Fit-for-Future Quarrying

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Executive Summary

1.1. Purpose

The Institute of Quarrying New Zealand's Fit for Futures Research Project aims to predict the trends that will impact the quarrying industry in New Zealand. The desired impact is a quarrying sector with the leadership and strategic foresight to reimagine a quarrying industry that continues to provide the foundations for the construction and infrastructure sectors. Furthermore, predicting these trends will support the quarrying industry and key stakeholders in guiding quarrying practice, informing vocational training, and guiding strategic policy directions across the government, the quarrying industry, its suppliers, and stakeholders.

1.2. Introduction

A fit for the future quarrying sector is a sustainable industry that is future-oriented and people-oriented. The quarrying industry will be known for its stewardship of natural resources. A fit for the future quarrying sector collaborates with customers and stakeholders to discover new value. To achieve a fit for the future quarrying sector, industry leadership needs to be strategic and innovative and foster upcoming talent to transform the culture and perceptions of quarrying in New Zealand.

The following questions guided the Institute of Quarrying New Zealand's Futures Research Project:

- • What are the possible futures of the New Zealand Industry by 2030?
- • What are the drivers of the future that will impact the future of the New Zealand Quarrying Industry by 2030?
- • What recommendations must be actioned by the New Zealand Quarrying Industry to address these drivers by 2030?

The project used the Delphi Method to gather expert opinions and determine factors relevant to the future of quarrying. The Delphi method seeks to synthesise contributions from a panel of experts (*N=25*) to address a clearly stated problem (see Appendix A). The key drivers identified by Delphi's panel of experts were

supported and validated through a PESTEL analysis[1]. The PESTEL used secondary data and the researcher's insights into the phenomenon to provide an in-depth understanding of the key drivers, alerting the New Zealand quarrying industry to potential impacts on the industry and opportunities for exploration. The analysis of the Delphi and PESTEL identified possible impacts on these futures and were used in developing three scenarios for the quarrying industry to consider the possible futures. The three scenarios provide those in the quarrying industry with tools to support strategic thinking and foresight to develop a quarrying industry that is fit for future.

1.3.　Strategic Thinking and Foresight

This research aims to provide the quarrying sector in New Zealand with an opportunity to envision potential futures, allowing them to engage with strategic thinking and foresight. Strategic thinking is defined as the synthesis of systematic analysis (rational) and creative (generative) thought processes that seek to determine the organisation's long-term direction. Foresight is the ability to envision possible futures creatively, understand the complexity and ambiguity of systems, and provide input for taking provident care in detecting and avoiding hazards while envisioning desired futures.

1.4.　Scenarios

The key drivers impacting the New Zealand Quarrying Futures emerged based on the results of the Delphi study and the PESTEL. These key drivers informed three possible scenarios to expand the scope of the New Zealand quarrying industry. The scenarios are not developed to predict 'a future' of the industry but rather to present a broader view of the industry within which more informed decision-making can occur using foresight and strategic thinking. In this report, the primary purpose of scenario building was to evaluate the possible futures of the New Zealand Quarrying Industry.

This report uses the deductive strategy for scenario building. Scenarios offer a way to address uncertainties by creating room for ideas. Often, several drivers can be recognised during the original stage, which has an

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[1] PESTEL – Political, Economic, Social, Technological, Environmental, leal factors that can impact an organisations operations and decision making.

important effect on the main topic but is difficult to predict. Therefore, the actual effect of these drivers remains uncertain (Lindgren & Bandhold, 2003). The deductive strategy can help complicated systems with changing characteristics overcome the hazards inherent in those evolving characteristics.

The three scenarios were:

- Leave us alone
- Testing the water
- Fit for future

1.5. Recommendations

The three scenarios were used to develop recommendations for the quarrying industry to move towards an industry that is fit for the future. These recommendations are broken into the four sections below.

Future focused leaders:

- Transform industry culture to create a more inclusive and empowering environment to attract diverse talent through initiatives promoting innovation, sustainability, and a commitment to diversity.
- Implement comprehensive professional development programs, including mentorship, apprenticeships, and partnerships with educational institutions.
- Develop and promote leadership qualifications and coaching programs that emphasise emotional intelligence and inclusive leadership. These programs should provide leaders with the knowledge and skills to address resistance to change actively.
- Create policies and initiatives that encourage diversity, gender balance, and equal opportunities within the workforce.

Diversity, Empowerment, and Inclusion

- Transform industry culture to create a more inclusive and empowering environment to attract diverse talent through initiatives promoting innovation, sustainability, and a commitment to diversity.
- Implement comprehensive professional development programs, including mentorship, apprenticeships, and partnerships with educational institutions.

- Develop and promote leadership qualifications and coaching programs that emphasise emotional intelligence and inclusive leadership. These programs should provide leaders with the knowledge and skills to actively address resistance to change.
- Create policies and initiatives that encourage diversity, gender balance, and equal opportunities within the workforce.

Embracing Emerging Technologies

- Prioritise digital transformation initiatives, particularly the adoption of artificial intelligence for decision-making and operational efficiency, through raising awareness of the benefits and emphasising long-term benefits over short-term costs. Ethical considerations for adopting emerging technologies should remain at the forefront of the decision-making process.
- Establish collaborative research efforts among industry players, research institutions, and government bodies (including advocating for government funding and incentives) to address common challenges.
- Implement pilot projects to test and showcase the effectiveness of new technologies in real-world scenarios.
- Develop knowledge-sharing platforms to disseminate information on successful technologies and encourage wider adoption.

Rebuilding Trust

- Prioritise environmental responsibility by investing in sustainable practices, environmentally friendly technologies, and responsible quarrying methods.
- Establish transparent communication channels with the public, government agencies, and local communities to address concerns and share progress.
- Invest in improved health and safety protocols, training programs, and technological advancements that enhance worker safety.
- Implement collaborative industry-wide initiatives for best practice, a code of conduct and ethics, and potentially self-regulation that set standards exceeding regulatory requirements. Develop and promote training programmes that support these standards.

2. Delphi and PESTEL Findings

A Delphi study was conducted to gather data from representatives from the quarrying sector in New Zealand. The Delphi method is a structured approach that leverages the expertise of a panel of experts to address specific problems. The Delphi Method requires participants to respond to carefully crafted questions which allow for the systematic collation and distillation of diverse viewpoints. The benefit of the Delphi Method is the anonymous process, which ensures opinions are evaluated on merit alone. The regular feedback loops encourage openness to critique and facilitate the revision of judgments based on evolving consensus, allowing collective intelligence to flourish. The Delphi Method was used for this research as it is a valuable tool for participative decision-making and strategy development, particularly in dynamic environments requiring innovative solutions. More information about the findings from the Delphi Study can be found in Appendix A in this document.

In conjunction with the Delphi Method, a PESTEL study was conducted to understand and validate the key drivers. The PESTEL study explored the changes and the effects of key drivers from the external macro environment on the future of the New Zealand Quarrying Industry. The PESTEL study looks at the political, economic, social, technological, environmental and legal factors from local and international sources and the researcher's insights to provide an in-depth understanding of the key drivers identified in the Delphi study. The analysis identified the possible impacts on the future of the New Zealand Quarrying Industry. In summary, the following key drivers were identified by the Delphi panel of experts and validated by the PESTEL:

2.1. Political Dimension

The following political dimension key drivers were identified by the Delphi panel of industry experts and validated by the PESTEL analysis from secondary sources as they relate to shaping the future of the New Zealand Quarrying Industry:

- Political perceptions.
- Changes in government.
- Community perceptions.

Each key driver is discussed below.

2.1.1. Political Perceptions

The New Zealand government is anticipated to impact the New Zealand Quarrying Industry increasingly. This anticipated impact is critical as it can influence infrastructure spending, new developments, and changes to legislation. Changes in government, regulation, and community perceptions, all products of political systems and discourse, are the main drivers of change in the political environment.

The convergence between the nature of the quarrying business, the environment, public sentiment, and a generally greater emphasis on corporate social responsibility has changed the nature of political perceptions of the industry. These perceptions are increasingly unpredictable and less supportive, thus placing the industry leaders under pressure to adopt more expensive and onerous development and more costly business plans. Quarrying industry leaders are engaging external consultants to meet the increasing demand to improve the political perceptions of the industry, as quarry managers do not have the knowledge, skills and experience to manage this task to a satisfactory level.

2.1.2. Changes in Government

Political parties are prone to being subject to public opinion. Where they are perceived to support quarrying activity, it is increasingly likely to harm voting numbers. With every change of government, some outcomes profoundly impact the New Zealand quarrying industry. These outcomes occur without first properly consulting with the industry or allowing sufficient time for businesses within the industry to adapt to the new expectations. The New Zealand Quarrying Industry is being affected by these changes, and this uncertainty is destabilising the industry's productivity levels, given the ongoing change in government policies and regulations.

2.1.3 Community Perceptions

Pressure from community groups is also mounting and will continue to increase. Community perceptions are an integral part of informing political behaviour and policies. Engagement with communities is critical; with New Zealanders supporting the global trend, the government must consider the community's views when planning or investing using taxpayer dollars. Community expectations can no longer be met with lump sum cash payments that quarries used to connect with local communities, a community event, or donations to

community causes. Each year, communities seek meaningful and measurable outcomes and influence consent decisions to start or expand a quarrying operation. This is taking a financial toll on the quarrying industry as sites cannot start up or expand to meet customer demands without incurring additional costs, which impacts profitability and productivity levels.

Increasingly, activist groups work to sway public opinion through online communications such as social media, and campaigns go viral. As activist groups become more vocal and organised, they can exert greater pressure on governments and communities considering quarrying project approvals, consequently impacting the future of the New Zealand Quarrying Industry.

Although some quarrying businesses rely on social media to engage with political stakeholders, they are not at the forefront of emerging trends. This places these quarrying businesses at a disadvantage to political stakeholders capable of mobilising full-scale media campaigns to support their expectations and demands. The New Zealand Quarrying Industry is increasingly required to become more active and spend more to deliver its messaging to engage directly and share targeted information with the various political stakeholders. This has made the industry increasingly vulnerable to the electorate's perceptions and political response.

The political stakeholder landscape will become increasingly complex, and the New Zealand Quarrying Industry will need to proactively engage political stakeholders to navigate the increasingly volatile political environment. Quarries that consistently engage with political stakeholders can realise tangible advantages related to their expectations. As evidenced by other industries, the New Zealand quarrying industry must demonstrate a high commitment to responsible corporate behaviour by engaging its leaders to play key roles in political stakeholder engagement and solution identification.

Quarries interested in reclaiming their license to operate are coming to realise that a new form of political stakeholder engagement is needed to balance the demands of multiple groups. Rather than simply reporting the amount of money spent on meeting legislative requirements and community initiatives, quarries may increasingly need to consider tracking and reporting on their impact on each stakeholder group. Quarries should show how their activities and investments contribute to GDP, economic transformation, and job creation. If the New Zealand Quarrying Industry can start aligning its operations with the underlying and long-term needs of the political stakeholders and further explore the concept of shared value, it could earn its

license to operate and grow.

2.1.4. Possible impact of political drivers for the Quarrying Industry

The political dimension of the New Zealand Quarrying Industry's operational environment consists of the following key drivers:

- Political perceptions.
- Changes in Government.
- Community Perceptions.

Responding proactively may result in the following outcomes in the future:

- Quarries do not fear a change of government as governments, communities and quarries are collaborating on regulations related to health and safety and land management.
- Automated government monitoring provides transparency in information to all stakeholders.
- All stakeholders view quarries as 'welcome guests' due to a reputation for responsible usage and rehabilitation.
- Governments are actively investing in promoting equitable and climate-resilient practices.
- Evidence of a highly compliant quarrying industry.

Failure to respond proactively may result in the following outcomes in the future:

- Unresponsive quarries are being taken over by those demonstrating proactive engagement, limiting market competitiveness.
- With limited competition in the quarrying market, the price for quarry products is increasing, greatly impacting infrastructure projects' affordability.
- Quarries are viewed as 'bad tenants'.
- Any proposed or actual change in government is providing uncertainty for ongoing and future quarry operations.
- Community groups' increased influence on local quarry operations impacts ongoing and future quarry operations.

2.2.   Economic Dimension

The following economic dimension key drivers were identified by the Delphi panel of industry experts and validated by the PESTEL analysis from secondary sources as they relate to economic factors influencing the future of the New Zealand Quarrying Industry:

- • Economic growth.
- • Availability of quarry products near market.
- • Infrastructure spend.

Each key driver is discussed below.

2.2.1.   Economic Growth

New Zealand seems to be in a "two-speed economy" again as it was a decade ago. The "two-speed economy" is creating unevenly distributed growth rates in the quarrying industry across New Zealand. Population growth is a key indicator for a government to increase or decrease infrastructure spending. The level of infrastructure activity directly impacts the quarrying industry, given the demand or lack of demand for quarry products.

2.2.2.   Availability of Quarry Products Near Market

Humanity is becoming more urban, with most population growth projected in cities and larger towns. Infrastructure demand in these areas is anticipated to rise dramatically in the next decade, requiring an increasing demand for quarry products.

A key issue for the New Zealand quarrying industry is the availability of quarry products near the market. Costs are kept to a minimum when quarry products are supplied close to the market. The further a quarry product needs to be transported, the greater the cost to the market. While the industry generally feels confident about meeting demand, it recognises that it will increase costs if it tries to do things too quickly because it must transport materials further away and work out how to deliver them. Having a good plan, pipeline, and industry certainty is important, but the industry also needs supply in the right places. Construction work is expected to increase over the next ten years. Many construction sectors tend to be materials-heavy regarding quarry products, so the demand for these materials will not abate anytime soon.

To ensure the availability of quarry products near market demand, the New Zealand quarrying industry must engage appropriate strategies for the best access to these materials without increasing the cost of projects and ensuring a sustainable industry in the future. Higher capacity rail and road transport technology may offset delivery costs and allow the industry to travel some distance from the quarrying source.

Another source of quarry products to meet market demand is recycled material. Produced at quarry sites from wastes from outside construction sites, recycled material makes it possible to optimise the availability of quarry products should a natural deposit not be available close to market demand. It is anticipated that recycled material will be a key feature of meeting market demand in the future.

2.2.3. Infrastructure Spend

New Zealand's infrastructure spending has been through a transition period with infrastructure investments and regulatory reforms, and it will face significant challenges in the future. The New Zealand government's role in the long-term responses to these challenges will impact national prosperity.

The New Zealand Quarrying Industry realises a need for steady investment over time that adequately addresses our population and economic growth, not big waves of infrastructure building and catch-up spending. Unfortunately, New Zealand's history is not good because it has severely underestimated its population growth and has not implemented the appropriate funding mechanisms to build infrastructure at the right time. This means that New Zealand is experiencing periods of catch-up. New Zealand is trying to catch up on infrastructure spending to compensate for decades of underfunding.

These periods of catch-up can be pretty intensive and very uncoordinated. New Zealand is not getting the best quality outcomes because the quarrying industry is simultaneously stretched so hard. This often drives prices up to respond to supply and demand. In terms of overall coordination, the New Zealand government must think inter-jurisdictionally. They must recognise that they are competing for the same resources for big, iconic infrastructure projects. The New Zealand government can do much more to coordinate their investment by being aware of what is happening in the market.

New Zealand needs to concentrate on the construction pipeline and needs a better funding system that promotes steady investment over time. New Zealand needs to think about how it can sequence projects effectively so as not to overstretch the construction industry and its supply chain, particularly the quarrying

industry. Many governments worldwide do not know well about the supply/demand balance for construction materials. Suppose the lack of good knowledge continues during the next decade. In that case, the New Zealand government may not know or have all the information it needs to prepare appropriate plans for the timely development of new quarries to support long-term infrastructure projects. This is likely to impact the rollout of infrastructure projects to meet the demands of a growing population.

2.2.4.   Possible impacts of economic drivers for the Quarrying Industry

The economic dimension of the New Zealand Quarrying Industry's operational environment consists of the following key drivers:

- Economic growth.
- Availability of quarry products near the market.
- Infrastructure spends.

Responding proactively may result in the following outcomes:

- Quarry planning is aligned with commercial objectives with sustainable goals in managing the economic cycle.
- Quarries are being opened in remote areas, given cost savings associated with automation and new transport solutions, allowing quarry products to be available to market demand.
- Increased confidence in the industry permits increased investment by government and private sectors in infrastructure spending.

Failure to respond proactively may result in the following outcomes:

- Quarries that are not ready to manage the growth period in the economic cycle are resulting in many quarrying operations being unable to meet economic growth demands, negatively impacting current and future infrastructure projects.
- Quarries not prepared to manage the economic cycle's decline period are declaring bankruptcy, negatively impacting unemployment figures and the local economies.
- Not being able to service the market with proximity to quarry products increases the time it takes to complete infrastructure projects and their project budgets.
- Quarries not using recycled materials are not being deemed competitive and/or viable in

the open market.

- The price of quarry products is increasing due to increased transport costs to get the product to market.
- Infrastructure spending is dictating the viability of quarrying businesses. During periods of low infrastructure spending, quarries must look for other business opportunities to keep their doors open, increasing competition between quarrying companies. This competitiveness is leading to unethical behaviour.

During periods of high infrastructure spending, quarries prepare to ensure they have ample quarry product supplies to meet market demand. This competitiveness is leading to unethical behaviour.

2.3. Social dimension

The following social dimension key drivers were identified by the Delphi panel of industry experts and validated by the PESTEL:

- Workforce health and safety.
- Resistance to change.

Each key driver is discussed below:

2.3.1. Workforce Health and Safety

The health and safety imperative on work sites is never far from the minds of leaders in the New Zealand Quarrying Industry. The risks associated with quarrying remain real, with fatalities, accidents and work-related health issues increasing across the industry. Considering these realities, the New Zealand Quarry Industry continues to refine its health and safety programs. In recent years, this has seen them turn to data analytics to pinpoint industry risks, organisational behaviours, and internal cultures most likely to result in severe health and safety events. As technology becomes more intuitive, it enables some quarries to implement health and safety programs focused on zero fatalities rather than zero harm.

Industry leaders realise that health and safety are not the only functions of process-driven policies. They also require the promotion of a culture of safety. Embedded in that notion is the idea that employees must be physically and mentally healthy for a safe and productive environment to flourish. Failure to do so may result

in an industry reputation of poor workplace health and safety practices, which will impact attracting and retaining industry talent. Poor workplace health and safety practices may also see a more vested interest from government regulators.

Two current health and safety issues impacting the New Zealand Quarrying Industry are declining mental health and increasing silicosis-related illnesses. Declining mental health and the increasing threat of silicosis-related illness are becoming more prevalent in the New Zealand Quarrying Industry and pose an emerging challenge to the industry, possibly to a greater extent than the more 'mechanical' nature of workplace health and safety issues in the past.

Ongoing challenges to corporate profitability, government regulations, community expectations and employee layoffs heighten employee despondency. Workplace stress is estimated to affect around 32 percent of all New Zealanders, thus being a significant factor in workplace reform. Some quarries are taking steps to assess the mental health of their workers and provide counselling services to assist those in distress. With concerns around mental health rising, new strategies will need to be deployed, including enhanced professional development and training, revised work schedules and the fostering of a work culture focused on preventing the onset of mental health issues. By using analytics, it is anticipated that these efforts will also be strengthened by helping companies uncover the risk factors contributing to mental health problems.

Another health risk from working in the quarry industry is exposure to fine dust containing crystalline silica (quartz). Workers exposed to fine dust containing quartz are at risk of developing a chronic and possibly severely disabling lung disease known as 'silicosis'. It usually takes several years of regular daily exposure before there is a risk of developing silicosis. However, since quarry workers are significantly exposed to dust, the New Zealand Quarrying Industry must act now. If there is a failure to act now, it is anticipated that there will be an increasing number of workers presenting with silicosis symptoms. There is also expected to be an increase in compensation claims for workers diagnosed with silicosis, leading to an increased cost of insurance policies, which will be passed on to the industry. There is also an expected increase in certain operators not reporting on workplace health and safety incidents for fear of regulatory investigations. Quarries that respond proactively to mitigate exposure to silica dust are expected to experience an increase in costs for personal protective equipment for operational workers. For those quarries that do not provide a silicosis mitigation strategy, it is anticipated that they will struggle to find applicants to fill employment

positions.

2.3.2. Resistance to change

Change is an inevitable part of business in today's fast-changing environment. While some businesses can deal with change efficiently, it can be a more complex process for others. Some employees may resist change, which can negatively affect the organisation. If these adverse effects are not addressed promptly, they can become widespread and detrimentally affect the business.

Given its traditions and culture, there is resistance to change in the New Zealand Quarrying Industry. When employees resist a change at work, they may feel less optimistic about their professional future with the organisation. This is particularly so if there is a lack of communication regarding the change. Among other negative effects of resistance to change, lowered morale can spread throughout the entire staff, which can, in turn, lead to staff recruiting and retention issues. Another adverse effect that results from employees focusing on resisting the changes in the workplace is that they become less focused on performing the daily tasks required by their jobs. This can lead to reduced employee efficiency and output, damaging the organisation's bottom line. Whether based on accurate information or misguided preconceptions, the New Zealand Quarrying Industry must not underestimate the effort it will take to overcome this resistance while recognising when it is worth the effort.

2.3.3. Possible impact of social drivers for the Quarrying Industry

The social dimension of the New Zealand Quarrying Industry's operational environment consists of the following key drivers:

- Workforce health and safety.
- Resistance to change.

Responding proactively may result in the following outcomes toward the future:

- Decrease in instances of workplace accidents and deaths.
- Improved public perception of industry practice.
- The workforce embraces change, given the consultative approaches evident in quarry operations.

Failure to respond proactively may result in the following outcomes toward the future:

- A poor workplace health and safety culture places all workers at risk.
- Not being able to recruit and retain talent due to a poor workplace health and safety culture and negative public perception.
- An increased industry regulator interest in quarrying operations where workplace health and safety practices are below industry standards (over-regulation).
- A workplace culture where resistance to change dictates the speed and adoption of innovative operations to ensure business viability.

Unable to recruit and retain talent due to a poor workplace culture dominated by resistance to change.

2.4. Technology dimension

The following technology dimension key drivers were identified by the Delphi panel of industry experts and validated by the PESTEL analysis from secondary sources as they relate to economic factors influencing the future of the New Zealand Quarrying Industry:

- Innovation.
- Automation.
- New technologies.
- New materials.

Each key driver is discussed below:

2.4.1. Innovation

Strong innovation leadership is among the most important factors promoting New Zealand's economic growth and competitiveness. If it fails to innovate and build innovation capacity, New Zealand risks being left behind in an increasingly interconnected and rapidly changing world. New Zealand needs to improve its innovation performance. As a percentage of GDP, its expenditure on innovation sites is below the OECD average. Innovation efficiency is the ratio of innovation output to innovation input.

The New Zealand Quarrying Industry has also spent several years ruthlessly reducing costs and restraining investment in research and development. This has forced the New Zealand Quarrying Industry to consider how to both sustain their cost take-outs and drive ongoing productivity improvements. The New Zealand

Quarrying Industry urgently requires a substantive investment in innovation, which is an industry leader enabled to ensure the future capabilities needed by the industry to retain competitive advantage. From automation, new transport solutions, new products and technologies, and quarries embracing innovation, quarrying intensity can be improved. However, this innovation is not occurring in many New Zealand quarries, particularly the smaller quarrying operations. This is mainly due to cost and resistance to change. Suppose innovation is not a priority for all quarrying operations. In that case, it is anticipated that several quarries will be unable to compete with quarries that engage in innovative practice as part of their daily operations. The New Zealand Quarrying Industry has the potential to prosper in the future. However, it must be achieved through new avenues, with innovation and early adoption of new technology playing a large role.

2.4.2. Automation

Over the next decade, the average New Zealand resource sector worker will spend two hours per week less on manual and routine tasks. Automation is predicted to make New Zealand jobs safer, more satisfying, and more valuable. Jobs will become safer as machines take over the most dangerous tasks at work, satisfying as machines take over the most routine tasks at work, and valuable as machines take over the least productive tasks in the economy.

The move towards autonomous vehicles and automated technologies has revolutionised some quarrying practices. As the capability of these machines grows over the next decade, they will be able to perform increasingly complex tasks, including hazardous processing activities, reducing labour costs and enhancing productivity as a result. Quarries could operate fully autonomous sites, concentrating labour in centralised functional hubs. It is predicted that there will be fully automated quarry sites operating in many countries, reducing costs and work site accidents and permitting a 24-hour operation.

The application of robotic technology has far-reaching potential for the quarrying industry during the next decade. Robotic devices powered by artificial intelligence can perform various quarrying tasks, including drilling, blasting, loading, and hauling. These new technologies will impact the way quarries currently operate.

2.4.3. New technologies

The Internet of Things (IoT) can transform the extractives industry by creating new ways to maintain safety

and productivity. This new technology involves connecting machines, fleets and people with unique identifiers based on radio frequency identification devices and sensor technologies. It allows them to automatically transfer and receive data over a network without requiring human-to-human or human-to-computer interaction.

This platform can improve the traceability and visibility of the quarrying operation, enabling computers to observe, identify, and understand different facets of quarrying operations without human intervention, automate and improve machine maintenance and operation, and develop machine learning and artificial intelligence capabilities.

Some businesses are considering if wearable technology can deliver business benefits. By incorporating computers and advanced electronics into personal protection equipment, quarry workers stand to realise a range of unprecedented advantages, e.g., devices can track operator fatigue to cut down on accidents that endanger worker safety. Wearable devices can even signal if their wearers are in physical distress, enabling rapid response to accidents or injuries.

Confined initially to custom prototyping, 3D printing has rapidly become a production-ready technology. The implications for the New Zealand Quarrying Industry are significant, enabling operations in remote locations to custom manufacture critical parts on demand. Thus reducing both delays in unplanned maintenance and the need to hold costly inventories. Another new technology that has emerged is 3D laser scanning, which helps to capture spatial data using laser light and enables geologists to build 3D geological maps combining surface mapping data. This new technology will assist quarries in identifying new product areas and site safety.

2.4.4.   New materials

An increase in infrastructure construction has increased the rate at which high-quality aggregates are consumed. This situation, coupled with an unbalanced geographical distribution of deposits, has created a supply problem in some areas of New Zealand. New materials offer a possible alternative to importing natural aggregates from other areas. As the aggregate shortage becomes more widespread and importing natural aggregates becomes too extensive and costly to be a sound practice, new materials provide a feasible solution. New materials like fibre composites are now being used for infrastructure applications. Many years

of research and development have successfully applied composite fibre technology to several applications, including road bridges, electrical cross arms and pedestrian structures.

2.4.5. Possible impact of technology drivers for the Quarrying Industry

The technology dimension of the New Zealand Quarrying Industry's operational environment consists of the following key drivers:

- Innovation.
- Automation.
- New technologies.
- New materials.

Responding proactively may result in the following outcomes toward the future:

- Many quarrying processes are managed by robotic technology.
- Innovation is integral to daily practice and has improved resource efficiency, extended product lifelines and waste production.
- Fully automated quarry sites are operating in many locations across New Zealand.
- Innovations at the quarries are globally recognised and endorsed.
- Artificial intelligence is helping to increase efficiency by apportioning resource use among competing priorities, ensuring the conservation of critical resources.
- New technologies allow more accurate exploration, saving time and cost.
- New jobs have been created to manage automated practices.

Failure to respond proactively may result in the following outcomes toward the future:

- Quarries are not evolving through innovative practice and are going out of business, while others are adapting, innovating, seizing opportunities and thriving by taking advantage of the new environment.
- Displaced workers, given technological advances, are unemployable in the quarrying industry and are searching to be reskilled to be redeployed to new opportunities within the work environment.
- New technologies are being adopted slowly, with quarries not keeping up with demand.
- Quarries that are not embracing new technologies continue using outdated operational

practices, which decrease productivity, safety, and corporate social responsibility.

- New synthetic materials reduce the demand for natural aggregates.

2.5. Environment dimension

The following environment dimension key drivers were identified by the Delphi panel of industry experts and validated by the PESTEL analysis from secondary sources as they relate to economic factors influencing the future of the New Zealand Quarrying Industry:

- Environmental politics
- Rehabilitation.

Each key driver is discussed below.

2.5.1. Environmental politics

Governments worldwide will continue vigilance with their green environmental agenda. They continue legislating the quarrying industry with stringent environmental laws and regulations deemed a political and ethical imperative. In the eyes of the public, quarrying is not an environmentally friendly operation because it produces vibration, noise, and dust. The perception of quarrying has changed significantly over the past twenty years, particularly with the rise of environmental politics.

Significant changes have been made to quarry approvals and contracts. For all approvals and contracts, the principles of environmental politics are included, with much focus and consideration placed on environmental aspects and the conservation of natural resources. The mandate for a quarrying project is to revert the site to a natural-looking state or to turn a once bare-looking eyesore into an area covered with vegetation in harmony with the natural environment and suitable for future development. It is predicted that these stringent environmental laws and regulations will continue to influence the practice of quarrying.

2.5.2. Rehabilitation

A quarrying rehabilitation contract is usually a long-term undertaking that takes more than ten years to complete. As a result, the quarry owner is starting to be more willing to spend time and effort investigating and adopting innovative ways to reduce environmental impacts and attending to matters affecting the environment and the community. Current practice recognises environmental impact assessments being

carried out for quarry rehabilitation works before they commence, and this practice is expected to become more stringent during the next decade. Air quality, noise, water quality, waste disposal and blasting are assessed, and assessment criteria are established. Mitigation measures and monitoring and audit requirements are also specified. Once the work commences, regular environmental control, monitoring and auditing is conducted.

Environmental issues, such as the operations' effects on any future development works near the site, are assessed, and measures are taken to mitigate the environmental impacts in compliance with relevant Acts and Regulations. Quarry rehabilitation works include re-contouring, extensive planting, and the conservation of flora and fauna unique to a location. It is anticipated that the rehabilitation of quarries agenda will continue to evolve.

2.5.3.   Possible impact of environmental drivers for the Quarrying Industry

The environmental dimension of the New Zealand Quarrying Industry's operational environment consists of the following key drivers:

- • Environmental politics.
- • Rehabilitation.

Responding proactively may result in the following outcomes toward the future:

- • New Zealanders have increased political power concerning land management and working collaboratively with quarries.
- • Rehabilitation practices are evident throughout the lifecycle of a quarry.
- • Governments, communities, and quarries are working in partnership to manage the environment for a sustainable future.

Failure to respond proactively may result in the following outcomes:

- • A quarry's licence to operate is being revoked, thereby ceasing all production, impacting unemployment levels and the local economy.
- • Permits continue to be under scrutiny due to sub-standard practice.
- • Poor community perceptions of the industry continue, placing increasing extra pressure on quarries in some cases.

- Government regulatory interventions continue and, in some cases, place increasing pressure on quarries.
- The cost of rehabilitating a quarry site is increasing substantially as rehabilitative practices are not started during the initial stages of operation.

2.6. Legal dimension

The following legal dimension key driver was identified by the Delphi panel of industry experts and validated by the PESTEL analysis from secondary sources as they relate to economic factors influencing the future of the New Zealand Quarrying Industry:

- Regulations

This key driver is discussed below.

2.6.1. Regulations

Reconciling the ever-changing regulatory needs of the government while still delivering a return on investment for quarrying businesses has been a concern in the quarrying industry for some time and is expected to continue during the next decade. The New Zealand government has not softened their stances around resource management and associated regulatory mandates. These are mostly in response to community sentiment and in response to seeking to gain the popular vote. On many occasions, quarrying organisations struggle to obtain environmental and other approvals and adhere to a range of regulations. At the same time, the cost of bureaucracy required to exert regulatory control is also being passed on to the industry, thus taking a toll on corporate profits and their license to operate. It is anticipated that reconciling regulatory needs will continue in the future and become more robust during the next ten years.

Lengthy permit processes cause delays in getting new and expanding quarrying projects operational. Community organisations, representative/interest/cultural groups, and the public are also often involved in the processes. The process to approve new and expanding quarrying projects is expected to maintain its current standing until government policy is refined during this ongoing period of regulatory reform. Quarrying businesses must remain patient during the reform process and continue to follow current regulations.

Environmental assessments, approvals, and compliance with regulatory requirements are mandatory for the

commissioning and operation of all quarrying projects in New Zealand. Quarrying businesses wishing to commission new or expanding operations must prepare an assessment of the anticipated environmental impact of their operation. The grant of environmental approval is generally subject to conditions that aim to minimise the overall environmental impact of the quarrying operation. For many quarries, an external consultant usually prepares an environmental assessment report, which becomes an added operational cost. External consultants are contracted to complete this work because industry leaders admit to not having the knowledge, skills, and time to develop these reports. Given the ongoing complexity of these reports, it is anticipated that many quarries will continue to find the costs of external consultants to develop these reports throughout the next decade.

New Zealand has commissioned mandatory continuing professional development for all quarry managers (A-Grade and B-Grade), as regulated by WorkSafe New Zealand, to maintain individual Certificates of Competency. Certificates of Competency are reviewed every five years with the need to apply for a new Certificate of Competency. This commissioned mandate can only become more stringent in the future.

2.6.2. Possible impact of legal drivers on the Quarrying Industry

The legal dimension of the New Zealand Quarrying Industry's operational environment consists of the following key driver:

- Regulations.

Responding proactively may result in the following outcomes toward the future:

- The industry embraces certificates of Competency.
- Quarrying organisations are self-regulated, given their history of compliance.
- Approval processes are streamlined and managed by governments, communities, and quarries.

Failure to respond proactively may result in the following outcomes toward the future:

- Negative regulatory and community perceptions, including native title and land rights, are increasing and negatively impacting the quarry organisation's operating licence.
- The cost of increased regulatory control and intervention continues due to quarry organisations' failure to adhere to regulations, which puts pressure on operating budgets.

- The permit process is delaying the delivery of quarry products, as current reforms have not succeeded in stalling infrastructure projects.

- Quarries continue to engage external consultants to complete regulatory reports, which increases operational costs.

- Limited evidence of continuing professional development having traction.

- Quarry managers are not having their Certificates of Competency renewed as they ignore the mandated continuing professional development requirements.

3. 2030+ Quarrying Scenarios

The previous chapter explored the key drivers impacting the New Zealand Quarrying Futures that emerged from the Delphi study and the PESTEL analysis. The empirical evidence was derived from the industry experts in the Delphi study, who identified key drivers of change, trends, and possible wildcards while identifying current leadership capabilities and inadequacies. The PESTEL analysis combined the Delphi findings with an environmental scan to finalise the drivers, trends, and wildcards that would inform the scenario development and the leader profiles.

This chapter will use the Delphi study and PESTEL findings to inform three possible scenarios to expand the scope of the New Zealand quarrying industry. The scenarios are not developed to predict 'a future' of the industry but rather to present a broader view of the industry within which more informed decision-making can occur. In this report, the primary purpose of scenario building was to evaluate the possible futures of the New Zealand Quarrying Industry.

The deductive strategy employed by the scenario development process in this report sought to combine empirical evidence from the present (validated identifications of trends, drivers of change, and wildcards) with the traditional four-quadrant approach (certainty/uncertainty and high control / low control matrix) to develop the scenarios. More information about scenarios and their development can be found in Appendix B.

Scenarios offer a way to address uncertainties by creating room for ideas. Often, several drivers can be recognised during the original stage, which has an important effect on the main topic but is difficult to predict. Therefore, the actual effect of these drivers remains uncertain (Lindgren & Bandhold, 2003). The deductive strategy can help complicated systems with changing characteristics overcome the hazards inherent in those evolving characteristics.

3.1. The 2024 'Leave Us Alone' Quarry in 2030+ Scenario

By 2035, the quarrying industry in New Zealand will be largely entrenched in a reactive approach, heavily leaning on past successes and focusing predominantly on current operational optimisation. This mindset appears to be influenced by a belief that the future is unpredictable due to rapid and discontinuous changes, leading to a reluctance to anticipate or plan for future shifts.

Several key characteristics define the industry leaders in this scenario:

- Past-Centric Focus: Leaders lacking a forward-thinking approach predominantly rely on past successes and business cycles to guide their decision-making.

- Reactive Future Orientation: This approach to the future primarily aims to adapt to changes as they occur rather than proactively anticipating or preparing for them.

- Limitation in Future Orientation: A belief that the future is unpredictable due to rapid changes limits their ability to envision and prepare for potential shifts.

- Short-Term Performance Incentives: Incentives and performance measures are heavily tied to short-term targets and financial gains, further reinforcing the focus on immediate results.

- Stakeholder Pressure for Short-Term Returns: The pressure for short-term returns from stakeholders, potentially including investors or shareholders, influences decision-making and strategic focus.

It sounds like the quarrying industry in New Zealand is experiencing challenges in its leadership approach, strategic decision-making, and innovation adoption. The directive management style, with limited employee participation in strategic decisions, might hinder the industry's ability to leverage diverse perspectives and innovative ideas from within the workforce. Relying solely on analytical projections and short-term profit targets might limit the industry's capacity to plan for long-term sustainability and innovation.

Several key points are notable:

- Limited Innovation and R&D: The industry's reluctance to invest in innovation, research, and development might stem from a lack of long-term strategic vision. This could hinder the exploration of new technologies and approaches beneficial to quarrying operations.

- Analytical Decision-Making: Relying heavily on analytical projections might overlook the potential of qualitative factors, innovative ideas, and industry-specific solutions that do not fit into predetermined models.

- Limited Technological Adoption: Depending solely on technologies developed and tested in the mining industry might restrict the quarrying industry from benefiting from tailor-made solutions that could enhance efficiency and sustainability.

It seems that in 2035, the quarrying industry in New Zealand is still heavily influenced by traditional and conservative leadership, often characterised by a reluctance to adapt to change unless prompted by a crisis. This 'tough boss' culture might prioritise toughness and resilience but could hinder the industry's ability to evolve and innovate in response to changing circumstances.

Key characteristics might include:

- Resistance to Change: The industry's conservative culture may resist change unless there is a pressing crisis, making it challenging to adapt to evolving market conditions or embrace new methodologies proactively.
- Isolationist Approach: A lack of collaboration with related industries might limit opportunities for cross-pollination of ideas, innovations, or best practices, potentially hindering overall progress.
- Traditional Leadership Style: Leadership that embodies a more traditional, authoritarian approach might stifle creativity and openness to new perspectives within the industry.

By 2035, the New Zealand quarrying industry appears to be facing a severe crisis in public perception, regulatory trust, and market dynamics, largely due to perceived exploitative practices and environmental concerns.

Key challenges and consequences:

- Negative Public Perception: Widespread negative public opinion about the industry's practices, perceived as exploitative and environmentally damaging, has led to a loss of trust.
- Regulatory Scrutiny: Increased public demands to limit environmental permits for quarrying are putting pressure on regulatory bodies. Substandard practices have fueled these demands, creating stricter regulations and limitations.
- Market Dynamics: Reducing quarrying product supply due to environmental limitations has increased prices, impacting smaller operators and favouring larger corporate entities.
- Impact on Government Projects: Rising prices and reduced availability of quarrying products have decreased government infrastructure projects, affecting the broader economy.

- Media Reports: Unprecedented negative media reports highlighting malpractices, environmental concerns, safety issues, and community conflicts exacerbate the industry's image problem.

It sounds like the quarrying industry in New Zealand is facing significant challenges that have led to stagnation, a lack of talent attraction, and negative perceptions as a relic from the past.

Key issues contributing to this situation:

- Stagnating Demand: The industry's reliance on old products and rising costs has reduced demand, impacting the need for a larger workforce.
- Outdated Image: The industry is perceived as an older, outdated sector, which could deter younger, skilled talent from considering it a viable career option.
- Talent Attrition: The inability to attract and retain talent is compounded by a toxic industry culture and the perception of a stagnant nature, leading to rapid employee turnover.

The rise in quarry acquisitions, leading to larger entities dominating the industry, can create challenges, especially if it results in a monopoly-like situation.

Key concerns in such a scenario:

- Lack of Competition: Monopolistic conditions can stifle competition, limiting incentives for innovation, quality improvement, and price competitiveness.
- Consumer Impact: High costs for consumers due to lack of competitive pricing and potentially lower quality products resulting from reduced market pressure to improve.
- Ethical Concerns: A lack of competition might lead to complacency and unethical behaviours such as corner-cutting in product quality or neglecting environmental and social responsibilities.

The quarrying industry in New Zealand seems to be in a dire situation, with numerous pressing issues impacting its viability and ethical standing.

- Decreased Productivity and Profit Decline: The lack of investment in modernisation and technology has led to decreased productivity, impacting profitability. Reliance on

outdated practices and technology has made quarries uncompetitive.

- Fractured Industry and Declining Quarries: Many quarries struggle to survive, leading to industry fragmentation as quarries restructure due to declining profits and economic viability.
- Ethical Concerns and Workplace Accidents: Unethical practices persist alongside increased workplace accidents and fatalities. Poor workplace health and safety practices contribute to this concerning trend, negatively impacting workers' well-being.
- Circular Economy and Recycling: There is a positive shift toward embracing recycling and the circular economy, showcasing a potential avenue for sustainability and ethical practices within the industry.

The industry and the communities affected face significant challenges due to the lack of investment in mitigating the cumulative impacts of quarrying operations and the absence of commitment to effective site closure and remediation techniques.

Key concerns arising from this situation include:

- Environmental Impact: Cumulative impacts from ongoing quarrying operations can have lasting and detrimental environmental effects, including land degradation, habitat destruction, and water pollution.
- Community Well-being: Failure to commit to effective site closure and remediation denies communities the opportunity to reclaim and repurpose valuable land, impacting their well-being and potential economic development.
- Long-term Sustainability: Neglecting investment in mitigating impacts and rehabilitating sites undermines the industry's sustainability and social responsibility, potentially leading to further environmental degradation and community disengagement.

The leadership within the New Zealand quarrying industry seems to be facing severe challenges, leading to a reactive approach that is struggling to address industry troubles and reputational deterioration.

Key issues with the current leadership and industry dynamics:

- Reactive Leadership: Involuntary administration leaders cannot respond effectively to the

industry's challenges. Decisions are inconsistent, defensive, and reactive, reflecting a lack of coherent long-term strategy.

- Lack of Future-Oriented Vision: The departure of experienced, future-oriented leaders further exacerbates the problem. The industry is losing individuals who could steer it towards proactive and progressive strategies.

Monopolistic Shift: The industry is moving away from being an international benchmark towards monopolistic control by a few large corporations, potentially stifling innovation and healthy competition.

3.2. The 2024 'Testing the Water' Quarry in 2030+ Scenario

The 'Testing the Water' scenario highlights an evolving mindset within the New Zealand quarrying industry. There is a recognition of the need to move beyond mere resilience and instead focus on proactive measures to thrive in an ever-changing market landscape.

The quarrying industry in New Zealand is facing some challenges in terms of forward-thinking leadership and long-term strategic planning. While important, the emphasis on day-to-day operations and immediate problem-solving hinders the industry's ability to innovate and invest in future-oriented strategies.

The short-term focus driven by shareholder expectations can restrict the capacity for long-term planning and investment in research and development. This emphasis on adaptation to immediate changes might limit the exploration of new ideas and hinder the implementation of innovative solutions that could drive growth and efficiency in the long run.

Interestingly, while the quarrying industry mixes directive management and participative decision-making, strategic decisions heavily rely on analytical inputs derived from past performance and current operating conditions. This approach is valuable for understanding trends and patterns but might limit the ability to anticipate disruptive or transformative shifts in the industry.

The belief that the future will follow a linear path without significant changes is a potential risk. Industries across the globe are experiencing rapid technological advancements, environmental concerns, and changing consumer demands, which could reshape the quarrying landscape. Dismissing the potential for dramatic change will hinder the industry's preparedness for evolving challenges and opportunities.

It is promising to note that despite the traditional values guiding organisational change and the emphasis on preserving leadership positions, there is evidence of a shift towards more proactive leadership within the quarrying industry in New Zealand. Acknowledging that leaders are becoming more open to experimentation, risk-taking, and innovation is a positive sign. Encouraging innovation among employees and fostering a culture that supports experimentation can lead to new ideas and approaches that drive progress within the industry.

While large-scale change might still be a gradual process due to the influence of traditional values, the shift towards a more proactive stance suggests a willingness to adapt and evolve. This gradual but noticeable change in leadership attitudes could signify a growing recognition of the need to embrace new strategies and approaches to stay competitive and resilient in an evolving industry landscape.

The quarrying industry in New Zealand is facing significant challenges related to its image, particularly concerning environmental and social impacts. The industry's practices remaining largely unchanged for two decades might contribute to negative perceptions and ongoing environmental concerns.

The "testing the water" approach, driven primarily by supply and demand, might not align with society's evolving expectations, especially regarding environmental sustainability and social responsibility. The industry's perceived impact on the environment could affect its reputation and relationship with the public and government.

The slow pace of technological development and limited investment in research and development within the New Zealand quarrying industry could hinder progress and innovation in areas such as recycling, reuse, substitution, and automation.

The quarrying industry in New Zealand seems to be facing multiple challenges related to talent retention, development, and diversity. These challenges contribute to a stagnant culture and difficulty attracting new talent. Addressing these issues is crucial for the industry's growth and sustainability.

The stable national economic performance might create a sense of sustainability within the quarrying industry in New Zealand. However, the absence of future-oriented strategic planning poses risks and limits the industry's potential for growth and resilience.

Consistent infrastructure spending offers stability, but industry leaders must recognise the importance of future-oriented thinking and strategic planning. Failing to invest in innovation, talent development, and improving the industry's public image misses the opportunity to capitalise on emerging opportunities and mitigate risks posed by discontinuous changes in the operating environment.

By incorporating future-oriented thinking into strategic planning, the quarrying industry can position itself to sustain its current performance and thrive in an ever-evolving economic landscape. Recognising the importance of long-term vision and proactive measures to unlock the industry's full potential is essential.

It is concerning to hear about the challenges faced by the New Zealand quarrying industry regarding regulatory issues, health and safety records, and the perception of unethical practices. This negative perception and lack of trust can significantly impact the industry's operations and stakeholder relationships.

The trend of small quarrying operators facing challenges and being acquired by larger corporate entities can have positive and limiting effects on industry progress.

Positive aspects of "Testing the Water" for the Quarrying Industry:
- Efficiency and Scale: Large corporate operators often bring economies of scale, better resources, and operational efficiencies that can enhance industry productivity.
- Investment Capability: Larger operators might have more resources to invest in innovation, research, and development, potentially driving technological advancements within the industry.
- Stability and Compliance: can often ensure regulation compliance, implement robust health and safety standards, and maintain stable operations.

Limitations of "Testing the Water" for the Quarrying Industry:
- Innovation and Agility: Sometimes, larger entities might not be as agile or innovative as smaller operators. This can limit the industry's potential for rapid adaptation to market changes and technological advancements.
- Market Control: Concentration of power within a few large entities might limit competition and innovation, potentially restricting industry progress.

3.3. The 2024 Fit for Future Quarry in 2030+ Scenario

This scenario paints an inspiring picture of the New Zealand quarrying industry in 2035. The emergence of future-oriented, progressive leaders indicates a shift towards innovation, adaptability, and sustainable growth.

Key highlights from this narrative:

- Forward-Thinking Leadership: Leaders are forward-looking, recognising the potential to shape the industry's future and are open to exploring diverse opportunities.
- Talent Attraction and Development: Prioritizing attracting top talent and creating environments encouraging ongoing strategic conversations fosters innovation and industry growth.
- Balanced Time Orientation: Leaders balance learning from the past, effectively managing current operations, and envisioning and shaping the future.
- Framing the Future: Embracing a framing style for the future involves testing new solutions and innovations, indicating a proactive approach to industry challenges.
- Long-Term Vision and Investments: Leaders understand the importance of investing in longer-term benefits, even if it means sacrificing short-term profits. This managed and informed approach ensures sustainability and growth.

This scenario portrays a promising future where industry leaders prioritise innovation, talent, and long-term sustainability. It sets a tone for an industry that's proactive, adaptable, and ready to embrace opportunities for positive change and growth.

The fit for future leaders in this scenario embodies adaptability while emphasising sustainability and innovation significantly. Here is a breakdown of their key traits:

- Expanded Future Orientation: They believe in shaping the future through present actions, showcasing a proactive and visionary mindset.
- Influence and Stakeholder Management: They can effectively manage stakeholder expectations, balancing accountability, financial performance, and corporate responsibility.

- Illustrating Long-Term Benefits: These leaders advocate for informed risk-taking, particularly in increased investment in research and development. They can demonstrate how such investments yield greater returns in the long run, emphasising the importance of strategic vision over short-term gains.
- Prioritising Sustainability and Innovation: Their priorities align with sustainability initiatives and fostering innovation within the industry, acknowledging the significance of these factors in long-term success.

This fit for future leader signifies a forward-thinking approach, emphasising the importance of strategic decision-making that considers both immediate needs and long-term sustainability. Their ability to navigate stakeholder expectations, promote innovation, and prioritise sustainability positions them as catalysts for positive change within the quarrying industry.

The fit for future leader embodies strategic acumen and a collaborative approach, fostering innovation and industry-wide collaboration:

- Dynamic Strategic Intent: They actively engage in strategic thinking, encouraging a dynamic and forward-looking approach that involves employees at all levels. This inclusivity promotes diverse perspectives and innovative ideas.
- Balanced Decision-Making: Their strategic decisions are based on analytical data and incorporate conceptualisation of new approaches and opportunities. This balance between data-driven insights and visionary thinking fuels innovation.
- Reconceiving the Industry Narrative: They can reshape the industry narrative, envisioning a new trajectory for the New Zealand quarrying sector. This reflects a forward-thinking mindset aimed at driving positive change.
- Collaboration and Partnerships: They actively collaborate with industry partners and competitors, recognising the value of collective efforts in driving innovation, setting industry standards, and fostering growth.

By engaging in strategic thinking, fostering a culture of participation and innovation, leveraging both data-driven analysis and visionary ideas, and collaborating across the industry, this fit for future leaders plays a pivotal role in redefining the future of the quarrying sector in New Zealand. Their approach prioritises

adaptability, innovation, and collective progress, setting a new standard for industry leadership.

The fit for future approach embodies a holistic focus on sustainability, collaboration, and efficient resource utilisation. Here are the key aspects:

- Sustainable Development: There is a deliberate effort to balance business interests with environmental considerations, prioritising sustainable outcomes. Corporate planning aligns commercial objectives with sustainability goals, demonstrating a commitment to long-term viability.
- Collaborative Landscape Approaches: Governments, communities, and quarries collaborate on landscape approaches to land management. This inclusive strategy ensures that various stakeholders work together to manage land resources effectively.
- Artificial Intelligence and Resource Efficiency: Integrating Artificial Intelligence (AI) aids in efficiently allocating resources. This technology helps optimise resource use while conserving critical resources and enhancing efficiency in quarry operations.
- Data Utilisation and Industry Integration: Vast data are utilised, fostering robust integration among related industries. This collaboration allows for more efficient resource utilisation, benefiting the quarrying industry and its interconnected sectors.
- Circular Economy Realization: Embracing the circular economy approach demonstrates the industry's commitment to sustainability. Most quarrying products are now part of a circular economy, minimising waste and maximising material reuse and recycling.

The fit for future approach represents a significant shift toward sustainability, efficient resource management, and collaborative practices. This forward-thinking approach benefits the quarrying industry, contributes to broader environmental conservation, and promotes a circular economy within New Zealand's industrial landscape.

The scenario described portrays immense progress and global leadership within the New Zealand quarrying industry:

- Collaboration with Non-Traditional Suppliers: Larger quarries have embraced partnerships with non-traditional suppliers and their innovative technologies. This collaboration has enabled a comprehensive 'Whole of Life Quarrying' approach,

considering every aspect from extraction to site closure.

- Global Recognition for Innovation: The industry's innovations have gained global endorsement and recognition. These practices have influenced not just the quarrying sector but have also sparked a transformation in sustainability practices across various industries worldwide.

- World-leading Quarry Closure Management: The New Zealand Quarrying Industry has set a global benchmark in quarry closure management. Beyond mere remediation, the focus is on regeneration, ensuring that closed sites contribute positively to ecological services, biodiversity, water quality, and land management.

- Increased Ecological Services and Biodiversity: Quarries contribute significantly to ecological services through innovative practices and holistic approaches to closure management. These closed sites foster increased biodiversity, improve water quality, and implement better land management systems.

This scenario highlights the quarrying industry's transformative potential when it actively engages in innovation, collaboration, and sustainability. By setting global standards in closure management and ecological restoration, the industry becomes a beacon of responsible resource extraction and land stewardship, positively impacting the environment and industries worldwide.

This scenario paints a picture of a transformed workforce within the fit for future industry, showcasing a shift in values, talent development, and inclusivity:

- Job Creation and Automation: While traditional quarrying roles have been automated, the industry has created new roles focused on managing automated practices, emphasising the need for specialised skills in this evolving landscape.

- Values-Driven Workforce: Employees within fit for the future seek employers who prioritise authenticity, ethics, and social awareness. This aligns with a growing trend of workers prioritising working for socially responsible and ethical businesses.

- Emphasis on Soft Skills: Employers value creativity, empathy, adaptability, and technical skills. This shift reflects the recognition of the importance of holistic skill sets in a dynamic industry.

- Talent Development Programs: Industry-wide talent development initiatives actively

enhance professional development, resulting in measurable improvements in workforce capabilities. These programs contribute to skill enhancement and adaptability.

- Secure Career Paths: Workers seek job security and attractive and respected career paths. This shift in mindset acknowledges the importance of stability and growth opportunities in career choices.
- Gender Diversity and Retention: The industry actively recruits and promotes female talent, reducing gender imbalances and enhancing diversity in leadership. Reduced staff turnover contributes to greater knowledge and skill retention, driving the industry towards new growth areas.

This scenario illustrates a shift in workforce dynamics, focusing on holistic development, inclusivity, and a values-based approach. The fit for future industry's emphasis on talent development, diversity, and retention positions it as an attractive, innovative, and forward-thinking sector, driving both technological advancement and social progress within the industry.

The integration of human and machine intelligence is a hallmark of the fit for future approach, where both technology and human expertise complement each other:

- Integration of Human and Machine Intelligence: In fit for future, the ability to orchestrate human and machine intelligence allows for harnessing the strengths of both. This synergy maximises efficiency and innovation, leveraging the unique capabilities of people and technology.
- Reskilling Programs for AI: Recognising the importance of artificial intelligence, reskilling programs have been introduced to train workers in AI. This initiative ensures the workforce has the necessary skills to leverage AI technologies effectively.
- Professional Certification: The industry's embrace of professional certification for quarry managers and supervisors signifies a commitment to setting industry standards and ensuring that leaders have the required qualifications and competencies.

These initiatives in fit for future not only foster a collaborative environment between humans and machines but also emphasise the importance of ongoing education and professional development to keep up with technological advancements and industry standards.

The emphasis on community trust and transparency within the quarrying industry reflects a proactive approach towards addressing community concerns:

- Community-Centric Approach: Recognising the paramount importance of community trust, the industry highly values transparency. This involves openly communicating and sharing information about quarrying operations' environmental and social impacts with the community.

- Investment in Community Perception: Significant investments have shaped the community's perception of quarrying. This proactive approach aims to educate and engage with the community, reducing costs associated with managing community concerns and impacts.

- Increased Community Participation: The industry's efforts have increased participation from First New Zealanders concerning land management. This signifies a more inclusive approach, where communities have a voice in managing land, fostering collaboration and understanding.

By prioritising transparency, investing in community perception, and encouraging community participation, the industry is taking positive steps toward building trust and fostering better relationships with local communities. This collaborative approach helps address concerns, minimise impacts, and promote a more inclusive and mutually beneficial relationship between the quarrying industry and its communities.

The emphasis on workplace health and safety within the context of sustainable environmental practices and community trust is a significant step forward for the quarrying industry:

- Investment in Advanced Health and Safety Initiatives: Recognising the interconnectedness of sustainable practices, public participation, and trust-building, the industry prioritises further development of advanced workplace health and safety initiatives. This reflects a commitment to fostering a safe working environment for employees.

- Recognized Safety Record: Regulators officially acknowledge the absence of significant quarrying-related deaths and accidents, receiving a commendation. This recognition signifies the industry's dedication to implementing robust safety measures and achieving

high safety standards.

This recognition by regulators validates the industry's commitment to workplace safety and demonstrates the success of the initiatives implemented. It showcases the industry's ability to prioritise employee well-being while aligning with sustainable environmental practices and building trust within the community.

The integration of automated government monitoring in the quarrying industry serves as a tool for enhancing transparency and empowering community groups:

- Enhanced Transparency: Automated government monitoring offers comprehensive information to community groups, fostering transparency about industry practices. This helps address public concerns and encourages informed decision-making.

- Ethical and Sustainable Quarry Products: The industry meaningfully collaborates to meet public demand for ethically sourced and environmentally beneficial quarry products. This effort aligns production practices with ethical and sustainable standards, catering to public expectations.

- Innovation for Resource Efficiency and Waste Reduction: The industry's innovation efforts primarily focus on resource efficiency, extending product lifetimes, and reducing waste. This highlights a commitment to sustainability by prioritising eco-friendly practices and waste reduction initiatives.

The industry's dedication to meeting public expectations, collaborating for ethical and sustainable practices, and channelling innovation toward resource efficiency and waste reduction underscores a responsible approach. This aligns with societal demands for environmentally conscious practices and demonstrates the industry's commitment to positive social and environmental impacts.

The issue of quarrying at new sites continues to be a point of sensitivity, drawing continuous scrutiny from government bodies and environmental organisations:

- Technological Advancements in Exploration: New technologies enable more precise exploration methods, offering improved accuracy in site assessment before quarrying commences. This aids in mitigating potential environmental impacts and addressing concerns raised by government and environmental groups.

- Quarrying in Remote Areas: Some quarries are established in remote locations due to the cost efficiencies associated with automation and innovative transport solutions. These remote sites offer logistical advantages and cost savings while potentially minimising direct impact on populated or sensitive areas.

Despite technological advancements aiding in precise exploration and the cost efficiencies of remote quarries, the industry continues to face scrutiny and oversight from regulatory bodies and environmental organisations. The goal remains to balance the need for resources with responsible environmental stewardship and community considerations.

The global focus on accelerating the energy transition has brought significant advancements to the quarrying industry:

- Decentralised Alternative Energy Sources: The availability of affordable decentralised alternative energy sources, coupled with highly efficient battery technology, enables quarries to generate power. This transition reduces reliance on traditional energy sources and fosters sustainability.
- Shift to Electric Vehicles and Machinery: Quarries have embraced the adoption of electric vehicles and machinery, leveraging advancements in clean energy technology. This shift reduces carbon emissions and environmental impact, aligning with global sustainability goals.

The quarrying industry's move towards self-generated power using decentralised renewable energy sources and the transition to electric vehicles and machinery represents a significant stride towards sustainability and reducing the industry's carbon footprint. This aligns with the global effort to transition towards cleaner, more sustainable energy solutions.

Fit for future leaders demonstrate strategic foresight and resilience by actively engaging in long-term planning and adaptability:

- Medium to Long-Term Outlook: These leaders prioritise a future-oriented approach, developing plans that extend beyond short-term goals. This ensures preparedness for potential challenges and opportunities on the horizon.

- Tolerance for Ambiguity: Their ability to navigate uncertain situations reflects a high tolerance for ambiguity. This trait allows them to remain adaptable and agile in changing environments.
- Contingency Planning: SMART leaders recognise the possibility of negative events and proactively develop contingency plans. This proactive approach minimises risks and prepares the industry for unexpected scenarios.
- Generation of Alternative Ideas: They actively encourage the generation of alternative ideas and trajectories, fostering a culture of innovation and adaptability. This openness to exploring new paths allows for flexibility and agility in decision-making.

The fit for future leaders' approach involves strategic planning, adaptability, and a readiness to embrace uncertainty. This mindset positions them to navigate changing landscapes and drive the industry towards sustainable growth and innovation.

4. Recommendations

In the kaleidoscope of today's dynamic business landscape, the success of the New Zealand quarrying industry is not just contingent upon responding to change; it is about leading change. Welcome to future-focused organisations, where visionary leadership, diversity and empowerment, cutting-edge technology, and rebuilding trust converge to shape a narrative of innovation, resilience, and sustainable growth. The following recommendations will support the New Zealand quarrying industry in moving from its current state to an industry that is fit for the future.

4.1.   Future-Focused Leadership

As we stand on the brink of an era of uncertainty and rapid transformation, the quarrying industry requires future-focused leaders to guide it from its current state to a fit-for-the-future state. While developing or employing future-focused leaders is essential, the industry requires acceptance of the future and strategic thinking leadership to thrive in a rapidly evolving world. By accepting and embracing future-focused leadership, organisations and the quarrying industry can experience transformative shifts that prepare them to navigate the uncertainties of the future with confidence and resilience.

Future and strategic thinking leadership require a commitment to continuous learning and a willingness to challenge conventional wisdom. The emphasis on cultivating a growth mindset, fostering collaboration, and leveraging technology underscores the dynamic nature of leadership in the 21st century. Leaders who actively engage in scenario planning, anticipate trends, and adapt to emerging opportunities are better positioned to steer their organisations through the complexities of an ever-changing landscape. By embracing these principles, leaders can inspire their teams, foster a culture of innovation, and drive the industry forward.

The recommendations outlined below serve as a compass, guiding leaders toward a mindset that transcends immediate challenges and positions them to navigate uncertainties with agility and foresight. By embracing these principles, leaders future-proof their organisations and contribute to a landscape where change is not a threat but an opportunity for growth and advancement.

Recommendations:

- Implement scenario planning and strategic foresight methodologies to prepare for future possibilities and build a growth mindset.
- Developing a long-term vision and strategic roadmap is crucial for leaders to balance short-term performance with long-term objectives. This approach ensures immediate goals are aligned with the overarching mission, fostering a culture of strategic planning and foresight.
- Invest in innovation, research, and development to foster a culture of continuous learning, continuous improvement and adaptability.
- Leadership development programs are key in preparing leaders for change management and fostering a forward-thinking, adaptable, and collaborative culture. Organisations can ensure that their leaders can navigate uncertainties and drive innovation by investing in such programs.

4.2. Diversity, Empowerment, and Inclusion

Future-focused organisations recognise that innovation thrives in diverse environments and prioritise inclusivity and empowerment. These organisations unlock a wellspring of creativity and problem-solving by fostering a culture that values diverse perspectives, experiences, and talents. Pursuing diversity, empowerment, and inclusion is not merely an ethical imperative but a strategic necessity. It is these principles that propel leaders and organisations toward innovation, resilience, and sustained success.

The recommendations outlined below provide a roadmap for New Zealand quarrying industry leaders and organisations committed to fostering a workplace culture that embraces differences, empowers individuals, and ensures inclusivity. As leaders, your role in prioritising diversity in hiring practices, promoting equal opportunities, and cultivating an inclusive environment is crucial. By doing so, you can unlock the full potential of your teams and position your organisations as champions of progress.

Diversity, empowerment, and inclusion are not standalone initiatives but integral components of a thriving organisational culture. The call for leadership commitment, cultural awareness, and continuous education underscores the dynamic nature of this journey. Leaders who actively engage in emotional intelligence practices, open dialogue, challenge biases, and champion diversity in all its forms lay the foundation for a

workplace that attracts top talent, sparks creativity, and ultimately drives success.

Organisations that embed diversity, empowerment, and inclusion into their DNA will create a workplace where every voice is heard and establish a competitive advantage in a diverse marketplace. As we look to the future, the journey toward diversity, empowerment, and inclusion is both a moral imperative and a strategic investment. Through these recommendations, leaders can shape a workplace culture that celebrates differences, values everyone, and cultivates an environment where innovation and success flourish. In doing so, organisations contribute to the well-being of their teams and a more equitable and progressive society at large.

Recommendations:

- Transform industry culture to create a more inclusive and empowering environment to attract diverse talent through initiatives promoting innovation, sustainability, and a commitment to diversity.
- Implement comprehensive professional development programs, including mentorship, apprenticeships, and partnerships with educational institutions.
- Develop and promote leadership qualifications and coaching programs that emphasise emotional intelligence and inclusive leadership. These programs should provide leaders with the knowledge and skills to actively address resistance to change.
- Create policies and initiatives that encourage diversity, gender balance, and equal opportunities within the workforce.

4.3. Embracing Emerging Technologies

The future belongs to those who embrace technological advancements as catalysts for progress. Future-focused organisations actively seek out and integrate emerging technologies, from artificial intelligence to blockchain, into their operations. Adopting emerging technologies is not merely a choice but a strategic imperative for New Zealand quarrying industry leaders and their organisations seeking to thrive in the dynamic landscape of the future. The recommendations outlined below provide a roadmap for leaders and decision-makers, offering insights into how they can navigate the complexities of adopting and integrating emerging technologies. Organisations can position themselves as pioneers in their respective industries by prioritising a forward-thinking mindset, fostering a culture of innovation, and investing in developing digital

capabilities.

Embracing emerging technologies is challenging, but the potential benefits outweigh the risks. Leaders who champion agility, collaboration, and continuous learning will be well-equipped to harness the transformative power of technologies like artificial intelligence, blockchain, and the Internet of Things. As organisations evolve into digital enterprises, they can enhance customer experiences, drive operational efficiency, and gain a competitive edge.

Moreover, ethical considerations surrounding adopting emerging technologies should remain at the forefront of decision-making processes. Leaders must prioritise responsible and sustainable practices, ensuring that technology's benefits are shared equitably and that potential risks, such as data privacy and bias, are diligently addressed.

In this era of unprecedented technological innovation, organisations that proactively embrace emerging technologies will survive and thrive. By staying attuned to market trends, fostering a culture of adaptability, and investing in the development of their workforce, leaders can chart a course towards a future where emerging technologies are not just tools but integral components of a strategic vision for success. As we stand on the cusp of a new era, the ability to embrace, adapt, and lead in the realm of emerging technologies will undoubtedly define the organisations that shape the future.

Recommendations:
- Prioritise digital transformation initiatives, particularly the adoption of artificial intelligence for decision-making and operational efficiency, through raising awareness of the benefits and emphasising long-term benefits over short-term costs. Ethical considerations for adopting emerging technologies should remain at the forefront of the decision-making process.
- Establish collaborative research efforts among industry players, research institutions, and government bodies (including advocating for government funding and incentives) to address common challenges.
- Implement pilot projects to test and showcase the effectiveness of new technologies in real-world scenarios.
- Develop knowledge-sharing platforms to disseminate information on successful

technologies and encourage wider adoption.

4.4. Rebuilding Trust

The global landscape has undergone seismic shifts, challenging the trust between organisations and their stakeholders. Future-focused organisations recognise that rebuilding trust is not only an ethical imperative but also a strategic necessity. Rebuilding trust is a profound journey that demands intentional efforts, transparency, and a commitment to ethical leadership. The recommendations provided offer a guide for New Zealand quarrying industry leaders and organisations seeking to mend and strengthen the bonds of trust. By prioritising honesty, fostering open communication, and demonstrating a genuine commitment to accountability, leaders can initiate a transformative process that rebuilds trust and establishes a foundation for sustained positive relationships.

Once broken, trust requires deliberate actions and consistent behaviours to be rebuilt. Acknowledging past mistakes, learning from them, and implementing meaningful changes cannot be overstated. Through active listening and empathy, leaders can connect with stakeholders on a human level, demonstrating an understanding of their concerns and a genuine desire to address them.

Furthermore, integrating technology and data in trust-building processes should consider privacy, security, and ethical implications carefully. Leaders must harness the power of technology responsibly, leveraging it as a tool to enhance transparency and communication rather than as a potential source of distrust.

Sustainability in trust-building efforts is paramount. The recommendations emphasise the need for ongoing evaluation, adaptation, and learning. Trust is not a one-time achievement but an ongoing process that requires continuous attention and nurturing.

Ultimately, leaders and organisations prioritising rebuilding trust will find themselves not only regaining the confidence of their stakeholders but also fostering a resilient and positive organisational culture. As we navigate the complexities of an ever-changing world, the commitment to rebuilding trust becomes a strategic initiative and a cornerstone for ethical leadership and enduring success. Through these recommendations, leaders can embark on a transformative journey toward rebuilding trust and creating a future where integrity, transparency, and authenticity are the bedrock of organisational relationships.

Recommendations:

- Prioritise environmental responsibility by investing in sustainable practices, environmentally friendly technologies, and responsible quarrying methods.
- Establish transparent communication channels with the public, government agencies, and local communities to address concerns and share progress.
- Invest in improved health and safety protocols, training programs, and technological advancements that enhance worker safety.
- Implement collaborative industry-wide initiatives for best practice, a code of conduct and ethics, and potentially self-regulation that set standards exceeding regulatory requirements. Develop and promote training programmes that support these standards.

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6. Appendix A: Delphi Study Information and Findings

The Delphi method seeks to synthesise contributions from a panel of experts to address a clearly stated problem. Panel members respond to semi-structured questions, in this case, via email. The primary researcher collates and distils responses by processing the information and filtering out irrelevant content. This avoids the adverse effects of face-to-face panel discussions and solves the usual problems of group dynamics. It also protects the identity of participants.

Regular feedback is provided. Participants comment on their perspectives and the responses of others. At any moment, they can revise their earlier statements. While in regular group meetings, participants tend to stick to previously stated opinions and often conform too much to the group leader, the Delphi method prevents this.

Usually, all participants remain anonymous. Their identity is not revealed, even after completing the final report. This prevents some participants' authority, personality, or reputation from dominating others in the process. Arguably, it also frees participants (to some extent) from their personal biases, minimises the "bandwagon effect" or "halo effect", allows free expression of opinions, encourages open critique, and facilitates admission of errors when revising earlier judgments.

The Delphi method has also been used to implement multi-stakeholder approaches to participative decision-making and strategy development. As a result, the widely acknowledged value of collective intelligence is recognised, especially in an environment of rapid change.
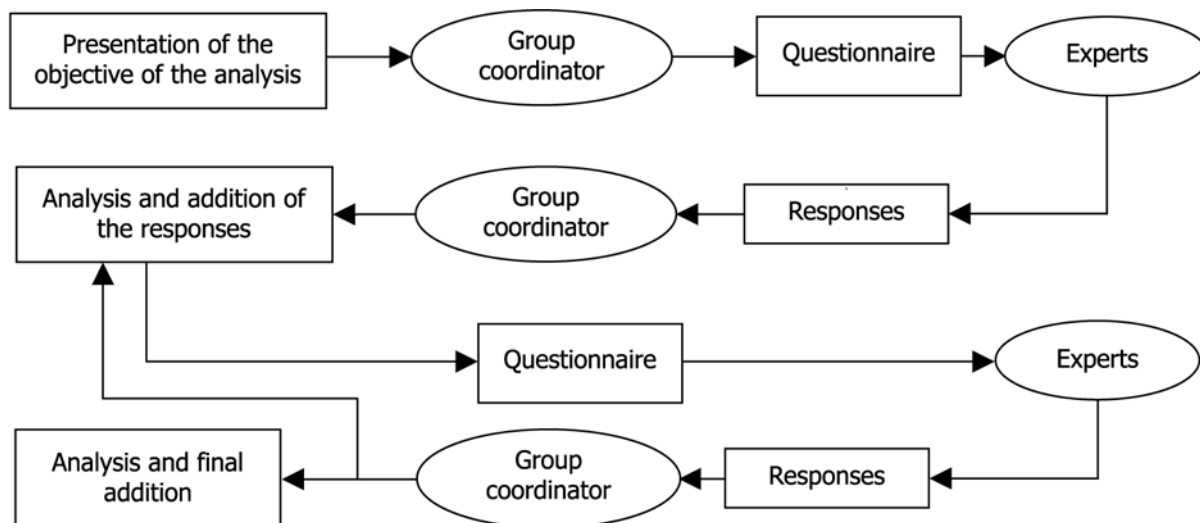
Source: Adapted from Landeta (1999)

Round 1 and 2 Findings

What is going to achieve FIT-FOR-FUTURE QUARRYING?

In Round 1, the industry experts were asked: What is going to achieve FIT-FOR-FUTURE QUARRYING?

Only the top five (5) responses from the industry experts were calculated. Among the industry experts there was consensus that *people, leadership, and the culture of the industry* were most important in achieving FIT-FOR-FUTURE QUARRYING. These were followed by an average to high consensus that *long-term strategy and innovation* would drive FIT-FOR-FUTURE QUARRYING.

Two industry expert responses did not reach consensus with the rest of the industry experts. The dissenting view was that *leadership* and *long-term strategy* were most critical, with *people* rated in the last quartile of importance.

In Round 2, the industry experts were asked to rank these keywords from highest (1) to lowest (5) to define FIT-FOR-FUTURE QUARRYING in the Institute of Quarrying New Zealand context. The results are in the table below.

Round 2 results:

Round 2 Industry Experts Rankings	Keywords defining FIT-FOR-FUTURE QUARRYING
1	People
2	Long-term strategy
3	Leadership
4	Innovation
5	Culture

In Round 1, there was generally strong agreement on the keywords associated with describing FIT-FOR-

FUTURE QUARRYING. These were assimilated into the descriptions below.

Industry experts described FIT-FOR-FUTURE QUARRYING as primarily being future- and people-orientated to develop a sustainable industry for the future while maintaining good stewardship of natural resources. It was noted that collaboration with customers and other stakeholders would develop new values previously untapped by the industry. How this is to be achieved was described as primarily being strategically ambidextrous (short-term, strategic exploitation; long-term strategic exploration), highly innovative and focused on developing and retaining talent that, over time, transforms the industry culture and perceptions of the industry. It was noted as important to exceed customer expectations and embrace change.

In Round 2, the industry experts were asked to indicate any words that should be removed or added. Given the feedback from Round 2, the description now reads:

Industry experts described FIT-FOR-FUTURE QUARRYING as primarily being future- and people-orientated to lead a sustainable industry for the future while maintaining good stewardship of natural resources. It was noted that collaboration with customers and other stakeholders would develop new values previously untapped by the industry. How this is to be achieved was described as primarily being strategically focused, ambidextrous (short-term, strategic exploitation; long-term strategic exploration), highly innovative and focused on developing and retaining talent that transforms the industry culture and perceptions of the industry over time. It was noted as important to exceed customer expectations, embrace change, and explore the 'bench strength' for succession planning.

Referring to the description above, several responses indicated how FIT-FOR-FUTURE QUARRYING can be achieved.

In Round 2, the industry experts were asked to rank the identified ways to achieve FIT-FOR-FUTURE QUARRYING.

Round 2 results:

Ways in which FIT-FOR-FUTURE QUARRYING can be achieved	Description	Round 2 Industry Experts Rankings

Capabilities	On the job learning	1
Leadership	VET or Higher Education, professional development courses	2
Strategy	Skills that meet tasks	3
Talent recruitment and retention	Future-orientated capacity leading to innovation and sustainability	4
Competencies	Conferences, workshops	5
Formal learning	e.g., leadership development and leader collaboration.	6
Informal learning	Purposeful people-orientated activities to increase industry talent	7
Innovation	New or repurposed ideas that increase value	8
Non-formal learning	Ability to purposefully exploit short-term opportunities and map long-term direction	9

In Round 1, the industry experts were asked: What factors do you consider to increase the likelihood of FIT-FOR-FUTURE QUARRYING success (ENABLERS)?

Members of the industry experts suggested that in addition to rapid change in the operational environment, (a) reducing margins, (b) decreasing talent availability, (c) negative perception of the industry in the community and (d) increased pressure to adopt new/advanced technologies all contribute to the need for the FIT-FOR-FUTURE QUARRYING initiative.

In Round 1, the industry experts were asked to identify additional factors that would increase the likelihood of FIT-FOR-FUTURE QUARRYING's success. In response, the industry experts listed the following additional factors that would increase the likelihood of the initiative's success (ENABLERS).

The additional enablers identified by the industry experts were:

- Innovation – incremental and radical industry ideas
- Institute of Quarrying New Zealand leadership – not only now but futures-orientated
- Enhanced career profile – communication of talent expertise and best practice
- Whole of life quarrying
- Functional experts – industry-developed expertise
- Consistent education – refined educational pathways
- Global connectivity – engaged connectivity in the digital environment
- Collaboration – co-creation of value
- Improved Health and Safety statistics

In Round 2, the industry experts were asked to add to the list of enablers if they disagreed with any of the above additional enablers.

Round 2 results:

90% of the industry experts agreed that *Improved Health and Safety statistics* are not an enabler.

- Additional enablers introduced by the industry experts:
- Whole of industry talent bench strength
- Mentoring programs for leaders
- Functional experts
- Adopting externally developed expertise

In Round 1, the industry experts were asked: What factors do you consider to DECREASE the likelihood of FIT-FOR-FUTURE QUARRYING (OBSTACLES)?

Members of the industry experts suggested that in addition to an industry culture resistant to change due to traditional views and short-term profit interests, the pressure of consistent Health and Safety statistics and

rehabilitation reputation will continue to decrease the industry's ability to self-regulate.

In Round 1, the industry experts were asked to identify additional factors that would decrease the likelihood of FIT-FOR-FUTURE QUARRYING. In response, the industry experts listed the following additional factors that would decrease the likelihood of the success of the FIT-

FOR-FUTURE QUARRYING initiative (OBSTACLES).

The additional obstacles identified by the industry experts were:

- Economic recession
- Government over-regulation
- Skills shortage
- Lack of company support
- Gender Inclusivity
- Lack of industry leadership
- Poor in-house talent development

In Round 2, the industry experts were asked if they disagreed with any of the above additional obstacles and to add to the list of obstacles.

Round 2 results:

100% of the industry experts agreed with the obstacles listed above.

- Additional obstacles introduced by the industry experts:
- Lack of support/endorsement from regulators/industry bodies
- International competition
- Government overregulation
- Poor personal and professional development

What approaches contribute to Professional Efficacy?

In Round 1, the industry experts were asked: What approaches contribute to Professional Efficacy?

The six highest-ranked responses were calculated. Industry experts agreed that capabilities, confidence, and

safety were most important in achieving professional efficacy.

One industry expert's response did not reach a consensus with the rest of the industry experts. The dissenting view was that coaching and mentoring were most critical in achieving professional efficacy.

In Round 2 the industry experts were asked to rank from highest (1) to lowest (6) the approaches contributing to professional efficacy.

Round 2 results:

Approaches	Round 2 Industry experts Rankings
Professional Capabilities	1
Mentoring and Coaching	2
Effective and Safe Professionals	3
Insightful and Trusted Professionals	4
Confident and Resilient Professionals	5
Professional Credentialing	6

In Round 1, the industry experts were asked to identify additional factors that would increase the likelihood of achieving professional efficacy.

The additional factors identified by the industry experts were:

- Owner/executive support and investment
- High quality and personalised learning opportunities
- Industry-agreed credentialing standards
- Succession planning
- Rewards

In Round 2, the industry experts were asked if they disagreed with any of the above additional factors and to add to the list of factors.

Round 2 results:

100% of the industry experts agreed with the factors listed above.

Additional factors introduced by the industry experts:

- Industry-wide networking for peer groups
- Improve industry perception of Quarry Management as a whole
- Harmonization of legislation to permit national credentialing
- Identifying the right individuals to successfully deliver the initiative will be more about natural ability and attitude than experience and credentials.
- Management succession planning
- Incentives rather than rewards

In Round 1, the industry experts were asked to identify additional factors that would decrease the likelihood of achieving professional efficacy.

The additional factors identified by the industry experts were:

- Self-paced or online learning
- Low investment in skills
- 'Tick the box' VET qualifications
- Organisational restrictions
- Low work-force trust
- Owners/executives devaluing quarrying professionals
- Diversity of small/large company interests
- Staff turnover
- Corporate greed

In Round 2, the industry experts were asked if they disagreed with any of the above additional factors and to add to the list of factors.

Round 2 results:

90% of the industry experts agreed that *Self-paced or online learning* will not decrease the likelihood of achieving professional efficacy.

Additional factors introduced by the industry experts:

- Budgetary constraints for professional development
- Difficulty aligning credentialing and training with job requirements
- Work/Life balance

Types of education may increase the likelihood of Professional Efficacy

In Round 1, the industry experts were asked: Please rate to what extent you agree or disagree that the following types of education may increase the likelihood of Professional Efficacy.

Types of Education	Round 1 Industry Experts' Results
Formal Education	70% of the industry experts agreed that formal education may increase the likelihood of Professional Efficacy
	20% of the industry experts neither agreed or disagreed that formal education may increase the likelihood of Professional Efficacy
	10% of the industry experts disagreed that formal education may increase the likelihood of Professional Efficacy
Informal Education	50% of the industry experts strongly agreed that informal education may increase the likelihood of Professional Efficacy
	40% of the industry experts agreed that informal education may increase the likelihood of Professional Efficacy
	10% of the industry experts neither agreed or disagreed that informal education may increase the likelihood of Professional Efficacy

What approaches in the future will shape the New Zealand Quarrying Industry?

In Round 1, the industry experts were asked: What approaches in the future will shape the New Zealand Quarrying Industry?

In Round 2, the industry experts were asked to rank the approaches that will shape the New Zealand Quarrying Industry identified in Round 1.

Round 2 results:

Approaches that will shape the New Zealand Quarrying Industry	Round 2 Industry Experts Rankings
New talent/talent	1
Industry responsibility to invest in talent development	2
Community/external perception	3
Foresight	4
Regulations (WH&S and environmental)	5
Whole-of-life quarrying	6
Supply and demand	7
Professional credentialing	8
Automation	9
Technology	10
Economy	11
Mergers and acquisitions	12

Collaboration	13
Multinationals	14

What in the New Zealand Quarrying Industry's present will continue into the future?

In Round 1, the industry experts were asked: What in the New Zealand Quarrying Industry's present will continue into the future?

In Round 2, the industry experts were asked to rank the present elements that will continue into the future identified in Round 1.

Round 2 results:

Present elements that will continue into the future	Round 2 Industry experts Rankings
Legislation and Regulation	1
Incremental innovation	2
Perception of product limitation	3
Consistent demand from engineering and construction	4

What in the past will shape the future or hold back the New Zealand Quarrying Industry?

In Round 1, the industry experts were asked: What in the past will shape the future or hold back the New Zealand Quarrying Industry?

In Round 2, the industry experts were asked to rank the past elements that will shape the future or hold back the New Zealand Quarrying Industry identified in Round 1.

Elements that will shape the future or hold back the New Zealand Quarrying Industry	Round 2 Industry Experts Rankings

Shape: New talent	1
Hold back: Poor Health and Safety standards	2
Hold back: Regulator perceptions	3
Hold back: Owners/managers' resistance to change	4
Hold back: Poor end-of-life closures	5
Shape: Industry profile	6
Shape: Heritage and nostalgia	7

In Round 1, the industry experts were asked to select the elements the New Zealand Quarrying Industry fully controls.

The industry experts regarded the industry as having full control over the following elements:

- Economic (high)
- Technological (high)
- Environmental (high)
- Ethical (high)

In Round 2, the industry experts were asked what dimension of the above elements they feel the industry has **full** control of.

From the Round 2 data, the industry experts listed the following elements that the industry has full control of:

- Ethical
- Environmental

In Round 1, the industry experts were asked to select the elements that the New Zealand Quarrying Industry has **more** control of.

The industry experts regarded the industry as having more control over the following elements:

- Environment and Technology (high)
- Social and Ethical (medium)
- Legal (Low)

In Round 2, the industry experts were asked what dimension of the above elements they feel the industry has **more** control of.

From the Round 2 data, the industry experts listed the following elements that the industry has **more** control over:

- Social
- Technical

In Round 1, the industry experts were asked to select the elements that the New Zealand Quarrying Industry has **less** control of.

The industry experts regarded the industry as having less control over the following elements:

- Legal (high)
- Political (medium)
- Social and Environmental (Low)

In Round 2, the industry experts were asked which dimension of the above they feel the industry has less control over.

From the Round 2 data, the industry experts listed the following elements that the industry has **less** control over:

- Political

In Round 1, the industry experts were asked to select the elements that the New Zealand Quarrying Industry has **no** control of?

The industry experts regarded the industry as having no control over the following elements:

- Political (high)

- Legal (medium)
- Social (Low)

In Round 2, the industry experts were asked which dimension of the above they feel the industry has no control over.

From the Round 2 data, the industry experts listed the following elements that the industry has **no** control over:

- Legal

In Round 1, the industry experts were asked to select the elements that are certain about the future of the New Zealand Quarrying Industry. The industry experts regarded the following elements are certain about the future of the New Zealand Quarrying Industry:

- Technological and Ethical (very high)
- Economic, Social and Environment (high)
- Legal (Low)

In Round 2, the industry experts were asked which dimension of the above elements they feel is certain about the New Zealand Quarrying Industry.

From the Round 2 data, the industry experts listed the following dimensions that are **certain** about the New Zealand Quarrying Industry:

- Economic
- Social
- Environmental
- Ethical

In Round 1, the industry experts were asked to select what elements are **not certain** about the future of the New Zealand Quarrying Industry

The industry experts regarded the following elements are not certain about the future of the New Zealand Quarrying Industry:

- Legal (very high)
- Political (high)
- Economic, Social and Environmental (medium)
- Technological and Ethical (low)

In Round 2, the industry experts were asked what dimension of the above elements they feel are **not certain** about the future of the New Zealand Quarrying Industry.

From the Round 2 data, the industry experts listed the following dimensions that are **not certain** about the New Zealand Quarrying Industry:

- Legal
- Political
- Technological

In Round 1, the industry experts raised the following further considerations related to the professionalisation of the quarrying industry.

- Logistics and distribution to market
- Degree in quarrying/educational pathways
- Government subsidisation at the tertiary level
- Increased strategic and innovative thinking
- Internationally recognised credentialing
- Talent-defining industry profile

In Round 2, the industry experts were asked if there were any further considerations they wished to describe related to the **professionalisation** of the quarrying industry

From Round 2 data, the industry experts listed these further considerations that describe the **professionalisation** of the quarrying industry:

- Collaboration with peers
- Logistics and distribution
- Continuous improvement

- Technical challenges
- Material quality

In Round 1, the industry experts raised the following further considerations related to drivers that will shape the **future** of the quarrying industry.

- Faster rate of change
- Influential industry leaders
- Enhanced talent
- Increased rate of innovation/technology

In Round 2, the industry experts were asked if they had any further considerations concerning the quarrying industry's future.

From Round 2 data, the industry experts listed these further considerations that describe the **future** of the quarrying industry:

- Globalisation
- Competitor products
- Access/proximity to resources
- Finite

In Round 1, the industry experts highlighted the following areas most in need of innovation:

- Visionary leadership to meet future needs and challenges
- Strategy to meet the predicted future of the industry
- Customer interface technologies
- People and attitudes
- New quarry business models
- Early adoption of technology
- Communication technologies
- Gender diversity

In Round 2, the industry experts were asked to list other areas in the industry that **need the most innovation**.

From Round 2 data, the industry experts listed the following other areas in the industry that **need the most**

innovation:

- Performance-based specifications
- Social media
- Value recognition of resources and resources
- Product efficiency
- Process control of materials
- Technical performance control
- Resource supply chain management

Round 3 Findings

Round 3 consisted of three tasks. The findings of these tasks can be found below.

Foresight Capability

The following table lists the dimensions of the Foresight Capability.

The industry experts were asked to categorise each dimension as HIGH, MEDIUM, or LOW to ensure the fit-for-future leaders of the New Zealand Quarrying Industry.

Foresight Capability	Dimensions	e.g., of Quarrying leaders' foresight considerations	Categorise as <u>HIGH, MEDIUM</u> or <u>LOW</u>
	Envisioning possible futures	Markets, product	60% of respondents categorised this dimension as HIGH; 40% of respondents categorised this dimension as MEDIUM.
	Future emerging patterns	Recycled products and rehabilitation	40% of respondents categorised this dimension as HIGH; 60% of respondents categorised this dimension as MEDIUM.
	Anticipate beyond ambiguous and complex systems	Political, social and legislative	20% of respondents categorised this dimension as HIGH; 50% of respondents categorised this dimension as MEDIUM; 30% of respondents categorised this dimension as LOW.
	Detection and avoidance of hazards and risks	Health and Safety, markets, new technologies	80% of respondents categorised this dimension as HIGH; 20% of respondents categorised this dimension as MEDIUM.
	Creative development of images of the future that appeal to human advancement	Talent development, assessment of normative images of the future of the industry.	70% of respondents categorised this dimension as HIGH; 30% of respondents categorised this dimension as MEDIUM.

Definitions of foresight

SOURCE	DEFINITION	APPLICATION
WEBSTER'S	Act or power of foreseeing, prescience, and looking forward with provident care or prudence.	Human cognition
OXFORD	The application of care and attention to the likely outcome of something or future needs.	Human Cognition or Technique
Reid (2004)	Understanding and anticipation of the future.	Human cognition
Raimond, (1996)	Foresight must be predictive and creative ('creative imagination'). Predictive – the ability to identify critical factors in the external environment, how they will behave in the future and how they will affect the organisation along the planned course of action. Creative – not concerned with predicting but what the future ideally could be if we could make it happen. Imagination of ideal futures then seeks ways to make it a reality.	Institutional technique
Slaughter, (2007)	An emergent capacity of the brain-mind system. Boundaries of perception are pushed forward by (1996): Consequence assessment – assessment of implications of present actions Early warnings and guidance – detecting and avoiding problems before they occur Pro-active strategy formulation – considers present implications of possible future events Normative visions – envisioning desired futures	Human cognition
Voros, (2003)	'Foresight opens up an expanded range of perceptions of the strategic options available so that strategy-making is potentially wiser' (p.12)	Technique

Amsteus, (2008)	Degree of analysing present contingencies and degree of moving analysis of present contingencies across time, and degree of analysing a desired future state or degrees or states a degree ahead of time concerning contingencies under control, as well as degree of analysing courses of action a degree ahead in time to arrive at the future state.	Human Cognition or Technique
Hayward, (2005)	The capacity to bring a consideration of the future into the present decision perspective (as opposed to foresight actions) An attribute or competence Important element of a person's foresight competence is their Future Time Perspective (FTP) – cognitive understanding of expectations of the future (p. 5). Detection and avoidance of hazards Assessment of consequences of actions Envisioning desired future states.	Human cognition
Tsoukas, (2004)	The engagement of memory and expectation that enlarges the consciousness of the present – know how is brought forward from the past, and extrapolations to the future are made (2004a, p. 11) Act of looking forward Taking provident care Ability to anticipate beyond seemingly ambiguous and complex systems Understanding ways in which patterns of the future can emerge (2004b)	Human cognitive
Cuhls, (2003)	Enlarge the choice of opportunities and assess impacts and chances.	Technique

Prospect for the impacts of current research

Ascertain new needs, new demands and new possibilities

Focus selectively on the environment/system

Define desirable and undesirable futures

Start and stimulate continuous discussion processes.

Foresight capability is therefore defined as:

A human ability to creatively envision possible futures, understand the complexity and ambiguity of systems and provide input for the taking of provident care in detecting and avoiding hazards while envisioning desired futures.

Strategic Thinking Capacity

The following table lists the dimensions of the Strategic Thinking Capability.

The industry experts were asked to categorise each dimension as either HIGH importance, MEDIUM importance, or LOW importance to ensure the fit-for-future leaders of the New Zealand Quarrying Industry.

	Dimensions	Quarrying Leaders	Categorise as <u>HIGH,</u> <u>MEDIUM</u> or <u>LOW</u>
Strategic Thinking Capability	Systems perspective ambiguous, inter-related, complex, multi-faceted holistic understanding of the system and value creation	Identifying position and interaction with the external environment.	45% of respondents categorised this dimension as HIGH, 45% of respondents categorised this dimension as MEDIUM, and 10% of respondents categorised this dimension as LOW.
	Intent focused directional, competitively unique, dynamic	Clearly defined activity; profit-orientated; sustainability intent.	70% of respondents categorised this dimension

		as HIGH; 30% of respondents categorised this dimension as MEDIUM.
Hypothesis driven; inspires sense of direct and goal orientation	Quarrying industry is foundational to construction	70% of respondents categorised this dimension as HIGH; 20% of respondents categorised this dimension as MEDIUM; 10% of respondents categorised this dimension as LOW.
Thinking in time, oriented in time, connects past, present and future in oscillating cycles	Resource limitation and management	60% of respondents categorised this dimension as HIGH; 40% of respondents categorised this dimension as MEDIUM.
Intelligent opportunism ambiguous, innovative, embraces new ideas	Recycled products; rehabilitation	60% of respondents categorised this dimension as HIGH; 40% of respondents categorised this dimension as MEDIUM.
Formulated judgements of assumptions required to achieve envisaged future position	Licence to operate now and in the future	80% of respondents categorised this dimension as HIGH; 20% of respondents categorised this dimension as MEDIUM.
Generative thinking	Different ways of doing business given environmental, economic and societal changes	55% of respondents categorised this dimension as HIGH; 35% of respondents categorised this dimension as MEDIUM; 10% of respondents categorised this dimension as LOW.

WEBSTER'S	Thinking - higher cognitive function and comprises activities like creative thinking, problem-solving, and decision-making. The analysis of thinking processes is part of cognitive psychology.
Inter-American Development Bank (Personnel Decisions, 2001)	A leadership competency. Going beyond the questions that are routine or required for one's job recognising the broader 'context' of 'the big picture'. Identifying key or underlying issues in complex situations.
Allio, (2006)	The systematic analysis of the organisation and the formulation of its longer-term direction.
Mintzberg, (1994)	A way of thinking that synthesises intuition and creativity whose outcome is an integrated perspective of the enterprise. Strategic thinking is not strategic planning.
Hamel, (2005)	Crafting strategic architecture emphasising creativity, exploration and understanding discontinuities.
Bonn, (2001)	Strategic thinking at an individual level comprises of i) a holistic understanding of the organisation and the environment, ii) creativity and iii) a vision for the future of the organisation.
Liedtka, (1998)	A particular way of thinking that includes five elements i) a systems perspective ii) intent-focused iii) thinking in time. iv) Hypothesis-driven and v) intelligent opportunism
Goldman, (2007)	A distinctive management activity aims to discover novel, imaginative strategies that can rewrite the rules of the competitive game and envision potential futures significantly different to the present, including being conceptual, systems-orientated, directional, and opportunistic.
O'Shannassy, (2005)	A particular way of solving strategic problems and opportunities at the individual and institutional level combining generative and rational thought processes.
Dickson, (2001)	The mental models managers use in the conjectures they make in their planning and strategising.
Tavakoli, 2005)	A cognitive capability. The cognitive process that precedes strategic planning or action whereby an individual contemplates the organisation's future development whilst

considering its attributes, past and present and the external realities within which it operates.

Strategic thinking is therefore defined as:

Strategic thinking is the synthesis of systematic analysis (rational) and creative (generative) thought processes that seek to determine the organisation's longer-term direction.

Appendix B: Scenarios Development

The scenario process is based on the premise that there are already key determinants or components of the future that exist in the present. The scenario method can be used as a methodology for future analysis to access and expose these futures. It is feasible to extrapolate from key future drivers of change and use qualitative and quantitative methods to explore them to reflect wisely and discuss what might occur more informally (Fourie, 2007). While it is argued that innovation should be crucial to the positive development of industry and society generally (Lindgren & Bandhold, 2003), it cannot take place outside of the context of including the identification of discontinuities, trends and the so-called 'wildcard ' (Loveridge, 2009).

Scenarios constitute the conducting of thinking experiments. They include developing narratives based on current empirical indicators that converge to memorably describe alternative images of the future, revealing possible occurrences that would otherwise be unknown. Schwartz (1991) agrees that scenarios do not involve prediction but rather present perceptions of the future and how it may evolve.

Scenarios are a precious methodology that helps organisations prepare for potential events, making them flexible and creative (Hiltunen, 2009). Herman Kahn is one of the founders of future studies and a planning father. He describes scenarios resulting from a series of future hypothetical occurrences built to explain potential changes in causal activities and their decision-making points (Kahn & Wiener, 1967).

Scenarios can describe the future and course of occurrences that enable one to go from the current position in the present to a possible future (Godet, 2000b). Scenarios can also be described as alternative futures arising from discontinuous trends and policies (Fontela & Hingel, 1993). Leaders often use scenario planning methods to articulate their mental models and views of the future to make better decision-making choices (Martelli, 2001).

Developing numerous feasible future options based on scenarios contributes to holistic future planning (Jetter, 2003). Scenarios also reduce uncertainty and the usefulness of the general decision-making method (Van der Heijden, 1996). Planning based on scenarios enables us to prepare for and innovate the future (Martino, 2003). Scenario planning allows stakeholders to ask key questions about the future (Barber, 2009). Scenarios offer an overview of the setting and highlight the relationships between future trends and

occurrences (Joseph, 2000). Furthermore, scenario planning introduces all complicated aspects coherently, systematically, fully and plausibly (Pillkahn, 2008). Scenario planning is also a structured approach that enables the realisation of preferable futures (Saliba, 2009).

In the last decade, scenario planning has increased considerably (Rigby & Bilodeau, 2020). Research suggests a correlation exists between scenario scheduling methods and the general company setting's insecurity, unpredictability, and instability (Malaska et al., 1984). The significance of defining future trends and anticipated industry landscapes has grown increasingly uncertain. Consequently, the use of scenarios has risen because the company climate is more complex and uncertain. Researchers also note a direct link between scenario planning and innovation (Sarpong & Maclean, 2020).

Scenarios do not predict the future, but they explore several plausible future situations to broaden the sphere of thought and scenario development participation (Godet, 2000a). Scenarios differ from predictions because they explore a variety of possible results arising from uncertainty, while predictions aim to identify the most probable pathway and estimate uncertainties (Saliba, 2009). Scenario planning, therefore, does not forecast the most likely future but generates several plausible futures (Wilkinson, 2009).