MANDELA MINING PRECINCT
MINDS FOR MINES

Guideline:

MINING MODERNISATION IMPACT ASSESSMENT – DIRECT AND INDIRECT IMPACTS OF MINING MODERNISATION (CHANGE PROCESS)

SATCAP 2020

science & innovation
Department: Science and Innovation
REPUBLIC OF SOUTH AFRICA

CSIR

MINERALS COUNCIL
SOUTH AFRICA

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About the Mandela Mining Precinct

The Mandela Mining Precinct is a Public-Private Partnership between the Department of Science and Innovation and the Minerals Council South Africa. The Precinct is jointly hosted by the Council for Scientific and Industrial Research and the Minerals Council. The Mandela Mining Precinct is an initiative aimed at revitalising mining research, development and Innovation in South Africa to ensure the sustainability of the industry. This is achieved through the South African Mining Extraction, Research, Development and Innovation (SAMERDI) strategy.

The strategy comprises six research programmes:

1. Longevity of Current Mining;
2. Mechanised Mining Systems;
3. Advanced Orebody Knowledge;
4. Real-Time Information Management Systems;
5. **Successful Application of Technologies Centred Around People**; and
6. Test Mine.

This guideline was developed under the Successful Application of Technologies Centred Around People (SATCAP) research programme. The programme is aimed at understanding the effects, impacts and challenges of mining modernisation on people in the minerals sector.

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Contact details enquiries@mandelaminingprecinct.org.za
www.mandelaminingprecinct.org.za
Author: Dr Sherin Ramparsad (Mandela Mining Precinct)
Approved: A. Saffy (SATCAP TSC Chairperson)

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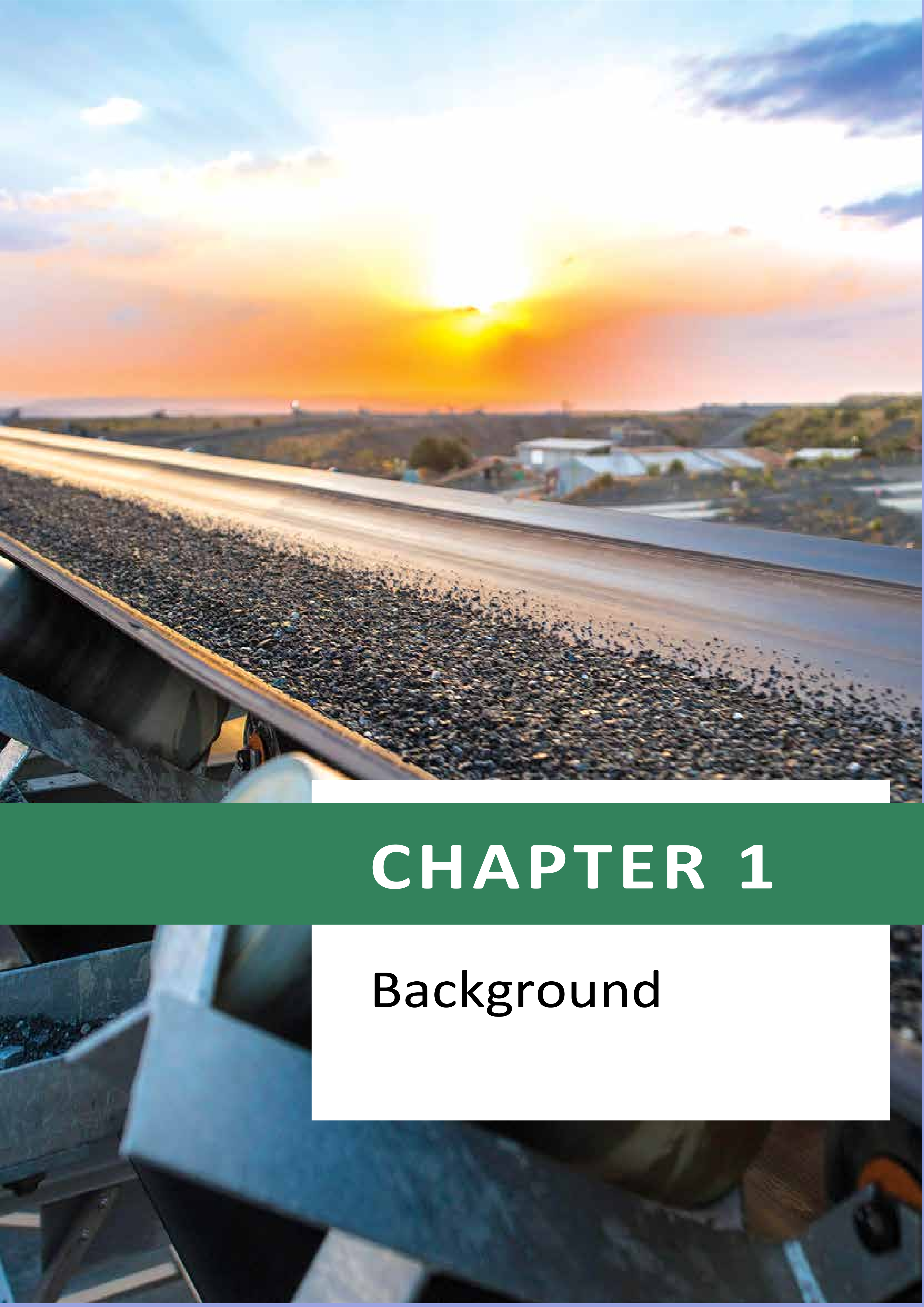


CHAPTER 1

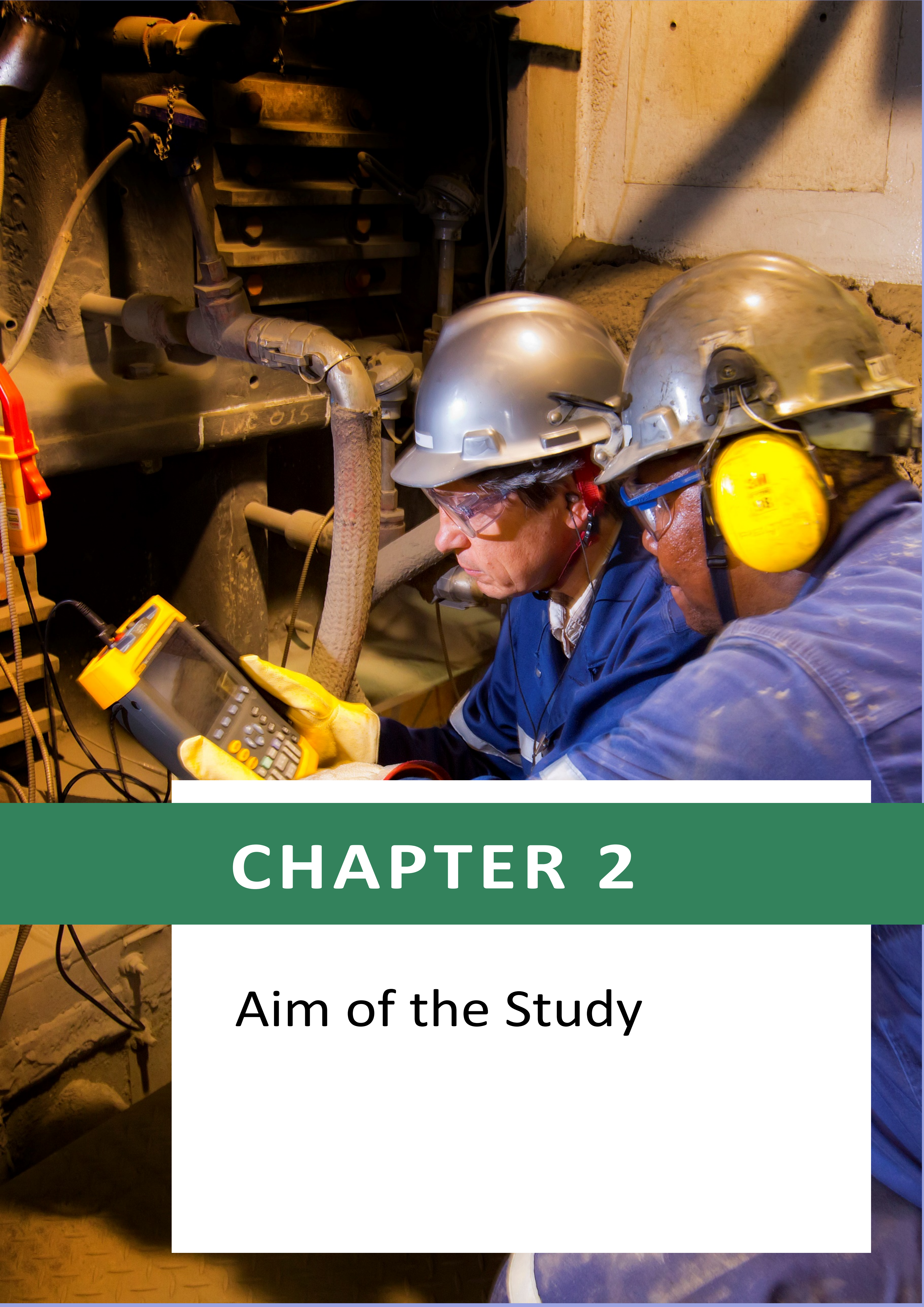
Background

1. BACKGROUND

Work-package	Number	Title
	2	Mining Modernisation Impact Assessment
Service Provider(s)	EUP, CSIR	

There is a consensus in literature that modernising (mechanising or automating) mines is driven by the desire to improve safety and productivity in mines. Literature suggests some of the following may be drivers for modernising mines:

- Efficiency and reliability: Machines are generally cheaper and more efficient than humans.
- Safety: There is increased responsibility on the mining leadership and stakeholders to operate safe mines and this has led to the increased drive towards mechanisation.
- Costs and productivity: Machines are generally thought to be more productive and free humans to perform other important tasks such as planning and other decision-related tasks.
- Increased orebody access: Mechanisation can improve the access to orebodies that were previously hazardous and unprofitable if mined through conventional means.
- Consistence and stability of operations: Machines are thought to provide process consistency and reliable data and information.

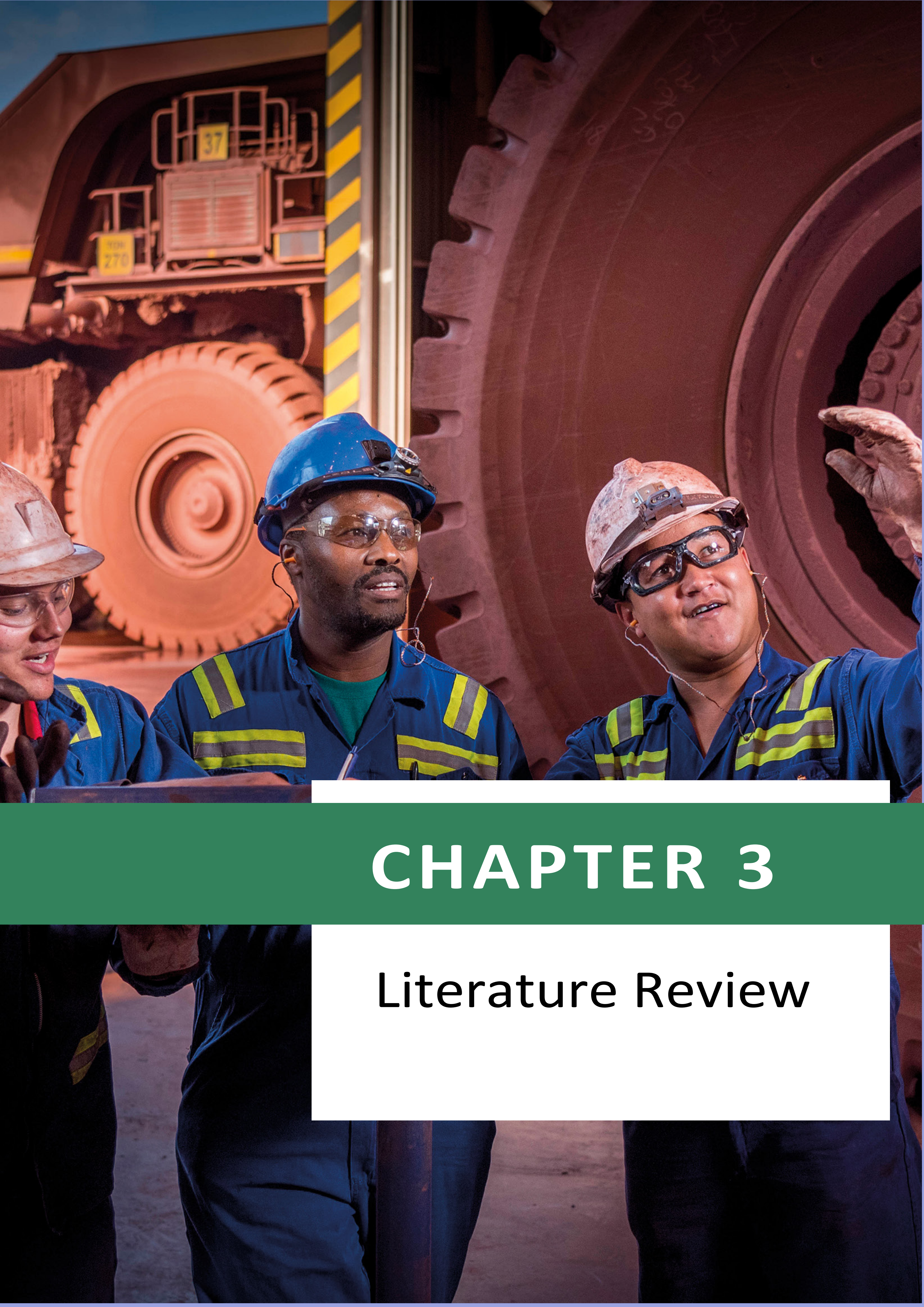


CHAPTER 2

Aim of the Study

2. AIM OF THE STUDY

The aim of this study was to conduct a modernisation impact assessment. There was a need to identify the possible direct and indirect impacts of mining modernisation.



CHAPTER 3

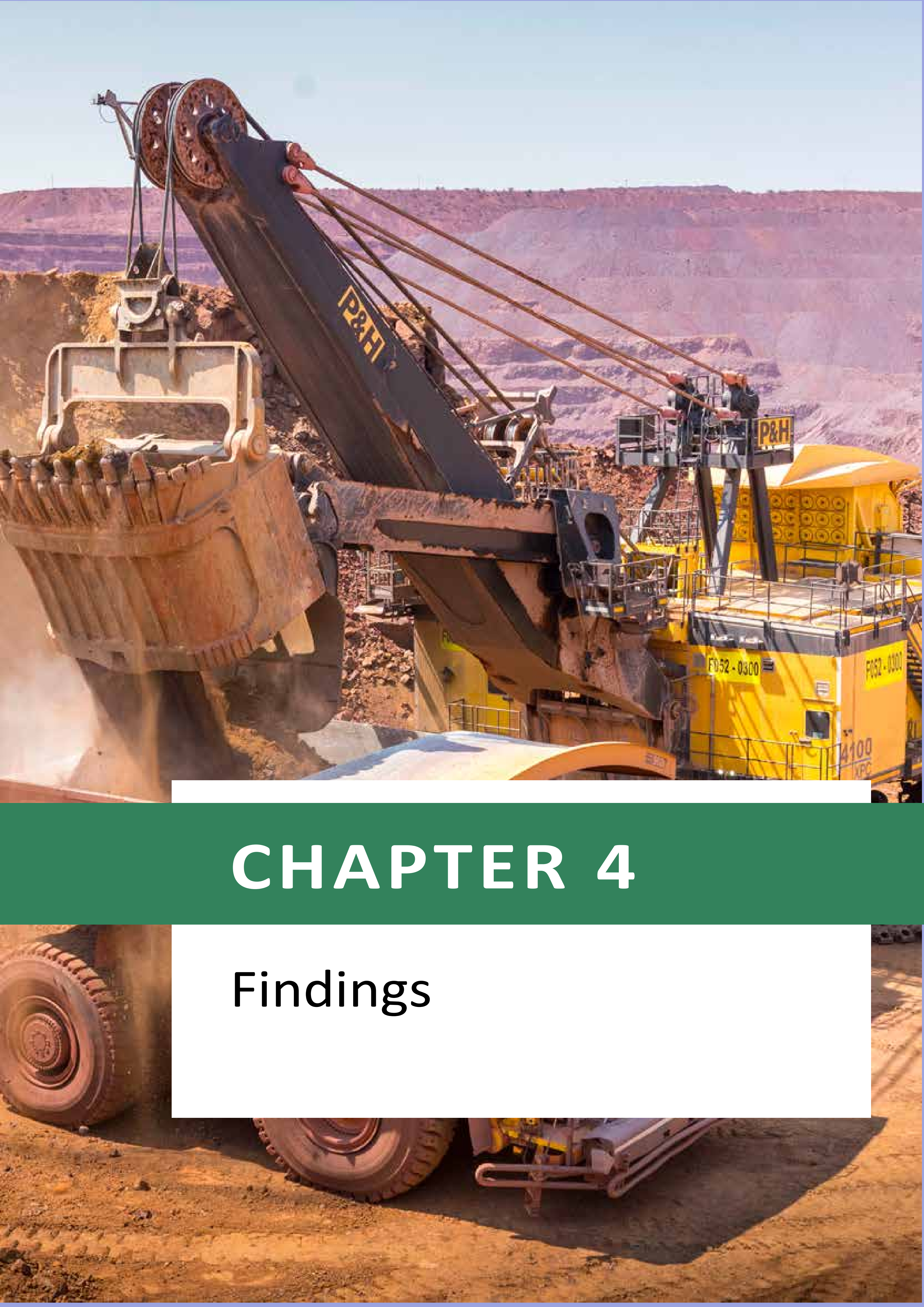
Literature Review

3. LITERATURE REVIEW

In Australian case studies undertaken in the coal sector, it was determined that there were positive impacts on the health and safety of personnel. This was mainly due to the focus placed on personnel proximity. Longwall mining was found to have higher productivity rates by the inclusion of new technologies. However, initial capital expenditure was a factor that increased significantly and return on investment was almost a halting factor to the development of the technology. A positive impact of the modernisation process was the increase in original equipment manufacturers (OEMs) that adopted new technologies. It meant that OEMs benefitted in the longer term and were able to increase supply to specific technological demands. The case studies also found that there was a serious need for adoption across operations. It was clear that it was an industry / commodity strategy for the adoption instead of a single operational strategy.

The Canadian case studies reviewed indicated towards three main areas of impact through modernisation. The first being stakeholder responsibilities. The modernisation of mining had to incorporate stakeholders at various levels. The examples provided were the impacts on engineers (e.g. became specialised into technologies), mining operations (e.g. structural and employee demographic changes) and government (e.g. legislative review and input to strategy development). The second area of impact was the sustainability of operations. The inclusion of technologies and revised strategies around modernisation had a positive impact on the sustainability of operations. The example was provided that there was a serious decline in production wastage which quickly translated to increased production levels. Lastly, the impact on the value chain was significant. The process of cradle-to-gate was incorporated in some of the case studies investigated and it was found that this part of the value chain was shortened. If the process was not shortened there was found to be an increase in the effectiveness of the value chain. The value chain became more specialised and non-core services were outsourced to specialised providers.

The China case studies indicated the strategy of "local supporting local". The adoption of fully mechanised mining (FMM) was fully supported by the local manufacturing and production of equipment. The reality was that there was a strong manufacturing, engineering and production system supporting mining operations already. The impact on local production was significant to justify the further development into their local manufacturing industry. The incorporation of FMM also showed increased levels in health and safety. The case studies indicated that health and safety was a serious concern, and the adoption of newer technologies had a positive impact on the levels of serious injuries and accidents. The last impact noted was the increased investment into research, development and innovation (RD&I). This increase translated to specialised research centres being developed which became even more supportive to the industry. It links back to increased investment into RD&I that leads to increased production and in turn to increased return on investment.



CHAPTER 4

Findings

4. FINDINGS

Modernisation and Change Modernisation has become standard operational practice across various industries. The literature review highlighted the fact that change is seen as part of the modernisation adoption process. Further to this it was determined that change is a broader term and not necessarily related to the direct impacts. The impacts felt through modernisation is more focused towards an activity that has a forceable effect on a specific area.

Modernisation has been linked to the dependency theory. The dependency theory is built on the construct that resources flow from underdeveloped countries to developed countries. These developed countries are in a position to transform these resources into income generating products. Therefore, these developed countries increase economic prospects for themselves at the cost of underdeveloped countries. This also points to the reliance that sectors might have on international providers (i.e., international equipment manufacturers). It was also determined that although modernisation is not a new concept, it has increased in complexity and the pace of change.

Direct Impacts of Modernisation

- Organisational Structures: The decrease in labour intensity leads to higher specialised persons. This would impact the structure of organisations with structures becoming more specialised and “flatter” in terms of hierarchy. Increases in oversight roles would have increased importance and movement from general operational personnel to specialised positions would indicate to pockets of specialisation being created in operations.

- Costing Models: Operational funding would be impacted due to changes in operation methodology. This is also related to the investment required into the advancement of technologies. An increased focus on research and development has been linked to increased external investments and growth in share prices. However, the increase in bottom line return is naturally dependent on the successful adoption of the new technologies. The telecommunications and motor industry case studies indicated that increased cost in technology development has a temporary negative influence on return on investment yet becomes more profitable once purchasing power has been reached through critical mass of demand.

- Standard Operating Procedures (SOPs): Modernisation has become a constant and consistent part of operations and thus requires the revision of SOPs. The process of change should become part of operating procedures (e.g. such as the adoption of change guidelines). Pace of technological advancements are increasing (e.g. related to the theory of Moore’s Law) and the adoption should become standard practice for operations.

- Education, Training and Skill Sets: There will be an impact into the competency definitions which are currently used. These changes in competency definitions are naturally linked to changes in skills. A direct impact is the changes that are experienced in current skill sets. These changes will need to be facilitated through education and training methodologies, practices and systems. The current system might not necessarily be able to align to the required pace in order to ensure that skill outputs address the needs of operations.

- Health and Safety: There have been numerous studies into the benefits of incorporating new technologies to increase the health and safety of employees. Studies indicated that, although linked to higher costs, there have been a decline in the number of serious/fatal injuries due to the incorporation of technologies. Examples of this would include removal of personnel from the rockface, personnel detection systems, increased tracking of machinery and personnel, et cetera. In addition to this there is the change in standards that need to be incorporated in operations, which forces operations to revisit their health and safety standards.

- Employment Levels: There has been much speculation from stakeholders on the impact modernisation will have on employment levels. The literature indicated a historical eb and flow of employment due to changes in industries. Although normally associated with a decrease in employment levels there were strong reasoning for modernisation to lead to redistribution of employment. Some of the redistribution was to associated industries and other to the entrepreneurial markets. New technologies have led to new opportunities, if capitalised on. This was also supported by the construct of social progress being made through modernisation. Social progress is linked to higher education levels, increased distribution of income and individualism.

- Maintenance Focus: With the increase in technology there has been a shift towards the maintenance of machinery. This change in focus also brings about the possibility of multiskilling as well as increased specialised skills (relates to skill sets section above). The positive impact is that lower skilled employees have the opportunity to move towards a maintenance role. This would increase quality of living and provide opportunities outside the boundaries of mining operations.

- Legislative / Regulatory Changes: There would be the need for revision and realignment of regulations and legislation. This is in part due to the current structures of regulations being built around traditional operating structures. Legal appointments can be distributed more evenly across structures and improve the shared responsibility and accountability. This creates a collective consciousness around health and safety within operations.

- Environmental Impacts: The incorporation of new technologies is found to have contributed to lower negative environmental impacts. Part of the positive impact is the reduction of waste and the decreased use of energy and water.

- Value Chain Impacts: The impact of technology can have a direct impact on the current value chain. The value chain is currently widely spread beyond the borders for South Africa. Modernisation can have both a positive and negative effect on the value chain. It can either bring the value chain closer to local operations or expand further beyond our borders. This will be determined by the industry and operational strategies that will be adopted.

Indirect Impacts of Modernisation

- Remuneration and Labour Costing: The costing model was addressed earlier in the summary, yet the indirect impact is relevant to increased skills being linked to increased costing. In addition to this, changes in aspects such as shift cycle changes would bring about changes in remuneration strategies. The indirect impact also refers to the costing models of local providers that can be impacted. The increase in local demand would positively impact local competitiveness. This increase would mean that economies of scale are created, and costing could be lowered.

- Labour Sending Areas: Local communities would be impacted by the adoption of new technologies, yet labour sending areas will also feel the effect. Higher skill levels would have a positive impact on labour sending areas due to skills being more transferable between industries. Currently labour sending areas are far removed from mining operations, with the development of new value chains there is the possibility of specialised entrepreneurial zones being created around local communities. This would decrease the need for communities to send labour to remote areas.

- Development of Specialised Zones: The creation of localised production would impact on creating specialised industrial zones. Examples of these are seen within the motor industry that has built value chains around specific value chain areas (both demographically and process oriented). Specialised zones would have concentrated areas of expertise, which can be based around the needs of operations as well as other related industries.

- Specialist Creation: Specialised skills become part of standard operations. There is movement away from general labour towards specialised skills. These specialised skills can become critical to operations and is not necessarily within the structure of the mine site.

- Revision of Educational Structures: The current structures of education are not intrinsically focused on specialised areas of skills. There are levels of progress through educational levels, yet past research has indicated that these levels are not always sufficient to address the needs of industry. The inclusion and adoption of new technologies would require the current educational structures to be revised and greater involvement from multiple stakeholders.

- Increase in Outsourcing: The need for specialised skills would have an impact on what is outsourced. Outsourcing may support local SME businesses. This in turn leads to greater contribution to employment levels within related and supportive industries.

- Transferability of Skills: Although there will be specialisation there is also the opportunity for skills to be transferred between industries.

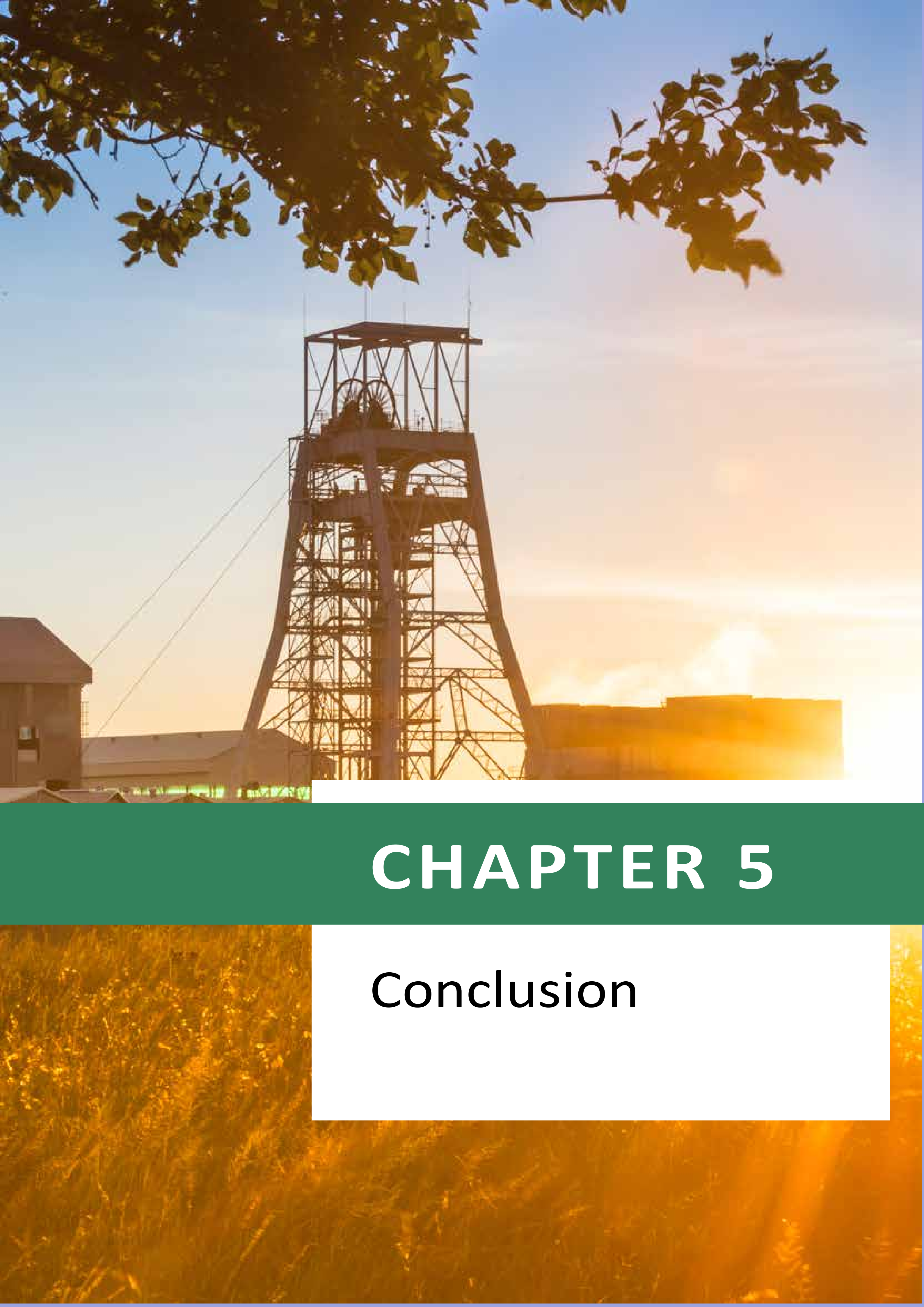
- Possibility of Education, Training and Development Sector Growth: Although there remains the need for the restructure and alignment of educational structures this does create opportunity. The advancement and growth of the education sector through the advancements of technologically focused curriculums. A positive impact could be the development of specialised skills pipelines through dedicated colleges.

- Gross Domestic Product (GDP) Contribution Changes: Mining remains a large contributor to the GDP of South Africa. With the increased development of manufacturing, logistical services, local production development and other supportive services there is genuinely the possibility of a change in the GDP contribution profile (Example: China export and manufacturing model).

- Life Span of Career and Mine Operation: The advent of technology will have a positive impact on the career paths that individual can take. This will increase the life span of certain careers seeing as though opportunities into different pipelines open to individuals. The inclusion of new technologies will also increase the life of mine in a positive manner. The possibility of reaching ore bodies which were previously out of reach is a genuine positive influence. This also indirectly creates longer term possibilities for employees.

- Competition Models: The increase in local manufacturing will have a positive impact on the competitiveness of the South African market. This will turn the dependency construct around and create both local and international competitiveness. This also increases the impact that South African mining can have on international markets. The impact could also include the increase in competitiveness of manufacturing, engineering and specialised skills development.

- Social Licence: The social licence that mines have with their communities and other related stakeholders will be impacted. There is the need for stakeholder engagement to be revised and the inclusion of terms such as co-creation becomes more important.



CHAPTER 5

Conclusion

5. CONCLUSION

It was evident through the study that structures of mining operations are transitioning from hierarchical frameworks to flatter and more specialised structures. Further, it was found that structures in the near future may be built on specialised areas and advisory services. These advisory services are not necessarily based on an outsourcing model but suggest a combined structure design. This would indicate a hybrid model of traditional structures, with specialised units (especially applicable to brown field operations). The core focus for mine operations remains the extraction of minerals. Thus, the specialised support structures around operations will enable the mine operations to focus their efforts on core services.

In addition, it became apparent that technology adoption will increase real time information and data systems. This will contribute to a considerable amount of data being managed effectively to support management decisions. The finding is that as organisational structures could develop from traditional hierarchical reporting to horizontal specialised unit structures, the organisational structure may in turn be supported by specialised services such as Information and Communication Technology (ICT), Research, Development and Innovation (RD&I), Projective Planning (modelling and simulations), data and analysis specialists and asset management specialists (including projective maintenance persons).

There are multiple modernisation initiatives taking place in operations in terms of technological advancements of equipment. The constraint, as per the findings, is that the impacts cannot yet be fully analysed. This is in part due to modernisation being a continuous process, with impacts not necessarily being instantaneous in nature. A finding is the need for the inclusion of OEMs, and where needed, the involvement of employees in the design, development and implementation of processes and modern mining technologies. Some possible modernisation opportunities identified were focussed on skills development, machine maintenance and specialised support.

It was found in the study that the current education systems/curricular, and training structures and methodologies may not be supportive of modernisation requirements. There is an impact on the skill requirements for mining modernisation, and a concern noted, is the lack of alignment of education system/curricular outputs and industry needs. Current training structures, curricular and methodologies may need review too, for applicability to mining modernisation.

There is a lack of policy alignment, related to modernisation, between national, regional, and local (community) levels. This has impact on local communities. It was determined that infrastructure development, strong public administration, ethical, responsible governance, and inclusion are prerequisites to effective community development to support localisation. Furthermore, a need for skills development at a local level within communities, has been highlighted.

Job creation potential needs to be considered, and the value chains investigated through this study, indicated similarities across countries and consistency in the value chain over time. The concept of Vertical Integration (VI) is introduced and found to assist in the span of control, specialised structures and alignment between stakeholders. Stakeholder engagement also identified the possibility of VI contributing to shorter value chains that are governed by mine operations, with the inclusion of local stakeholders.

Finally, in addition, in order to support job creation potential, the study has recommended a possible localisation framework for consideration, as below.

A recommended Localisation Framework