians while Aravali (2018) estimates that Rajasthan's mining sector alone might employ 2.5 million. IBM estimates that the dimension stone sector employs more than a million direct workers (IBM 2018e) and valuates the granite industry at 40 billion USD (33.5 billion EUR) while highlighting its employment generation potential in rural areas (IBM 2019b).

The exact make-up of the minor minerals sector between ASM and more industrialised forms of mining is also unclear as this information is not reported by the States' mineral authorities; small-scale operators seem to be the smallest players and work alongside bigger players using the same type of technology and processes (field research). The exception to this is the limestone sector where vertical integration of mines into cement manufacturing plants as well as sustained interest from IBM give additional visibility to the sector. The increased data availability on limestone is likely also due to the fact that some types of limestone, which represent a narrow percentage of the overall production, are considered major minerals.[6] Limestone classified as a major mineral provided employment to about 20,000 people in 2018 (IBM 2019d). In line with their status, no employment statistics are available with regards to limestone classified as a minor mineral.

Rule implementation and monitoring often sits at the district level for these minerals and these are layers of governance that have access to a much narrower pool of resources. A particularly problematic point is the staffing of these agencies at the District and Sub-District level. These agents are in charge of monitoring and enforcement in rock, clay, and sand extraction sites. However, they are, as a rule, stretched incredibly thin to the point that they cannot do their work. They also lack means of transportation to visit the extraction areas regularly and are staffed by candidates that could not obtain a more prestigious posting and are often easily corruptible. The few civil servants unwilling to engage in corrupt practices are often promoted sideways to new postings where they will not be able to cause any trouble[7]. Illustrating these issues, a recent Comptroller and Auditor General of India report (CAG 2019) focusing on Haryana has highlighted the following notable shortcomings:

- Multiple lapses of the Mines and Geology Department have led to a loss of revenue to the state amounting to more than 178 million EUR (INR 1,476.21 crore) from 2012 to 2017
- The absence of an internal audit wing, despite a previous CAG audit pointing out its absence in 2004. No remedial action has been taken since.
- A number of districts with substantial mining activity have vacant positions while 20 staff were posted in districts where no mining license was registered.
- An 80% vacancy in mining accountant and clerk positions, affecting the maintenance of records and tax recovery monitoring.

Similarly, while no mining is allowed in the Faridabad district of Haryana since 2002 (Hridayesh 2020) until recently details on 16 still valid stone mining licenses and 200 rock crushing licences in the district could be found on the website of the Mines and Geology Department of Haryana[8].

[6] At this point in the research, it was not possible to ascertain how the distinction between the types of limestone falling under the major and the minor minerals worked in practice. According to the Mines and Minerals (Development and Regulation) Act, 1957 Limestone used for industrial purpose falls under 'major mineral', while the use of limestone in lime kilns and for building purposes comes under 'minor mineral'. However, we could not find any indication on when, how, and by whom this is determined in practice.

[7] According to interviews with Prem Mahadevan and Thangaperumal Ponpandi, also see Rege (2015).

[8] Since the writing of this report intermediary version in June 2020 the website of the Mines and Geology Department of Haryana (https://minesgeologyharyana.in/) has been changed as was no longer publicly accessible at the time of writing of this report (February 2021).

LOCAL EXTRACTION, LOCAL IMPACTS

Located West and South-West of Delhi the Aravallis is, along with the Yamuna River, one of the two natural features located in this research's area of interest that is mentioned in Delhi medias with some regularity. Both play a role in the city's provision of ecosystem services and are also substantial sources of informally extracted material for the local construction industry. The Yamuna provides the city's water and serves as its wastewater evacuation and the Aravallis help to contain the advancement of sand from the Thar desert (Down to earth 2019; Reuters 2018). Yet both have been significantly damaged by these extraction practices. For example, in the District of Alwar (Rajasthan) out of an observed sample of 128 hills, 31 have disappeared due to mining since 1967 according to a report from SC (Times of India 2018). It should be noted that the Government of Rajasthan contested these claims, insisting that 28 of these hills had disappeared prior to 1960 and that no illegal mining was taking place in the area (Times of India 2018; DNA India 2018).

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Crushed stones at the Bhaniyana mine in Rajasthan

Compounding this lack of capacity is the fact that the extraction of minor minerals generates revenue at the district and state level through the collection of taxes, livelihood opportunities for the local population, and inputs for local industries, chiefly among them construction. As a result, mining activities are seen as an economic development engine to be encouraged by states. On the other hand, federal-level agencies with a mandate to protect the environment or uphold labour standards, such as the Ministry of Labour, the Ministry of Environment, Forest and Climate Change (MoEFCC) and the National Green Tribunal (NGT) have different sets of incentives, and these can sometimes clash. For example, in 2019 the Haryana government attempted to open up part of the Aravalli Hills to industrial mining and industrial developments, attempts that were stopped by a decision from the Supreme Court (SC) following cases from environmental activists (Down to earth 2019). In another instance, NGT was instrumental in closing environmentally destructive mines, closures that led to job losses and social unrest in north-eastern India (Delve 2019), and recently both SC and NGT have issued blanket bans on mining in parts of the area of focus. As a rule, these bans have not had a strong impact on the ground as states have not devoted sufficient resources to their enforcement (Down to earth 2019a; CAG 2019) or have even in certain cases been exploiting loopholes to make their implementation partial. This includes reclassifying forested land under other land usage categories to avoid licence granting falling under the remit of the MoEFCC or prolonging expired mining titles without renewing them (Down to earth 2019). This preference for local economic development is reflected in the attitudes of most local dwellers who must focus on day to day survival over long-term impacts, even when aware of said impacts (Interview with Kuntala Lahiri-Dutt).[9] And while the informality of the sector is environmentally and socially detrimental it lowers barriers to entry and ensures that the sector provides livelihoods, however exploitative they may be, to some of the poorest segments of the population: migrant workers, scheduled casts and scheduled tribes (SC/ST) members, and rural villagers in drought affected areas (GITOC 2019). Siddiqui and Lahiri-Dutt (2015) estimate that more than 42% of the households engaged in mining and quarrying (approximately 1.4 million people in total across India) are considered to be living in extreme poverty.

The following sub-sections will present the supply chains of the materials selected for this study. Due to the similar nature of their extraction process and associated impacts the materials of interest have been clustered as follows: clay (brick earth and fire clay),

[9] See also Rege 2015: "As one labourer stated, "What is a sanctuary?. . . What is a mammal? What is a bird? I don't have time to worry about these things" (AP 2015, p. 4).

sand, rock (limestone, gypsum, and crushed rock (composed of: limestone, dolomite, granite, marble, feldspar, sandstone, and quartzite).

Clay

Clay extraction processes are mostly overlooked by secondary sources, with information concentrating on the environmental and social flashpoints: brick kilns, as clay containing soil is used to produce fire bricks. Note that throughout this report clay in the Indian context will refer to clay containing soil unless more specific detail is provided.

Extraction processes take place in close proximity to the brick kilns to reduce transport costs (GIZ 2016). Clay extraction is based on a monetary agreement between the kiln owner and the agricultural landowner.[10] In theory, the kiln owner is also required to acquire a permit from the State Environmental Impact Assessment Authority before excavating soil from agricultural land (GIZ 2016) but with the exception of brick earth mining titles in Hanumangarh District (Rajasthan) no information on clay extraction titles or authorisation could be found for the entire area of supply. Consulted brick kiln workers noted that mandatory clearances are not obtained and that producers instead rely on arrangements with landowners and local civil servants.

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Clay mounds on the site of Bhagwati bricks in Jamalpur village in Bhiwani in Hisar District, Delhi NCT

CLAY EXTRACTION IMPACTS

(for further details and sources see Annex 3)

Forced and worst forms of child labour (WFCL). These grave human right violations are both endemic to the brick manufacturing sector.

Competing land uses. Clay extracted for brick manufacturing forms part of the soil used for agricultural activities thus creating a competition in the use of the resource. And while this topsoil is refilled through floods, the current rate of extraction surpasses the rate of replenishment leading to diminishing stock and agricultural land.

Modification of landscape. Lack of backfilling in clay extraction creates stagnant ponds during the monsoon providing perfect breeding grounds for waterborne diseases and disease vectors such as mosquitoes.

While norms from MOEFCC exist regarding the depth of extraction, which is limited to 2m, these are seldom followed in this unorganised and loosely monitored industry, and extraction areas are also not back filled as a rule.

Sand

Sand mining employs over 35 million people and is valued at well over 106 billion EUR per year (NGT 2020). Three different patterns of sand extraction emerge based on consulted stakeholders and reports:[11] daytime small-scale mining, nighttime large-scale mining, and daytime large-scale mining.

Small-scale mining is conducted manually and is generally destined for local construction activities, whereas large-scale mining is heavily mechanised, making use of backhoes or dredges to extract sand from the riverbed (Rege 2015). In Uttar Pradesh mechanised mining requires the sign off from a District Magistrate (MoM 2018).

While nighttime activities are conducted without any extraction title under the cover of darkness, daytime

[10] According to the information collected during our field visits in Bhiwani district (Rajasthan), the agreement specifies the depth of the soil that can be dug out – generally around 2 feet - and lasts only one season. The season rent for a ~0.4ha is currently at 3,000 INR (around 1,000 EUR), an increase from the 70,000 INR (806 EUR) paid 2-3 years ago according to respondents.

[11] Based on a phone interview with Prem Mahadevan and a review of the different cases summarised by the South Asia Network on Dams, Rivers and People (https://sandrp.in/).

SAND EXTRACTION IMPACTS

(for further details and sources see Annex 3)

Groundwater depletion and pollution has been noted as an issue across large parts of India.

Modification of landscape. Over-extraction of sand from rivers can shift the course of rivers impacting agriculture dependent communities. These changes can also directly impact critical infrastructure and changes in concentration of suspended sediment can lead to the siltation of water projects.

Impacts on fauna and flora are caused by changes in water flow speed, sedimentation, levels, and river course.

Worst forms of child labour are reportedly common in sand extraction.

Occupational health and safety include silicosis, and some labourers also work as divers with no form of safety equipment, which has led to deaths.

Corruption and bribery are reported as routine in the sand extraction sector, and one of the reasons behind the lack of oversight of extraction areas, in combination with lack of resources. Certain politicians are reported to support the operations of big construction companies as they receive significant funds and electoral support from those companies.

Misdeclaration of origin of minerals occurs with sand until it is traded for the first time, a process during which it is "legalised".

Violence or threats thereof. Between 2015 and 2018 7 journalist that were working on issues related to sand or rock mining have been killed in India. Attacks on police officers involved in the fight against illegal sand mining have also taken place and some were carried out with seemingly lethal intent.

activities take place within the framework of an official extraction title or are tolerated as local officials turn a blind eye on an activity that allows poor villagers to build affordable housing (GITOC 2019). However, when operating formally, sand operations tend to either extract more than their allotted volume or to operate outside of the borders of their concession. Despite not complying with the applicable law these operations benefit from all the advantages of officialdom granted to them by their title, and with the limited controls enacted by state governments can usually proceed unhindered for a long time.

Where riverbed mining is possible, the operations are open cast and trucks are simply filled prior to departure. In cases where sand is sourced from former, ancient, riverbeds, as in Rajasthan, the removal of 5-20m of overburden must first be done with machinery and it is likely that the sand will have to be sieved and washed to remove debris[12].

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Trucks making their way to collect sand from an illegal sand mining hub in Chak Basantpur, Delhi NCR

Rocks[13]

India's rock sector is characterised by open pit extraction relying on substantial amounts of manual labour but making use of some machinery as well (IBM 2018a; IBM 2018c; IBM 2019d). Manual labour is generally limited to sorting, some stone breaking and the loading and unloading of trucks. Women are exclusively engaged in manual operations and paid less than their male counterparts (field research).

[12] Interview with Prem Mahadevan.

[13] While information on hard rock quarries for aggregates isnon-existent, some research on hard rock quarries for dimension stones, which export to markets where human rights consideration are starting to be relevant, exist. These secondary sources complement our field data collection in aggregate quarries as not only do dimension stone quarries also produce material for aggregates as a by-product, but their operations and impacts are very similar to those of crushed rock quarries given that they both mine hard rock.

Stone extraction is a seasonal activity as monsoons create waterlogging and impede the extraction work. These extraction processes can also make use of small explosive charges to break the rock and facilitate its extraction (ICN, SCL, Glocal 2017; GIZ 2016; Chinnadurai and Jayamani 2019; field observations), most often with the help of backhoes or cranes. Drilling and channelling are sometimes carried out using hand chisels and hammers or drilling machines. Once extracted, stones are gathered in piles and may be broken into smaller pieces with hammers or loaded on trucks and transported either to a storage area, an on-site crushing facility, or an external crushing facility (field research).

Dimension stones extraction generates substantial rock waste which is processed into money generating opportunities, such as manufactured sand (M-sand) aggregates, or cobblestones (IBM 2018e; ABA, 2020).

The raw processing of rock consists of breaking stone into boulders that can then be fed into a crusher and can be conducted in two different ways. Either the quarry management hires the workers for processing the waste rock or the quarry management dumps the waste rock in a corner of the quarry and allows local people to process and sell the waste rock. After being processed, waste rock is paid for on a piece-rate basis either to workers that work for the quarry through a labour contractor or to local villagers with access to the waste rock site (ICN, SCL, Glocal 2017; Interview with Kuntala Lahiri-Dutt).

Limestone extraction can differ from this mode of operation. Limestone mines that are vertically integrated into the operation of cement and steel makers, often referred to as captive mines, are highly mechanised while other mines are only semi-mechanised and rely on the same combination of techniques as other rock

ROCK EXTRACTION IMPACTS (INCL. LIMESTONE AND GYPSUM)

(for further details and sources see Annex 3)

Competing land uses. Rock mining requires the removal of topsoil in its areas of operation making land unfit for future agricultural use.

Groundwater depletion. Local communities have been quoted in reporting regularly the lowering of the water table caused by rock extraction.

Impact of dust on flora. The high levels of dust generated by rock extraction can cover leaves which lowers their capacity to photosynthesize and thus their growth and general health.

Modification of landscape. Among others the levelling of parts of the of the Aravallis hills has exposed the city to sand blowing from the Thar Desert.

Forced labour is common in rock quarries and is a product of debt bondage and linked to the use of labour brokers.

Worst forms of child labour. The rock extraction sector is characterised by substantial levels of child labour.

Occupational health and safety. Work on the quarries is as a rule conducted with no PPE and accidents are common, sometimes resulting in the death of workers. Most accidents go unrecorded but estimates of around 460 known deaths in 2005 in Rajasthan exist. Studies conducted in Rajasthan show that 50 to 75% of mineworkers are impacted by silicosis, which can lead to a premature and painful death (Ghosh 2016).

Corruption and bribery are reported as routine in the rock extraction sector and one of the reasons behind the lack of oversight, in combination with lack of resources. Certain politicians are reported to support the operations of big construction companies as they receive significant funds and electoral support from these companies. Further, Politically Exposed Persons (PEPs) are involved in the sector.

Violence or threats thereof. Between 2015 and 2018 7 journalist that were working on issues related to sand or rock mining have been killed in India.

Gender and discrimination. Gender repartition of roles is the norm. Women only have access to purely manual work and are paid less than men. Migrant labourers are often recruited as workers by labour brokers; coming from disadvantaged environments they are more at risk of exploitation than locals.

quarries (IBM 2019d). Crushing of limestone and gypsum for cement manufacturing takes place outside of the mine sites themselves (GIZ 2016), with the exception of some gypsum mines in Rajasthan (IBM 2018a).

The limited information collected from traders, transporters, and miners highlights that Rajasthan is the key state for the supply of "rocks" to Delhi, which includes limestone and gypsum. While this information cannot be confirmed with publicly available information it does match the limited media coverage of the issue as well as the existence of a significant dimension stone industry in the state (ABA 2020), an industry whose waste is transformed into aggregates. Interestingly, some of the sites visited that are supplying to customers in Delhi are located more than 300km away from the city, much farther afield that is traditionally assumed for construction raw materials when considering transportation costs. This is because it allows the customers to procure directly from the mine site, bypassing the middlemen, which is considered to provide greater value for money.

PROCESSING

Clay

No processing step could be identified in the case of the use of brick clay. Clay is extracted and then used as a raw input in the manufacture of bricks.

Sand

With the exception of the washing and screening of sand extracted from non-alluvial deposits, no processing step could be identified in the case of sand. This initial processing is enmeshed into the extraction operations.

Rock aggregates

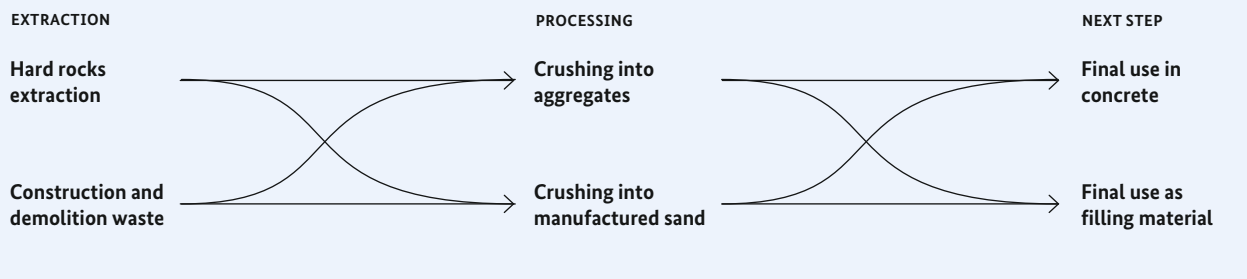
Processing of rocks involves crushing the material into the appropriate size, from aggregates and M-sand to powder size. In line with a media and NGO focus on impacted communities and materials for export, significantly less information is available about this stage of the supply chain than about the extraction stage.

Rocks processed into aggregates can be used as ballast for train tracks, as macadam pavement, or terrazzo, but their main use remains in the manufacture of concrete (and by extension concrete blocks) and as a filler material in the construction of roads (GIZ 2016; field research). It was noted by rock crushing operators that 30-40% of the products are sold to onsite buyers and the other 60-70% are sold directly to different parties (resellers and private construction contractors) in Delhi NCR and to government contractors, these contractors being their regular clients.

Rock crushing units form clusters in proximity to areas of rock extraction, their markets, and highways in order to reduce transportation costs (Sivacoumar et al. 2006; field observations). Most stone crushing units in Rajasthan are organised in clusters. Rocks are usually ground from a size of 200–300 mm into smaller pieces more adapted to the needs of the construction industry, generally size fractions < 6, 6 - 12, or 12 - 25 mm (Sivacoumar et al. 2006). Different sizes of rocks can have their own colloquial names in North-Western India, and in particular the research area; for example, the crushing unit on which data was collected produces jeera, half-inchi, and inchi aggregates (respectively sized at < 10,10 - 20, and 20 - 40mm).

Three modalities of operations have been observed during field visits: crushing units that are vertically integrated within a mine, crushing units that purchase rocks and then process them before selling them, crushers that provide the crushing service to the mine operators; however, the latter modality is quite uncommon. Heavy machinery and basic transport trucks are owned by the company while some tools are rented from local dealers for cost reasons.

Figure 3 – Rock supply chain



ROCK CRUSHING IMPACTS

(for further details and sources see Annex 3)

Impact of dust on flora. The high levels of dust generated by rock crushing can impact local crops.

Impact of dust on public health. Stone crushing is a major contributor to air pollution in the Delhi region.

Occupational health and safety and community health. Lack of PPE for workers and lack of investment and interest in OHS create conditions that are conducive to accidents. Elevated levels of dust in the air both within the operations and in neighbouring residential areas lead to a high incidence of respiratory diseases, including silicosis.

Misdeclaration of origin of minerals. The processing stage offers an opportunity for the legalisation of illegally procured material.

Gender and child labour. Women working on site can often be forced to leave children close-by due to the lack of day-care options, leaving them exposed to dust. Some children can also be found working alongside their parents. According to existing reports there are over 300,000 children working in Rajasthan's stone quarries. Most of the labourers come from poorer States through labour brokers, typically West Bengal.

CO_2 emissions. The production of aggregates from rock produces significant amounts of CO_2.

Rocks that arrive at a crushing unit are first manually broken into smaller pieces if required. They are then fed into manual crushers or mechanical crushers[14]. Crushing plants include crushers with decreasing opening sizes that produce progressively smaller material according to the demand. Once processed these aggregates are then classified by size and sent to the buyers.

Crushing of rocks into aggregates is a labour-intensive small-scale industry depending largely on migrant and unskilled labourers, mostly from West Bengal (field observations). The activity offers a seasonal employment alternative for agricultural workers. According to Delve (2019), at the national level the rock crushing sector alone was estimated to provide direct employment to over 500,000 people in 2012 and to have an annual turnover of over 1 billion USD (837 million EUR).

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Crushed stones at the Bhaniyana mine in Rajasthan

Systematic delays in the submission of grants for the renewal of rock crusher licenses in Haryana, of up to 650 days (CAG 2019) confirm claims from operators that oversight over this node of the supply chain is limited and that activities are still mostly unorganised.

Gypsum and limestone

The production of lime requires the calcination of limestone in kilns at a temperature of up to 1,200°C. The process releases the CO_2 present in limestone to produce 'quicklime' (CaO) in the form of hard white lumps (IBM 2019d). When slaked with water and mixed with sand, quicklime forms mortar and plaster. In the hardening process the lime hydroxide absorbs again the CO_2 from the air.

LIMESTONE CALCINATION IMPACTS

(for further details and sources see Annex 3)

CO_2 emissions. Limestone calcination produces substantial amounts of CO_2. Limestone calcination was estimated to represent an annual release of 137 million tonnes of CO_2, approximately equivalent to 7% of Indian total man-made CO_2 emissions.

[14] Manual crushers require 3-4 workers to operate them but do not depend on a supply of electricity, which can be intermittent.

Specific information on the internal processing of limestone and gypsum in cement and steel plants in India is not publicly available. Limestone is one of the raw materials for the production of iron, which is the basis for steel. Issues mentioned in the reviewed material are limited to CO_2 emissions, likely a consequence of their size and the associated need to operate formally.

MANUFACTURING

Gypsum is virtually reserved for the production of cement in India. With only 0.15% of India's gypsum consumption being used in either the manufacture of plaster of Paris or the manufacture of drywall (IBM 2018a), the manufacturing processes and supply chains for this material are not further elaborated on here.

Bricks

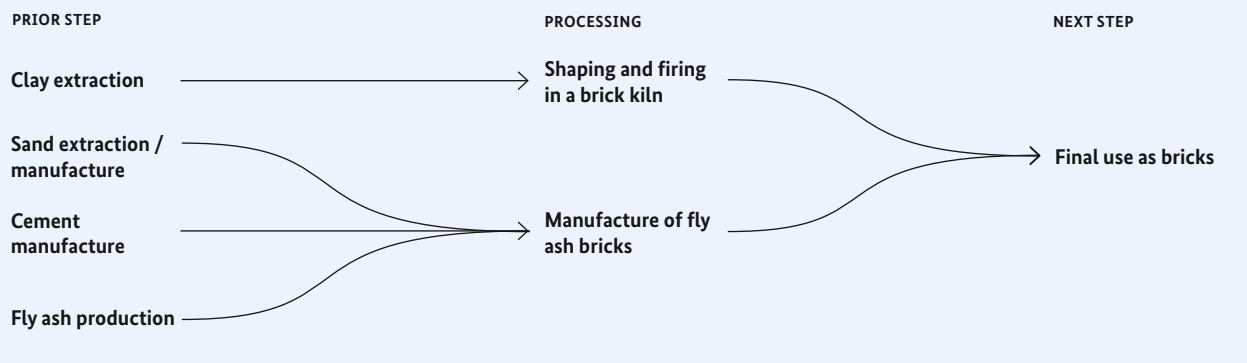
In the last years bricks made out of fly ash (a waste product of coal burning) have emerged as a growing sector following efforts from the Government of India to promote the use of secondary raw materials in the construction sector and have become an alternative to traditional bricks (henceforth referred to as bricks). The promotion of fly ash bricks serves the double objective of lessening the exploitation of soil deposits, and thus of arable land, and to dispose safely and beneficially of a polluting waste-product (Interview with Vikash Nayak).

Clay brick manufacturing takes place all year long, except for the monsoon season between June and September, in clusters located close to the site of clay extraction to minimise transportation costs (field observations). These clusters are located outside of the cities and in the outskirts of small towns where the customers are located (Misra et al 2020; Interviews with Dr Gurdeep Singh and Vikash Nayak). An example is the Bhiwani District in NCT where the three brick kiln sites visited during the field research are located within 10-12 kilometres of each other. Brick manufacturing is one of the biggest employers of migrant labour, with more than 10 million labourers (Chinnadurai and Jayamani 2019) in the estimated more than 140,000 kilns operating in the country (GIZ 2016). The National Sample Survey Organisation estimated that in 2009-2010, brick kilns employed around 23 million labourers in total (Anti-slavery 2015). Most of the bricklayer migrant workers come from Uttar Pradesh, Bihar and West Bengal.

Sites are supervised by munshis (account keepers-managers), while the owners tend to live in the local bigger cities. Agreements are made between the kilns and local landowners for the right to dig out soil. Generally, the depth of extraction is fixed at around 60 cm. This agreement only lasts for one season (from late September to early June) and has to be renewed yearly. A brick kiln may produce 3 to 4 stacks of 1-1.6 million bricks each during a single cycle of 2-3 months. In a year, a brick kiln can go through 3-4 such cycles or seasons, with work only being disrupted by the monsoon (Misra, et al. 2020; field research). The production of 4 million bricks consumes 12,000 tonnes of clay bearing soil and 600 tonnes of coal (Misra et al. 2020).

Once extracted and transported to the kiln, clay is mixed with the material added by the specific kiln. Depending on local availability and price, this can include: sand, lime, magnesia, iron oxide, straw, among others. As the manufacture of bricks is extremely cost sensitive if materials become too expensive, due to transportation costs for example, a material can be replaced with other locally available materials (Inter-

Figure 4 – Brick manufacture and associated steps



view with Pradip Chopra; field research). The mixing process can be fully manual or be supported by the use of machines that are generally hired by the kiln to speed up production. Bricks are then formed and are put into a kiln to be fired, a process that requires the intervention and oversight of skilled labourers. Once fired, they are either stored on site or transported directly to end users (Praxis and Partners in Change 2017; Anti-slavery 2015).

The kiln management's responsibility ends at the site. Small local constructions projects generally order directly from the kilns and arrange transportation on their own, while large orders for major construction sites, such as public projects, are managed by intermediaries who work with a loose network of kilns and are in charge of arranging transportation to the construction site.

Most of the unskilled labourers (brick mixers, transporters, and loaders, etc...) are from poorer States (Uttar Pradesh, Bihar and West Bengal) and come as couples. They are paid on a per brick basis as a whole family, and as a result their work is often supported by that of their children. These workers are brought by labour brokers and live on site for the entire season before going home during the monsoon. Skilled workers, in charge of stacking bricks into the kiln, operating the fire and generally managing the site are paid on a monthly basis and receive a salary equivalent to that of the munshi and well over the minimum salary.

Fuel for the kilns takes the form of coal (sourced from major producers) and sawdust (sourced from local wood mills/workshops). Highly flammable but polluting products such as tires and plastic are sometimes used to stoke the kiln fire. The use of these polluting products is contrary to local norms and thus not openly acknowledged and may require the payment of bribes in case of inspections from air pollution control officials. The use of coal and sawdust marks departure from the earlier practice of using agricultural waste (straw) triggered by the need to achieve higher efficiency in order to limit pollution and to better compete against the growing use of fly ash and cement bricks which reduced the demand for clay bricks. Other measures widely adopted to mitigate pollution and boost fuel efficiency are the use of "zig-zag chimneys" [15] and "high draught bhattas"[16] designs in the kilns.

As fuel represents a significant proportion of a kiln's operational costs they are only fired once a significant portion of the stack has been ordered, generally about half the stack. The operator then has confidence that the remaining bricks will find buyers through orders received during the time it takes for the firing process to complete.

Better-quality bricks are used in façades and walls and over-baked bricks are used for laying foundation and priced slightly higher than normal bricks. Under-baked bricks are sent to Rajasthan where the dry environment makes their use possible.

The sector is characterised by its unorganised nature. Brick kilns are not visited by civil servants as a rule and implementation of legal requisites is often non-existent. Praxis and Partners in Change (2017) note that during a visit of the National Commission for Protection of Child Rights in 2013, of the 300 brick kilns functioning in Bhilwara, only 45 were registered with the district administration. The Commission's representatives were also surprised by the district administration's indifference to the issue. Anti-slavery (2015, p.6) notes that: "In order to ensure minimum wages are paid, the Labour Department must inspect worksites. Although India has ratified ILO Convention 81 on labour inspections and there is domestic law in place regarding this, in practice, Anti-Slavery International and its partners have found that very few brick kilns are inspected. Almost all brick kilns fail to keep employment records, meaning that it is impossible to determine what workers are being paid."

[15] In zigzag kilns, bricks are arranged to allow hot air travel in a zigzag path. As the zigzag path is around three times longer than the straight line, this improves the heat transfer from the flue gases to the bricks, making the production process more efficient. In addition, better mixing of air and fuel allows complete combustion, reducing coal consumption to about 20 per cent. The zigzag design also ensures uniform distribution of heat and reduces emissions.

[16] The high draught kilns also follow the zigzag firing concept. The kiln consists of a rectangular gallery which is divided into 24 chambers by providing temporary partition walls. The wall of each chamber runs along the width of the gallery, with one end providing a space of 60-65 cm for communication to the next chamber. Draught is created by an induced draught fan for proper combustion of fuel. Usually two chambers are fired per day which can achieve a daily output of 15,000 to 30,000 bricks.

BRICKS MANUFACTURE IMPACTS
(for further details and sources see Annex 3)

CO_2 emissions from brick kilns are significant, coupled to other harmful emissions (carbon monoxide, sulphur dioxide, nitrogen oxides (NO_x) and suspended particulate matter) as brick kilns are coal fired.

Impact of dust on flora. The air pollution and bottom ash generated by these kilns cause damage to property and crops.

Forced labour is ubiquitous in brick kilns due to low cost of bricks and relatively high cost of production. Many of the workers are migrant workers who come from marginalised communities and are easy to exploit.

Worst forms of child labour. The presence of WFCL on brick kilns is endemic.

Occupational health and safety and living conditions in brick kilns are harsh and include intense physical activity likely to result in long term debilitating injuries. Accidents such as injuries from brick falls and burns are common and despite exposure to the air pollution and ash generated by the kilns, labourers are not issued any form of PPE, leading to respiratory illnesses. On-site accommodations are sub-par and represent short- and long-term health risks.

Corruption and bribery seemingly enable the functioning of the sector in its current conditions.

Violence or threats thereof is directed towards workers and their families, in particular towards those seeking out help to escape their conditions of forced labourers. Women are also vulnerable to abuse and sexual violence.

Gender and discrimination. Gender discrimination is limited as pay is based on production, notwithstanding the additional household work women accomplish. Contracting is always done with the male head of the household. Caste and migration-based discrimination is rampant as brick kiln migrant workers are predominantly from the poorer states (Uttar Pradesh, Bihar and West Bengal) in the country and are in the majority of cases from Scheduled Castes and Scheduled Tribes (SC/ST).

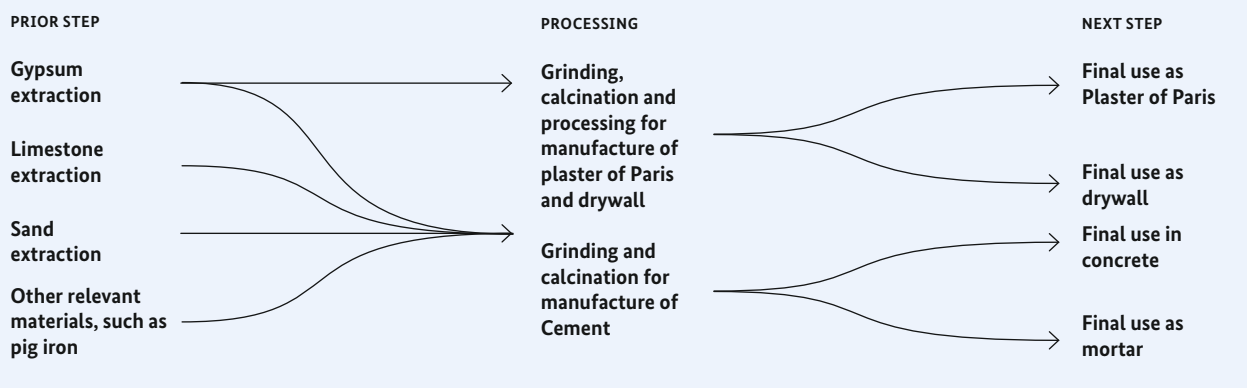
In contrast to this unorganised sector the manufacture of fly ash bricks is characterised by full formalisation and the use of modern machinery. To make the most of the free fly ash they can receive due to government policies, fly ash brick plants have been established in proximity to power stations (Interview with Vikash Nayak). The scale of the inversion required to establish such plants along with their non-mobility makes them fully dependent on the energy plants located close enough for the aforementioned regulation to apply. If one of these plants closes, a new supply would have to be identified (Interview with Sanjay Seth, Megha Behal, and Ankita Bokhad). This dependency also makes fly ash brick producers vulnerable to corruption in order to secure their supply of fly ash. This is not a far-fetched scenario as issues have been already noted in that regard and can "range from fly ash being sold at higher rates to cement manufacturers to halt in supply during inspections or visits at thermal power plants, and giving priority to road or other project contractors owing to 'election compulsions' " (Down to earth 2019b).

Cement

Given the more limited attention the manufacture of cement receives in media, academic, and NGO reporting, no overall information on the manufacture of this commodity and its impacts could be found. Neither did industry information prove to be relevant.

At most it can be said that based on IBM information (IBM 2018b), as mentioned previously, plants are typically located next to limestone extraction sites and take advantage of railway connections to limit transportation costs. An example is the cement plant and Nimbeti limestone mine of Shree Cement Limited situated in the village Ras, Jaitaran Tehsil, Pali District (Rajasthan). Furthermore, due to coal being the key source of energy for cement companies, the industry also generates substantial amounts of fly ash which can then be used in the manufacture of fly ash bricks.

Figure 5 – Cement manufacture and associated steps



TRADING AND TRANSPORTING

While the role of intermediaries is recognised, the term 'trader' might be a misnomer in many cases as few trade actors actually take ownership of the materials. In most cases their work is limited to finding a product for a buyer and potentially arranging transport. As such they rarely maintain stocks in a significant way. Furthermore, in the case of big construction projects manufacturers tend to come directly on site to sell their products, thus often bypassing intermediaries (Interview with Pradeep Chopra). Nevertheless, stocks of materials can be found lying next to roads or parked on trucks in certain areas of Delhi NCT. The low volume they represent points towards the supply of small individual projects or the supply of gaps in larger projects. Most of the transactions at the trading and transport level take place on credit (field interviews).

Vehicles ranging from carts to semis are used to transport the materials depending on the distance and the commodity. Notably, as a consequence of India's motor park, all transporters use trucks built in India, and models from Indian brands dominate the market: Tata Motors control 51% of the market share, Ashok Leyland 34% and Mahindra Mahindra 3%.[17]

In Haryana, Rajasthan, and Uttar Pradesh the legal transport of minor minerals requires a booklet issued by the state's authorities to accompany the cargo. In Rajasthan, Haryana and Uttar Pradesh this process is done online (MoM 2018; CAG 2019). The informal sector usually does not abide by this rule and smuggling activities occur in and across these states.

TRANSPORT IMPACTS

(for further details and sources see Annex 3)

CO_2 emissions from trucking are a concern shared by all materials.

Corruption is often required to transport sand to the final destinations, the majority of the officially registered illegal mining cases are related to the illegal transportation of sand.

Modification of landscape can happen when temporary roads and bridges are constructed to facilitate the transport of illegally extracted sand.

In Haryana these booklets contain numbered mineral transit passes containing the relevant information (source of dispatch, registration number of the vehicle, weight of mineral or quantity of mineral dispatched, name of the transporter and destination of the consignment). Conversely mineral concession holders need to maintain a register of all receipts and dispatches along with the particulars of the mineral transit passes issued. A complete account of the booklets of mineral transit passes should be maintained by the license holders and mineral transit passes should be presented upon demand from an authorized officer, but spot checks from Haryana agencies are limited and are not recorded (CAG 2019).

While supply distances vary from project to project, interviews with traders and transporters have established that most of the bricks used by projects in Delhi come from neighbouring districts of Uttar Pradesh or Haryana and generally from within a 45 to 60km radi-

[17] For further details see https://www.autopunditz.com/commercial-vehicles-sales-trend-india/, as visited on the 01.02.2021.

A roadside suppliers den, Kuleshara village, Noida, Delhi NCR

A truck waits to collect sand, cement and aggregate stones at Kulashera, Delhi NCR

us, meanwhile sand and aggregates can come from up to 150km or more away.[18] Most cement plants are also located more than 100-150km from Delhi but cement is purchased by final users through local distributors. These large distances can impose significant costs to the buyer.

Crushed rock

There is no physical marketplace for aggregates. Individual rock crushers get in touch directly with building contractors. The crusher is paid after reception of the aggregates (Interview with Pradip Chopra). Transport to the construction site is paid for by the crusher and aggregates are transported by a contracted third party (Interview with Pradip Chopra). These transport service providers are generally small to mid-size players with up to 20-30 trucks (Interview with Vikash Nayak).

Sand

No vertical integration between the construction sector and sand operators was observed (Interview with Prem Mahadevan; field research) nor was any indication of a known physical marketplace.

Transport takes place between the extraction site and either a storage area or a user such as a cement manufacturing plant or a construction site where it is mixed to produce concrete and mortar or is used as a filler for example in the construction of roads (Rege 2015; MOEFCC 2016). In certain cases, alluvial extraction requires the construction of temporary roads and bridges to allow for the transport of sand (Rege 2015).

Transporters are usually contractors or part of sand mining operations, although there are some reports of enterprising village youths ferrying sand in private vehicles (GITOC 2019). Operators can range from sizeable legal companies with inhouse transport to small-time independent "contractors" (including transporters) that can loosely coordinate their operation or be managed by a single person operating as a manager (Rege 2015).

Not only do sand prices vary nation-wide according to proximity of supply and associated transport costs, they also vary seasonally when monsoon, temporary mining bans related to the monsoon, or blanket bans constrain extraction activities (MoM 2018; GIZ 2016). Despite these variations the sand price from illicit sources is noted as being nearly half as expensive as sand from legitimate sources due to its reduced operational costs, even when factoring in the required bribes (GITOC 2019), an important element for an industry as cost-conscious as construction. A current typical buying price for middlemen is 40 INR (0.46 EUR) per quintal (1 tonne = 9.07185 quintals), with the selling price being 45 INR (0.52 EUR) per quintal.

If required, sand can be stored for varying time periods, for example to take advantage of high sand prices during the monsoon season. This storage can take place on private plots either belonging to the operator, to legitimate sand mining operations, or to mem-

[18] A dolomite quarry, which sends parts of its production do Delhi, that was visited during fieldwork is located more than 600km from the capital. Location: Chacha Jaisalmer (26.9775° N, 71.7267° E), Rajasthan.

bers of the local community. Local community members are generally compensated but there are cases in which land has been forcibly occupied to store sand, including public land (Rege 2015).

Despite a lack of manufacturing or processing to add value to the commodity, sand appears to gain in value as it moves down the supply chain. It is reported that prices increase approximately fourfold from extraction to final point of sale, due to factors such as transportation, storage and bribes paid to local police and administration officials (GITOC 2019). However, it is not clear whether this price change is reflected in a decent living pay for miners.

Cement, limestone and gypsum

Depending on the size of the different supply chain actors, transport can take place from cement plants to stockists to retailers to construction companies or skip a number of these steps (field research).

Information on the transport of limestone and gypsum to cement factories is not available as the workers interviewed during the field research did not have the information. At most it can be deduced that these materials are transported both by road and rail (IBM 2018a).

END USAGE IN CONSTRUCTION

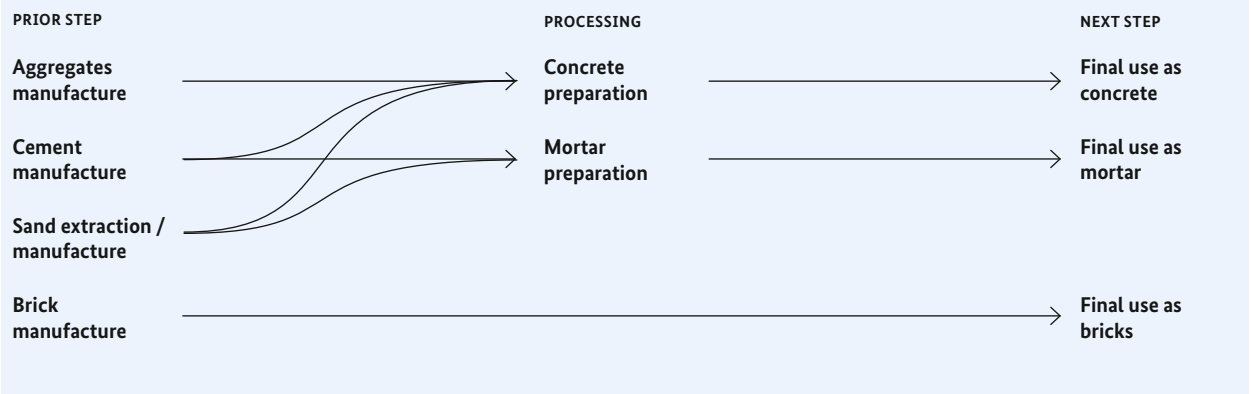
Generally, suppliers bear the cost of supplying the construction project with the materials, at credit most of the time. Builders have currently no obligation to ensure the legal origin of the construction material they use and as such sourcing decisions are driven by cost considerations as few variations in quality are noted for the materials under consideration (field consultation of builders and traders).

Once the different materials arrive on site they are temporarily stored until final usage and then assembled or poured into the different building elements. Recycled materials are not widely used according to respondents and rates of recycling have also been noted as being low.

It was estimated in 2011 that there were around 31,000 companies in the construction industry in India, 29,600 of which are small scale enterprises, around 1050 medium scale, and around 350 large scale (Negi and Ahuja 2017; Field research). And while the construction sector is India's second source of employment after agriculture and employs more than 40 million migrants (Chinnadurai and Jayamani, 2019) working conditions on sites present a number of risks from a labour and human rights perspective (CDPR 2014). Work on construction sites is dangerous with workers rarely being issued PPE such as tethering, dust masks, or gloves (BBC 2019; Field research). As a result, workers are exposed to accidents and illnesses such as respiratory affections and skin infections caused by cement handling (Outlook 2019).

The vast majority of the workforce, 84%, are migrants from poorer states (majorly from Bihar and Rajasthan) that are hired through labour brokers and generally do not have contracts. As is often the case with migrant workers, this places them in a position of increased vulnerability as they fully depend on labour brokers to provide them with transportation (which they must then repay) and accommodation on the site (CDPR 2014; Field research). Often entire families come to work and while children do not work officially, they nevertheless end up "assisting" their parents, against no remuneration (Field research). Without contract these workers do not receive social benefits or social protection (Field research), as such most workers (92%) have no access to injury compensation

Figure 6 – On-site processing and end usage of aggregates, cement, sand and bricks



CONSTRUCTION IMPACTS *(for further details and sources see Annex 3)*

Forced labour is endemic in the construction sector. 84% of workers are contracted through labour brokers and 94% of migrant workers do not have a formal contract. The average daily wage for unskilled construction workers is about two-thirds of the official minimum wage and payments are often irregular.

Occupational health and safety present major gaps, and risks both in the short and in the long run. PPE is not issued to workers, including tethering or dust protection and more than half of workers complain about work-related health problems.

Living conditions. More than 70% of workers live in fenced-off and guarded areas where provision of sanitation and water is most often lacking and electricity supply is intermittent. It is not uncommon for whole families to leave in these camps.

Corruption and bribery. The sector is noted for its high level of political clout, allegedly gained through corruption of political elites. Bribes are used in particular to be able to avoid environmental regulations and pollution requirements.

Right to free association and collective bargaining. Unions are not present on construction sites nor any other collective organisation and workers are actively discouraged from seeking collective representation.

Gender and discrimination. The labour force being made-up of migrant these face the same structural barriers as in the other stages of the supply chain. Additionally, women are restricted to low-skilled work, and only make three quarters of the pay of men.

Misdeclaration of origin of minerals. There is no traceability of minerals at the construction stage, nor requirements to demonstrate the legality of the materials used.

Construction waste mismanagement. Generates multiple impacts to the environment and urban infrastructure both directly and indirectly. An example is the contamination of groundwater and pollution of air around the Bandhwari landfill which is estimated to contain around 3.5 million tonnes of untreated waste.

or health benefits (94%) and they must rely on unregistered private medical practitioners for their healthcare (CDPR 2014). Following on from the previous more descriptive part, the following sections will further analyse the construction material value chain, in particular the topics of market structure; import, export, and demand trends; recycling; public construction; prices and taxes; and climate-mitigating actions.

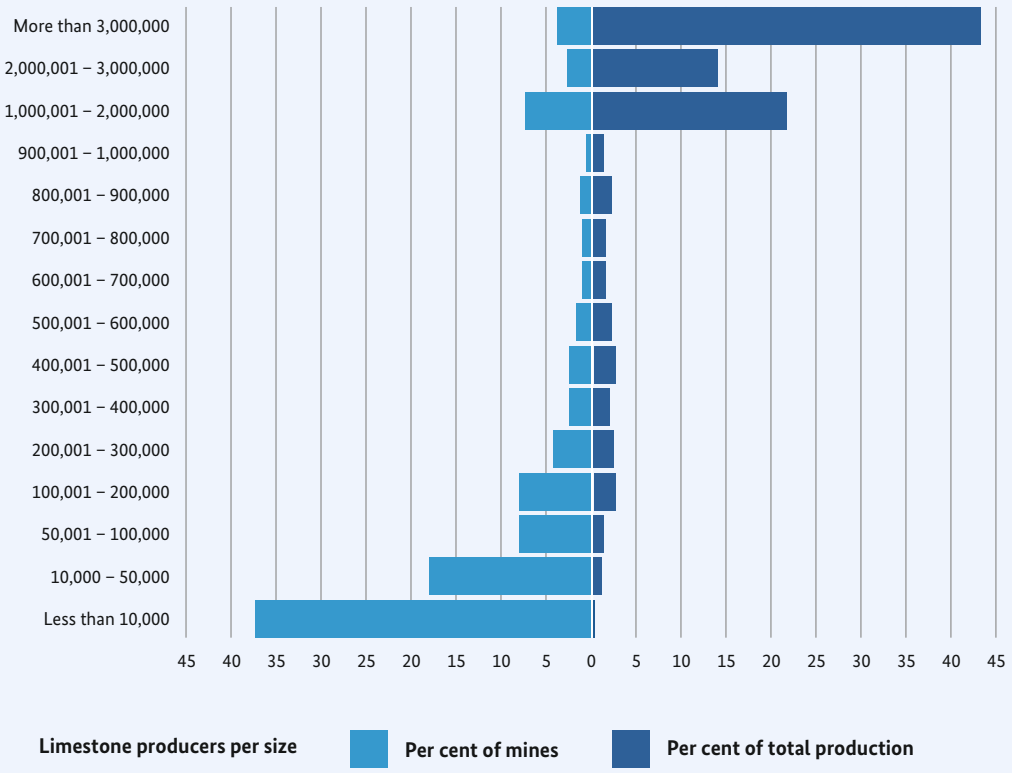
MARKET STRUCTURE

Despite happening entirely at the national level, value addition in the construction raw materials sector nevertheless differs based on the commodities produced and the specifics of their production. While brick making and aggregates manufacture are dominated by a vast number of operations that are not industrial in size, cement manufacture is composed of industrial scale operations and can even be characterised as an oligopoly market, where large players have partial pricing control (IBEF 2020d). This size characterisation can be extended to the rest of the supply chains these commodities are a part of as small extraction sites generally work with other small actors due to the volumes produced and transported.

There are however some outliers in terms of size in the limestone production stage. As outlined above, 95% of limestone production is geared towards cement production and tends to be vertically integrated with it. At the same time, all formal producers combined, representing 71% of overall producers, produce less than 200,000 tonnes per year, amounting to about 5% of the official limestone production. It is likely, although this has not been confirmed, that smaller operators supply the other value chains, as industrial cement production relies on its larger, captive mines. These small producers would thus extract the raw material then used for soil conditioning, sculptures, medicines, cosmetics, toothpaste, paper, plastic, paint, and in other materials as both white pigment and cheap filler (IBM 2020d)[19].

[19] These supply chains are not currently known as they are outside of the scope of our research and the stakeholders that were consulted on the matter did not have an inkling of non-cement limestone supply chains.

Figure 7 – **Limestone production and size of operators, India (Source: IBM 2020d)**



IMPORT, EXPORT AND DEMAND TRENDS

Rajasthan is the country's biggest producer and the source of 20% of the national production of limestone (IBM 2020d). This production is complemented by the annual imports of 24.4 million tonnes in 2018-19, which represents an increase of 17% from the previous year's imports and 6.5% of the limestone mined in the country (IBM 2020d). Over the same period India exported 3.88 million tonnes of limestone, 96% of which to Bangladesh, a comparatively small volume, although representing a 38% increase in comparison to the previous year (IBM 2020d). The geographical destinations of these imports are unknown but would likely be limited to the proximity of their harbour of arrival due to transportation cost issues.

Furthermore, Rajasthan officially also produces 99.999% of India's mined gypsum[20] (IBM 2020b), with a national mine production of 2.05 million tonnes. Assuming that the production ratio of mine vs artificial gypsum (IBM 2018a) remained somewhat consistent over the last years, this means that India has produced somewhere in the vicinity of 3.51 million tonnes of gypsum in 2017-18. In parallel the country imported as much as 4.06 million tonnes of gypsum and only exported around 111,000 tonnes in 2015-16 (IBM 2018a); figures that are consistent with the main destination of India's gypsum production being the national cement industry.

[20] In the case of gypsum, it should be noted that mining represents only 58.4% of India's total gypsum production. The rest coming as by-product of salt pans (4.7%) and of several chemical production and industrial processes (36.9%), such as: borax and boric acid production, aluminium fluoride and hydrofluoric acid production, phosphoric acid production, and flue gas desulfurization in fossil fuel plants, including coal plants (IBM 2019d).

Both limestone (95%) and gypsum (99%) are nearly exclusively destined for the manufacture of cement (IBM 2019d, IBM 2020b). The total installed capacity of Indian cement plants in 2018-2019 was calculated at 537 million tonnes per year, with an additional 350 mini cement plants adding 11.1 million tonnes per year to that total.[21] The actual production of these plants was reported at 337 million tonnes, a 13% increase from the previous year. The combined installed capacity and production of the States of Haryana, Rajasthan and Uttar Pradesh was calculated at respectively 119and 54 million tonnes during the same period[22] (IBM 2020a). No cement production was identified within Delhi NCT.

In the absence of exploration and development in the gypsum sector, the forecasted growing demand for cement will increase the reliance of India on imports and synthetic gypsum (IBM 2020b, Times of India 2020a), which somewhat contradicts IBM claims in the yearbook that "India's domestic resources of gypsum are large enough to meet increased demand" (IBM 2020b). Similarly, India's limestone import dependency would rise from 0% to 20% if no new reserves are identified in the coming 20 years (IBM 2019d).

In contrast to limestone and gypsum, India did not until recently import significant quantities of sand, yet the coastal States of Tamil Nadu, Karnataka and Kerala imported sand from Malaysia for the first time in 2017 (The Tribune 2019; CSE 2020) which could represent the emergence of an import market. However due to sand's bulkiness it is unlikely that imports will supply Delhi. The capital will likely continue to rely on closer to home sources, which include riverine deposits in Uttar Pradesh and parts of Haryana along the Yamuna river, agricultural fields in Haryana, and remnants of inactive rivers in Rajasthan (MoM 2018), as well as reportedly quarries within Delhi NCT.[23] Most of these sources are informal at best. Indeed, according to the Indian Minerals Yearbook 2015, published by IBM, sand production in the country in 2014-15 was 2.1 million tonnes, yet this figure is a clear underestimation of the actual production as domestic sand demand in 2016 was calculated to be at 750 million tonnes and estimated to double by 2020 (GIZ 2016; Mahadevan 2019), illustrating the size of the non-regulated sand sector. This demand-supply gap is filled by informal and/or illegal activities, which are thought to fetch 250 million USD (209 million EUR) every year (ABC 2017) and has also been noted to lead to the mixing of low-quality sand with usable sand which could lead to structural failure in buildings (MoM 2018).

The lack of brick earth licenses makes the systematic estimation of production and its location to any level of precision impossible. Recent kiln-identification pilots using satellite imagery have shown that the number of kilns in the survey area was underestimated by 28%, despite dedicated rare efforts having been made to conduct a census of kilns in the region (Misra et al 2020). At most it can be said that brick kilns favour operating at the outskirts of the activities they supply in order to keep transportation costs as low as possible and minimise travelled distance and thus potential breakage of bricks.

With the exception of cement, whose consumption is expected to grow from 328 million tonnes in 2019 to 379 million tonnes in 2022 (IBEF, 2020d), numbered estimates of future demand for materials are not available. However broad trends have been described by the consulted stakeholders and are congruent with the planned investments of the Indian Government both in housing and in infrastructure development. The amount of sand and aggregates needed for the manufacture of concrete has already delayed several civic projects in the country (CSE 2020) and future demand for these structural materials will likely only make these shortages more evident. The demand for drywall, plaster of Paris, and fly ash bricks is also projected to keep growing.

Meanwhile the demand for traditional bricks is either seen as remaining constant or decreasing somewhat according to the consulted construction stakeholders; a difference in forecasted demand that could be attributed to the emergence of fly ash bricks as a suitable construction material (Interview with Vikash Nayak) or to the progressive relegation of bricks towards exterior walls (Interview with Pradip Chopra).

[21] Mini cement plants are loosely defined by their production capacity, namely less than 200 tonnes a day or 66,000 tonnes per year.

[22] More specifically the respective installed capacity and production of the States was calculated as (in million tonnes): Haryana: 7.2, 1 | Rajasthan: 84.17, 49.54 | Uttar Pradesh: 27.58, 3.39

[23] These later claims could not be verified by our research.

RECYCLING

Materials generated by construction and demolition (C&D) waste recycling (henceforth referred to as recycled materials) offer a potential complement to natural production and could make-up a non-negligible part of certain material needs of the construction sector (such as aggregates, manufactured sand, concrete blocks, paver blocks, tiles, etc...). To that effect local urban governments across the country have established C&D waste recycling plants and as of January 2020 there were three such plants in Delhi and a further four more such plants were in the works, all operated under a public-private partnership agreement by IE-ISL (IL&FS Environmental Infrastructure Services Ltd, India's biggest integrated waste management company). The development of this recycling capacity has not integrated the city's existing informal material recycling sector.

With initial teething challenges overcome,[24] the legal framework for the use of recycled materials is in place and has been furthered bolstered by local-level requirements based on an overarching national policy.[25] For example, Delhi government authorities are required to incorporate in their tenders a clause specifying that builders need to use at least 2% of recycled materials in buildings and 10% such material in roadworks. In practice, however recycled materials are far from achieving their full potential as a source of responsibly produced construction materials for a number of reasons (CSE, 2020):

- There is a lack of confidence in recycled products, which are perceived as being inferior in quality, amongst private sector operators despite their official acceptance and endorsement by authorities;
- Public agencies that are supposed to make use of set percentages of recycled materials in public works have failed to do so up until now;
- Target recycled products and markets appear not to align with the functioning of the sector.
- On the one hand recycling facility operators are asked to manufacture value added products such as concrete blocks and pavers, for which they may not have the required expertise.
- On the other hand, these recyclers have refused to sell these products to small- and medium-scale buyers, who are said to be more innovative in their use of materials.
- Pricing issues have also been problematic. While the stated objective of the Ministry of Housing and Urban Affairs was that recycled materials should be cheaper or on par with conventional building materials, applicable taxation rates can make recycled materials non-competitive. For example, red bricks are taxed at 5 per cent while recycled C&D waste blocks were taxed at 18 per cent as the latter are considered manufactured products and thus subject to higher Goods and Service Tax (GST) rates.

In line with these challenges, field surveys conducted by CSE (2020) have shown that the two biggest reasons for the low uptake of recycled materials are: 1) the higher cost of the recycled product owing to a high GST rate (18 per cent) (higher than conventional products); and 2) the poor quality of the products manufactured at existing recycling facilities. The production of recycled materials is also impacted by significant hard and soft infrastructure bottlenecks that limit the recollection of the raw material – i.e. the C&D waste. This is an issue both at the national level and in Delhi (CSE 2020).

The design of the recycling schemes and infrastructure was a top-down process that did not integrate the existing market for recyclables or the informal actors that operated that sector; as a result, the newly developed formal recycling sector has to compete with the informal sector, creating redundancies. This competition has even led to some material that was being recycled as low-value fillers (used for backfilling, elevation improvement or in road construction) to be diverted towards the recycling centres where higher value materials are manufactured.

On paper, the established network of C&D waste collection points established throughout Delhi, which in turn feed the recycling centre, is a good solution. In

[24] Most notably the Bureau of Indian Standard specifications for aggregates for concrete (IS:383-1970) stated that concrete could only be made with 'naturally accessed material'. This wording, which has now been changed, disincentivized most of the operators from sourcing aggregates from C&D waste due to potential compliance risks.

[25] Specifically, MoEFCC's 2016 Construction and Demolition Waste Management Rules, which created the comprehensive legal framework needed for recycle and reuse of C&D waste in the construction industry.

practice, however, this ignores the economic model of C&D waste disposal, where this material is treated as a saleable commodity and not waste. Compliance with these new demands can therefore create more costs for builders. As such, C&D waste dispatch to these collection points or recycling centres is often ignored by construction sites, even though it is legally required (CSE 2020). Furthermore, this network of collection points is not well known amongst operators and many collection points do not have enough space for the incoming waste. Transporters are also impacted as transportation of C&D waste to official collection points may require longer commutes that generate additional costs. And at arrival they may be denied entrance or may have to pay a bribe to enter, further raising costs and encouraging them to dispose the waste illegally, creating multiple hazards and negative impacts throughout the city (CSE 2020).

Despite the aforementioned lack of detailed data, the overall demand trends coupled with the available formal production indicators and recycled material use rates seem to indicate that formal production of key construction commodities and their raw materials can currently not keep up with the forecasted increased demand from the construction sector. While a dramatic increase in recycled materials uptake and production could help solve some of the supply issues, this would still leave gaps in the supply, in particular for limestone and gypsum. As a result, the sector will have to rely more heavily on imports and new extraction sites will need to be identified. However, this will likely result in more expensive raw materials in the case of imports and developing new assets will take time if done properly.

PUBLIC CONSTRUCTION

The growth of the Indian construction sector is significantly driven by public infrastructure and housing projects. But the public sector is also well present amongst the extraction stage. For example, Rajasthan State Mines and Minerals Ltd. a SOE of the Government of Rajasthan is the largest producer of steel grade limestone and the leading producer of gypsum in India. The manufacturing sector however is much more dominated by the private sector as no evidence points towards the involvement of state agencies in traditional brick kilns and as only one of the 175 cement plants with a capacity over 1 million tonnes is a public undertaking (IBM 2020a). And while a number of public agencies play a substantial role as both producers and clients, their environmental and labour practices as well as compliance with the applicable regulations do not differ notably from the practices of private sector actors. Monitoring of public sector works is more limited than that of the private sector (Interview with Adarsha Kapoor); which as noted in prior sections, is already very limited due to capacity constraints.

Similarly, when queried none of the construction stakeholders consulted made any mention of additional efforts by public projects to source materials that are at minimum produced in strict compliance with regulatory demands. Drivers of material and supplier selection are strictly limited to price and quality considerations. This attitude towards sourcing is reflected for example by Delhi government departments failure to comply with the city's rule mandating the use of recycled materials to the height of 2–10% in public projects, which prompted Delhi's Public Works Department (PWD) to reissue an advisory note on the matter to all departments.

PRICES AND TAXES

Information on prices was not forthcoming as this information was either considered too sensitive or not known to the persons in charge of the site. However, based on the limited information collected it was possible to establish that construction raw material supply chains are very cost-competitive, characterised by thin margins. Currently supplier selection is based overwhelmingly on price, and as a result, operators compete to lower the prices as much as possible in order to be competitive. Externalising costs such as compliance or maintaining wages as low as possible are amongst the most efficient strategies to do so.

Supply chains have thus reached an equilibrium of sorts that is entirely cost based and due to the limited existing monitoring and enforcement avoids compliance wherever possible and cost-effective. This analysis was confirmed by the consulted stakeholders and sector experts.

As for prices, information on taxes paid was not forthcoming as this information was considered too sensitive by the consulted operators and it is thus not currently known which taxes are paid in reality. And while the implicit perception of reports referring to revenue losses caused by informality is that operators either pay all of their taxes or none at all, the reality

is less black and white as not necessarily all taxes are paid in formal operations – under-declaration of sand production, for example, is a common practice (NGT 2020; CSE 2016). Furthermore, the payment of "taxes" by informal actors has also been noted. These range from compensatory payments to landowners (which were reported for brick earth extraction and some sand mining operations[26]) to the payment of bribes to local officials, and while not confirmed could also include the payment of some formal taxes.

It should also be noted that while these are not tax payments these activities do contribute to the local economy not only by providing both direct and indirect earning opportunities, but they also supply local areas with the construction raw materials they need. This is not to say that the non-payment of taxes or corruption should be condoned but rather to highlight both that information on the revenues generated by construction raw material value chains is limited and to reflect the breadth of horizontal and vertical linkages construction raw materials create and the contribution these make to the local economy, even when operating under dubious legal circumstances.

Despite these information gaps, the implementation of the GST, which has replaced a number of indirect taxes such as excise duties or VAT since 2017, has been noted as creating some issues at various stages, specifically:

- The filling of the related paperwork has been noted as being taxing on the resources of small operators.[27]
- Categories of applicable GST have impacted the desirability of recycled materials as these are considered manufactured products, including recycled aggregates and concrete blocks, and are thus taxed at 18%, while natural aggregates and traditional bricks are taxed at 5% (CSE 2020).

[26] Those are also noted to exist for stone quarries where business enterprises enter into partnership with villagers who own the land and run mines with or without appropriate licenses from the government (ABA 2020.

[27] According to field consultations of a transporter and a cement storage unit operator.

EXISTING CLIMATE-MITIGATING ACTIONS

It was estimated in 2011 that there were around 31,000 companies in the construction industry in India, 29,600 of which are small-scale enterprises, around 1,050 medium scale, and around 350 large scale (Negi and Ahuja 2017). This industry contributed somewhere between 22% of the country's total carbon emissions in 2006 (Maity et al. 2015) to 10% of said emissions in 2010 (ADB, 2015; MoEFCC, 2015; Jajal and Mishra 2018). Given the magnitude of the country's construction boom any decrease in the carbon footprint of India's construction sector would go a significant way towards achieving the country's 2° target. To that effect, several government policies have come into play in recent times to encourage, incentivise and, where necessary, mandate the implementation of sustainability principles and practices in the construction sector. These efforts can be broadly classified into regulatory demands for the uptake of alternative materials and the use of certifications, the latter being based either on incentives or obligations. These approaches also led to the update of material standards to make said alternative materials compliant with building codes (MOEFCC 2016) and integrate them into certifications.

The Fly Ash Notification is one of these key policies. It mandates the use of fly ash in building materials for construction projects falling within a determinate radius of coal or lignite based thermal power plants (GIZ 2016. In certain states (Odisha, Madhya Pradesh and Bihar) this notification has also been complemented by state level notifications and the Bureau of India Standards (BIS) has issued production and performance standards for fly ash bricks in line with these efforts. Furthermore, the use of fly ash bricks is also taken into account during the evaluation of public tenders (GIZ 2016).

In addition, guidelines for the use of C&D waste recycling and reuse are also being developed. The Ministry of Housing and Urban Affairs (MoHUA) has drafted a Strategy for Promoting Processing of Construction and Demolition (C&D) Waste and Utilisation of Recycled Products (MoHUA 2018). Concrete steps have also been taken to facilitate the adoption of this strategy, for example the Building Materials & Technology Promotion Council of MoHUA has developed a Ready Reckoner for the Utilization of Recycled Produce of Construction and Demolition Waste (BMTPC 2018). Yet while this reckoner clearly defines the imple-

mentation process along with the duties and responsibilities of various stakeholders involved, including the local authorities, its usage remains limited (TERI 2019). According to The Energy and Resources Institute (TERI) the Ministry of Micro, Small & Medium Enterprises (MoMSME) is working with state agencies and industry clusters in targeted sectors, which does not include construction suppliers, to support them in the adoption and mainstreaming of energy efficient practices. This takes the form of training as well as fiscal incentives.

A focus on climate change mitigation has translated into a focus on interventions looking at architectural and civil engineering designs for low energy consumption,[28] as well as promoting adequate waste management, material circularity and the selection of materials with lower embedded CO_2.[29] These elements favour the mitigation of CO_2 emissions above all, and do not take into scope the mitigation of impacts that are difficult to quantify (such as biodiversity or ecosystem (services) conservation). Furthermore, with the exception of embedded CO_2 considerations, these interventions are focalised on the construction site and have few, if any provisions, that consider the supply chain of materials and the conditions in which their extraction, processing, trading, transport, processing and manufacturing takes place. Social issues in the supply chain, such as human rights or labour conditions, are not taken into account.

The Energy Conservation Building Code (ECBC), Indian Green Building Council (IGBC) and Green Rating for Integrated Habitat Assessment (GRIHA) are the most widely implemented standards in the country and share the aforementioned shortcomings.[30] More specifically:

- ECBC aims to optimise energy savings and has influenced the legislation of most States. In order for a building to be considered ECBC-compliant, it would need to demonstrate energy savings of more than 25% during building usage (MoEFCC 2018). The code does not have provisions that go further than the energy consumption of the building during its usage.

- Of the more than 50 elements of IGBC, only one (Sustainable Building Materials, BMR Credit 1) can be seen as taking a mineral supply chain perspective as it aims to "encourage the use of building materials to reduce dependence on materials that have associated negative environmental impacts"; and this element is not mandatory. Furthermore, of the 5 components of this element 3 are concerned with C&D waste and recycled material usage and 1 with the use of wood-based products. The lone component concerned with mineral supply chains requests projects to "ensure at least 20% of the total building materials [...] are manufactured locally within a distance of 400 km"; a wide definition of local sourcing that does not take into account the conditions in which these materials are extracted or manufactured.

- And while SSP Credit 10 (basic facilities for construction workforce) is a positive development from a human rights and labour conditions perspective, it should be noted that it is the sole such consideration under the standard, and that compliance is not mandatory. Furthermore, its gender/maternal components are not applicable to smaller operations.

- While GRIHA is composed of 29 different criteria, only 3 look at supply chain considerations, and none of these are mandatory to pass certification.[31]

- Furthermore, the suggestion to use "Stones from India" as part of criteria 19 (utilisation of alternative materials in building) and 21 (alternative materials for external site development) in order to encourage the use of alternative materials to conserve finite natural resources, makes no mention as to how to take into account the conditions in which these materials are extracted. This approach could even put additional stress on ecosystems

[28] Currently India's residential and commercial buildings account for 24% and 9% of the country's total electricity consumption (TERI 2019), which leaves substantial space for energy savings.

[29] Material circularity shows significant promise in decreasing CO_2 production as aggregates production from recycled construction and demolition waste has been shown to produce 40% less CO_2 than the quarrying, transport and manufacturing of hard rocks (GIZ 2016).

[30] While there is a non-negligible implementation of the Leadership in Energy and Environmental Design (LEED) standard, which does look slightly more into supply chain issues, this is not an indigenous standard and as such Indian stakeholders only have extremely limited leverage on it.

[31] Namely criteria 19, 20, and 21. See GRIHA User Manual (Volume I), v.2019 for further details. As accessed via http://www.grihaindia.org/sites/default/files/pdf/Manuals/user-manual1/mobile/index.html on the 02.02.2021

that are already suffering from over-quarrying, such as the Aravalli mentioned previously.

- Nevertheless criterion 23 (safety and sanitation for construction workers) which aims "to ensure safe, healthy and hygienic working, and living conditions for construction workers" is a notable positive development. Especially as the criterion incorporates gender/maternal considerations for all projects.

Incentives are also being deployed to promote adoption of more sustainable practices. Given that the sector is highly price-sensitive and final consumers are not sensitive to environmental performance for its own sake (Interview with Pradip Chopra), builders that certify their projects as green receive a 5% additional FSI allowance, or in other words can build 5% more floorspace.

And while the uptake of certifications has been non-negligible due to these additional construction entitlements as well as their potential as a marketing tool (Consultation of builders), in practice the impact of these incentives on both construction practices and energy consumption could be more limited than their adoption suggests. Not only are there currently no systems to systematically calculate the actual impact of standard implementation on a building,[32] but a building can receive the aforementioned benefits of a green certification merely by registering with one of the main schemes. The actual implementation of such measure is only verified by GRIHA (TERI 2019), and agencies apparently lack the capacity to do so (Interviews with Adarsha Kapoor and Pradip Chopra).

The Energy and Resources Institute (TERI) is working to build a national directory of 5000 energy efficient building materials for BEE and GIZ. The focus lies on energy efficient usage and energy consumption (at the manufacturing plant level). To do this, TERI needs to know where the manufacturing takes place and where the material comes from. This is an uphill task as it requires extensive data collection from organised and unorganised sectors and reaching out to material manufacturers to register their products as part of the directory. The directory promises to provide transparency and support the establishment of standards and labelling of building materials. In terms of getting producers to abide by energy efficiency standards, a particular challenge lies in the lack of finance of small- and medium-sized businesses in adapting to new practices. Instead, they need simple solutions to integrate energy efficiency. The Ministry for Medium, Small and Micro Industries accompanies the businesses on this journey, organising the activities in clusters, providing training and moving them gradually towards adaptation. The Ministry also has a financial incentives programme. Another challenge mentioned by TERI is the mental block regarding the usage of alternative materials. Customers are worried about the quality of alternative materials, for example perceiving red bricks as stronger than fly-ash bricks. Construction companies don't know where to source sustainable materials from and how they can ensure they do not pay more than for standard material. There is a distinct lack of awareness and information about alternative materials.

IMPACT OF COVID-19 ON CONSTRUCTION MATERIAL CHAINS

Effects of COVID-19 on the sector are not yet known as the measures implemented to fight the pandemic are still in flux and the form of the recovery measures to be implement is not yet final either.

At the level of forecasted demand for construction materials, after a moderate dip in 2020 demand is forecasted to be above the 2019 level in 2021 based on projected cement demand (IBEF 2020d). 2020 would thus have marked only a temporary setback from a construction material demand standpoint.

At the level of the operators only very anecdotal information could be collected. Based on the complaints from small operators the possibility that smaller operators, less able to deal with negative cash flows, will be harder hit and potentially driven out of business exist. Such impacts on the reserves of all operators are likely to constrain reinvestment in the short term, in particular for small operators.

[32] Even for ECBC, which is arguably the standard whose narrow focus makes its impact the easiest to measure, there are currently "no quantifiable mechanism in place to track the impact of ECBC adoption through regular reporting or surveying of energy consumption" (AEEE, 2017)

4. Indonesia

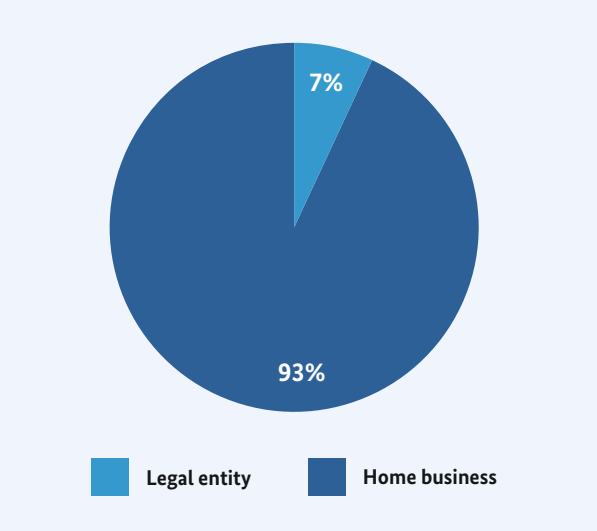
4.1. Country overview

About 34% of India's population lives in urban Indonesia is the 4th most populous country in the world, with a growing population and high rates of urbanisation. The share of people living in urbanised areas grew from 22% in 1980 to 31% in 1990 (Supriadi and Sui Pheng 2018), 42% in 2000 and 54% in 2015 and is expected to reach 71% in 2030, meaning 209 million people (Asiagreen Real Estate n.d.). Indonesia counts 11 cities with a population of more than 1 million people. Indonesia was the world's 16th largest economy in 2016 and is expected to be the 7th largest in 2030 and the 4th largest in 2050 (ITE Build & Interiors 2016).

Indonesia has important natural resource deposits, in particular oil and natural gas, coal, copper and nickel, gold and bauxite (van der Eng 2014). However, the mining sector's contribution to the national economy has been falling in recent years due to certain legislative reforms – it's contribution in 2018 was only 5% (Wacaster 2014; PwC 2019). At the local level, however, it remains a significant economic contributor, often making up the largest proportion of local government revenues in areas where there is a large mine or important ASM activity (EITI Indonesia 2015).

Indonesia produces many different industrial or development industrials, including construction raw materials. The sector can roughly be split into so-called legal entities and home businesses. The former tend to be formal establishments with a license while the latter tend to be small-scale and informal businesses. The most important construction raw materials by volume of production in 2018 were (starting with the highest) sand, stone and andesite, gravel, granite, limestone, soil, and clay (BPS 2019). Across all materials, the quarrying sector in 2018 counted 731 legal entities with 27, 663 workers and 116,636 home businesses with 366, 897 workers, which is a total of 394,560 people working in the sector, an overwhelming majority of which in the small-scale and informal home business sector (see Figure 8).

Figure 8 – Percentage of quarrying sector workers in legal entities and home businesses, Indonesia (BPS 2019)



Indonesia's construction sector is the third-largest contributor to the economy, providing around 11.1% of GDP in 2018, having grown from 6.5% in 2013 and 9.96% in 2016, supporting a labour force of at least 7.72 million people (Oxford Business Group 2019; Abduh and Pribadi 2014; ITE Build & Interiors 2016). This growth was likely triggered by the promotion of infrastructure development by the government under President Joko Widodo, who tripled infrastructure project funding in 2015 (HFW 2019; Oxford Business Group 2019). In 2018, the Ministry of housing, which is responsible for providing affordable housing to low-income households, received 26% of the infrastructure budget. The Ministry of Transportation re-

ceived around 12% (Chong and Stefano, n.d.). Indeed, around 820,000-920,000 new housing units are needed every year in the country to meet the demand of a growing population. 400,000 units are built by the private sector each year, 150,000-200,000 are built through public sector initiatives, which leaves around 220,000-370,000 households having to rely on informal housing (ITE Build & Interiors 2016). Other infrastructure efforts include the Medium-term master plan (RPJM) and economic acceleration master plan (MP3EI) which made it a priority to create sustainable infrastructure better connecting six parts of Indonesia, including Java (Abduh and Pribadi 2014).

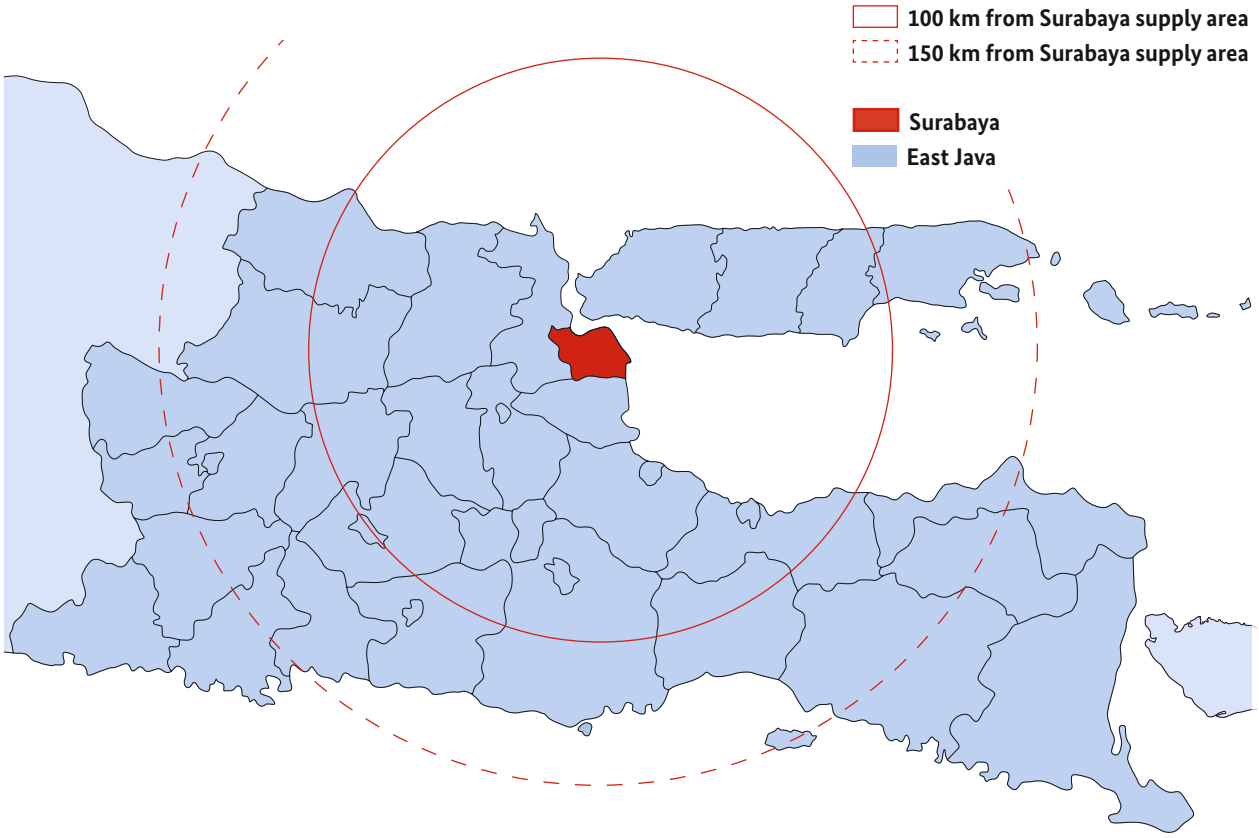
The best performing part of the construction sector is infrastructure development, with 60 billion USD (50.2 billion EUR) worth of projects having been given to Chinese investors as part of the Belt and Road programme, half of it for hydropower plants. Railway projects and toll roads are other important infrastructure initiatives. The government has aimed at increasing private sector participation in infrastructure development, amongst others through Public Private Partnerships (Rahmansyah 2020). The second and third best performing construction sub-sectors are logistics and low-cost apartment buildings. In Jakarta for example, the government is planning to build 14,000 apartments between 2019 and 2024 (Turner & Townsend 2019). And in 2015, the President announced the One Million Houses project, aiming at building at least one million houses per year, 70% of which for low-income families. In 2018 the government exceeded that target, with 1.13 million new houses having been built, up from 700,000 in 2015, 805,000 in 2016 and 905,000 in 2017. 20% of the budget for the construction came from the government, in particular for low-income households, 30% came from a government mortgage programme, and 50% of houses were constructed with funds from individuals and companies (The Jakarta Post 2019).

The Indonesian construction sector consists mainly of small-sized companies, who make up nearly 90% of registered construction contractors.[33] However, the biggest share of construction projects in terms of value go to large contractors, namely 85% in 2012, reflecting the strong hold that large contractors have over the market and larger projects (Abduh and Pribadi 2014). The majority of the construction sector workforce in Indonesia do not have access to these large, formal markets – the sector employs only 269,000 full time employees, whilst the vast majority (4.5 million people) are skilled and unskilled part time workers, many of whom work in small companies or the informal sector (Supriadi and Sui Pheng 2018). Growth in the construction sector remains strong – it was 7.9% between 2005 and 2009, and 7.2% between 2010 and 2014. This is reflected also in employment growth rates, which between 2005-2009 was 4.7%, and between 2010-2014 it was 5.4% on average (Aswicahyono, Hill, and Narjoko 2012). Whilst sector performance is strong, Indonesian companies face increasing competition from foreign firms, coming mainly from Japan, China, South Korea and India (Suraji, Pribadi, and Ismono 2012).

The metropolitan area which is the focus of this research is Surabaya, the capital of the East Java province. East Java is the second most populous province, but outward migration has kept the population growth low at an average of 0.7% per year between 2000 and 2010 (International Labour Office 2013). The rate was still at 0.66% in 2016 (Knoema nd). Employment rates are higher compared with other provinces in the country, and East Java has the second highest GDP after Jakarta. The province is structured into 38 districts and under those 29 regencies and 9 municipalities (International Labour Office 2013). The provincial capital Surabaya is the second largest city in Indonesia after Jakarta, with 2.85 million inhabitants (Asiagreen Real Estate n.d.). Population growth is around 0.65% per year, and population density 8,500 inhabitants per square kilometre (Ostojic et al. 2013). The construction industry contributes 10% to the city's GDP. The main industries in the city are trade, hotels, restaurants, and manufacturing (Asiagreen Real Estate n.d.). Outside of the urban area, in East Java in general, most people work in agriculture, namely four out of ten people (International Labour Office 2013). Surabaya's port has a high importance for the country and for Southeast Asia, with more than 3.2 million containers passing through the port in 2015. The average economic growth in the city was 7% per year between 2011 and 2015 (Asiagreen Real Estate n.d.). The city has a large informal sector across industries, with the formal sector only providing 44.1% of employment (Ostojic et al. 2013). Infrastructure development is an important sector in Surabaya. The Suramadu bridge between Surabaya and Madura Island has been completed in

[33] Firms are classified by their working capital. Small firms have a working capital of maximum 1 billion IDR (58,000 EUR), medium firms have a working capital between 1 billion and 10 billion IDR (580,000 EUR) and large firms a working capital above 10 billion IDR (Supriadi and Sui Pheng 2018). In 2013, there were 117,042 registered construction contractors, of which 89.9% were small-size, 9.4% medium-size and 0.8% large-size.

Map 2 — **Surabaya area of supply**



2009 and an upgraded railway between Jakarta and Surabaya as well as monorails and trams are in planning. Local developers dominate the city's construction market. (Asiagreen Real Estate n.d.). Surabaya's GHG emissions in 2010 totalled 8.6 million tonnes of CO_2 equivalent, of which 35% came from industrial energy use. Surabaya received the 2012 ASEAN Environmentally Sustainable City Award and since 2006 the city has regularly received the highest environmental awards amongst all Indonesian cities (Ostojic et al. 2013). The area of interest for this study lies within a radius of around 100-150km around the city of Surabaya, as demonstrated in Map 2.

East Java is the province with the largest number of quarrying establishments in the whole of Indonesia (see Figure 9), namely 13,465 in total, of which 13,387 are home businesses and 78 are legal entities. This count includes sand, stone and andesite, gravel, limestone, quartz, marble, clay, soil, feldspars, granite, kaolin, and a number of less important materials (BPS 2019). The importance of East Java for the quarrying sector is even more pronounced when looking at worker numbers in the home business sector, which is the highest of any Indonesian province (see Figure 10). Although home businesses tend to employ fewer workers per entity – an average of 3 workers per home business compared with 35 for legal entities – they nevertheless remain the more important employer, comprising of 93% of the province's total quarrying workforce. This importance for employment is highlighted by an analysis of the demographics of the home business workforce. The home business construction raw materials sector is an important employer for women – whilst legal entity workforces tend to be male dominated, the home business construction raw materials sector has a much higher proportion of female workers (see Figure 11). The home business sector is also a slightly better employer of unskilled or uneducated workers, comprising almost completely of workers who do not have any qualifications after high school (compared to at least 10% of legal entity workers who have achieved baccalaureate or higher) (BPS 2019).

The home business construction raw materials sector also tends to be more of a 'family business' comprising of workers who are categorised as unpaid workers, but who are typically family members who might help with managerial and excavation tasks. This proportion of family workers reflects the importance of the sector for the income of whole households, who often work together in the production and processing of construction raw materials. Foreign workers are hardly present in the sector.

Figure 9 – Number of quarrying establishments by province (BPS 2019)

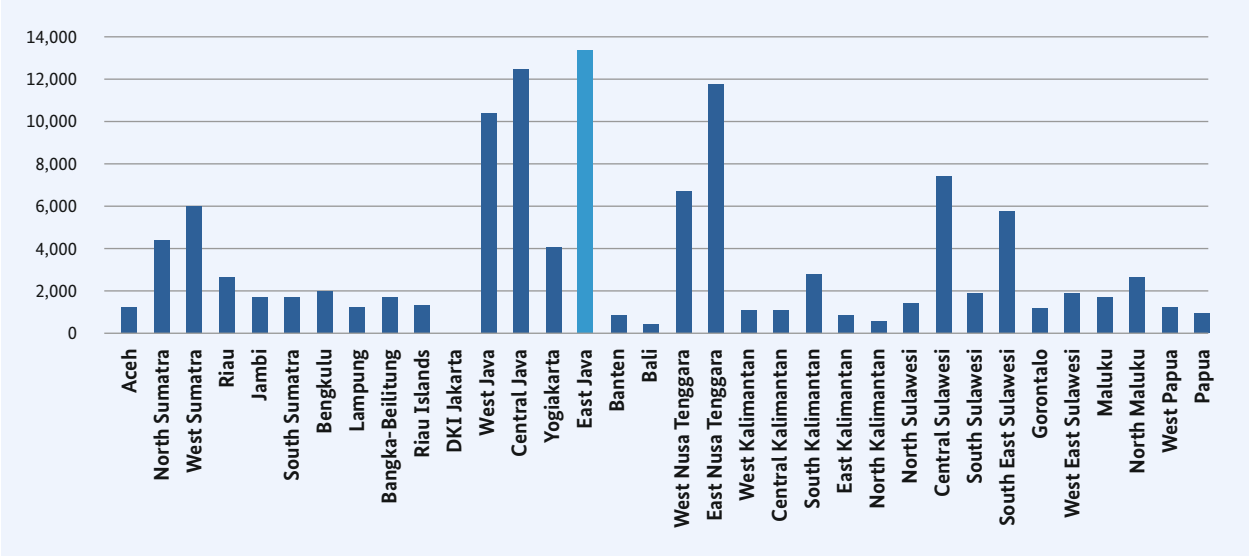


Figure 10 – Number of quarrying workers per province [home businesses] (BPS 2019)

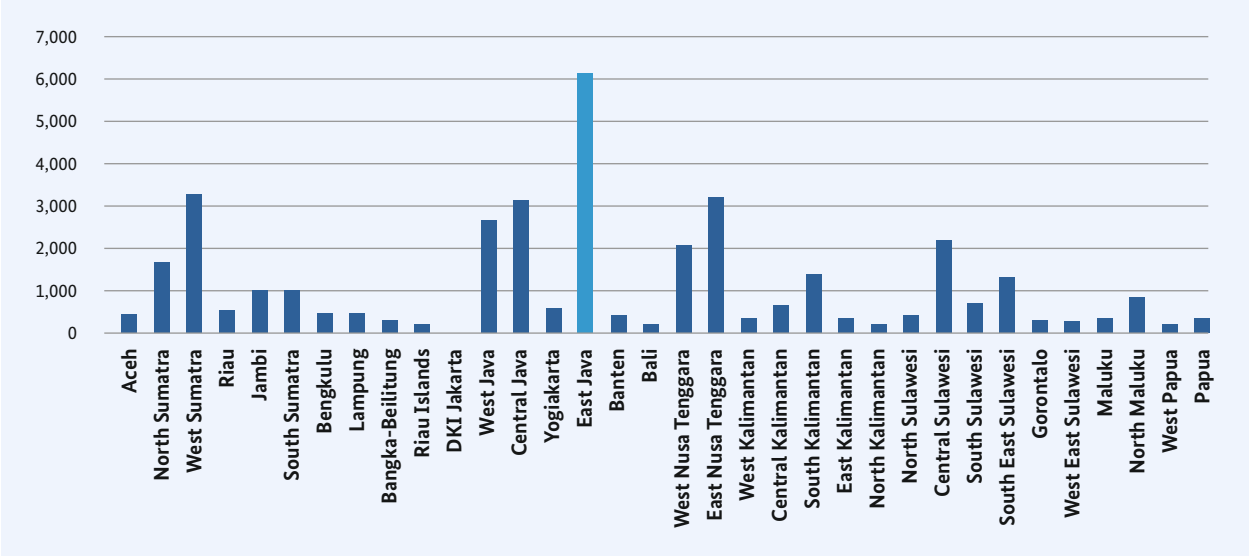


Figure 11 – Percentage of female and male workers in quarrying establishments, East Java (BPS 2019)

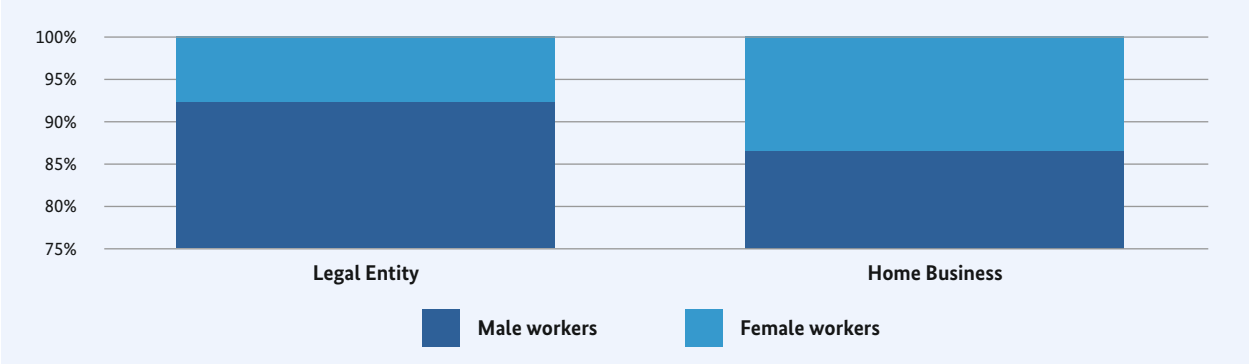
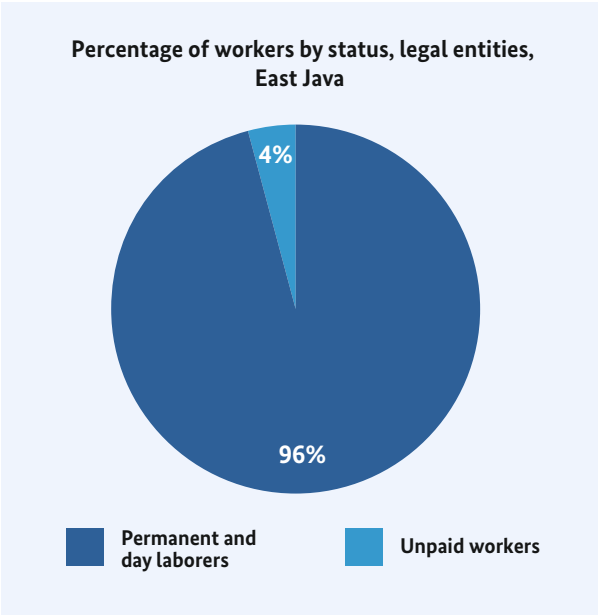


Figure 12 – **Percentage of workers by status, home businesses and legal entities, East Java (BPS 2019)**



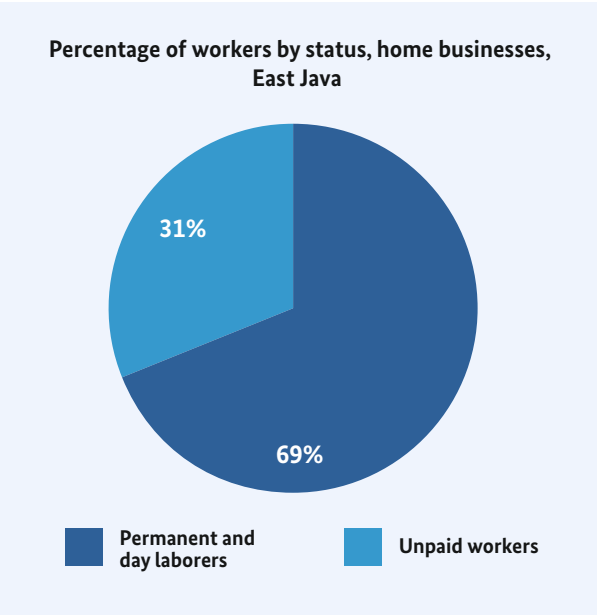
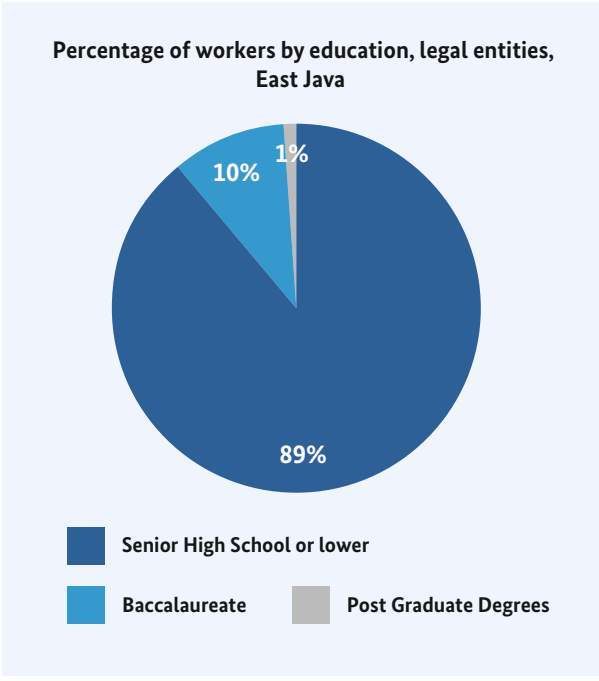
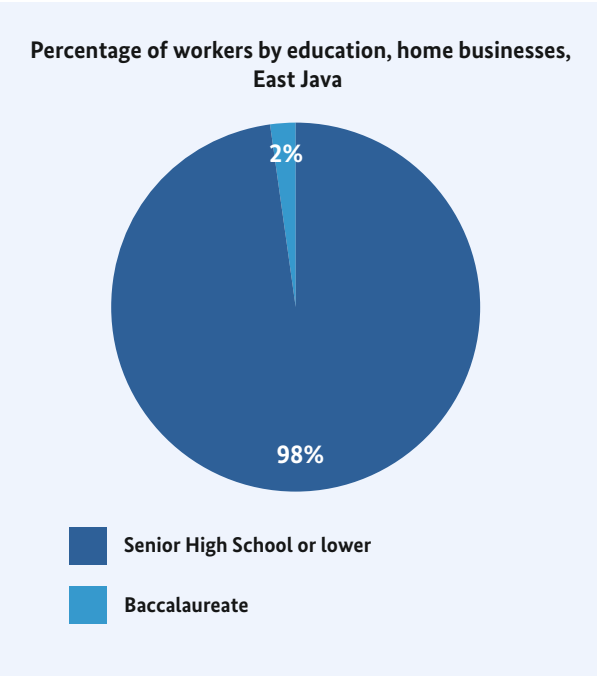


Figure 13 – **Percentage of workers by education, legal entities and home businesses, East Java (BPS 2019)**





LEGAL AND REGULATORY FRAMEWORK

Two branches of the Ministry of Energy and Mineral Resources (MEMR) are responsible for governing the mining sector at the national level, namely the Directorate General of Mineral and Coal (DGMC) – responsible for policy formulation and implementation and granting national level licenses, and the Geological Agency – responsible for determining license areas for auction and providing geological research and services. At the provincial level, also two government bodies are responsible for managing the mining sector, namely the governor who is responsible for granting mining licenses in the province, as well as related permits, and the ESDM, the provincial agency of the MEMR, responsible for monitoring and supervision of mining in the province (Indonesian Mining Institute 2018). Trading licenses are issued by the Industry and Trade Service. Other agencies involved in the governance of the mining sector are at national level: Ministry of Environment, Forest and Climate Change, Ministry of Land and Spatial Planning, Ministry of Finance; and at provincial level: Environmental Agency, Forestry Agency, and Spatial Planning Office.

Indonesia's Government Regulation number 23 (2010) divides mining commodities into five classes, namely radioactive minerals, metal minerals, non-metal minerals, rocks, and coal. The raw materials that are subject of this study fall into the non-metal minerals and rock classes (Government Regulation 23 [2010]). They include sand, gravel, rock, limestone, clay, and quartz sand (Indonesia field interview 14).

There are three types of mining licenses in Indonesia: The mining business license (Ijin Usaha Pertambangan [IUP]) for large-scale mining; the special mining business license (Ijin Usaha Pertambangan Khusus [IUPK]) for state reserve areas for projects of national strategic interest; and the people's mining license (Ijin Pertambangan Rakyat [IPR]). Licenses for exploration and production are different (Devi and Prayogo 2013).

People's mining in Indonesia is artisanal and small-scale mining, meaning non-mechanised and labour-intensive mining. Local participation in the governance of ASM has been strengthened, which is why the Regent/Mayor is now allowed to issue artisanal mining licenses (Law 4/2009), to decide on areas for ASM (Law 22/2010), and to monitor and regulate ASM (Law 55/2010). ASM often occurs in the informal economy, not being formally authorised by the government. 90% of all ASM miners are considered illegal by the government (Devi and Prayogo 2013). As in many countries, the sector suffers from environmental, social and health risks. ASM is a widely unregulated industry, with the sub-national governments not being very involved in its management (Devi and Prayogo 2013). The government also does not consistently offer training to ASM in an effort to improve their activities, training only being available in certain provinces (Indonesian Mining Institute 2018).

A term related to people's mining and utilised in this report is the one of home businesses, which are typically small-scale businesses consisting of family members as managers, owners, and workers. They usually produce small volumes and use simple equipment. Home businesses are typically identified as being informal, or semi-formal, meaning they do not comply fully with the permit requirements of the government.

Law Number 4 of 2009 concerning Mineral and Coal Mining (Minerba Law) is the main law regulating the mining sector in Indonesia. The House of Representatives ratified the revision of the latest Minerba Law on May 12th, 2020. Under the new law, the People's Mining Area (WPR) can be maximum 100 hectares in size, up from 25 hectares in the previous version (Ramli 2020). The control of metal minerals is given to the central government. However, the management of non-metal and rock minerals as well as artisanal mining can be delegated to the regional government (Ramli 2020). The Minerba law also established the new Rock Mining Permit (SIPB). The SIPB is granted by the governor and can be requested by a regionally or village-owned business entity, a private business entity in the context of domestic investment, or a cooperative. The mining area can be maximum 50 hectares large. Small-scale rock permits will be granted by local governments.

According to the Minerba law, mining without a permit is punishable by a maximum prison sentence of 5 years, and a maximum fine of 100 billion IDR (5.8 million EUR). The same penalty is applicable for license holders who intentionally submit fraudulent reports or false information, for those holding an exploration license only but also conducting production operations, and for those processing, refining, transporting, or trading minerals originating from unlicensed mine sites.

The Minerba law also includes a Transportation and Sale License and a Mining Business License for Sales. The law however establishes that the MEMR does not

regulate processing activities that are not integrated with mining activities. Such processing licenses are issued by the Ministry of Industry (Lexology 2020).

The revised mining law has been criticised for giving greater rights to mining companies, including longer contracts and larger concessions. Environmental groups have expressed concerns about the environmental repercussions that the new regulations will have (Jong 2020).

The governance and regulation of the mining sector is negatively impacted by two factors: The national and sub-national governments do not coordinate enough in implementing policies. Further, sub-national governments lack human resources and institutional capacity to monitor and regulate mining activities adequately (Devi and Prayogo 2013).

Additionally, the construction sector is subject to a layered permitting regime:

- An Individual Business Registration License (TDUP) provided by the regency or city government to individuals;
- A Business Entity Certificate (SBU) for Indonesian and foreign companies issued by the Construction Services Development Institution; and
- A Construction Services Business Licence (IUJK) provided by the regency/city government for local companies and the Capital Investment Coordinating Board for foreign companies.

Companies also must obtain several specific licenses before they are allowed to start construction activities, namely a land utilisation permit, a building construction permit, an environmental permit, and technical approvals. These are in general provided by the regional government (Rahmansyah 2020). Construction projects with a significant environmental impact must provide an Environmental Impact Assessment (Supriadi and Sui Pheng 2018). After the construction has been completed, a so-called Certificate of Worthiness must be provided in some regions. In others, the regional government might ask for regular reporting and inspections (Rahmansyah 2020).

4.2 Value chain overview and analysis

As in India, whilst construction raw materials supply chains differ in the ways explored in the sections below, commonalities across different raw materials value chains were identified:

1. In the small-scale sector, we can observe common use of intermediaries such as processing companies, traders, or stockpile companies. Large companies usually cut out the intermediaries and buy directly from the miners (Indonesia field interview 18).

2. Many processors and transport businesses as well as end users seem hesitant to buy from informal quarries due to growing incidences of police crackdown on informal extraction operations. The only exception to this trend is the brick sector, where informality is commonplace and seemingly accepted.

3. The construction raw material sector is highly competitive, with businesses needing good online presence and offering good quality and prices to their customers in order to stay in the market.

4. Access to infrastructure and transport links is a major challenge in the sector and a critical point for competitiveness. Businesses are more likely to sell their product if they are closer to a road.

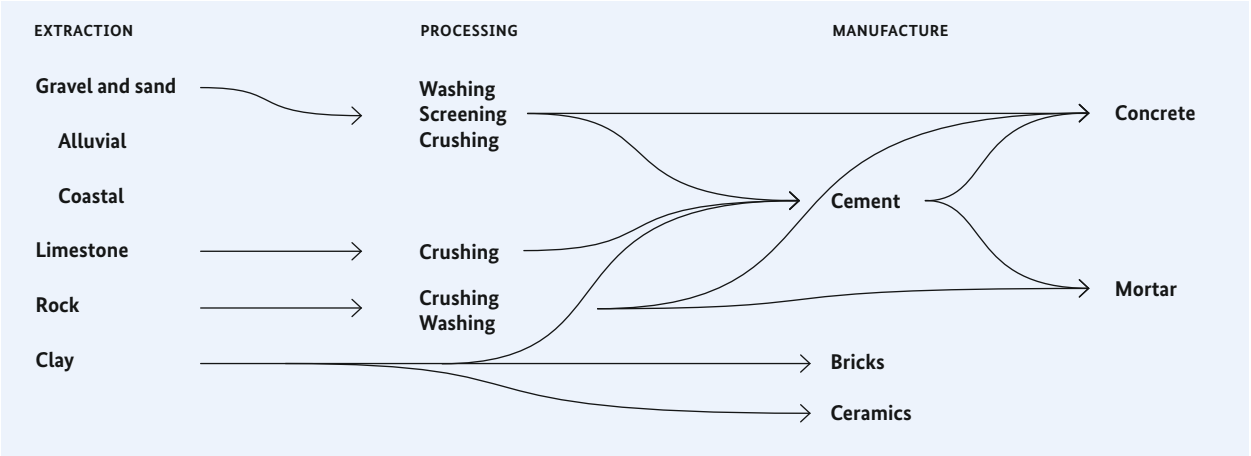
THE CONSTRUCTION RAW MATERIALS SUPPLY CHAIN

The following section gives an overview of the supply chains of the project's target construction raw materials, namely sand, gravel, rock, stone, limestone, and clay, with a particular focus on cement and bricks as manufactured materials.

PRODUCTION

In the Indonesian quarrying sector, certain materials are dominated by legal entities while others are predominantly extracted by home businesses. Kaolin, granite, and feldspars seem to be exclusively extracted by a relatively small number of legal entities. Marble and quartz also have a relatively low percentage of home business workers. On the other hand, the labour force for soil, clay, limestone, gravel, stone and andesite and sand is dominated by workers from the home business sector. The Indonesia case study focuses on sand, gravel, stone, rock, limestone and clay as raw materials, and ceramics, bricks, and cement as

Figure 14 — **Value chains of gravel and sand, limestone, rock, and clay in Indonesia**



manufactured products. This choice derives from the importance of those materials in the construction sector. For example, sand, gravel, and crushed rock are key components of cement and concrete, limestone is one of the key ingredients of cement and clay is the basis for bricks from which many houses in Indonesia are built. Given the overlap in the end-use sector of these materials, it follows that there is also significant overlap in their production – many of the production, processing, transport, and trade processes are very similar for the various materials, and some of them are handled by the same actors.

Legal entities and home businesses dominate different types of materials in terms of production volume. Kaolin, granite, and feldspars are entirely produced by legal entities, while the majority of marble, quartz and clay is produced by legal entities. Limestone is produced more or less in equal quantities by home businesses and legal entities, while home businesses dominate soil, gravel, stone and andesite, and sand production (BPS 2019) (see figure 19).

Interestingly, comparing production volume and production value does not paint the exact same picture for all materials in terms of home business and legal

Figure 15 – **Percentage of workers by material, legal entities and home businesses, Indonesia (BPS 2019)**

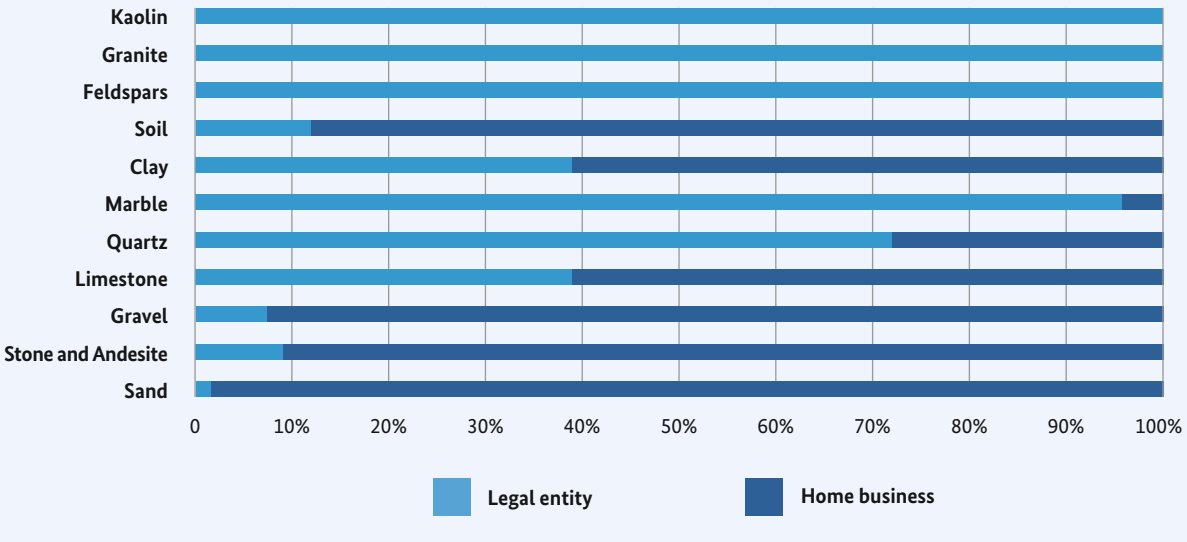


Figure 16 – **Percentage of legal entity and home business production volume by material, Indonesia (BPS 2019)**

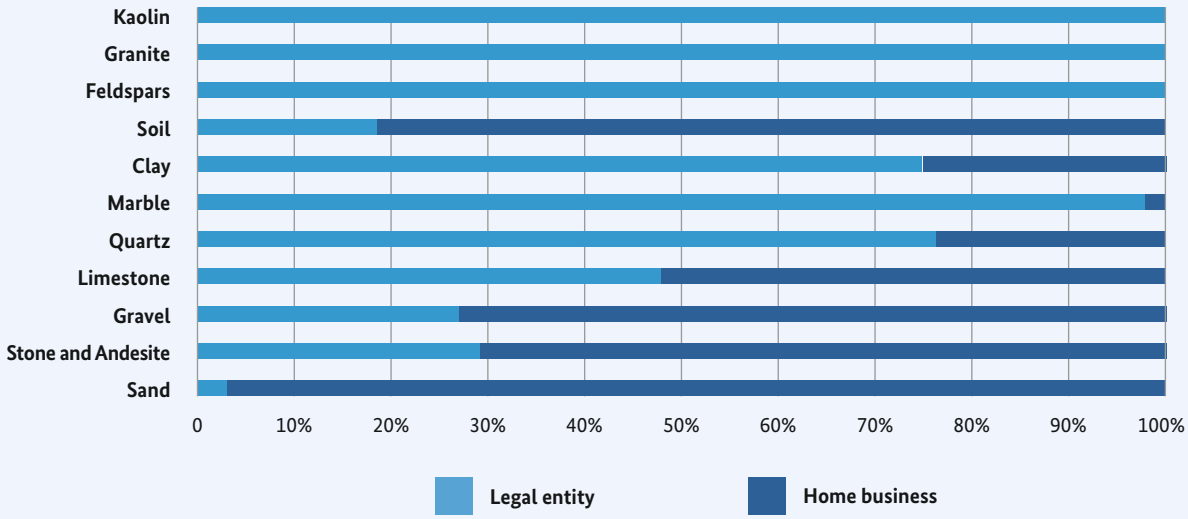
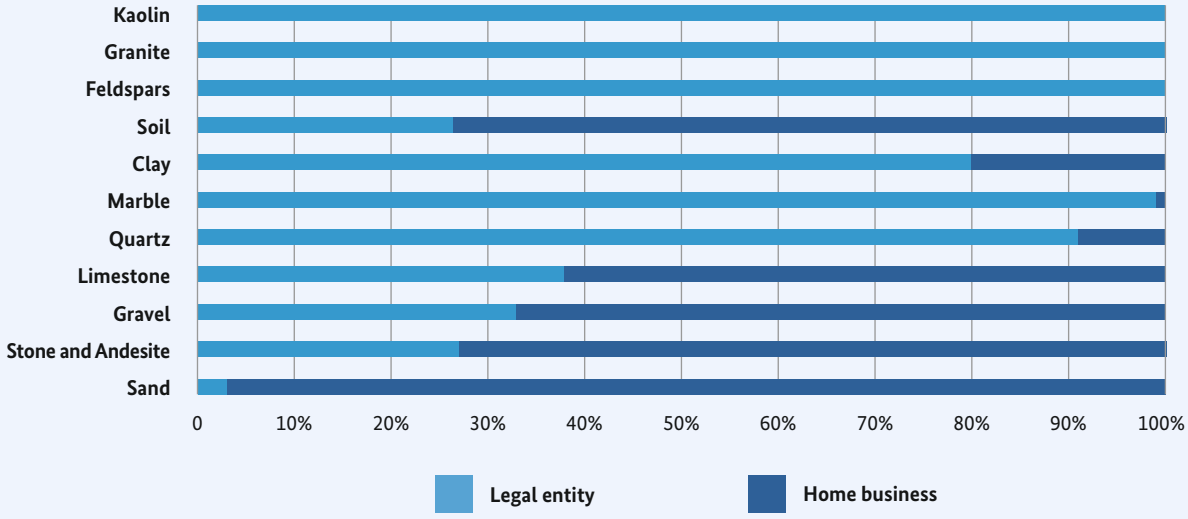


Figure 17 – **Percentage of legal entity and home business production value by material, Indonesia (BPS 2019)**



entity split (compare figures 19 and 20). This is due to the value per m^3 being different for legal entities and home businesses, as the following table (Table 1) shows. Particularly pronounced are the differences in marble and quartz, where legal entities' production value is far higher than the one from home businesses. For stone and andesite and limestone however, the production value is higher for home businesses. The most valuable materials per m^3 for legal entities are marble, granite and quartz, while for home businesses it is marble, limestone and stone and andesite.

TABLE 3 – VALUE PER M³ OF MATERIAL (BPS 2019)				
Material	Legal Entity		Home Business	
	IDR	EUR	IDR	EUR
Sand	84,904	4.96	71,694	4.19
Stone and Andesite	117,165	6.85	127,049	7.42
Gravel	102,647	6.00	79,723	4.66
Limestone	162,142	9.47	248,508	14.52
Quartz	233,012	13.61	69,338	4.05
Marble	2,454,073	143.36	474,058	27.69
Clay	78,950	4.61	56,750	3.32
Soil	65,760	3.84	41,606	2.43
Feldspars	182,663	10.67	–	–
Granite	238,836	13.95	–	–
Kaolin	156,782	9.16	–	–

Sand and gravel

Indonesia has important deposits of sand and gravel which are widely used in the construction sector. In 2018, a total of 251 million m³ of sand were extracted in the country, of which the vast majority – 96%, to the value of 17,400 billion IDR (1 billion EUR) – is extracted by home businesses, the majority of which are informal (Nuryati 2019). Home businesses dominate the sand market also in number of workers, with 61,528 businesses employing 200,920 people versus 159 legal businesses employing 4,067 people (Nuryati 2019). Although legal entities occupy a slightly larger market share (in terms of value) than their production suggests – the value of sand per m³ is on average 84,900 IDR (5 EUR) for legal entities and 71,700 IDR (4.20 EUR) for home businesses – the sector remains dominated by the largely informal production of home businesses.

Sand is mainly extracted informally and on a small scale. Small businesses with limited capital struggle to achieve legal status because of the high requirements and costs associated with formalisation. Interviewees from the Trade and Industry Agency in East Java pointed towards a poorly regulated sector, with the

© Yayasan Tambuhak Sinta

Loading sirtu (sandstone) by Elf Truck with a capacity of 6 m³

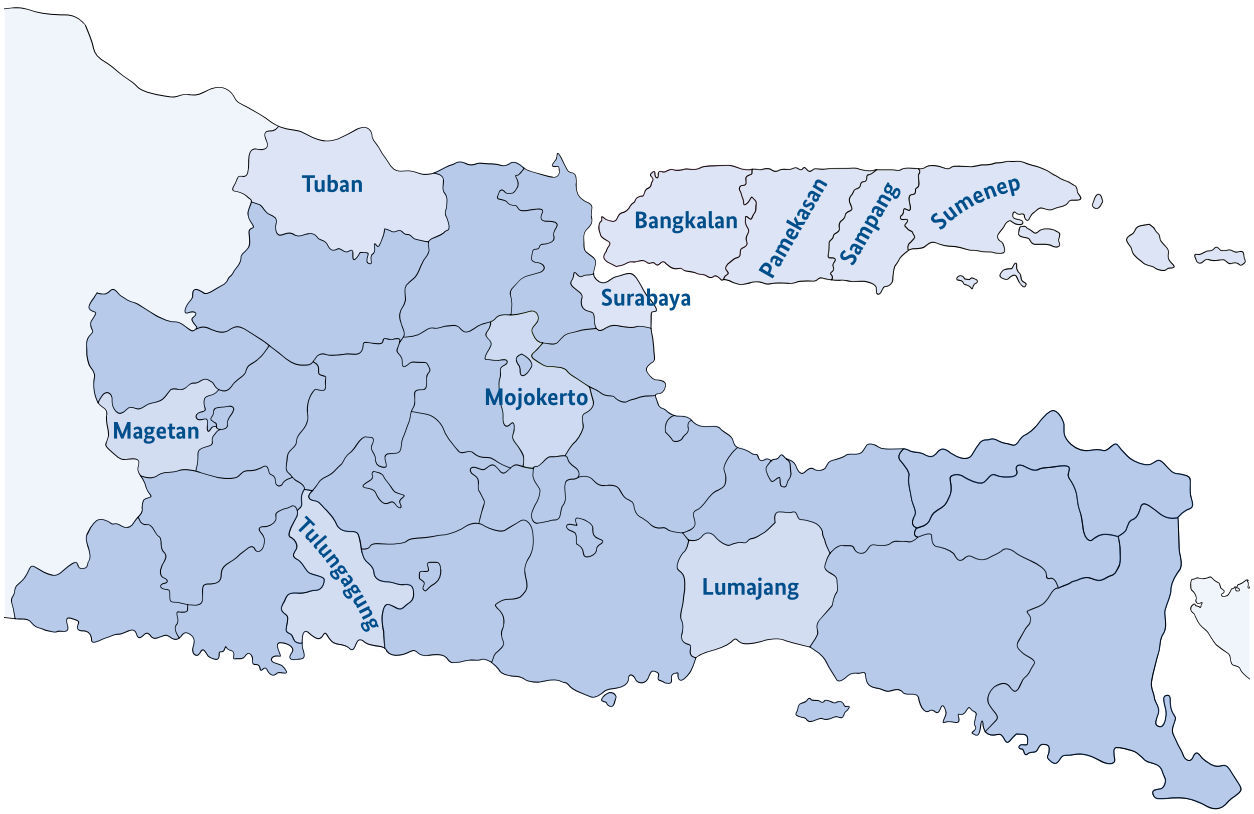
SAND EXTRAC TS

(for further details and sources see Annex 3)

Impact on landscape. Sand extraction can lead to erosion of riverbanks, water turbidity, abrasion, and damages to the coastal ecosystem. An example in East Java is Brantas River, the river base of which has fallen significantly because of mechanised sand mining. This has led to damaged buildings and infrastructure and reduced biodiversity.

Violence and conflict. Sand miners are vulnerable to police raids and regularly encounter confrontations with communities or environmental activists.

Map 3 — Regencies with sand production



involved sand and gravel businesses being less willing to share production data with the Agency. Usually, they only share data with the Integrated Licensing Management Office when they need to apply for a permit extension, and even then the data is often not accurate (Interview, Trade and Industry Agency, East Java, 01 June 2020). To get a small-scale quarrying permit, a business needs to obtain a mining permit from ESDM, which includes the Mining Business Permit Area (WIUP), an exploitation permit, the letter of context and the business license (Indonesia field interview 3).

In the surroundings of Surabaya and in wider East Java, sand mining takes place largely in Lumajang regency, 150km southeast of Surabaya, along the Bengawan Solo river near Simo village (Tuban), in Tulungagung, and in Trowulan, less than an hour away from Surabaya by car (Jones and Perkasa 2019). Map 7 shows those locations and indicates that sand mining occurs all across the interest area.[34]

[34] The locations cannot be seen as exhaustive. They are taken from the literature and field research findings. It is possible that sand mining also takes place in other regencies.

A typical small sand and gravel quarry works in various stages. In a first step, the topsoil is removed with heavy equipment. After the material is excavated, it gets screened and separated by type, namely between sand, gravel, and stone. The material is collected in a shelter at the mine site before it is prepared for transport. One person is responsible for arranging the entry and exit of the transport fleet, while a few workers are responsible for tidying the road and access to the mine. The head of mining engineering provides control and monitoring services (Indonesia field interview 3).

Sand and gravel quarries sell to various types of customers. They sell to construction contractors or infrastructure builders, to traders, stockpile service providers, processing businesses or small businesses which produce concrete blocks and retail materials (Indonesia field interview 3).

Rock

No dedicated rock quarry workers or managers could be interviewed for this study, which is why the information is sparse. A study from East Kalimantan, around the city of Samarinda, provides insights into

the rock quarrying sector in Indonesia. Most stonecutters are of Madurese descent) and live in simple sheds or houses on the outskirts of the city. Many city inhabitants are not even aware of the amount of Madurese living and working in the area. Men are usually responsible for cutting, women for crushing, using simple tools like hammers, chisels, levers, and shovels. The workers use fire to facilitate cracking of the rock. Sometimes middlemen use excavators to remove sand and rocks and create roads for trucks. The stonecutters sell the rocks for road building and construction work. Working conditions are difficult, and earnings are low and dependent on location, the construction sector, and the weather. The best earnings are up to 100,000 IDR (6 EUR) a day, the lowest less than 15,000 IDR (0.80 EUR) per day. Some of the quarries are owned by Chinese nationals (Nooteboom 2008).

Limestone

Limestone production in Indonesia in 2015 amounted to 649 million tonnes, dolomite production to 2.7 million tonnes (Ministry of Energy and Mineral Resources 2015). In 2018, a total of 7.26 million m^3 of limestone were produced in Indonesia, around half of it by legal businesses and half by home businesses (Nuryati 2019). The demand for limestone is rising due to the increased cement production in the country (ITE Build & Interiors 2016). Legal businesses produce much more volume per company than home businesses, with there being 58 legal business units and 2,363 home business units extracting limestone in the country (Nuryati 2019). The legal sector employed 3,766 people in 2018, the home sector 5,824 people (Nuryati 2019). The average value per m^3 for legal entities is 162,000 IDR (9.40 EUR), while for home businesses it is 249,000 IDR (14.50 EUR). Limestone is, after marble, the most valuable material for home businesses (BPS 2019). Given that the process to obtain a limestone extraction permit is complex and expensive, there remains an important informal sector.

Limestone extraction in the surroundings of Surabaya takes place in the city of Gresik, around 20km from Surabaya city centre, and on Madura island just off the coast from Surabaya. The island reserves are around 152 billion tonnes of limestone. The deposits currently have low economic value (Munawaroh et.al. 2018), which might change with increasing demand for cement production. Limestone is also extracted from the Kendeng Mountains, reaching from North to Central and East Java (Tuban) (Keller and Klute 2019). Important limestone deposits also exist in the districts of Kerek, Merakurak, Tambakboyo, Palang, Semanding and Montong in Tuban Regency (Sukojo and Majid 2019). These locations are indicated in Map 4.[35]

Limestone is typically used for a mixture of cement substitutes, for bricklaying or for wall paint (Indonesia field interview 8).

ROCK EXTRACTION IMPACTS

(for further details and sources see Annex 3)

Forced labour. There have been reports of debt-bondage for workers of Madurese descent in East Kalimantan.

Worst forms of child labour. Children have been found working in rock quarries under poor health and safety conditions.

Environmental impacts. Rock quarries produce noise and dust pollution from the use of explosives and contribute to deforestation.

LIMESTONE EXTRACTION IMPACTS

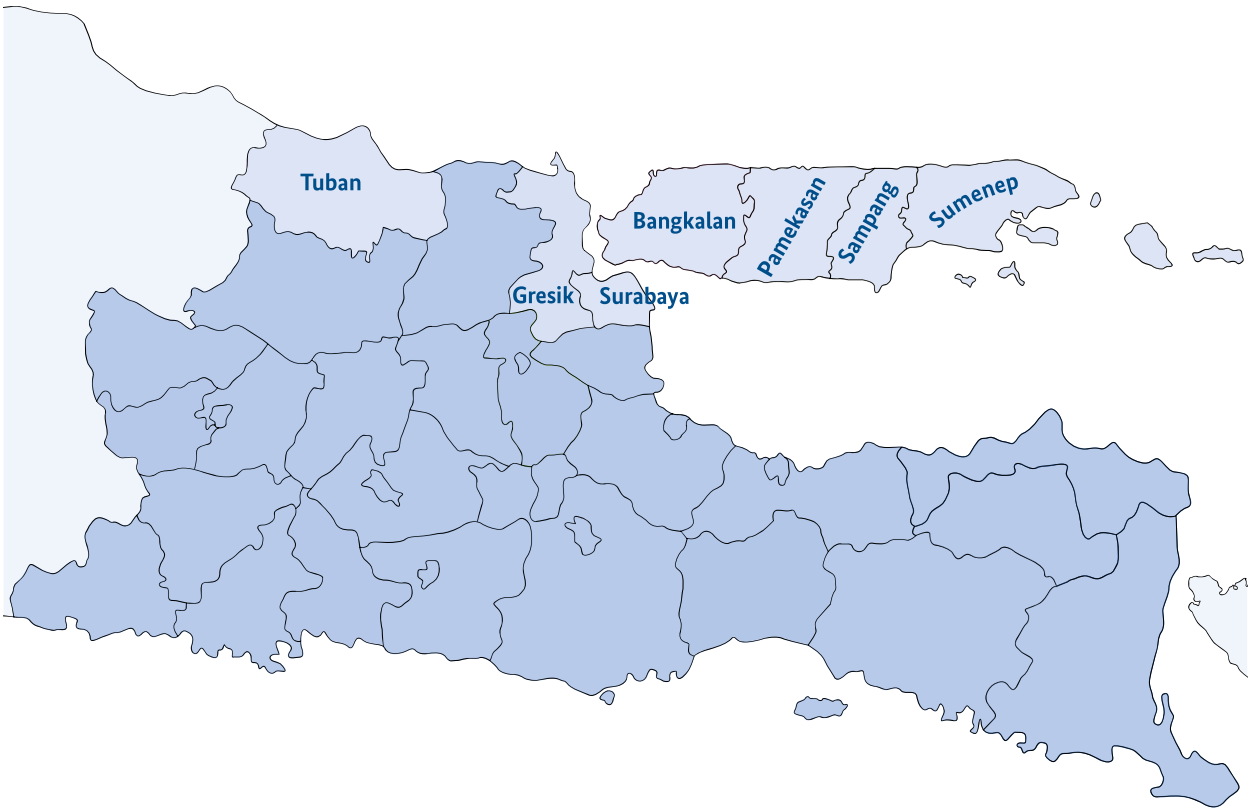
(for further details and sources see Annex 3)

Landscape and land use impacts. The extraction of limestone can cause damage to landscapes, air and water pollution and pose problems for smallholder agriculture.

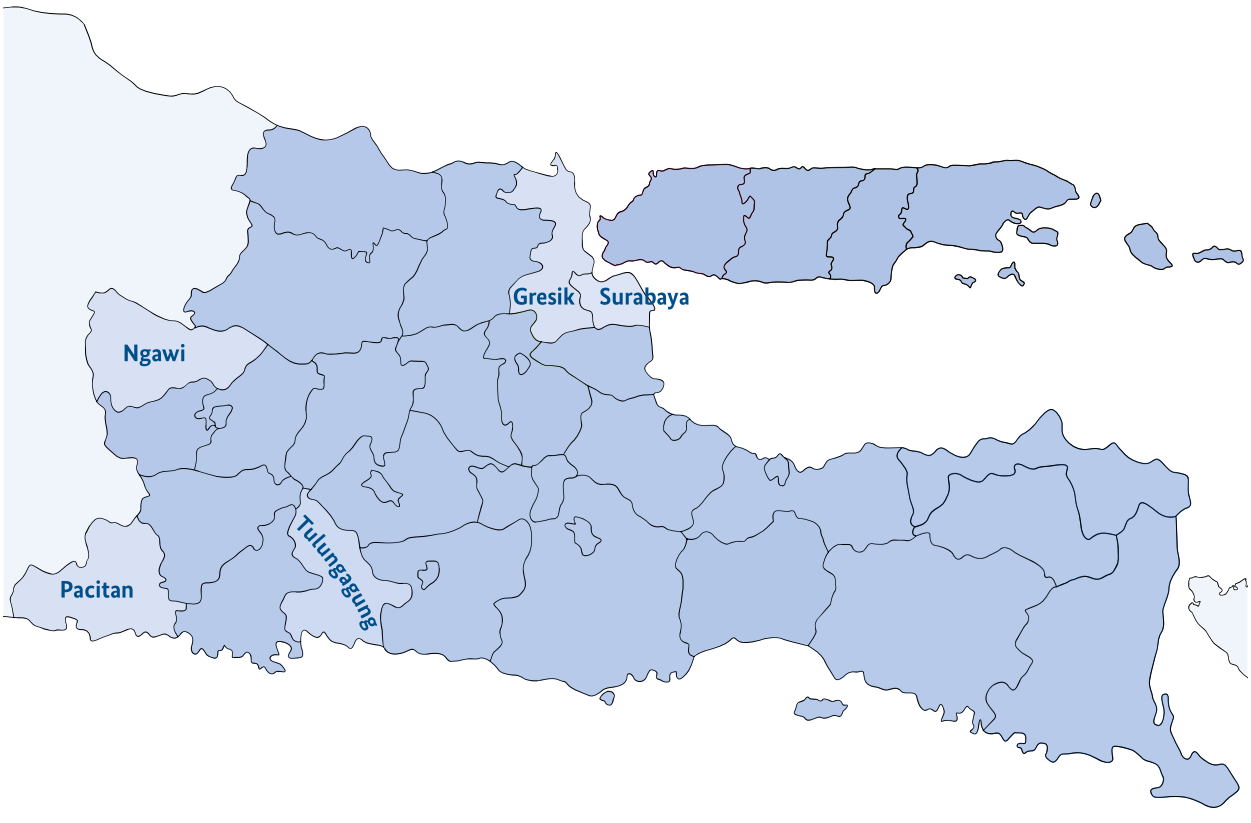
Conflict. Competing land uses and environmental damage in the Kendeng mountains lead to conflicts with community members.

[35] The locations cannot be seen as exhaustive. They are taken from the literature and field research findings. It is possible that limestone mining also takes place in other regencies.

Map 4 — Regencies with limestone production



Map 5 — Regencies with clay production



Clay

Clay is found in almost all provinces of Indonesia. The country produces a variety of different types of clays. In 2015, Indonesia produced 2.5 million tonnes of kaolin, 1.8 million tonnes of bentonite, and 241 million tonnes of clay (Ministry of Energy and Mineral Resources 2015). Although the informal home businesses dominate the sector in terms of numbers, production is split fairly evenly between formal and informal entities – in 2018, 41 legal businesses (1,187 workers) produced 3.42 million m^3 of clay, and 686 home businesses (2,232 workers) produced 3.94 million m^3. Production value was 301 billion IDR (17.5 million EUR) for legal businesses and 175 billion IDR (10 million EUR) for home businesses (Nuryati 2019). This sets the average value per m^3 for legal entities at 79,000 IDR (4.60 EUR) and for home businesses at 57,000 IDR (3.30 EUR). Clay is the lowest value material for home businesses apart from soil. The more valuable kaolin is entirely extracted by legal entities (BPS 2019).

Clay in the Surabaya area can be found and is extracted amongst others in Gresik, Tulangagung, Pacitan and Ngawi. Map 9 shows these locations and suggests that clay is found across East Java.[36] Typically, clay is extracted directly at the brickmaking locations and by the brickmakers and does not have separate quarries.

CLAY EXTRACTION IMPACTS

(for further details and sources see Annex 3)

Landscape and land use impacts. Clay extraction can have negative landscape and soil fertility impacts, which affects agriculture.

Forced labour. Madurese labourers in East Kalimantan have been found to work in bonded labour relations as the brickyard owner advances accommodation costs, cash and/or loans.

[36] The locations cannot be seen as exhaustive. They are taken from the literature and field research findings. It is possible that clay extraction also takes place in other regencies.

PROCESSING

Basic processing like crushing, washing, and screening of material often takes place on the site of extraction, and sometimes in specific processing areas or operations.

Sand, gravel and rock

Sand processing businesses are those who buy raw materials containing sand, gravel, and rocks from sand quarries, and separate them to produce the individual raw materials needed for construction. These businesses often do not mine material themselves because they lack the permit, capital and mining land and instead purchase from quarries. Despite high levels of informality in the sand mining sector, research findings indicated that some businesses seem reluctant to purchase from informal small-scale miners due to the risk of arrest should they be caught in a police inspection. More risk-averse businesses tend to buy instead from large mining companies (Indonesia field interview 4).

A sand processing business described the process: an operator adjusts and controls the work of the stone crusher according to the desired size. A heavy machine operator manages the screening machine to sort out sand and rock, after which the rocks go through the stone crusher to be grinded. A small team of people monitor and manage the production volume. An operations manager oversees the processing area and regulates the purchase and sales of material. Those who can afford their own drivers use them to deliver material to clients, generating greater revenues than those without their own drivers due to their cutting out of externally contracted transporters. (Indonesia field interview 4; Indonesia field interview 18).

Gravel processing involves someone recording incoming and outgoing goods, workers loading the material into the processing machine which is operated by dedicated workers. One person typically monitors and coordinates the activities, while another arranges the transfer and delivery of products (Indonesia field interview 7).

For sand processing, businesses need a deed of establishment, a company license, a company registration certificate, a processing license, and a sales license/trade permit. An indicative number of the total funds required to obtain these permits is 5-10 million IDR (290-580 EUR) (Indonesia field interview 18). Fees paid by a formal small-scale sand processing business include land rental fees, the refining permit, the

environmental permit, a licensing fee to the national government and a local retribution to the local government (Indonesia field interview 4).

Sand and gravel processing businesses sell to infrastructure contractors, stockpile businesses, building shop owners and housing contractors (Indonesia field interview 4).

The processing of dimension stones also consists of various stages, often carried out by different teams. It starts with washing the stones with a spray pump, drying them, and then cutting them with dedicated stone cutting tools. Afterwards, they are polished before getting packed for transport (Indonesia field interview 6).

MANUFACTURING

The raw materials presented so far are used for a wide variety of end uses. They are often used directly in construction but sometimes also to manufacture other products. The focus here lies on a select number which seem to have a particular importance, namely ceramics, bricks, and cement.

Ceramics

The main use of clay outside of brickmaking is in the production of ceramic products. Ceramics are common as tiles used for floors, walls, roofs, countertops and fire places, as well as non-refractory bricks ("Ceramics and Glass in Construction" n.d.). The clay tiles and earthenware industries count 526 and 204 businesses respectively in East Java (Interview, Trade and Industry Agency, East Java, 02 June 2020).

Roof tiles are typically produced by medium- to large-scale companies because the manufacturing requires more advanced technology and production equipment (Indonesia field interview 11).

Bricks

The majority of houses in Indonesia built in the last two decades are made of masonry, as opposed to wood, typically red bricks and made by hand (Roachanakanan and Nichols 2009). Increased awareness of negative environmental impacts is reportedly driving a recent trend away from bricks and back to traditional houses made from specially treated bamboo, that provides better air circulation and is more environmentally friendly (Indonesia field interview 18). However, the scale of this trend could not be verified, and it is unlikely that it will have a significant impact on the demand for bricks going forward.

BRICK MANUFACTURING IMPACTS

(for further details and sources see Annex 3)

Worst forms of child labour. Children have been found to work in the rooftiles and brick industry in West and Central Java.

The Trade and Industry Agency in East Java reported that the construction raw material supply chain that counts the highest number of businesses in production is bricks, with around 4,158 business units being involved – both as producers and as distributors. All of them are small- and medium-sized businesses. Clay is the most common basic ingredient of the bricks produced in East Java (Interview with Trade and Industry Agency, Surabaya, 06/20).

As bricks are usually produced by home businesses and on a small scale and the clay is often taken from people's own land, red bricks do not underly the same permitting regime as other materials such as sand, rock, and gravel. Extracting clay to produce bricks does not require permission (Indonesia field interview 18).

The traditional brick making process in Indonesia starts with the mixing of raw materials which can include clay, sand, and ashes, or simply water, and then continues to the moulding/printing, drying, and burning. These processes have been handed down through generations (Atmodiwirjo et al. 2018). The traditional firing fuel used in Indonesia is rice husks. Firing is usually done in an open kiln, and bricks are moulded by hands. Per plant, there are usually 5-7 workers. The typical plant production capacity per day is 700 bricks, or 140 bricks per worker. A unit of bricks costs 4 Eurocents. A typical masonry house needs 6,000 bricks (Roachanakanan and Nichols 2009).

A study in East Kalimantan found that many of the immigrant Madurese workers had high debts towards the brickyard owner because of provision of housing, cash advances or loans, and therefore find themselves in bonded labour relations. These kinds of labour relations were found on around half of the brickyards studied by Nooteboom (Nooteboom 2014). Through interviews we could confirm that labour relationships based on debt also exist in East Java, here typically with families being employed as a brick producing team (Indonesia field interview 9).

Brick makers sell their products to traders, stores, construction contractors, or house owners (Indonesia field interview 9).

Demand for red bricks seems to have decreased in the past five years due to the emergence of lightweight bricks which have a higher economic value than red bricks. Lightweight bricks were introduced by a large contractor engaged in hotel construction, as they are more efficient, reduce construction weight and speed up execution. They are faster to produce and the process is not affected by the rainy season as the drying is done with machinery. Lightweight bricks are four times larger than red bricks, more expensive and made of quartz sand, cement, lime, gypsum, water, and aluminium paste.[37] The bricks are usually produced by medium- to large-scale formal companies as a lot of capital is needed to invest in the process (Interview with ceramics company director, Surabaya, 05/20; Indonesia field interview 10; Indonesia field interview 18).

Apparently, limestone demand for construction has decreased since around 2016 which could be due to an increasing use of lightweight bricks for building construction (see above). Lightweight bricks use a special glue and do not contain limestone (Indonesia field interview 8).

Cement

The Indonesian government has identified cement as a strategic material (Abduh and Pribadi 2014). Production capacity in the country has risen from 47 million tonnes per year in 2004 and 2005 to 61 million tonnes per year in 2012 (Panjaitan et al. 2018). In 2020, the Indonesian cement producers produced a total of 73 million tonnes (Statista 2021). Indonesia is thereby the worldwide fifth largest cement producing country, after China, India, the U.S. and Iran (Keller and Klute 2019).

Cement is produced by large companies in the cities. Limestone used in cement usually comes from the cement companies' own supply and they therefore have their own closed supply chains (Indonesia field interview 18). East Java is an important province for cement production in Indonesia – of the 42 cement plants in Indonesia, 6 of them are located in East Java, namely in Tuban (2), Gresik (2), Jember and Banyuwangi (CemNet 2020). Similarly, of the 6.5 million tonnes of cement sold in Indonesia in the month of August 2018, 874,535 tonnes came from East Java, which was the 4th highest producing province in the country. Semen Indonesia Group is the country's largest cement producer, having a market share of 47% and capacity of 50.7 Mt per year (ZKG Cement Lime Gypsum 2019).

Java is also by far the biggest cement-consuming region in Indonesia, constituting 56% of the country's cement sales and consumption in the first half of 2018, followed by Sumatra (22%) and Sulawesi (8%) (Indonesian Cement Association 2019). Given the prioritisation of the sector more widely, the importance of Java as a cement consumer looks set to continue. Firstly, the national demand for cement has grown significantly over the past two decades – domestic cement consumption is also up from 32 million tonnes per year in 2004/5 to 51.8 million tonnes in 2012 (Panjaitan et al. 2018) and 69.5 million tonnes in 2019 (Bisnis 2019). Since 2008, cement sales in the country have increased every year, at rates of 1.1% in 2009, 4.2% in 2010, 20% in 2011, 14.6% in 2012, 5.6% in 2013, 3.3% in 2014 and 2.5% in 2015 (ITE Build & Interiors 2016). From 2018 to 2019, cement sales increased by 9.5% to 7 Mt (CemNet 2019). Secondly, the largest consumer of cement is the residential sector (ZKG Cement Lime Gypsum 2019), which, given population growth, is likely to be a growing sector.

A trend in Indonesia replaces the Ordinary Portland cement by Portland Pozzoland cement and Portland Composite Cement which have properties more suitable to certain environmental conditions (Abduh and Pribadi 2014).

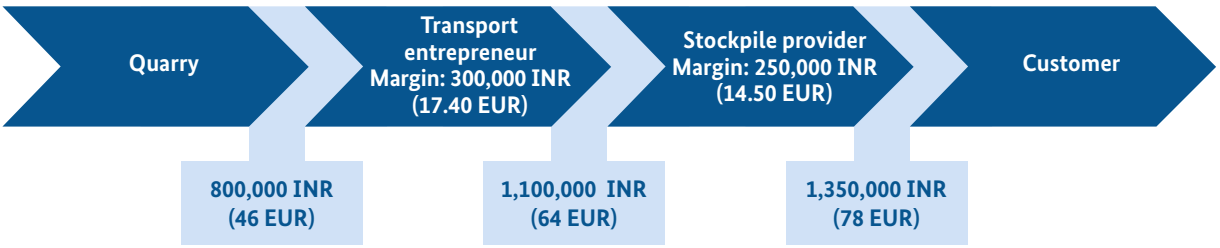
TRADING AND TRANSPORTING

In the formal material supply chain, the seller issues a Delivery Order (DO) to the buyer. The DO is valid proof of the delivery of the material and the price paid. Each supply chain actor needs to issue their own DO. With these DOs from each actor in the supply chain, everyone involved can monitor each other's prices which ensures that prices are competitive and reasonable.

In order to become a licensed mineral transporter, the business or individual needs to pay a vehicle tax and obtain a motor vehicle test (Indonesia field interview 18) as well as a license from the Department of Transportation (Indonesia field interview 12). The licensing situation for transport businesses has become much

[37] Aluminium paste is produced from aluminium powder and used as paints and coatings in a variety of industries.

Figure 18 – Sand prices flowchart (N.B. prices are indicative and subject to fluctuation)



stricter recently. If a driver is caught with unlicensed material and cannot show a DO, they pay a fine of 100,000 to 200,000 IDR (6-12 EUR). These changes of increased police action apparently began in mid-2020 (Indonesia field interview 12). To obtain a license to trade in construction raw materials, traders must obtain a permit from the Industry and Trade Office (Indonesia field interview 5).

Findings from the study show that each construction raw material is generally subject to a standard price, although variations based on quality may occur. Prices are competitive due to the large number of suppliers. Transport is included in the respective purchase price (Indonesia field interview 1).

A sand trading business typically has workers with different roles: an operator uses heavy machinery to load sand onto trucks while a cashier receives the DO sheets and payments. Checkers are tasked with levelling the sand on the truck, and drivers deliver the material to the place of order. It is common for traders to have their own trucks and drivers (Indonesia field interview 5).

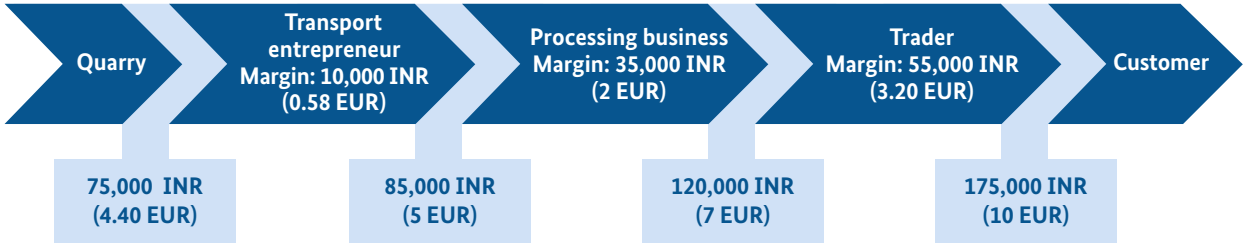
In the sand supply chain, intermediaries play a crucial role as many end customers struggle to buy directly from the producers. These intermediaries can be processers, traders, shops and/or stockpile service providers (Indonesia field interview 18; Indonesia field interview 4). Sand traders can sell to individual transport fleet owners, building contractors or homeowners (Indonesia field interview 5). According to one interlocutor, there are sand stockpiling and trading businesses that do their own processing, while others do not because processing permits, and requirements are complex and expensive to procure (Indonesia field interview 5).

Legal sand trade requires a DO form being issued by the miners. The form was mentioned as essential by several interlocutors as a means to ensure the legality of the transaction and to ensure the price is reasonable. The following flowchart shows indicative prices in the sand value chain as reported by an architect (Indonesia field interview 18). The price is per truckload and can vary by location, the flowchart showing one example of how much margin transport entrepreneurs and stockpile providers make.

Sand and gravel prices seem to rise during the rainy season due to reduced quarrying activity and less supply (Indonesia field interview 1). A sand trader reported that during the rainy season the maximum price is reached (Indonesia field interview 5).

A sand trader mentioned a way to make higher margins by buying sandstone instead of sand as it is much cheaper. By screening and washing the sandstone the same quality of sand can be produced. However,

Figure 19 – Gravel prices flowchart (N.B. prices are indicative and subject to fluctuation)



obtaining a processing license is burdensome (Indonesia field interview 5).

The following flowchart shows the same breakdown of prices for gravel, this time the price per tonne (Indonesia field interview 18).

The stone and andesite quarrying sector in 2018 counted 293 legal businesses with 10,778 workers and 31,388 home businesses with 103,588 workers. The legal businesses produced 16.4 million m^3 that year, or 4,940 billion IDR (287 million EUR) in value, and home businesses 29 million m^3, or 9,920 billion IDR (576 million EUR) (Nuryati 2019). These numbers show that the majority of stones are extracted in the informal sector. The average value per m^3 of stone and andesite for legal entities is 117,000 IDR (6.80 EUR), while for home businesses it is 127,000 IDR (7.40 EUR).

A wide variety of natural stone products for wall cladding

Brick producers prefer working with intermediaries, allowing them to reach a wider market segment than just immediate users (Indonesia field interview 18). While we were not able to obtain reliable brick price lists, interviewees reported prices between 320,000-480,000 IDR (19-28 EUR) per 1,000 bricks (Indonesia field interview 1; Indonesia field interview 10).

END USAGE IN CONSTRUCTION

In order to participate in construction project tenders, in particular the ones issued by the government, construction businesses must obtain several licenses, namely a permit from the One Stop Integrated Licensing Service Agency (BP2TSP), a Construction Services Business License (IUJK), P2L form (environmental planning), AMDAL (environmental impact analysis), and Rekomtek (Technical Recommendations) (Indonesia field interview 18).

Typically, in small companies, the administration, management, and supervisory staff are permanent employees who are paid monthly and stay with the company across projects, while the daily and skilled workers are recruited on a project basis from the local area. Some construction workers in small businesses come from other parts of the province and go from project to project, for example when the rainy season affects activity in certain sectors.

Construction contractors typically do not source directly from the quarry or mine sites, but from stockpile companies, traders, or buildings shops. Everything must come from formal sources, otherwise the police can arrest them, an exception being bricks (Indonesia field interview 1). Sand is not always sourced from the closest quarry to the construction site. This is because many construction projects contain contractual clauses regarding material specifications and only sand from certain areas complies with those requirements (Indonesia field interview 18). Many companies seem to be buying from the same suppliers due to reliability and trust, and only change supplier when there are delivery issues (Indonesia field interview 1).

TAXES, RETRIBUTION AND OTHER EXPENDITURES

The following table summarises the average expenditures per quarrying business per year for legal entities and home businesses in East Java.

The pie charts below (figure 21) depict the relative expenditures of quarrying businesses in East Java. Stationeries and services are negligible expenses for both legal entities and home businesses. While taxes and retribution make up 30% of legal entities' expenditures, it is only 5% for home businesses. On the reverse however, home businesses pay a larger share of their expenditures on renting land, office buildings, vehicles, machinery, and equipment, namely 25%, while these items only represent 4% of legal entities' expenditures. This could be amongst others because they rather rent machinery and equipment as well as land and buildings than own them. This reflects findings from the fieldwork, which showed that many small businesses noted land and building rent as one of their main taxes and fees. Legal entities spend more in percentage terms on purchasing spare parts, equipment,

TABLE 4 – EXPENSES PER BUSINESS PER YEAR (BPS 2019)				
Expense category	Legal entities		Home businesses	
	IDR	EUR	IDR	EUR
Fuel and electricity	883,885,051	51,625	59,923,373	3,500
Stationeries	6,606,462	386	47,804	2.80
Spare parts, maintenance, minor repairs, purchase of equipment and supplies less than 1 year	354,692,372	20,716	6,364,262	372
Rent land, office buildings, vehicles, machinery, and other equipment	120,146,077	7,017	29,144,394	1,702
Services	37,759,115	2,205	0	0
Taxes and retribution	834,722,974	48,753	5,263,717	307
Total	2,237,812,051	130,703	100,743,550	5,884

and supplies (13% of their expenditure budget, versus 5% for home businesses). Home businesses on the other hand pay more for fuel and electricity in relative terms – 51% versus 32% for legal entities. Legal entities spend 20% of their expenditures on recovery, environmental and other costs, while home businesses spend 14% on these items.

Another expense noted in the interviews for actors along the value chain is road maintenance for public roads. Mining entrepreneurs and the government seem obliged to maintain joint roads and share the repair work (Indonesia field interview 3). Truck drivers typically also pay something to the villages whose roads they use. This is not an official fee and fluctuates but can for example be 5,000 IDR (0.30 EUR) for a truckload of 4m^3 or 15,000 IDR (0.90 EUR) for a large truckload (Indonesia field interview 12). This represents just a tiny fraction of the 46 EUR for which a truckload of sand is sold from mine to transport business. Construction businesses also provide support to villages to repair roads, as construction activities can cause damage because construction companies want to maintain a good and collaborative relationship with the communities (Indonesia field interview 18).

Table 2 provides an overview of average taxes and retribution paid by legal entities and home businesses in the quarrying sector in Indonesia and in East Java. Formal businesses along the value chain pay earnings and income tax to the national government and a retribution to the regency. In addition, informal businesses seem to pay land and building taxes.

Home businesses largely operate informally and therefore do not pay official taxes to the national or local governments. While legal entities in East Java seem to be paying below general industry average, home businesses in East Java pay almost four times more than the average home business in Indonesia. Across Indonesia, legal entities pay on average 1.15 IDR billion (67,000 EUR) per year while home businesses pay 1.5 million IDR (87 EUR). In East Java, legal entities pay an average of 835 million IDR (48,500 EUR) annually, and home businesses 5.3 million IDR (308 EUR) (see Table 2).

Figure 20 – **Expenditures, legal entities and home businesses, East Java (BPS 2019)**

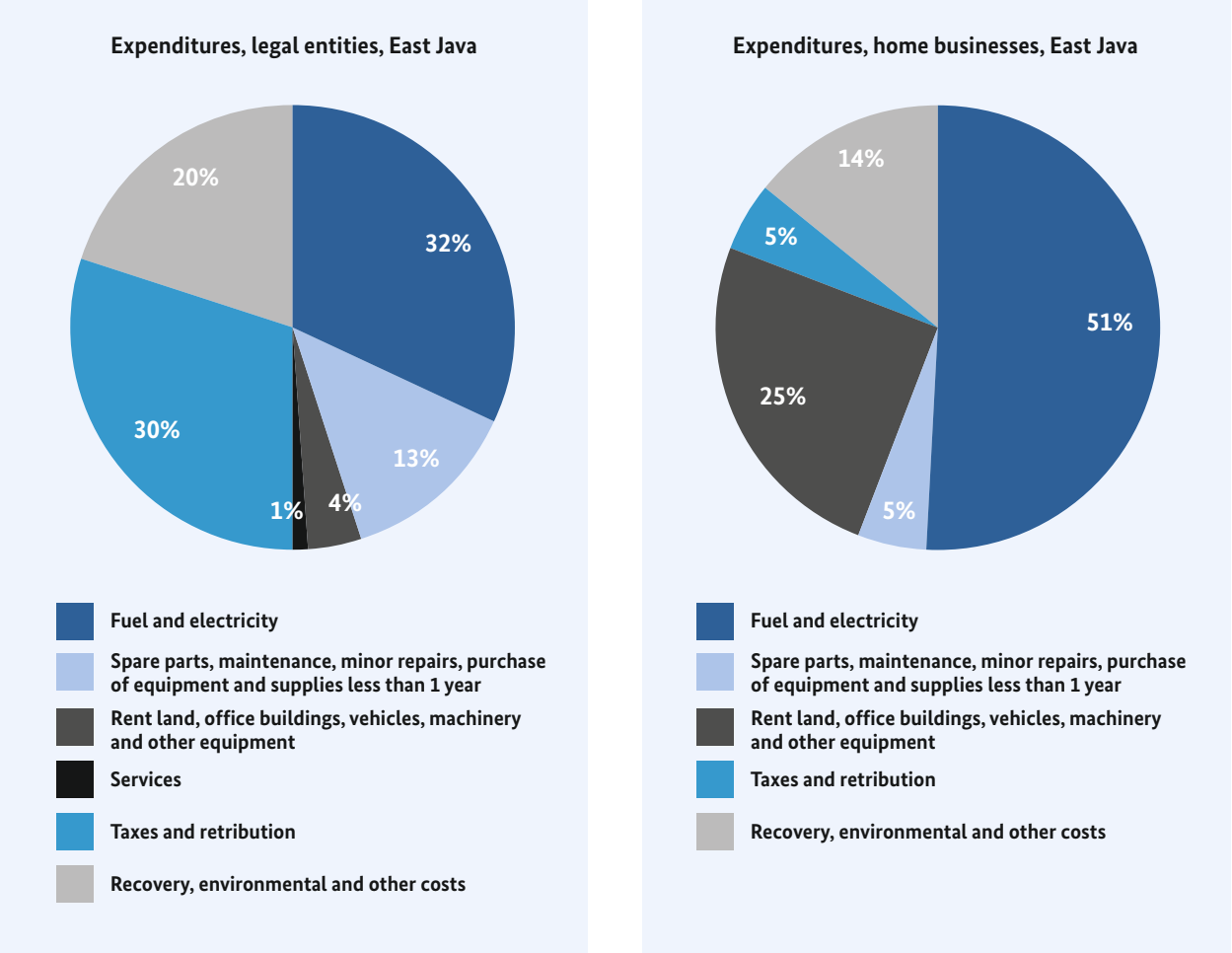


TABLE 5 – TAXES AND RETRIBUTION BY THE QUARRYING SECTOR (BPS 2019)				
INDONESIA				
	Legal Entities (n = 731)		Home Businesses (n=116,636)	
	IDR	EUR	IDR	EUR
Taxes and retribution per year (all entities)	838,520,000,000	48,984,600	170,646,000,000	9,968,780
Taxes and retribution per year (per entity)	1,147,086,183	67,010	1,463,065	85
EAST JAVA				
	Legal Entities (n=78)		Home Businesses (n=13,387)	
	IDR	EUR	IDR	EUR
Taxes and retribution per year (all entities)	65,108,392,000	3,803,500	70,465,386,000	4,116,440
Taxes and retribution per year (per entity)	834,722,974	48,763	5,263,717	308

TABLE 6 – INCOME TAX RATES FOR CONSTRUCTION COMPANIES (SEE LINK BELOW)	
Taxable Income (IDR)	**Tax Rate**
Annual income up to 50,000,000	5%
Annual income above 50.000.000 – 250.000.000	15%
Annual income above 250.000.000 – 500.000.000	25%
Annual income above 500.000.000	30%

https://www.online-pajak.com/tentang-pph21/tarif-pajak-pph-21

Construction businesses need to pay various taxes, including an income tax, a tax on won tenders and taxes on company property such as land, buildings, and vehicles. Company owners are furthermore required to pay income tax on the company profits. Construction companies typically contribute to the villages where they operate, and this support can be inkind in the form of construction raw materials for the repair of public buildings.

As for the business income tax, there are four bands with a progressive tax rate (see Table 6).

SALARIES

The average salary for permanent/day quarrying workers in East Java is 98,535 IDR (5.70 EUR) per day in legal entities and 71,230 IDR (4.20 EUR) per day in home businesses (see table 4). Interestingly, the difference between the two is not very pronounced. The salaries are similar to other sectors of the economy for non-skilled daily workers in East Java and Surabaya.

One sand, gravel and stone business reported that supervisors and managers as well as office staff receive monthly salaries, while the site owner is paid per truck (40,000-50,000 IDR per truckload [2.30-2.90 EUR]). Daily workers receive a minimum of 100,000 IDR (5.80 EUR) per day (Indonesia field interview 3).

A brick trader reported a truck of bricks being accompanied by one driver and three workers for the loading and unloading of material. One truck can hold 4,000-5,000 bricks, and the three workers receive a total of 220,000 IDR (12.80 EUR) for an average trip, which is usually divided equally between them and corresponds to the average wages for daily workers in the quarrying and construction sectors. If the delivery is far and exceeds an eight-hour day, an additional 20,000 IDR (1.20 EUR) are paid for each worker (Indonesia field interview 10). A transportation business reported the drivers are paid 10,000 IDR (0.60 EUR) per km, excluding gasoline (Indonesia field interview 12). Another one reported that drivers are paid 70,000 to 80,000 IDR (4-4.60 EUR) for each one-way trip, with the option of receiving more when the distance is far. Fuel for a day costs on average 200,000 IDR (11.60 EUR) (Indonesia field interview 12).

Salaries in the construction sector depend on the position, type of work, skills and job difficulty, and the type of work agreement. Some workers are permanent employees and paid on a monthly basis while some are daily workers or workers who get a weekly salary. The respondents refused to provide salary data, but we know from a source that a typical day rate for non-skilled daily workers in the construction sector is 50,000-70,000 IDR (2.90-4 EUR) (Indonesia field interview 18). Apparently during rainy season, daily workers' fees rise slightly as the works take longer (Indonesia field interview 1).

TABLE 7 – AVERAGE ANNUAL REMUNERATION PER WORKER IN EAST JAVA (PERMANENT/DAY WORKERS) (BPS 2019)		
Taxable Income	**Legal entity**	**Home business**
in IDR (per year)	28,378,189	20,514,136
in EUR (per year)	1,650	1,190
in EUR (per month)	137.50	100
in EUR (per day)	5.70	4.20

Per day means: Based on 6 days work a week, 4 weeks a month

5. Barriers and opportunities to expansion of local value chains

This section builds on the information presented thus far in the report and presents a number of barriers to the expansion and development of local value chains. It also hints at opportunities where relevant, but these priority areas for intervention to promote value chain development are treated more in-depth in the following chapter on potentials. In terms of barriers, we identify the primary factors – be they socioeconomic, market, institutional or regulatory – that prevent the possible development and increase of value along the construction raw materials value chains in question. The barriers and opportunities presented in this section are by no means exhaustive – they have been identified as key ways in which sector trends are currently hampering the expansion of local value chains.

5.1. India

As presented in the previous sections, the Indian market is currently characterised by a strong and increased demand for construction raw materials, and a notable part of this demand comes from public projects that look to expand either affordable housing or infrastructure. At the same time India already benefits from a significant installed hard capacity to manufacture the goods it requires to fuel this demand for construction raw materials. However, the soft capacity (human capital and incentive structures) required to make the best use of this manufacturing capacity is lacking, leading to a sector that is increasingly unorganised the more upstream one goes. This has been compounded by looming material shortages and resulted into a market characterised by narrow margins and intense cost competitiveness. This incentivises operators to gain a commercial advantage by "cutting corners" where regulatory compliance is expensive and where the regulatory and institutional framework allows them to do so with little risk. Compounding this issue, India's growing demand for construction raw materials will put further pressure on the governance of the sector as identified resources are being exhausted, unless new resources are identified and developed in the short term either through the development of mining assets, increased usage of recycled and alternative materials, increased imports of raw materials, or scientific breakthroughs leading to sustainable material substitution.

REGULATORY AND INSTITUTIONAL FRAMEWORK

In terms of barriers deriving from the regulatory and institutional framework, these relate mainly to a) complexity generated by responsibilities being spread across different levels of government; b) a focus of government agencies on employment creation and material supply, without much consideration for the quality and impacts of activities; and c) a weak monitoring and enforcement capacity of government agencies to promote higher social and environmental sustainability standards.

As noted in previous section the applicable legal framework in India is complex and sits at different levels. While law making responsibilities are spread

between state and central government, due to the nature of minor minerals the enforcement of such regulations depends on the state authorities, and implementation is often overseen by district or sub-district representations of the agencies. As highlighted above, this creates conflicting incentives for local authorities who have to date favoured the creation of jobs and ensuring material supply for the construction industry through the limited enforcement of rules.[38] In a September 2020 note (GoI 2020) on proposed mining reforms that are part of the Government's Atmanirbhar Bharat Abhiyaan or Self-reliant India campaign it was made clear that "the biggest need for the country today is employment generation" and that "any improvement in mining sector implies employment generation in all the connected sectors [mining machinery, steel, aluminium, commercial vehicle, rail transportation, ports, shipping, power generation, etc...]". The reforms that are proposed focus foremost on generating more mining activities; very little attention is paid to the quality and nature of these activities. While these efforts are made at the federal level and will mostly target major minerals this value prioritisation from the top is likely to further bolster the incentives that individual States respond to and thus to strengthen the tolerance of mining activities despite their also negative impacts.

A problematic issue with this reliance on enforcement at the level of district level agencies is that the available skill base of these agencies is very limited. They are often notably under-staffed and under-funded for the magnitude of the task at hand (CSE 2016), for example:

- It has been reported that in a district of Jharkhand there is one labour inspector for 200,000 inhabitants (Interview with Thangaperumal Ponpandi)[39];
- An estimated 30 mines inspectors look after the entire state of Uttar Pradesh (CSE 2016);
- Despite the existence of a comprehensive array of legislation and policies to prevent forced labour and rescue bonded labourers on the paper only 1,845 labourers, including 611 children, were rescued from Rajasthani quarries between 2004 and 2016 (Praxis and Partners in Change 2017) despite estimates of child laborers in Rajasthani quarries going as high as 375,000 in 2009 and 2010 (ABA 2020).
- The request for IBM to temporarily take over certain roles falling under the purview of state geological services further illustrates this issue.

Additionally, due to the nature of India's Civil Service, good civil servants are heavily promoted toward positions of higher influence, or in other words towards state capitals, major cities, and Delhi. As a result of this policy, the available staff in rural (sub)districts has been characterised by some stakeholders as "those that couldn't make a better posting" (confidential interviews). It has also been noted by the same stakeholders that some of the local civil servants might have entered the service specifically with the purpose of making money, particularly in less monitored rural districts. Together, both phenomena significantly increase the risks of uneven implementation of laws and of policies. And while the latter issue is slowly improving, notably thanks to the implementation of e-governance and the use of bank transfers, the process will take time (Interview with Thangaperumal Ponpandi).

This limited monitoring capacity is further stretched out by the nature of the regulatory frameworks that can exist at the local level. In Uttar Pradesh for example "instead of comprehensive regulatory reforms to deal with the problems, as was the need of the hour, there was reliance on a patchy course of action. The justification mining officials provide for such action is that they "had to keep mining going on". Officials argue that "since amendments take time to come into force, such actions were taken to deal with immediate issues at hand. While amendments were in the process of being made, waiting for them would delay the action to address these issues" (CSE 2016). This creates complex legal frameworks that are both difficult to follow for operators, who have complained about said complexity during our data collection, and difficult to enforce for state agents. This "patchy" approach also provides ample opportunities for established operators benefitting from the status quo to bring litigation against specific articles, stalling their implementation. These litigations and the regulatory quagmire they produce can also impact legal operators as the delivery of certain services may be frozen. In Uttar Pradesh for example the granting of river-

[38] For a summary of the key rules applicable at the national level, see Annex 4.

[39] These statistics are not publicly available for the area of interest. However, the descriptions of state capacity given by all consulted stakeholders are unanimous in pointing out that controls are episodic at best and that the agencies are very understaffed for the tasks they ought to perform.

bed sand mining leases has been frozen for years at a time for such reasons, meanwhile illegal mining continued (CSE 2016). During this freeze formal mining was made possible through the use of mining permits that were valid for 6 months (CSE 2016). As these permits required the operator to pay upfront the royalty for the entire permitted production,[40] these were only an option for the established actors that already benefitted from the status quo.

Limited monitoring capacity also presents barriers to sustainability at the level of construction. A building can receive the FSI incentives of a green certification merely by registering without necessarily undertaking any form of verification. An exception is GRIHA (TERI 2019), but as agencies lack the capacity to monitor compliance, this opens the door to the possibility of massive greenwashing within the sector (TERI 2019).

Similarly, while environmental regulations are generally in place, their enforcement by authorities is hampered by a lack of monitoring capacity (Interview with Adarsha Kapoor). Of particular concern in that regard are the impacts generated by improper construction waste disposal, as an estimated 4% to 30% of the total weight of a building turns into waste (CSE 2020). This improper disposal is a result of both hard and soft infrastructure challenges and the aforementioned limited monitoring capacity. And while no clear official estimates of the magnitude of construction waste exists it is notable that some of the biggest contributors to irregular construction waste disposal are sometimes public entities. For example, the Delhi Metro Rail Corporation, has been fined multiple times by NGT for the unlawful disposal of its C&D waste and has acknowledged that construction waste is one of its biggest challenges (CSE 2020).

Enforcement is also made complex by the fact that both rule making and enforcement at different stages will not be assigned to the same actors/agencies, for example mineworkers fall under the purview of Central legislations, while mines fall under the domain of the state governments (ABA 2020) and their respective enforcement authorities, not to mention other stages such as processing, construction or (cross-state) transport. Solving supply chain issues thus requires complex inter-agency coordination both between and within States.

As a result of these factors rule compliance comes at a cost for operators while non-compliance is rarely sanctioned. And given the price sensitive nature of the sector, this disadvantages actors interested in working according to the applicable regulations.

Encouragingly, there are also cases where the authorities have effectively addressed legislative gaps in a speedy or proactive manner to encourage the sector towards better sustainability performance. These advancements are generally made with regards to material circularity and are generally crafted from an engineering or legalistic perspective, approaches that do not account for the existence of informal actors and markets:

- When it emerged that the wording of the earlier BIS standard IS:383-1970 relating to aggregates for concrete stated that concrete could only be made with 'naturally accessed material' BIS modified this requirement in early 2016 to ensure that construction agencies could make use of aggregates made from recycled C&D waste.

- The publication and amendments of the Fly Ash Notification have opened the market for fly ash bricks and created new supply chains and served the double objective of lessening the exploitation of soil deposits, and thus of arable land, and to dispose safely and beneficially of a polluting waste-product (Interview with Vikash Nayak). In 2016 about 12% of the total fly ash generated in India was used for the production of bricks and tiles (GIZ, 2016).

- Multiple states, led by Karnataka, have enacted policies and incentives to promote the manufacture and use of m-sand, to an already non-insignificant effect that is expected to grow. In contrast Haryana, Rajasthan and Uttar Pradesh do not have dedicated policies for m-sand (MoM 2018; GIZ 2016).

[40] Paragraph 54, Uttar Pradesh Minor Minerals (Concession) Rules, 1963, 27th amendment.

DATA SCARCITY

As mentioned above, India's oversight of limestone, gypsum, hard rocks, sand, and brick earth is the responsibility of the different States' mineral oversights authorities, who administer these resources based on their own regulations and policies. An unfortunate consequence of this governance structure is that information on these resources and their extraction is neither centralised nor standardised. The latter is particularly true when it comes to sand and aggregates which can be classified into different categories depending on the state they are found in. Depending on the state information on mineral occurrences, licences, and production may or may not be public and even IBM depends on the information they may or may not receive from the States' agencies for their official statistics. Hence, any information on mineral occurrences and production is not only partial but could also misrepresent the sector as the widespread informality of operators, data discrepancies and absence might distort any snapshot of the sector. For example, while data from Rajasthan can be found in IBM reports (regardless of its actual representativeness) data from Haryana or Uttar Pradesh is much scarcer, a scarcity that may not mirror their actual mineral production.

Such data scarcity makes designing interventions in the sector challenging as any good programme to promote more effective local value chains or social and environmental sustainability would rely on good knowledge of the sector.

SUPPLY RELIABILITY

The Indian construction material sector suffers from supply reliability issues, related to seasonal impacts and the dominance of and therefore dependence on few actors in certain value chains.

Sand and aggregates represent key bottlenecks in the supply of raw materials to the construction sector supply issues of sand and aggregates needed for the manufacture of concrete have already delayed several civic projects in the country (CSE 2020). Season-wise, not only does the monsoon impact the capacity of operators to extract sand and rocks and operate kilns, but winter and the associated rise in Delhi's pollution also triggers measures designed to limit the generation of smoke, airborne dust, and exhaust fumes, which impact the extraction, processing, and transport of construction raw materials (India Today 2020; The Tribune 2021).[41] These fluctuations in material availability trigger in turn seasonal price variations that are likely to become more pronounced as a result of changing climate patterns.

Despite the ongoing use of thermal energy plants, the sourcing of fly ash for brick production can also be unreliable and has made fly ash brick manufacturers easy prey to corruption. An interviewed cement storekeeper mentioned that fly ash supplies are hogged by major contractors and commissions are fixed at each step, which blocks small and local suppliers from getting much material. For example, thermal power plants often sell fly ash at higher rates to cement manufacturers or give priority to road contractors.

MARKET STRUCTURE

As mentioned in earlier sections, India's construction value chains are developed fully within the country. The processes that have established them in their specific locations are a combination of geography and hard infrastructure (proximity to sources of material, markets of destination, and a transport axis[42]). As mentioned above, industrial size players dominate some of the industries, however there could potentially be a few opportunities to incentivise the entry of smaller operators in certain construction material supply chains (sand, transport, hard rock mining), which would likely incentivise local spending instead of spending at the national level. But in doing so implementers should be cognisant of the additional monitoring required to oversee the operations of numerous small operators (operators that may have issues with complying with the applicable regulations given their size/resources), compared to the monitoring of fewer bigger producers. In the existing context where monitoring resources are already stretched too thin, this might not be plausible.

[41] In 2020 the winter season has also coincided with sustained protests from India's farmers, which lead to the blockage of roads supplying Delhi and thus affected the distribution of construction materials.

[42] For example, to quote Misra et al. (2020) in the case of bricks: kilns are located along the flood-plains (river Yamuna) and along secondary roads [...] Flood-plains provide access to the raw materials such as fine alluvial clayey soil and water, for producing bricks. Network of secondary roads is used for transporting bricks, possibly due to the current guideline of the [CPCB] that bars brick kilns from being located next to highways. Construction of buildings requires bricks, and brick kilns are located close to wherever dense horizontal expansion has taken place.

TABLE 8 – KNOWN MATERIAL USES FOR RAW MATERIALS		
Material	**Other known material uses**	**Comments**
Limestone	Soil conditioner, sculptures, medicines, cosmetics, toothpaste, paper, plastic, paint, white pigment and cheap filler.	Known usages are outside of the construction supply chain.
Gypsum	Also used in industrial processes as a reagent in fuel-gas desulphurisation, quicklime and slaked lime (IBM 2020d).	Known usages are either outside of the construction supply chain or will compete with the needs of the cement industry.
Sand	Fertilizer and soil conditioner, surgical plaster, plaster of Paris and drywall, binder in fast dry tennis court clay (IBM 2020b).	Known usages are outside of the construction supply chain.
Aggregates	Glass production and foundry casting, ceramics, chemical manufacture, soil conditioning, abrasive or refractory material in industrial processes (IBM 2020c).	In the case of glass, the specific quality of sand required classifies it as a major mineral.
Brick earth	Asphalt, macadam, ballast for train tracks, terrazzo.	

LACK OF OPPORTUNITIES FOR DIVERSIFICATION / VALUE ADDITION

As noted in previous sections, India consumes the vast majority of the construction raw materials it produces, with gaps in demand filled by imports.

Table 5 shows a number of known uses for construction raw materials outside of the construction sector, which could in theory represent opportunities for economic diversification, in particular if they were promoted amongst smaller operators. The promotion of product diversification should, however, be balanced against the raw material scarcity from which the construction sector is already suffering. On the one hand, for example, the development of gypsum-based products, such as drywall, would be supported by contemporary designs and growing demand as well as offering an opportunity for value addition. But this might not be possible to implement as gypsum is a key component of cement, which is structurally more important to construction than other gypsum-using products. On the other hand, however, manufacturers of gypsum-based products other than cement could create healthier competition for gypsum, reducing the grip that the cement industry has on the material and allowing for the entry of new players into the expanded value chain.

One exception to this lack of opportunities for diversification of products may be the limestone sector, as discussed previously. Whilst the vast majority of limestone production is vertically integrated into the cement manufacturing industry, there is a small percentage of smaller operators who likely supply limestone for other uses, such as soil conditioning, sculptures, medicines, cosmetics, toothpaste, paper, plastic, paint, and in other materials as both white pigment and cheap filler (IBM 2020d).[43] Whilst these uses constitute a much smaller market segment than cement, they may nonetheless represent an opportunity for the promotion and development of smaller operators within the value chain.

INFORMALITY

As discussed above, there is widespread informality in the Indian construction raw materials sector. Informality creates various issues in terms of hindering value addition and better local economic development, hampering efficiency and quality in the construction sector, and creating unwanted social and environmental impacts.

The widespread use of migrant labour, contracted through labour brokers and often toeing the line of forced labour, at every stage of the value chain but

[43] These supply chains are not currently known as they are outside of the scope of our research and the stakeholders that were consulted on the matter did not have an inkling of non-cement limestone supply chains.

transport, creates systemic issues by driving down the cost of labour throughout the value chain and thus artificially depressing the cost of materials or increasing the return on investment for a supply chain actor.

Informal operations are likely further marginalised by reputational barriers. Due to prevalence of negative social and environmental impacts (see Annex 3) relations with civil society are often strained and public opposition to mining is pronounced, particularly in urban-centric media reporting. This type of reporting contributes to building a non-nuanced blanket anti-mining narrative, especially as it does not make clear distinctions between LSM and ASM or formal and informal forms of mining. This lack of nuance has both strengthened the divergence of priorities between the Federal and the state levels and has led these different forms of mining to coalesce into important power groups in extraction areas, groups that are supported by the powerful construction industry. This negative perception can further entrench informality if informal actors are demonised while the gap between formal and informal (the 'good guys' and the 'bad guys') grows deeper and becomes more difficult to overcome.

Along with the lack of opportunities for value addition, informality represents an important barrier to the potential 'upgrading' of smaller operators in construction supply chains towards better products, more efficient production, or access to higher-value markets. The poor labour conditions that often accompany informality in the construction raw materials sector in India also mean that, even if supply chain expansion were to take place, those who make up some of the most vulnerable segments of the construction raw materials labour force – migrant workers – are unlikely to see any of the benefits of this expansion. The integration of these actors into any interventions is essential. A step-by-step process to formalisation is important in making the process an inclusive one, as loading more requirements onto the existing (small) operators without fundamentally changing the cost structures within which they operate is unlikely to push operators towards more sustainable practices and is instead likely to move them further towards informality if not illegality.

RECYCLING AND ALTERNATIVE MATERIALS

As described above, waste disposal from the construction industry is a significant problem. In theory, this could be mitigated with more widespread use of, and greater production of, recycled materials. In practice, however, uptake of recycled materials in the construction sector has been low, and recycled materials are far from achieving their full potential as a source of responsibly produced construction materials.

The recycling of C&D waste nonetheless seems to offer significant opportunities in light of the demands of the construction sector and the availability of "raw" material. However, the supply of construction raw materials it represents might benefit, somewhat counterintuitively, from less value addition per unit in order to drive up volume. A focus on "semi-processed materials" (aggregates, m-sand, soil, and debris for backfilling) as opposed to fully manufactured and ready to use goods such as concrete blocks would facilitate the uptake of recycled materials. This in turn would diminish non-recycled C&D waste and its impacts. The semi-processed materials would also be more easily produced by smaller players who already operate informally, creating an opportunity for formalisation through value addition. A lower GST rate for non-final goods such as aggregates and m-sand could also be easier to justify and implement.

The use of alternative materials could also represent an opportunity for expansion of existing construction material value chains. However, the growth of this sector is hampered by a number of factors. The promotion of fly ash bricks serves the double objective of lessening the exploitation of soil deposits, and thus of arable land, and to dispose safely and beneficially of a polluting waste-product (Interview with Vikash Nayak). However, given the high levels of formality and mechanisation in the fly ash (as well as cement) brick sector, any promotion of these supply chains to the detriment of clay bricks should be carefully considered. Although the clay brick sector is characterised by informality and poor labour conditions as well as serious forced labour issues, it is nonetheless a significant employer, providing livelihoods for a large number of people from all over India. Any initiatives to promote the development of alternative bricks, therefore, should consider parallel initiatives to support the clay brick sector and labour force, rooting out the sector's reliance on labour brokers and practices akin to forced labour and also supporting better techniques

or more efficient production to allow the clay brick sector to remain competitive against alternatives.

At construction level, it has been noted that while government incentives are in place, the uptake of alternative materials is affected by consumer attitudes towards these materials. In particular, private buyers do not want builders to experiment when building their house, and final consumers are usually not sensitive to environmental performance for its own sake (CSE 2020; Interviews with Sanjay Seth and Pradip Chopra).

INCREASING RELIANCE ON IMPORTS

A country's construction sector should ideally be able to rely on locally produced materials, instead of on imports. As already discussed, the majority of construction raw materials produced in India are used in country and contribute little to sector exports. Until recently, the sector has been able to produce enough raw materials to fulfil the majority of its needs, as well as producing most of the heavy-duty equipment and vehicles used along construction materials value chains.

However, our findings show a potential trend towards reliance on imports for a few key commodities. Limestone production, for example, is complemented by the annual imports of 24.4 million tonnes in 2018-19, which represents an increase of 17% from the previous year's imports and 6.5% of the limestone mined in the country (IBM 2020d). It is estimated that India's limestone import dependency would rise from 0% to 20% if no new reserves are identified in the coming 20 years (IBM 2019d). In parallel the country imported as much as 4.06 million tonnes of gypsum and only exported 111,000 tonnes in 2015-16 (IBM 2018a).

In contrast to limestone and gypsum, India did not until recently import significant quantities of sand, yet the coastal States of Tamil Nadu, Karnataka and Kerala have imported sand, from Malaysia, for the first time in 2017 (The Tribune 2019; CSE 2020) which could represent the emergence of an import market. However due to sand's bulkiness it is unlikely that imports will supply Delhi, and the capital will continue to rely on closer to home sources, which include: riverine deposits in Uttar Pradesh and parts of Haryana along the Yamuna river, agricultural fields in Haryana, and remnants of inactive rivers in Rajasthan (MoM 2018), as well as reportedly quarries within Delhi NCT.[44]

These trends could represent an increased reliance on imports for the construction raw materials sector in India. This is not in itself necessarily a barrier to the development of the sector – it is not uncommon for countries to operate trade deficits, especially for specific sectors. However, imports are subject to impacts from externalities such as exchange rate fluctuation and macroeconomic performance, which may make them more expensive and so diminish the overall contribution of the construction raw materials sector to wider economic performance. As already discussed, high transport costs and bulk of material make construction raw materials particularly suited to local production. Therefore, noting high global rates of urbanisation and the accompanied demand in construction raw materials, local production where possible ought to be prioritised to ensure supply of and access to raw materials at predictable and viable prices in the long-term.

INFRASTRUCTURE CHALLENGES

At the mine site, in addition to the regulatory elements mentioned at the beginning of this chapter, the supply of electricity has been noted as being irregular and thus requiring generators to fill these gaps. The location of most mines away from towns also complicates the availability of spare parts and the maintenance of machinery according to mine-site respondents.

COVID-19

During the lockdown triggered by the COVID-19 pandemic, millions of migrant workers trekked back from the cities where they work to their hometowns (BBC 2020); on the sites visited only 20% of the workers stayed on the sites during the lockdown, during which they received 50% of their salary and otherwise had to rely on their own savings (Field research). After this exodus, certain industry insiders predicted that construction workers, both skilled and unskilled, would be able to command higher wages (KPMG, 2020). To date these higher wages have failed to materialise and labour prices are at the same level as prior to the lockdown (Consultations with construction workers).

[44] These later claims could not be verified by our research.

5.2. Indonesia

The barriers and opportunities along the Indonesian construction material value chain can be divided into several sub-topics: competition from imports, foreign companies, and workers; domestic competition and lack of localisation; supply chain fragmentation; seasonal impacts; informality; cement oversupply; climate impact; workers skills gap; financing and cashflow; and COVID-19.

COMPETITION FROM IMPORTS, FOREIGN COMPANIES, AND WORKERS

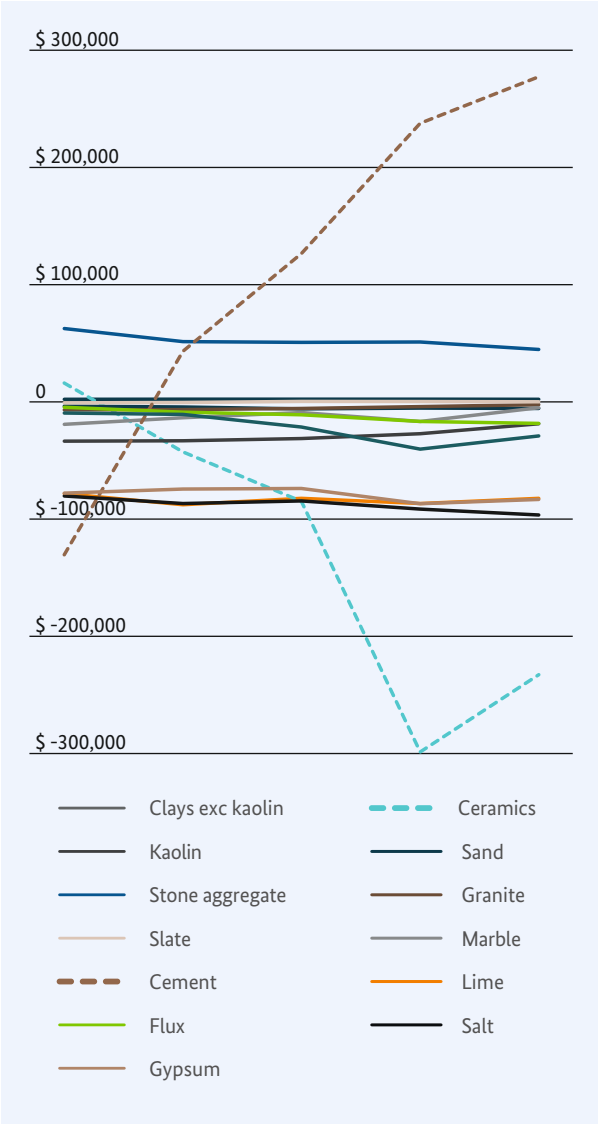
Whilst imports can be an incentive for the development of local value chains, expensive imports and large trade deficits can present a barrier to the development potential of a mineral value chain. Given the costs associated with the trade and transport of construction raw materials, this can be especially true of the sector. Adding to this the developmental impacts of employment creation and the sustaining of rural economies, the sector is therefore particularly well-suited as a priority sector for domestic production and processing. This is in line with Indonesian government priorities and policies as further described below.

The trade deficit[45] from relevant construction raw materials in 2019 was 250.2 million USD (209.5 million EUR), constituting 7.7% of Indonesia's total trade deficit that year of 3.23 billion USD (2.7 billion EUR).[46] Whilst this is not always the case – Indonesia's trade balance has fluctuated significantly over the last decade – the sector presents an opportunity to mitigating potential trade deficits in the future (see potential analysis). Two value chains in particular stand out – gypsum for cement and ceramics.

Cement is an important export material for Indonesia. Although gypsum is an important ingredient in ordinary Portland Cement as well as Portland Composite Cement and Portland Pozzolana cement, the Indonesian cement sector relies almost completely on imported gypsum, and gypsum accounts for 14% of the trade deficit attributed to construction raw materials in 2019 (see figure 22 and figure 23). Further research is warranted to understand why gypsum production does not take place, despite confirmed reserves across the country, including East Java and efforts since late 1990s to produce more domestically. It could be due to the fact that the reserves are hypothetical and not feasible to exploit.

The development of the cement industry is not without its challenges. The domestic cement manufacturing industry is not competitive against cheap foreign import material, in particular from China, a situation

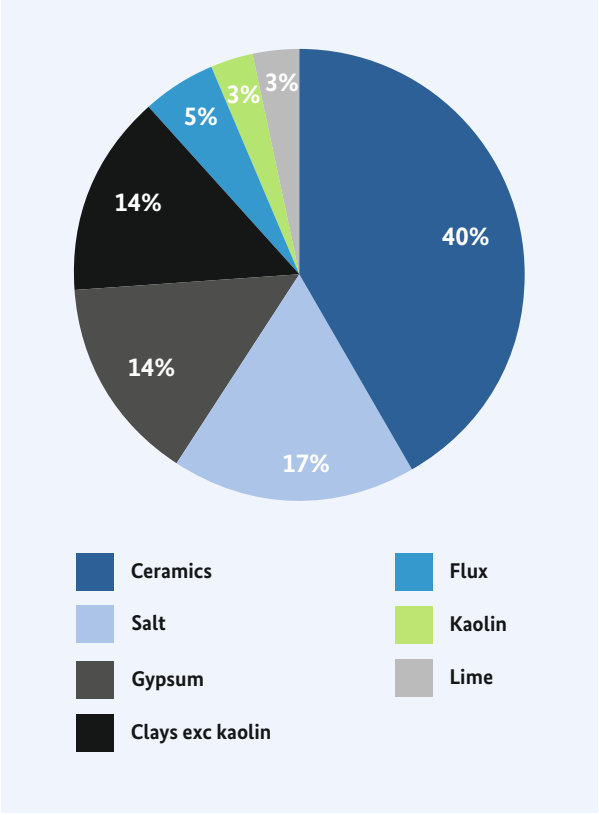
Figure 21 – Trade balance attributed to construction raw materials, 2015-2019 (ITC Trademap)



[45] According to Investopedia, a "trade deficit occurs when a country's imports exceed its exports during a given time period." (Bloomenthal, A. 2020. "Trade Deficit." Investopedia, accessed 19th March 2021 at https://www.investopedia.com/terms/t/trade_deficit.asp)

[46] Calculated using data from ITC Trademap; Reuters 2019, accessed 23rd February 2021 at https://www.reuters.com/article/uk-indonesia-economy-trade-idUKKCN1P90AZ

Figure 22 – **Main contributors to trade deficit attributed to construction materials, 2019 (ITC Trade Map)**



that has to be closely monitored if the industry continues to grow. In reaction, with the aim to protect domestic manufacturers, industry stakeholders have called for higher duties on imports (Oxford Business Group 2019).

Ceramics is by far the biggest contributor to the construction raw materials trade deficit in Indonesia (see figure 22 and figure 23), making up 40% of the total trade deficit attributed to construction raw materials in 2019. This trend has greatly increased over the past five years (see figure 22). According to an interviewee from an Indonesian ceramics company, local entrepreneurs are rarely involved in the medium- and large-scale ceramics business, as they cannot compete in terms of connections and capital. The ceramics business in Indonesia is further dominated by Chinese entrepreneurs (Interview Ceramics Industry Representative, 13 May 2020).

Competition from foreign companies more generally also presents a barrier to the development of the construction sector. Indonesian construction companies are facing increased competition from foreign companies, above all from China, Japan, South Korea and India. Chinese companies in particular are taking over infrastructure projects as they are winning public tenders, amongst others linked to the Belt and Road Initiative. Also workers in the construction sector are sometimes foreigners, because of an apparent shortage of local workers.

DOMESTIC COMPETITION AND LACK OF LOCALISATION

The Indonesian construction sector is dominated in numbers by small-sized companies, but they only receive 15% of construction projects in terms of value. The sector suffers from a lack of localisation. This is because of excessive intervention from large national contractors in local district projects, because there is a lack of capacity building for local contractors and because of vertical integration of some state-owned enterprises (Abduh and Rahardjo 2013). State-owned enterprises dominate the significant government infrastructure projects such as construction of toll roads and bridges. According to the law they are only allowed to bid for projects valued above 100 billion IDR (5.8 million EUR), however it does happen that they win government tenders outside of their class (Indonesia field interview 18).

Small construction businesses have the opportunity to be subcontracted to large projects. According to the Regulation of the Minister PUPR No. 14/2020, projects valued above 25 billion IDR (1.5 million EUR) must sub-contract part of the work to small businesses. However, in order to be able to become a sub-contractor, businesses have to be formal and a member of Gapensi, the Association of Construction Companies in East Java. Small informal companies experience increasing competition from Gapensi members (Indonesia field interview 18), which would exclude small home businesses and other informal companies.

The lack of localisation also applies to the heavy equipment sector. The construction industry consumes around 13-20% of heavy equipment sold in Indonesia. The industry uses a lot of reconditioned equipment, with 65 companies in the country providing such equipment. However, the number is decreasing because of import restrictions on used equipment (Abduh and Pribadi 2014). Only 30% of heavy equipment is made by the local industry, using up to 50%

local materials, while 70% of equipment is imported (Abduh and Pribadi 2014).

At the upstream side of the supply chain home businesses do not have access to the high value markets of marble, granite, and kaolin. This is due to high capital requirements and the need for excavators and other high technology (Indonesia field interview 18). Most interlocutors along the value chain, including mining, processing and trading businesses, mentioned a lot of and increasing competition from other businesses. Good online marketing was mentioned repeatedly as one of the key factors of success. Also being located close to a road helps quarries or processing companies to gain customers due to easier accessibility.

A challenge for certain businesses in the construction value chain to access opportunities is the existence of closed networks where businesses with prior connections get exclusive access to business deals and those outside of those networks lose out. This impacts in particular smaller businesses (Indrawan et.al. 2020).

SUPPLY CHAIN FRAGMENTATION

An important barrier to the efficiency of local construction value chains has been identified in the literature: construction value chains tend to be complex and composed of a large number of actors with competing interests and a lack of coordination between each other (De Groote and Lefever 2016). Indonesia has a highly fragmented construction supply chain, which leads to low productivity, disputes and cost and time issues (Abduh, Soemardi, and Wirahadikusumah 2012). The relationships between actors in the supply chain are ad-hoc, temporary and lack loyalty and stability (Abduh and Pribadi 2014), leading to fragmented project delivery (Supriadi and Sui Pheng 2018). This not only relates to trade and transport, but to business relationships more in general.

Indeed, there are issues of domestic provision of construction raw materials. The Indonesian construction sector suffers from a lack of information on the demand of materials, with details on quantity, quality, location and time (Abduh and Pribadi 2014; Supriadi and Sui Pheng 2018). The high cost of material purchasing has shown to be a challenge (Abduh, Soemardi, and Wirahadikusumah 2012). Before the government does not strengthen efforts to reduce raw material prices, self-sufficiency in construction raw materials will be difficult to achieve (Oxford Business Group, n.d.). Price fluctuations can also pose important challenges to supply chain actors, especially to small-scale operators who are not as resilient to financial shocks as their larger counterparts. Prices for raw materials change quickly if there is a change in fuel prices or a monetary crisis. There is therefore no predictability of prices for actors in the value chain. Another issue is the lack of infrastructure and therefore the difficulty to get raw materials to remote areas.

SEASONAL IMPACTS

The impact of the rainy season was an important topic in the interviews with all supply chain actors. In the quarrying sector, activity continues during the rainy season, however the workers have to occasionally pause activity for a few hours before they continue in case of heavy rainfall. The rains also slow down distribution of products because the roads become muddy (Indonesia field interview 3). Sand processing businesses experience a drop in demand during the rainy season and an increase during the dry season (Indonesia field interview 4).

A red brick producer reported producing around 15-20% less during rainy season as raw brick is difficult to dry and takes longer to burn at that time, which slows down production (Indonesia field interview 9). This seems to be a common issue for brick makers.

At the construction end, activities slow down during the rainy season on the one hand because of reduced quarrying of raw materials but in particular because of transportation issues and limited access to and from the project sites because of damaged, muddy, or flooded roads (Indonesia field interview 1; Indonesia field interview 2).

On the other hand, in particular house building projects are usually not taking place in October and November as clients prefer to construct houses at the beginning or middle of the year during the dry season (Indonesia field interview 1). Certain types of activities cannot be done during heavy rains, for example making foundations, laying bricks, or plastering walls. Rains also create many risks for the construction workers such as landslides and lightning, which is why they often stop during those times (Indonesia field interview 18).

INFORMALITY

The construction value chain is riddled with informality. 90% of ASM miners are considered illegal by the government. It is difficult to obtain legal status as an ASM business. According to the ESDM this has to do with the District Government not having consistently established People's Mining Areas, which limits the ESDM in providing People's Mining Permits (Indonesia field interview 14). The informal sector is prone to social and environmental issues, as it is poorly regulated and monitored. Linked to this informality is the fact that there is no dedicated government unit responsible for ASM, that sub-national governments do not have the human resources and capacity to monitor mining activity adequately and that they do not coordinate enough with the national government. This also leads to a lack of data on informal and small-scale actors. Most daily workers across the supply chain seem to be working without contracts and are therefore vulnerable to market fluctuations caused by seasonal impacts or COVID-19 restrictions.

A respondent from the sand, gravel and stone quarrying sector mentioned regulatory changes as causing problems in the sector. The authority for licensing has been passed between levels of government and the process is more complicated now as there are additional requirements (Indonesia field interview 3). Previously, mining permits were issued by the provincial ESDM office while now they come from the Directorate General of Mining and Coal in Jakarta (Indonesia field interview 7). The high requirements and fees for mining permits prevent some processing businesses to start mining themselves (Indonesia field interview 4). Apparently also getting a processing permit is burdensome and costly, with certain environmental requirements being in place for being allowed to operate a stone crusher (Indonesia field interview 5).

The lack of formality in the sector can have very material effects. Low quality bricks produced in the informal sector – linked to the burning temperature and kiln construction – and the lack of regulation around that have for example led to the production of bricks that provide poor earthquake safety (Roachanakanan and Nichols 2009). A study of bricks in East Java found that the compressive strength of bricks was between 0.55 and 0.9 MPa, and the modulus of elasticity of low-quality bricks was between 279 and 571 MPa. This is lower than in most countries that the researchers compared it to, and therefore the quality is worse. Improving the quality of bricks in Indonesia in particular for earthquake-preparedness is however a challenge because the industry is dominated by home businesses (Ridwan, Kurniawan, and Agus 2018).

The widespread informality makes the sector vulnerable to corrupt behaviour. In 2010 for example, there were reports of semi-legal clay and rock quarry workers having arrangements with the police who protect their businesses and facilitate informal activities while taking a premium which could amount to up to 5-20% of earnings (Aspinall and van Klinken 2010). Also other informal actors are vulnerable to police raids and extortion.

FINANCING AND CASHFLOW

Cashflow seems to be an issue across the sector and value chains, and is needed to cover operational costs, employee salaries, taxes, and other expenses. Many respondents mentioned low-interest loans as one of their most need support services. The lack of licensing can be an issue to access such financial support. This is because informal firms lack the documentation to qualify for loans issued by banks or government support (Farazi 2014).

Trading and processing businesses mentioned financing needs in particular with relation to heavy machinery maintenance and the need for more machinery to increase productivity and efficiency (Indonesia field interview 5; Indonesia field interview 7).

Cashflow issues in the construction sector exclude smaller businesses from government projects as the government usually does not pay immediately for services. In order to access bank loans, the businesses would have to be licensed which again is not easy because of a complex and expensive process (Indonesia field interview 18).

CLIMATE IMPACT

Environmental and climate issues exist along the value chain. A major barrier to tackle them is the lack of government monitoring and enforcement of environmental standards, mainly due to capacity constraints. Further, technical assistance in the area of environment can only be provided to the formal sector, which leaves the informal sector neglected, despite its often serious negative impacts.

The environmental impacts of brick manufacturing mainly stem from air emissions and high energy consumption during the firing of clay bricks. More modern kiln systems have proven to be more environmentally friendly but are often not accessible for traditional brick making businesses as they are more adapted to industrial-scale mechanised processes. Other efforts to improve the environmental footprint of brick production include reducing the temperature and therefore energy in the firing process through the use of specific clays and using organic and inorganic waste materials as an additive to the bricks. However, these measures do not come without problems in the traditional brick making industry. As pointed out above, reduced temperature can harm the brick quality and therefore earthquake safety. Further, the cost of adding waste materials often is higher than the economic benefit, and during the firing process, the waste materials might release contaminants (Atmodiwirjo et al. 2018).

Cement producing companies harm the environment through the release of dust and toxic gases during manufacturing (Keller and Klute 2019). Cement is the manufacturing industry in Indonesia that emits the most greenhouse gases. The cement sector releases 40 million tonnes of CO_2 equivalents yearly, of a total of 600 million tonnes from the energy consumption and production sector (Panjaitan et al. 2018). The production of one tonne of cement releases 600 kg of CO_2 (Keller and Klute 2019).

In terms of moving towards a more climate-friendly construction industry, Panjaitan et al. (2018) have identified the following two barriers: first, the Indonesian government does not provide the industry with enough regulatory and policy support in planning greenhouse gas emission reductions and developing new standards. Second, existing regulation prohibits certain innovations from gaining ground. For example, the opportunities for substituting clinker with domestic fly ash for producing cement are limited because the law prohibits the purchase or import of hazardous and toxic materials, amongst which fly ash (Panjaitan et al. 2018).

WORKERS SKILLS GAP

A major issue in the Indonesian construction sector is the skill gap of workers in the industry (Oxford Business Group 2019). 60% of construction workers are semi- or non-skilled, 30% are classed as skilled workers, and 10% certified as professionals. As the Indonesian construction law only allows certified professionals and skilled workers to work in construction projects, some companies rent worker certificates from other regions – in particular from Java – when they bid for a project. However, when they are awarded the contract, they hire local workers without any certifications (Abduh and Pribadi 2014). The companies hiring non-certified workers include those involved in community building projects, or private businesses involved in constructing housing or shops. However, non-certified workers are also employed in official government construction projects. An additional human resources challenge is that the Construction Services Law No. 2 (2017) favours Indonesian nationals for positions in the construction sector, but as there is a shortage of local construction workers, foreign workers are often employed instead (HFW 2019; Supriadi and Sui Pheng 2018).

Shortly before 2017, the National Construction Services Development Board called on the government and the private sector to implement a policy that requires construction workers to have a certificate of competency. Law 2/2017 on Construction Services implemented this request, requiring every construction worker to have a Certificate of Occupational Competency, obtainable through successful completion of a competency test (PwC 2017). This is an ambitious goal, given that out of the estimated 7.7 million construction workers in 2017, only around 10% were certified. Further, a study has shown that people with low education levels have only limited access to further education opportunities and certification courses (Allen 2016). To address the shortage of certified construction workers, the government ran the Accelerated Construction Training Program from 2010-2014 to provide training and certificates to 3 million construction workers (Abduh and Pribadi 2014). On a local level, the Trade and Industry Agency in East Java further provides annual capacity building for businesses, in particular SMEs (Interview, Trade and Industry Agency, East Java, 01 June 2020). Law 2/2017 on the Certificate of Occupational Competency only had limited effects. While many certifications have been obtained since its issuance, most construction workers in Indonesia do not know or do not care about the existence of the regulation. They are still able to find work, and the certification fee of 3 million IDR (174 EUR) is by many considered too expensive. The lack of access to training and thereby certification means that many construction workers are denied the advantages that come with a certificate, namely legal recognition

and protection, higher renumeration and a health insurance (PwC 2017).

COVID-19

The COVID-19 pandemic has had an impact on the Indonesian construction value chain. It is unclear whether these impacts will be temporary or have longer term consequences.

Construction work was largely halted because of large-scale social restrictions between March and August 2020 which also impacted material supply. Many government construction projects stopped because funds were diverted into handling the pandemic. Since August 2020, construction work has gradually started up again, but it still has not reached normal levels. One construction contractor said his business had experienced a 20% decrease in demand for their services in comparison to before the pandemic (Indonesia field interview 1). Another said that even five months ago many workers were being laid off and only are being reemployed gradually again in early 2021 (Indonesia field interview 2).

The decrease in demand for materials has impacts across the value chain. Businesses from the quarrying, processing, trading, and transportation stages of the supply chain reported a decrease in income, production and/or demand of between 20 and 50% in comparison to before the pandemic. This relates both to domestic and export business. A transportation provider also reported falling prices because of increasing competition linked to shrinking demand (Indonesia field interview 12).

6. Analysis of value chains and sector potentials

The following section presents an analysis of the main areas within the construction minerals sectors in Indonesia and India that show a potential for development. The focus lies on the optimisation of existing value chains for local development.

When referring to addition of 'value' to a particular chain, this report is not referring only to value in a monetary or economic sense, but mainly to other types of value, be they socio-economic, environmental, infrastructure, etc. Measures that look to promote value addition at a very localised level, for example, may not be as efficient in terms of supply chain performance as measures that focus mainly on larger operators with greater capacities and skills. Localised value addition tends to have more redistributive and inclusive effects that are likely to benefit 1) a large group of stakeholders and 2) provide access to income for some of the most vulnerable segments of the respective populations.

Moreover, value addition can take place at different levels – national, sub-national and local. Different types of interventions will generate value at different levels. An import-substitution approach, for example, is likely to generate macro-economic impacts at the national level, whereas more localised incentives such as value addition promotion and the provision of incentives for greener buildings, for example, will have much more local impacts. Whilst neither approach is in itself better, and nor are they mutually exclusive, it is important to consider the implications of factors such as government capacity for the various types of approach. Any measure looking to localise value addition, particularly through the formalisation and/or improvement of smaller local operators will require more local capacity (but will likely have more redistributive effects) than an approach focusing on a few nationally operating big players who will require less monitoring and enforcement capacity (but will likely have less redistributive effects and promote less local reinvestment). These are trade-offs that must be taken into account when considering the greatest potential for the development of construction raw materials value chains.

The following suggestions are based on the analysis of the construction raw material sectors in India and Indonesia. Nonetheless, where relevant the chapter points towards recommendations that can be applied also outside these contexts. Annex 5 contains a summary list of the general approaches.

6.1. India

The two identified avenues for value addition in the Indian context are concerned with the improvement of environmental, social, and climate-related performance and in strengthening the manufacture and uptake of recycled C&D waste on the other hand. The possible interventions presented below are geared towards these objectives and while they offer a general blueprint any implementation should take additional care to take the following elements into consideration to fully tailor the responses to their local context.

Pragmatism is key. As the case of Uttar Pradesh reaction to EIA implementation requirements illustrates, while thorough reform might be desirable it may not be possible as the required democratic processes take time and actors that benefit from the current status quo generally have considerable participation power

in said processes (CSE, 2016). Implementation capacity at the exact level of implementation will have to be taken into account. And while interventions that are more limited in their scope might be easier to implement it is necessary to avoid as much as possible further complexifying the existing "patchy" framework for both the implementing and overseeing agencies as well as the operators. Pragmatism also dictates that interventions should be able function on their own and not depend on other interventions. Even though potential synergies are not to be discarded the robustness of impacts should be prioritised. Consequently, the design and implementation of interventions must favour incremental improvements, which must also be reflected in milestones.

Interventions cannot shy away from the fact that, with the exception of the cement supply chain, and even then, nearly all materials reaching construction sites are produced by supply chains that are structurally informal. Public sector construction projects must be open to acknowledge the fact that their supply is currently by necessity not fully formal and must aim to shift this in a realistic fashion. Given the nature of the sector and the incentives that underline it, heaping additional regulatory demands on operators will not solve issue. Instead, it would only further entrench the problem and push smaller operators towards greater informality, while at the same time further disenfranchising the already extremely vulnerable labour force that depends on this sector and its economic linkages. This applies to construction value chains more generally. Additional regulatory burden without the required support system for smaller operators will just push them further into informality.

BETTER GOVERNANCE FOR THE PROMOTION OF LOCAL VALUE CAPTURE

This study has identified scope for the promotion of greater value capture amongst small, local operators in existing supply chains, thus promoting the addition of social and environmental value or capital at the local level in the form of better employment, access to formal (and therefore higher value) markets and reduced environmental impacts of these actors. As in any sector intervention, the approaches defined below assume a design that minimises negative impacts, promoting avoidance of negative impacts first and foremost, followed by minimising and mitigating unavoidable impacts.

Public sector project procurement. The public sector is a key construction driver in India through both infrastructure and real estate development projects, giving it incredible leverage on supply chains. This leverage gives government agencies direct opportunity to impact supply chains through contractual agreements, supplier selection procedures, and project-based oversight and monitoring. At the same time, and contrary to private sector projects, public sector projects can justify the purchase/use of materials that are more expensive than the market based on their characteristics.

Public projects could take into account in their proposal or supplier selection processes, as relevant to the situation, the legality of the materials used. Whilst this is already, in theory and as standard, a condition for public procurement, the lack of fully legal construction raw materials supply chains in India mean that it is not enforced in practice. The explicit promotion, therefore, of legally produced and traded materials could open up an entry to market for construction raw materials production that would otherwise not be competitive in local markets due to the elevated costs of operating formally. If weighted properly this could offset the additional costs created from sourcing legal materials –i.e., materials that are extracted, traded, processed, manufactured, and transported via operations and operators that are all strictly legal at all times – allowing legal materials to be competitive. As fully legal supply chains are currently extremely rare, if they do exist, it might be necessary for such sourcing efforts to take longer times so that supply chains that are not yet fully legal can become so.

In practice this would amount to paying for suppliers to be compliant and it would be important to ensure that these efforts do not only benefit the most advanced actors and further sideline small producers with less resources. Public projects should also ensure that they follow to the letter the regulatory demands that concern C&D waste disposal. Compliance should then form part of contracts and be proactively monitored, and sanctions in case of non-compliance should be predetermined and agreed upon.

Under such a scenario public sector projects will have to absorb the cost of their supply chains achieving compliance with legal requirements. Instead of a cost this should be seen more as an investment as the current non-compliance is having significant negative social, governance, and environmental impacts.

However, the benefits from this investment might be enjoyed by other agencies.

This recommendation is relevant for other contexts where there are high levels of informality in construction value chains. Public procurement can be an important starting point for progressive formalisation of the sector, by requiring actors in the supply chain to (increasingly) abide by regulations, as well as providing opportunities for those whose costs are higher due to adherence to legal and regulatory frameworks, making them non-competitive in a largely informal market. In the spirit of a continuous improvement approach, financial support and capacity building should be provided to operators involved, and particular attention should be paid to supporting small and local businesses.

Stage-specific vade mecums. In order to simplify rule compliance for operators, every stage of the supply chain should be issued with a handbook containing consolidated information on all the applicable legal requirements and payable taxes, making them the sole document operators need to consult. They should also highlight the rights of operators and make clear that any payment that is not listed in these handbooks is not a payment that operators have to make and should therefore be refused on grounds of illegality. These handbooks should be issued at the state level given the nature of minor minerals and should be endorsed by the authorities to the extent that they could be used in court as a reference text.

These handbooks should complement the applicable legal text/paragraphs they present with simple to understand explanations and examples to ensure comprehension for the readers.

As regulations will continue to evolve it would be pertinent to ensure that the vade mecums are updated as soon as necessary, are easily accessible to anyone at no cost, and that changes from the prior versions are summarised. This presupposes a web-based distribution of soft copies, soft copies that should be found amongst the first results of a simple internet search. A free alert service informing subscribers of any new version would ideally complement this strategy.

Non-governmental organisations and development agencies can play an important role in the distribution of the vade mecums and the provision of training to operators on the rules and their implementation. This idea is not only applicable to the Indian context but can be of benefit to construction raw material sectors in many countries, in particular those where the supply chain is characterised by wide-spread informality and complex rules.

Strengthen the enforcement of existing regulations and policies. While a regulatory and policy framework exists, its enforcement has been noted as being limited at best by all stakeholders. To illustrate the situation with the case of Uttar Pradesh "[a] review of the regulatory framework guiding mining of minor minerals and small-scale mining in UP suggests that it is the systemic malfunction of governance mechanisms that has sustained various irregularities that the state suffers from. These include poorly framed and confusing regulatory provisions, weak institutions and inadequate monitoring and enforcement. Poor governance has prompted court intervention from time to time but that has not helped the matter either" (CSE 2016). Additional capacity is therefore key in ensuring the implementation of measures. And while the recruitment and training this presupposes would generate costs, these would be easily recouped by the additional tax revenue generated by inspections that is currently being lost.

Given the required inter-state, inter-level, and inter-agency oversight of construction raw material supply chains the creation of dedicated minor mineral task forces at the level of NCR might be necessary;[47] the creation of which will need to consider not only which are the agencies that should participate but also what are the reporting lines and hierarchy, who owns the responsibilities of its operations and how it is financed. It is important that any recruitment effort considers the level at which regulations are actually implemented so that implementing agencies are not top heavy with poor presence in the field.

More strenuous implementation of the applicable regulations should be careful as not to focus only on the small players, which rarely possess the capacity to reach compliance without support and that represent easy targets, but also to go after bigger players that have the capacity to be compliant. And while these bigger players often beneficiate from support from

[47] Notably Haryana has already started to consider establishing its dedicated taskforce in the form of a Mining Minister Flying Squad consisting of one officer each from Mines and Geology, the Regulatory Wing of the Transport Department and the Police Department (The Indian Express 2020).

key politicians, they also represent more tax-generating opportunities because of their proper taxation. Non-governmental organisations and development agencies can provide capacity building to smaller operators in their efforts to become compliant. E-governance solutions have been mentioned as being able to reduce corruption issues by avoiding face to face interaction and leaving written records. They do offer unquestionable advantages and are generally being rolled-out at all levels of government in India. However, care should be taken to ensure that the digitisation of administrative operations does not exclude citizens that do not have access to these tools, in particular during community consultation processes and for the dissemination of information. These citizens are typically amongst the most vulnerable populations in the country. In short, the digital divide should not compound existing socio-economic ones. Non-governmental organisations and development agencies can play an important role here, ensuring information also reaches the most vulnerable and enhancing access to e-governance infrastructure to those populations through material support and capacity building in digital literacy.

Lack of enforcement is an issue beyond the Indian context and similar approaches could work in other countries as well, for example the creation of additional capacity and provision of financial resources for implementation and enforcement and the creation of a dedicated mineral task force. E-governance solutions however require a larger government effort and investment which is being undertaken in India but not necessarily feasible for other countries in the short term.

Common minor mineral databases. At the NCR or the national level, a publicly accessible resource centre of applicable information on the minor mineral sector would support both the coordination of agencies and allow civil society to have access to the resources they need to independently monitor the situation in the field. Finding common definitions for the different types of minor minerals and their categories would facilitate the establishment of such a resource.

At the NCR or the national level, a satellite imagery-based system to flag potential minor mineral extraction sites should be established. Satellite imagery-based identification of mining and some processing stages has proven its potential (see for example Niazi et al. 2020, University of Nottingham 2019). Having such a service provided at the national level would take some burden off the individual States' agencies who could then direct their efforts towards targeted interventions. Providing this service would also give some direct information to IBM and would be a good fit for IBM's capacities and the expertise of the Indian ICT sector at large. A satellite imagery-based information system would also support the States' monitoring of formal activities once overlaid over mining cadastres and could trigger red flags when indications of mining outside of the assigned perimeter or at higher than allowed volumes is taking place.[48]

Making such a database publicly accessible online would reinforce civil society by giving it important information and would help to inform individual constituents about what is happening in their districts, which could empower them to demand accountability from their representatives.

This is a popular approach in the management of mineral sectors and applicable outside of the Indian context. Many countries are conducting satellite imagery studies of their mining sectors and creating databases. However, these efforts seem to usually be more focused on high-value materials such as gold. Development agencies can build on existing initiatives[49] to promote the uptake of satellite imagery technology and databases also for construction raw materials.

Interventions through certifications. From a construction material supply chain perspective, it would be necessary to expand the scope of the certifications from site-based to supply chain-based; such indicators would likely have to look at company-level supply policies and management systems. Given the current configuration of the construction material supply chains this inclusion could not be as part of the criteria where compliance is mandatory.

Verification of the commitments made by registering under any certification scheme should be implemented in order to ensure that operators do not receive incentives they are not entitled to.

[48] This approach is aligned with a number of the recommendations made by NGT (2020) for Uttar Pradesh's sand mining sector for example.

[49] See, for example, the University of Nottingham's 'Fighting Slavery from Space', which uses satellite imagery and remote sensing to map brick kilns across South Asia's 'Brick Belt' with a view to informing the identification of the occurrence of modern slavery in the sector.

Productive clusters. Indian government agencies have a long history of making use of a cluster approach in their management/support of focus industries, an approach that is still ongoing (IBEF 2020f). The same approach can be extended to construction raw materials by providing them with the correct incentives. Working with clusters can make the monitoring, avoidance, and mitigation of impacts more efficient and facilitate the provision of support towards these operators to ensure their use of good practices and incentivise their compliance. The exact nature of the incentives that would underline a cluster would have to be stage specific. For illustrative purposes two hypothetic cluster options are presented.

- Sand mining clusters could be established by state authorities. In these clusters an EIA would already have been performed and the environmental management plan of each title within the parcel would have been designed. Access roads would be established with single entry points that could be remotely monitored.

  → *This saves the costs and complications of undertaking EIAs for operators and essentially offers them a turnkey title. And at the same time for state authorities, it ensures that some sand mining takes place formally and contributes to the treasury.*

- Stone and C&D crushing operations could be offered a reliable supply of electricity (potentially at a preferential rate) in set locations, in addition to other punctual benefits. This location will have to be carefully chosen to ensure that the incentives offset the associated costs (of additional transport by ex).

  → *Depending on the location of said clusters this could allow to limit the risks generated by heavy traffic and by dust generation to communities and would facilitate monitoring of production.*

Incidentally, these types of clusters would facilitate the production of legal materials, which could then be used by public projects looking to purchase such products.

While this is a very context-specific recommendation as the cluster-approach is not applied in all countries, development agencies can take inspiration from it and test its applicability in other contexts.

STRENGTHENING C&D WASTE RECYCLING AND USAGE

The Centre for Science and Environment (CSE 2020) offers a number of highly relevant recommendations for improving C&D waste management in Indian cities, including their recycling. The reader is referred to them in particular when it comes to infrastructure bottlenecks. Three of the elements that are part of this report's recommendations will be further highlighted in this section given the current report's supply chain focus. These elements should nevertheless be read alongside CSE's recommendations.

Align recycled material production with market characteristics. The production of recycled materials is currently a top directed effort that focuses on a few big-scale PPP and a collection network with the objective of producing high value-added goods, the quality and the price (due to a high GST) of which have been noted as the two factors complicating the uptake of recycled materials (CSE 2020).

Realigning the production with the market would first require the inclusion of the informal C&D waste processors as these operators offer a commercially viable channel for C&D waste not to be illegally dumped when official collection centres are too far or not sufficient. Their inclusion would also bolster the recycling capacity and by extension lower the volume of waste not processed.

Second, the installed capacity in official centres might be better used, from a supply chain point of view, for the production of lower value-added goods in particular aggregates and m-sand. The Indian construction sector is not currently facing a potentially disrupting shortage of cement blocks, kerbstones or tiles but instead it is facing a shortage of both aggregates and sand that play a much more structural role in construction and are a resource whose current extraction is creating significant impacts throughout the country and in NCR.

Furthermore, the creation of these lower complexity materials would make the participation (and gradual formalisation) of the existing informal sector easier and would smoothen out the quality issues that have been observed with the production of more complex materials. Higher participation might also incentivise operators to proactively target known C&D dumping sites in order to proactively harvest (clean) existing illegal C&D waste dumps.

GST rates adjustment for "manufactured" alternative materials. These should be considered in order to make recycled materials as competitive as their less processed natural counterparts. The pricing should reflect both the service rendered by the industry in the form of C&D waste removal and the avoidance of impacts caused by virgin material extraction. When looking at price alignment it is important to keep in mind that goods produced illegally can be less expensive than those produced legally. For example, sand from illicit sources is noted as being nearly half as expensive as sand from legitimate sources due to its reduced operational costs, even when factoring in the required bribes (GITOC 2019); and these are the supply chains m-sand would have to compete with as they represent the vast majority of the supply.

Making m-sand and aggregates a competitive source of raw materials could incentivise operators to not only depend on the continuous generation of C&D waste but also to proactively harvest (clean) existing illegal C&D waste dumps.

Promote recycled materials. Communication with final clients will be necessary in order to convince them that the quality of recycled materials can be as good or better than of natural and/or traditional products. Overcoming the stigma associated with recycled materials and the "experimentation" they represent is absolutely key. Non-governmental organisations can play an important role here, promoting the increasing uptake of recycled material through campaigning and capacity building.

These recommendations regarding C&D waste recycling and usage can in a general sense be applicable to any other country. Given the increasing focus on environmental issues, this approach can be promoted by development agencies when they work on construction raw material value chains.

STRENGTHS, WEAKNESSES, OPPORTUNITIES AND THREATS TO PROPOSED INTERVENTIONS

Option/ Recommendation	Strengths	Weaknesses	Opportunities	Threats
Public sector project supply chains.	Size of the public sector makes it an important consumer. Only operator that can justify paying more than the "current market value".	Further entrenching operators that are already advanced and sidelining smaller operators with a bigger progression potential.	In due time creating a legal supply that is more than what is required by the public sector and whose production could spill-over into private sector projects and thus change the economic equilibrium of construction material supply chains.	Effort capture by existing elites and establishment of de-facto oligopolies.
Stage-specific vade mecums.	Relatively simple and inexpensive process if done through soft copies. Useful to all stakeholders, including agencies' staff.	Requires frequent updates and dedicated communication about the updates.	Could foster the participation of civil society and constituents.	Decision making about the creation of the handbook rests and ongoing updates rests at the various states level and could be disrupted by shifting political priorities.

STRENGTHS, WEAKNESSES, OPPORTUNITIES AND THREATS TO PROPOSED INTERVENTIONS				
Option/ Recommendation	**Strengths**	**Weaknesses**	**Opportunities**	**Threats**
Strengthen the enforcement of existing regulations and policies	All the required legal and policy framework exists. This approach could bolster capacity while raising tax revenue.	Small players might not be able to implement regulations without dedicated support and would then risk being driven out if the efforts are solely focused on enforcement.	While bolstering the capacity of the relevant ministries this approach also strengthens the general governance capacity of the state governments. Mining issues being transversal, addressing some of their issues will support the work of other agencies.	Shifting political priorities may interrupt efforts at strengthening the required skill base. Recruitment of skilled and dedicated agents willing to work at the local level is difficult.
Common minor mineral databases.	A common database will support the work of all agencies at the state and federal level.	Oversight of minor mineral sites and the creation of such database could be constructed as being a state-level effort and would thus potentially create redundancies and non-alignment.	India's significant pool of IT capable professionals would contribute greatly to the design and fine tuning of satellite imagery-based analysis. The information produced could foster the participation of civil society and constituents and expand demands for accountability	Mapping of potential sites could lead to accountability being requested, which could be resisted by well-connected operators and even agencies that would feel questioned/threatened.
Interventions through certifications.	India has its own certification standards which could be specifically tailored.	Required performance measuring indicators with supply chain issues are more complex to measure than current ones and rely more on the judgement of the auditors. Implementation verification will require additional capacity from Delhi's authorities.	Delhi authorities would no longer distribute incentives that are illegitimately gained.	Resistance from the standard management bodies as they could consider that supply chains or non-energy linked issues do not fall under their responsibility.
Productive clusters.	Can create a win-win situation for operators and the government and gradually formalize stages of the supply chain.	Operators with installed physical production capacities might not be interested in moving their assets. Badly designed regulatory obligations and incentive structures could push certain operators to the margins. Monitoring of operators could be over focused on existing clusters, putting a disproportionate compliance burden on them.	A cluster approach is aligned with the existing Indian Government agencies approach to MSME operators.	Difficulty to locate areas that cater to the needs of a productive cluster. Illegal operators continuing to undercut formal (cluster) operators if enforcement does not ensure that non-compliance is no longer a viable business advantage.

STRENGTHS, WEAKNESSES, OPPORTUNITIES AND THREATS TO PROPOSED INTERVENTIONS				
Option/ Recommendation	**Strengths**	**Weaknesses**	**Opportunities**	**Threats**
Align recycled material production with market characteristics.	Offers the opportunity to lower CO_2 emissions throughout the supply chain, incentivize the removal of illegal C&D waste and its associated impacts, preserve fast depleting natural reserves and integrate some sectors of the informal economy into the mainstream.	Requires a fundamental reorientation of the existing schemes, which might be resisted or might take significant time to be reengineered and implemented.	C&D waste reduction would have transversal positive impacts across the Delhi agencies.	Shifting political priorities may interrupt the required efforts at shifting the model and implementing said shift.
GST rates adjustment for "manufactured" alternative materials.	An adjustment would correct one of the biggest market access challenge for recyclables.	Would require changes to national-level legislation that depends from non-construction centric government agencies as well as potentially a vote from elected representatives.	Could also provide opportunities for beneficial revisions of the GST for other supply chains.	Requests for the revision of the GST for these products would open the door to the revision of the status of other goods. Which would complicate and lengthen the time needed for its adoption. Lowering GST rates might not in itself offset the advantages enjoyed by those operating informally and not paying such taxes.
Promote recycled materials.	Implementation of this measure would not require significant investment from authorities.	Preconceptions about materials and their characteristics run deep and would require a multi-faceted approach.	Acceptance of recycled materials in one of India's main construction markets would strengthen their acceptance in other urban areas.	Companies who want to sell other materials might be offended.

6.2. Indonesia

PROMOTION OF LOCAL VALUE CHAINS AND SMALL BUSINESSES

Addressing the issue of competition from foreign construction companies, notably Chinese ones (see previous chapter), Indonesian actors are favoured over foreign ones in the legislation. For example, according to Construction Services Law No. 2 (2017), foreign entities are not allowed to work in the construction sector unless they have an office or a legal entity in Indonesia and cooperate with an Indonesian company. In addition, the majority of workers hired must be Indonesian citizens, including the head of the office (HFW 2019). In order to support the construction industry's contribution to the national economy, the Indonesian government has created the National Construction Services Development Board (LPJK) which provides research, training and registry services in the construction sector (Supriadi and Sui Pheng 2018). These developments are positive from the point of view of construction sector potentials. The government seems to consider the construction sector as being of national importance and protects national companies as well as workers and provides them with research and training services. Further research is needed to assess the effectiveness of the government services provided through the LPJK and the actual implementation of the protective measures. Hiring mostly Indonesian citizens for example can be a challenge because of insufficient numbers of skilled workers (see above), and the requirement will have to be accompanied by training efforts.

Tackling the identified issues of a dominance of large companies in the construction sector, an opportunity lies in promoting smaller businesses, subcontracting and local procurement. The government is undertaking efforts in this direction, by promoting local content rules and providing incentives for large construction companies to work with local and small businesses. The Ministry of Public Works has made efforts to improve construction supply chains in Indonesia, including forcing large-size companies to partner with local companies, promoting specialisation of small- and medium-sized contractors, and promoting an environment conducive to subcontracting (Abduh and Pribadi 2014). The government also provides financial incentives for companies to favour local content and local value addition and beneficiation. Under the Investment Law, for example, companies can receive fiscal incentives if they employ a large number of workers, invest in a remote or deprived area, cooperate with micro, small or medium-sized enterprises or cooperatives, use locally produced goods or equipment, or work on a project related to environmental sustainability (Rahmansyah 2020). These are positive approaches from a local value addition perspective, but they must go along with formalisation and capacity building efforts to ensure the most vulnerable operators and workers have fair access to these opportunities, and to ensure these requirements can actually be met by large contractors. More research is needed to assess the impact and challenges of these measures to date.

Tackling issues of supply chain fragmentation, the government, through the Center for Investment Resources in the Construction Development Agency, Ministry of Public Works, started a project on harmonising construction supply chains in 2012, aiming at guaranteeing provision of materials for the construction industry and promoting the autonomy and efficiency of the national construction industry (Abduh and Pribadi 2014).

The Indonesian government has also made efforts to promote downstream processing and local inputs in the mining sector, and even introduced some protectionist policies (Devi and Prayogo 2013). The government has shown support for value addition and domestic mineral use, and greater participation of Indonesian businesses and communities in mining (World Bank 2013). Under Indonesian law, mining companies must use nationally produced goods, local services, and technology as well as a national workforce. The government has made efforts to promote domestic value addition through the Ministerial Regulation MEMR 7/2010 which banned the export of raw materials from 2014, with the aim of developing a larger value-adding downstream industry. Companies need to develop refining and processing industries in the country (Devi and Prayogo 2013). According to Ministerial Regulation 5/2017, non-metal and rock minerals need to undergo basic processing before they can be exported. Certain non-metal and rock minerals cannot be exported at all, following the Minister of Trade Regulations 45/2019. Among the minerals that are prohibited from export are limestone sand, sand, quartz sand and clays. Minister of Trade Regulation 69/2019 defines minimum processing requirements for materials intended for export. Minerals subject to this Regulation include milled limestone, slate, marble, granite, gravel, and perlite. Representatives from the Ministry of Trade said that the purpose of this le-

gislation is to avoid state assets from being sold and to use natural resources for the welfare of the country and the benefit of Indonesian citizens. While acknowledging that business actors would have felt the impact of these regulations, they said that in the future companies will benefit from selling products of higher economic value after processing (Interview with Ministry of Trade, Jakarta, 05/20). Such an approach is positive from a value addition perspective as it ensures that value is created in-country and not only abroad. Again, capacity building and formalisation must be part of these efforts to ensure the opportunities are available also to small operators and that informal businesses do not get sidelined further. Consistent monitoring on the effects of these measures must be undertaken by government or non-governmental actors, as they could have unintended negative side effects. The export ban on sand for example led to increased sand smuggling and similar results can be expected for other materials.

The efforts to promote small and local businesses could focus on specific strategic materials. On the one hand, materials such as granite, marble and kaolin have been found to be amongst the most valuable construction raw materials but are dominated by legal entities, with almost zero participation of home businesses. Opening opportunities for home businesses to participate in these value chains, under the condition of formalisation, taking into account capital and material requirements, could ensure more benefits flowing into smaller businesses.

As has been identified in the value chain analysis, lightweight bricks increasingly compete with red bricks and they are of higher value. An effort to promote local procurement of the construction raw materials composing lightweight bricks is an opportunity to ensure the value of this new material is felt locally.

The trend of ceramics being increasingly responsible for an important share of the trade deficit attributed to construction raw materials in Indonesia (see previous chapter) highlights the value chain as a potential priority area for support and intervention. A greater emphasis on ceramics manufacturing by local entrepreneurs within Indonesia has the potential for employment creation and opportunities for entry into higher-value markets for entrepreneurs. It would also increase value addition in country in the form of ceramics manufacturing and significantly decrease the total trade deficit presented by construction materials.

All these approaches would require capacity building for small and local businesses and the provision of incentives to enter these materials. Civil society organisations and development agencies can play a role here, building on the necessary frameworks and regulations provided by the government.

Cement is another material with potential for increasing value addition in Indonesia. Cement exports have seen a rapid increase over the past five years in Indonesia, occupying a 2.4% share of world exports in 2019 (ITC Trademap). Cement manufacturing, therefore, represents a key opportunity for development in Indonesia. Whilst it did not make up a priority material for this study, an increased production of gypsum in Indonesia may help to supply the growing demand for cement for use and export. As mentioned in the previous chapter, gypsum is currently almost entirely imported into the country. While it is positive that the Indonesian industry adds value to the imported gypsum and then exports the cement, if the gypsum was produced in-country that would create further value nationally. However, this study did not cover the feasibility of national gypsum production, something that needs to be further explored in future research.

These approaches can be applied to other contexts. Governments can support their national industries in the construction raw material value chains by enacting regulation that requires presence in the country, the hiring of local workers, subcontracting of local and small businesses and local procurement. The regulation needs to be accompanied by monitoring and enforcement efforts but also by capacity building, formalisation and the right incentives. Non-governmental organisations and development agencies can provide services for these implementation efforts. Governments and development agencies can further specifically promote the participation of small and local businesses in the supply chains of high-value materials which they might not currently have access to.

FORMALISATION

Given that most of the construction raw material value chain is informal and the challenges this poses in economic, social, and environmental terms, the formalisation of businesses and operators along the supply chain should be a priority for the government. This would as a first step involve making licensing across the supply chain more accessible, less complex, and cheaper. If the local government has the mandate

and capacity to designate People's Mining Areas, issue licenses and monitor compliance with standards, this will facilitate this process. However, the overall impetus for formalisation must come from the national level, more precisely the MEMR.

Businesses also need incentives to formalise and the process needs to come with benefits and not only costs such as taxation and increased regulatory requirements. One of those incentives could be providing businesses that commit to formalise access to finance, more specifically low-interest loans. As this was repeatedly mentioned as the most important need by interlocutors, it would certainly act as an incentive. Another incentive could be offering participation of small businesses in public tender processes for construction projects. As the government controls those tenders, they could offer integration of small businesses as material or service suppliers under the condition they formalised. The formalisation of course has to be a supported step-by-step process focused on progressive improvement.

Promoting the formation of cooperatives would allow small businesses to access formalisation, financing, technical support, and capacity building more easily. In all of Indonesia, only 18 quarrying businesses were organised as cooperatives in 2018 (BPS 2019), which points towards huge potential for the home business sector to formalise through this pathway. Small producers could access People's Mining Areas through cooperatives as well.

Formalisation efforts could benefit from a multi-stakeholder approach during which supply chain actors and local government officials participate in workshop sessions to discuss issues and potential solutions. Also non-governmental organisations could play a part in this process, by providing a perspective on the social and environmental issues of the sector and how they can be tackled.

At the downstream end of the supply chain, formalisation in the construction sector could take the form of enhancing existing efforts in promoting skills improvement of workers and providing them with the certificates needed to find formal employment. As outlined in the previous chapter on barriers, the training and certification programme for construction workers offers many opportunities for improvements in the sector once the current weaknesses are addressed. Currently, the lack of access to training and the high certification fees mean that many workers do not have access to the certification process. Non-governmental organisations could be involved in the capacity building process.

These potentials from formalisation efforts can be applied in contexts other than the Indonesian one where construction raw material value chains are characterised by informality.

CLIMATE-FRIENDLY ALTERNATIVE MATERIALS

As pointed out in the previous chapter, cement production is responsible for a large amount of Indonesia's CO_2 emissions. Here therefore lie concrete opportunities to address climate impacts of the construction value chain. 90% of the energy needed for cement production goes into the making of clinker (composed of limestone and clay soils). An option for the reduction of the CO_2 footprint of concrete is the use of fly ash instead of clinker. Fly ash is waste from other industrial processes such as coal power plants, containing silica, aluminium, and iron oxides. In the metropolitan area of Surabaya, cement plants are allowed to use industrial waste as raw materials – already in 2015 one third of their raw materials were copper slag, blast furnace slag and biomass waste (Panjaitan et al. 2018; Amellina et.al. 2016).

Also in concrete production, fly ash is commonly used. Concrete consists of cement, water, and fine and coarse aggregate (Darmawan et al. 2015). The Indonesian concrete manufacturing industry has been using fly ash from coal power plants for the past two decades. This process has two advantages, namely reducing material cost because of the reduced clinker content and reducing waste from power plants. However, high quality coal is becoming scarce in the country, and hence fly ash from lower quality coal is becoming more common. Competition between concrete manufacturers leads to many of them having to use less good fly ash which leads to lower concrete strength (Darmawan et al. 2015).

As highlighted in a study by Manado University, tailings from ore waste processing could be used as construction raw materials. This has the benefits that the tailings will be reutilised instead of causing environmental harm, and that it would save energy and construction raw materials. Examples are tailings from gold mining and from tin mining being used as lightweight construction materials, for the manufacture

of cement, concrete, or paving blocks. Before tailings can be used in construction however they must be tested for harmful substances to ensure they will not harm the environment or human health (Riogilang & Masloman 2009).

The government could build on these positive steps and actively promote the innovative use of alternative materials for a more climate-friendly construction sector. This relates to the recommendations made for India regarding the strengthening of C&D waste recycling and usage. The promotion of alternative and recycled materials with a lower carbon footprint in the manufacturing of products or in the construction sector can be applied in other contexts as well, depending on the available materials.

SUSTAINABLE CONSTRUCTION

The Indonesian government has also made efforts towards more sustainable construction. An interviewee from the Ministry of Environment and Forestry explained that the Ministry issues certifications for environmentally friendly and low-carbon construction raw materials, coordinated by the Environment Standardization Center (Interview, Ministry of Environment and Forestry, 01 June 2020). In Presidential Regulation No. 22 regarding General Planning for National Energy (2017), the government lays out that rooftops of government and luxury apartment buildings need to be covered by photovoltaic panels by 30% and 25% respectively (HFW 2019). Surabaya further has a Green City Master Plan and Local Action Plan for reduction of greenhouse gas emissions in East Java (Amellina et.al. 2016). And while there are no regulations on low-carbon buildings in Indonesia, buildings can get a certificate for environmental friendliness under Minister of Environment Regulation 8/2010 (Supriadi and Sui Pheng 2018).

The national government could leverage these existing efforts in environmental and climate sustainability to promote further innovations in this area. Instead of only focusing predominantly on incentives such as certificates, regulation requiring certain minimum standards to be upheld could help a shift in the sector towards more environmentally friendly practices. A mix of incentives and regulations for a more environmentally friendly construction industry can be applied also in other contexts.

STRENGTHS, WEAKNESSES, OPPORTUNITIES AND THREATS TO PROPOSED INTERVENTIONS

Option/ Recommendation	Strengths	Weaknesses	Opportunities	Threats
Favour Indonesian businesses	There are existing government efforts that can be leveraged.	Lack of skills and capacity in the national sector.	An increasingly technically capable and competitive national industry along all stages of the supply chain.	Power and leverage of foreign businesses, in particular from China.
Promote small and local businesses	There are existing government efforts that can be leveraged.	Lack of skills and capacity of small and local businesses. Informality of many small and local businesses.	Increasing demand from small and local businesses from state-owned companies.	Existing market connections and networks between larger businesses.
Local processing requirements	There are existing government efforts that can be leveraged.	Lack of skills and capacity of local businesses.	Adds to the value of the product and therefore for more revenue for the producer and seller.	Such requirements can lead to smuggling to circumvent regulation.
Small business participation in high value materials	Existing government efforts in promoting local businesses.	Need for capital and machinery inaccessible to small businesses.	Could contribute to more overall production of the materials.	Existing business relationships.

STRENGTHS, WEAKNESSES, OPPORTUNITIES AND THREATS TO PROPOSED INTERVENTIONS				
Option/ Recommendation	**Strengths**	**Weaknesses**	**Opportunities**	**Threats**
Local procurement for lightweight bricks	Small local businesses are already producing materials that go into lightweight bricks.	Many small local producers are informal.	There might not be enough material produced by larger companies to fulfil the future demand.	Existing business relationships.
Domestic ceramics production	There should be clear incentives because of the contribution of ceramics imports to the trade deficit.	Indonesian businesses might lack the skills needed for ceramics production.	Opportunities to build a national industry.	There might not be enough of the high-value clay available in Indonesia.
Domestic gypsum production	There should be clear incentives because of the contribution of gypsum to the trade deficit and the importance of gypsum for cement production.	There might not be a local industry ready to produce gypsum in the quantities needed.	Potential supply issues for imported gypsum could incentivise local production, in particular in light of increasing cement production.	Imported gypsum might be cheaper.
Make licensing more accessible	Licensing is already managed at the provincial level.	Local government capacity to change the licensing regime and implement a new system.	Experiences from other sectors (e.g. ASGM).	Vested interests in the status quo.
Provide access to finance	High demand from businesses and willingness to take up low-interest loans.	Risk of indebtedness of small businesses.	Could incentivise formalisation and licensing.	Lack of the adequate infrastructure to provide and manage the loans. Lack of willingness of financial institutions to participate.
Small business participation in public tenders	Existing government efforts to promote small businesses.	Lack of capacity, widespread informality of small businesses.	Could incentivise formalisation and licensing.	Domination of public tendering by large producers.
Promote formation of cooperatives	Demand among small businesses to have access to finance and other support.	Lack of experience working with cooperatives in the construction raw materials sector.	Could incentivise formalisation and licensing.	Risk of poorly run cooperatives if not managed properly.
Leverage lessons learned from ASGM formalisation efforts	Direct and recent experience exists.	The sectors are very different in terms of their conditions and needs.	High visibility of ASGM sector and programmes.	ASGM is much more high-profile, also internationally.
Multi-stakeholder workshops on formalisation	Wish for changes in the sector towards tackling informality and associated risks.	Lack of interest of actors to participate in the workshops.	Global experiences in similar formalisation approaches.	Actors with vested interest in the status quo.

STRENGTHS, WEAKNESSES, OPPORTUNITIES AND THREATS TO PROPOSED INTERVENTIONS				
Option/ Recommendation	**Strengths**	**Weaknesses**	**Opportunities**	**Threats**
Workers' skills improvement and certification	Existing regulation and programmes in this area.	Not reaching all workers, the programme being inaccessible to workers.	Leverage training programmes from other sectors.	Foreign workers and unskilled workers being a cheaper labour force.
Use of industrial waste in cement and concrete production	Regulation that allows the use of waste material.	Scarcity of high-quality coal and fly ash in the country.	Use of other waste materials in the construction value chain.	Law prohibiting fly ash import.
Sustainability incentives in the construction sector	A few incentives have already been put in place.	Lack of capacity to implement changes.	Leverage wider Indonesian government approach towards sustainability.	The incentives to change might not outweigh the costs, and sticking to the status quo might be more beneficial.
Sustainability regulation in the construction sector	There are existing efforts towards a more sustainable construction sector.	Monitoring and enforcement capacity.	Leverage wider Indonesian government approach towards sustainability.	The incentives to change might not outweigh the costs, and sticking to the status quo might be more beneficial.

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Annex 1: List of interviewees

INDIA: REMOTE EXPERT INTERVIEWS		
	Name and Role	**Organisation**
1	Prof. Abdul Baqi, Professor	Aligarh Muslim University
2	Adarsha Kapoor, Principal Urban Designer and Architect & Author	Creative Footprints Down to Earth (former Centre for Science and Environment)
3	Anjan Mitra, Practicing Architect & Urban Designer	The Appropriate Alternative, School of Planning and Architecture
4	Arunava Dasgupta, Associate Professor of Urban Design	School of Planning and Architecture
5	Anonymous	Geological Survey of India
6	Dr. Gurdeep Singh, Founding member	Centre of Mining Environment (CME) and Department of Environmental Science & Engineering (ESE) at Indian School of Mines, Indian Institute of Technology, Dhanbad
7	Kuntala Lahiri-Dutt, Professor	Resource, Environment and Development (RE&D) Program, Australian National University
8	Manager, Resource mobilization and M&E (anonymous)	CREDAI
9	3 representatives (anonymous)	Former Centre for Science and Environment
10	Representative (anonymous)	The Energy and Resources Institute
11	Nilanjana Bhowmick, Independent Journalist	Independent
12	Pradip Chopra, Chairman	PS Group, Former Governing Board Member CREDAI
13	Prem Mahadevan, Senior Analyst	Global Initiative Against Transnational Organised Crime. Author of: Sand mafias in India: Disorganized crime in a growing economy.
14	Thangaperumal Ponpandi, Country Manager India	Terre des Hommes Netherlands
15	Sanjay Seth, Senior Director of the Sustainable Habitat Division; Megha Behal, Associate Fellow; Ankita Bokhad, Research Fellow	The Energy and Resources Institute
16	Vikash Nayak, Construction sector consultant	Independent

INDIA: FIELD INTERVIEWS				
	Role	Gender	Location	Supply chain stage
1	Operator	Male	Rajasthan	Mining
2	Head mistri / Operator	Male	Rajasthan	Mining
3	Manager	Male	Rajasthan	Mining
4	Labourer	Female	Rajasthan	Mining
5	Labourer	Male	Rajasthan	Mining
6	Labourer	Male	Rajasthan	Mining
7	Labourer	Male	Rajasthan	Mining
8	Site In-Charge	Male	Rajasthan	Mining
9	Manager	Male	Rajasthan	Mining
10	Operator	Male	Rajasthan	Mining
11	NGO Worker	Male	Rajasthan	Mining
12	NGO Worker	Male	Rajasthan	Mining
13	Local Political Worker	Male	Rajasthan	Mining
14	Local Political Worker	Male	Rajasthan	Mining
15	Landowner	Male	Delhi NCT	Mining
16	Truck owner	Male	Delhi NCT	Mining
17	Supplier	Male	Delhi NCT	Mining
18	Supplier	Male	Delhi NCT	Mining
19	Loader	Male	Delhi NCT	Mining
20	Activist	Male	Delhi NCT	Mining
21	NGO Worker	Male	Delhi NCT	Mining
22	NGO Worker	Male	Delhi NCT	Mining
23	NGO Worker	Male	Delhi NCT	Mining
24	Local Political worker	Male	Delhi NCT	Mining
25	Youth Club representative	Male	Delhi NCT	Mining
26	Munshi/ Manager	Male	Haryana	Manufacturing/ processing
27	Manager	Male	Haryana	Manufacturing/ processing
28	Manager	Male	Haryana	Manufacturing/ processing
29	Labourer	Female	Haryana	Manufacturing/ processing
30	Labourer	Male	Haryana	Manufacturing/ processing
31	Operator	Male	Haryana	Manufacturing/ processing
32	Operator	Male	Haryana	Manufacturing/ processing
33	NGO Worker	Female	Haryana	Manufacturing/ processing

INDIA: FIELD INTERVIEWS				
	Role	Gender	Location	Supply chain stage
34	NGO Worker	Male	Haryana	Manufacturing/ processing
35	Labourer	Male	Haryana	Transportation
36	Driver	Male	Haryana	Transportation
37	Driver	Male	Haryana	Transportation
38	Labourer	Male	Uttar Pradesh	Mining/ manufacturing/processing
39	Labourer	Male	Uttar Pradesh	Mining/ manufacturing/processing
40	NGO Worker	Male	Uttar Pradesh	Mining/ manufacturing/processing
41	Youth Club Representative	Male	Uttar Pradesh	Mining/ manufacturing/processing
42	Activist	Male	Uttar Pradesh	Mining/ manufacturing/processing
43	Local Political Worker	Male	Uttar Pradesh	Mining/ manufacturing/processing
44	Tea Stall	Male	Uttar Pradesh	Mining/ manufacturing/processing
45	Labourer	Female	Delhi NCT	Construction
46	Labourer	Female	Delhi NCT	Construction
47	Labourer	Male	Delhi NCT	Construction
48	Labourer	Male	Delhi NCT	Construction
49	Contractor	Male	Delhi NCT	Construction
50	Manager	Male	Delhi NCT	Construction
51	Loader	Male	Delhi NCT	Trader
52	Trader	Male	Delhi NCT	Trader
53	Trader	Male	Delhi NCT	Trader

INDONESIA: REMOTE EXPERT INTERVIEWS		
	Name and Role	Organisation
1	Company director (anonymous)	Ceramics producer, Surabaya
2	Three staff (anonymous)	Ministry of Trade, Jakarta • Oil & Gas and Mining Division • Mining Product Section
3	Representative (anonymous)	Ministry of Environment and Forestry, Jakarta – Sub Directorate of Planning, Policy and Mitigation Tools at the Directorate of Climate Change Mitigation
4	Representative (anonymous)	Ministry of Environment and Forestry, Jakarta – Environmental Monitoring and Follow-up Section
5	Two staff members (anonymous)	Trade and Industry Agency, Surabaya – Non-agro division

INDONESIA: FIELD INTERVIEWS				
	Role and organisation	Gender	Location	Mineral
1	Owner/Director, Construction contractor	Male	Sidoarjo District, Sidoarjo Regency	N/A
2	Project Implementer, Construction contractor	Male	Sidoarjo District, Sidoarjo Regency	N/A
3	Owner, sand, gravel and stone mining business	Male	Parang District, Magetan Regency	Sand, gravel and stone
4	Manager, Gravel and stones purification and processing company	Male	Pasuruan Regency	Gravel and stone
5	Owner, Sand trading business	Male	Sidoarjo District, Sidoarjo Regency	Sand
6	Sales, Stone processing and trading business	Female	Sidoarjo District, Sidoarjo Regency	Stone
7	Head of Production, Gravel processing and trading business	Male	Kutorejo District, Mojokerto Regency	Gravel
8	Owner, Limestone trading business	Male	Sidoarjo District, Sidoarjo Regency	Limestone
9	Entrepreneur, Red brick trading business	Male	Jatirejo District, Mojokerto Regency	Clay
10	Seller, Red brick trading business	Male	Jatirejo District, Mojokerto Regency	Clay
11	Seller, Tile trading business	Male	Candi District, Sidoarjo Regency	Clay
12	Manager, Transport business	Male	Gempol District, Pasuruan Regency	Sand
13	Driver, Truck fleet	Male	Jatirejo District, Mojokerto Regency	Sand
14	Staff, Mining Permits, ESDM East Java	Male	Surabaya	N/A
15	Staff, Mining Permits, ESDM East Java	Male	Surabaya	N/A
16	Staff, Environmental Assessments, Provincial government East Java	Male	Surabaya	N/A
17	Director, NGO	Male	Surabaya	N/A
18	Architect	Male	Surabaya	N/A

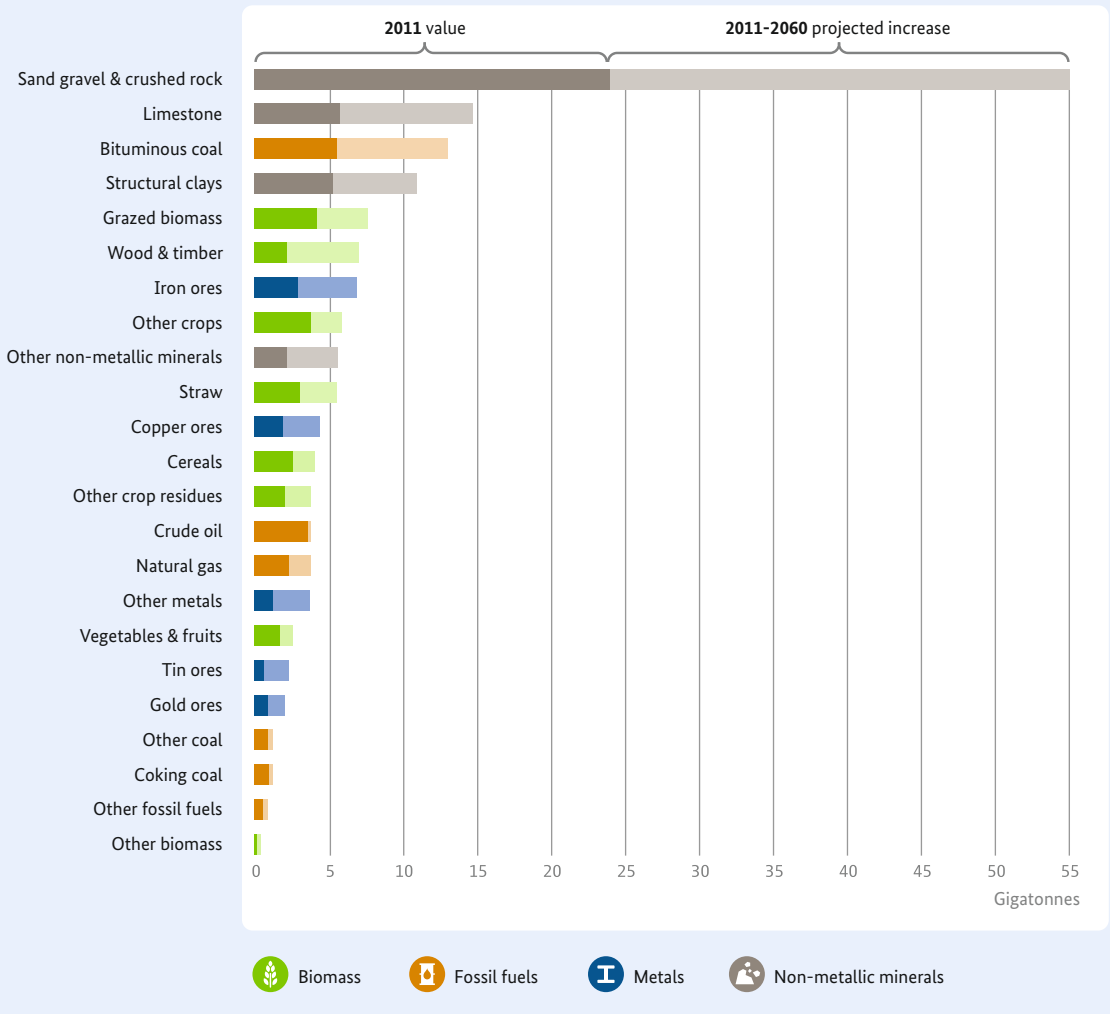
Annex 2: Material selection

This Annex is a revised version of the material selection chapter of the preliminary report of this study published in 2020.

As the processes of extraction and processing as well as manufacturing of the raw materials researched in this study are often similar or the same across countries, this Annex provides a general overview of the materials. It explains their composition, production and consumption, extraction, processing, and manufacturing, and how they are used in the construction industry.

The following graph shows the dominance of construction materials in materials use across the world. In particular sand, gravel and crushed rock as well as limestone are already widely used and expected to rise even more in the coming decades.

Figure 23 — Global Material use in 2011 and 2060 (OECD 2016)



SAND AND GRAVEL

Sand and gravel are types of aggregates. Sand is a fine granular material whereas gravel is larger in size. Sand and gravel are extracted from pits or dredged from water bodies (Langer 2001). Sand from the sea and desert are not as suitable for the construction sector as sand from rivers, which is therefore the most popular, but also the most environmentally destructive form of extraction (Pearce 2019). The extraction of sand and gravel has grave environmental impacts, for example negative consequences for biodiversity, water turbidity, and the climate because of CO_2 emissions from transport. In Indonesia, whole islands have disappeared because of the illegal mining of sand (UNEP Global Environmental Alert Service (GEAS) 2014).

Basic processing of sand includes washing organic matter from the sand or reducing salinity of sand from the seaside. Gravel might go through one primary crusher and one or more secondary crushers, in case its size is too large for the intended use. Then the material will be washed, screened, or processed further to remove undesirable material (Langer 2001).

Globally, out of the 47-59 billion tonnes of material which is mined each year, sand and gravel are responsible for 68-85% of that, and their extraction increases the fastest. Global consumption of sand and gravel is estimated at more than 40 billion tonnes per year (UNEP Global Environmental Alert Service (GEAS) 2014). The materials have a low value per unit but are large in quantity. Their value hence mainly stems from being located close to the market (Hilson 2016). Sand and gravel are used for the production of concrete, mortar and asphalt when mixed with a binding material (Langer 2001). Concrete is composed of sand, gravel and cement, sand and gravel making up around 75% of a tonne of concrete. Asphalt on roads is composed to 90% of sand, and concrete roads to 80%. Other uses of sand are land reclamation, for example in Singapore, or glass manufacturing (Pearce 2019).

CRUSHED ROCK

Langer (2001) distinguishes different types of aggregates, namely sand and gravel as described above, and crushed rock. What distinguishes crushed rock from sand and gravel is that the material is produced by artificial crushing, as opposed to natural abrasion. There are four general types of crushed rock: limestone (carbonate rocks such as limestone, dolomite and marble), granite (true granite and other light-coloured rocks), traprock (volcanic rock including basalt) and sandstone (including metamorphic quartzite) (Langer 2001).

Crushed rock is extracted from open-pit quarries, often involving blasting and potential secondary breaking at the mine site if the pieces are still too big for crushing. Mined crushed rock is transported to the processing facility. The first processing step is the primary crusher, in which large rock pieces are broken into smaller pieces. Subsequent steps are one or more secondary crushers, reducing the size of the material to the desired shape. After each crushing step, the material is searched to separate pieces that are already in the desired size. Washing or other processing might take place to remove undesired material. The rocks are then moved by conveyers onto different stockpiles where they are stored until sales (Langer 2001, 2009). Rock can also be extracted and crushed manually, using simple tools such as pickaxes for extraction and hammers for crushing.

Crushed rock is also available as recycled material, either as recycled concrete aggregate or as recycled asphalt pavement (Langer 2001; Glavind 2009). Processing is needed to recycle these materials as for example concrete usually contains steel bars which need to be separated by magnet, and cement paste which has different properties to aggregate. Recycled concrete is therefore not usually used to produce new concrete, but for low-specification uses (Langer 2009). Whereas the environmental benefits of recycling waste material are big, recycling can create dust, noise (Langer 2001) and CO_2 emissions from transportation. Further, the demolition and crushing processes require energy (Glavind 2009).

Crushed rock, like sand and gravel, is commonly used for producing concrete, mortar, and asphalt, being mixed with a binding material. Aggregates occupy about 72-75% of volume of concrete and they influence the strength of concrete, as do the particle size distribution, water contents and curing time. Other uses are as railroad ballast, road base, for blocks, bricks and pipes, as decorative stone, or as landscape rock (Langer 2001; Kumar et. al. 2015; U.S. Geological Survey 2020).

Crushed rock is low value, heavy and bulky, and transportation can have significant cost implications (Langer 2001, 2009), which is why they are often sold locally – even though an import/export business also exists. The transport of crushed rock is probably also the most energy consuming step in the value chain until its use in materials such as concrete. Using local materials helps to reduce CO_2 impact (Glavind 2009). Environmental impacts of crushed rock extraction include landscape changes, noise, dust, vibrations from blasting, and water degradation (Langer 2009). The crushing of rocks often creates dust or water pollution in case the washing water is directly discharged into water bodies. Processing of rocks has significant impact on air pollution in the form of dust particles that results in pulmonary fibrosis and premature death of quarry and rock crusher workers (Kumar et. al. 2015).

DIMENSION STONES

Dimension stones, also called building stones by the British Geological Survey, are naturally occurring rocks which are consolidated enough for being cut into blocks or slabs. The main types of dimension stones are limestone, marble, sandstone, slate and granite (British Geological Survey 2005).

In the industrial sector, dimension stones are extracted in quarries or shallow underground mines. Blasting is not used as it could negatively affect the structure of softer stones. Instead, naturally occurring openings in the rocks are used to open a quarry, and drilling and splitting or diamond saw techniques are employed to extract the stones (British Geological Survey 2005). In the artisanal and small-scale sector, dimension stones are extracted using simple tools such as pickaxes and split into slabs manually.

The processing of dimension stones can take place at the quarry or at a centralised cutting shed and consists of shaping or cutting by hand or sawing with machines. Some stones might undergo polishing (British Geological Survey 2005). The main types of dimension stone products are blocks, coming directly from the quarry, or semi-finished slabs, finished tiles and cut-to-size products from the processing factory (Cosi 2015).

The main producers and exporters of dimension stones in 2001 were China, India, Italy, Iran and Spain, making up 74% of the world production (British Geological Survey 2005). In India, dimension stones like marble, granite, slate, limestone, and sandstone are used for building construction. Working conditions in Indian stone quarries present significant occupational health and safety (OHS) gaps. Most of the small mine operators are reluctant to adopt safety and health measures and do not comply with the relevant laws. Silicosis is widespread among miners (Sharma 2015).

LIGHTWEIGHT AGGREGATES (PUMICE, PERLITE)

Pumice is a volcanic rock formed by the cooling-down of air-pocketed lava. It is lightweight, has low density and is porous. It is usually extracted in open pits, and processing includes drying, crushing and screening, or sawing blocks into different shapes (Crangle 2017). Pumice is predominantly used as aggregate in lightweight building blocks, but also for concrete aggregate or for abrasives. Global pumice production in 2018 was 18.1 million tonnes. Indonesia produced 770,000 tonnes of that (U.S. Geological Survey 2020).

Perlite is a siliceous volcanic glass which, when heated quickly, expands up to 20 times (USGS 2020). Perlite and pumice are closely related, with the main difference lying in their density, perlite being denser. The mining of perlite involves heavy machinery, cutting or blasting. Afterwards, perlite is crushed and subsequently heated for expansion respectively popping, which decreases its density (Bolen 2010). Perlite is mainly being used in building construction products and for filters or as horticultural aggregate. The world's leading producers of perlite are China, Greece, Turkey and the US, accounting for 96% of global production in 2019 (USGS 2020).

Not only pumice and perlite, but also other naturally lightweight materials such as vermiculite and scoria are used in place of sand and gravel in ordinary structural concrete mixes. The resulting light weight concrete is about one half the weight of hard structural concrete (Kakamare et al. 2017).

Perlite and pumice deposits are present across many provinces in Indonesia, but not including East Java. They are used widely as raw materials for light bricks and for sound dampening in music studios. The material is mined on a small- and medium-scale in open pit mines with simple equipment, and subsequently cleaned by hand. No perlite production has been recorded in India since 2007-8 (IBM 2020c). No more specific information about lightweight aggregates could be found for India and Indonesia.

SLATE

Slate is a fine-grained sedimentary hard rock that can be easily split with hammer and chisel into thin sheets due to its natural composition. Similar hard rock materials are mudstones and shale. In fact, slate results from applying heat and pressure to those rocks. Slate consists of quartz silt and clay minerals. Slate is the most used roofing stone in the world. Apart from use for roof tiles, slate is also used in more decorative fields, as dimension stone, for walls, pavements, fire places or tabletops (British Geological Survey 2005; Merriman, Highley, and Cameron 2003).

Slate in India is a low-cost decorative stone used for exterior and interior decoration of buildings. It is also significantly used in roofing (IBM 2018e). The production of slate in India was at 218 tonnes in the year 2014-15 (up to January 2015) decreased by 38% as compared to that in the previous year due to decrease in demand (IBM 2018e).

Slate in Indonesia is mined mainly in the provinces of Aceh and West Sumatra, in small- and medium-scale mines. It is mined by sawing in blocks, and then cut in thin layers depending on its intended use. Slate in Indonesia is nowadays mainly used for wall and fence decoration.

CARBONATE ROCKS

Limestone is probably the main carbonate rock used in construction. Limestone is relatively soft, and there are various types (British Geological Survey 2005). One of the types is chalk, a very fine marine limestone (Bliss, Hayes, and Orris 2008). Marble is a limestone that has been recrystallized by metamorphism. In the construction sector the term marble often however is used to describe any hard and polishable limestone (British Geological Survey 2005). Dolomite is a limestone that contains a certain portion of magnesium (IMA Europe, n.d.).

Limestone is mined mostly in quarries, but also underground. Main environmental concerns are dust and noise pollution, blasting, vibration, and traffic. Limestone is used in construction as crushed rock, and as a key ingredient of Portland cement. Marble is used as a decorative stone mainly, travertine as a dimension stone, and certain white limestone is used in crushed form in roofing. Dolomites are used for industrial purposes, in concrete as an aggregate, or in asphalt, amongst others. Limestone is also a raw material for the production of lime, used to treat soils, for water purification and smelting of copper (Bliss, Hayes, and Orris 2008), as well as for mortar, and certain building blocks and bricks. The production of lime releases important CO_2 emissions (IMA Europe n.d.). As for many other construction raw materials, the cost of limestone is mostly defined by how far it has to be transported, and by what means (Bliss, Hayes, and Orris 2008).

GYPSUM AND ANHYDRITE

Anhydrite is the anhydrous form of calcium sulphate, gypsum is the hydrated form. Gypsum is formed by the hydration of anhydrite at or close to the surface, anhydrite therefore lying deeper under the ground (Highley, Bloodworth, and Bate 2006).

Gypsum and anhydrite are produced by both surface and underground mining, depending on the location. After extraction, the material is screened and crushed. If the gypsum/anhydrite is intended for cement production, it is grinded with cement clinker. If it is intended for manufacturing plaster, it is finely ground on its own and then heated. Emissions of this process are only steam, the waste production during gypsum/anhydrite processing is therefore minimal. There is also synthetic gypsum, produced as a by-product for example of coal-fired power stations, which often has a higher purity than natural gypsum. It is now commonly used in the production of plasterboard (Highley, Bloodworth, and Bate 2006).

Gypsum is mostly used in the construction industry, for example for building plasters and producing plaster board, as an ingredient of Portland cement, or for wallboard products. Wallboard is increasingly being used in Asia, which has increased production on the continent (U.S. Geological Survey 2019). In comparison to gypsum, anhydrite has limited uses and less economic value. It is often used however for the production of Portland Cement together with gypsum (Highley, Bloodworth, and Bate 2006). The production of gypsum in India in 2017-2018 was 2 million tonnes. In 2015, India had gypsum reserves of 36.6 million tonnes (IBM 2020b) . More information about gypsum in India can be found in the subsequent chapter.

In Indonesia, gypsum is almost to 100% being imported (Abduh and Pribadi 2014). This is despite gypsum reserves existing across many provinces of the country, including East, West and Central Java. Since the 1997 recession, the government has been trying to produce gypsum within the country, however with limited results. Gypsum is imported as a raw material and subsequently processed in Indonesia by formal businesses, for use in Portland cement, plaster, walls, and ceilings.

CLAYS

Clay is a fine-grained sedimentary rock that is characterised by its plasticity and ability to be easily cut or moulded (Merriman, Highley, and Cameron 2003). There are various types of clays, some examples being ball clay (used in floor and wall tile), bentonite (used as pet waste absorbent or drilling mud), common clay (used for bricks, lightweight aggregate or cement), fire clay (used for bricks or cement), fuller's earth (used as pet waste absorbent), and kaolin (used as paper coating and filling, for ceramics or paint and as catalysts) (U.S. Geological Survey 2020).

GYPSUM AND ANHYDRITE

Quartz sand is commonly used for glass production, foundry casting and metal extraction, for the making of ceramics, chemical manufacture, or water filtration (Platias, Vatalis, and Charalampides 2014).

Quartz sand is found across many provinces in Indonesia, including East Java. There it is present in Tuban, Ngadon, Bumen, Tambakbayo, Tasikharjo, Malang, Jember, Bangkalan and Madura (Rumidi 1988). Across Indonesia, 27 legal businesses (with 634 people) produced 1.2 million m^3 in 2018, and 26 home businesses (with 876 people) produced 386,000 m^3. The production value in 2018 was 283 billion IDR (16.4 million EUR) for legal businesses and 27 billion IDR (1.6 million EUR) for home businesses (Nuryati 2019). Quartz sand in Indonesia is usually used as a raw material for the production of cement, glass, and tiles to be used in construction.

Official production of quartz in India stood at 1.4 million tonnes in 2013-14. The term 'quartz' is often referred to as a synonym for silica. In India, quartz sand is used in making glass and bricks. India exported around 51.50 EUR worth of quartz, which accounted for 13% of the global quartz export (Agarwal 2019). Workers not wearing the appropriate personal protective equipment (PPE) are at risk of "silicosis" in quartz, silica sand and gravel mines (IBM 2019f).

GLASS

Glass mainly consists of silica, the primary component of sand, as well as soda and lime. Typical glass used in the construction sector is composed of 69-74% silica, 5-14% lime and 10-16% soda, next to some minor ingredients like magnesia and alumina. Flat glass sheets are produced by blending the raw materials with recycled broken glass, and then heating the mixture in a furnace to around 1,600 degrees Celsius to form molten glass. The molten glass is then put on a molten tin bath and subsequently through an annealing lehr where it is cooled down and shaped into a certain thickness (Achintha 2009).

Glass is a more sustainable building material than concrete and steel, as it is more durable, less volume is needed, and glass can reduce the carbon usage of buildings. Glass sheets used in buildings are usually not recycled, as it is difficult to remove coatings and other materials that are being mixed with waste glass. Further, the energy savings are very low for the recycling of glass sheets. Glass can however be reused as an aggregate in concrete, or for road construction as well as for other purposes such as abrasives, aquarium sand, or in reflective paint. Reusing glass in that way is more sustainable than recycling it (Achintha 2009). Glass manufacturing therefore only produces low amounts of waste. The main source of carbon emissions in the glass sector is melting the raw materials, because of the use of fossil fuels and the decomposition of raw materials (IFC and CPLC 2018).

Significant increase in the use of commercial glass in construction of buildings in India is anticipated on account of its quality, easy installation and low maintenance cost as compared to traditional gypsum constructions (Research Nester 2020). This segment comprises of sheet plate float glass for residential and commercial construction, rolled glass, cast glass and other flat glasses which are used mainly for architectural and automotive applications. Flat glass, commonly called float glass after the process by which most of it is made, plays a dominant role in the Indian building construction industry (TERI 2012).

The flat glass industry in Indonesia had a reported production capacity of 1.34 million tonnes per year in 2019, up from 1.13 million tonnes the year before (Kementerian Perindustrian 2019). Three large companies dominate the Indonesian glass industry: PT Asahimas Glass with factories in Cikampek, West Java and Sidoarjo, East Java; PT Mulia Glass in Jakarta; and PT Tossa Sakti in Kendal, Central Java. Glass is mainly used for windows and walls. Glass waste is so far not widely used in Indonesia for further processing into other materials, and is mainly used as a raw material for handicrafts (Meilita et.al. n.d.).

CEMENT

Cement is produced by heating crushed limestone and other raw materials such as shells, chalk, shale, clay, slate, silica sand or blast furnace slag to a temperate of 1,400-1,450 degree Celsius in a cement kiln. The resultant Portland clinker is mixed with a small amount of gypsum and limestone and ground to cement (Glavind 2009; PCA n.d.; Bliss, Hayes, and Orris 2008). There are two processes to produce cement, one is a dry process and the other a wet process, where water is used to grind the raw materials (PCA n.d.).

There are different types of cement, with various compositions of cement clinker and other materials such as fly ash, blast furnace slag or pozzolanic material. According to the British Standards Institution for example, these types are Portland cement (the most commonly used type), blended cements, blast furnace cement, Pozzolanic cement and composite cement (British Geological Survey 2014).

Cement is used for the production of concrete, but also for mortars and stuccos (U.S. Geological Survey 2020). Concrete is the globally most used material, with 10 km^3 per year. The projected increase of global demand for Portland cement between 2010 and 2050 is 200% to around 6 billion tonnes per year (Pacheco-Torgal and Labrincha 2013).

The high temperatures in cement production mean that waste materials are combusted completely, and there is very low pollution. The carbon impact of cement production is significant, however. The production of cement clinker is particularly high in energy consumption. Per tonne of clinker produced, around 800-900 kg of CO_2 are emitted (Glavind 2009). The cement industry's contribution to global greenhouse gas emissions nearly doubled between 1990 and 2010, from 2.8 percent to 5.5 percent, which can largely be attributed to China's increased cement production. In 2017 the cement industry was responsible for 7% of global CO_2 emissions and the third largest energy consumer (IFC and CPLC 2018). Portland cement is responsible for almost 80% of the total CO_2 emissions of concrete (Pacheco-Torgal and Labrincha 2013). Concrete itself is responsible for 9% of global greenhouse gas emissions. Its impact per kilo is smaller than the impact of metals, but the sheer volume of concrete production makes its total emissions higher (OECD 2018). The cement industry is listed by the Indian central pollution control board as one of the 17 most polluting industries in India.

Nowadays blended cements are becoming more popular. They replace clinker with other materials such as granulated slag from the production of pig iron, fly ash from coal power plants or uncalcined limestone. This has positive effects on the CO_2 emissions. Alternatively, new clinker types use alternative compositions to lower CO_2 emissions of cement production (Glavind 2009).

2018, worldwide there were 4 billion tonnes of cement produced (U.S. Geological Survey 2020). In 2018-2019, 337 million tonnes of that were produced in India (IBM 2020a), making it the second largest producer after China, and 75 million tonnes in Indonesia (U.S. Geological Survey 2020). The International Energy Agency expects a 12 percent increase in the global production of cement by 2050 (IFC and CPLC 2018).

Annex 3: Social and environmental impacts

This Annex is composed of information from the preliminary report of this study.

INDIA

CO_2 and other emissions for all materials at the extraction level are concentrated in the use of machinery and any deforestation required by the extraction processes. No measures to mitigate climate change at the extraction step could be identified, nor could any emission statistics.

CLAY EXTRACTION

Forced and worst forms of child labour (WFCL). These grave human right violations are both endemic to the brick manufacturing sector (Anti-slavery 2015). WFCL has been observed and documented during our field visits.

Competing land uses. Clay extracted for brick manufacturing forms part of the soil used for agricultural activities thus creating a competition in the use of the resource. And while this topsoil is refilled through floods, the current rate of extraction surpasses the rate of replenishment leading to diminishing stock and agricultural land (GIZ, 2016).

Modification of landscape. Lack of back-filling in clay extraction creates stagnant ponds during the monsoon providing perfect breeding grounds for waterborne diseases and disease vectors such as mosquitoes (GIZ, 2016).

SAND EXTRACTION

Groundwater depletion and pollution caused by sand has been noted as an issue across large parts of India (GI-TOC 2019; MoM 2018). Sand acts as a natural filter of surface water and a diminution of this layer can lead to the pollution of aquifers (MoM 2018).

Modification of landscape. Over-extraction of sand from rivers can shift the course of rivers (MoM 2018) as in the case of the Yamuna river (CAG 2019), impacting agriculture dependent communities on its banks who lost part of their land and livelihoods (The Hindu 2016). Loss of livelihoods triggered by changes in landscape can make destitute farmer more vulnerable to exploitative employment practices (GIZ 2016). Extraction induced changes to a river's stream speed and banks can directly impact critical infrastructure such as bridge supports, pipelines, levies, or other structures, and changes in concentration of suspended sediment can lead to the siltation of water projects (MoM 2018). Four bridges, two canals and one barrage were damaged across India in 2018 due to sand mining (The Tribune 2019), all types of infrastructure that can be critical in mitigating the impacts of climate change. Delhi, receiving part of its drinking water supply from the extraction intensive Yamuna, is vulnerable to impacts on the river's upstream flow.

Impacts on fauna and flora of river sand extraction are not limited to the impacts on aquatic life (fish, insects, amphibians, flora) but also affect the riparian habitat and its associated species (birds, mammals, reptiles, insects, etc...). These impacts are caused by changes in: water flow speed, sedimentation, levels, and river course (MoM 2018).

Worst forms of child labour are reportedly common in sand extraction according to sources cited in GIZ (2016) but not accessible at the time of writing. The Times of India (2013) reports that in Maharashtra "child labor was also used on occasion, and children as young as 10 years of age worked for over 6-hour shifts loading and unloading illegally mined sand into trucks, which offered quick money".

Occupational health and safety includes issues related to silicosis (see sub-section on rock). Some sand mine labourers also work as divers, extracting material from the bottom of the river with no form of safety equipment (GIZ 2016), which has led to deaths in the past (Rege 2015).

During the 2019-2020 period 193 people died in accidents related to sand mining operations or sites, including 76 "minor kids or young children or teenagers who entered the river to have a bath, unaware of deep pits in the riverbed" (Reuters, 2021).

Corruption and bribery are reported as routine in the sand extraction sector by both NGO and media, and one of the reasons behind the lack of oversight of extraction areas, in combination with lack of resources (Rege 2015). The issue of possible cartel formation during the auction of sand mining titles has been noted by MoM (2018). In addition to bribes paid to local civil servants, politicians are reported to support the operations of big construction companies as they receive significant funds and electoral support from those companies, support that when required extends to the suppliers of these companies. GITOC (2019) describes the following situation:

> *"The abundance of sand supply depresses profit margins and provides an incentive for government ministers to stay one step removed from the illicit extraction side of the business. Instead, they indirectly patronize it by maintaining close ties with their client base – the builders who purchase illegally and extra-legally mined sand. Not coincidentally, these builders sit atop large construction companies that undertake infrastructure projects offering multiple opportunities for corruption. In return for donations to political parties, the builders exploit their proximity to policymakers and thus deter law-enforcement personnel from pursuing them. [...] In effect, permission to mine sand in India – legally or otherwise – means being part of a web of patronage. The formal letter of the law counts for little. To sustain their own profits, politicians restrict the number of mining permits issued to legitimate traders in order to push up sand prices and boost the profits of illegal and extra-legal mining. By periodically ordering police crackdowns on the lowest, artisanal level of the supply pyramid, they concentrate revenues in favour of well-connected companies".*

Notably arrest made in operations against illegal sand mining do not identify the owners of seized trucks, suggesting that the big players benefit from some form of immunity (Rege 2015).

Misdeclaration of origin of minerals occurs with sand until it is traded for the first time, a process during which it is "legalised."[50] Hiding stone from dubious origin under sand to transport it to crushers has been observed in Haryana (Times of India 2018a).

Violence or threats thereof, contrary to the South of India where most of the media reporting is taking place, northern India, and Uttar Pradesh in particular, have been noted as having more violent cultures which can put interlopers at risk. This can take the form of (un)armed muscle or of corrupted police agents, the latter having been noted as representing the highest risk to media and activists.[51] Between 2015 and 2018 7 journalist that were working on issues related to mining, predominantly sand but also rock, have been killed in India (Thakur Family Foundation 2019). Attacks on police officers involved in the fight against illegal sand mining have taken place either during or after interventions, some of these have been carried out with seemingly lethal intent (Rege 2015).

ROCK EXTRACTION

Groundwater depletion. Local communities have been quoted in reporting regularly the lowering of the water table caused by rock extraction (Dow to earth 2019; Reuters 2018).

Impact of dust on flora. The high levels of dust generated by rock extraction can also have an impact on agricultural livelihoods. Dust covers leaves which lowers their capacity to photosynthesize and thus grow, lowers

[50] Interview with Prem Mahadevan.

[51] Interview with Prem Mahadevan.

their protein production, and renders crops more sensible to insect depredation, thereby impacting both plant growth and potentially local nutrition (Saha and Padhy 2011, field observations).

Modification of landscape. Rock extraction modifies the physical landscape through the removal of vast quantities of rock, as illustrated by the disappearance of a quarter of the hills forming the Aravalli in parts of Alwar District (Rajasthan) (Times of India 2018; DNA India 2018). The establishment of roads to access remote quarries could potentially lead to higher levels of human occupation and thus impact on forested areas.[52] These impacts to the landscape can also further expose Delhi NCT to the impacts of climate change. Among others the levelling of sections of the Aravallis has exposed the city to sand blowing from the Thar Desert (Down to earth 2019; Reuters 2018).

Forced labour is rampant in rock quarries and is a product of debt bondage and linked to the use of labour brokers to supply mine-sites with labour while simultaneously outsourcing their social obligations towards the workers (ABA 2020; ICN, SCL, Glocal 2017; field visit observations). Typically, labourers are paid on a piece rate basis whether they work on extraction or raw material processing. In Rajasthan men can earn the local minimum wage for mining areas (around 300 INR, or 3.50 EUR with current exchange rates) but women and children typically earn much less (120-200 INR, or 1.40-2.30 EUR) as they "cannot perform the more physically demanding work"; in one visited site women were paid as little as 70 INR (0.80 EUR) and children are often noted as not being paid as they do not work for the operator but spend time on site helping their parents (field observations, Aravali, 2018). ABA (2020) notes that in Rajasthani sandstone quarries more than 50% of mineworkers interviewed are unaware of the minimum wage they are entitled to and more than 54% are unaware of the law requiring labour registration, this situation was confirmed by our field visits. These meagre incomes reinforce issues of bonded labour and encourage the use of family members to bolster household income. Work as a family production unit is a confirmed driver of the worst forms of child labour,[53] whether it takes place on the quarries or at home (Praxis and Partners in Change 2017; ICN, SCL, Glocal 2017). Labour bondage in Rajasthan quarries is characterised by debt bondage created by salary advances and there are recorded cases where debt is passed on to the next of kin after the labourer is no longer able to perform his work, in affect trapping a new generation into forced labour. A dynamic that is often amplified in cases of occupational induced silicosis or other form of illnesses, which pushes families to further indebt themselves in order to access (dubious) medical treatment that is not provided by their employer despite its obligation to do so (ABA 2020, field observations). And while on paper a comprehensive array of legislation and policies exists to prevent forced labour and rescue bonded labourers, in practice these are not effective and/or implemented due to a lack of resources and /or political will. Despite lack of resources, 1,845 labourers, including 611 children, were rescued from quarries between 2004 and 2016, illustrating the extent of the problem (Praxis and Partners in Change 2017).

Worst forms of child labour. The rock extraction sector is characterised by substantial levels of child labour, which was observed during our field visits. According to a UNICEF sampling of two Rajasthani sandstone mining localities 38% of children sampled had worked in rock quarries. Aravali (2018) estimates that as many as 375,000 children work in/with quarries in Rajasthan. These children are driven to do so due to the high levels of poverty and lack of alternatives in their localities (Praxis and Partners in Change 2017) as well as dissatisfaction with the schooling opportunities (Aravali 2018). Children are particularly likely to be involved in the raw processing of rock as they are not able to undertake the more physically demanding tasks in the quarry and due to the "lighter" nature of their work are paid less and earn less than the legal minimum wage (ICN, SCL, Glocal 2017). Mine site workers and local civil society actors informed our field researchers that the closure of schools triggered by COVID has sent higher than usual numbers of children to the mine sites.

Occupational health and safety. Work on the quarries is as a rule conducted with no PPE and safety protocols are implemented, if they exist at all (field observations). Accidents are common, sometimes resulting in the death

[52] For further details on these indirect impacts of mining refer to: The World Bank. 2019. "Forest-Smart Mining: Artisanal & Small-Scale Mining in Forest Landscapes."

[53] According to an interview with Kuntala Lahiri-Dutt.

of workers (Delve 2019; GIZ 2016). Accidents go unrecorded (ABA, 2020), but Aravali (2018) reports esti-mates of around 460 known deaths in 2005 in Rajasthan. Increased mechanisation of quarries coupled with lax oversight and an untrained workforce could result in higher risks to workers rather than decreasing them (GIZ 2016).

Impacts on health are pervasive and include respiratory ailments such as coughing, shortness of breath, chest pain, silicosis, asthma, bronchitis as well as skin illnesses, temporary and permanent hearing or eyesight loss (GIZ 2016; ICN, SCL, Glocal 2017), all of which have been noted during our field visits in addition to body-aches, urinary problems, leukorrhea, and anaemia. Silicosis, a lung-illness caused by the inhalation of dust containing silica, is noted as the most salient health issue at the mining stage (Praxis and Partners in Change 2017) with studies conducted in Rajasthan showing that 50 to 75% of mineworkers are impacted (Sharma 2015). Silicosis is irreversible and impacts the physical wellbeing of workers, and thus their long-term livelihood-earning capacity, and can lead to a premature and painful death. Debts taken to afford any form of medical care often compound the issues of debt bondage according to the mine site workers consulted.

As for the cases of forced labour and the worst forms of child labour, a significant array of regulations exists in Rajasthan to address OHS gaps, but in practice these are not implemented to a significant extent due to lack of resources and/or interest (Praxis and Partners in Change 2017). The use of labour contractor allows mining operators to distance themselves from OHS obligations towards the labourers on their quarries (ABA 2020; ICN, SCL, Glocal 2017). And while *"India's strong tradition of trade unions could help support worker's rights and improve labor conditions, due to the sector being largely confined to the informal economy, there are no significant independent unions or associations representing the rights and advocating on behalf of miners"* (Delve 2019). ABA (2020) notes that effectively: *workers in the sandstone industry cannot hold their employer responsible for accidents for the following reasons: i) an absence of a formal employer-employee relationship and proof of employment; ii) an absence of social security or health insurance coverage; iii) an absence of other means of employment; and iv) an absence of workers' organizations and health committees in the workplace to demand basic OSH [sic] protections, training, and reporting.* This is supported by our field findings as workers have noted that they fear for their safety and health on the sites but do not have access to any redressal mechanism and they fear losing their livelihood if they protest or talk about these issues.

Corruption and bribery are reported as routine by both NGO and media and one of the reasons behind the lack of oversight of extraction areas, in combination with lack of resources. In addition to bribes paid to local civil servants, the involvement of Politically Exposed Persons (PEPs) is noted (Tehelka 2012), refer to the sub-section on sand for the involvement of construction companies. The involvement of PEPs in the mining business is facilitated by the existing mining subcontracting practices, where a mine license owner subcontracts a third party to mine on its behalf or rents the title to a third party.[54]

Misdeclaration of origin of minerals occurs routinely for rocks until they are processed, at which time they are "legalised".[55] See section on transport and trading for details.

Violence or threats thereof, between 2015 and 2018 7 journalist that were working on issues related to sand or rock mining have been killed in India.

Gender and discrimination. As noted earlier, gendered repartition of roles is the norm, with women only having access to purely manual work and being paid less than men. As the Mining Act of 1952 forbids women to work in mines underground and at night, women are not able to find better paying jobs in the larger, more mechanised mines (Delve 2019). While no specific information on sexual violence in quarries was available at the time of research, ABA (2020)'s survey shows than less than 13% [of them] were aware of the existence of laws protecting them against sexual harassment.

[54] Interviews with Kuntala Lahiri-Dutt. Also see Chinnadurai and Jayamani, 2019.

[55] Interview with Thangaperumal Ponpandi.

Generally, there is a higher percentage of migrant labour in rock quarries than in the Indian economy at large (Chinnadurai and Jayamani 2019), although use of migrant labour seems to be more important in mines requiring a bigger workforce (ICN, SCL, Glocal 2017). Migrant workers predominantly perform semi-skilled or unskilled work and are noted as being preferred by owners for certain activities (machine operation, rock cutting, breaking and dressing, blasting) as they are found to be more obedient and work flexible and longer hours as they often have fewer social or family commitments, and as they are often paid lower wages (Chinnadurai and Jayamani 2019; ICN, SCL, Glocal 2017). The seasonal nature of the work further entrenches the use of labour brokers and the associated risks (field observations). Migrant workers are usually denied access to social security entitlements and basic health facilities because they often do not possess the documents needed to establish their identity and claim support (ABA 2020; Sharma 2015). The majority of the labourers toiling in quarries originate from vulnerable populations. In Rajasthan it is estimated that 95% of workers are Scheduled Castes and Scheduled Tribes (SC/ST) (Aravali 2018); most of the workers that were consulted during site visits were from poorer states such as West Bengal and Bihar and while many had returned home during the lockdown but are now back to the quarries.

AGGREGATE PROCESSING

Groundwater pollution, due to metal leaching, can occur in crushed rock waste dumps or in the rare cases where aspersion is used as a dust supressing method (Sheikh et al. 2011).

Impact on biodiversity and the landscape. According to activists the presence of these rock crushing clusters creates strong demand for materials at the local level. They are thus an integral part of the pull factors leading to illegal rock extraction both in their districts and in neighbouring districts (Times of India 2018; Down to earth 2019a).

Impact of dust on flora. The high levels of dust generated by rock crushing can impact local crops. Refer to the sub-section in the rock extraction section for further details.

Impact of dust on public health. Stone crushing is a major contributor to air pollution in the Delhi region; stone crusher operations have been halted by notices from the Central Pollution Control Board as recently as December 2020/January 2021 due to their contribution to Delhi's air pollution (The Tribune 2021, India Today 2020.).

Forced labour. While no recent (since 2000) mention of bonded labour could be found, it remains that the reliance of the sector on migrant labour suggest the participation of labour brokers which represents a significant risk of debt bondage for labourers, as illustrated in the rock extraction section. Limited oversight by authorities heightens that risk.

Occupational health and safety and community health. Seasonality, high turnover, asymmetric power positions and lack of OHS knowledge among workers has resulted in the high risk exposure of workers, dependents and local communities through the location and design of rock crushing sites and their processes, lack of PPE for workers and social attitudes towards OHS. Studies conducted in Orissa (Amitshreeya and Panda 2011), West Bengal (Saha and Padhy 2011), Uttar Pradesh (Sheikh et al. 2011), and Tamil Nadu (Sivacoumar et al. 2006), have all reported elevated levels of dust in the air with measures both within the industrial operations and in neighbouring residential areas, levels that exceed limits set for industrial operations, let alone residential areas. Impacts on health are noted as being pervasive and include respiratory ailments (coughing, shortness of breath, chest pain, asthma, bronchitis (Sheikh et al. 2011), skin diseases, temporary and permanent hearing loss, and accidents. As at the extraction level, silicosis is the main risk for labourers at the rock processing stage.

Misdeclaration of origin of minerals. The processing stage offers an opportunity for the legalisation of illegally procured material.[56] Applications for a rock crushing license do not require to list the origin of the rocks to be sourced and there is no monitoring of the origin of the processed material (CAG 2019).

[56] Interview with Thangaperumal Ponpandi.

Gender and discrimination. Migrant workers are usually denied access to social security entitlements and basic health facilities because they often do not possess the documents needed to establish their identity and claim support (Sharma 2015). Women working on site can often be forced to leave children close-by due to the lack of day-care options, leaving them exposed to dust (Sheikh et al. 2011). This issue is likely to be more pronounced for migrant women, who cannot count on a family network to look after their children.

CO_2 emissions. The production of aggregates from rock produces significant amounts of CO_2. It is estimated that about 20 kg of CO_2 is emitted during the quarrying, crushing and transport stages of 1,000 kg of rock into aggregates (GIZ 2016).

LIMESTONE PROCESSING

CO_2 emissions. Limestone calcination produces substantial amounts of CO_2. Limestone calcination was estimated to represent a release of 137 million tonnes of CO_2, approximately equivalent to 7% of Indian total man-made CO_2 emissions (Maity et al. 2015; IBM 2019d).

BRICK MANUFACTURING

CO_2 emissions from brick kilns are significant, coupled to other harmful emissions (carbon monoxide, sulphur dioxide, nitrogen oxides (NO_x) and suspended particulate matter) as brick kilns are coal fired. The Central Pollution Control Board calculates the emissions of the estimated 140,000 brick kilns in the country to be about 66 million tonnes of CO_2 (GIZ 2016).

Impact of dust on flora. The air pollution and bottom ash generated by these kilns cause damage to property and crops (GIZ 2016), especially as these kilns are located in close proximity to their source of soil, often agricultural land.

Forced labour is ubiquitous in brick kilns due to low cost of bricks and relatively high cost of production (GIZ 2016) and takes the form of *"the employment of a workforce that has predominantly migrated internally, the majority whom are from socially excluded and economically marginalised communities, the widespread use of large advances and loans to secure and control workers, exploitative recruitment practices, and a piece rate wage system which treats the entire family as the wage unit rather than each individual worker therefore resulting in extremely low wages. This is combined with a failure by the Government to implement relevant laws and prosecute offenders"* (Anti-slavery 2015). It is estimated that a couple making 4,000 bricks over the course of 2 days of back breaking labour will earn IRN 250 (2.90 EUR) or IRN 125 (1.45 EUR) per day for the two of them (Praxis and Partners in Change 2017). Unskilled workers on the sites visited have reported working with no days off, leaves are granted Amava and Purnima (no moon and full moon days), and workers are said to rest for 2-3 days every fortnight once they fulfil their brick-laying targets, but this is unofficial and may not take place if they are unable to reach their quota on time. Working hours are not fixed as work depends on the number of bricks, respondents have admitted that some days the layers might work 12 hours a day. Labour bondage in Rajasthan quarries is characterised by debt bondage created by salary advances, and while on paper a comprehensive array of legislation and policies exist to prevent forced labour and rescue bonded labourers, in practice these are not effective and/or implemented due to a lack of resources and /or interest (Praxis and Partners in Change 2017; Anti-slavery 2015). It is estimated that Rajasthan had more than 300,000 bonded labourers in brick kilns in 2014 (Praxis and Partners in Change 2017).

Worst forms of child labour. Given the aforementioned use of families as production units and their migration from other parts of the country, the presence of children on brick kilns is endemic. When present on the sites said children do not attend school and work alongside their parents to achieve higher production and thus higher incomes. Children can be seen working in all activities of the manufacturing process, although only the older children will do the most demanding physical labour such as loading trucks and transporting bricks (Praxis and Partners in Change 2017; Anti-slavery 2015). As for forced labour, while on paper a comprehensive array of legislation and policies exist to prevent forced labour and rescue bonded labourers in Rajasthan, in practice these are not effective and/or implemented due to a lack of resources and /or interest (Praxis and Partners in Change

2017; Anti-slavery 2015). According to Anti-slavery (2015) Anganwadi (nursery services) workers, as well as other relevant welfare officers such as health officers, refuse to visit brick kilns.

Occupational health and safety and living conditions in brick kilns are harsh. The average working day is 15 to 16 hours long and includes intense physical activity likely to result in long term debilitating injuries (Anti-slavery 2015; GIZ 2016), back or knee pain caused by truck loading for example. Accidents such as injuries from brick falls and burns are common (Praxis and Partners in Change 2017). Despite exposure to the air pollution and bottom ash generated by the kilns, labourers are not issued any form of PPE, leading to health issues, especially respiratory illnesses (GIZ 2016). Furthermore, as workers live on site, they are also exposed to sub-par living conditions characterised by high levels of hazardous substances such as arsenic, burnt plastic and dust, overcrowded makeshift accommodation, limited access to drinking water and extremely limited or non-existent provision of toilet facilities, if present these are not gender appropriate (Anti-slavery 2015; Praxis and Partners in Change 2017). As for the cases of forced labour and the worst forms of child labour, a significant array of regulations exists in Rajasthan to address OHS gaps, but in practice these are not implemented to a significant extent due to lack of resources and/or interest (Praxis and Partners in Change 2017).

Corruption and bribery seemingly enable the functioning of the sector in its current conditions. Anti-slavery (2015) notes that poor enforcement of laws and prosecution of the operators exploiting bonded labourers is potentially linked to these operators belonging to powerful local elites; interviewed stakeholders confirm the significant, albeit disorganised, local political leverage of kiln owners.[57]

Despite operating formally, fly ash brick manufacturing plants may also experience the impacts of corruption as issues of fly ash supply from thermal power plants have emerged despite wide availability of the waste-product. Shift in availability may *"range from fly ash being sold at higher rates to cement manufacturers to halt in supply during inspections or visits at thermal power plants, and giving priority to road or other project contractors owing to 'election compulsions'"* (Down to earth 2019b). Oversupply of fly ash has been noted as an ongoing problem (Newsclick 2020).

Violence or threats thereof is directed towards workers and their families, in particular towards workers and their families seeking out help to escape their conditions of forced labourers. Women are also vulnerable to abuse and sexual violence (Praxis and Partners in Change 2017; Anti-slavery 2015). Stakeholders that have *sought to organise to demand minimum wages, improved working conditions, or to protest against abuse,* also report violence and threats from operators (Anti-slavery 2015).

Gender and discrimination. While the gendered aspects of work on a kiln seem to be limited as pay is based on production, the fact that the contracting of the work is done with the male head of the households means that women and children working as part of the family production unit are not recognised as workers and do not receive any pay directly (Anti-slavery 2015), putting them in a situation of additional vulnerability.

Caste and migration-based discrimination is rampant as brick kiln migrant workers are predominantly from the poorer states in the country and are in the majority of cases SC/ST, making them vulnerable to exploitation (Anti-slavery 2015).

TRANSPORT

CO_2 and fine particle emissions from trucking are a concern shared by all materials as transport of takes place predominantly by road. However, while the issue is acknowledged, there are currently no estimates of the volume of said emissions. Similarly, the information that would be required to calculate these emissions, such as

[57] Interviews with Kuntala Lahiri-Dutt, and, Sanjay Seth, Megha Behal, and Ankita Bokhad.

the amount of trucks, the length and number of their travels, the average dryness of their load, etc... does not currently exist owning to the lack of transparency of the sector.

Corruption is often required to transport sand to the final users as the use of booklet is limited. According to the MoM (2018) the majority of the registered illegal mining cases are related to the illegal transportation of sand. Rege (2015) notes the existence of different types of corruption practices to avoid controls:

- Bribes can be paid at each checkpoint;
- A single bribe per loaded truck can be paid, the truck is assigned a code number and will no longer be stopped on route; or,
- A monthly fee is paid and the truck is free to move as many loads as desired during that lapse of time.

Modification of landscape can happen when temporary roads and bridges are constructed to facilitate the transport of sand illegally extracted[58] (Rege 2015; The Tribune 2019). The impacts created by this temporary infrastructure are presented in the sand-extraction section.

CONSTRUCTION

Forced labour is endemic in the construction sector as the majority (84%) of workers are contracted through labour brokers. Workers regularly have to request advances as their wages are only paid upon completion of their work and 94% of migrant workers do not have a formal contract. The average daily wage for unskilled construction workers is about two-thirds of the official minimum wage and wage payments are often irregular (CDPR 2014).

Occupational health and safety presents major gaps, and working conditions present risks both in the short and in the long run. PPE is virtually never issued to workers, including tethering (BBC 2019) or dust protection equipment. As a result, more than half of construction workers complained about work-related health problems (such as respiratory issues and back pain). As most workers (92%) have no access to injury compensation or health benefits (94%) they rely on unregistered private medical practitioners for their healthcare (CDPR 2014, field observations). Men and women labourers at construction sites who handle cement or are exposed to it are at high risk of contracting skin infections owing to its chemical composition (Outlook 2019).

Living conditions. The vast majority of construction workers (more than 70%) live in fenced-off and guarded areas, either on or off site, and most often in temporary sheds. It is not uncommon for whole families to migrate together and they must then stay together in these camps. Provision of sanitation and water is lacking and electricity supply is intermittent (CDPR 2014).

Corruption and bribery. As noted in the section on sand extraction, GITOC (2019) describes the following situation: *"builders sit atop large construction companies that undertake infrastructure projects offering multiple opportunities for corruption. In return for donations to political parties, the builders exploit their proximity to policymakers and thus deter law-enforcement personnel from pursuing them."*

Right to free association and collective bargaining. Unions are not present on construction sites nor any other collective organisation, despite being present in Delhi NCR. Workers are afraid to lose their job would they get involved with a union and the tight security at work and the campsites discourages contact (CDPR 2014).

Gender and discrimination. In addition to the structural disadvantages faced by migrant labourers hired through labour brokers, female workers face additional hurdles. While in 2014 nearly a quarter of the workers were female, due among other to the migration of whole families, the industry is becoming more 'masculinised' as contrac-

[58] See for example: https://www.youtube.com/watch?v=WgDIYj6kqio&feature=emb_title or https://sandrp.in/2020/05/28/yamuna-riverbed-mining-miners-govts-throw-rule-book-in-river/, as accessed on 03.06.2020.

tors prefer young males, able to work harder according to them. They are thus restricted to low-skilled work, and only make three quarters of the pay of males. In 2014 the average monthly wages of female unskilled construction workers was equivalent to about 65 EUR a month (CDPR 2014).

Misdeclaration of origin of minerals. There are no requirements for construction projects to track the origin of their raw material supply nor is it necessary to highlight the plausible origin of materials when applying for a construction permit.

Construction waste mismanagement. Generates multiple impacts to the environment and urban infrastructure both directly and indirectly (CSE 2020), such as:

- Urban flooding due to waste dumping in low-lying areas, storm-water drains, open drains and water channels. Which can also cause pools of stagnant water to form and the proliferation of mosquitos that are disease vectors of malaria and dengue.
- Destruction of water bodies as waste is frequently dumped in or used to fill illegally wetlands, ponds, lakes, water channels and riverbeds.
- Clogging landfills and hindering municipal waste management, in particular its recycling or composting.
- Degradation of open spaces and obstructing mobility as waste can be dumped in public spaces such as parks or streets. It frequently contributes towards traffic congestion and even accidents.
- Dust pollution, C&D waste is the prime culprit for local deterioration of the air quality from non-combustion sources.
- Groundwater pollution as a few minor sub-streams of C&D waste may contain small quantities of hazardous components like paints, oil and asbestos sheets, which can leach out and lead to soil and groundwater pollution.

INDONESIA

In terms of Indonesia-specific social and environmental impacts, most of the secondary literature points towards environmental damages and disappearance of islands, smuggling of material due to an export ban, and violent clashed and conflict with communities and environmental activists.

SAND EXTRACTION

Impact on landscape. Sand extraction in Indonesia has significant environmental impacts. This includes erosion of riverbanks, water turbidity, abrasion and damages to the coastal ecosystem. At least 24 small islands have disappeared across the country since 2005 because of excessive sand extraction (Pearce 2019). An example in East Java is Brantas River, the river base of which has fallen significantly because of mechanised sand mining. This has led to damaged buildings and infrastructure and reduced biodiversity (Nawiyanto et. Al. 2020). In 2007, the government banned the export of sand and gravel to prevent the environmental devastation.

Violence and conflict are regular occurrences in the sand mining sector. Informal businesses are vulnerable to police raids or disagreement with communities. In Lumajang regency there have been clashes with villagers due to the illegal activity (Jones and Perkasa 2019). Also environmental activists and sand miners regularly end up in confrontations. Complaints by environmentalists range from landslides to muddy water to damaged roads. Violent actions are undertaken by miners against environmental activists in an attempt to silence them (Rakhman and Nugraha 2019).

ROCK EXTRACTION

Forced labour is a risk in the Indonesia rock quarrying sector. In the vicinity of the city Samarinda, East Kalimantan, there have been reports of situations of debt-bondage of rock miners with middlemen. However, this only really happens for workers of Madurese descent, not for other ethnic groups (Nooteboom 2008), pointing towards discriminatory practices.

Worst forms of child labour. In 2001, children have been found working in Indonesian rock quarries, mainly boys between 11 and 15 years old. They were involved in finding big rocks in water and breaking rocks into smaller pieces. The health and safety conditions and equipment were poor, children having been exposed to heavy lifting and injuries as well as cramps and spasms from being in the water (International Labour Organization 2001).

Environmental impacts are common in the extraction of rocks in Indonesia. They include noise and dust pollution from the use of explosives, as well as deforestation.

LIMESTONE EXTRACTION

Impact on landscape and competing land uses. The extraction of limestone can cause damage to natural landscapes, changing the morphology and topography and thereby soil and rock characteristics (Djakamihardja and Mulyadi 2013). Large-scale limestone mining involves blasting and therefore noise, and can cause air pollution and water pollution. Extraction of limestone from the Kendeng Mountains has endangered the mountains' karsts. The mining activity poses problems for water supply, the bird population and smallholder agriculture. Twenty percent of Java's karsts have already been destroyed. The cement lobby even manages to receive mining licenses for karsts in protected areas, amongst others in the Kendeng Mountains. According to national laws, karst regions are protected geological zones (Keller and Klute 2019).

Conflict. Due to competing land uses and environmental damage caused in the Kendeng Mountains, there are conflicts with community members about the establishment of limestone extraction sites and factories (Keller and Klute 2019).

CLAY EXTRACTION

Impact on landscape and competing land uses. Clay extraction can have a negative impact on the landscape and the fertility of the soil, as it starts with the opening of the soil layer. The activity can therefore harm the prospects of agriculture in the area of extraction.

Forced labour. In East Kalimantan, many Madurese workers have high debts towards the brickyard owner because of provision of housing, cash advances or loans, and therefore find themselves in bonded labour relations. These kinds of labour relations were found on around half of the brickyards studied by Nooteboom (Nooteboom 2014). Given the close proximity of Madura island to Surabaya, it is likely that Madurese labourers are also engaged in brick production in the study area.

BRICK MANUFACTURING

Worst forms of child labour. Data from 2001 pointed towards child labour in the rooftiles and brick industry in Indonesia (ILO 2001).

CONSTRUCTION SECTOR

Social and labour issues. The legal framework in Indonesia foresees construction contracts to include provisions on worker protection, health and safety, social security and environmental protection (Rahmansyah 2020). However, the sector is not free from social and environmental issues. Wages in construction highly differ between the diverse regions of Indonesia. In Jakarta, a skilled worker can earn 100,000 IDR (5.80 EUR) per day while in Yogyakarta the wage would only be 40,000 IDR (2.30 EUR) (Suraji 2007). For so-called semi- or non-skilled worker the wage would lie below that.

Annex 4: India's mining obligations framework

At the national level

For environmental aspects (ICC and CUTS 2018)

- The Forest (Conservation) Act (FCA 1980), amended in 2014, empowers the Central Government to take all measures deemed necessary to protect the environment, and prevent, control, and abate pollution. Its administration is part of the responsibilities of the Ministry of Environment, Forest and Climate Change (MoEFCC).

- The Environment Protection (Amendment) Act (EPA 2006) lays down the requirements of the Environmental Impact Assessments (EIA) required for project approval by MoEFCC when required, most notably this applies when mining would take place on forested land in which case MoEFCC approval is required even for minor minerals extraction. Since 2016 all mining operations require an environmental clearance including those exploiting minor minerals in areas less than or equal to five hectares. EIA Guidelines are currently being revised, and according to environmental stakeholders are being watered down (Times of India 2020, Opangmeren 2021).

- The National Green Tribunal (NGT) is a federal special tribunal established to handle environmental issues.

For labour and social issues (ICN, SCL, Glocal 2017)

- The Mines Act, 1952, as well as the Child Labour (Prohibition and Regulation) Amendment Act, 2016, prohibit the employment of children under 18 years in mining operations.

- The Industrial Establishments Act requires businesses employing ten or more workers at any time to provide formal employment contracts.

- The Contract Labour Regulation and Abolition Act, 1970, protects contract labourers. The act makes a number of provisions for the welfare of contract workers including payment of minimum wage, social security benefits and others. The government can also decide to prohibit the use of contract labour to perform core activities of the enterprise of perennial nature.

- The Inter-State Migrant Workmen Act, 1979, prescribes that companies need government documentation and approval to employ migrant workers. The Act encompasses issues relating to the payment of travel and the provision of suitable residential accommodation for migrant workers.

- The Minimum Wages Act, 1948, in India guarantees the payment of minimum wages to workers in various sectors, including the mining sector.

- The Bonded Labour Abolition Act, 1976, prohibits the practice of bonded labour. This Act frees all bonded labourers, cancels any outstanding debts against them, prohibits the creation of new bondage agreements, and orders the economic rehabilitation of freed bonded labourers by the state.

- Despite the existence of the laws that constitute this framework, structural gaps still exist from a human and labour rights perspective as India has not ratified ILO Convention No. 87 on Freedom of Association and Protection of the Right to Organize, or ILO Convention No. 98 on the Promotion of Collective Bargaining, and only ratified ILO Convention 182 on the Worst Forms of Child Labour in June 2017.

Fly Ash Notification

The Fly Ash Notification (S.O. 763 [E]) was issued by MoEFCC in 1999 and subsequently amended in 2003, 2007, 2009.

As GIZ summarizes *"according to the regulation, all construction agencies within a radius of 100 km from a coal or lignite based thermal power plant shall use only fly ash based products for construction. These products will have a minimum of 50% of fly ash by weight. It also stipulates that thermal power plants should provide at least 20% of dry fly ash free of charge to units manufacturing fly ash or clay fly ash bricks, blocks and tiles on a priority basis over other users. Other Central and State Government agencies and State Electricity Boards should help manufacturers by making available land, electricity and water and provide access to the ash lifting area for setting up ash based units. The notification is again being amended to increase the radius to 500 km. If the manufacturing unit is within a radius of 100 km, the cost of transportation of fly ash to the manufacturing site should be borne by the power plant. Beyond that, the cost shall be borne equally by the manufacturers and the thermal power plants".*

Annex 5: Social and environmental impacts

This Annex presents a non-exhaustive summary of general approaches to the improvement of construction raw materials value chains. These general approaches are derived from the more specific approaches for overcoming the barriers identified in the Indian and Indonesian contexts during this study. Where the authors of the report felt that a particular approach could be applicable to other contexts, they have been included below. As such, this should not be considered an exhaustive list of approaches to construction raw materials value chain improvement in general, rather a list of the approaches that are relevant to the Indian and Indonesian contexts but that also have the potential for application elsewhere. It goes without saying that, given the very different political contexts, economic, social and cultural conditions and business operating environments of construction raw materials sectors around the world, any intervention must be based on detailed data collection and analysis of its specific context.

Acknowledging the extent of informality and ensuring an inclusive and constructive engagement of the informal sector is crucial. It is widely understood – and reflected in this study's findings – that the construction materials sector worldwide is characterised by informality. In many cases, the majority of operators in the sector are informal. Monitoring and enforcement capacity tends to be very low, and the costs – both monetary and bureaucratic – of formalisation tend to be high. Coupled with constant and rising demand for construction materials meaning that informal producers still have access to markets, incentives for formalisation are generally lacking for informal operators.

However, informality continues to be a barrier to the expansion and development of construction material value chains at the local level. The wide gap between smaller, generally informal operators and industrial, generally more formal (although in many cases not fully compliant with all relevant e.g. environmental and labour regulations) operators is difficult to bridge. Smaller, informal operators are generally prevented, because of their informal status, from accessing credit, government support programmes, and higher-quality, higher-value markets such as public tenders and large infrastructure projects. Furthermore, in highly cost-sensitive contexts such as India, the costs associated with compliance render formal operations practically commercially inviable.

The barrier to expansion posed by informality is made greater by the general lack of acknowledgement as to its extent. The market share held by informal producers of some materials – for example sand and aggregates – can be very great. The supply of these materials can be a bottleneck to construction and public sector infrastructure projects. It can safely be assumed, then, that the large amounts of material that are being produced informally are inevitably entering into most construction supply chains, both private-sector and public infrastructure projects. This, although obvious, is important for policy and programming actors to acknowledge. The current reality is that a large proportion of the materials feeding our construction booms, especially in less-developed economies, are informally or illegally produced, and potentially associated with detrimental social and environmental impacts.

Accepting this reality provides an opportunity for engagement, and by extension for greater development and value retention at the local level. Currently, given generally low levels of government capacity for monitoring and enforcement, there is little incentive for government actors to attempt engagement with informal sites. This is partly an issue of manpower. The informal construction materials sector tends to be characterised by large numbers of small operators, who are more difficult to monitor than the smaller numbers of larger companies who tend to make up the (more) formal sector. A further barrier, however, is a lack of understanding as to how to engage with the informal sector, in the absence of an obvious process to support gradual improvement at these sites. However, acknowledging that a large proportion of construction materials actors operate informally and that these actors fall just as much under mining monitoring and enforcement mandates as formalised actors, is a first step towards providing a space in which i) the needs of the sector (access to finance, access to technical support, etc) and ii) the negative impacts associated with the sector can begin to be addressed in an inclusive way.

One barrier to the acknowledgement and the engagement of the informal sector is often a lack of data. Any intervention to promote increased value addition in the construction raw material sector must start with an ac-

knowledgement of the importance of the sector for local employment and livelihoods, for providing the materials needed for housing and infrastructure development, and for the wider economy of the country. ***The conduct of large-scale surveys or censuses by the government authorities can allow for the capture of knowledge about whole supply chains, the actors involved and the economic, social and environmental challenges and value opportunities.*** This can in turn facilitate the making of the political case for increased investment in improving the sector. Better data will increase the visibility of the sector and might also mobilise other actors such as civil society organisations to advocate for reform. Having in-depth knowledge about the conditions of production, trade and demand will further allow to tailor measures to the specific needs.

Another barrier to continued support to construction raw materials value chains is that changes in government, which in many contexts take place every few years, can mean that crucial medium- and long-term reforms are often not followed through. To overcome this, ***interventions must take into account the implications of potential changes in political cycles.*** If there is a change of government, previous efforts undertaken to promote local value addition can be easily undone. It is therefore important to take a more small-scale bite-size approach to reform, implementing changes gradually and making it difficult to reverse improvements made. This also implies that any changes need to be able to stand alone and produce benefits independently of other subsequent measures.

Public procurement, in conjunction with support measures to lower-capacity operators, can provide an opportunity for the inclusive engagement of and support to the informal sector. Public procurement can be an important starting point for progressive formalisation of the sector, by requiring actors in the supply chain to (increasingly) abide by regulations and providing formal actors with access to preferable prices to cover the costs of compliance with legal and regulatory framework. However, in countries with large informal sectors in the construction raw material value chains, any requirements for suppliers of public sector construction projects to be fully formal must identify and acknowledge current levels of informality and aim to shift this in a realistic fashion. Given the nature of the sector and the incentives that underline it, putting additional regulatory demands on operators will not solve the issue. Instead, it would only further entrench the problem and push smaller operators towards greater informality, while at the same time further disenfranchising the already vulnerable labour force that depends on this sector and its economic linkages. The operators should be supported in this process in terms of financial support and capacity building, and particular attention should be paid to supporting small and local businesses.

Instead, to promote formalisation the complexity and costs of the licensing process must be reduced, ***and incentives such as access to finance and public tenders can be built into the licensing regime.*** The promotion of cooperatives can be an additional way to help informal producers to organise and access the formal sector. Another approach is the ***decentralisation of the licensing process and increased responsibility for local governments to issue licenses and monitor compliance.*** This however must go hand in hand with financial resources and capacity building of the local agencies.

In the context of legal and regulatory framework that can be complex and fragmented, it may be useful ***to develop and distribute – to all supply chain nodes – a handbook (vade mecum) containing consolidated information on all the applicable legal requirements and payable taxes,*** making it the sole document operators need to consult. This could also highlight the rights of operators and make clear that any payment that is not listed in these handbooks is not a payment that operators have to make and should therefore be refused on grounds of illegality. These handbooks could be issued at regional or local level, depending on where the construction raw material sector is managed. As regulations will continue to evolve it would be pertinent to ensure that the vade mecums are updated as soon as necessary, are easily accessible to anyone at no cost, and that changes from the prior versions are summarised. This presupposes a webbased distribution of soft copies, accessible through simple internet search. A free alert service informing subscribers of any new version could complement this strategy. Non-governmental organisations and development agencies can play an important role in the distribution of the vade mecums and the provision of training to operators on the rules and their implementation.

A construction raw material sector truly beneficial for the country and the local areas of production, trade and usage must ***address the negative environmental and climate impacts of the sector.*** This can take differ-ent

forms. Governments should allow and promote innovative approaches to material substitution to promote more climate-friendly production and construction processes such as the use of fly ash from coal power plants for cement and concrete production or the use of mine tailings as construction materials. Another opportunity lies in the increasing use of recycling methods and circular economy approaches. ***The strategy of strengthening C&D waste recycling and usage can apply to most construction sectors.*** It is important that such a strategy takes account of the inclusion of the (often existing) informal recycling sector, uses existing recycling centres for the production of lower value-added goods and goods that face a national shortage, makes the pricing competitive; and promotes uptake among consumers. Campaigning and capacity building through non-governmental organisations can help with the promotion of the new products, as well as raise awareness amongst construction raw materials producers about the negative impacts that their activities can have on the environment.

Finally, ***governments can support their national industries in the construction raw material value chains by enacting regulation that requires presence in the country, the hiring of local workers, sub-contracting of local and small businesses and local procurement.*** Regulation needs to be accompanied by monitoring and enforcement efforts but also by capacity building, formalisation and the right incentives. Non-governmental organisations, private sector entities such as consultancies and development agencies can provide services such as research, capacity-building, awareness-raising, advocacy and community support for these implementation efforts. Governments and development agencies can further specifically promote the participation of small and local businesses in the supply chains of high-value materials which they might not currently have access to.