Final Report

Development of a state-of-the-art Personal Hygiene Ante Room Utilising AI and UV

Project code
2022-1084

Date submitted.
26/05/2025

Published by
AMPC

Date published.
26/05/205

Prepared by
Kalani Moss

Contents

1.0 Abstract

This project addressed the need for advanced hygiene compliance monitoring in the red meat processing industry by designing and deploying an innovative, AI-powered Personal Hygiene Ante Room at Northern Co-operative Meat Company (NCMC) Retail Ready facility. The initiative responded to increased industry expectations around hygiene, particularly in the wake of the COVID-19 pandemic, and aimed to enhance both employee safety and product integrity.

A computer vision system was developed and installed to automatically monitor critical hygiene behaviours, including handwashing, use of personal protective equipment (PPE), and removal of foreign objects. The project demonstrated the potential improvements in hygiene compliance, reduced reliance on manual inspections, and increased the accuracy of QA reporting. While the AI module was decommissioned due to limited commercial benefit specific to host site in ongoing operation at the completion of the project, the broader initiative demonstrated the potential of AI and automation in food safety environments. This project has provided a scalable and replicable model for hygiene infrastructure and offers valuable insights for future technology integration across the meat processing sector.

2.0 Executive summary

The project was initiated to address increasing demands for improved hygiene compliance in meat processing environments, driven by both regulatory changes and the long-term impacts of the COVID-19 pandemic. The core goal was to implement an AI-enhanced, automated Personal Hygiene Ante Room within the Northern Co-operative Meat Company new Retail Ready Facility. This space aimed to ensure stringent hygiene practices by reducing manual contact, integrating advanced monitoring technologies, and collecting compliance data in real time.

The system featured sensor-driven handwashing units, automated boot scrubbers, and AI-powered behavioural monitoring. These technologies were integrated into a dashboard to provide compliance scores and alerts. The implementation demonstrated significant improvements in detection accuracy and a reduction in reliance on manual inspections.

Despite delays caused by extreme weather, COVID-19 disruptions, and multiple project manager transitions, the initiative successfully delivered key milestones. However, after reviewing the long-term commercial viability, the AI module was decommissioned. The infrastructure, however, remains operational and sets a new standard for hygiene systems in the industry. The project offers a model that other facilities can replicate to enhance operational safety and compliance.

3.0 Introduction

Maintaining hygiene standards in meat processing is not only best practice but is essential for regulatory compliance and protecting export markets. The Australian meat processing sector is bound by both domestic and international expectations concerning food safety, requiring robust systems that can be reliably audited. In the wake of the COVID-19 pandemic, the urgency to implement enhanced hygiene measures and mitigate future disruptions became even more pronounced. This global event exposed vulnerabilities in manual hygiene monitoring systems, where compliance often relied heavily on human observation and subjective judgement.

To address these limitations, this project undertook an initiative to develop and implement an AI-enhanced Personal Hygiene Ante Room combined with state-of-the-art hygiene equipment from a range of providers. This space was envisioned not only as a functional point of sanitation but also as a data-driven compliance checkpoint. Equipped with intelligent monitoring systems, hands-free technology, and sanitisation hardware, the ante room was designed to support a rigorous hygiene culture while increasing operational efficiency. It represented a shift toward proactive QA management, offering a replicable model for other facilities.

The introduction of AI to monitor hand hygiene and PPE adherence in real-time also reflects a broader trend in industry 4.0 transformations within agriculture and food production. With support from partners Lumachain, Jarvis, and Australian Ultraviolet, the project combined cutting-edge technology with compliance-focused operational design, contributing to sector-wide insights into future hygiene infrastructure. This project thus serves as both a practical innovation in hygiene practice and a strategic investment in digital capability.

4.0 Project objectives

This project aims to create a state-of the art Ante room where employees are able to move through the product area with reduced contact and increased automation, intention was to achieve through the following objectives:

- Build a state-of-the-art Lobby Washroom, with A1 technology, with a Covid management overlay
- Share positive results and benefits with AMPC in terms of training, swabs, people acceptability and learnings
- Become an industry first in A1 technology monitoring worker behaviours and trends, to alert industry on issues.
- Benefiting QA department in monitoring washroom trends and results and worker positivity
- Required report writing for both internal and any external requirements.
- Involvement in wider meat industry strategy programs and conferences

5.0 Methodology

Overarching Project Methodology:

Step I - Internal awareness, promotion, and idea generation of the program, and conceptual designs for the business to review.

Step 2 - Development of a draft preferred design/layout for review by Northern Co-operative Meat Company and AMPC

Step 3 - Installation and evaluation of preferred design

Step 4 - Ongoing high-level management and reporting of data collected from the room, including generating new additions and initiatives, to add to the system.

Step 5 - Ongoing reporting of results and data to stakeholders

The project was delivered in a series of defined stages, facility design, hygiene system installation, and AI-based behavioural monitoring. The methodology was adapted throughout the project lifecycle to accommodate emerging challenges, shifts in COVID-related priorities, and evolving stakeholder requirements.

Stage 1: Internal Awareness and Concept Development

The project commenced with internal engagement to raise awareness of the hygiene initiative and generate ideas for an optimal entry room configuration. Conceptual designs were developed with a focus on compliance, traffic flow efficiency, and suitability for the greenfield site at the new Retail Ready Facility. These designs were reviewed by NCMC and AMPC, ensuring alignment with operational needs and industry expectations.

Stage 2: Draft Design Development and Stakeholder Review

A preferred layout was created and refined through consultation with key stakeholders. This design incorporated distinct hygiene control points and equipment zones, promoting an intuitive progression through the anteroom. The layout supported COVID-safe distancing heuristics and sought to minimise loitering and congestion, particularly during high-traffic periods such as shift changes.

Stage 3: Equipment Procurement and Installation

Following design finalisation, the project progressed to equipment selection and installation refer to figure 1 & 2 for layout. Although providers were reviewed, the process lacked a formal evaluation matrix, which contributed to downstream complications during integration. Jarvis was engaged to supply the core hygiene equipment, which included but not limited to:

- Sensor-based hand wash basins with integrated air-drying units
- Automated boot scrubbers for sidewall and tread cleaning
- Heated boot drying racks.
- Hands-free sanitiser stations with integrated turnstile activation

Australian Ultraviolet supplied UV-C lighting systems, installed for overnight automated sanitation of surfaces within the anteroom. All hardware was fitted and confirmed to be operational.

Stage 4: AI Hardware Deployment and Infrastructure Setup

To enable AI-based hygiene compliance monitoring, Lumachain installed a complete hardware network consisting of private servers, network switches, communications infrastructure, and high-resolution IP cameras. Camera placement was designed to provide comprehensive visual coverage of hygiene activities. The deployed cameras included:

- **Entry camera**: DS-2TD2637-15/P model with temperature and facial recognition
- **Exit camera**: UNV 8MP, 2.8–10 mm lens.
- **Automated boot wash camera**: UNV 8MP, 2.8–10 mm lens
- **Hand Wash Station 1 camera**: UNV 8MP, 2.8–10 mm lens

- **Hand Wash Station 2 (dual) camera**: UNV 8MP, 2.8–10 mm lens
- **Hygiene room tracking camera**: UNV 8MP, 2.8–10 mm lens.

Stage 5: Computer Vision AI Development and Testing

The AI module was developed to perform compliance monitoring using computer vision algorithms. High-resolution video captured from the hygiene stations was analysed to detect key compliance behaviours including soap usage, wash and dry duration, PPE adherence (hairnets and beard nets), and foreign object detection (rings, watches, bracelets, and hair ties).

Computer vision AI Methodology:

The development of this computer vision AI to monitor and assess hand washing practices in real time.

1. High-resolution cameras are strategically placed to capture video footage of employees performing hand washing tasks. AI-powered image recognition algorithms analyse the footage to detect key handwash compliance indicators.
2. To train the AI, a large dataset of annotated images and videos is collected, highlighting correct and incorrect hand washing practices. These annotated images are used to train the AI model, enabling it to recognize non-compliant activities.
3. System dashboard is provided to integrate with QA monitoring process and provide real-time on-site feedback on hygiene compliance.
4. The system provides real-time feedback on compliance and generates compliance scores, offering a more accurate, efficient, and automated solution compared to traditional manual monitoring.

Stage 6: Reporting, Review, and Rescoping

Regular milestone reporting was carried out through presentations and written updates to AMPC and other stakeholders. As the project progressed, several originally scoped features were revised or descoped due to practical or contextual constraints.

Project Required to be rescoped:

- Due to covid relevance no longer making some items applicable e.g. temperature recognition.
- Due to delays, causing some elements to be too difficult to achieve within limited timeframe e.g. facial recognition, turnstile.

Design and operational layout of equipment:

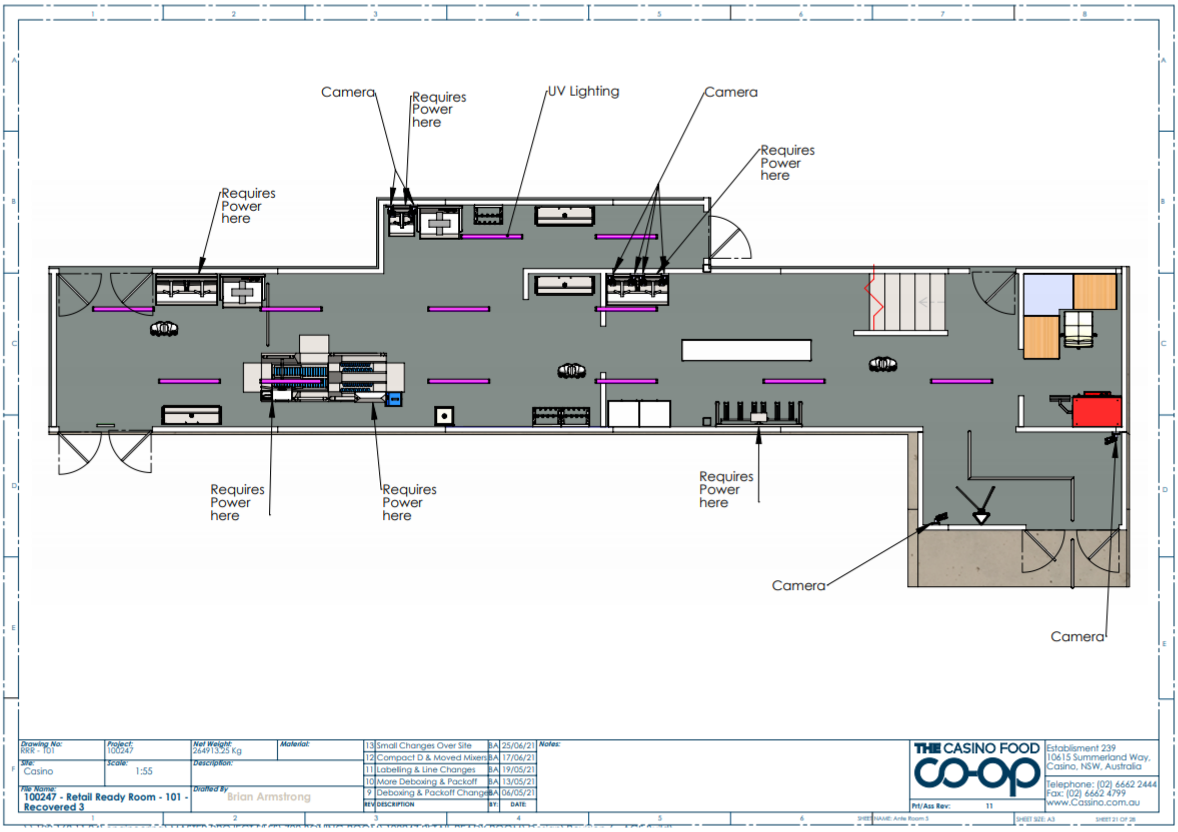


Fig 1: Casino Food Coop Ante Room Layout.

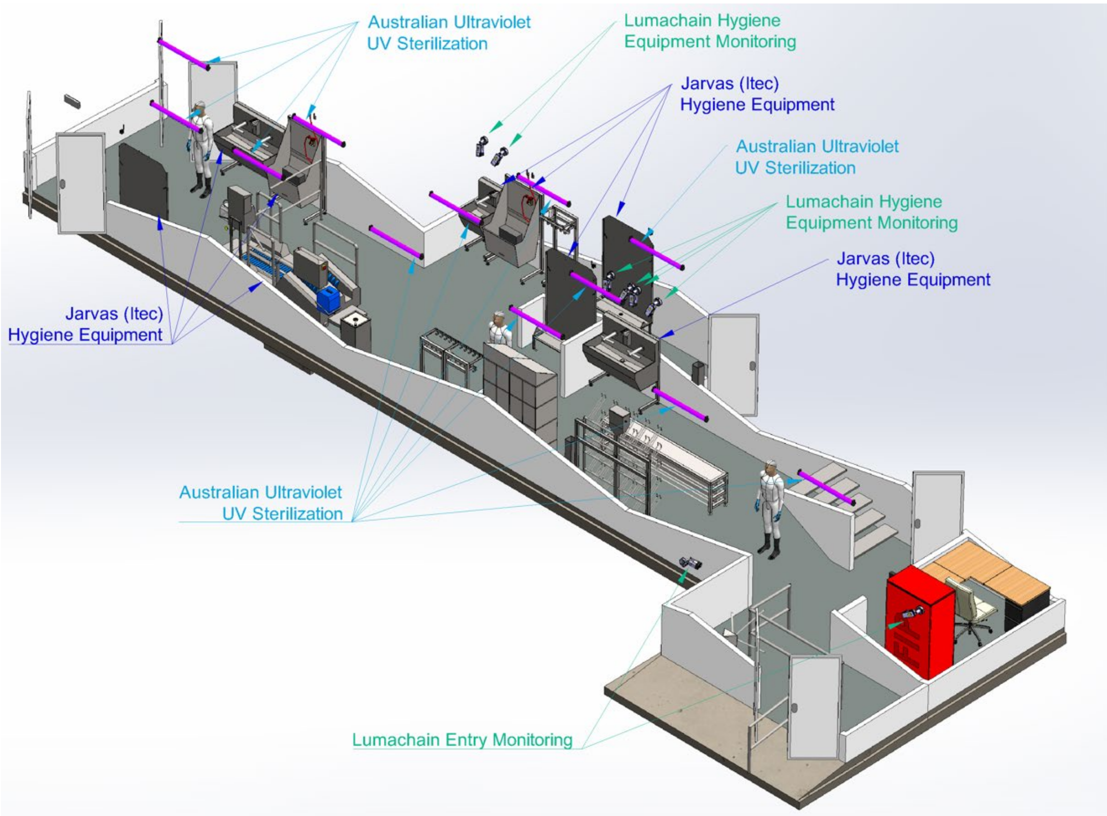


Fig 2: Casino Food Coop Ante Room Layout.

6.0 Results

The project resulted in the successful installation and commissioning of all hygiene control equipment, with systems operating in alignment with the original implementation plan. The physical infrastructure—including automated handwashing units, boot scrubbers, and sanitising stations—proved to be operationally viable and effective. These systems supported the project's objectives of creating a hygienic, efficient, and COVID-safe entry process for staff. The anteroom layout was successful in promoting streamlined employee flow, reducing congestion, and reinforcing compliance with distancing protocols initially framed around "anti-loitering" principles. Staff movement into and out of production areas was noticeably improved as a result. Refer to appendix A, for overview of new Retail Ready Anteroom and Facilities.

While the hygiene equipment consistently performed to expectations and delivered reliable cleaning outcomes for both hands and footwear, some overarching project objectives were affected by broader contextual changes. Specifically, the decline in COVID-19 prevalence led to a formal rescoping of the project. As a result, certain components—such as temperature recognition and facial identification—were removed from scope, limiting full completion of the original COVID-focused compliance project objectives.

The AI computer vision module utilising object detection machine learning demonstrated strong potential in enhancing and assisting hygiene compliance monitoring, refer to Appendix B. During its operational period, the system appeared capable of achieving high detection accuracy rates for the specified key hygiene behaviours, these included:

Hand Wash Compliance

- Each individual was assigned a unique tracker ID and timestamp upon entering the handwash station's region of interest.
- The system monitored:
  - Soap usage (PASS/FAIL)
  - Washing duration (minimum 20 seconds)
  - Drying time (minimum 14 seconds)
- Overall handwash compliance was rated as PASS only if all steps were met and the total wash cycle exceeded 35 seconds.

This washing time and drying time was revised to have no minimum time, as found that above metrics were not operationally feasible or required. Minimum time able to be reintroduced at later stage in implementation if deemed required or beneficial.

Personal Protective Equipment (PPE) Detection

- Targeted PPE included:
  - Hairnets (must fully cover ears)
  - Beard nets (where applicable)
- Detection occurred within the same ROI used for handwash and foreign object modules.
- Compliance was achieved if both hairnet and beard net were detected correctly while the user was in position. If note detected present or worn correctly resulted in a FAIL rating.

Foreign Object Detection (FOD)

- Specified foreign objects:
  - Rings, watches, bracelets, hair ties

- Detection was limited to objects located on hands, wrists, or fingers; skin-toned objects were excluded.
- Any foreign object identified during handwashing resulted in a FAIL rating.
- At delivery, baseline detection accuracy was 75%, with improvement expected over time.

This project presented invaluable opportunities for learnings applicable to the business and industry for future applications.

7.0 Discussion

The implementation of the Personal Hygiene Ante Room presented a combination of operational achievements and real-world learning opportunities. One challenge involved managing delays resulting from unforeseen events such as severe flooding in the Northern Rivers and pandemic-related disruptions. The natural disaster of the flooding in the local area provided the opportunity where the retail ready facility was utilised to pack food and care packages for the local community. Although halting operations this provided a location where the facility was able to serve the wider community and assist the perception of the red meat industry.

The project experienced considerable disruption due to a series of unforeseen events, which significantly impacted timelines, staffing continuity, and access to critical equipment. These challenges were further compounded by an unusually high turnover of project managers—five over the course of the initiative, with three changes occurring during the development phase of the AI module. This turnover resulted in the loss of project knowledge, delays in onboarding new personnel, and diminished overall continuity, undermining the momentum required for successful delivery. This was experienced by project manager changes by both parties; NCMC and provider Lumachain, resulting reluctance to continue project and frustrations. This was resolved and project progressed.

On a technical level, the AI system required an extensive amount of annotated footage to reach functional accuracy. Training the algorithm to distinguish between compliant and non-compliant behaviours — such as proper handwashing techniques or incorrect use of PPE — proved time-consuming this combined with the above-mentioned project manager changes resulted in the development of the AI module exceeding 18 months. Additionally, deploying the AI model within a production environment necessitated multiple rounds of testing and refinement to reduce false positives and improve user trust.

Divergences in expectations regarding project scope led to repeated clarification and renegotiation efforts, while technical obstacles in the AI handwash module—such as differing times, and requirements for compliant and non-complaint events necessitated ongoing adjustments to better align with operational requirements. Additionally, as experienced when training an AI module further retraining and refinement was required where the system misclassified compliant handwashing behaviours as non-compliant, incorrectly identified foreign objects when no personnel were present, and at times failed to detect actual breaches. These inconsistencies demonstrated the need for validation, ongoing training and refinement that can be expected when developing an AI module.

The hygiene equipment installed throughout the entry room, complemented by a logistically efficient flow design, was received positively by staff. The combination of automated handwash basins, boot scrubbers, and sanitising units contributed to an anteroom experience that was not only effective and efficient but also well-regarded for its ease of use and overall user satisfaction. It is important to note that Workplace Health and Safety (WHS) concern also emerged after a period of operation, whereby the uniform of an operative was caught in automated boot scrubber causing a soft tissue injury. This led to a re-evaluation of PPE requirements and staff training procedures highlighting the importance of integrating human factors engineering into technology design. Staff adaptation required ongoing engagement, education, and feedback to ensure smooth adoption and procedural consistency.

Despite the challenges encountered, the project successfully demonstrated the capability of AI technology to detect hygiene non-compliance with a high degree of precision. It showcased the potential for AI to serve as a scalable, consistent, and objective layer of quality assurance, complementing traditional monitoring methods, enhancing visibility over hygiene practices and supporting training of employees. However, following implementation and evaluation, the AI module was ultimately decommissioned due to insufficient commercial viability. The system did not yield measurable labour efficiencies hoped for and lacked integration with existing QA platforms, resulting in duplicated effort and increased workload for operational staff. Integration into QA system was not specified in the scope of the project but is highlighted as a recommendation for future work in this space. To elaborate, rather than replacing a labour unit this module would require the QA team to monitor or review the dashboard, this module was then explained to be intended for training, and or reviewing purposes to support Quality System rather than substituting for a labour unit. In the event that the AI dashboard integrated into the already development Quality System and provided automated reports this duplication of work could be reduced.

This misalignment in the business case potentially could have been eased with further commercial focused at project development stage and business wide project support, as well as increased understanding of outputs. Furthermore, the decline in relevance of COVID-specific hygiene measures greatly reduced the perceived long-term value of the system within NCMC’s operational setting. While the project delivered substantial technical insights and highlighted the broader potential of AI in industrial compliance environments, it was determined that the solution was not viable for the company’s current operational context and evolving business priorities, though it may still offer value in other business environments.

The project also opened up valuable dialogue around the ethical and cultural implications of workplace monitoring. Although facial recognition was never implemented, concerns about staff privacy and surveillance were raised consistently in stakeholder discussions. These conversations highlight the importance of transparency, consent, and clear governance frameworks when deploying AI systems in industrial settings.

8.0 Conclusions

This project successfully developed and implemented a hygiene ante room that raised industry standards for compliance, cleanliness, and operational efficiency. Though the AI module was not continued due to cost-benefit analysis, despite this its performance validated the potential of AI-driven QA in food processing to support operations. The infrastructure and operational learnings from this project are invaluable as they provide a platform for future implementations across the red meat and broader food industries.

9.0 Recommendations

To support future implementations and broader industry adoption of automated hygiene systems, several key recommendations have been identified based on the outcomes and insights of this project. Prior to initiating similar initiatives, it is essential to undertake an in-depth feasibility study. This should encompass an evaluation of technical requirements, providers, and the overall commercial viability of AI-based compliance systems. The assessment should consider the entire lifecycle cost of acquiring, implementing, training, and maintaining such technology, weighed against projected benefits including labour cost savings, improved audit preparedness, regulatory compliance, and risk mitigation. As the nature of this project is research and development elements of the above were not able to be completed.

It is also important that future deployments ensure integration with existing Quality Assurance system and digital management platforms. Fragmented or non-compatible data systems can significantly hinder the value of AI insights and the willingness for teams to engage in utilising technology. Ensuring integration with existing platforms, compliance dashboards, and operational management tools will support long-term scalability, efficiency, and effectiveness.

Technologies introduced during the COVID-19 period, such as temperature sensing and facial recognition, should be critically reviewed for ongoing relevance. Their inclusion must be based on up-to-date risk assessments and practical alignment with current operational needs.

With the growing role of AI and behavioural monitoring systems, it is crucial to establish and enforce robust data governance protocols surrounding privacy. These should address ownership, employee consent, data retention, access rights, and the ethical usage of monitoring data. Transparency in these practices will be essential to maintaining employee trust and ensuring adherence to privacy regulations.

Finally, continuous evaluation and refinement of installed systems should be embedded in operational strategy. Establishing feedback mechanisms that link QA teams, IT, and frontline staff will support the identification of improvement opportunities. Regular performance reviews of the system, user feedback sessions, and impact assessments will ensure the system remains aligned with evolving organisational goals and industry standards.

10.0 Project outputs

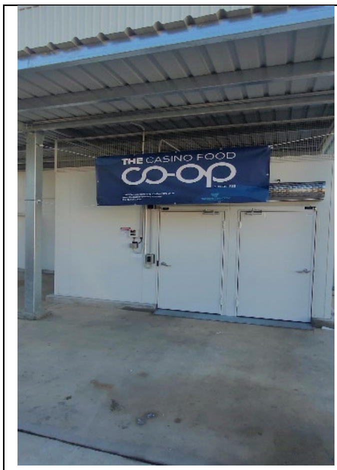
Project Outputs/Deliverables

- Development, demonstrate, and document (including videos) of a Covid 'safe' best practice staff plant induction and exit lobby.
- Training and development of staff
- Training of A1 on behaviours, to monitor hygiene behaviours
- Deliver a high successes rate of factory swabbing, and staff swabbing results compare to historical Data.
- Deliver data focusing on staff behaviour hygiene outcomes
- An industry first in technology
- A clear blue-print sizing washroom lobbies to staff compliment to avoid loitering and comply with agreed Covid social distancing heuristics.

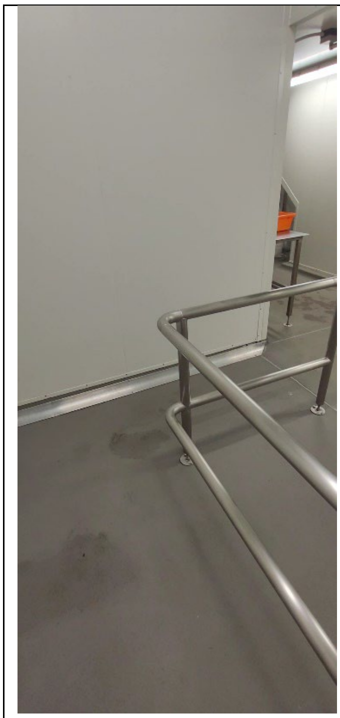
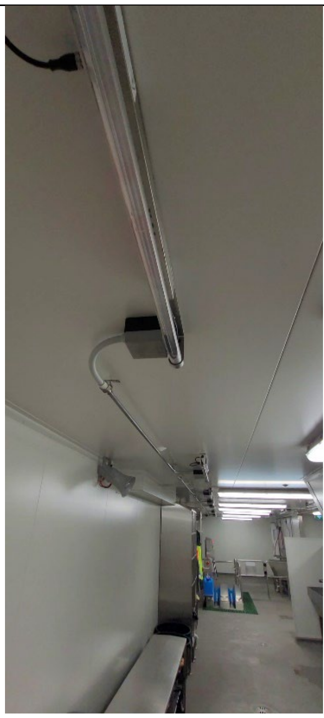
11.0 Appendices

Appendix A: overview of new Retail Ready Anti Room and Facilities

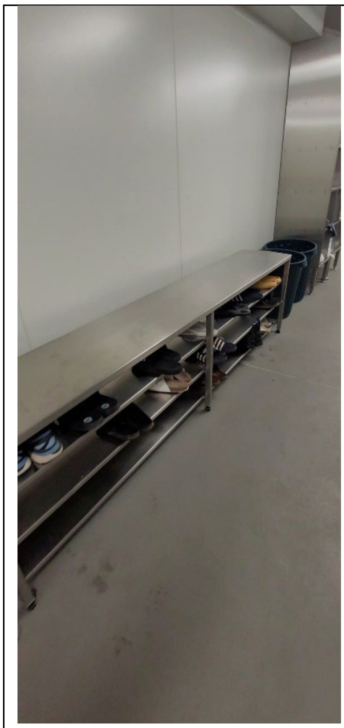
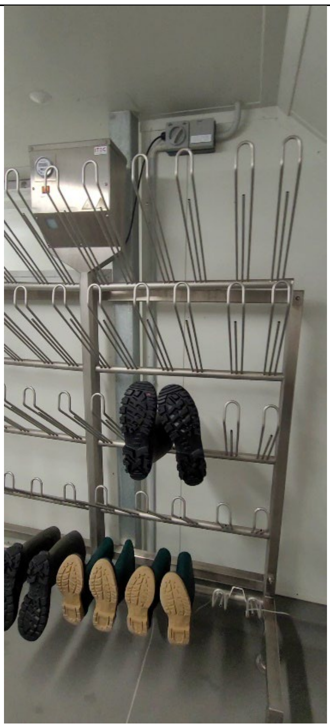
Entry to new facility (key points)

	
Entry to new Retail Ready Anti Room	Security Release doors for approved staff via RFID cards

Main entry room space –

		
Entry path separated from outgoing staff	View of anti-room design utilising narrow thoroughfare concept	Ultraviolet light applications. Run overnight after cleaning to reduce mould, bacteria and virus populations

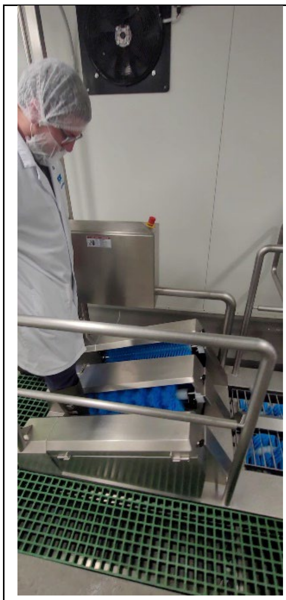
Features for employees –

		
Employee shoes held on shelves Not in lockers	Employee boot rack with sanitizing/heated dry air technology	Boot wash station
		
Paperless handwash station. Incorporating heated water, soap and air-drying capabilities	Additional boot wash area and sink	Boot sanitizing station

Project features (Paperless handwash combination unit)

 Staff using the hand wash water feature	 Application of hand soap
 Soap lathering/rinse procedure	 Drying hand using warm air blade feature

Project features (Boot and hand sanitizer stations)

 Staff using the side boot scrubber and sanitizer application	 Staff using the bottom tread scrubber and sanitizer application
 Application of both hands for sanitizer delivery (**note:** red light and turnstile preventing movement until both hands are placed in receptacles)	 Application of sanitizer to both hands (note**:** green light now allows the employee access through turnstile to Retail ready room)

Appendix B: Artificial Computer Vision Algorithm and Data Collection in

1. Hand washing procedure: Data Collection of hand wash events that included:

- Handwashing: use of hand sanitiser, user of dryer
- Presence of foreign objects such as jewellery, rings etc
- PPE present and worn correctly, e.g. Hairnet.
-

2. AI-CV Detection

The following pictures illustrate the algorithms in operation to detect and capture data on each component. Data captured include

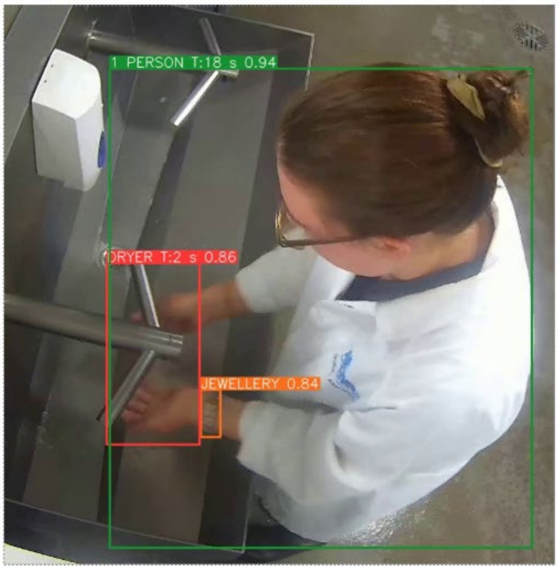
- Date and Timestamps,
- wash ID,
- Wash Secs,
- Soap Usage

In addition, the hygiene module also can detect

- Foreign Object such as Jewelry, rings, watch etc. worn on the hand and wrist*

WEARINGS
HAIRNET
PPE
JEWLLERY

- Presence and correctly worn PPE such as Hairnet*

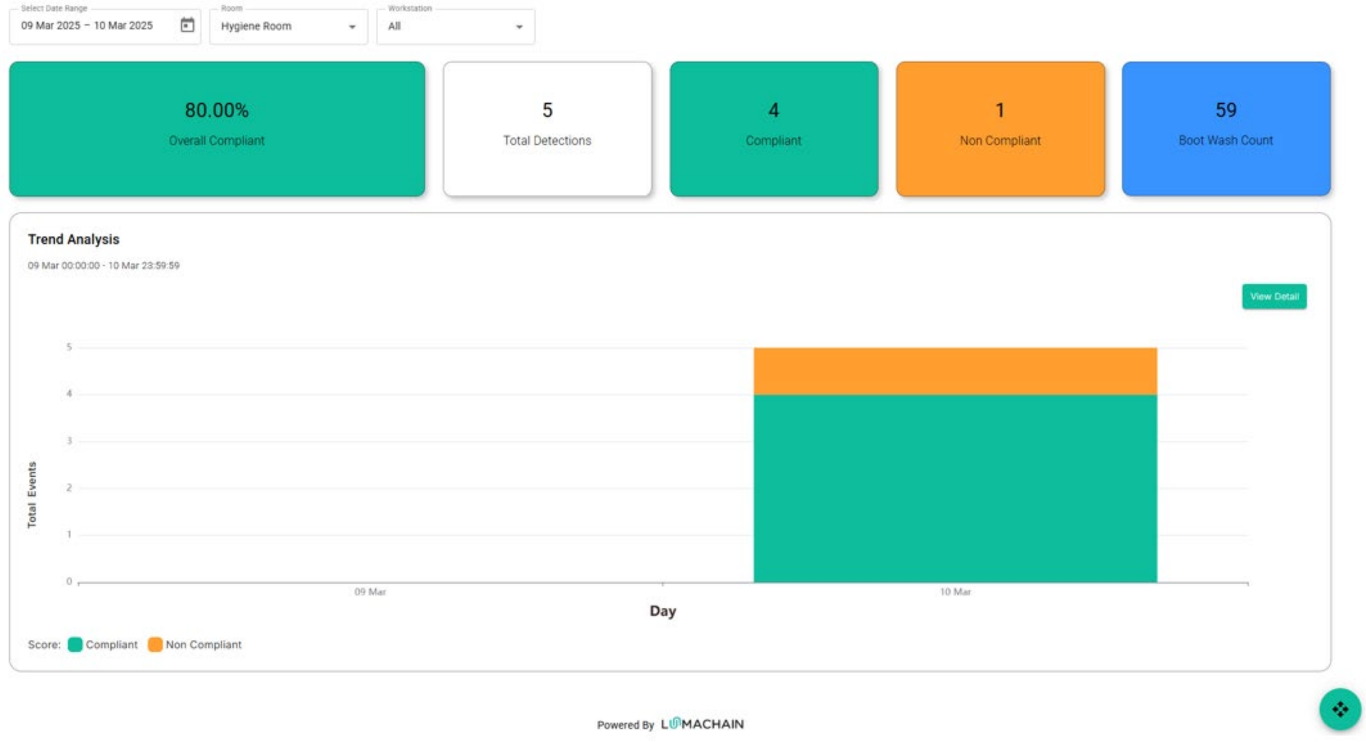


* Images above highlight items detected by AI engine. The hairnet not detected in the image on the left is recognised as non-compliant by the system.

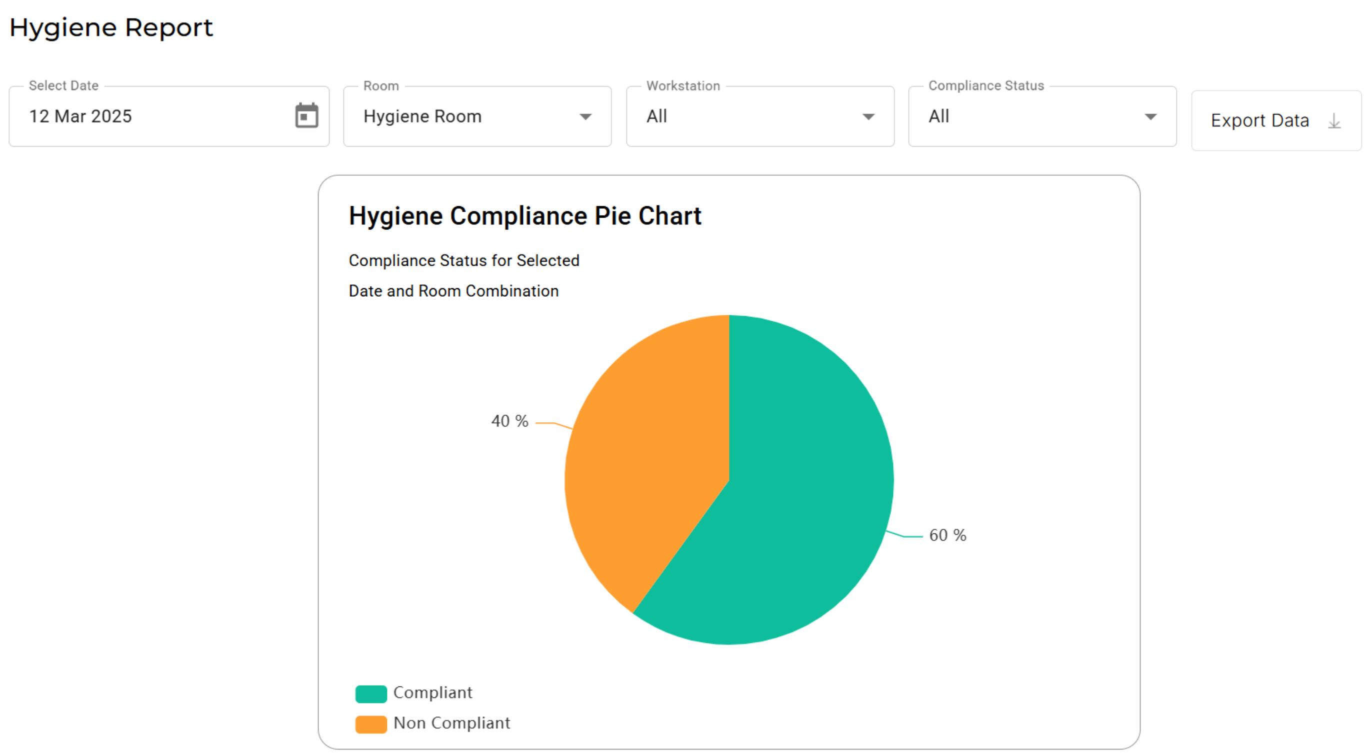
3. Boot Wash Compliance

Below images illustrate the boot wash station. Data captured include date and time stamps, direction, i.e. employees entering, event ID.

4. Report Dashboard accessed via app.lumachain.io showing trend analysis breakdown of compliant and non-compliant hygiene data



Detailed record of each handwash event broken down for each compliance check



Detailed Report

Show Video Only

Date	Time	Workstation	Wash Time	Soap Used	Dry Time	FOD	PPE	Overall Compliance Status	View Event	Incidents
12 Mar 2025	04:43:04	WS 3	Pass	Pass	Pass	Pass	Pass	Compliant		
12 Mar 2025	04:45:14	WS 4	Pass	Pass	Pass	Pass	Pass	Compliant		
12 Mar 2025	05:00:41	WS 4	Pass	Pass	Pass	Pass	Fail	Non		
12 Mar 2025	05:06:03	WS 4	Pass	Pass	Pass	Pass	Pass	Compliant		
12 Mar 2025	05:25:51	WS 4	Pass	Pass	Pass	Pass	Pass	Compliant		
12 Mar 2025	07:00:50	WS 4	Pass	Pass	Pass	Pass	Pass	Compliant		

Items per page: 1000   1 – 20 of 20   Go To: 1

Each event is accompanied by video reference which is used for further AI training as well as staff training if necessary.