![Regional Development Australia Loddon Mallee logo]

LODDON MALLEE

Industry 4.0 Business & Investment Prospectus

Maturity Assessment Report

January 2023

REGIONAL DEVELOPMENT VICTORIA

Contents

Executive Summary

This Maturity Assessment Report reviews and analyses key documents, data, and the views of expert stakeholders across Loddon Mallee to understand the Region's advantages, opportunities, and gaps in the Industry 4.0 sector.

The purpose of this Report is to provide relevant insights, analysis and direction for improving the Region's Industry 4.0 opportunities and support the development of an Industry 4.0 Business and Investment Prospectus.

Process

This Report's assessment employs research, engagement, and data analysis to understand the global and local trends driving Industry 4.0 development in Loddon Mallee.

Targeted interviews with academics, researchers, and regional businesses, were undertaken to understand the best that Loddon Mallee has to offer potential enterprises, investors, and new residents.

In tandem with analysis of Industry 4.0 jobs data in Loddon Mallee, key economic and social indicators were benchmarked across the Region's LGAs to give an outcomes-based assessment of Industry 4.0 performance and potential.

These insights form the core of the final maturity assessment beginning on page 31.

Key Findings

This Report identifies key trends driving Industry 4.0 maturity both globally and in Loddon Mallee, including:

Cyber Security	Decentralisation
Demand for Connectivity	Industrial Internet of Things (IIoT)
Industry 4.0 Inevitability	Demand for Skills

The Report also highlights potential action areas for decision-makers in Loddon Mallee to boost the Region's existing Industry 4.0 maturity, including:

- Accessibility and affordability of adequate connectivity
- Attraction and retention of a suitable workforce
- Accommodation shortages
- Misconceptions of the Loddon Mallee Region, and misconceptions of careers in manufacturing, agriculture, healthcare etc

A detailed summary of these key insights can be found on pages 8 and 9.

Introduction

Regional Development Australia Loddon Mallee (RDALM) have engaged Delos Delta to prepare an Industry 4.0 Investment and Business Prospectus (the Prospectus).

This Industry 4.0 Maturity Assessment Report (the Report) analysed the Industry 4.0 competitive advantages enjoyed by Loddon Mallee (the Region). It identified opportunities to enhance funding and investment for Industry 4.0 in the Region.

The Region was broadly assessed across the following areas of interest:

- Knowledge of pre-existing Industry 4.0 and IT businesses within the Region and the extent to which they cluster across locations and sectors
- Research, development, and innovation capacity in the Region
- Strength and resilience of the manufacturing sector to embrace digital disruption in the Region
- Liveability and amenity of the Region and the implications this has on Industry 4.0
- The availability of training and education resources
- The availability of a suitable workforce
- The availability of the requisite technology necessary to enable Industry 4.0

This assessment underpinned the development of Prospectus that showcases the best of Loddon Mallee for potential enterprises, investors, and employees.

What is Industry 4.0?

Industry 4.0 refers to the fourth era of industrial development and innovation. As opposed to the conventional automation processes of Industry 3.0, Industry 4.0 is characterised by the integration of cyber-physical systems (CPS) into industrial processes and automation.[1] Cyber-physical systems are software-embedded networks which collect, store, and evaluate data, affect processes, connect with other systems, and possess interfaces for human-machine interaction.[2]

While cyber-physical systems form the core of Industry 4.0[3], the original conception of Industry 4.0 rests upon nine technological pillars through which industry and business are transformed to become increasingly integrated, automated, and more efficient.

Table 1: The Nine Foundational Pillars of Industry 4.0

Big Data and Analytics	**System Integration**
Autonomous Robots	**Industrial Internet of Things (IIOT)**
Simulation	**Cybersecurity**
Cloud Computing	**Additive Manufacturing**
Augmented Reality[4]	

Definitions of Industry 4.0 have evolved as regions develop and adapt digital technology, data, and innovation to suit local requirements. For instance, Industry 4.0 paradigms have become increasingly individualised[5], or tailored to local contexts. This trend could have significant implications for Loddon Mallee as it looks to develop advantages in specific sectors and industries.

In Loddon Mallee, the shift towards Industry 4.0 could impact several sectors including manufacturing, agriculture, healthcare, education, and the public sector (where the delivery of critical infrastructure and services will be increasingly aided by the use of digital technology, data, and innovation). This Report has focused its analysis on areas of Industry 4.0 relevant to Loddon Mallee.

Why is Context Important?

To build lasting Industry 4.0 competitive advantages in Loddon Mallee, it is necessary to identify:

- The existing regional strengths across industries, sectors, and geographic locations
- The specific ways in which digital technologies, data, and innovation can be leveraged to improve the efficiency of outcomes in these areas

Contextual analysis helps to inform decision-makers of the opportunities and challenges facing local industry and service providers looking to integrate smart solutions into their operations.

Analysis included:

- Global trends
- Regional jobs growth
- Skills shortages
- Education offerings
- Economic and digital readiness indicators

Methodology

Desktop Research   **Stakeholder Engagement**   **Economic Indicators**

This Report leveraged insights from three distinct inputs: desktop research; stakeholder engagement; and a variety of economic indicators.

Desktop Research

This Report synthesised Industry 4.0 trends at the global, national, and local levels, with an explicit focus on the current and emerging opportunities relevant to business and services in Loddon Mallee and its constituent regions.

Stakeholder Engagement

Targeted stakeholder engagement built a comprehensive understanding of the strengths, challenges, and barriers to increased Industry 4.0 activity at both the regional and local level.
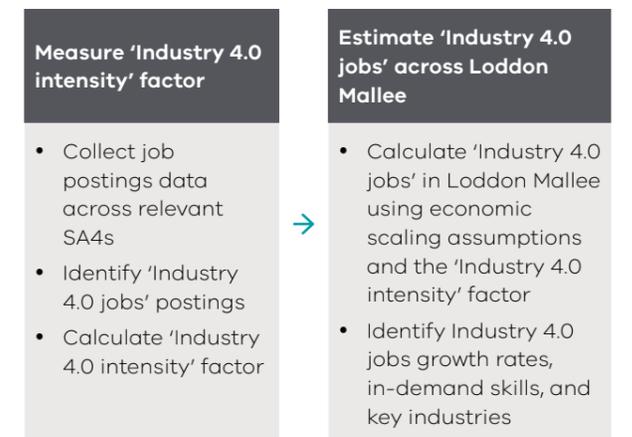
Economic Indicators

The benchmarking of key Industry 4.0 indicators presented insights into the skills, qualifications, and economic clusters across the Region's constituent Local Government Areas. The inclusion of four LGAs outside of Loddon Mallee helped to build a broader comparative analysis.

At the most granular level, the analysis of Industry 4.0-related jobs across the Region offered insights into the competitive advantages, as well as sector and skills-based deficiencies, in the Loddon Mallee.

It is worth noting that Industry 4.0 related activities are difficult to measure due to the lack of direct statistics. Industry 4.0 job postings thereby offer a representative sample of Industry 4.0 employment in a given year.

The following assessment method was adopted to measure the number of total Industry 4.0 related jobs across Loddon Mallee:

Measure 'Industry 4.0 intensity' factor	**Estimate 'Industry 4.0 jobs' across Loddon Mallee**
- Collect job postings data across relevant SA4s - Identify 'Industry 4.0 jobs' postings - Calculate 'Industry 4.0 intensity' factor	- Calculate 'Industry 4.0 jobs' in Loddon Mallee using economic scaling assumptions and the 'Industry 4.0 intensity' factor - Identify Industry 4.0 jobs growth rates, in-demand skills, and key industries

1. Shane Loughlin, 2018, 'Industry 3.0 to Industry 4.0: Exploring the Transition', 2.
2. Rajabahadur V. Arcot, 2021, 'Cyber-physical systems: The Core of Industry 4.0'.
3. Fengwei Yang, Sai Gu, 2020, 'Industry 4.0, a revolution that requires technology and national strategies', 1312.
4. Michael Rüßmann, Markus Lorenz et al, 2015, 'Industry 4.0: The Future of Productivity and Growth in Manufacturing Industries', 2015.
5. Yang, Gu, 2020, 'Industry 4.0, a revolution that requires technology and national strategies'.

Key Insights

Leveraging insights from research, engagement, and the analysis of economic indicators, several key focus areas for Loddon Mallee were identified.

## Economic Foundations and Industry 4.0 Readiness

The Report examined Loddon Mallee's existing progress and ability to embrace future disruption including Industry 4.0 concepts and technologies.

- Loddon Mallee possesses developing clusters of Industry 4.0 activity in urban centres e.g. Bendigo and Mildura, and along emerging growth corridors e.g., Murray Mallee, and the Regional Employment and Innovation Corridor.
- Clusters of Industry 4.0 activity broadly correlate with higher living standards across Loddon Mallee.
- The uptake of Industry 4.0 technologies in Loddon Mallee could be accelerated through direct financial support from government, along side the purchase or rezoning of land for industrial purposes.
- Local endowments make Loddon Mallee an attractive place to live and work, but misperceptions of the Region persist exacerbating workforce shortages.
- A lack of suitable and affordable digital connectivity has constrained Industry 4.0 maturity in remote areas of primary production.

Skills, Education, and Jobs

- Research and engagement revealed that Loddon Mallee's Industry 4.0 activity benefits from the existence of several innovation networks, centres, and industry advocacy groups. These groups provide advantageous links between industry and academia, and help to promote the uptake of Industry 4.0 concepts and technologies.
- In the Mallee, workforce shortages are exacerbated by a lack of suitable accommodation. This challenge is particularly acute for agricultural place-based learning and research providers (see for example Birchip Cropping Group, page 16).
- Loddon Mallee is home to world-leading research and educational institutions with specialisations in Industry 4.0.
- Loddon Mallee was estimated to have an approximate total of 4,000 Industry 4.0 jobs as part of a total 138,450 jobs across the Region in 2021.
- There exists a clear trend in recent years towards the integration of Industry 4.0 concepts into sectors across the Region. Figure 1 shows a year-on-year growth rate of the total number of Industry 4.0 jobs over the past year alone was 66.8%, despite a 2.0% reduction in total jobs across the same period.

Figure 1: Total Jobs vs. Total Estimate Industry 4.0 Jobs – Loddon Mallee

Total Jobs   ● Estimate Industry 4.0 Jobs

Delos Delta Analysis, Lightcast™
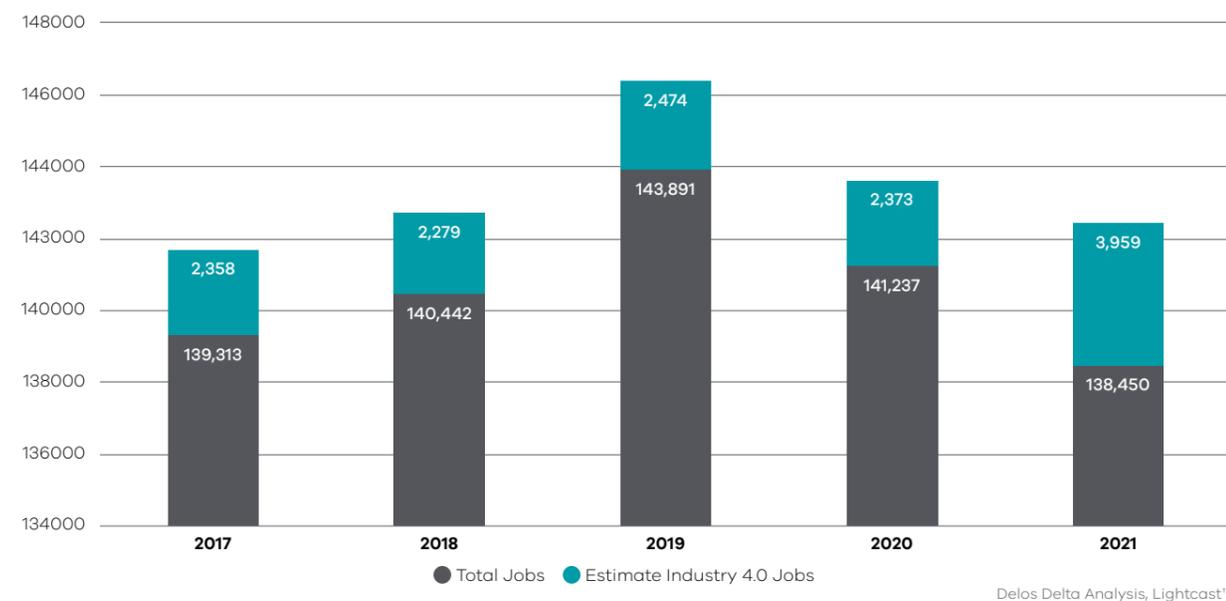
For Loddon Campaspe (in the southeast of Loddon Mallee), Figure 2 shows Financial and Insurance Services, and Professional, Scientific, and Technical Services lead in providing total Industry 4.0 job postings in 2021 (33.3% and 17.9% respectively). This reflects Bendigo's status as a diverse business and services hub.

Figure 2: Top Industries by Industry 4.0 Job Postings – Loddon Campaspe

Delos Delta Analysis, Lightcast™
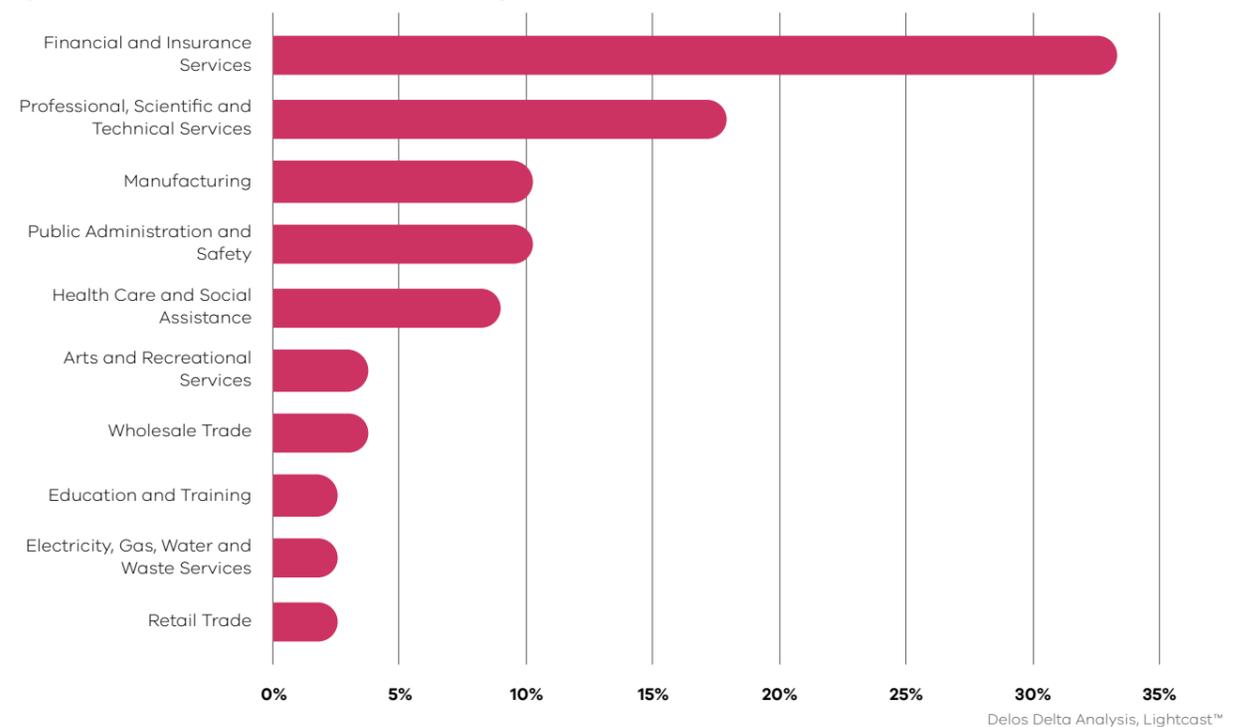
Global Trend Analysis

This section presents a sample of the global trends shaping the development of Industry 4.0 across the world and the associated opportuities and challenges they may present for Loddon Mallee.

A clear understanding of Industry 4.0 trends is important to help define best practices, measure success in relation to global leaders, and to assess the maturity of Loddon Mallee.

Table 2: Industry 4.0 Trends

Global Trend	Opportunities and Challenges	Examples
Inevitability The transition towards Industry 4.0 is an ongoing and unavoidable process.[6] As digital systems become increasingly prevalent and sophisticated, businesses and communities stand to reap the benefits of increased productive capacities.	As an ongoing but early-stage process, Industry 4.0 can provide interested parties with early mover advantages, allowing for the solidification of relative regional strengths. The uptake of smart technology will likewise pose difficulties for regions that were slow to integrate Industry 4.0 concepts and could see the entrenching of regional deficiencies in these areas.	The Fraunhofer Institute for Industrial Mathematics ITWM, was an early mover in the Industry 4.0 space, linking university mathematics with practical applications. The Region's existing partnerships with this institution have highlighted the circular benefits associated with the development of world-leading educational institutions.
Decentralisation Within the policy space, a dispersion of responsibility avoids rigid and hierarchical decision-making. In productive settings, decentralisation means optimising manufacturing processes, enabling autonomous systems to oversee new, flexible, and modular approaches to production.[7]	Taking a regional and local approach to Industry 4.0 will allow Loddon Mallee's communities to develop distinct and decentralised policies to suit local conditions.	In Belgium, the decentralised federal system of policymaking allowed separate regional governments to introduce distinct and tailored digital transformation policies to develop regional advantages[8]
Industrial Internet of Things (IIoT) The Internet of Things relates to sensor-embedded physical objects with software to relay critical information over communication networks like the internet. Industrial IoT allows for increased automation, predictive maintenance, and the creation and analysis of big data in industrial settings.	Connected agriculture could provide significant opportunities for a key industry in Loddon Mallee. One estimate adds $3.5 billion of value to the agricultural sector in Victoria by 2030 through the use of internet-enabled digital agricultural practices.[9] IoT devices can provide the Region's farmers with opportunities to monitor soil nutrient levels, water levels, and livestock, and improve supply chains.[10]	Between 2016 and 2017 IoT activity contributed $74 billion or 4.5% to Australia's gross value added.[11] Farmers in the Shires of Loddon and Buloke have already participated in Victoria's successful On-Farm Internet of Things Trial which led to Agriculture Victoria's Digital Agriculture Investment Scheme.

Global Trend	Opportunities and Challenges	Examples
Demand for Connectivity Connectivity is the backbone of information communication. It acts as an enabler of Industry 4.0 because it allows data to be collected and exchanged more realiably and at ever increasing speeds.[12]	Inadequate connectivity is a key challenge for regions looking to attract Industry 4.0 related businesses. IoT devices, internet-enabled industrial processes and supply lines cannot be sustainably developed in areas with intermittent or slow connections.	The 100 Gig Bendigo project exemplifies the Region's existing commitment to world-leading connectivity and its intention to attract Industry 4.0 related businesses.
Cyber Security With increased connectivity and communication between internet-connected sensors, networks and systems comes a proportional increase in the importance of effective cyber security measures to safeguard industrial systems and manufacturing lines from digital threats.[13]	While the opportunities for effective and up to date cyber security are often intangible, the difficulties posed by cyberattacks can be devasting for any business or service provider.	In 2017 the 'Petya' ransomware brought businesses, factories, and service providers across the world, including Cadbury's Hobart-based factory, to a standstill by encrypting businesses out of their critical ICT infrastructure.
Demand for Skills To facilitate the transition to Industry 4.0, demands on the workforce are expected to change. A lack of skilled workers could inhibit the growth of Industry 4.0-related activity globally.	In Loddon Mallee, suitable connectivity could facilitate institutional partnerships and strengthen opportunities to employ talent remotely. Skills shortages also provide an opportunity for local education providers to cater their offerings to suit local businesses.	The global manufacturing industry is already using digital technology to accommodate shifts in the workforce. One example includes digital machine health technology which allows for workers to remotely monitor machine health and guide onsite activity.

6.   Ibid, 1316
7.   Nnamdi Anyadike, 2019, 'Decentralised Systems for 'Next Generation' Industrial Production
8.   Yang, Gu, 2020, 1325
9.   NFF, NBN, 2021, Connecting Australian Agriculture, 7
10. Australian Government, BCARR, 2021, Working Paper- Economic Impact of Ubiquitous High-Speed Internet: Agriculture Sector, 16
11. Ibid, 16

12. Yang, Gu, 2020, 1314
13. Saurabh Vaidya, Prashant Ambad, Santosh Bhosle, 2018, 'Industry 4.0 – A Glimpse', 236

The Industry 4.0 Context

This section offers a glimpse into the Industry 4.0 landscape of Loddon Mallee by looking at the policies, strategies and larger projects which go some way to demonstrate the Region's maturity in the Industry 4.0 space and the level of support and acceptance for Industry 4.0 concepts from governments and institutions.

The following list is not exhaustive but is designed to showcase a balance of initiatives across Loddon Mallee.

Research Insights

This section provides a summary of the key themes uncovered during the examination of the contextual landscape of Industry 4.0 maturity in Loddon Mallee.

Connectivity

Loddon Mallee faces a range of ongoing connectivity challenges for business and industry, with a particular need for better coverage for rural tourist sites, farm offices, and homesteads. As a fundamental requirement for the implementation of Industry 4.0 concepts and projects connectivity will remain a barrier to Industry 4.0 maturity if not improved.

Innovation Capacity

Loddon Mallee is strategically placed to benefit from the transition towards Industry 4.0. Local key industries including manufacturing, mining, and agriculture are suited to adopting Industry 4.0 concepts, while the Region's numerous innovation and research institutions can help to facilitate maturity for local business.

Partnerships

Loddon Mallee benefits from a network of partnerships which drive growth in the Industry 4.0 space. These networks help to promote smart solutions amongst business owners, identify local leaders to represent regional industries, and foster a collaborative environment of knowledge sharing and mutual benefit.

Local Endowments

Loddon Mallee benefits from a variety and abundance of endowments, including mineral resources, extensive agricultural space, transport connections and corridors, and several research and education facilities. There remains additional scope for optimisation to unlock the benefits of these endowments and attract business and skilled workers to the Region.

Industry 4.0 Testlabs in Australia

In 2017, the Australian Government launched the Industry 4.0 Testlabs with an explicit focus on improving the country's manufacturing industries. The initiative aimed to introduce organisations across sectors to Industry 4.0 concepts and develop collaboration amongst advanced manufacturing stakeholders.

Hosted by universities across Australia, Industry 4.0 Testlabs catalyse transformation in the Industry 4.0 space by providing a 'low-risk' means for companies to trial technologies in a collaborative or clustered environment.[14] The national Industry 4.0 Testlabs represent international cooperation between Australia and Germany, with collaborative working groups established across four key elements:

- Reference architectures, standards, and norms
- Security of networked systems
- Research and innovation
- Work, education, and training

The Testlabs mark the start of the Australian Government's official attempts to incorporate Industry 4.0 concepts into industries nation-wide, especially through the development of international standards. Government led efforts towards Industry 4.0 previously sat within the context of 'a broader government digitalisation agenda', with much of the Industry 4.0 specific progress to date driven by the collaboration of industry and research consortia.[15]

Industry 4.0 Testlabs in Melbourne provide opportunities across Victoria for increased cooperation and collaboration between world-class research institutions and regional industry.

Central Victorian Advanced Manufacturing Initiative

The Central Victorian Advanced Manufacturing initiative was launched in 2020 as a partnership between La Trobe University, the City of Greater Bendigo, and the Bendigo Regional Manufacturing Group. With support from Germany's Fraunhofer Institute for Experimental Software, the group promotes advanced manufacturing in Bendigo.

The initiative will be a key enabler for Bendigo's Industry 4.0 maturity progression and represents an important partnership for the Loddon Mallee Region more broadly. Backed by $1 million of Victorian Government funding, the partnership aims to 'bridge the gap between research and practice', facilitating the free flow of information, processes, and relevant technology between researchers and regional industries.[16]

The benefits of projects associated with the partnership have already been felt throughout the Region:

Table 3: CVAM's Successful Partnerships - A Selection

Theme	Project	Opportunity
Agtech	Live bird traceability	Hazeldene's Chicken Farm in Lockwood are using sensor networks for the predictive maintenance of cages and to monitor livestock flows and animal health
Construction	Heavy vehicle turntables	The Australian Turntable Company in Kangaroo Flat are developing a heavy vehicle turntable to improve construction site safety and traffic management
Digital Twin	Digital network	Bendigo Telco is building a digital twin to assess the city's current network, helping to identify areas of low connectivity and assist future planning for a 100 Gig Bendigo. Don KR are building a digital factory model to help equipment and production integration and the creation of consumer demand data

In sum, Bendigo acts as a regional hub for the implementation of advanced manufacturing concepts and practices, with businesses embracing disruptive digital solutions to industry problems.

La Trobe University's Regional Advanced Manufacturing 4.0 Hub

In 2021, the Australian Government announced $2 million of funding from the Strategic University Reform Fund for the development of La Trobe University's Regional Advanced Manufacturing 4.0 Hub. Situated in La Trobe University's Bendigo campus, the Hub is building links between manufacturers, academics, technology providers, and promoting greater access to global markets for regional industries. The Hub is boosting Industry 4.0-related jobs in Bendigo and increasing the availability of skilled workers necessary for regional manufacturers across Loddon Mallee to compete in world markets.

Like other initiatives, international partnerships remain a key feature of the Manufacturing 4.0 Hub, with Germany's Fraunhofer Institute for Experimental Software Engineering playing a key role in the implementation of internationally recognised applied system innovations tailored to the unique characteristics of regional Victoria.[17]

La Trobe University's RAM 4.0 Hub represents a significant step for regional maturity in the Industry 4.0 space, with potential for the project to extend its reach to other regional campuses in Victoria including Mildura.

14. Prime Minister's Industry 4.0 Taskforce, 2017, 'Industry 4.0 Testlabs in Australia', 16
15. Mark Dean and John Spoehr, 2018, 'The fourth industrial revolution and the future of manufacturing work in Australia: challenges and opportunities', 166 – 178.

16. La Trobe, 2021, 'Partnership boosts local innovation'
17. La Trobe, 2021, 'Regional manufacturing gets new hub'

Deakin University Partnerships (ManuFutures)

As a key education provider in regional Victoria, Deakin University has established several partnerships to help drive Industry 4.0 maturity across Loddon Mallee.

Deakin University's collaboration with BendigoTAFE allows students to pursue combined qualifications between the two institutions.

Deakin's collaboration with Bendigo and Adelaide Bank has enabled the development of the Deakin University Community Bank, which establishes partnerships in regional centres to fund and facilitate innovative research.

Deakin University's partnership with the Bendigo Regional Manufacturing Group (BRMG) likewise provides opportunities for enhanced Industry 4.0 maturity by recalibrating how manufacturing careers are perceived, making them more appealing to new graduates and offering pathways for students into local businesses. BRMG have supported the Region's manufacturing sector since 2001 bringing innovative and high-valued manufacturing strategies to the Region while advocating for the uptake of Industry 4.0 concepts more broadly. Deakin University's commitment to advanced manufacturing is evidenced in its ManuFutures Innovation Hub. Built near Geelong, the Hub has provided businesses with skilled graduates, helped to incubate start-ups and comes equipped with spaces for industry collaboration and networking.

Deakin University's partnerships create new avenues for Industry 4.0 funding and research across Loddon Mallee.

100 Gig Bendigo

In 2020, the partnership between The City of Greater Bendigo and Bendigo Telco announced the 100 Gig Bendigo initiative, representing Bendigo's ambition to attract global talent, new businesses, and compete with Australia's largest cities.

The availability of superfast fibreoptic cable offers Bendigo a competitive advantage over other regional cities who have been slower and less ambitious in their provision of high-quality business grade connectivity. Connectivity is a key enabler for Industry 4.0 related services and forms a bedrock on which internet-enabled manufacturing, and other Industry 4.0 concepts, can be developed.

As a regional hub and digital leader, the City of Greater Bendigo is now interested in developing a geographic 'Regional Employment and Innovation Corridor', leveraging the existing advantages of the Region by infilling connection blackspots across Loddon Campaspe with a focus on the existing industry clusters situated along the Gisborne to Echuca rail corridor.[18] Ongoing international partnerships, such as with the Fraunhofer Institute in Kaiserslautern, as well as collaboration with other councils in the Region, also offer the chance for enhanced Industry 4.0 maturity in Loddon Mallee. For instance, while Bendigo-centric, a proposed Innovation District across Loddon Campaspe with 'spoke' options stemming from Bendigo could facilitate multiple opportunities for regional cooperation and Industry 4.0 integration. Likewise, the presence of tier three datacentres in Bendigo represents the city's desire to be competitive on a global stage.

Victoria's Cross Border Commissioner

In 2018, the appointment of Victoria's first Cross Border Commissioner represented a state-led aspiration to promote the interests of businesses, organisations, and individuals in Victoria's border regions. From Mildura to Campaspe, Loddon Mallee's border regions often operate with the additional challenge of differing rules, regulations, policies and practices. The Cross Border Commissioner's Strategic Plan 2021 – 2023 outlines ambitions to develop cross border approaches to Industry 4.0-related enablers including education and training, infrastructure, transport, and digital connectivity.

Victoria's Cross Border Commissioner will help Loddon Mallee leverage its tri-state location in the transition towards Industry 4.0.

Agriculture Victoria – Digital Agriculture Programs

Agriculture Victoria's 2030 Agriculture Strategy makes explicit commitments to modernising Victoria's farms, by increasing the adoption of new technology, and growing a globally competitive AgTech industry in Victoria.[19]

In Loddon Mallee this investment has taken the form of:[20]

- $3.0 million of food to market grants
- $11.4 million of on-farm energy grants
- $0.2 million of young farmer scholarships
- $3.2 million of small-scale, craft, and AgriLinks grants
- $2.4 million of IoT grants

In particular, the creation of SmartFarms in the Shires of Buloke and Loddon, demonstrate Victoria's commitment to integrating Industry 4.0 concepts into one of the Region's predominant sectors both in terms of total output and workers employed. The Horsham SmartFarm in the Wimmera is focused on grains, using digital technology to develop 'seed-to-landscape' innovations which could help mitigate the impacts of climate change. Likewise, the Mildura SmartFarm works collaboratively with other SmartFarms in Victoria to develop and demonstrate new applications of AgTech.[21]

Success of the SmartFarms led to the development of the Digital Agriculture Investment Scheme to further support the adoption of technology in the food industry.

Mallee Regional Innovation Centre

The Mallee Regional Innovation Centre (MRIC) opened in 2019 to support the integration of innovation practices in production and natural resource management. The MRIC coordinates research across the University of Melbourne, La Trobe University and the Mallee based SuniTAFE to find solutions for local challenges in horticulture, water, energy, and the environment, in the Mallee region[22]. The Centre also supports industry collaboration and the sharing of new ideas within the Mallee community by hosting networking and innovation events.

A $1.7 million funding scheme has been committed by the National Energy Resources Australia to develop an Australian network of hydrogen clusters, one of which will be led by MRIC. The Mallee is therefore strategically positioned as a viable location to develop its own hydrogen capabilities. The announcement is a crucial step to build local skills and capabilities, which will help to unlock the Region's potential for a globally competitive hydrogen industry - expected to bring $11 billion and thousands of jobs to the national economy by 2050[23].

The MRIC has created real value, supporting the integration of Industry 4.0 concepts and technology in Loddon Mallee. The Innovation Centre continues to play a key role in strengthening the collaboration between the Region's leading academics and industry innovators.

18.   The City of Greater Bendigo, 2021, 'Submission to Infrastructure Victoria's Draft 30 Year Infrastructure Strategy, 1-34.

19.   Agriculture Victoria, 2021, 'Strong, Innovative, Sustainable: A New Strategy for Agriculture in Victoria'
20.   Agriculture Victoria, 2022, 'What is the Agriculture Strategy?'
21.   Agriculture Victoria, 2020, 'Our SmartFarms'
22.   Melbourne University 2020, 'Mallee Regional Innovation Centre (MRIC)'
23.   Regional Development Victoria 2019, 'Mallee Regional Innovation Centre'

Coliban Water

In partnership with Ventia, Coliban Water's IoT network provides commercial grade connectivity across 52 sites stemming from Kyneton to Gannawarra in the southeast of Loddon Mallee. Ventia's LoRaWAN technology facilitates the connection of Coliban's IoT devices across the Region, providing real-time data from automatic meter-readers in the field. The use cases for this Industry 4.0 capability extend well beyond utilities, where their use has allowed businesses to improve asset management, service levels, and reduce costs.

Existing IoT networks across Loddon Mallee provide a ready-made foundation to test and deploy Industry 4.0 solutions.

Birchip Cropping Group

The Birchip Cropping Group (BCG) apply science-based research to enhance agricultural practices with a particular focus on broadacre cropping. BCG is a not-for-profit led by farmers from the Wimmera and Mallee regions of Victoria who aim to improve agricultural communities through farmer-driven innovation.

BCG has research trial sites across the Mallee which investigate innovative solutions to a variety of farming problems in areas such as agronomics, farming systems, climate, plant nutrition, crop diseases, and weed, pest and risk management.

BCG have supported the development of several new agronomic technologies and farming practices, helping the Region mature in the Industry 4.0 space. With over 400 members BCG continues to help farmers make informed decisions, develop risk management strategies, and develop sustainable farming practices.

BCG is in the process of funding its NEXUS project which will provide an immersive and place-based experience, building on-site accommodation to support community collaboration and house researchers, academics and students.

Research from BCG is helping innovate the agricultural sector in the Mallee region by helping farmers find solutions to local challenges.

Loddon Mallee's Regional Partnerships

Mallee Regional Partnership and Loddon Campaspe Regional Partnership

The Mallee Regional Partnership and Loddon Campaspe Regional Partnership are two of nine partnerships across Victoria, established in 2016 by the Victorian Government in recognition that local communities are best positioned to understand the challenges and opportunities faced in their region.

When assessed collectively, the partnerships' plans and strategies help to give some indication of the Industry 4.0 maturity to date, and the specific advantages and deficiencies of the respective regions.

Table 4: Regional Digital Plans

Mallee Regional Digital Plan	Loddon Campaspe Regional Digital Plan
The Regional Digital Plans represent the partnerships' respective strategies to bridge the digital divide. The plans have far-reaching implications for Industry 4.0 where concepts and processes are increasingly reliant on internet-enabled and digital technologies. Between the two plans, the overarching challenge identified for additional Industry 4.0 maturation includes the provision of suitable connectivity networks for business and industry, with particular need for better coverage for tourist sites, farm offices, and homesteads.	
Specific digital advantages of the Mallee identified through the region's Digital Plan include: • The presence of core digital services (broadband and mobile) on par with Melbourne in Mildura, Swan Hill and other larger towns Specific digital challenges include: • Connectivity issues at tourism hotspots (fixed broadband, mobile) • Low infrastructure investment and service quality relative to metropolitan areas	Specific digital advantages of Loddon Campaspe identified through the region's Digital Plan include: • The presence of high-capacity fibre assets • The presence of advanced education institutions • The presence of advanced technology users including utility providers and manufacturers • Community and business collaboration to develop digital infrastructure Specific digital challenges include: • Poor regional mobile connectivity

Table 5: Regional Economic Development Strategies

Mallee Regional Economic Development Strategy	Loddon Campaspe Regional Economic Development Strategy
The Region's Economic Growth Strategies specify the aims, objectives, advantages, and deficiencies of the economies of the Mallee and Loddon Campaspe respectively, providing useful summaries of the key investment areas for the Region. Common to both strategies is the identification of growth corridors, including the Murray Mallee cross-border region and the Loddon Campaspe Employment and Innovation Corridor, and the increased demand for skilled workers in these areas.	
The Strategy also identifies the Mallee's comparative advantages, with endowments relevant to Industry 4.0 including: • Abundant mineral resources and fertile acreage • Environmental amenities necessary to attract talent and convenient cross-border hubs • Road and air transport connections, energy assets, and numerous education institutions The Mallee's strategic directions reflect the desire to develop new and diverse industries, enhance existing industries, promote cross-border participation, and attract talent to the Mallee.	The Strategy also identifies Loddon Campaspe's comparative advantages, with endowments relevant to Industry 4.0 including: • Abundant mineral resources, fertile land and water resources • A culture of innovation • Road, rail and air transport connections, energy assets, and numerous education institutions and partnerships Loddon Campaspe's strategic directions reflect the desire for diverse and innovative industries, growth in the regions supply chain and enhanced competitiveness with global players.
The 5 strategic directions identified by the Strategy include: 1. Drive sustainable growth in the food industry 2. Leverage natural endowments to diversify the economy into emerging industries 3. Enhance the visitor economy by developing natural, cultural and built attractions 4. Ensure an accessible and suitably qualified workforce to unlock the growth potential 5. Harness the economic potential of the region's cross-border zones	The 5 strategic directions identified by the Strategy include: 1. Support growth in agriculture and food product manufacturing to enhance value-adding throughout the supply chain 2. Pursue diversification of the tourism sector by leveraging natural, cultural, and built endowments 3. Maximise gains in the 'employment and innovation corridor' 4. Foster better links between education providers, industry, research, employers and students to develop career pathways and a workforce that meets the future needs of the region 5. Leverage local opportunities to strengthen value chains and diversify into new industries, including mining, renewable energy and waste processing

Table 6: Regional Skills Plans

Mallee Skills Plans	Loddon Campaspe Skills Plans
In the Mallee, the Victorian Skills Commissioner's 2017 Regional Skills Demand Profile, and its 2020 Pulse Check Update provide a comprehensive assessment of regional skills demand and the potential for a looming skills shortage.	In Loddon Campaspe, the 2019 Regional Engineering and Advanced Manufacturing Skills Road Map and the 2021 Health Sector Skills and Pathways Road Map provide recommendations to ensure workforce availability in these two important sectors.
Future growth is seen as dependent on attracting or developing workers across three categories: 1. Specialised roles including GPs, irrigation experts, and agronomists 2. High volume roles including carpenters and truck drivers 3. Seasonal roles predominantly in the horticulture and grain cropping sectors High workforce demand was predicted in sectors such as horticulture, transport, construction, and related industries, and was expected to flow into manufacturing industries where high yields and prices have driven demand for investment and machinery.[24] The Profile recommends a two-pronged approach to alleviate workforce challenges. This includes removing structural barriers to help attract and retain the region's workforce, while aligning local education and training opportunities with business needs.	Collectively the two road maps identify the following regional strengths and opportunities: • Good transport links for commuters and goods • Education opportunities including both vocational and tertiary • Affordable housing options • A large economy with linkages between the education and health sector particularly Likewise, they identify the following challenges: • Misconceptions over manufacturing and health sector jobs • Limited industry placements for current students • Skilled migration, and a gap between education and industry. The Health Sector Roadmap suggests that the health sector is not removed from the impact of the transition towards Industry 4.0, with technological change increasing the need for digital navigators who can utilise digital health solutions.[25]

24. Regional Development Australia, Regional Partnerships Mallee, 2020, 'Mallee Regional Skills Demand Profile'
25. Regional Partnerships Loddon Campaspe, 2019, REAM Skills Road Map, 2021 Health Sector Skills and Pathways Roadmap

Engagement Insights

Targeted engagement was undertaken to understand the best that Loddon Mallee has to offer potential enterprises and investors.

To elicit a range of opinions, opportunities, projects, and partners that drive Industry 4.0 success in the Region, stakeholders were engaged across a variety of sectors from the whole Loddon Mallee Region. The following stakeholders were engaged:

Organisation	Industry	Location
La Trobe University	Research / Education	Loddon Campaspe
Bendigo Health	IoT / Health	Loddon Campaspe
AgriNous	Agriculture	Loddon Campaspe
Bendigo Regional Manufacturing Group	Automation / Manufacturing	Loddon Campaspe
Birchip Cropping Group	Research / Dry Land Farming	Mallee
Mallee Regional Innovation Centre	Research/ Drought / IoT/ Water	Mallee
Mildura Regional Development	Research / IoT / Automation	Mallee
Cann Group Limited	IoT / Automation / Medicinal Cannabis	Mallee

Regional Advantages

Stakeholders across Loddon Mallee listed several industry-specific advantages enjoyed by the Region including the local manufacturing, AgTech, agriculture, mining, health, and education sectors. More specifically, **localised collaboration** between industry representatives, universities and research bodies, and businesses, were seen to give the Region a unique advantage in its ability to help businesses embrace digital disruption, affordably trial innovative technologies, and ensure a productive and mutually beneficial relationship between stakeholders.

Local skills and education offerings for Industry 4.0 related pathways were generally seen as adequate although stakeholders were broadly unanimous that more work could be done by education providers to ensure alignment with business needs. Some stakeholders suggested that micro-credentials and short courses aimed at experienced workers would be useful for businesses looking for employees who could

integrate specific smart technologies and processes. Stakeholders also saw Loddon Mallee as possessing relatively high capacities for Industry 4.0 related research and innovation, through the presence of education and research institutions including those in Bendigo, Mildura, Castlemaine, Echuca and Swan Hill.

In Bendigo specifically, stakeholders saw **access to high quality connectivity networks** as being a unique selling point of the city, allowing businesses to compete with national and international leaders and attract talent. Moreover, several stakeholders characterised Bendigo as a gateway to the north of Victoria and were aware of the strong rail, road, and air links in the area. Across Loddon Mallee more broadly, **transport links** were seen as adequate, with Mildura Airport playing a crucial role in enabling physical connections with metropolitan regions. However, some stakeholders in the Mallee saw a need for improved rail infrastructure as opposed to road infrastructure to help cater to industry growth in the agricultural sector and emerging hydrogen sector in this area.

More generally, stakeholders were unanimous in their appreciation for the high degree of liveability in the Loddon Mallee Region. Stakeholders saw low house prices, the availability of jobs, and the provision of amenities such as schools and parks as key strengths of the Region and were interested in their inclusion in the Industry 4.0 Business and Investment Prospectus. Nevertheless, stakeholders were concerned about the need to attract people to the Region to live and work. While stakeholders were generally happy with the ease of attracting investment capital in the Region, this potential growth was seen to be hindered by a perceived lack of suitable candidates to employ in expanding businesses.

Regional Challenges

Stakeholders across Loddon Mallee saw the attraction and retention of skilled workers as one of the greatest challenges facing the Region on its journey towards Industry 4.0 maturity. Stakeholders noted current misconceptions of the Region and the manufacturing and agricultural industries in particular as being key barriers to attracting talent. To address these misconceptions, stakeholders were interested in seeing more initiatives and actions aimed at marketing the Region as a place to live, work and settle. With its high levels of liveability, stakeholders emphasised the need

to promote the existing advantages of the Region and change attitudes of skilled workers who are hesitant to relocate from metropolitan areas.

Likewise, to address industry-specific misconceptions, stakeholders were interested in seeing local or state-led initiatives to promote education and career pathways into STEM, while also promoting the large variety of skills, jobs and experience needed in the manufacturing, agricultural, health, and mining sectors. Stakeholder sentiments regarding skills shortages aligned with the various skills plans and roadmaps undertaken throughout Loddon Mallee over the last five years which evidences a sustained challenge for the Region.

To drive Industry 4.0 maturity in Loddon Mallee, stakeholders identified a role for **government grants** to help businesses adopt smart technologies. Stakeholders suggested that grants should be used to reward businesses for integrating Industry 4.0 technologies and processes and should in some instances be delinked from the number of the potential jobs that would be created.

Figure 3: The Local Government Areas of Loddon Mallee

While housing and accommodation were sometimes viewed positively in the Region (and were generally characterised as affordable in comparison to metropolitan areas), several stakeholders in the Mallee highlighted **accommodation shortages** as a barrier to improving the offering place-based education and skills development programs in the Region. To address this issue, some stakeholders were interested in seeing sustained investment and funding for local networks and industry groups who were viewed as best placed to address local business needs. Likewise, stakeholders across Loddon Mallee interested in the idea of local governments rezoning or purchasing land to boost the availability of industrial space. These stakeholders also saw a role for state government to assist and advise on land use changes across Loddon Mallee.

Connectivity was a common theme of engagement and was identified as both a comparative advantage of the Region, as well as a potential barrier to increased Industry 4.0 maturity. Stakeholders operating near major roads, or towns and cities like Bendigo, were happy with the provision of reliable connectivity, including 5G networks to support their operations. Elsewhere across Loddon Mallee, a lack of reliable connectivity was viewed as a barrier to the use of internet-enabled technologies and IoT projects, especially in geographically remote areas of primary production. Stakeholders near Mildura identified suitable connectivity as being prohibitively expensive despite the ostensible access to NBN in the area. Stakeholders in the Mallee saw a role for local and state governments in ensuring that new developments and industrial zones are adequately connected. Stakeholder sentiments regarding connectivity aligned with the findings of the respective digital plans for the Mallee and Loddon Campaspe Regional Partnerships which explain in detail the widespread connectivity challenges facing the Region.

Industry 4.0 Benchmarking

This section examines Loddon Mallee and its constituent LGAs across a range of key indicators. Four additional LGAs outside of Loddon Mallee, Shepparton, Horsham, Yarriambiack, Ballarat, are also assessed to provide a state-based comparison.

Benchmarking Loddon Mallee's constituent LGAs gives an outcome-based assessment of Industry 4.0 performance and potential. A range of indicators have been used to provide a holistic approach to the assessment in the absence of direct Industry 4.0 statistics. This benchmarking provides both an important outline of the current level of Industry 4.0 maturity success and a valuable assessment of key areas of strength and challenges to target.

Methodology and Purpose

Benchmarking uses publicly available data on key indicators of Industry 4.0-ready regions to give a quantified measure of potential. Indicators provide a holistic snapshot of Loddon Mallee's economic foundations, Industry 4.0 potential, and information pertaining to relevant skills, qualifications, and jobs. While indicators can never tell the full story, they provide a valuable input into the final maturity assessment. LGAs are ranked on a scale of 1 – 10, with 1 being the best attainable rank. The selected indicators are shown in Table 7.

Table 7: Benchmarking Indicators, Rationale or Assumptions*

	Indicator	Rationale or Assumptions
ECONOMIC FOUNDATIONS	Median Age[26]	Lower median age can indicate increased potential for skills development and community with new technologies.
	Total Number of Businesses – Annual Growth Rate[27]	Accounting for business exits, the annual growth rate of new businesses from 2017 to 2020 can indicate the level of support provided to businesses, the ease of doing business, while also indicating the broader appeal of starting a business in the Region.
	Participation Rate[26]	Clusters of Industry 4.0 activity can provide increased employment & fulfilling opportunities as indirectly measured through the percentage of those aged 15-64 in the labour force.
	Gross Regional Product (GDP) Growth[28]	A growing economy is one that is thriving. This is critical in supporting modernisation and the uptake of Industry 4.0 concepts and practices.
	SEIFA Index of Relative Socio-Economic Advantage and Disadvantage[29]	A region with socio-economic disadvantage can have lower access to career and skills pathways, and technology, which can act as a barrier to Industry 4.0 maturity.
REGIONAL READINESS	Access to high-quality broadband[26]	High quality broadband is essential infrastructure for the innovation economy.
	Digital Inclusion Index[30]	Digital inclusion is vital for the maturity of regions in the Industry 4.0 space by ensuring digital skills and access to digital tools.
	Industry 4.0-Capable Land Use[31]	High levels of agricultural and intensive non-agricultural land use can indicate a future potential for the uptake of Industry 4.0 concepts in relevant sectors.
	Economic Development Expenditure[32]	Economic development expenditure as a percentage of total Council expenditure can give an indication of the level of local support and funding for integrating Industry 4.0 concepts into economies across Loddon Mallee.
SKILLS, EDUCATION, AND JOBS	% Population with University Qualifications[26]	Educated populations tend to learn more quickly which would result in rapid Industry 4.0-related skill improvement.
	% Population with Technical Qualifications[26]	High levels of technical qualification can evidence the existence of Industry 4.0 skills within a population, or the ability to acquire them.
	Employees in Industry 4.0-Capable Primary & Secondary Sectors[26]	Primary and secondary industries especially stand to rapidly benefit from the adoption of Industry 4.0 concepts and processes.

*Please note this benchmarking was undertaken prior to the release of Census 2021 data.

26. ABS (2016)
27. ABS (2017 - 2020), Delos Delta (2022)
28. RDV (2017 – 2021)
29. Profile.id (2016)
30. ADII (2021)
31. DAWE (2021)
32. Councils (2021 – 2022), Delos Delta (2022)

Economic Foundations

As broad measures of economic and business activity as well as socio-economic advantage and disadvantage, these Economic Foundations refer to 'building block' statistics which help to give an overall indication of Industry 4.0 maturity in Loddon Mallee.

Key Insights

- Based on the selected indicators, across Loddon Mallee, Macedon Ranges ranked 1/10, Bendigo ranked 2/10 while Loddon ranked 9/10 and Central Goldfields ranked 10/10.
- This benchmarking assessment highlights some of Loddon Mallee's existing employment and knowledge economy clusters including the section of Loddon Campaspe Innovation Corridor stemming from Gisborne (Macedon Ranges) to Bendigo. Likewise, in the strength of the cross border region of the Mallee is reflected in the relatively younger and more business-friendly economies of the Mildura and Swan Hill LGAs.
- Despite these clusters, there are greater opportunities to further improve each LGAs ranking following the development of the Industry 4.0 Investment and Business Prospectus and accompanying Activation Strategy.

Table 8: Economic Foundations

	Estimate Median Age[33]		Total Number of Businesses – Annual Growth Rate[34]		Participation Rate[35]		Annualised GRP Growth[36]		SEIFA IRSAD Ranking[37]		Score	Rank
Mildura	39.2	2	0.5%	8	55.6%	6	-0.4%	7	921	7	30	5
Swan Hill	40.3	3	1.7%	4	54.2%	6	-0.5%	7	934	6	26	4
Buloke	51.7	9	0.4%	8	49.9%	8	-1.6%	10	949	5	40	7
Gannawarra	50.9	8	-1.0%	10	52.2%	7	-1.8%	10	934	6	41	8
Loddon	53.0	10	-0.6%	10	47.4%	10	-0.5%	7	932	6	43	9
Campaspe	45.9	5	0.6%	8	55.1%	6	-1.2%	8	943	5	35	6
Bendigo	38.5	1	1.9%	3	58.2%	4	1.2%	3	961	5	16	2
Central Goldfields	51.3	9	1.2%	7	43.5%	10	-1.0%	8	870	10	44	10
Mount Alexander	50.1	8	1.9%	3	50.1%	8	1.4%	2	979	4	25	3
Macedon Ranges	42.1	3	2.6%	2	60.0%	3	1.4%	2	1047	1	11	1
Shepparton	39.0	2	0.8%	7	56.4%	6	-1.2%	8	937	6	29	5
Horsham	41.0	4	0.1%	9	60.2%	2	-0.7%	7	958	5	27	4
Yarriambiack	51.2	9	-0.9%	10	48.9%	9	-1.9%	10	932	6	44	10
Ballarat	37.6	1	3.0%	1	59.0%	3	2.8%	1	965	6	12	1

LGAs are ranked on a scale of 1-10.

Figures have been rounded.

● Mallee   ● Loddon Campaspe   ● Other LGAs

33. ABS (2020)
34. ABS (2017- 2020)
35. ABS (2016)
36. RDV (2017-2021)
37. Profile.id (2016)

Regional Readiness

As measures of digital access, inclusion, expenditure and land use, these Regional Readiness statistics help to give an indication of future Industry 4.0 potential in Loddon Mallee.

Key Insights

- Based on the selected indicators, across Loddon Mallee, Macedon Ranges ranked 1/10, Bendigo ranked 2/10 while Swan Hill and Central Goldfields jointly ranked 9/10.
- This benchmarking assessment highlights some of Loddon Mallee's future potential to incorporate Industry 4.0 concepts. Except for Mildura, where conservation reserves cover 46.6% of the LGA, land uses across Loddon Mallee are predominantly agricultural or intensive non-agricultural and can thus provide a setting for the use of Industry 4.0 concepts and technologies.
- Likewise, despite difficulties in comparing economic development spending percentages across Councils, half of the Region's local authorities take an active role (defined as >2% of total expenditure) in facilitating an environment conducive to a growing business sector, providing funding for residents to improve skills and access to employment.

Table 9: Regional Readiness

	Residential Access to Internet[38]		Digital Inclusion Index[39]		Industry 4.0 Capable Land Use[40]		Economic Development Expenditure*[41]		Score	Rank
Mildura	74.0%	5	64	7	42.4%	10	4.0%	5	27	6
Swan Hill	71.2%	7	64	7	90.4%	3	15.8%	1	18	3
Buloke	68.8%	9	60	8	94.4%	1	0.5%	10	28	9
Gannawarra	69.7%	8	60	8	86.7%	4	1.6%	7	27	6
Loddon	68.4%	8	58	10	89.6%	3	0.5%	10	31	9
Campaspe	74.6%	5	64	7	88.7%	4	10.9%	3	19	4
Bendigo	80.2%	3	70	2	77.7%	7	3.5%	5	17	2
Central Goldfields	68.2%	9	61	8	75.2%	7	1.3%	7	31	9
Mount Alexander	79.1%	3	64	7	81.3%	6	1.0%	7	23	5
Macedon Ranges	86.8%	1	71	2	88.5%	3	3.9%	5	11	1
Shepparton	77.4%	4	66	6	93.0%	2	1.0%	8	20	3
Horsham	75.2%	5	65	7	86.1%	4	1.2%	7	22	4
Yarriambiack	71.0%	7	61	8	90.2%	3	9.2%	3	21	4
Ballarat	80.6%	3	66	6	86.3%	4	1.3%	7	20	3

LGAs are ranked on a scale of 1-10.

● Mallee   ● Loddon Campaspe   ● Other LGAs

*There exist difficulties in accurately benchmarking this indicator given the inconsistent ways in which economic development activity is classified and reported.

38. ABS (2016)
39. ADII (2021)
40. DAWE (2020)
41. Councils (2021 – 2022)

Skills, Education, and Jobs

As measures of skills, education and jobs, these statistics, alongside the subsequent jobs posting analysis, help to give an indication of the availability of workers and the potential growth of Industry 4.0 related jobs in Loddon Mallee.

Key Insights

- Based on the selected indicators, across Loddon Mallee, Macedon Ranges ranked 1/10, Loddon ranked 2/10 while Mildura and Swan Hill jointly ranked 8/10 and Central Goldfields ranked 10/10.

- This benchmarking assessment highlights some of Loddon Mallee's regional strengths, including the high number of technical qualifications within the workforce. With practical and technical skills often a necessary component for continued Industry 4.0 maturity, areas of the Mallee including Gannawarra, Buloke, and Mildura strengthen their appeal for new or prospective businesses by offering a technically qualified workforce. These regions, including Loddon, already currently employ a large percentage of employees in primary and secondary industries which can readily benefit from the uptake of Industry 4.0 concepts and processes.

- In Loddon Campaspe, the Innovation Corridor from Gisborne (Macedon Ranges) to Bendigo, including Mount Alexander, again demonstrates its appeal to new businesses with both an academically and technically qualified workforce. With burgeoning tertiary industries, including healthcare and education services, these LGAs exhibit diverse economies, a strength which is not reflected in the benchmarking. Regardless, as seen from the research and engagement process, tertiary industries such as healthcare have readily adopted Industry 4.0 and smart concepts, while a strong education sector is likewise important to support ongoing Industry 4.0 maturity and provide knowledge sharing opportunities with local businesses.

Table 10: Skills, Education, and Jobs

	University Qualification[42]		Technical Qualification[42]		Employees in Industry 4.0-Capable Sectors[42]		Score	Rank
Mildura	10.3%	6	27.9%	4	25.8%	8	18	8
Swan Hill	9.0%	7	25.8%	6	33.0%	5	18	8
Buloke	9.8%	7	26.0%	6	39.0%	4	17	7
Gannawarra	7.8%	9	27.6%	4	40.8%	3	16	6
Loddon	8.5%	8	27.3%	4	48.9%	1	13	2
Campaspe	9.9%	7	30.1%	2	35.5%	5	14	3
Bendigo	16.3%	4	30.6%	2	23.2%	8	14	3
Central Goldfields	7.4%	9	29.0%	3	29.8%	7	19	10
Mount Alexander	22.4%	1	26.8%	5	24.7%	8	14	3
Macedon Ranges	22.0%	1	31.6%	1	22.5%	9	11	1
Shepparton	12.2%	5	27.6%	4	29.1%	7	16	6
Horsham	13.0%	5	31.3%	1	24.0%	8	14	3
Yarriambiack	8.2%	8	28.3%	4	36.1%	5	17	7
Ballarat	18.9%	3	29.1%	3	20.0%	10	16	6

LGAs are ranked on a scale of 1-10

● Mallee   ● Loddon Campaspe   ● Other LGAs

Industry 4.0 Jobs Analysis

This section examines Industry 4.0 activity by analysing relevant job postings across Loddon Mallee.

As noted, definitions of Industry 4.0 can be nebulous while the lack of direct measurement statistics can make it difficult to assess the growth of Industry 4.0 related activity. Despite this, interest in Industry 4.0 has grown world-wide as communities have become cognisant of the benefits, jobs and investment opportunities that can be realised.

As one of many inputs in the final maturity assessment, this jobs analysis provides important information relating to in demand Industry 4.0 skills in Loddon Mallee. The data demonstrates the general trend towards increasing Industry 4.0 intensity in the Region.

In this Report, Industry 4.0 job postings are used as a representative sample of Industry 4.0 employment in a given year. Industry 4.0 jobs are defined here as those that contain certain keywords in their job listing.[43] The applied methodology in this Report relies on the calculation of the 'Industry 4.0 intensity' factor as a proxy to estimate total Industry 4.0 jobs. Despite these difficulties, analysis of Loddon Mallee's Industry 4.0 activity identified key trends.
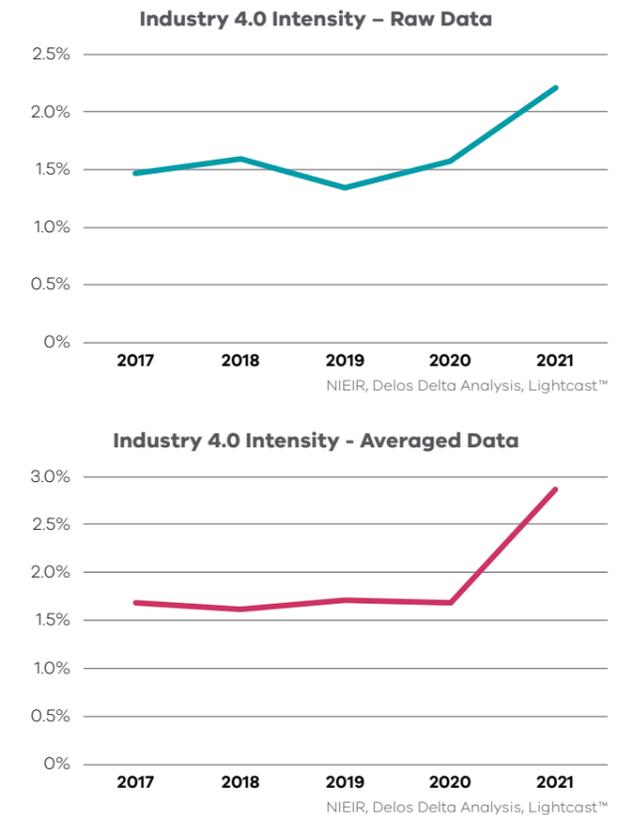
Industry 4.0 Intensity

Industry 4.0 intensity is calculated as the ratio of job postings that contain Industry 4.0 keywords to total job postings in a given year. In 2021, the data shows that the Loddon Campaspe region had approximately 175 Industry 4.0 job postings out of 5129 total job postings which represents an Industry 4.0 intensity factor of 3.41%. The Mallee region had approximately 67 Industry 4.0 job postings out of 3335 total job postings which represents an Industry 4.0 intensity factor of 2.01%. The combined Industry 4.0 intensity factor for Loddon Mallee in 2021 was 2.86%.

Figure 4 illustrates the difference in Industry 4.0 intensity trends before and after using the averaged approach. In both instances there is a trend towards increasing Industry 4.0 intensity in the Loddon Mallee jobs market.

Figure 4: Industry 4.0 Intensity – Loddon Mallee

Industry 4.0 Intensity – Raw Data

NIEIR, Delos Delta Analysis, Lightcast™

Industry 4.0 Intensity - Averaged Data

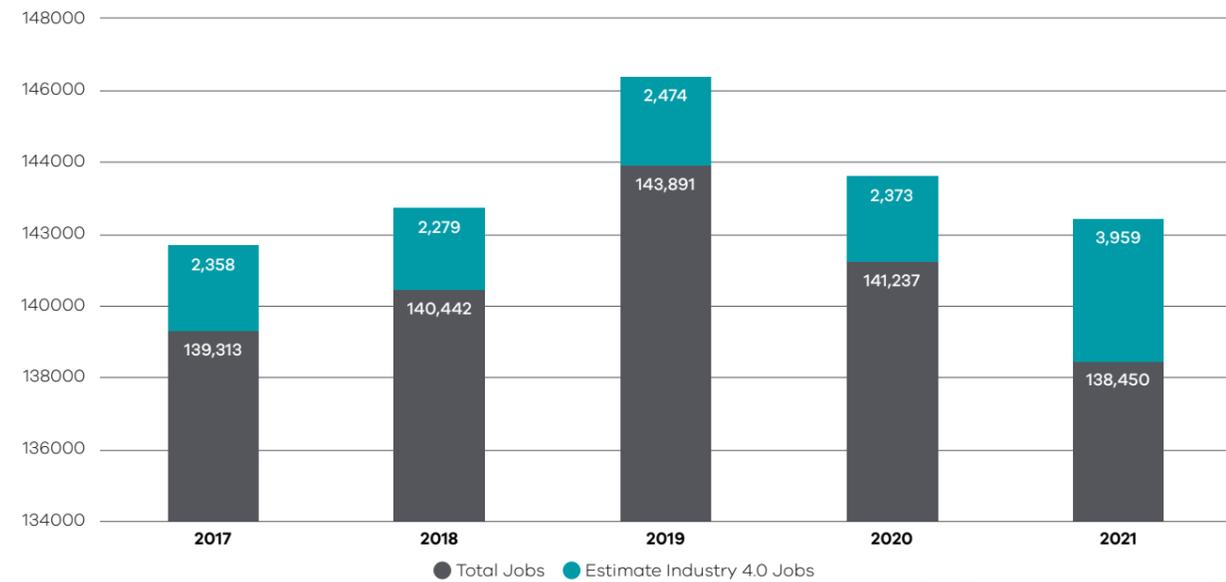NIEIR, Delos Delta Analysis, Lightcast™

Estimate Number of Industry 4.0 Jobs

Loddon Mallee was estimated to have an approximate total of 4,000 Industry 4.0 jobs in 2021 as part of a total 138,450 jobs across the Region (Figure 5). The average annual growth rate of Industry 4.0 jobs over the past four years was 17.0%. The year-on-year growth rate of the total number of Industry 4.0 jobs over the past year alone was 66.8%, despite a 2.0% reduction in total jobs across the same period.

These figures reflect several trends, including the overall growth in Industry 4.0 related activity and skills, and the reduction of total jobs partly resulting from the COVID-19 pandemic.

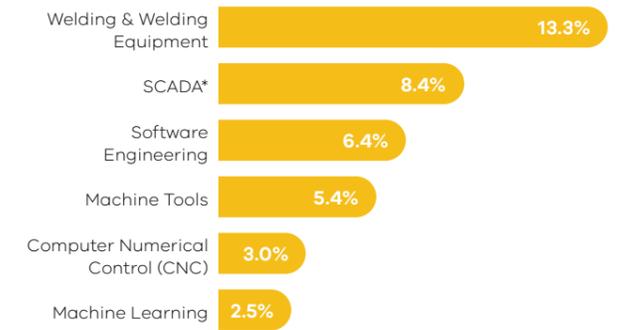## Industry 4.0 Jobs Analysis by Skills, Industry and Occupational Categories

To understand Industry 4.0 growth areas in Loddon Mallee, and the skills required to sustain their growth, this section specifically analyses Industry 4.0 job postings in 2021. By offering a variety of data cuts, this analysis can build a more representative understanding of the kinds of Industry 4.0 jobs available in the Region.

Figure 6 shows the high demand across Loddon Mallee for welding and welding equipment skills representing over 13.3% of total in-demand Industry 4.0 skills in the Region. The digitisation and automation of welding will form a key part of the Industry 4.0 revolution, with Industry 4.0 methodologies becoming increasingly common in globally leading manufacturers and fabricators.[44] A lack of access to these skills could currently be acting as a barrier to Industry 4.0 maturity in the Region.

When looking at occupational categories (Figure 7) Construction, Extraction, and Architecture, and Information Technology based occupations are in high demand representing 16.9% and 11.4% of Industry 4.0 related job postings respectively. Loddon Mallee has a rich history of extraction-based occupation specialisation including non-metallic mineral mining and quarrying in the Mallee, and gold mining in Loddon Campaspe. The strong representation for extraction-based job postings suggests a level of ongoing growth in this sector and may also reflect the current high employment concentration for mining in Loddon Campaspe in particular (4.1 times greater than the Victorian average).[45]
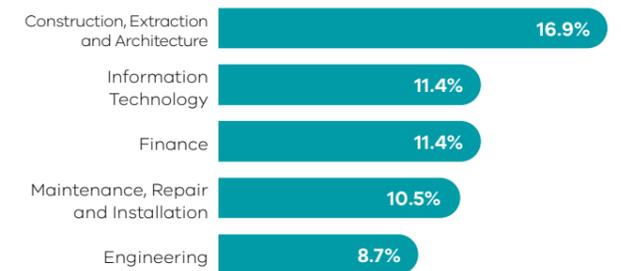
*Supervisory Control and Data Acquisition

Figure 5: Total Jobs vs. Total Estimate Industry 4.0 Jobs – Loddon Mallee

Delos Delta Analysis, LabourInsights, NIEIR

Figure 6: In Demand Industry 4.0 skills – Loddon Mallee

Welding & Welding Equipment — 13.3%
SCADA* — 8.4%
Software Engineering — 6.4%
Machine Tools — 5.4%
Computer Numerical Control (CNC) — 3.0%
Machine Learning — 2.5%

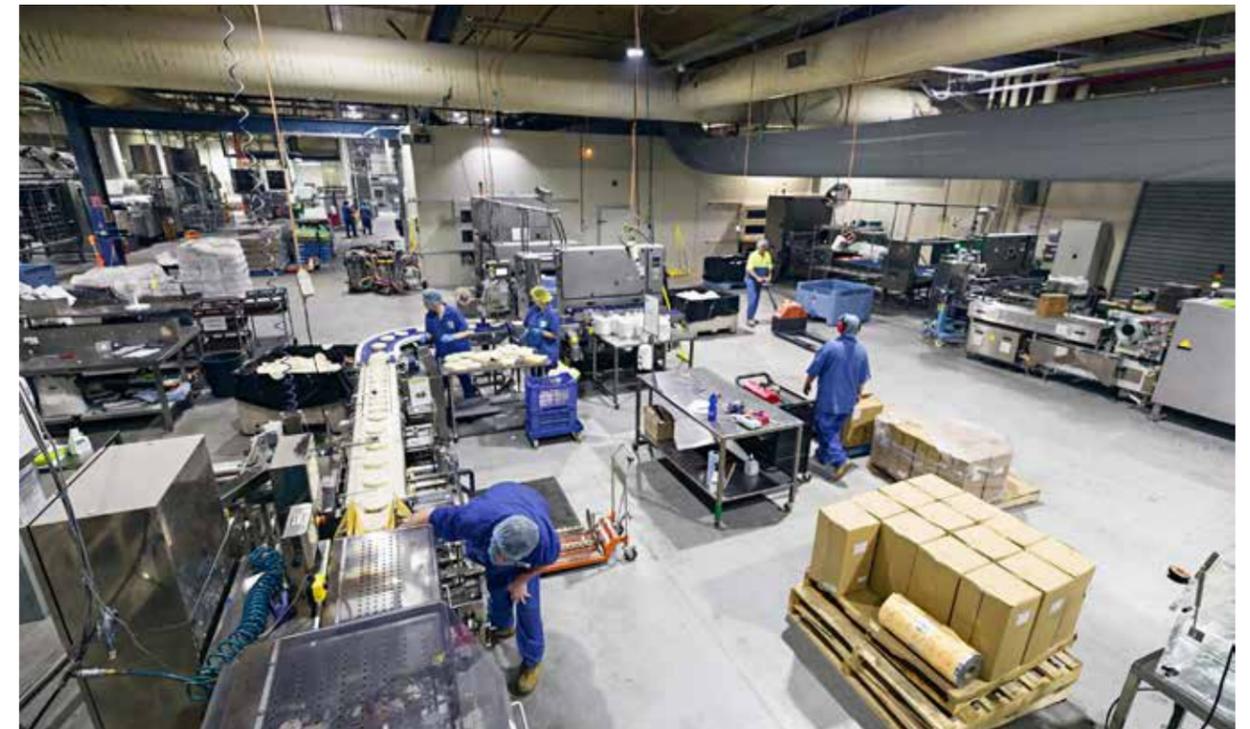Delos Delta Analysis, Lightcast™

Figure 7: Top Occupational Categories by Industry 4.0 Job Postings – Loddon Mallee

Construction, Extraction and Architecture — 16.9%
Information Technology — 11.4%
Finance — 11.4%
Maintenance, Repair and Installation — 10.5%
Engineering — 8.7%

NIEIR, Delos Delta Analysis, Lightcast™

44. Weld Australia, Welding 4.0: The Future of Industry, 2022
45. Regional Development Australia, Loddon Campaspe Regional Economic Development Strategy, 2022.

Figures 8 and 9 allow for an industry-focused comparison of Loddon Campaspe and the Mallee. In Loddon Campaspe, Financial and Insurance Services, and Professional, Scientific, and Technical Services provided the most Industry 4.0 job postings in 2021 (33.3% and 17.9% respectively) reflecting Bendigo's status as a business and services hub.

Across Loddon Mallee, the Health Care and Social Assistance sector is a key provider of Industry 4.0 jobs, confirming this industry's status as a major employment sector in both Loddon Campaspe (9.0% of Industry job postings) and the Mallee (12.5% of Industry

4.0 job postings). In the Mallee, the ongoing decrease in total employment in the Agriculture, Forestry, and Fishing industry is likewise reflected in the relatively small percentage (3.1%) of Industry 4.0 job postings in this sector. It is worth noting, however, that this may also reflect unacknowledged biases towards non digital based recruiting methods in some industries.

The manufacturing sector is another key provider of Industry 4.0 jobs in the Region, providing 18.6% of Industry 4.0 job postings in the Mallee and 10.3% in Loddon Campaspe.

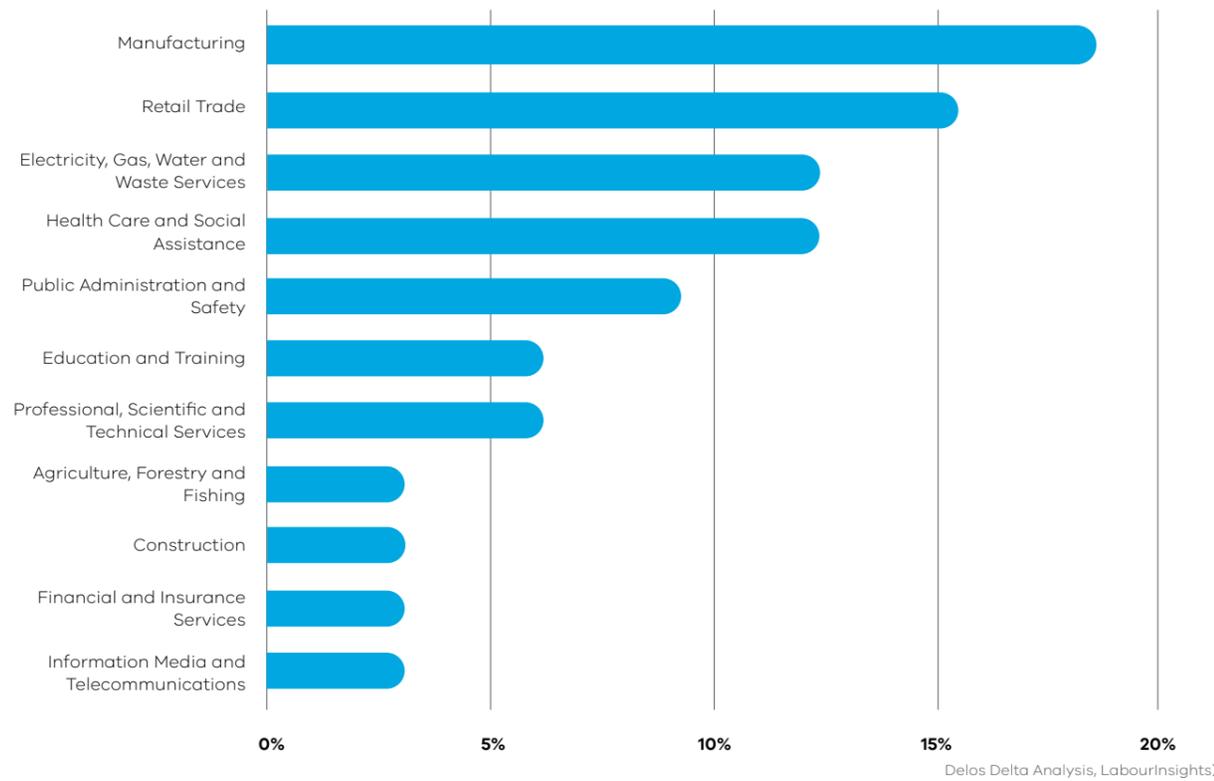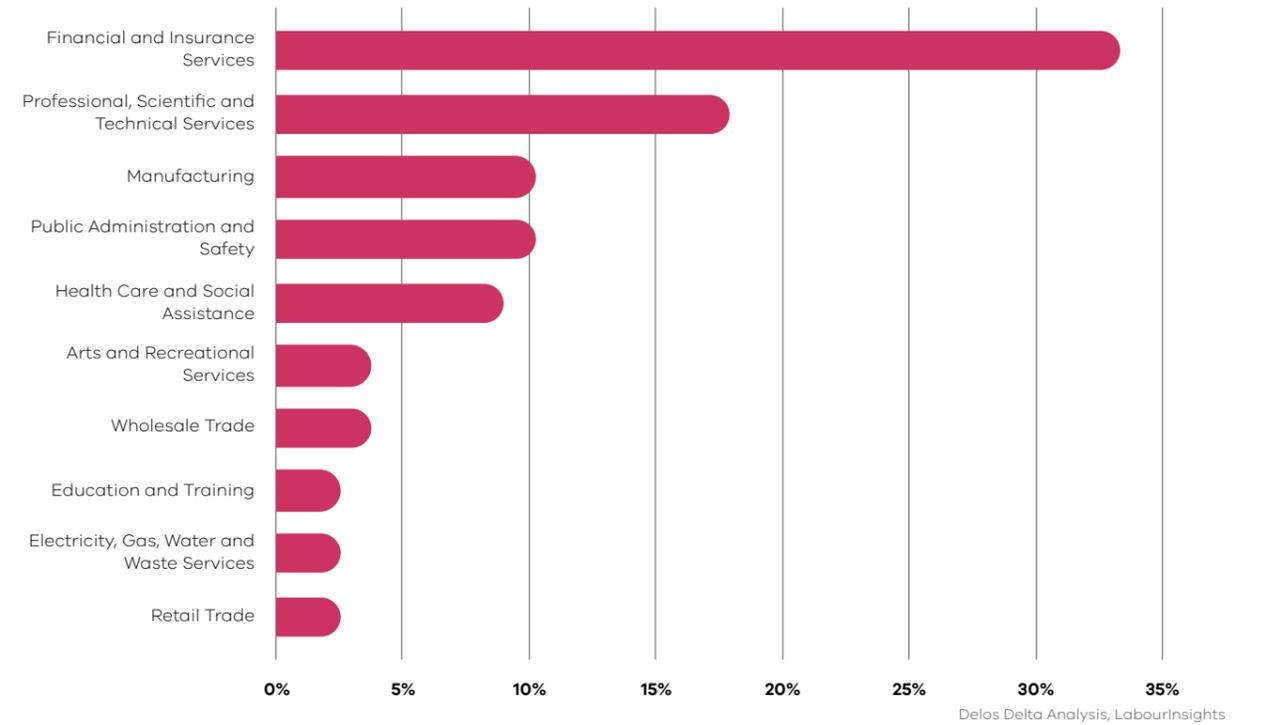**Figure 9:** Top Industries by Industry 4.0 Job Postings – Loddon Campaspe

Delos Delta Analysis, LabourInsights

Figure 8: Top Industries by Industry 4.0 Job Postings – Mallee

Delos Delta Analysis, LabourInsights)

Industry 4.0 Maturity Assessment and Next Steps

This final Industry 4.0 maturity assessment distils insights from the research, engagement and data analysis contained within this Report.

The assessment dimensions considered below offer a holistic evaluation of:

- Loddon Mallee's economic foundations including current Industry 4.0 specialisations
- Loddon Mallee's readiness to embrace digital disruption and Industry 4.0 concepts and technology
- The availability of skilled workers, and skills pathways.

Assessment dimensions are supported by a range of indictive actions to help drive Industry 4.0 maturity in the Region.

Economic Foundations

The assessment of Loddon Mallee's economic foundations considers the liveability of the Region and the pre-existence Industry 4.0 clusters. Due to effects on the Region's ability to attract and retain talent and investment, levels of liveability and amenity have important implications for Loddon Mallee's continued maturity in the Industry 4.0 space.

Liveability and Amenity of the Region

Stakeholders were optimistic on the topic of liveability and suggested that urban centres especially enjoyed high living standards In Loddon Mallee. These sentiments were broadly corroborated through benchmarking, with the LGAs of Macedon Ranges, Mount Alexander, and Bendigo enjoying relatively high participation rates, growth in new businesses and GRP despite the impact of the COVID pandemic. Research and engagement highlighted a range of natural and cultural assets which make the Region a more enjoyable place to live and work. From a liveability standpoint, transport infrastructure was viewed positively by stakeholders, with the Region's tri-state location being a unique selling point.

As a drag on Industry 4.0 maturity, stakeholders were concerned about the Region's perception amongst in-demand workers looking to relocate from metropolitan areas. Miconceptions surrounding the liveability and amenity of the Region were seen to exacerbate current workforce shortages. Stakeholders in the Mallee identified accommodation shortages as a current barrier to Industry 4.0 maturity. Low SEIFA scores in certain LGAs across Loddon Mallee likewise indicate a degree of variation in the living standards enjoyed by residents across the Region.

Action
• Schedule regular updates to the Business and Investment Prospectus
• Develop informational videos showcasing the enhanced lifestyle and appeal of Loddon Mallee

Pre-existing Industry 4.0 Clusters

Research, engagement, and benchmarking highlighted existing areas of Industry 4.0 activity including clusters of research, education, innovation, and implementation. These areas broadly correspond to the Region's urban hubs, and corridors of activity including Loddon Campaspe's Employment and Innovation Corridor, and the Murray Mallee Economic Region. Benchmarking demonstrated that these areas have proved more resilient over recent years in comparison to LGAs situated away from these hubs and corridors.

Action
• Promote the expansion of existing and developing innovation corridors into unconnected or disadvantaged LGAs

Regional Readiness

The assessment of Loddon Mallee's regional readiness considers the availability of the technology required to enable Industry 4.0, and ease at which industries across the Region can embrace digital disruption.

Availability of Technology

Research and engagement uncovered several successful case studies demonstrating the success of local business in adopting Industry 4.0 concepts and technology. A level of regional Industry 4.0 maturity is also evident in the existence of local partnerships and networks which foster collaboration, showcase and pilot new technologies, and guide businesses on the acquisition of Industry 4.0 equipment.

However, from a technological standpoint, several barriers were identified which currently impede the uptake of Industry 4.0 technologies. Chief among these, and corroborated through engagement and research, was a lack of adequate, and at times affordable, connectivity, especially in areas of primary production. As a regional hub, Bendigo was less challenged in this regard, with stakeholders noting the efficacy of the city's 5G networks.

Where Industry 4.0 technology was available to businesses, it was found that the prohibitive cost of new technology was at times delaying the Region's inevitable transition to Industry 4.0. Stakeholder engagement also uncovered an imbalance in regional demand, with Loddon Mallee more capable of attracting capital investment and technology and less able to attract skilled workers necessary to operate machinery and make use of such investment.

Action
• Commit funding to improve connectivity in areas of primary production.

Ability to Embrace Digital Disruption

Loddon Mallee is strategically positioned to benefit from increased Industry 4.0 maturity. Benchmarking and research highlighted regional specialisations and employment concentrations in primary and secondary industries such as mining, manufacturing, and agriculture, which can readily integrate Industry 4.0 concepts. In the more economically diverse areas of Loddon Mallee, including Bendigo, engagement revealed a high degree of existing Industry 4.0 integration in tertiary sectors such as healthcare (for example Bendigo Health's recently constructed digitally-enabled Regional Health Innovation Hub). Likewise, industry-specific analysis of jobs postings in Loddon Campaspe showed that Financial and Insurance Services have been quick to embrace digital methods and Industry 4.0 concepts.

From an industry perspective, the need for improvement to transport infrastructure, especially rail freight, were seen as potential barriers to future Industry 4.0 activity in the northwest region. A misconception of STEM careers was likewise identified as a current impediment to attracting skilled employees or young adults into Industry 4.0 related careers in Loddon Mallee. However, this challenge is likely of national importance and not endemic to the Region.

Action
• Collaborate with primary and secondary education institutes to develop Industry 4.0 career workshops

Skills, Education, and Jobs

This assessment considers the research, development, and innovation capacity of Loddon Mallee, the availability of training and education resources, and the availability of a suitable workforce.

Capacity for Research, Development, and Innovation.

Loddon Mallee benefits from the presence of numerous tertiary research and education centres, with ongoing plans for additional campuses and facilities. Engagement and research identified strong links between business and education providers as an advantage of the Region, while benchmarking highlighted a healthy level of technical qualification amongst residents. The Region's capacity to innovate is further strengthened by international institutional partnerships with the Fraunhofer Institute in the Industry 4.0 space.

The availability of free space for development was viewed by stakeholders as a potential advantage of the Region in adopting Industry 4.0 concepts. However, current planning, zoning, and a lack of Council industrial land purchases were viewed as a barrier to unlocking this potential.

Action
• Financially incentivise young graduates to stay in Loddon Mallee post-graduation
• Advise LGAs on the purchase of land for industrial purposes
• Conduct a review of Industrial zoning in areas of high manufacturing growth

Availability of Training and Education Resources and a Suitable Workforce

Loddon Mallee's continued Industry 4.0 maturity is restricted by the lack of a suitable workforce. Research and engagement predicted and confirmed the existence of skills bottlenecks, with jobs analysis suggesting a heightened demand for manufacturing skills and a demand for employees in Finance, IT, Extraction, and Engineering.

The presence of Industry 4.0 dedicated education facilities is a key advantage of Loddon Mallee. Engagement revealed that education providers are becoming better at providing qualifications tailored to the Industry 4.0 needs of local businesses; yet there remains room for more training and education resources to be dedicated to delivering short courses for experienced workers looking to specialise in particular and specific Industry 4.0 concepts and technologies. Engagement revealed that the lack of a suitable workforce in the Mallee is exacerbated by a lack of suitable accommodation particularly in place-based learning and research environments.

Action
• Coordinate the continued development of micro-qualifications and short courses with local business and education providers
• Collaborate with existing innovation networks to showcase Industry 4.0 concepts to small agricultural businesses.
• Collaborate with partnerships in the Mallee to build accommodation for place-based learning centres

Bibliography

- Agriculture Victoria, 2022, 'What is the Agriculture Strategy?
- Agriculture Victoria, 2021, 'Strong, Innovative, Sustainable: A New Strategy for Agriculture in Victoria'
- Agriculture Victoria, 2020, 'Our SmartFarms'
- Australian Government, BCARR, 2021, Working Paper- Economic Impact of Ubiquitous High-Speed Internet: Agriculture Sector
- Emsi Burning Glass (now Lightcast) (2022)
- Fengwei Yang, Sai Gu, 2020, 'Industry 4.0, a revolution that requires technology and national strategies'
- La Trobe, 2021, 'Regional manufacturing gets new hub'
- Mark Dean and John Spoehr, 2018, 'The fourth industrial revolution and the future of manufacturing work in Australia: challenges and opportunities'
- Melbourne University 2020, 'Mallee Regional Innovation Centre (MRIC)
- Michael Rüßmann, Markus Lorenz et al, 2015, 'Industry 4.0: The Future of Productivity and Growth in Manufacturing Industries'
- NFF, NBN, 2021, Connecting Australian Agriculture
- Nnamdi Anyadike, 2019, 'Decentralised Systems for 'Next Generation' Industrial Production
- Prime Minister's Industry 4.0 Taskforce, 2017, 'Industry 4.0 Testlabs in Australia'
- Rajabahadur V. Arcot, 2021, 'Cyber-physical systems: The Core of Industry 4.0'
- Regional Development Australia, Regional Partnerships Mallee, 2020, 'Mallee Regional Skills Demand Profile'
- Regional Development Victoria 2019, 'Mallee Regional Innovation Centre'
- Regional Partnerships Loddon Campaspe, 2019, REAM Skills Road Map, 2021 Health Sector Skills and Pathways Roadmap
- Saurabh Vaidya, Prashant Ambad, Santosh Bhosle, 2018, 'Industry 4.0 – A Glimpse'
- Shane Loughlin, 2018, 'Industry 3.0 to Industry 4.0: Exploring the Transition'
- The City of Greater Bendigo, 2021, 'Submission to Infrastructure Victoria's Draft 30 Year Infrastructure Strategy
- Weld Australia, Welding 4.0: The Future of Industry, 2022

Assumptions and Limitations

Industry 4.0 Jobs Data

The Industry 4.0 jobs data does not account for all jobs which may contain Industry 4.0 elements.

This analysis may also favour certain sectors and larger employers.

Time Series Data

The time series of Industry 4.0 intensity 'raw data' between 2017 and 2021 is impacted by the increasing number of total job postings in recent years. To account for this volatility in the denominator value, resulting from a range of factors including the continual improvement of job posting data collection methods, we suggest using an a three year average.

Economic Development Expenditure

There exist difficulties in accurately benchmarking economic development expenditure by local government area given the inconsistent ways in which economic development activity is classified and reported. This process could be refined in future benchmarking.

ABS Data

Please note benchmarking within this Report was undertaken prior to the release of Census 2021 data.

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