Industry 4.0

Aotearoa's Industry 4.0 journey

The progress made implementing these transformative technologies and the work still to be done.

→ **www.industry4.govt.nz**

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Introduction

As New Zealand's manufacturing industry embraces the transformative potential of Industry 4.0 technologies, a new era of innovation and growth dawns on the horizon.

Advancements in automation, artificial intelligence, robotics, and data analytics, allow our manufacturers, primary producers, healthcare providers, and transport sector numerous opportunities to improve their productivity.

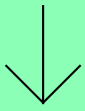
By streamlining processes, optimising supply chains, and enhancing product customisation capabilities, these technologies hold the key to unlocking meaningful efficiency gains, contributing to greenhouse gas emissions reductions in the process.

But our uptake of Industry 4.0 technologies, which underpin the fourth industrial revolution currently underway, has lagged that of other advanced nations. To continue to have a competitive edge on a global scale, our businesses will need to invest more in advanced technologies, employ lean manufacturing methodologies, and upskill the manufacturing workforce to take advantage of more efficient technologies and processes.

Callaghan Innovation has sought to play a key enabling role with our Industry 4.0 Demonstration Network. A partnership with Employers Manufactures Association (EMA), Beca and LMAC. Now into its third year, the showcase of this network has engaged more than 6,000 people across more than 280 events.

Our Industry 4.0 video webinar series and case studies are an invaluable source of information offering insights and lessons learned from dozens of New Zealand businesses that are on their own Industry 4.0 journey.

Drawing on these videos and case studies, this whitepaper outlines our progress as a nation in adopting Industry 4.0 technologies and practices. We look at the key motivations behind investing in Industry 4.0, the lessons learned, and the barriers to uptake that are holding us back.



Introduction

The aim is to use this whitepaper to share insights and stimulate discussion about the path we have taken so far in applying technology to improving manufacturing processes, and the work we can do collectively to shift the needle on uptake of Industry 4.0 in Aotearoa in 2024 and beyond.

The ability to offer high-quality products efficiently produced through smart manufacturing techniques will undoubtedly bolster the competitiveness of New Zealand's manufacturing sector on a worldwide stage.

While Industry 4.0 initially gained traction as a way to leverage technology to reduce costs, increase capacity, and boost profitability, more mature manufacturers are also developing smart, connected products, and finding new business opportunities in the process.

Not only will this wave of technological uptake propel local manufacturers towards higher levels of productivity, it also gives them a competitive edge on a global scale. As New Zealand's exports gain momentum fueled by Industry 4.0 innovations, the country stands to carve out a stronger presence in international markets.

Sean Doherty
Product Manager, Industry 4.0 / Advanced Manufacturing
www.industry4.govt.nz

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What is Industry 4.0?

Industry 4.0 - also referred to as the fourth industrial revolution - is a broad term for the new technologies and data - such as cloud computing, Internet of Things (IoT), and artificial intelligence - that are revolutionising the worlds of manufacturing and distribution.

Just as businesses 150 years ago had to adapt to electricity enabling mass production, today's enterprises face the challenge of embracing smart technologies and data to drive intelligent action in the physical world.

Knowing when and how to incorporate these new technologies into your business model isn't easy, and helping companies adapt to Industry 4.0 is a priority for Callaghan Innovation in its role as New Zealand's innovation agency.

Industrial Revolution

TRANSFORMING INDUSTRIES AND INNOVATION

Industry 1.0	Industry 2.0	Industry 3.0	Industry 4.0
Mechanisation, Steam power, weaving loom	Mass production, assembly line, electrical energy	Automation, computers and electronics	Cyber Physical Systems, internet of things, networks
1784	1870	1969	TODAY

Key Industry 4.0 technologies include:

Internet of Things (IoT): Monitoring and control for increased efficiency

Recent advances in sensing and communication technologies enable you to better understand your production and manufacturing processes. You can identify process bottle-necks and implement predictive and preventative maintenance. Sensors can provide you live updates on your production process as well as identifying when tools are becoming worn or require maintenance.

Digital twin: Modelling your product and processes

Using the data collected by sensors and building a computer model of your product or process will allow you to create a Digital Twin. This will give you real-time status updates on your product and processes, as well as going through 'what-if?' scenarios, without putting your assets at risk.

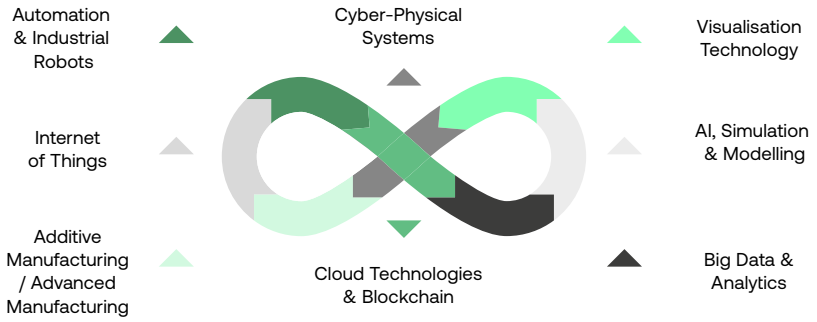
Robots and automation: Increased efficiency and precision, reduced health and safety risks

Modern production systems are increasingly automated. However you can also retrofit automation to existing and older machinery to improve performance. Integration of assistive robots, e.g. to perform repetitive and dangerous tasks, delivers further benefits.

Artificial intelligence and machine learning: Automating mundane tasks and using data to gain insights

Applying Artificial Aintellegence (AI) and Machine Learning (ML) to manufacturing data can automate processes, predict equipment failures, and optimise production parameters for higher quality and yield.

Industry 4.0 Technologies



Source: Australian Government, Department of Industry, Science, and Resources

Global trends in Industry 4.0

Recent global trends in adoption of Industry 4.0 technologies

In 2024, the use of Industry 4.0 technologies has become increasingly widespread, with significant growth and adoption across various sectors. The strongest uptake of these technologies is observed in the manufacturing sector, driven by the need for increased efficiency, flexibility, and cost-effectiveness.

However, the adoption is not uniform across all industries or regions, and several barriers to uptake still exist.

Extent of use in 2024

Industry 4.0 technologies have seen strong growth in the last decade, with the global Industry 4.0 market expected to reach a value of US$195.8 billion by 2028[1], indicating a robust compound annual growth rate (CAGR) of 19.9% according to KBV Research.

This growth is primarily fueled by the industrial sector's embrace of advanced technologies like the Internet of Things (IoT), Artificial Intelligence (AI), big data analytics, and automation.

Manufacturers are primarily automating equipment and tools that enhance efficiency, reduce production costs, and minimise human errors.

1. https://www.kbvresearch.com/industry-4-market/

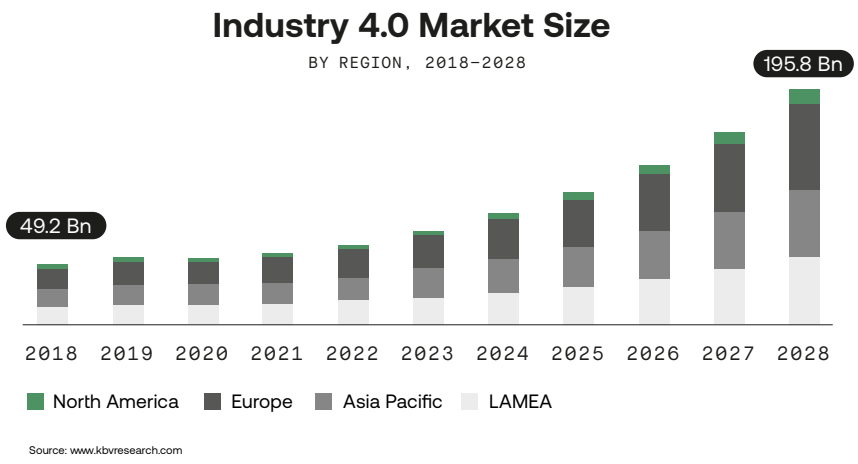
Regions with strongest uptake

North America

North America has traditionally lagged **Asia-Pacific** and **Europe** in Industry 4.0 adoption, but a renewed focus on high value manufacturing in the **US** is changing the picture. Investment will only increase thanks to initiatives such as the CHIPS and Science Act[2], a U.S. federal statute signed into law by President Joe Biden on August 9, 2022.

It provides up to US$280 billion in funding to boost research and development, and manufacturing of semiconductors, including a 25% tax credit to encourage investment in manufacturing equipment, and US$13 billion for semiconductor research and workforce training.

The **US and Canada** witnessed accelerated digital transformation during the pandemic, with companies increasingly investing in automation, IoT, AI, and data analytics to improve efficiency and competitiveness. Government initiatives and industry collaborations, including innovation clusters across the US and Canada, further support the regional growth, making North America a leader in the adoption of Industry 4.0 technologies. Adoption is driven by factors such as a strong emphasis on innovation, a mature IT infrastructure, a focus on automation, and a robust ecosystem of tech companies.



Europe

The European Industry 4.0 market will witness market growth of 19.2% CAGR during the period 2022-2028, according to KBV.

Germany is often cited as the birthplace of Industry 4.0 and continues to be a key player in its adoption. Germany is expected to maintain its dominant role in Industry 4.0 out until 2028, when its market value in the category is expected to top US$13 billion.

2 https://www.whitehouse.gov/briefing-room/statements-releases/2022/08/09/fact-sheet-chips-and-science-act-will-lower-costs-create-jobs-strengthen-supply-chains-and-counter-china/

European manufacturers show higher than average adoption of cloud technologies but trail in the adoption of other technologies such as collaborative robots (cobots) and edge computing. The EU has created a €1.15 billion public-private partnership called Factories of the Future to advance manufacturing research and innovation, signalling how high the issue is on the European policy agenda.

Europe is already well down the track towards Industry 5.0, which it describes as "human-centric" manufacturing that "empowers workers, addressing their evolving skills and training requirements".

The **United Kingdom, France, Sweden, the Netherlands,** and **Denmark**, are the other countries in the region heavily adopting Industry 4.0 technologies.

Asia-Pacific

The Asia-Pacific region, including **China, Japan,** and **South Korea,** is experiencing rapid growth in Industry 4.0 adoption. The growth is driven by expanding industrial sectors, government initiatives, and a strong focus on technology innovation.

China is the manufacturing behemoth in the region. In 2015, China's Industry 4.0 programme was dubbed 'Made in China 2025'[3] indicating the importance of advanced manufacturing to the country's economic development. China claims a large share of the state of the art manufacturers listed as part of the World Economic Forum's Global Lighthouse Network[4], a list of 132 member sites selected by an independent expert panel. The network spans industry sectors from consumer-packaged goods, process industries and advanced industries, to pharmaceutical and medical products.

China's 14th five-year plan (2021 - 2025) listed the development of seven key "frontier technologies" as the nation's top policy priority, with advanced manufacturing underpinning most of them. The prioritisation of technological development has seen **China** move ahead of the likes of the European Union, the United States and Japan in Industry 4.0 take-up when it comes to investment.

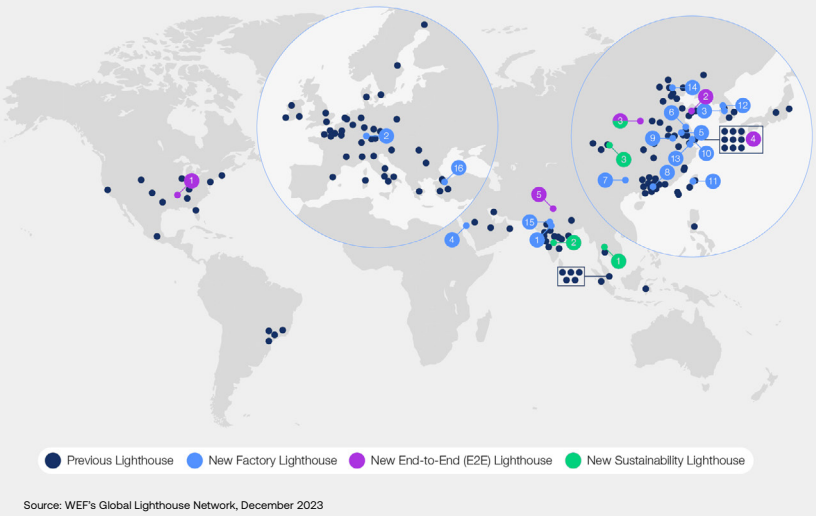
Rising geopolitical tensions and the increasing polarisation of technology development for sensitive technologies like semiconductors, artificial intelligence, 5G network infrastructure, and quantum computing, has seen **China** scale up its national efforts with the aim of becoming fully self-sufficient in producing these technologies by the end of the decade. China's BYD recently overtook Tesla[5] as the world's largest electronic vehicle maker, and the country's EV producers have employed Industry 4.0 technologies to reduce manufacturing costs and compete on the world stage.

3 http://english.www.gov.cn/policies/latest_releases/2015/05/19/content_281475110703534.htm

4 https://www3.weforum.org/docs/WEF_Global_Lighthouse_Network_2023.pdf

5 https://www.ft.com/content/716c9b0b-d8cd-491a-a91b-d70c1e540797

The leaders in Industry 4.0 around the world



Source: WEF's Global Lighthouse Network, December 2023

Asia Pacific is the fastest growing region for uptake of Industry 4.0, with large manufacturers including Procter and Gamble (Japan), Foxconn (China), and LG Electronics (South Korea) leading the way with major investments in manufacturing technologies.

Among small nations, **Singapore** stands out as a leader. Manufacturing accounts for around 20% of the country's GDP, and it is an acknowledged leader in adoption of advanced technologies in manufacturing electronics, equipment, and pharmaceuticals. Singapore's Manufacturing 2030 strategy aims to increase manufacturing value-add by 50% by 2030[6].

The Smart Industry Readiness Index (SIRI) is a measurement tool developed by the Economic Development Board of Singapore (EDB), and has been adopted around the world, including here in New Zealand.

India is emerging as a manufacturing powerhouse, and many local and multinational manufacturers there have invested in their factories and workforce to make the most of advanced manufacturing, particularly as western companies seek to reduce their reliance on China as a manufacturing base.

By 2025, digital technologies are estimated to comprise 40% of all manufacturing tech spend. The Indian government's initiatives, such as the 'Make in India' campaign and the Production-Linked Incentive (PLI) scheme, are significant catalysts in promoting the adoption of these technologies. In 2021 alone, US$5.5 - $6.5 billion were spent on Industry 4.0 technologies in India, focusing primarily on foundational technologies like cloud computing and IoT.

6 https://www.gobusiness.gov.sg/images/budget2024/MTI%20Business%20Budget%20Booklet%202024_21%20Mar.pdf

Australia is actively trying to reinvigorate its manufacturing sector following moves by automobile makers Ford, Mitsubishi and Holden to end production in Australia. With its massive mineral resources responsible for a significant component of Australia's exports, including to China, Australia is now looking to how it can add value to those raw materials locally, and move into production of EV batteries and solar panels. Australia is also ramping up its pharmaceutical manufacturing capacity.

In the Federal Budget released in May 2024, the Australian Government announced a A$15 billion funding package for manufacturing and renewable energy as part of the Future Made in Australia strategy. In total A$22.7 billion is committed to manufacturing-related investments over 10 years. [7]

It includes billions of dollars of investment finance to "rebuild Australia's competitiveness across the manufacturing value chain". The government funding includes[8]: targeted initiatives in renewables and low emissions technologies (A$3 billion), medical manufacturing (A$1.5 billion), value adding in resources (A$1 billion), critical technologies in the national interest (A$1 billion), and advanced manufacturing (A$1 billion).

The CSIRO's Innovate and Grow programme[9] offers a 10-week training programme for free small- to medium-sized enterprises (SMEs) working on advanced manufacturing solutions and exploring how research and development (R&D) can advance their project or idea. Additionally, six Australian universities were funded to the tune of A$1 million each to establish the national Industry 4.0 Testlabs network[10], with the universities matching the funding for a total investment of A$12 million designed to spur manufacturing innovation partnerships with businesses.

We will focus on Aotearoa's Industry 4.0 journey in the following section.

7 https://www.packagingnews.com.au/manufacturing-today/budget-what-s-in-it-for-the-manufacturing-sector

8 https://www.legislation.gov.au/F2023L01564/latest/text

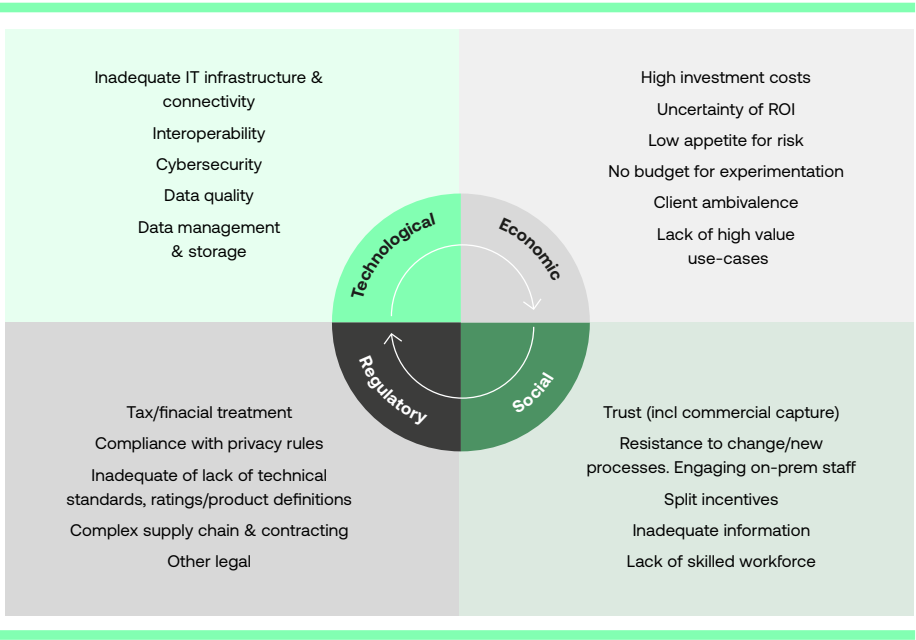
9 https://www.csiro.au/-/media/SME-Connect/Innovate-to-Grow/Advanced-Manufacturing/24-00141_SC_FACTSHEET_ITG-AdvancedManufacturing_WEB_240405

10 https://mhdsupplychain.com.au/2019/01/09/six-universities-selected-for-industry-4-0-pilot-program/

Barriers to uptake around the world

Despite the significant growth and benefits of Industry 4.0 technologies, several barriers to their adoption remain. High implementation costs pose a significant challenge, especially for Small and medium-sized enterprises (SMEs).

The integration of advanced technologies often requires substantial investments in equipment, software, and skilled personnel, which can be prohibitive for smaller businesses. Legacy platforms and IT systems need to be upgraded to best accommodate Industry 4.0 technologies often requiring a wave of digital transformation that is fundamental to the business to pave the way for the rollout of advanced technologies.



Source: Australian Government, Department of Industry, Science, and Resources[11]

Additionally, the need for infrastructure upgrades and cybersecurity measures further escalates expenses.

Other barriers include a lack of clarity regarding economic benefits, value-chain integration challenges, risk of security breaches, low maturity level of preferred technology, and resistance to change.

These challenges highlight the need for phased implementations, collaborative ventures, and partnerships to share the cost burden and facilitate wider adoption of Industry 4.0 technologies

While the adoption of Industry 4.0 technologies in 2024 is extensive and continues to grow, especially in the manufacturing sector and regions like North America, and Asia Pacific, barriers such as high implementation costs and resistance to change still hinder their broader uptake. Addressing these challenges is crucial for enabling more industries and regions to leverage the full potential of Industry 4.0 technologies.

11 https://issuu.com/racefor2030/docs/r4b_b2_oa_final-report_191222

Aotearoa and Industry 4.0 technologies

New Zealand's uptake of Industry 4.0 technologies is progressing, but it is not at the forefront compared to some other nations.

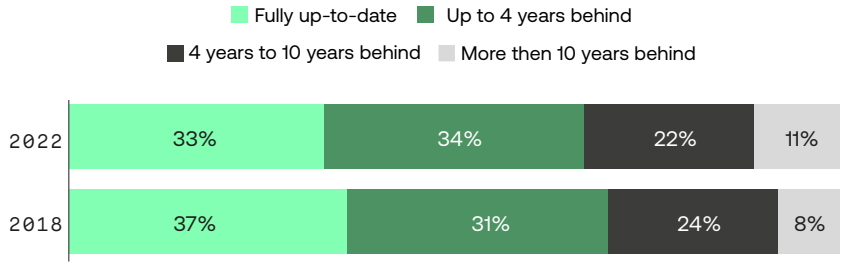
According to Westpac NZ industry economist Paul Clark[12], New Zealand is at least a decade behind Europe in adopting digital technologies in manufacturing:

"The adoption of digital technologies by New Zealand's manufacturers is lagging global peers. Where technology is used, it is typically focused on specific applications and on eking out additional efficiency gains from existing operating models. Globally, the trend is to use digital technologies to transform existing operating models that deliver more substantive gains."

This suggests that while there is movement towards embracing Industry 4.0, New Zealand manufacturers may find themselves falling behind as the world moves on if they do not accelerate their adoption of these technologies. This should be of significant concern given the importance of manufacturing to the New Zealand economy.

12 https://www.westpac.co.nz/assets/Business/tools-rates-fees/documents/economic-updates/2024/Bulletins/Industry_Insight-Manufacturing_report_15Feb24.pdf

Usage of best commonly available technology in manufacturing businesses



Source: Advanced Manufacturing Report 2023, Technology Investment Network

Callaghan Innovation has also estimated that New Zealand's manufacturing sector is at least a decade behind many European countries, which itself trails Asia Pacific and the US in adoption of technology.

For instance, New Zealand has 55 robots per 10,000 manufacturing workers, compared to 371 in Germany, and 934 in South Korea[13]. Automation in the manufacturing sector using robots is largely the domain of countries with deep manufacturing roots, which is why 79% of the 437,599 robots installed in factories in 2021[14] were deployed in just five countries - China, Japan, the United States, the Republic of Korea, and Germany. China alone has been the world's largest industrial robot market since 2013 and accounted for 52% of total installations in 2022.

While New Zealand is making strides in Industry 4.0, particularly with initiatives like the Industry 4.0 Demonstration Network and the Smart Industry Readiness Index (SIRI) assessments, it still has significant ground to cover to catch up with leading nations in this technological revolution.

Manufacturing is a major contributor to our economy, jobs and communities. The sector employs 10.7 per cent of the workforce (248,400 people), accounts for 10% of GDP ($24.1 billion), 73.5% of goods exports ($44.5 billion), and 30.5% of business expenditure on research and development ($825 million), according to the Advanced Manufacturing Industry Transformation Plan[15]. Manufacturing is also the second largest employer of Māori and Pacific peoples.

13 https://www.westpac.co.nz/assets/Business/tools-rates-fees/documents/economic-updates/2024/Bulletins/Industry_Insight-Manufacturing_report_15Feb24.pdf

14 https://ifr.org/img/worldrobotics/Executive_Summary_WR_Industrial_Robots_2023.pdf

15 https://www.mbie.govt.nz/dmsdocument/26245-advanced-manufacturing-industry-transformation-plan

Not ‘up-to-date’

The 2023 Advanced Manufacturing Report from the Technology Investment Network, identified a lack of preparedness to implement Industry 4.0 technologies among New Zealand manufacturers.

“Over 60% of manufacturers feel they are not up-to-date with available technology.”

Of those technologies that have been adopted, IoT has the strongest uptake, with other 50% of companies included in the report survey using it, and 83% of companies in the $200m+ revenue band employing IoT in the form of smart sensors around factories and production lines to monitor equipment, and provide real time insights into the status of production.

Adoption of Advanced Technology by Best in Class Companies

Revenue Band	Internet of Things	Agile Supply Chain	Robotics & Automation	Data Warehousing & Analytics	Computer Aided Engineering & Simulation	Additive Manufacturing & 3D printing	Human-centered Technology & Safetytech	Artificial Intelligence & Machine Learning	Engineering Biology & Bioinformatics
$200m	83%	67%	67%	67%	50%	17%	17%	33%	0%
$50m-$200m	60%	30%	35%	30%	15%	10%	15%	15%	0%
<$20m-$50	53%	27%	33%	13%	27%	13%	7%	0%	0%
<$20m	50%	20%	10%	0%	5%	5%	5%	0%	10%
Total	57%	30%	30%	20%	18%	10%	10%	8%	3%

Source: Advanced Manufacturing Report 2023, Technology Investment Network

“Internet of Things acts as a force multiplier – corresponding to higher adoption rates of other technologies such as automation, data analytics, and artificial intelligence. These have their potential unlocked when combined with the data collection capabilities of Internet of Things implementations,” the TIN report found.

Our big manufacturers have the financial resources to invest in building agile supply chains, robotics and automation, data analytics, and computer-aided engineering, and building digital twin technologies. But these technologies generally have an adoption rate of lower than 50% in smaller companies.

The rise of servitisation

New Zealand’s tech sector has a strong track record in providing services, with the likes of Xero, Vend, and Seequent becoming significant international businesses selling software as a service (SaaS).

This positions New Zealand well to embrace the global trend towards servitisation in manufacturing. As the TIN report points out:

"The lines between manufacturing and services are blurring, as companies offer related and post-production services like installation, logistics, repair, recycling, and engineering. In sectors such as machinery and equipment, the diffusion of digital technology can bring about new value-added revenue streams."

One company that has embraced servitisation is Christchurch-based Clever First Aid[16]. It offers replenishment of first aid products, based on IoT sensors in first aid boxes that detect what items have been used. Rather than a company needing to purchase first aid kits, Clever First Aid takes care of the entire process for a set fee. Auckland-based iMonitor offers smart food manufacturing software as a service, integrating with Industry 4.0 technologies like "SCADA, PLCs or IIoT devices to improve operational efficiency and productivity"[17].

A tough manufacturing environment

The recessionary environment has created difficulties for the country's manufacturers, putting pressure on their ability to invest in productivity-enhancing technologies and processes.

Activity in New Zealand's manufacturing sector experienced stronger contraction during March 2024, according to the BNZ – BusinessNZ Performance of Manufacturing Index (PMI). The manufacturing sector has now been in contraction for 13 consecutive months.

"In addition, the proportion of negative comments increased to 65% in March, compared with 62% in February and 63.2% in January. A lack of orders was again mentioned by numerous respondents, along with the general economic slowdown," noted BusinessNZ's Director, Advocacy Catherine Beard.

Westpac's Paul Clark writes that as well as adopting technologies to become more productive and efficient, our manufacturers can become more resilient to economic downturns, and supply chain disruptions, through the adoption of Industry 4.0 technologies.

"That means investing in smart connected machinery, moving to micro-factories for products that have short production runs, and embracing digital twinning (virtual prototyping) to speed development times, reduce costs, and minimise adverse impacts on the environment, while at the same time delivering products hyper personalised to customer requirements."

16 https://cleverfirstaid.com/smart-first-aid-system

17 https://www.imonitor.net/food-manufacturers

What can be done about lagging take-up?

The industry consultation undertaken for the Advanced Manufacturing Industry Transformation Plan revealed valuable insights into what manufacturers need to increase their Industry 4.0 adoption. Key barriers identified included a lack of capability to roll out new technologies, skills shortages, and lack of access to capital.

Many manufacturers in New Zealand may struggle to keep up with new digital technologies and are likely to find themselves at a growing competitive disadvantage. They could be consumed by more tech savvy competitors.

Westpac's Paul Clark sees three things as key to increasing Industry 4.0 adoption - education, investment in digital technologies, and workforce development:

Education: Tapping into Callaghan Innovation's Industry 4.0 Demonstration Network, assessing digital readiness and coming up with a transformation plan. Use insights gained from others to develop a smart manufacturing strategy.

Investment: Possible measures that could boost investment include accelerated depreciation, an investment fund similar to the Government Investment in Decarbonising Industry (GIDI) fund for co-investment, and investment grants and/or low interest loans to help businesses invest in new equipment. ASB's recently announced $500 million pool of loan funds and accompanying Producivity Grants worth $5 million dedicated to productivity-enhancing initiatives, is an example of how capital can be made available to spur uptake of Industry 4.0 technologies[18].

Spark has committed $15 million[19] to an innovation fund to help customers deploy advanced technologies, while Westpac[20] and Meridian[21], respectively, are offering loans and funding for sustainability-related innovation. Venture funds, such as Green Investment Fund (NZGIF)[22], and the Climate Venture Capital Fund[23] have also emerged in recent years to channel finance into sustainability initiatives, with manufacturing companies considered worthy candidates.

18 https://www.asb.co.nz/business-banking/productivity.html#get-one-step-ahead-with-us

19 https://www.sparknz.co.nz/news/spark_one_tech_gen_forward/

20 https://www.westpac.co.nz/business/products-services/loans-overdrafts/sustainable-business-loan/

21 https://www.meridianenergy.co.nz/business/sustainable-options/process-heat-electrification-programme

22 https://www.nzgif.co.nz/

23 https://climatevcfund.com/about/

Workforce development: Automation and the rise of AI calls for significant investment in workforce engagement and training in new skills, much of it delivered using digital tools.

The industry group Advanced Manufacturing Aotearoa, established in 2023, is attempting to build critical mass among advanced manufacturers with regional networks, networking and training initiatives.

Significance work has been undertaken by the New Zealand Qualifications Authority and Hanga-Aro-Rau - Manufacturing, Engineering and Logistics Workforce Development Council. to develop new microcredentials for Industry 4.0[24].

AMA Board Member Glenn Hansen – Group CFO, Vortex Engineering Group, has identified three additional things[25] that need to be addressed to prepare New Zealand manufacturing for the future - reducing reliance on imports, collaboration, changing poor perception.

Reducing reliance on imports: *"NZ already provides a wide range of products, and technological advances such as additive manufacturing offering opportunities to broaden that range further. Such technologies aid in reducing reliance on imported goods if necessary."*

Greater collaboration: *"Silos develop naturally, but management theory tells us that silos inhibit innovation, production, and efficiency. New Zealand manufacturers partner with the local technology sector to create innovative new products and industrial solutions that are having a profoundly positive effect on lowering carbon emissions and reducing waste. Much more could be realised from such partnerships if local companies and their capabilities are more widely known and better promoted."*

Changing poor perception: *"A poor perception of the sector, or just a low public profile (as we undoubtedly have) does not encourage the capital investment needed to enable many excellent operators to scale up and realise their export market potential. Many of our successful exporters are family owned businesses that have had to self-fund their growth. Imagine what could be achieved with additional financial support, probably linked with managerial or governance expertise to fill knowledge gaps?"*

24 https://www.nzqa.govt.nz/nqfdocs/skills/pdf/40007.pdf

25 https://www.amanz.nz/news/debunking-the-myths-a-case-for-manufacturing/

Industry 4.0 2023 Insight survey

What our survey found - a snapshot of progress

To find out how New Zealand manufacturers are approaching the uptake and use of Industry 4.0 technologies, Callaghan Innovation periodically surveys manufacturers in the Industry 4.0 Network.

Our latest survey, completed in July 2023, featured input from 75 respondents. The survey conducted as part of Callaghan Innovation's Industry 4.0 Demonstration Network programme, in partnership with Beca and the EMA, aimed to understand the barriers New Zealand manufacturers face when adopting new technologies.

The survey's findings are crucial for informing the next phase of programme implementation and provide manufacturers with insights on where to focus their efforts.

Key takeaways

Steady adoption in recent years: The level of organisations actively implementing Industry 4.0 technologies has remained relatively steady compared to 2021.

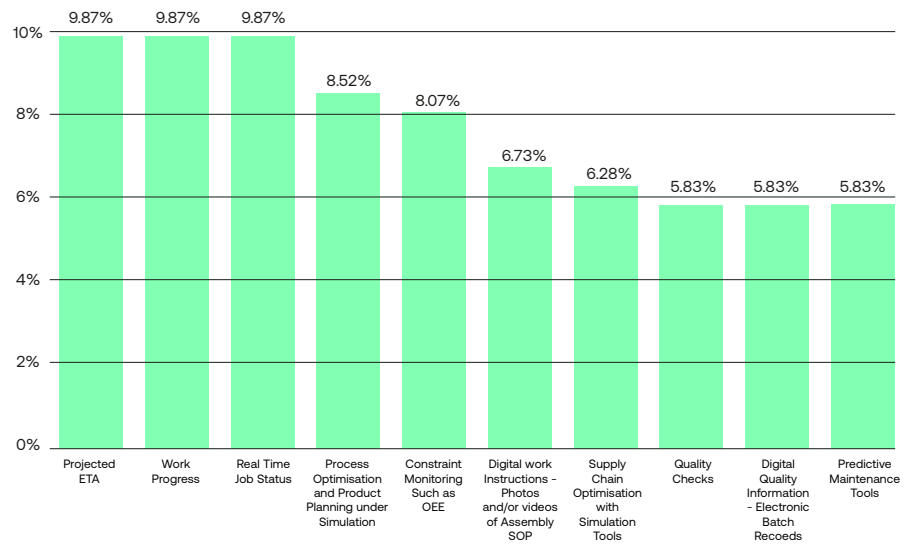
Education gap and awareness has increased: 37% (down 27% from 2021) understand the benefits and/or are implementing Industry 4.0 solutions. 24% of respondents are actively implementing Industry 4.0 solutions (down 5% from 2021), whilst 12% of respondents have never heard of Industry 4.0 (down 1% from 2020).

Factors preventing adoption differ slightly based on Industry 4.0 maturity – the highest priority for people who understand the benefits but not yet implementing are: access to funds, clear implementation strategies.

Businesses need examples to guide the way - case studies of successful implementations across New Zealand business was a highly scored support service across all maturity levels. Callaghan has an extensive collection of case studies to draw on.

The in-demand technologies: robotics & Automation, big data and analytics, and Internet of Things were perceived as adding the most value in future.

Biggest insights sought: projected estimated time of arrival (ETA), work progress and real time job status are considered to be the key solutions of interest to implement in the near future.



Source: Industry 4.0 Network Industry 4.0 Insights survey

Opportunities pursued by respondents

Respondents are looking to improve various business functions through Industry 4.0. The most common areas targeted for improvement are engineering functions, including manufacturing, asset and equipment efficiency, and health and safety. Those already implementing Industry 4.0 are focusing on manufacturing, equipment efficiency, and product quality.

In terms of value-add technologies, robotics & automation, big data and analytics, and the Internet of Things are perceived to add the greatest value. Respondents were asked to pick the top three technologies they believe will add the most value to their business.

Specific Industry 4.0 solutions of interest for near-future implementation include: projected ETA, work progress, and real-time job status. These were among the top three specific Industry 4.0 Solutions of interest for implementation in the near future.

Barriers to technology uptake

The survey identified several factors preventing the adoption of Industry 4.0 technologies, which differ by digital maturity:

- 10% of respondents already implementing Industry 4.0 solutions cite difficulty in creating business cases or obtaining funds.
- 36% of respondents who understand the benefits but are not yet applying Industry 4.0, cite difficulty in obtaining funds, no clear strategy, and difficulty in creating business cases for funding.

The highest priority for those who understand the benefits but are not yet applying the technology, is highlighting successful Industry 4.0 implementations in New Zealand, followed by workshops with senior leadership teams and access to funding.

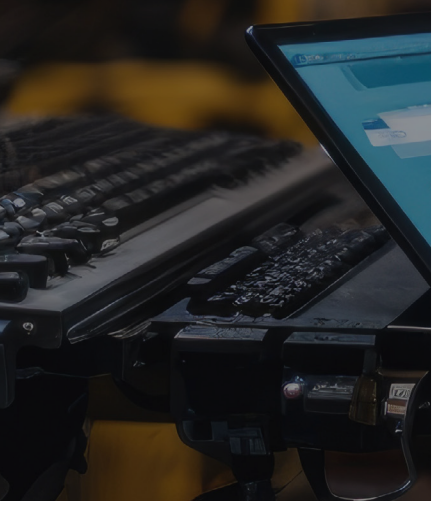
Steady implementation, room for improvement

The survey provides a comprehensive overview of the current state of Industry 4.0 uptake among New Zealand manufacturers. While there is a steady level of implementation, there is also a clear need for more awareness and understanding of the benefits of Industry 4.0. The opportunities being pursued indicate a focus on improving efficiency and quality through advanced technologies.

However, the barriers to uptake, particularly around funding and strategic implementation, highlight the challenges that need to be addressed to drive further adoption of Industry 4.0 technologies in New Zealand.

The Smart Industry Readiness Index

– finding your baseline



Implementing Industry 4.0 technologies presents a transformative opportunity for manufacturing businesses, aiming to enhance efficiency, productivity, and competitiveness.

However, the journey towards digital transformation is fraught with challenges and barriers, as well as marked by notable successes. The Singapore Government's Economic Development Board (EDB) recognised this early and developed the Singapore Smart Industry Readiness Index (SSIRI).

The tool has since been adopted by numerous New Zealand manufacturers, who have taken advantage of a voucher scheme funded by Callaghan Innovation, to undertake a SIRI assessment in conjunction with an assessment provider such as LMAC, Beca, and HERA (Heavy Industry Research Association) and Callaghan Innovation itself, as part of the Smart Factory Assessment Programme.

What is SIRI?

SIRI is a comprehensive framework developed to assist manufacturers in assessing their readiness for Industry 4.0 transformations. Launched in November 2017, SIRI was created through a collaboration between the Singapore EDB and TÜV SÜD, a company specialising in inspection, certification, and training.

The index is designed to be a practical, easy-to-use self-assessment tool tailored specifically for manufacturing companies in Singapore, regardless of their size or industry sector. Since then, it has been applied to manufacturers all over the world.

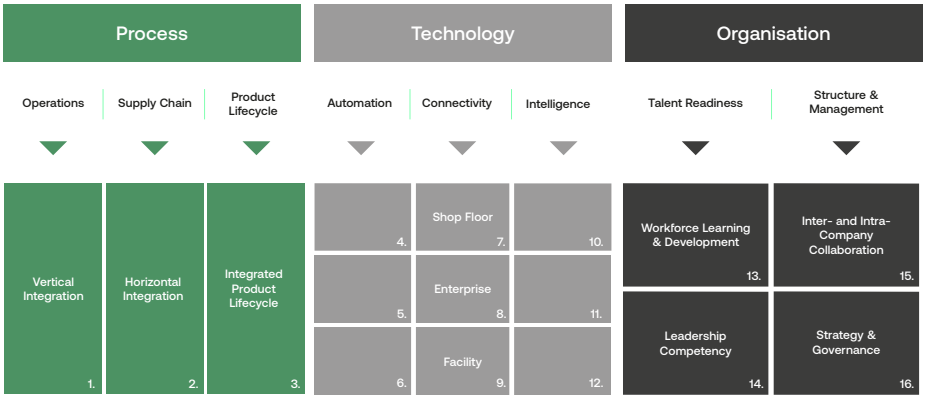
SIRI assesses readiness across three core areas:

Process: Evaluating the effectiveness and efficiency of manufacturing operations and supply chain management.

Technology: The adoption and integration of smart technologies within manufacturing processes.

Organisation: The structure, culture, and workforce capabilities within the company

Smart Industry Readiness Index



Source: Industry 4.0 Network Industry 4.0 Insights survey

SIRI Tools and Frameworks

SIRI includes several tools and frameworks to aid manufacturers:

Assessment Matrix: This tool provides a snapshot of a manufacturing facility's current Industry 4.0 maturity level across 16 different dimensions, helping companies identify areas for improvement

TIER Framework: This prioritisation framework helps companies focus their resources on areas that will yield the greatest benefits, based on an analysis of the company's current state, impact to the bottom line, and essential business objectives.

Prioritisation Matrix: A management planning tool that helps identify high-priority areas within the SIRI dimensions that can deliver the greatest impact to the organisation.

Singapore-based Industry 4.0 expert Jackie Tan, who helped develop SIRI when he was Vice President, Head of Industry 4.0 Consultancy at TÜV SÜD, says a SIRI assessment starts with understanding what a manufacturer is setting out to achieve.

"We always ask the clients what specific challenges they want to solve. If they're able to understand the specific pain points and challenges, they'll be in a better position to find relevant case studies." says Tan.

Many manufacturers around the world are already practicing lean manufacturing principles but uncertain about the next steps involved in embracing advanced technologies on the factory floor.

For many companies, connectivity between systems and machines is a priority, allowing real-time monitoring of the entire production process. Others are seeking to deploy specialist machinery that will dramatically improve productivity and allow diversification of product lines.

But SIRI prioritises preparedness, change management, and a focus on people.

"You can deploy the most effective technology, but without getting your people involved, it will be a white elephant. Get people involved at the beginning, get their input, get their feedback," Yan advises.

The Global Smart Industry Readiness Index Initiative: Manufacturing Transformation

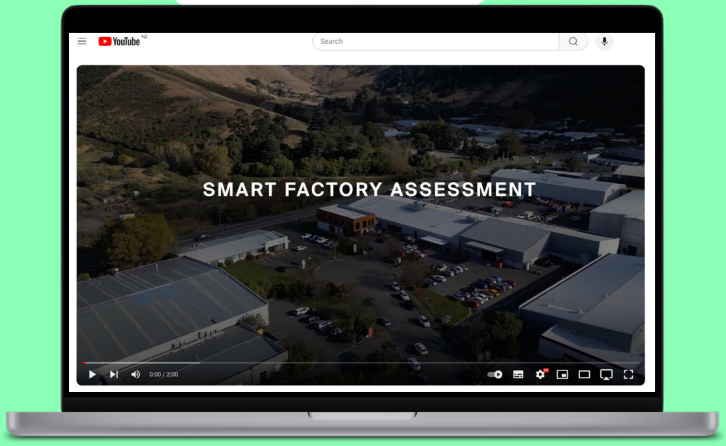
Insights Report 2022 drew on data from 600 manufacturers worldwide, many of which had undertaken SIRI assessments:

"One key insight," the report found, "is that companies ahead of the digitalisation curve (Best-in-Class) have focused significantly on plant/factory connectivity, underscoring the importance of this in helping firms to better leverage data to generate new insights and facilitate more real-time decision-making; these activities are critical for success in the Fourth Industrial Revolution."[26]

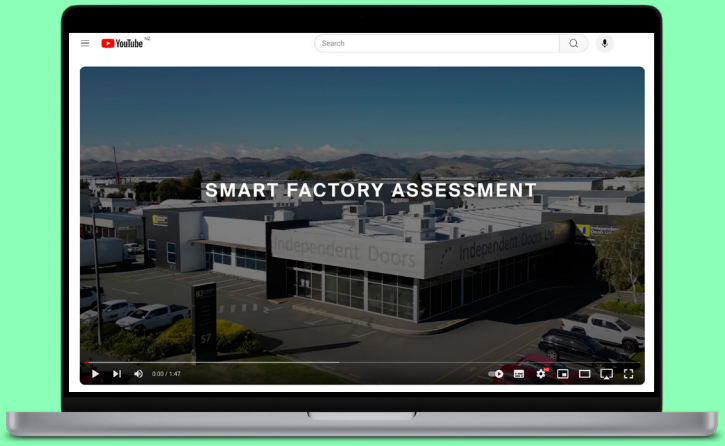
26 https://www3.weforum.org/docs/WEF_The_Global_Smart_Industry_Readiness_Index_Initiative_2022.pdf

Smart Factory Assessment:

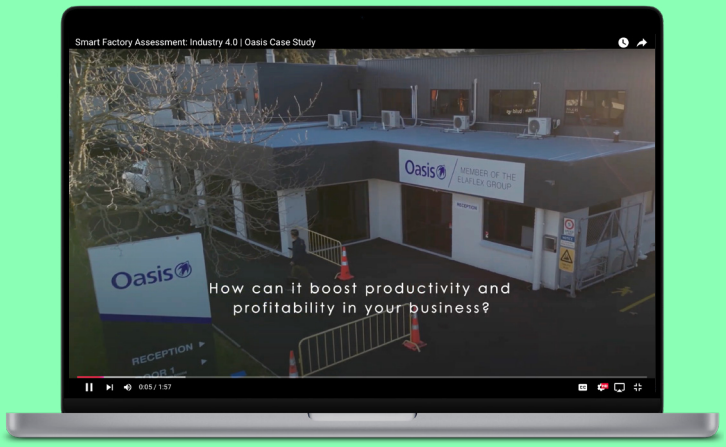
Case studies



Argus Manutech



Independent Doors



Oasis Engineering

Convex Packaging

Key takeaways

Five key takeaways from SIRI for New Zealand manufacturers:

1. Going through a SIRI-like assessment can educate teams on Industry 4.0 concepts and language in order to embark on their digital transformation.
2. It helps translate Industry 4.0 to a company's specific situation and identify priority areas for improvement.
3. Applying both lean manufacturing principles and advanced technologies optimises processes for improved efficiency and competitiveness. SIRI can help plot the course.
4. Change management is important to successfully adopt new technologies and energise workforces around opportunities.
5. Tracking progress over time through reassessments allows companies to monitor their transformation and receive targeted support from the government.

WEBINAR: Watch the webinar with Industry 4.0 experts Jackie Tan and Dr Andreas Hauser on what the SIRI methodology can offer your business.

Callaghan Innovation has engaged

Six driving factors for adopting Industry 4.0

with hundreds of New Zealand companies over the last five years through the Industry 4.0 Network, Network Site Visits and other initiatives.

The case studies, webinars, and regular surveying of manufacturers in New Zealand's Industry 4.0 ecosystem gives us a good indication of the priorities for businesses as they consider adopting Industry 4.0 technologies.

Here are six key priorities we have identified:

1 Improved productivity and efficiency - digitisation, the connected shop floor, and real-time visibility into production

Industry 4.0 technologies enable greater automation, reduced downtime, and better resource allocation, leading to higher productivity and output. Real-time monitoring allows for proactive maintenance and faster problem resolution.

Enhanced quality and reduced errors: Connecting machinery and using integrated data systems allows manufacturers to detect errors immediately, rather than at later stages when repairs are more costly. This improves product quality.

Increased flexibility and agility: The connectivity and data insights provided by Industry 4.0 allow manufacturers to be more responsive to changing customer demands and market conditions. They can quickly adapt production to create customised products.

Reduced costs: Automation, predictive maintenance, and optimised processes help manufacturers cut costs related to labor, materials, and energy consumption.

Technologies employed:

Cyber-Physical Systems (CPS)

Cyber-physical systems integrate computation, networking, and physical processes. Embedded computers and networks monitor and control the physical processes. CPS enables real-time data collection and analysis, allowing for immediate adjustments and improvements in manufacturing processes.

Internet of Things (IoT)

IoT refers to the network of physical objects that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet.

In manufacturing, IoT devices can monitor various aspects of the production process, such as temperature, speed, and quality, providing real-time data that can be used to optimize operations

Data and analytics

The data generated by IoT devices and CPS can be fed into software programs, and enterprise resource planning platforms for real-time intelligence and predictive analytics to improve production planning.

Advanced data processing techniques, often powered by AI and machine learning, can extract actionable insights from large and complex data sets.

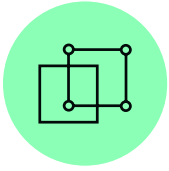
Cloud computing

Cloud computing infrastructure is increasingly being drawn upon by New Zealand manufacturers to store and process large amounts of data generated by Industry 4.0 technologies. It offers scalable computing resources and storage space, enabling companies to capture and analyse data efficiently.

The cloud also facilitates the sharing of information across an organization, breaking down silos and promoting integrated operations.

Robotics and automation

Robots and automated systems in smart factories are equipped with sensors and can be connected to the IoT network, enabling them to perform tasks with high precision and adapt to changes in the manufacturing environment. They can also communicate with other systems to ensure seamless production flows



Digital Twins

Digital twins are virtual replicas of physical devices or systems. They are used to simulate and analyse real-world conditions, test scenarios, and predict outcomes in a virtual environment before they are applied to the actual physical counterpart

This allows for experimentation and optimization without disrupting the ongoing production processes.

CASE STUDY: Independent Doors

Unlocking the door to efficiency

CASE STUDY: Bremworth
Improving visibility on the factory floor

CASE STUDY: Oasis Engineering
Connecting your shop floor

CASE STUDY: Comvita
Agile Supply Chain and Digital Strategy

WEBINAR: Oasis Engineering
Shop floor Connectivity and the Paperless Factory

WEBINAR: Griffin's
Shop floor intelligence - have I had a good day?

2 Reducing downtime: Leveraging technology to avoid costly disruptions

Industry 4.0 technologies significantly reduce downtime in factories and improve efficiencies in manufacturing processes, saving businesses time and money. This is achieved through several key strategies:

Predictive maintenance: Predictive maintenance utilises data analytics and machine learning to predict equipment failures before they occur. By analysing data from sensors and other sources, manufacturers can identify potential issues and address them before they result in downtime or equipment failure.

This approach enables maintenance teams to schedule repairs proactively and minimise unplanned downtime, leading to significant cost savings.

Real-time monitoring: The use of sensors and IoT devices allows for the immediate detection of any anomalies or inefficiencies in the production line, letting staff address issues before they pose a problem for the plant's productivity.

Automation and robotics: The integration of advanced robotics and automation technologies in manufacturing processes not only speeds up production but also reduces the likelihood of human error, which can lead to downtime. Robots can operate 24/7 without fatigue, ensuring continuous production and significantly reducing the time taken for manufacturing processes.

Improved supply chain visibility: being able to track and monitor the status of materials and products in real-time throughout the supply chain is crucial. This visibility helps in anticipating and mitigating supply chain disruptions, ensuring

timely availability of materials, and reducing production delays.

CASE STUDY: Plazmax
Remote management and control

CASE STUDY: Howard Wright
Robotic welding to reduce downtime

3 Sustainability: Reducing waste is a growing priority as sustainability reporting is increasingly required

Our manufacturers are responding to changing consumer preferences, regulatory requirements, and ESG (environmental and social governance) standards by prioritising sustainability in their production, and in their entire supply chain.

Here are some ways Industry 4.0 technologies are being deployed to reduce waste:

3D printing for material efficiency: 3D printing, or additive manufacturing, builds objects layer by layer, using only the material that is needed for the product. This contrasts with traditional subtractive manufacturing methods that often result in significant material waste. 3D printing can reduce waste in the construction industry by up to 95% or more, making it a highly efficient technology for producing customized parts and products with minimal waste.

Robotics and precision: Robotics technology can significantly reduce waste by enhancing precision in manufacturing processes. Robots can perform tasks with high accuracy, reducing the margin of error and the amount of material wasted. Robotics can also be used in recycling processes to sort and process waste more efficiently than manual methods.

Computer vision systems: Artificial Intelligence-powered computer vision systems can improve quality control and reduce waste by automatically sorting materials and products in the production process. Our food and beverage makers, and horticultural producers are already making extensive use of computer vision and AI to improve quality and reduce waste.

IoT and efficiency: By embedding sensors in manufacturing equipment and using connected devices, manufacturers can optimise energy use, identify inefficiencies, and reduce unnecessary waste production. For instance, IoT sensors can monitor energy consumption patterns, identify inefficiencies, and develop strategies to rectify these, leading to significant savings in energy costs.

The rise of the smart factory: When Industry 4.0 technologies are employed throughout the manufacturing process, the entire production process can

be optimised for efficiency and sustainability. Smart factories use connected machinery and infrastructure, digital platforms, IoT, and data analytics to monitor and adjust production processes in real-time, reducing waste and improving resource utilisation. This integration supports the transition from linear to circular economy models, where waste is minimised, and materials are reused and recycled.

CASE STUDY: ENI
Optimising the use of manufacturing inputs

CASE STUDY: Breadcraft
Making good use of raw materials

4 Improving health and safety and better managing use of labour

Manufacturing in New Zealand has one of the highest rates of workplace injury in the country, with 152 work-related claims per 1,000 full-time equivalent (FTEs) in 2022[27]. A priority among New Zealand manufacturers is to improve their healthy and safety processes.

Another priority is to improve sluggish labour productivity growth in the manufacturing industry by upskilling staff, nurturing talent and using technology in smart ways to free up employees from mundane and repetitive tasks.

Here are some ways Industry 4.0 technologies can play a role in health and safety, and labour productivity:

Improved environmental monitoring: Sensors can detect hazardous conditions such as toxic gas leaks or extreme temperatures, triggering alarms and automated responses to protect workers' health and safety.

Enhanced ergonomics: Robotics and automation can take over repetitive, physically demanding tasks, reducing the physical strain on workers and lowering the risk of musculoskeletal disorders.

Wearable technology: Wearable devices equipped with sensors can monitor the physiological status of workers, alerting them and supervisors to potential health risks such as exhaustion or overheating. This can prevent workplace injuries and ensure that workers are not operating machinery when they are not in optimal condition.

Predictive maintenance: By integrating IoT sensors and data analytics, manufacturing businesses can monitor equipment health in real-time. Predictive maintenance algorithms identify potential failures before they occur, allowing for proactive maintenance processes which can reduce the risk of accidents

27 https://www.stats.govt.nz/information-releases/injury-statistics-work-related-claims-2022/#:~:text=41,33%20claims%20per%201%2C000%20FTEs.

caused by equipment failure.

Safety training: Digital training tools, including Virtual Reality (VR) and Augmented Reality (AR) can be used for safety training, allowing workers to experience and react to potential safety scenarios in a controlled environment, which can improve their preparedness for real-life situations.

Boosting labour allocation and efficiency:

Collaborative robots (Cobots): Cobots are designed to work alongside humans, taking on the more dangerous or tedious aspects of a task while humans focus on the more intricate parts, thus optimizing labour allocation.

Data-driven forecasting: AI can predict production peaks and troughs, allowing for better planning of labour needs. This ensures that labour is allocated efficiently to meet demand.

Skill development and training: Monitoring worker productivity on the shop floor can identify skill gaps in the workforce and suggest targeted training programmes, ensuring that labour allocation is not only efficient in quantity but also optimised for the quality of work.

Enhanced communication: Digital technologies, such as collaboration software and messaging apps facilitate better communication, ensuring that labour allocation decisions are made with input from all relevant stakeholders and that workers are informed and prepared for their roles.

CASE STUDY: Bonson
A vision system automates quality control

CASE STUDY: PanPac
Safe repairs and upgrades

CASE STUDY: United Machinists
Flipping cobots at it again

CASE STUDY: Argus Manutech
Redesigning the line for productivity and ergonomics

CASE STUDY: Tasman Bay
Enhancing safety in the packing process

5 Maintaining a competitive edge - faster time

to market and price competitiveness

Lean manufacturing and the use of Industry 4.0 technologies can deliver a competitive edge for New Zealand manufacturers by enhancing efficiency, productivity, and innovation while reducing costs and waste. Here's how these two concepts can work together to create a competitive advantage for our manufacturers exporting to the world:

Customisation and flexibility: Industry 4.0 technologies such as 3D printing enable manufacturers to offer customised products without significant increases in production costs. This flexibility can meet consumer demands for personalisation while adhering to lean principles of minimising inventory and overproduction.

Supply chain optimisation: Digital technologies provide better visibility and control over the supply chain. Manufacturers can respond more quickly to changes in demand, reducing lead times and inventory levels, which are key objectives of lean manufacturing.

Quality improvement: Machine learning and AI can improve quality control by detecting defects that might be missed by human inspection. This improvement in quality reduces waste and aligns with the lean goal of doing things right the first time.

Sustainability: Lean manufacturing aims to use resources efficiently, and Industry 4.0's ability to optimise energy usage and reduce material waste contributes to more sustainable manufacturing practices. That reduced environmental impact offers our manufacturers competitive differentiation.

CASE STUDY: Convex
Supplier Technology and Focussing on your Value

CASE STUDY: Fi Innovations
Automating the supply chain with digital inventory

CASE STUDY: Gyro
Better connection with customers

CASE STUDY: Northpine
Tracking and tracing

WEBINAR: Bostock
Staying globally competitive with innovative Industry 4.0 Technology

6 Data analytics can really start to change the game if implemented correctly

As our manufacturers' maturity in the Industry 4.0 space develops, there's scope for data analytics to inform their decision making, helping them to manage resources and reflect changing market conditions in their production.

Here are some ways Industry 4.0 technologies can help with planning in the manufacturing process:

Improved supply chain visibility and efficiency: Digital technologies make supply chains smarter, faster, and more resilient. Accurate, reliable, and consistent data ensures end-to-end visibility of supply chains, enabling businesses to communicate better with suppliers and customers.

This visibility allows for real-time tracking of orders, providing customers with up-to-date information on the status of their products. Such transparency builds trust and enhances customer satisfaction by reducing uncertainty and enabling customers to plan based on accurate delivery estimates.

Faster and more reliable deliveries: By adopting technologies that optimise inventory management and supply chain operations, manufacturers can ensure that products are delivered to customers more quickly and reliably.

Personalised customer experiences: The integration of real-time data, automation, and AI enables organisations to deliver highly personalised customer experiences at scale. By analysing customer behavior and preferences, manufacturers can tailor their marketing, sales, and service efforts to better meet individual customer needs. This level of personalisation improves customer engagement and satisfaction by making customers feel valued and understood.

Proactive problem solving and support: Automation and AI tools can predict potential issues with products or services before they affect the customer. This proactive approach to problem-solving can significantly enhance customer satisfaction by preventing issues from arising and ensuring that any potential problems are addressed swiftly and effectively.

CASE STUDY: Balance
Data-driven decision making

CASE STUDY: Metco Engineering
A digital footprint of every job

How some of our best companies are progressing with Industry 4.0

Bostock New Zealand

Bostock New Zealand is a family owned, vertically integrated, horticultural company specialising in producing and marketing premium produce to high paying customers around the world. The company built a prototype to automate the process of size grading its crop of squash.

What Bostock has learned on its Industry 4.0 journey:

- Bostock's management realised they had good data already but needed to improve how it was shared across the supply chain.
- Doing the SIRI assessment helped identify areas for improvement and prioritise a digital roadmap.
- Automating processes like squash sorting improved efficiency, accuracy and reduced costs.
- Real-time data dashboards gave visibility that helped optimise operations and reduce downtime.
- The Bostock IT team played an important role in developing solutions and generating new ideas.

"The investment and really expensive optical sorting equipment has a very long payback period if it is available. So we wanted to focus on what we could immediately adopt around what is readily available and just make some immediate gains across the business." - Matt Stafford, Bostock New Zealand

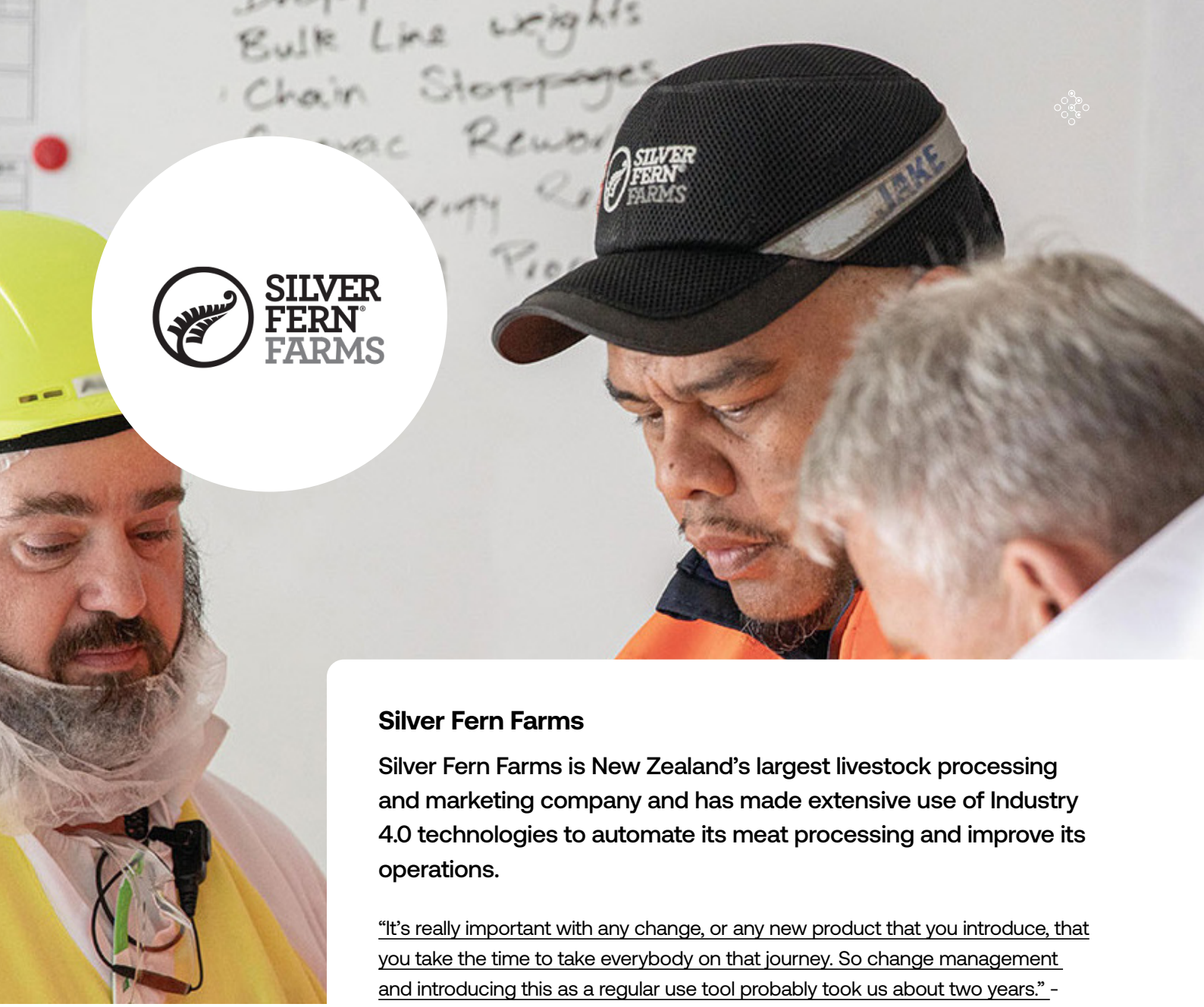
Gyro Plastics

Fielding-based Gyro Plastics is a leading plastics engineering company that has implemented several Industry 4.0 technologies to improve shop floor efficiency and productivity, boost customer engagement, and better manage its supply chain.

"A large part of our business is labour, physical labour work. We wanted to be able to understand how we can provide more skilled, meaningful work and take some of the tasks away that didn't add value or add to a person's day." - Trudi Duncan, Gyro Plastics

What Gyro has learned on its Industry 4.0 journey:

- Gyro needed help defining where to start and asking the right questions to improve.
- Implementing new technologies required workarounds due to limitations in their enterprise resource planning (ERP) system.
- Defining processes was important before digitalising them.
- Gyro faced barriers like resistance to change from some employees and integration challenges.
- Some of their successes were implementing a manufacturing execution system (MES) system to automate planning and scheduling, digital displays to improve production efficiency, automation of administrative tasks through apps, and gaining real-time data visibility across their operations.



Silver Fern Farms

Silver Fern Farms is New Zealand's largest livestock processing and marketing company and has made extensive use of Industry 4.0 technologies to automate its meat processing and improve its operations.

"It's really important with any change, or any new product that you introduce, that you take the time to take everybody on that journey. So change management and introducing this as a regular use tool probably took us about two years." - Andrew Mitchell, Silver Fern Farms

What Silver Fern Farms has learned on its Industry 4.0 journey:

- Silver Fern Farms had to establish trust in their health and safety data by simplifying data collection and ensuring accuracy before they could gain useful insights.
- Combining different data sources like injury reports and HR data allowed them to identify disproportionate risks and focus improvement efforts.
- Comparing data across sites highlighted best practices, like another site's 'paunch room' design, that could be implemented elsewhere.
- Collaboration with other meat processors through the Meat Industry Association can further data-driven improvements by facilitating industry-wide comparisons.
- Real-time data collection through technologies like AI and sensors could help justify further investment by identifying risks and impacts more comprehensively.

Griffin's

Griffin's Food Company is a New Zealand company that has been making food for over 150 years, including biscuits, crackers, potato chips, and nut bars. It has introduced lean manufacturing processes and Industry 4.0 technologies into its production lines to good effect.

"It was quite striking how few of our leadership team knew about Industry 4.0 and the benefits. If we had shared that and made everyone aware two years ago, I think we would have been even a bit further along on the journey for sure."
- Peter Richardson, Griffin's

What Griffin's has learned on its Industry 4.0 journey:

- The importance of visibility into manufacturing data and performance for empowering operators and improving decision making.
- That retrofitting existing equipment with sensors and data collection is possible, even on older equipment.
- Starting small with pilots and getting feedback from users is important before rolling technologies out more widely.
- Forming an agile team with the right expertise helped them test and trial new technologies quickly
- Doing a SIRI assessment provided valuable insights into priorities like leadership competency around Industry 4.0

Bremworth

Carpet maker Bremworth has pursued Industry 4.0, including in one project integrating its cloud-based Enterprise Resource Planning (ERP) system with its manufacturing execution system (MES) software, which allows machine sensors to auto-schedule batches of dying.

"XML and SQL databases are not good enough anymore, because we are talking about gigabytes or terabytes of data in different shapes and forms - videos, images, CSV files. They all need to be combined and be analysed if you need more insight. So current tools, or conventional tools are not designed for that purpose." - Reza Hamzeh, Bremworth

What Bremworth has learned on its Industry 4.0 journey:

- Developing a data management and analytics system (DMS) to create a single source of truth by collecting and integrating data from multiple systems into a centralised pipeline. This overcame data silos and inconsistencies.
- The DMS allows full visibility and traceability across the production process, enabling customers to trace products back to raw materials and understand environmental impacts.
- Root cause analysis that previously took weeks can now be done in days by leveraging the infrastructure to drill down from finished products to specific machine data and raw material batches.
- Digital twins and historical process data storage help solve new problems that arise by facilitating quick comparisons of different machine set-ups and product batches.

Lessons learned - from our webinar series

Think big, start small, scale fast.

Avoid fragmentation with a systemised approach.

The leadership team's involvement is crucial.

Established change management principles should be followed.

Get an assessment on smart factory readiness. Singapore's Smart industry Readiness Index is a good tool for manufacturers to benchmark their readiness and progress.

You need a focus on workforce learning and development - it is an ongoing process.

Five big myths about Industry 4.0 debunked

The advent of Industry 4.0 has been a game-changer for the manufacturing sector and can deliver real returns for New Zealand businesses, through increased efficiency, productivity, and innovation.

But some manufacturers remain hesitant to embrace these technologies. This reluctance often stems from persistent myths that cast doubt on the practicality and benefits of Industry 4.0.

In this section, based on Callaghan Innovation's experience working with New Zealand manufacturers who are on their Industry 4.0 journey, we dispel some of these myths and provide evidence-based solutions to encourage manufacturers to confidently step into the future of industry:

Myth 1: Industry 4.0 is only for large corporations

The Reality: Industry 4.0 is not exclusive to large enterprises. Small and medium-sized enterprises (SMEs) can also leverage these technologies to enhance their operations. Indeed, as a nation of SMEs, this is where Industry 4.0 technologies arguably have the most potential to boost productivity and economic output. Companies like Nautech, and United Machinists, are two examples of SMEs deploying Industry 4.0 technologies to good effect.

The key is to start small and scale up. For instance, SMEs can begin by implementing sensors and data analytics to optimize their existing processes. Retrofitting new hardware systems to older equipment can be a cost-effective way to integrate Industry 4.0 technologies without the need for significant upfront investment.

Myth 2: Exorbitant costs outweigh the benefits

The Reality: While initial investments may seem daunting, the long-term benefits of Industry 4.0 technologies can lead to substantial cost savings and increased efficiency. A PwC study found that companies can expect to reduce operational costs by 3.6% annually while increasing efficiency by 4.1% annually, on average, by embracing Industry 4.0.

The declining cost of developing and deploying these technologies as they become standardised, has also made them more accessible than ever before.

Myth 3: Automation will lead to massive job losses

The Reality: Automation does not necessarily equate to job elimination. Instead, it often leads to the creation of new roles and opportunities. A classic example of this from the world of manufacturing is the introduction of the assembly line by Henry Ford in 1913. It reduced the amount of time it took to build a Model-T Ford from 12.5 hours to 1.5 hours. It led to more production, increased sales, and expanded employment.

Similarly, Industry 4.0 generates demand for new skill sets, such as data scientists, software engineers, and specialist machine operators, which poses new opportunities for employees to upskill and take on higher-value, better paying roles.

Myth 4: Implementation is too complex

The Reality: While integrating Industry 4.0 technologies can be complex, it is not insurmountable. New Zealand companies such as Silver Fern Farms, Fisher & Paykel Healthcare, and Bostock, have discovered that integrating these technologies as pilot projects can lead to them being scaled up to be used effectively on a wider scale.

Myth 5: Industry 4.0 lacks proven success

The Reality: There are numerous success stories locally and around the world that showcase the tangible benefits of Industry 4.0.

To overcome these myths, manufacturers should consider the following evidence-based solutions:

- **Start Small and Scale:** Begin with pilot projects that address specific pain points and gradually expand as confidence and expertise grow.
- **Focus on training and upskilling:** Invest in training programs to equip the workforce with the necessary skills to work alongside new technologies.
- **Leverage Partnerships:** Collaborate with technology providers and industry experts to navigate the complexities of implementation.
- **Monitor ROI:** Keep track of the return on investment to evaluate the effectiveness of Industry 4.0 initiatives and make informed decisions about future investments.
- **Stay Informed:** Keep abreast of industry trends and success stories to understand the evolving landscape and potential applications of Industry 4.0.

By addressing these myths with clear, evidence-based solutions, manufacturers can confidently adopt Industry 4.0 technologies and secure their place in the competitive landscape of the future.

New Zealand's productivity paradox

– how Industry 4.0 can help

Despite having a policy environment that should theoretically support high levels of productivity, New Zealand's actual productivity is significantly below the OECD average.

This gap has persisted for decades, raising concerns about the country's economic future and the well-being of our citizens. Successive governments have sought solutions to this problem, including adjusting immigration settings to make it easier to make it easier to import skilled labour, and offering the 15% R&D Tax Incentive to encourage business investment in research and development.

Our policy settings, including investment in physical capital and education, suggest that New Zealand's GDP per capita should be 20% above the OECD average. Instead, it lingers over 20% below.

The New Zealand Institute of Economic Development released two reports in early 2024, commissioned respectively by ASB and Spark, which pointed to relatively low uptake of advanced technologies as contributing to our stubbornly low productivity growth.

Below, we explore the lag in take-up of advanced technologies in New Zealand, and the potential for increased investment in Industry 4.0 to boost the productivity of our manufacturing sector.

But poor use of technology is just one factor contributing to our patchy productivity track record. Here are some of the others:

International isolation, primary focus and market access

One of the key factors contributing to New Zealand's productivity paradox is its geographical isolation. Our country's distance from major markets hinders our firms' access to large customer bases and participation in global value chains, which are crucial for the transfer of advanced technologies. This isolation not only affects the export potential but also limits the inflow of new ideas and innovations that typically accompany close international trade relations.

Additionally, the importance of the primary sector to our economy may place a limit on the productivity gains we can make. While dairy and sheep farmers, as well as horticulturalists and aquaculture firms have made significant productivity gains over the last decades, these industries are inherently less able to achieve significant productivity increases compared to knowledge-based industries.

"It's very hard to get an extra litre of milk out of a cow, or an extra metre of timber out of a tree. But it's really easy to get additional productivity growth out of IT, or out of financial services," Council of Trade Unions economist Craig Renney, told the Herald in April, 2024[28].

Underinvestment in knowledge-based capital

Another significant issue is the underinvestment in "knowledge-based capital," particularly in research and development (R&D) by the business sector. New Zealand's R&D expenditure is among the lowest in the OECD, which impairs its capacity for "frontier innovation" – the development of new technologies and products.

According to Stats NZ29, between 2020 and 2022, R&D expenditure reached $5.2 billion, up 11%. R&D as a percentage of GDP increased from 1.46% to 1.47%. But the business sector's contribution to R&D expenditure as a percentage of GDP fell from 0.87% to 0.86%. The number of full-time equivalent (FTE) staff working on R&D stayed static at 39,000.

Research and Development Expenditure

Sector[2]	2016[3]	2017	2018[3]	2019[4]	2020		2021[4]	2022
	$(million)							
R&D Expenditure								
Business	1,602	...	2,134	2,407	2,709		2,843	3,093
Government(excl higher education)	658	...	828	...	802	R	...	900
Higher education	877	...	960	...	1,202	R	...	1,254
Total all sectors	**3,136**	**...**	**3,922**	**...**	**4,713**	**R**	**...**	**5,247**
Expenditure as a proportion of GDP[6]								
Business	0.63	...	0.73	0.79	0.84		0.87	0.86
Government(excl higher education)	0.26	...	0.28	...	0.25		...	0.25
Higher education	0.34	...	0.33	...	0.37		...	0.35
Total all sectors	**1.23**	**...**	**1.35**	**...**	**1.46**		**...**	**1.47**

Source: Stats NZ

28 https://www.nzherald.co.nz/business/productivity-fails-to-fire-why-are-we-working-more-for-less/

29 https://www.stats.govt.nz/information-releases/research-and-development-survey-2022/

As the Productivity Commission, which was disestablished in March, noted: "New Zealand businesses are typically capital-shallow (i.e. workers have limited equipment and other capital goods to work with) and this has held down labour productivity".

This underinvestment also affects the country's ability to absorb and implement existing technologies developed elsewhere, a process known as "technological catch-up."

The regulatory environment

An excess of regulation and red tape can dissuade businesses from pursuing investment in research and innovation that has the potential to boost productivity.

Dave Heatley, an economic consultant who worked at the Productivity Commission up until 2021, says restrictive regulation and the country's planning and consenting systems have had an impact on productivity.

"We're making it harder to make pro-productivity choices. If a factory can expand when demand goes up, that's going to help the economy along. But if it costs too much to expand the factory, you'd leave it the same size," he told the *New Zealand Herald*.

"Improving productivity requires change, and we've got a lot of institutions that are almost designed to slow down, or even prevent, change."

A key policy of the National Party30 leading into the 2023 election was to liberalise biotechnology laws in New Zealand, with the aim of stimulating innovation in genetic engineering and pioneering new techniques including gene editing.

The coalition Government's Fast-track Approvals Bill31 l is also designed to spur investment in significant land use development projects.

The role of management quality

The quality of management in New Zealand has been identified as a factor that lowers productivity gains from new technology.

Good management practices are essential for effectively integrating new technologies into business operations. Without skilled management, even the best technologies can fail to produce the desired productivity improvements.

Government's role in encouraging technology adoption

The government has a crucial role to play in encouraging technology adoption and addressing the productivity paradox. This includes monitoring technology adoption and labor market trends, fostering business-research links, and providing support for firms to navigate the digital transformation

30 https://www.national.org.nz/harnessingbiotech

31 https://www.rnz.co.nz/news/political/514743/government-releases-list-of-organisations-shoulder-tapped-for-fast-track-consents

There is much debate as to whether successive governments have put the right policy settings and funding mechanisms in place to incentivise R&D spending.

Policies that strengthen the national innovation system can help raise the "absorptive capacity" of local firms, enabling them to better identify and adopt productivity-enhancing technologies.

Advanced manufacturing was prioritised by the former Labour Government as one of seven areas of industry that would receive an Industry Transformation Plan. The Advanced manufacturing ITP was published in 2023, though its future development under the new coalition Government is unclear.

However, the new Government signalled the importance of manufacturing early in its new term, appointing Andrew Bayly as Andrew Bayly Minister for Small Business and Manufacturing November 27, 2023.

Manufacturing has a lot to gain from investment in advanced technology

The slow adoption of advanced technologies in manufacturing is a critical aspect of New Zealand's productivity paradox. Manufacturing employs around 250,000 New Zealanders,

accounting for 10.7 per cent of the workforce32.

While some manufacturers in New Zealand are at the forefront of digitalisation, many are far from adopting digital technologies that could transform their operations and boost productivity.

"New Zealand has a longstanding productivity problem, and continues to grapple with sluggish output per worker, most noticeably within the manufacturing sector. Over the last 20 years, the country recorded annual labour productivity growth of 1.44%. Manufacturing was the lowest performing sector with 1.14%, behind the service and primary sectors on 1.50% and 1.61% respectively," the Technology Investment Network's 2023 Advanced Manufacturing Report noted.

Advanced technologies that automate routine processes, improve health and safety, and free up workers to devote time to higher value tasks, will ultimately improve the manufacturing sector's labour productivity - if deployed at scale.

As the Advanced Manufacturing Industry Transformation Plan points out33: Experience domestically and internationally... is that investment in advanced technologies improves productivity, requires higher-skills, and leads to wage growth for workers in advanced manufacturing.

32 https://www.mbie.govt.nz/dmsdocument/26245-advanced-manufacturing-industry-transformation-plan

33 https://www.mbie.govt.nz/dmsdocument/26245-advanced-manufacturing-industry-transformation-plan

"We have heard from companies who upskilled existing employees, who were then able to move into new, more productive roles following the introduction of advanced technologies and processes."

While investment in specialist machinery, robots, and technologies like 3D printing can aid manufacturers, an overall productivity boost can be achieved simply by embracing digital transformation, an area where manufacturing has traditionally lagged relative to other sectors of the economy.

This hesitancy to embrace new technologies is partly due to a lack of understanding of the potential benefits, as well as concerns about the costs and complexities involved in implementing such technologies.

Two recent studies by the New Zealand Institute of Economic Research, commissioned by ASB and Spark respectively, combined insights from global research of small-advanced economies and economic modelling by NZIER.

The research found that a 20% uplift in advanced digital technologies would increase industry output by up to $26 billion over the next decade, and GDP by as much as 2.08% per year.

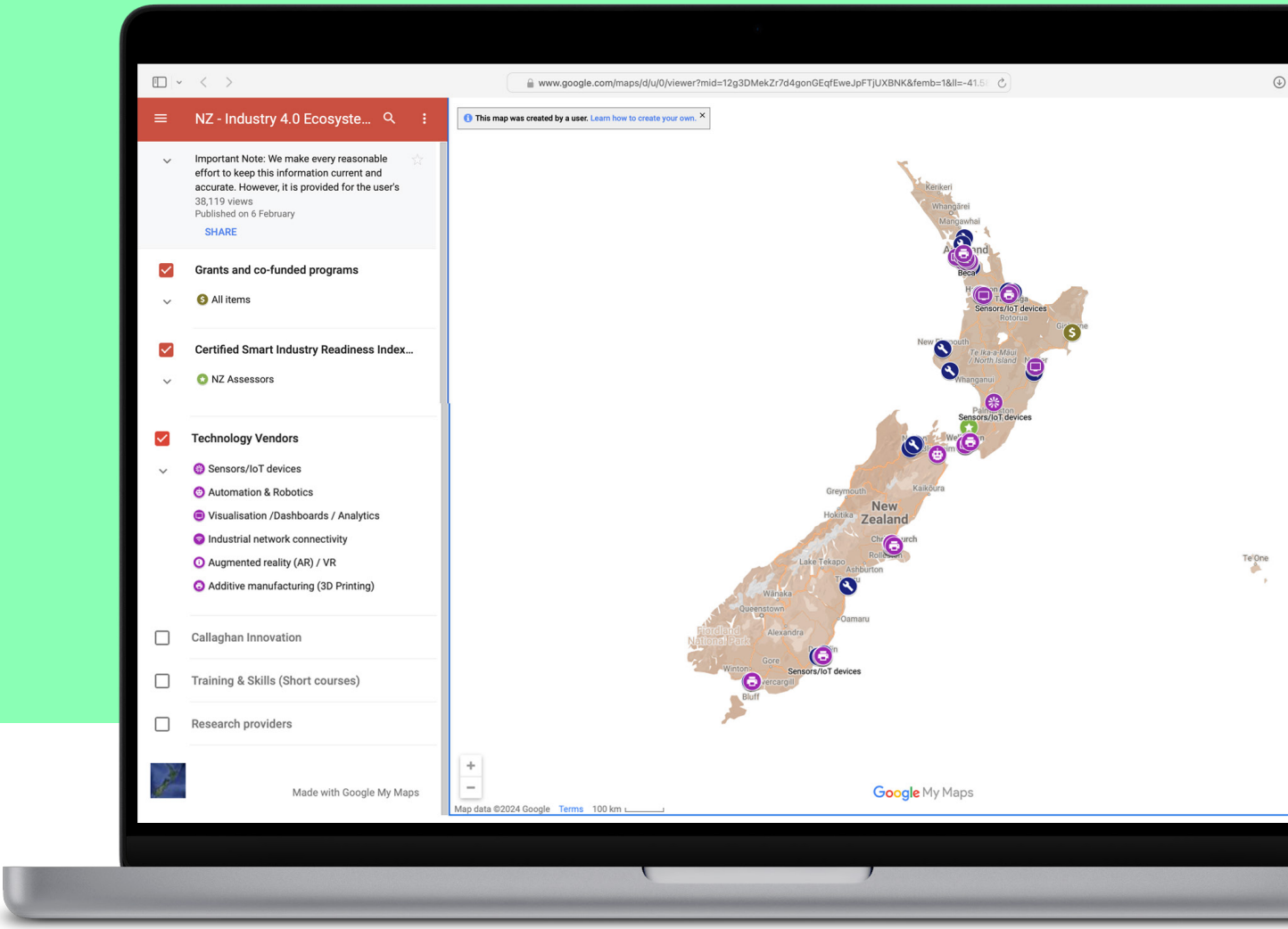
"Aotearoa is getting bigger, older, and more diverse. Inflation is forcing a greater focus on efficiency and cost control, and we are facing more frequent and extreme weather events. The good news is that the pace of technological advancement globally is accelerating at an even faster rate, and advanced digital technologies are now reaching a level of maturity where they have the potential to solve business challenges where it wasn't possible in the past," Spark Chief Executive Officer Jolie Hodson said.

Final thoughts

New Zealand's productivity paradox is a multifaceted issue that requires a concerted effort from both the private and public sectors. While the country's isolation and underinvestment in R&D are significant hurdles, the lagging adoption of advanced technologies is an area where immediate improvements can be made.

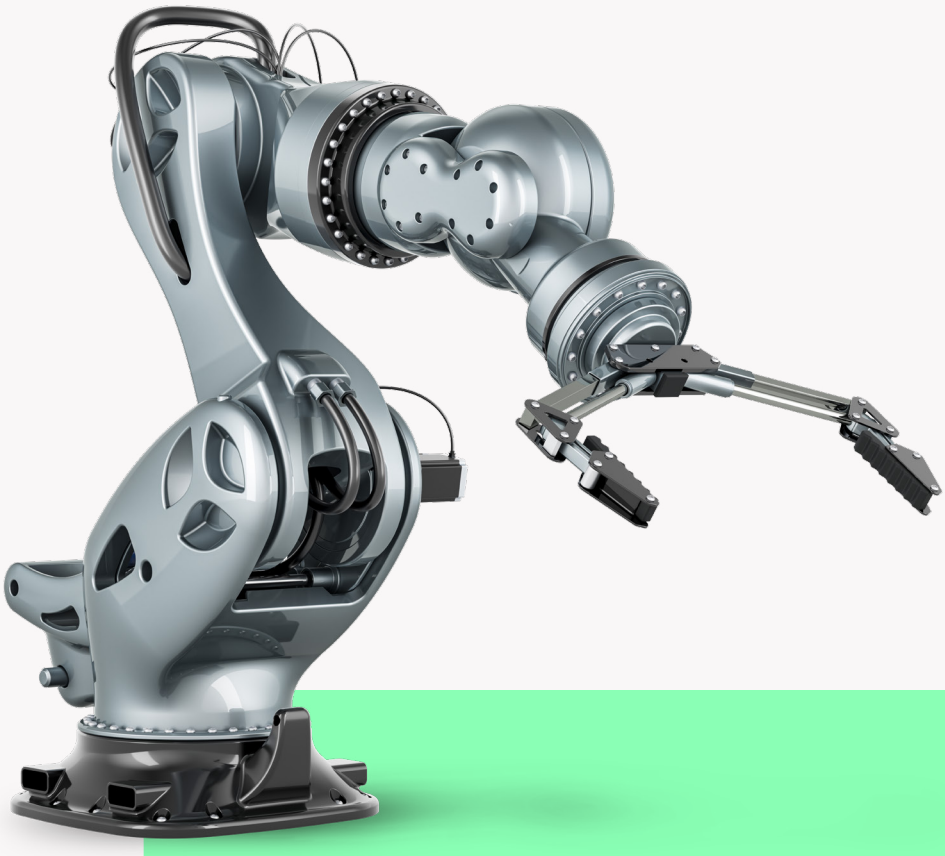
By embracing digital transformation and fostering a culture of innovation, New Zealand can close the productivity gap and secure a prosperous economic future.

NZ Industry 4.0 Ecosystem Map



Go to map

Industry 4.0



Sean Doherty
Product Manager, Industry 4.0 / Advanced Manufacturing
www.industry4.govt.nz

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