HOW CAN AUTOMATION CONTRIBUTE TO ENERGY EFFICIENCY AND REDUCED ENVIRONMENTAL IMPACT IN IRON ORE MINING OPERATIONS?

Framework Step:

STEP 4. Support and contribute to innovation leading to new products and services

4. A What can host governments do?

- Identify changing trends in global consumption and production patterns (progressive ore grades decline and increasing labour, transport, energy, processing, capital/equipment costs), changes to end uses for minerals (innovation in final products), and carbon emissions trading.
- Fully consider trade-offs associated with technological innovation (i.e. automation and remote tele-operation, where potential gains in productivity are off-set by potential losses in social and economic benefit for local communities).

4. B What can extractives industries do?

- Invest in specialised technologies for planning, handling, processing, maintenance, operational monitoring and recycling (excavation, concentration, ore prospecting, monitoring of the state of the environment) that reduce environmental impact.

Tags:

☒ local employment
☐ local supplier participation and development, including SMEs
☐ marginalised groups (women, indigenous people)
☒ skills development and upgrading
☐ access to credit
☐ shared infrastructure (transport, water, power)
☐ technology transfer
☒ innovation
☐ economic diversification
☒ Other: Low Emission Transition

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Problem Statement:

Mining companies face growing pressure to reduce both the cost and environmental impact of their operations. For Rio Tinto, the energy used to power its operations – generated predominantly from fossil fuels – contributes more than 90% to the company's total green-house gas (GHG) emissions (Rio Tinto, 2017a). At an open-pit iron ore mine site, haulage activity comprises a large proportion of total energy consumption, with research indicating that loading and hauling make the largest contributions to total GHG emissions (Norgate and Haque, 2010). As an advanced economy, Australia has comparatively high labour costs, and fuel costs can also be substantial, further driving the need for greater efficiencies. In the Pilbara, Western Australia, where as of 2017 Rio Tinto operated 16 iron ore mines, up to 30% of the total mine operating costs came from diesel usage (Bellamy and Pravica, 2011).

Automation, namely driverless technology, has the potential to reduce fuel consumption in mining operations by 10% to 15% through greater fuel efficiency (Cosbey et al., 2016). Requiring fewer stops and manoeuvres, automation is likely to also lead to increased outputs as well as decreased maintenance costs of up to 8% (Cosbey et al., 2016). Automation also offers a potential means to improve health and safety outcomes on mine sites. Combined, these factors demonstrated a clear business case for Rio Tinto to adopt automation technology in its iron ore operations in Western Australia, while also offering a means to align resulting efficiency gains with the company's strategy to meet GHG emissions targets.

Productivity gains through the adoption of automation are likely however to be met by trade-offs, such as fewer job opportunities on mine sites. The retrofitting of haul-trucks with autonomous operation technology at two of Rio Tinto's 16 Pilbara mine sites resulted in the reduction of approximately 200 jobs, and 500 jobs were expected to be cut across all 16 mines in total, accounting for approximately 4% of the company's workforce in the region. Such reductions in job opportunities have the potential to limit the scope for social and economic benefits from mining activities for local communities.

Parties Involved:

- Rio Tinto
- State Government of Western Australia
- South Metropolitan TAFE, Western Australia (a local Technical And Further Education institution)
- Komatsu Ltd (Japanese construction and mining equipment manufacturer)
- Federal Government of Australia, Department of Industry, Innovation and Science

Common Ground:

Rio Tinto's decision in 2008 to adapt its iron ore operations in Western Australia towards greater automation presented common ground with the State government. Automation in mining offers firms efficiency gains and a potential avenue to reduce GHG emissions, thus helping companies to meet host country environmental requirements and to contribute to meeting the objectives of the 2015 Paris Agreement.

The importance of mining to the economy of Western Australia provided motivation for the government to also take steps to offset job losses with the deployment of a skilled workforce to meet the sector's shifting demands driven by the technical skills required to operate new technologies. At the same time, the changing mix of skills required as a result of automation meant that Rio Tinto also faced a potential gap in the number of technical employees trained for new autonomous roles. This

potential disruption to the workforce, from the perspectives of both industry and government, meant that government, industry, and a local Technical And Further Education (TAFE) college were able to align their objectives and find common ground to address the need to develop and maintain a skilled and relevant workforce within the region.

Actions Taken:

Rio Tinto launched its Mine of the Future innovation programme within its Pilbara operations in 2008. The strategy articulated a long-term vision to mobilise new technologies to deliver efficiency, lower production costs and improve health and safety and environmental performance. The strategy focused in particular on finding efficiencies in the energy intensive haulage activities of iron ore mining. At the same time, the company's climate change strategy, which prioritised reducing both the energy intensity of its operations and the carbon intensity of its energy sources (Rio Tinto, 2017a), provided a clear, overarching mandate to invest in innovative solutions.

Rio Tinto's Pilbara operations include a network of 16 iron ore mines, four independent port terminals, and a 1 700 kilometre rail network. In partnership with mining equipment suppliers Komatsu and Caterpillar, to implement the strategy new technologies were developed and rolled out in the network in stages, including through the retrofitting of existing infrastructure. As of 2017, approximately 20% of the fleet of almost 400 haul trucks had been fitted with the driverless Autonomous Haulage System (AHS). Following the completion of projects with Komatsu and Caterpillar to retrofit existing infrastructure, autonomous trucks are expected to represent approximately 30% of the fleet (Rio Tinto, 2017b).

To increase haulage capacity without investing in additional trains, the company also aimed to deploy an autonomous heavy-haul long distance rail network system (AutoHaul). In 2015, locomotives fitted with the AutoHaul technology were trialled, to test systems including signalling, safety mechanisms and communications prior to commencement of regulatory approvals processes. In September 2017, the system completed its first 100-kilometre driverless pilot run, with completion of the network expected by the end of 2018.

Meeting skills gaps while addressing host country concerns about impacts on jobs required subsequent, coordinated action. Recognising host government concerns about the impact of mining automation on jobs, in 2017 Rio Tinto made a commitment to double the number of people it took on in training roles (The West Australian, 2018). In order to meet its own demand for different skills, the company also launched in 2017 a partnership with the Western Australian Government and the South Metropolitan TAFE to develop a new vocational curriculum for robotics, data analytics and digital techniques, and to provide vocational training for existing mining workers. The company pledged to spend AUD 2 million developing courses to upskill potential and existing workers with the ability to manage data analytics and complex IT systems (ABC, 2017). This action was in part in preparation for the AUD 2.7 billion Koodaideri mine, for which construction is expected to begin in 2019, and is anticipated to require 600 new operational roles.

The Federal Government of Australia also sought, through long-term studies, to determine the impact of automation on the future workforce needs for the country and to plan accordingly. In 2015, the Federal Department of Industry, Innovation and Science's Office of the Chief Economist undertook research into the impacts of automation on the Australian economy (Office of the Chief Economist, 2015). Through these studies, which anticipated for instance that 44% of Australian jobs as of 2015 were highly susceptible to automation, with mining at the median of Australia's major industries (Office of the Chief Economist, 2015), there emerged an understanding that by being proactive and adapting to the changes brought about by automation, embracing the shift towards automation early could help position the country as a global leader to train and supply the next generation of engineers, miners and technologists. Automation was therefore seen as an opportunity at a Federal level for mining to contribute to modernising the country's workforce, helping in turn to provide an enabling framework for the adoption of automation in the sector.

Obstacles:

- Without concomitant measures to re-skill and re-deploy workers, automation could result in potentially significant disruptions to the workforce on a mine-site. Haul truck automation may have the greatest direct impact on mine employment, as truck drivers comprise a large portion of the workforce. Automating haulage processes, through the use of algorithms, replaces the need for haul truck drivers. The operators of these automated systems also require substantially different skillsets from those of truck drivers.
- Re-training programmes also often face the risk of misalignment in that the skills and capacities targeted by such programmes may not ultimately address the longer term needs of the company or sector. This can be due to further changes in the sector's needs, resulting for example from new technologies coming online, or to issues with the programme design itself and failure to anticipate changes due to a lack of long-term analysis and data. Steps should therefore be taken to ensure that the various actors are able to successfully align their objectives over the long-term through the effective design and implementation of such re-skilling programmes.
- While there are no local content targets mandated in the State of Western Australia, that comparatively few job openings on the Pilbara mine sites were expected as a result of full truck haulage automation (Cosbey et al., 2016) also created concerns regarding continued social licence to operate. In contexts where meeting the requirements of host-country local content legislation is relevant, ensuring such changes to job opportunities do not negatively impact employment opportunities at mine sites will require a long-term and collaborative approach that fosters relationships with local education and/or government institutions.
- The need to retrofit or invest in new equipment required significant capital investment, and may present an obstacle to some mining operations. Rio Tinto is one of the top-three producers of iron ore in the world, and its Pilbara operations contribute substantially to the company's bottom line. Investing in automation was therefore a viable long-term strategy for the company despite requiring substantial up-front investment.

Enabling Factors:

- The downturn in mineral prices accelerated mining sector investment into new technologies, to mobilise innovation for enhanced efficiency in operations and reduced energy costs. Automation provided demonstrated efficiency gains for the firm and a possible means to reduce emissions through more efficient fuel consumption.
- Mining is central to the State of Western Australia's economy, and the government therefore had a strong interest in ensuring the sector's productivity and sustained attractiveness to foreign investment. The facilitative approach of the State Government, informed by studies at the Federal level, was therefore an important factor in ensuring the link between automation and jobs was recognised and managed in a collaborative and win-win manner. Rio Tinto for example committed to working closely with its workforce as it transitions to AHS, including providing opportunities for new roles, redeployment, retraining and upskilling (Rio Tinto, 2017b).
- The advanced country context of this particular example should also be emphasised. Australia is an advanced mining country, with mining comprising 7% of GDP; and with Mining Equipment, Technology and Services (METS), 15% of GDP. Local authorities were therefore relatively well-placed to ensure automation had a limited or indeed positive impact on the local economy such as through the investment in advanced and modernising education

programmes and collaboration with local government and institutions. Developing or less-advanced economies, or those with less advanced mining sectors, are likely to face different, unique challenges with regard to the impact and interaction of automation in the mining sector with efforts to create linkages and develop the local economy through employment and jobs, including through local content policies. The challenge of meeting the demand for a differently skilled labour force might be greater for developing countries where institutional capacity – both in training institutions and local government – may we weaker.

- Improving energy efficiency in mining is of particular relevance to mines operating in high cost economies – in terms of labour and energy – where the rising cost of fuel has added to broader productivity issues. In Western Australia, where the energy intensity of operations coupled with high and fluctuating costs of fuel meant that up to 30% of Rio Tinto's total mine operating cost came from diesel usage, and fuel savings alone may therefore have warranted a transition to automated technologies (Bellamy and Pravica, 2011).
- An operations centre in Perth enables all of Rio Tinto's mines, ports and rail systems in the region to be operated from a single location. This increased opportunities for shared experience and knowledge transfer within the firm as skill requirements shifted, as well as overall system efficiencies, potentially smoothing the transition to automation within the network.

Lessons Learned:

- The impact of automation in mining on jobs and employment, including the interplay between automation and local content policies is an important consideration for firms. Introducing fully autonomous equipment has the potential to reduce the workforce of an open-cut, iron-ore mine by 30% to 40%, with some studies suggesting that automation could reduce the number of workers of a single operation by up to 75% (Cosbey et al., 2016). In Western Australia, there are no formal local content targets set by government, with firms expected instead to submit local participation plans and reports. Such considerations however go beyond the specific context of Australia. In contexts where local content policies include mandatory employment targets, reductions in or changes in the nature of job opportunities caused by automation may trigger compliance issues for firms, by limiting an operations' ability to meet local content requirements or targets set by government or by reducing savings attained through automation due to the possible application of penalties. It may also cause social licence issues for mining companies.
- On the side of government, in the case of Rio Tinto's operations in the Pilbara, there was recognition that by embracing the move to automation and by taking a collaborative approach to re-training, re-skilling and re-deploying, automation in mining may contribute to broader government efforts to upskill, support and develop future workforces both within and beyond the sector.
- Rio Tinto's AHS trucks have created a direct increase in productivity. In 2016, on average, each of Rio Tinto's autonomous haul trucks operated an additional 1000 hours and at 15% lower load and haul unit cost than conventional haul trucks. In 2017, Rio Tinto also achieved a 2% reduction in GHG emissions intensity, although this was achieved at least in part by divestment of Rio Tinto's coal assets in Australia (Rio Tinto, 2017c). Automation alone will not generate the required reductions in GHG emissions, which could be achieved by also integrating low-carbon energy sources into the energy mix.
- That the government undertook studies to estimate the impacts of automation is a key point that is relevant in a range of contexts beyond advanced mining countries such as Australia. Such studies can significantly enhance the effectiveness of initiatives to limit the trade-offs

involved in innovation and efforts to move the sector towards a low-emission global economy. Such studies are also critical to building collective understanding of changing patterns of production, driven by the low-emission transition or otherwise, to inform concerted and coordinated actions and informed policy making.

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