# Technology adoption in pig lairages

***Enhancing animal welfare through innovation***

foodagility

Curtin University

Department of Primary Industries and Regional Development
GOVERNMENT OF WESTERN AUSTRALIA

Xsights

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# Contents

## Executive summary

This report presents the current and emerging technologies used in pig lairage facilities, focusing on their role in enhancing animal welfare, operational efficiency, and meat quality. Drawing on 13 in-depth interviews with key stakeholders, including academic researchers, processing facility operators, industry associations, animal welfare organisations, and technology providers, this report captures expert perspectives across the Australian and international pork processing sectors. Key findings reveal that lairage technology adoption is driven by a combination of regulatory mandates, retailer requirements, operational efficiency gains, and reputational benefits. Welfare-enhancing technologies currently implemented include automatic handling systems, advanced environmental controls, AI-assisted monitoring tools, digital recordkeeping, and lairage design innovations tailored to pig behaviour. Interviewees also highlighted several barriers to implementation, including high capital costs, infrastructure constraints, technology customisation issues, and staff resistance to surveillance or automation. Future trends point toward greater integration, predictive AI systems, enhanced transparency, and welfare-focused facility design. Recommendations include prioritising cost-effective technologies in the early stages, harmonising regulatory standards across market segments, and developing collaborative funding and training models to support smaller facilities. Change management and workforce engagement are also essential to ensure successful adoption.

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## 1 | Background

The pig lairage represents a critical transitional space in modern pork processing facilities, serving as the interface between transportation and slaughter operations. These facilities have evolved significantly from basic concrete holding pens to sophisticated systems that prioritise both animal welfare and operational efficiency. Lairages serve multiple essential functions: providing recovery time for animals after transportation stress, creating staging areas for orderly processing workflows, and offering opportunities for welfare assessment and veterinary intervention. For pigs, which demonstrate high sensitivity to environmental stressors and exhibit low tolerance for poor handling, properly designed and managed lairage facilities are essential to achieving optimal welfare outcomes and maintaining meat quality standards. The growing emphasis on animal welfare, driven by consumer expectations, retailer requirements, and regulatory frameworks, has positioned lairage management as a critical component of sustainable pork production. This technological evolution reflects the industry's

recognition that welfare-enhancing systems deliver measurable benefits in product quality, operational efficiency, and regulatory compliance while supporting the sector's social licence to operate. This research 1) examines current technology adoption patterns in pig lairage facilities, 2) identifies the key implementation drivers and barriers, and 3) explores future trends in welfare-enhancing technologies across the Australian and international pork processing industry.

## 2 | Research methodology

### *2.1 Data collection*

This study employed a qualitative research approach using semi-structured interviews to gather in-depth insights from industry stakeholders. This research received human research ethics approval from Curtin University's Human Research Ethics Committee (HRE2024-0589). Thirteen interviews were conducted between November 2024 and April 2025 via video conferencing platforms (i.e., MS Teams), after the participants provided a signed consent form. Each interview lasted approximately 45 minutes and followed a standardised protocol focusing on current technology use, implementation experiences, barriers and drivers, and future trends in lairage technology adoption. We conducted 13 interviews with 14 participants (P5 and P6 were interviewed together). Participants were selected through purposive sampling to ensure representation across key stakeholder groups, including academic researchers, industry processors, technology providers, animal welfare organisations, and industry associations. The sample included participants from Australia and other international locations to capture diverse perspectives on lairage technology adoption.

### *2.2 Participant profile*

| Participant | Interview date | Stakeholder type | Experience* | Location | Expertise area |
|---|---|---|---|---|---|
| P1 | 1 November 2024 | Academic researcher | >31 | Australia | Animal welfare science, stunning research |
| P2 | 20 November 2024 | Academic researcher | 21-30 | Canada | Meat science, animal welfare, and processing |
| P3 | 3 December 2024 | Industry processor | 21-30 | Australia | Vertically integrated pork producer |
| P4 | 12 December 2024 | Academic researcher | >31 | Australia | Technology development, AWISH project |
| P5 | 7 February 2025 | Industry processor | >31 | Australia | Large-scale pork processing facility |
| P6 | 7 February 2025 | Industry processor | <10 | Australia | Large-scale pork processing facility |
| P7 | 19 February 2025 | Technology provider | 21-30 | USA | Digital livestock management systems |
| P8 | 19 February 2025 | Academic researcher | <10 | Australia | Animal welfare, abattoir assessment |
| P9 | 6 March 2025 | Industry processor | 21-30 | Australia | Biosecurity, animal welfare research |
| P10 | 7 March 2025 | Animal welfare organisation | 11-20 | Australia | Welfare technology implementation |
| P11 | 11 March 2025 | Animal welfare organisation | 11-20 | Australia | Industry standards, policy advocacy |
| P12 | 27 March 2025 | Industry association | 21-30 | Australia | Multi-species processing, industry leadership |
| P13 | 11 April 2025 | Industry processor | >31 | Australia | Regional processing, facility development |
| P14 | 17 April 2025 | Industry association | 11-20 | Australia | Research program management, integrity systems |

* Years of experience in the current industry/sector

### *2.3 Data analysis*

The study employed thematic analysis as the primary methodological approach, supported by NVivo 15 software. Analysis followed the six-phase framework outlined by Braun and Clarke (2006)[1], involving: (1) familiarisation with data through multiple readings of transcripts; (2) systematic line-by-line coding to identify meaningful concepts; (3) searching for themes by grouping related codes; (4) reviewing and refining themes for coherence; (5) defining and naming final themes; and (6) producing the analytical report. The coding process was conducted systematically, with both descriptive and interpretative coding applied to capture explicit and implicit meanings. Five major themes emerged from the analysis: (a) Implemented technology, (b) Drivers for technology implementation, (c) Benefits of technology implementation, (d) Barriers and challenges, and (e) Future trends. An overview of the key findings is presented in Appendix 1.

## 3 | Current technology landscape and evolution

### *3.1 Automatic handling system*

Sophisticated automated handling systems have been increasingly adopted in modern pig lairage facilities to enhance animal welfare and operational efficiency. Push gates with pressure sensors enable gentle pig movement without traditional manual herding stress (P1, P5, P8, P11). Automated loading ramps adjust to different truck levels, streamlining unloading processes and reducing transition stress (P8, P9). These systems reduce human-animal interactions, a key factor in decreasing pig stress during pre-slaughter periods (P1, P2, P8, P12, P14). Semi-automated gate systems leverage natural pig behaviour, allowing animals to move through facilities with minimal human intervention whilst maintaining operational control (P9, P12). This approach creates more natural flow patterns that respect instinctive animal behaviours while improving processing efficiency.

### *3.2 Environmental control system*

Modern lairage facilities have implemented sophisticated environmental control systems to maintain optimal conditions for pig welfare. Temperature-controlled areas equipped with automated misting and sprinkler systems provide immediate cooling relief during elevated temperatures (P3, P5, P8, P12). Fan systems programmed to activate at preset temperature thresholds offer additional climate management, automatically responding to environmental changes (P8, P9). These automated controls are essential for preventing heat stress in pigs, which are exceptionally susceptible to temperature-related welfare issues (P2, P5, P11). However, smaller facilities without automated systems often rely on manual interventions, such as manual wetting pigs during hot weather, which reveal operational disparities between large-scale and smaller processing operations (P12). These environmental management systems represent essential welfare infrastructure directly impacting animal comfort and meat quality outcomes.

### *3.3 Surveillance technology*

CCTV cameras have become standard infrastructure throughout lairage areas and races, providing comprehensive visual coverage of animal handling operations (P3, P5, P8, P11, P14). While many facilities initially installed cameras for compliance purposes, progressive operations now actively monitor footage rather than relying solely on passive recording systems (P5, P11). This footage serves as a valuable tool for identifying operational issues and continuously improving handling practices through detailed behavioural analysis (P3, P11). Advanced systems enable multiple managers to monitor operations remotely in real-time, enhancing oversight capabilities and rapid response to welfare concerns (P5). Some facilities have incorporated thermal imaging cameras that monitor livestock temperature and identify potential health issues before they become

[1] Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77-101.

critical, representing an evolution towards predictive welfare management (P10, P12). These surveillance systems collectively enhance transparency, accountability, and welfare outcomes whilst supporting continuous improvement in lairage management practices.

### *3.4 Lighting system*

Specialised lighting systems have emerged as a critical component of modern lairage design, with facilities implementing green lights in races to eliminate shadows that commonly cause animals to baulk and hesitate during movement (P2, P4, P5, P11). These lighting solutions are specifically designed to reduce stress levels and improve animal flow through processing areas, acknowledging the significant impact that visual stimuli have on pig behaviour and movement patterns (P2, P12). Effective lighting management requires careful calibration to achieve appropriate illumination levels that provide sufficient visibility for both animals and handlers whilst avoiding overly bright conditions that can create additional stress or discomfort (P12). These targeted lighting interventions demonstrate the industry's growing understanding of how environmental factors influence animal welfare and operational efficiency, representing a relatively simple yet highly effective technological improvement that enhances both animal comfort and facility throughput.

### *3.5 Digital record-keeping*

Digital applications have revolutionised lairage management by replacing traditional paper-based tracking systems. There are some apps that enable real-time animal health monitoring, allowing faster responses to welfare issues and providing comprehensive data collection capabilities (P7). These systems integrate with other facility technologies to create seamless information flow throughout operations (P7). Some companies use their own truck scheduling applications to coordinate vehicle arrivals and reduce waiting times, minimising transport stress and improving operational efficiency (P12). These digital solutions represent a fundamental shift towards data-driven livestock management, enhancing both animal welfare outcomes and facility productivity through improved coordination and real-time monitoring capabilities.

### *3.6 AI-powered monitoring systems*

AI systems are being tested to analyse CCTV footage and automatically identify welfare issues, including detecting electric goad usage, monitoring animal behaviour, and evaluating handling practices (P8, P10). Currently in early implementation stages across Australia, these technologies are already established in some European facilities, particularly in the Netherlands (P7, P10, P11). However, systems require customisation for each facility and are not yet plug-and-play solutions (P4, P10). These emerging technologies represent the future of automated welfare monitoring, promising enhanced oversight capabilities and improved compliance with welfare standards through continuous, objective assessment of lairage operations (P14).

### *3.7 Lairage design*

Modern lairage infrastructure prioritises pig welfare through design elements that accommodate natural behaviours and reduce stress. Long, narrow pens allow pigs to lean against walls for comfort, acknowledging their need for physical security (P12). Solid walls instead of mesh fencing minimise visual distractions and external stimuli that could cause anxiety (P11, P12). Non-slip flooring ensures safe movement whilst facilitating easy cleaning and hygiene maintenance (P12). Well-designed lairage layouts, characterised by long, narrow pens and solid partitions, help maintain existing social groups, reduce mixing with unfamiliar animals, and minimise stress and aggression. These layouts support pigs' behavioural needs by allowing them to lean against walls for comfort while also enabling movement within the pen to avoid potential conflict (P9, P12). Quiet gate mechanisms and

latches contribute to maintaining calm environments, recognising that excessive noise can significantly impact pig welfare and behaviour during the critical pre-slaughter period.

### *3.8 Transport system concepts*

Innovative crate systems, adapted from established poultry transport methods, allow pigs to remain in the same container from the farm through to stunning (P9). By maintaining familiar social groups and reducing the need for human handling, these systems help minimise stress throughout the pre-slaughter process (P9). The consistent environment and limited interactions with unfamiliar animals or people are critical factors in reducing fear responses and promoting calmer behaviour. The approach would substantially improve biosecurity through easier cleaning and decontamination protocols between loads (P9). However, implementation would require significant infrastructure modifications at both farm and abattoir facilities, representing a substantial capital investment for widespread adoption (P9). Despite the promising welfare and biosecurity benefits, the extensive infrastructure changes needed present considerable barriers to industry-wide implementation of these container-based transport solutions.

## 4 | Drivers of technology implementation

### *4.1 Regulatory compliance and market forces*

Industry animal welfare standards serve as key drivers for technology adoption in modern lairage facilities (P8, P11). Mandated CCTV installation in specific areas ensures compliance with welfare monitoring requirements[2], providing accountability and transparency in animal handling practices (P8, P11). However, regulatory frameworks create a two-tier system with different standards applied to export versus domestic abattoirs, resulting in varying levels of technology implementation across the industry (P11, P12). Export facilities typically face more stringent requirements and subsequently invest more heavily in advanced welfare technologies, whilst domestic operations often operate under less demanding regulatory conditions. This regulatory disparity influences investment decisions and creates inconsistent welfare standards across different market segments within the pork processing industry.

### *4.2 Customer and retailer requirements*

Major retailers, including Coles and Woolworths, have become primary catalysts for welfare technology adoption by implementing specific welfare standards as contractual requirements for suppliers (P8, P12, P14). Export market demands further drive investment in advanced welfare systems, as international customers increasingly expect demonstrable animal welfare standards throughout the supply chain (P3, P8). Premium market segments represent additional commercial opportunities, with consumers willing to pay higher prices for products that meet enhanced welfare standards (P18). These market forces create competitive advantages for facilities that invest in welfare-enhancing technologies, whilst establishing standards that drive industry-wide improvements. The commercial incentives align welfare improvements with business sustainability, demonstrating that ethical practices can deliver tangible economic benefits in modern food markets.

### *4.3 Operational efficiency and welfare synergy*

Technology adoption delivers significant operational improvements across lairage facilities. Automated systems create more consistent animal flow, reducing bottlenecks and improving processing efficiency (P1, P2). Enhanced traceability and accountability throughout operations provide comprehensive oversight and

[2] CCTV monitoring is mandated under the Industry Animal Welfare Standard. The Standard is owned by the Australian Meat Industry Council and compliance is verified/audited by AUS-MEAT.

regulatory compliance capabilities (P3, P7, P9). Real-time monitoring enables improved response times to animal health issues, preventing welfare problems from escalating (P4, P7). Digital systems enhance biosecurity and traceability by enabling processors to maintain oversight of farm conditions without needing frequent on-site visits. This reduces biosecurity risks associated with cross-site movements while improving real-time traceability of animals and cohorts through the supply chain (P7, P9). AI-powered monitoring allows targeted interventions when specific issues arise, optimising resource allocation and welfare outcomes (P10, P11). Scheduling applications reduce driver and transport time, minimising costs and animal stress (P11).

### *4.4 Meat quality*

Welfare-enhancing technologies deliver measurable meat quality benefits that provide direct economic returns on investment. Reduced stress levels correlate with fewer instances of PSE (Pale Soft Exudative) meat in pigs, a condition that significantly impacts product value and consumer acceptability (P5, P8, P11). Proper animal handling through automated systems results in less carcass bruising, reducing condemnations and improving overall carcass quality grades (P2, P8, P9). Calmer animals at slaughter achieve better bleeding out, improving carcass appearance and reducing blood spots that affect product presentation (P5). Additionally, reduced stress contributes to decreased drip loss in chilled carcasses, maintaining product weight and improving shelf-life characteristics (P9). These quality improvements demonstrate that welfare investments deliver tangible economic benefits through enhanced product value, reduced waste, and improved customer satisfaction across both domestic and export markets.

### *4.5 Social license*

The pork production and processing industries face increasing public scrutiny regarding animal welfare practices, making technology adoption essential for maintaining social acceptability (P1, P3, P11). Investment in welfare-enhancing technologies serves as crucial risk mitigation against negative publicity that could damage brand reputation and consumer confidence (P3, P7, P11). Modern facilities must demonstrate transparency about industry practices to meet growing societal expectations for ethical animal treatment (P11). In addition, investors and financial institutions increasingly incorporate animal welfare considerations into their evaluation criteria, making welfare technology adoption essential for accessing capital and maintaining competitive positioning (P11). These social licence pressures create compelling business cases for welfare technology investment, as facilities that fail to meet evolving public expectations risk losing market access, consumer trust, and financial support in an increasingly welfare-conscious marketplace.

### *4.6 Economic benefits*

Welfare technology investments deliver substantial economic returns through multiple pathways. Improved meat quality resulting from reduced animal stress provides direct value enhancement, reducing product defects and increasing carcass grades (P2, P5, P8, P9). Automated systems enhance labour efficiency in various operational areas whilst reducing overall labour costs through decreased reliance on manual handling (P2, P12). Technology adoption creates competitive advantages through market differentiation, enabling access to premium markets and customer segments that value welfare standards (P3, P8). These economic benefits demonstrate that welfare technology represents sound business investment rather than mere compliance expense, delivering measurable returns through improved product quality, operational efficiency, and market positioning that justify implementation costs across both large and smaller processing operations.

## 5 | Implementation challenges and barriers

### *5.1 Cost concern*

High capital requirements represent the most frequently discussed barrier to welfare technology adoption; an example was given by a processor (P5) that the installation of $CO_2$ stunning infrastructure and associated handling systems required an investment of approximately $11 million. Ongoing maintenance and subscription costs for software systems create additional financial burdens, particularly affecting smaller operations with limited budgets (P4, P7, P8, P10). Economic returns from welfare investments are not always clearly quantifiable, making business case development challenging for decision-makers (P3, P8, P12). Smaller facilities struggle to justify substantial technology investments due to limited throughput volumes and profit margins (P2, P3, P8, P12). Retrofitting existing facilities proves significantly more expensive than incorporating technology into new builds, creating additional cost pressures, with infrastructure changes for major system upgrades requiring millions of dollars in investment (P12, P14). Regulatory approval processes for facility modifications impose further financial burdens through compliance costs (P12). Limited capital availability affects both processing facilities and AgTech startups, constraining innovation and implementation across the industry (P4).

### *5.2 Implementation issues*

Complex implementation processes present significant barriers to technology adoption, with AI system configuration requiring three or more months per facility for proper customisation (P8, P10). Integration with existing infrastructure creates compatibility challenges that often require substantial modifications to legacy systems (P3, P8, P12). Staff resistance to new technologies or monitoring systems can impede successful implementation, particularly when workers perceive systems as surveillance rather than welfare tools (P1, P4, P7). Camera maintenance and positioning prove critical for effective monitoring, requiring ongoing technical expertise and regular adjustments (P8, P10). Regional facilities face particular challenges accessing technical expertise for installation and ongoing support (P4, P12). Regulatory hurdles for facility modifications add complexity and delays to implementation timelines (P12). The variety of available technology providers creates additional complexity, as processors struggle to determine which systems will work effectively before making substantial investments (P4, P14).

### *5.3 Technology limitations*

Environmental and technological constraints significantly impact system effectiveness and reliability. Outdoor lairage areas present particular challenges for camera systems, requiring weatherproofing and enhanced protection against environmental elements (P8). Australian climate conditions differ substantially from European environments where many systems were originally developed, necessitating modifications for local conditions (P8). Technical support for international systems becomes complicated by time zone differences, delaying problem resolution and maintenance activities (P8). Connectivity issues in regional areas limit data transfer capabilities, affecting real-time monitoring and cloud-based system functionality (P4, P12). Computer vision systems remain limited in their detection capabilities, unable to reliably identify all welfare concerns or behavioural patterns (P4, P10). Current AI systems flag potential risks but don't yet provide specific recommended actions, requiring human interpretation and intervention (P4, P10). Internet reliability issues persist even in developed regions, whilst building materials such as metal structures interfere with wireless connectivity, creating additional technical challenges for system deployment (P4).

### *5.4 Staff adoption*

Human factors represent significant barriers to successful technology implementation in lairage facilities. Employee resistance to increased accountability through monitoring systems creates implementation challenges, as staff may perceive technology as surveillance rather than welfare enhancement tools (P4, P7). Training requirements for new systems demand substantial time and resource investments, particularly for complex AI and monitoring technologies that require specialised knowledge (P3). Generational differences in technology adoption create additional challenges, with older employees often requiring more intensive support and training to effectively utilise digital systems (P7). Some staff members value direct animal interaction as part of their professional identity, and automation may reduce these meaningful connections, potentially affecting job satisfaction and employee retention (P9). Successful technology adoption requires comprehensive change management strategies that address these human factors, ensuring staff understand the welfare benefits and feel supported throughout the transition to more automated and monitored working environments.

## 6 | Future trends and technological evolution

### *6.1 AI and automated monitoring*

The future of lairage technology centres on increasingly sophisticated AI systems capable of advanced animal behaviour and welfare analysis (P4, P8, P10). Companies are actively developing comprehensive monitoring systems that promise enhanced detection capabilities and automated welfare assessment (P8, P10). However, implementation challenges regarding cost and technical complexity remain significant barriers to widespread adoption (P4, P8, P10). Future AI systems are expected to evolve beyond simple monitoring to provide specific recommended actions, enabling proactive rather than reactive welfare management (P4, P10). Advanced acoustic analysis represents a promising frontier, with systems capable of interpreting pig vocalisations and stress levels to provide real-time welfare indicators (P4). These developments suggest that AI-powered monitoring will transition from basic surveillance tools to comprehensive welfare management systems that guide operational decisions and enhance animal outcomes through predictive analytics and automated intervention recommendations.

### *6.2 Increased integration*

Future lairage systems will feature enhanced connectivity with multiple technologies communicating seamlessly to create comprehensive monitoring networks (P7, P10). Data flow from farm to processor will become increasingly smooth, enabling better traceability and welfare continuity throughout the supply chain (P4, P7). However, the potential for sharing detailed welfare data with consumers remains uncertain, presenting both opportunities and challenges for industry transparency (P7). Integration of multiple data sources will enable more comprehensive welfare assessments, combining visual, acoustic, environmental, and behavioural indicators for holistic animal monitoring (P4, P10). Centralised databases collecting welfare and environmental data across the entire production chain represent the ultimate integration goal, creating industry-wide benchmarks and enabling predictive analytics for welfare management (P4). This integrated approach promises to transform isolated technology implementations into coordinated systems that optimise welfare outcomes through data-driven decision-making and comprehensive supply chain visibility.

### *6.3 Increased transparency*

The industry is moving toward comprehensive monitoring and accountability systems that track welfare throughout the entire processing chain (P4, P7, P8). Data collection is rapidly becoming standard practice across facilities, creating detailed welfare records that support both compliance and continuous improvement initiatives

(P3, P7). Financial institutions are placing greater expectations on welfare practices, incorporating animal welfare metrics into investment and lending decisions (P11). However, the ongoing challenge remains balancing implementation costs with growing consumer expectations for welfare transparency (P12). Future developments will include comprehensive welfare assessment systems that monitor animals throughout their entire lifecycle, from farm to processing, creating unprecedented visibility into welfare outcomes (P4). This transparency evolution will require industry-wide coordination to establish standardised metrics and reporting frameworks that satisfy stakeholder expectations whilst maintaining commercial viability. Enhanced transparency represents both an opportunity for industry differentiation and a necessity for maintaining social licence in increasingly welfare-conscious markets.

### *6.4 Innovative design*

Future lairage design will incorporate enrichment features, including toys and enhanced misting systems that promote natural behaviours and reduce stress during holding periods (P12). Transport container innovations aim to minimise handling by maintaining animals in the same units from farm to processing, eliminating multiple transfer points that cause stress (P9). Design philosophies increasingly emphasise working with natural animal behaviours rather than forcing compliance through restrictive systems (P11, P12). The industry is shifting toward holistic approaches that consider the entire pre-slaughter experience, from transport through lairage to stunning, rather than focusing solely on final processing stages (P9, P11). These innovative design concepts represent a fundamental evolution in facility planning, prioritising animal welfare as a core design principle rather than an afterthought. Future lairage facilities will integrate behavioural science, environmental psychology, and operational efficiency to create spaces that support both animal welfare and processing effectiveness through thoughtful, evidence-based design approaches.

## 7 | Recommendations

Industry stakeholders should prioritise phased technology implementation, beginning with cost-effective solutions such as specialised lighting systems and environmental controls before progressing to more complex AI-powered monitoring systems. Establishing industry-wide standards for technology integration will facilitate economies of scale and reduce implementation costs across all facility sizes. Collaborative funding mechanisms should be developed to support smaller processors in adopting welfare-enhancing technologies, ensuring equitable access to innovations that benefit the entire industry. Government and industry bodies should create targeted support programs that address the technical expertise gap in regional areas, including training initiatives and shared technical resources. Regulatory frameworks should be harmonised across domestic and export markets to ensure consistent welfare standards and eliminate the current two-tier system that creates competitive disadvantages. Technology providers must focus on developing plug-and-play solutions that reduce customisation requirements and implementation timeframes. Enhanced connectivity infrastructure is essential for enabling seamless data integration from farm to processor. Industry partnerships should be fostered to create comprehensive welfare databases that enable benchmarking and continuous improvement across the sector. Finally, comprehensive change management strategies must accompany technology rollouts, ensuring staff engagement and addressing resistance through education about welfare benefits and career development opportunities in increasingly technology-enabled environments. The key recommendations are presented in Appendix 2.

## 8 | Conclusion

The Australian pork processing industry stands at a critical juncture where technology adoption in lairage facilities has evolved from optional enhancement to essential infrastructure. This research demonstrates that welfare-enhancing technologies deliver measurable benefits across multiple dimensions: improved animal welfare, enhanced meat quality, operational efficiency, and social licence maintenance. While implementation barriers persist, particularly regarding cost and technical complexity, the convergence of regulatory requirements, market demands, and technological advancement creates compelling drivers for continued innovation adoption. The industry's future success depends on strategic technology implementation that balances welfare outcomes with economic viability, supported by collaborative approaches that ensure equitable access to innovations across all facility scales.

**Appendix 1.** Overview of the key findings

# Technology Adoption in Pig Lairage

Key Findings from Industry Stakeholder Research (Nov 2024 - Apr 2025)

| 14 | 45min | 5 | 6 |
|---|---|---|---|
| Stakeholders interviewed | Average interview length | Stakeholder types | Months research period |

## Current Technology Landscape and Evolution

- **3.1 Automatic Handling System:** Push gates with pressure sensors, automated loading ramps
- **3.2 Environmental Control System:** Temperature-controlled misting, automated fan systems
- **3.3 Surveillance Technology:** CCTV monitoring, thermal imaging cameras
- **3.4 Lighting System:** Green lights in races to eliminate shadows
- **3.5 Digital Record-keeping:** Apps used for real-time health monitoring and scheduling coordination
- **3.6 AI-powered Monitoring Systems:** Early-stage welfare issue detection systems
- **3.7 Lairage Design:** Long narrow pens, solid walls, non-slip flooring
- **3.8 Transport System Concepts:** Container systems from farm to stunning

## Drivers of Technology Implementation

**4.1 Regulatory Compliance and Market Forces**
Industry welfare standards, CCTV mandates, export vs domestic requirements

**4.2 Customer and Retailer Requirements**
Major retailer standards, export market demands, premium market segments

**4.3 Operational Efficiency and Welfare Synergy**
Consistent animal flow, enhanced traceability, real-time monitoring

**4.4 Meat Quality**
Reduced PSE meat, less carcass bruising, better bleeding out

**4.5 Social Licence**
Risk mitigation, brand protection, investor confidence

**4.6 Economic Benefits**
Value enhancement, labour efficiency, competitive advantages

## Implementation Challenges and Barriers

**5.1 Cost Concern**
High capital requirements, ongoing maintenance, smaller facility challenges

**5.2 Implementation Issues**
Complex processes, integration challenges, regulatory hurdles

**5.3 Technology Limitations**
Environmental constraints, connectivity issues, detection capabilities

**5.4 Staff Adoption**
Employee resistance, training requirements, generational differences

## Future Trends and Technological Evolution

**6.1 AI and Automated Monitoring**
Advanced behaviour analysis, predictive welfare management, acoustic analysis

**6.2 Increased Integration**
Enhanced connectivity, farm-to-processor data flow, centralised databases

**6.3 Increased Transparency**
Comprehensive monitoring, financial institution expectations, welfare records

**6.4 Innovative Design**
Enrichment features, transport innovations, behaviour-based systems

**Appendix 2.** Key recommendations