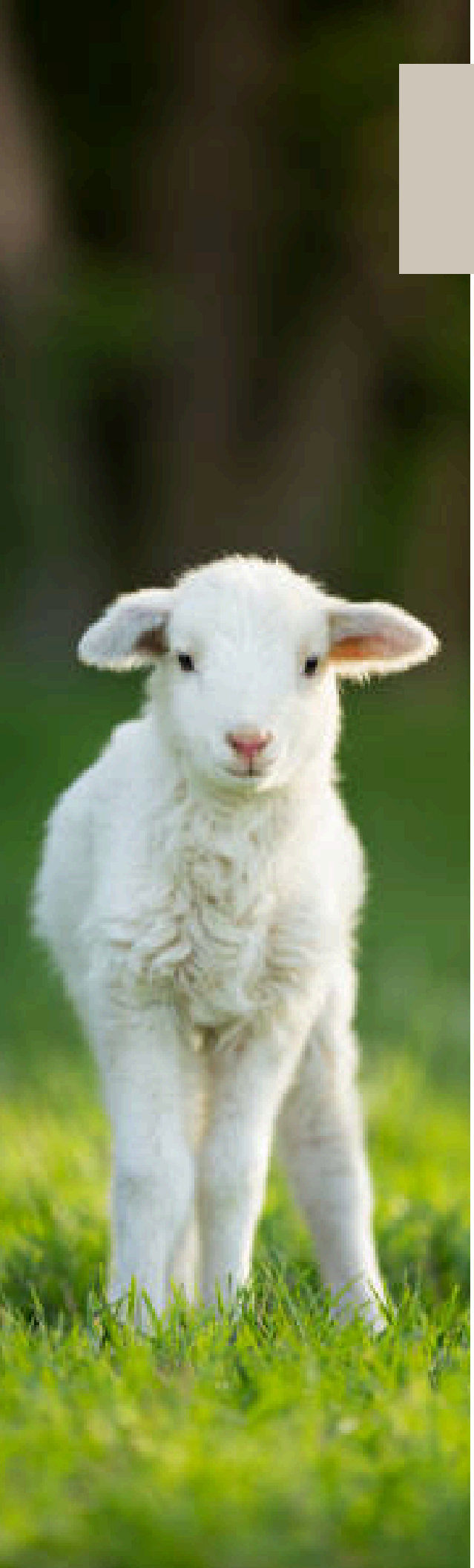
Analysis Report

March 2024

Prepared By
DOUBLE DOUBLE CONSULTING

Prepared For
CANADIAN SHEEP FEDERATION

TABLE OF CONTENTS



APPENDIX

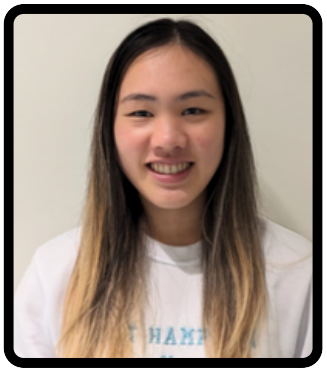
GROUP BIOGRAPHY

KRYSTAL CHAN

Krystal is a fourth-year HR & MIS student who has successfully led and overseen projects from initiation to closure from previous internships. With great attention to detail, she is skilled at managing resources, mitigating risks, and delivering high-quality results on time and within budget. She contributed to the executive summary and conclusion, formal system request, economic feasibility, to-be system use cases, and DFDs.

NICOLE MAN

Nicole is a third-year Finance & MIS student who made significant contributions to the project's success. She brought her strategy expertise to the project to develop effective strategies that align with CSF's goals and objectives. With her communication, adaptability, and strategic thinking skills, she contributed to the description of the as-is system and to-be system, formal systems request, to-be system use cases, and DFDs.



HEIDI TSUI

Heidi is a fourth-year Operations & MIS student with a proven track record of successfully translating business requirements into innovative solutions from work experience. Armed with a strong analytical mindset, exceptional problem-solving skills, and a keen eye for detail, she has been a key contributor to the Gantt chart, formal systems request, to-be system use cases, and ERDs while delivering valuable insights and driving informed decision-making.

DAISY ZHANG

Daisy is a fourth-year Finance & MIS student who has an understanding of change methodologies, training and development, and stakeholder engagement to drive strategic initiatives. With excellent communication skills and a passion for empowering teams through change, she contributed to the description of the non-functional and functional requirements, formal systems requests, to-be system use cases, and ERDs.

EXECUTIVE SUMMARY

The Canadian Sheep Federation (CSF) is an organization representing sheep farmers and industry stakeholders across Canada. Our project focuses on the Canadian Sheep Identification Program (CSIP) aimed at establishing a full-scale traceability system in order to address producer concerns regarding sheep health, offer valuable management feedback to producers, and fulfill consumer expectations for quality assurance and food safety. They are currently exploring the transition from traditional RFID tags to AI-powered facial recognition technology in sheep farming to enhance accuracy, efficiency, and animal welfare in livestock management. The CSF can do this by engaging with farmers, livestock handlers, and regulatory bodies to facilitate the adoption of new technology.

AS-IS SYSTEM

DESCRIPTION

The CSF currently utilizes and relies on Radio Frequency Identification (RFID) tags for livestock identification, particularly sheep. As traceback systems became mandatory on January 1, 2004, sheep farmers in Canada have adopted RFID tagging systems for their flocks for two decades. This indicates a widespread acceptance and recognition of the benefits of RFID technology in sheep management among Canadian farmers (Cansheep, 2024). Farmers use RFID tags to establish a full-scale traceability system in order to address producer concerns regarding sheep health, offer valuable management feedback to producers, and fulfill consumer expectations for quality assurance and food safety. These tags are essentially small electronic devices consisting of a microchip, receiver, and transmitter that are used for identification and tracking, costing roughly $2.50 each. After an RFID tag is attached to a sheep, users can input relevant data through a specific frequency into a chipset (RFID Journal LIVE!, 2021), connecting specific information to unique RFID tag identifiers. You can also assign animals in the tags as a digit number for easy identification and upload a CSV file of the sheep's basic information. Farmers and livestock managers can then use RFID readers to capture information emitted by the tags through radio waves to track individual sheep within a flock. The retrieved information can be used for many things other than identification, from monitoring sheep health, tracking movements within the flock, and making informed decisions regarding breeding, feeding, and medical situations.

How It Works

When someone buys a package of tags, they need to input customer information into the RFID tagging system. Tags need to be activated before use and when it is activated, you can create an inventory of animals and different reports such as transport documents, replaced tags, breeding histories, health records, animals transferred to another farm, move-in reports, information about vehicles that animals came is on, dates/times of arrivals/departures, quantities of animals, and destination premises.

RFID tagging systems can be integrated with physical documents, where each unique identification number can be linked to corresponding physical records stored in paper format. In some cases, RFID tagging systems can be integrated with other farm management software or databases, such as AgroLedger. The connection between RFID and AgroLedger allows the transfer of paper documents to digital files, where paper reports are used to capture sheep information as some users find it challenging to switch to digitalized reports due to preference.

AS-IS SYSTEM

Benefits:

- **Non-Visual Identification:** RFID tags allow for non-visual identification of animals, which is beneficial during situations where visual identification through facial recognition is unsuitable due to low-light conditions, crowded environments, or when sheep do not face the camera.

- **Durability:** RFID tags are generally durable and resistant to wear and tear compared to visual tags or facial features ensuring reliable performance over longer periods. They withstand harsh environmental conditions like natural disasters such as rain storms where there's water and mud.

- **Easy Integration:** RFID systems have been around for decades and have been widely used by many Canadian farmers because they can be easily integrated into existing livestock management practices and infrastructure. Minimal setup and training are required which make RFID tags easy to use and becomes accessible for farmers with different levels of technical skill and expertise.

AS-IS SYSTEM

Challenges

The CSF currently faces challenges that include the time-consuming process of reading RFID tags, high cost of the tags and readers, the data loss from tags being torn off or damaged, and inability of real-time welfare updates.

- **Time-consuming Process:** Reading RFID tags can be a time-consuming task, particularly when managing large flocks of sheep. The process of scanning individual tags, especially in crowded or fast-moving environments, can lead to inefficiencies and delays in data collection and management. Additionally, RFID tags involve transferring files from a reader to the reporting system, another time-consuming aspect of using RFID tags.

- **High Cost of the Tags and Tag Readers**: The initial investment required for purchasing RFID tags and compatible tag readers can be high for many sheep farmers. Additionally, CSF needs enhanced tracking and identification capabilities and to steer away from ongoing maintenance, limited accuracy, and replacement costs that can further strain financial resources. The RFID tags currently require the use of specialized handheld readers that have a five-year lifespan costing over $1000 each. However, due to time constraints, handheld readers are not practical and feasible for high-volume usage. Moreover, the deployment of panel readers costs roughly $10,000 to $15,000 each, which creates financial strain. Both handheld and panel readers also require a backup method for capturing IDs unless each tag is manually read by a farmer, leading to time inefficiencies.

- **Data Loss:** RFID tags are susceptible to damage from environmental factors, handling, and animal behavior. Tags may become torn off or damaged during grazing, handling, or transportation activities, leading to data loss and reduced effectiveness of the tagging system. CSF is looking to provide a reliable and non-invasive method for identifying and tracking individual sheep.

- **Inability of Real-time Welfare Updates:** RFID systems lack the capability to deliver timely information about the health status and well-being of animals. As such, farmers cannot promptly identify and address emerging issues such as illness, injury, or distress in animals, potentially compromising animal welfare and farm productivity. Undetected illnesses or injuries in one sheep can spread to others if left unchecked, leading to increased morbidity rates and economic losses.

CSF aims to minimize data and transcription errors, reduce time delays in data reporting, alleviate the workload for regulated parties, minimize data loss from tags being torn off or damaged, and find a better way to track the welfare statuses of sheep. The hope is to incorporate AgroLedger, a blockchain database created to simplify livestock traceability for Canadian Sheep Producers with AI facial recognition technology. AgroLedger allows for an easier performance assessment than RFID tags by creating a means to capture, report, and analyze trace data and will be used as the regulated data management system for sheep traceability.

SYSTEM REQUEST

Project Sponsor: Corlena Patterson, Executive Director of the Canadian Sheep Federation

Business Need:

- Eliminate the need for regulated parties to purchase tag-reading hardware RFIDs.
- Set a new standard for data accuracy and operational efficiency in the livestock management industry.
- Provide guidance to stakeholders in understanding and trusting AI's capabilities to overcome resistance to technological change.
- Improve operational efficiency in trace report completion.

Business Requirements:

- Ensure that AI facial recognition will integrate with current farm management systems. Real-time capture of facial profiles and biometric data, eliminating the need for physical RFID tagging.
- Give farmers access to the biometric information of all their sheep.
- The system is compatible and integrates well with the AgroLedger platform.
- Address data privacy and security concerns, given the sensitivity of biometric data.

Business Value:

- Improved operational process efficiency through time saved in livestock identification, tracking, and data reporting; by eliminating the stages of file transfers from the reader to the reporting system.
- Improve the accuracy in animal identification up to 99.3%[1] compared to RFID leading to enhanced traceability throughout the sheep supply chain.
- Improved long-term cost-saving**s** by switching from RFID to AI by reducing $2.50 per tag annually.
- Further improved long-term cost-savings by reducing $1000 per handheld RFID reader and $10-15k per panel RFID reader.
- Emphasis on advantages for farmers over RFID in terms of animal welfare.

Constraints:

- Requirement to integrate with AgroLedger and CSF's existing systems.
- Ensure compliance with relevant data privacy laws and government regulations.
- Stakeholders may resist adopting AI into existing systems and processes.
- Farmer's lack of time and knowledge of AI may hinder the speed of adoption.

[1] https://www.pnas.org/doi/10.1073/pnas.1719367115#:~:text=Our%20deep%20neural%20networks%20automatically,rapidly%20in%20years%20to%20come.

ECONOMIC FEASIBILITY

	Year						
	2024	2025	2026	2027	2028	2029	Total
Benefits							
Sales in AI visual tags		$1,600,000	$1,600,000	$1,600,000	$1,600,000	$1,600,000	$8,000,000
Sales in AgroLedger fee		$377,600	$377,600	$377,600	$377,600	$377,600	$1,888,000
Reduction in labor costs		$27,248	$27,248	$27,248	$27,248	$27,248	$136,240
Total Benefits		$2,004,848	$2,004,848	$2,004,848	$2,004,848	$2,004,848	$10,024,240
Costs							
Costs in replacing RFID tags	$160,000	$160,000	$160,000	$160,000	$160,000	$160,000	$960,000
Hardware (security camera)	$390,000	$0	$0	$0	$0	$0	$390,000
Maintenance & Improvement	$85,000	$85,000	$85,000	$85,000	$85,000	$85,000	$510,000
Trace system	$292,759	$292,759	$292,759	$292,759	$292,759	$292,759	$1,756,554
Total costs	$927,759	$537,759	$537,759	$537,759	$537,759	$537,759	$3,616,554
Net Benefits	-$927,759	$1,467,089	$1,467,089	$1,467,089	$1,467,089	$1,467,089	$6,407,686
Cumulative NCF	-$927,759	$539,330	$2,006,419	$3,473,508	$4,940,597	$6,407,686	
Discount Rate	10%						
NPV	$11,183,599.59						
ROI	177%						
BEP	0.56						

Assumptions

We assume that the benefits mainly come from the sales of AI visual tags, the cost of AgroLedger tags, and the reduced labour costs after transferring to AI facial recognition. First, we assume that 640,000 tags will be sold in a year, and the price of each tag is $2.50. Therefore, the annual revenue from AI visual tags is approximately $1,600,000. Second, we also assume that 640,000 tags are sold in a year, and the cost of each AgroLedger is $0.59. Therefore, we will obtain revenue from AgroLedger of $377,600 per year. In addition, we assume employees save 4 hours per day after switching to AI facial recognition. According to Statistics Canada data, the average hourly wage for full-time employees in agriculture is $26.[1] Based on a 262-day working day per year, this would save $27,248 in employee costs per year.

Costs come from three parts, trace system cost, hardware costs, and the cost of replacing RFID tags. First, we assume that the quantity of replacement RFIDs is the same as the quantity calculated for sales, which is 640,000, and the replacement cost of each tag is $0.25. Therefore, the cost to replace RFID tags is $160,000. Second, the cost of hardware for the purchase of security cameras and handheld readers. We assume that security cameras are used instead of panel readers, costing $30 each. Its total cost is $390,000. We assume that the cost of hardware is only incurred at the inception of the project. Finally, the entire trace system costs $377,759 per year. Of this amount, $85,000 is spent on maintenance and improvements. We list maintaining and improving costs separately for a more precise cost structure.

1 https://www.statcan.gc.ca/en/start

ECONOMIC FEASIBILITY

	AgroLedger Fee	NPV
Change in AgroLedger fee	0.39	$9,820,068.29
	0.49	$10,501,833.94
	0.59	$11,183,599.59
	0.69	$11,865,365.24
	0.79	$12,547,130.89
	0.89	$13,228,896.55
	0.99	$13,910,662.20

	Labour Wage	NPV
Change in Labour wage	24	$11,161,271.76
	25	$11,172,435.68
	26	$11,183,599.59
	27	$11,194,763.50
	28	$11,205,927.41
	29	$11,217,091.33
	30	$11,228,255.24

Sensitivity Analysis

In the sensitivity analysis, we analyzed two variables: changes in the AgroLedger tags fee and changes in labour wages, assuming that other variables stay constant. The changing results are reflected in the NPV.

Scenario Summary				
	Current values	Most Likely	Best	Worst
Changing Cells				
Discount rate	10%	10%	7%	20%
AgroLedger fee increase	0.59	0.59	0.79	0.39
Labour wage increase	26	26	26	30
Handheld readers increase	0	0	0	3250000
Result Cells				
NPV	$11,183,599.59	$11,183,599.59	$14,005,536.72	-$6,064,283.66

Scenario Analysis

In our scenario analysis, the project most likely to result in a positive NPV is $11,183,599.59 within 5 years, which is worth investing in. The best valuation in NPV of this project is estimated at $14,005,536.72. The worst valuation in NPV of this project is estimated at -$6,064,283.66. In the worst situation, we will add on the increased number of handheld readers. We assume that the number of producers with handheld readers is 40%, growing to 65% after the new regulations are announced. Therefore, the total incremental cost for handheld readers is $3,250,000.

In conclusion, the project's NPV is a positive value of $11,183,599.59, which is worth investing in.

GANTT CHART #1 - OVERVIEW: ANALYSIS & DESIGN

The actual project timeline lasted from January 22, 2024 - April 8, 2024 with a total span of 77 days (Refer to Appendix B). However, the project process involved several adjustments in tasks, milestone deadlines, and responsibilities; proving that projects rarely go exactly as planned. This highlights the importance of being flexible and adaptable as a project team to accommodate unforeseen circumstances. As such, our team has learned 3 key takeaways about planning and scheduling throughout the project process.

3 KEY TAKEAWAYS

Learn through continuous improvement: Through implementing Business Process Analysis concepts, past Lab Assignments, and in-class problems, our team learned to constantly optimize key project deliverables throughout the project timeline. This included the development and refinement of Use Cases, Level 0 DFD, and ERD to achieve accurate and effective outcomes for CSF. In addition, through the iterative process of reviewing and adjusting deliverables based on new information gathered by requirements elicitation strategies, this helped to ensure that the to-be system aligned with changing project requirements and constraints.

Be adaptable and flexible with change: Our team learned that unforeseen circumstances can occur, resulting in misalignment between planning and execution. As such, it is important to have a mindset that embraces change and challenges. This enables the team to pivot and reallocate resources as necessary to keep the project on track.

Maintain open channels of communication: Whether synchronous or asynchronous, it is important to be transparent as a project team. This helps empower team members to voice concerns or uncertainties to overcome challenges and foster effective communication for successful project execution.

GANTT CHART #2 OVERVIEW: IMPLEMENTATION

The implementation timeline will be from **April 9, 2024 - June 27, 2024** with a total span of 79 days (Refer to Appendix C)..

IMPLEMENTING AI WITH GENESMITH

During the Analysis Phase, research on vendors have been finalized and selected to provide CSF with an outsourced company, Genesmith. Genesmith is already well-established in the market as an AI livestock management solution (Refer to Appendix D for more details). A collaboration with an outsourced company will allow CSF to reduce costs, enhance customer experience through ongoing technical support, and improve future scalability of AI facial recognition systems within farms and livestock management..

CHANGE MANAGEMENT

Another key aspect to highlight is the change management process of transitioning stakeholders from RFID to AI facial recognition for livestock identification. With farmers, livestock handlers, and regulatory bodies being the main stakeholders of the AI system, detailed mapping of workshops, training sessions, and consultations have been provided in Gantt Chart #2 to demonstrate the benefits and usability of AI facial recognition to these important stakeholders.

TO-BE SYSTEM

DESCRIPTION

The proposed system integrates AI facial recognition technology to replace traditionally used RFID tags which is a leap forward in modernizing livestock tracking and management practices. This system is for sheep management and tracking, designed to streamline farm operations and improve animal welfare. It connects facial recognition technology with a centralized database called AgroLedger to enable farmers to register, monitor, and manage individual sheep profiles. The project aims to build confidence in AI technology and to showcase its advantages over RFID in terms of accuracy and animal welfare.

How It Works

Farmers can use their mobile devices equipped with AI facial recognition software. This application provides a user-friendly interface for accessing sheep management features such as registering new sheep or checking a sheep's health status. When a farmer needs to register a new sheep or pull a profile, they use their mobile device to take a picture of the sheep's face. The system's facial recognition algorithm analyzes the sheep's unique facial identifiers and compares them with data in the AgroLedger database. Once the sheep is identified, the system retrieves its profile which contains detailed information about the sheep, such as breed, age, date of birth, gender, origin, weight estimate, and health status. Any changes made to the sheep's profile are synchronized in real-time with AgroLedger, this ensures that all information remains accurate and up-to-date. By leveraging mobile devices and facial recognition technology, the system streamlines sheep management tasks, making them more efficient and accurate. Farmers can easily access and update sheep profiles on the go, leading to improved farm productivity and animal welfare.

TO-BE SYSTEM

Benefits:

- **Accessibility:** The AI facial recognition system is accessible through mobile devices, a convenient alternative to RFID tags. It also has a user-friendly interface which will improve adoption rates by making sure farmers can effectively use the system's features without extensive training.

- **Improved Efficiency:** The system lets farmers quickly access and update sheep profiles using their mobile devices and facial recognition technology. This reduces the time and effort required for manual data entry, tagging, and scanning. The AI facial recognition system can autonomously assess and input data based on a facial scan of the sheep. This reduces manual labour of data entry as the farmers don't have the burden of these tasks.

- **Enhanced Accuracy:** Facial recognition technology ensures accurate identification of sheep based on their unique facial features. This eliminates the risk of tags being ripped off or damaged.

- **Real-Time Data Updates:** Changes made to sheep profiles are synchronized in real-time with the AgroLedger database, ensuring that farmers have access to up-to-date information at all times.

- **Cost-Effectiveness:** Compared to traditional methods such as RFID tags, the facial recognition system offers a cost-effective solution. Farmers can also use existing mobile devices without the need for expensive equipment (Refer to Economic Feasibility for more details).

- **Improved Animal Welfare:** AI provides farmers with accurate and up-to-date information about their sheep which leads to better animal welfare as this method offers a non-invasive alternative to RFID tags.

TO-BE SYSTEM

Costs:

- **Initial Setup Costs:** This may include the cost of acquiring/developing the facial recognition technology and integrating it with existing farm management systems.

- **Maintenance and Support Costs**: Ongoing maintenance and support costs may include fees for software updates, technical support services, and any necessary repairs or replacements for hardware components.

- **Data Storage Costs:** Storing and managing the data generated by the system, including sheep profiles and images, can generate additional costs.

- **Training and Education Costs:** Providing training and education to farm staff on how to use the system effectively can also be a cost.

- **Operational Costs**: There may be ongoing operational costs associated with using the system, such as electricity costs for charging mobile devices or internet connectivity fees for accessing cloud-based services.

TO-BE SYSTEM

Functional Requirements

Process-Oriented Requirements:

- The system should allow farmers to register new sheep profiles, assigning a unique animal ID to each sheep.
- The system should allow the farmers to view and update sheep profiles.
- The system should automate the daily sheep counting process to reduce the time and effort required for inventory management.
- The system should be able to detect health status “InPain” or “NotInPain” through facial recognition technology to detect signs of distress or illness.
- The system should be able to categorize sheep based on their health status.
- The system should be able to categorize sheep based on use type.
- The system should let farmers have access to historical data and reports from AgroLedger.
- The system should have automated reminders and alerts for scheduled tasks such as vaccinations or treatments.

Information-Oriented Requirements:

- The system should store sheep profiles, including biometric data, breed, age, gender, origin, weight estimate, and health status.
- The system should be able to access data from the AgroLedger database.
- The system should generate and store daily count files containing photos of all sheep captured during the counting process.
- The system should have records of a sheep’s past health and treatments.
- The system should store transportation details such as time, date, location, quantity of sheep, and destination facility for each transportation event.

TO-BE SYSTEM

Non-Functional Requirements

Operational Requirements:

- The system should operate on all mobile devices.
- It should integrate with the existing farm management systems.
- Any interaction between the user and the system should not exceed two seconds to maintain user efficiency.
- The system should maintain real-time updates on sheep profiles.
- Availability of the system for use should be maintained 24 hours per day, 365 days per year.

Performance Requirements:

- It should be able to process and recognize sheep facial images with high accuracy and speed.
- Response time for queries and operations within the system should be minimal to enhance user experience.

Security Requirements:

- Farmers have access to their own flock of sheep.
- The system should safeguard data storage, data access, and sheep biometric data

Cultural and Political Requirements:

- System should comply with animal welfare and data privacy laws.
- The system should comply with Canadian regulations involved in the livestock Identification and Traceability Program issued by the Canadian Food Inspection Agency.

Key Performance Indicators (KPIs) and Business Goals

The business goals of the to-be system are to achieve the following key performance indicators:

Stakeholder Adoption Rate: Track the percentage of stakeholders transitioning to AI facial recognition.

Accuracy Rate of AI Identification: Evaluate the precision of AI in identifying livestock compared to RFID.

Training Completion: Monitor the number of stakeholders completing AI technology training.

Feedback and Satisfaction Scores: Analyze stakeholder feedback to gauge satisfaction with AI technology.

Operational Efficiency Improvement: Measure changes in process efficiency, including time saved in livestock identification and tracking.

Cost-Benefit Analysis: Assess the financial impact of switching from RFID to AI, considering both short-term and long-term costs and savings.

USE CASE 1

Use Case Name:	Create a New Sheep Profile	**ID:**	UC-1	**Priority:**	High
Actor:	Farmer				
Description:	The farmer scans sheep to register a new sheep profile and create a new animal ID.				
Trigger:	The farmer wants to register a new sheep.				
Type:	External				
Preconditions:	1. Farmer has access to AgroLedger and is listed under a farm. 2. There is an existing database (Sheep_Database) where all the sheep profiles and basic information (breed, age, DOB, gender, origin, weight estimate, health status) are saved to AgroLedger. 3. Each farm is already assigned to a specific premise ID to identify different farm locations.				

Major Steps:	**Information for Steps:**
1. The farmer scans a sheep with a mobile device camera to recognize the sheep's biometrics (unique facial identifiers).	(i) Sheep Facial Image Scan
2. The farmer inputs basic sheep information into Sheep_Database and the sheep is assigned an animal ID to complete the profile.	(i) Sheep Information (breed, age, DOB, gender, origin, weight estimate, health status) (o): Animal ID
3. The farmer assigns the registered sheep to a farm (premise).	(i) Premise ID
4. A confirmation notification showing successful registration of sheep into the system.	(o) Successful Registration Confirmation

Postconditions:	1. Sheep registered with a new profile and gets assigned with a unique animal ID. 2. Sheep's information is saved or updated (Exception 1) to Sheep_Database.
Exceptions:	**Exception 1 (refer to Appendix A for more information): IF** sheep are already registered in the system, they need to be rescanned and updated to keep track of sheep development in the Sheep_Database. • Scan and update profile every month for the first three years of age. • Scan and update profile every 6 months after three years of age. **ELSE**, refer to major step 1.

Summary			
Inputs	**Source**	**Outputs**	**Destination**
Sheep Facial Image Scan	Farmer	Animal ID	Sheep_Database
Sheep Information (breed, age, DOB, gender, origin, weight estimate, health status)	Farmer	Successful Registration Confirmation	Farmer
Premise ID	Farmer		

[1] https://ruminants-care.nl/uploads/images/FAWB_PainBooklet-Sheep_spreads-1-14.pdf

USE CASE 2

Use Case Name:	Automated Daily Sheep Count	**ID:**	UC-2	**Priority:**	High
Actor:	Farmers				
Description:	This use case details the automated counting of sheep as part of daily inventory management to maintain an accurate and up-to-date count of all registered sheep.				
Trigger:	The farmer needs to conduct a daily sheep count process as a routine to maintain operations.				
Type:	Temporal				
Preconditions:	1. All sheep profiles are registered in Sheep_Database with facial recognition data. 2. AI facial recognition system is made available through a mobile device				

Major Steps:	**Information for Steps:**
1. The farmer inputs a video recording filmed from a mobile device to count the sheep.	(i) Video Recording
2. The video system captures photos of each sheep that passes by.	(o) Individual Sheep Photos
3. The video system compiles photos of all the sheep into a file. It's named after the date in the following format: DDMMYYYY (all numerical) and saved to AgroLedger.	(i) All Sheep Photos (o) DailyCountFile (DDMMYYYY)
4. The video system counts the number of photos in the DailyCountFile. The system outputs the total number of sheep in the video and displays the number of sheep counted yesterday for reference.	(i) Photo Count (o) Total Sheep Count (Present day) (o) Total Sheep Count (Previous day)

Postconditions:	1.Farmers have accurate and up-to-date counts of all registered sheep. 2.DailyCountFile to identify individual sheep
Exceptions:	Trigger for manual action is needed when: • The system fails to recognize sheep and an error flag is displayed to the farmer. The farmer needs to manually take a picture of the sheep and add it to the DailyCountFile. Trigger for re-scan is needed for the following: • The previous day's total sheep count is inconsistent with the total sheep count on the present day.

Summary

Inputs	**Source**	**Outputs**	**Destination**
Video Recording	Farmer	Individual Sheep Photos	Video System
All Sheep Photos	Video System	DailyCountFile (DDMMYYYY)	AgroLedger
Photo Count	Video System	Total Sheep Count (Present day)	Farmer
		Total Sheep Count (Previous day)	Farmer

USE CASE 3

Use Case Name:	Maintain Sheep Welfare	**ID:**	UC-3	**Priority:**	High
Actor:	Farmer				
Description:	The farmer monitors sheep behavioural patterns for early detection of health issues through the AI facial recognition system.				
Trigger:	The farmer needs to update the health status of all the sheep after the daily count is completed.				
Type:	Temporal				
Preconditions:	1. The daily sheep count is completed. 2. All sheep pictures are saved into the DailyCountFile.				

Major Steps:	**Information for Steps:**
1. The farmer inputs the photos of all the sheep and prompts the system to identify all the sheep according to their unique facial identifiers (biometrics).	(i) DailyCountFile (DDMMYYYY) (i) Farmer Request
2. The AI facial recognition system identifies the health status of the sheep through visual facial detections and categorizes whether the sheep is in pain or not in pain. The health status of the sheep is saved into AgroLedger under the animal ID.	(i) InPain Status Change (i) NoPain Status Change
3. A list of sheep in pain is compiled and the farmer is notified of the sheep that need treatment.	(o) Treatment List
4. The farmer updates the sheep health status on the Sheep_Database to NoPain when sheep treatment is completed. The treatment details are updated to the original Treatment Needed List (including treatment type, date, and the vet the sheep was treated. By).	(i) NoPain Status Update (i) Treatment Details (type, date, vet)

Postconditions:	1. Treatment for pained sheep is completed. 2. Sheep_Database is updated with NoPain Status Change and Treatment Details
Exceptions:	

Summary

Inputs	**Source**	**Outputs**	**Destination**
DailyCountFile (DDMMYYYY)	AgroLedger	Treatment List	AgroLedger
Farmer Request	Farmer		
InPain Status Change	AI System		
NoPain Status Change	AI System		
NoPain Status Update	Farmer		
Treatment Details (type, date, vet)	Farmer		

USE CASE 4

Use Case Name:	Transport Sheep to Market Facilities	**ID:**	UC-4	**Priority:**	High
Actor:	Farmer				
Description:	The farmer needs to sort and transport sheep to their destination facility.				
Trigger:	The farmer receives a request for sheep by a market facility for sheep transfer.				
Type:	External				
Preconditions:	1. The farmer gathers all the information about a sheep's use type based on characteristics. 2. There is an existing database for sheep sorting and transportation destinations (Transportation_ Database).				

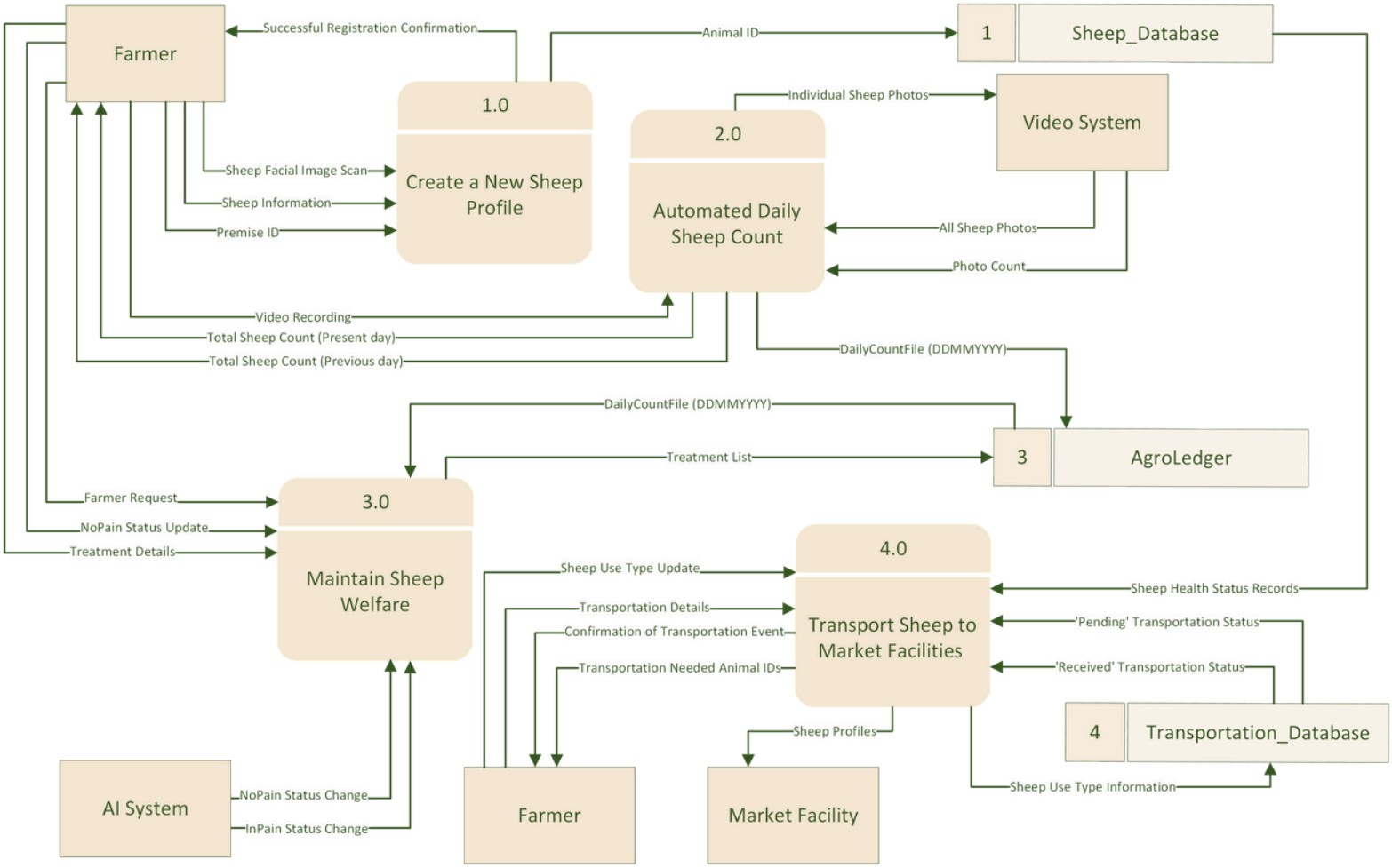
Major Steps:	**Information for Steps:**
1. The farmer categorizes the sheep based on characteristics into market destinations (meat, milk, breeding, wool). The use type of the sheep is updated in the Transportation_ Database.	(i) Sheep Use Type Update (o) Sheep Use Type Information
2. Sheep health status records are extracted from the Sheep_Database to confirm compliance with health certification requirements required by the market facilities.	(i) Sheep Health Status Records
3. The farmer creates transportation details (time, date, location, quantity of sheep, sheep use type) to schedule a transportation event to their market facility.	(i) Transportation details (time, date, location, quantity of sheep, sheep use type) (o) Confirmation of transportation event
4. The AI system pulls the Animal IDs from the Transportation_ Database of the sheep that need to be captured by the farmers and transported. The status of the transportation is changed to 'Pending' in the Transportation_ Database during this process.	(i) 'Pending' Transportation Status (o) Transportation Needed Animal IDs
5. Sheep profiles from Sheep_Database are sent to the destination facility's database. The status of the transportation is changed to 'Received' in the Transportation_ Database when the destination facility confirms receival of the sheep.	(i) 'Received' Transportation Status (o) Sheep profiles

Postconditions:	1. Confirmation of sheep arrival from the market facility.
Exceptions:	There may be no request for sheep by market facility for sheep transfer.

Summary

Inputs	**Source**	**Outputs**	**Destination**
Sheep Use Type Update	Farmer	Sheep Use Type Information	Transportation_Database
Sheep Health Status Records	Sheep_Database	Confirmation of Transportation Event	Farmer
Transportation Details (time, date, location, quantity of sheep, sheep use type)	Farmer	Transportation Needed Animal IDs	Farmer
'Pending' Transportation Status	Transportation_Database	Sheep Profiles	Market Facility
'Received' Transportation Status	Trasporation_Database		

PROCESS MODEL – LEVEL 0 DATA FLOW DIAGRAM



Being a process model, the main changes from the as-is system's DFD lie in how much of the data flows are prompted by the farmers. This contrasts with the as-is system, which may rely on manual data entry or less advanced tracking methods like RFID tags. Whereas in the to-be system, after being prompted by the user, there are additional data flow actions that are being autonomously triggered from the system such as the daily "Total Sheep Count" being assessed or "InPain"/"NotInPain" health status changes being automatic. The level 0 DFD showcases the proposed system's streamlined processes facilitated by AI facial recognition technology, allowing for efficient sheep management tasks such as registration, daily counting, health monitoring, and transportation scheduling.

DATA MODEL – ENTITY RELATIONSHIP DIAGRAM

The to-be system's ERD has not changed much compared to the as-is system as we focused on changes to the process of how data flows, not the data itself. Therefore, being a data model, the ERD would not be that different from the as-is system. For example, regardless of before and after, the database would still need to maintain information about sheep counts, farms, farmers, sheep profiles, their health and transportation records.

CONCLUSION

In conclusion, this project moves the Canadian Sheep Federation towards modernizing and optimizing sheep farming practices through the integration of AI facial recognition technology. By leveraging AI facial recognition, the CSF makes it a goal to overcome the limitations associated with traditional RFID tagging systems, such as time-consuming data collection processes, high costs, and susceptibility to data loss. The proposed system offers a non-invasive and efficient alternative, allowing the Canadian Sheep Federation to streamline sheep management processes, increase accuracy, and maintain animal welfare. Through the implementation of facial recognition technology, farmers can easily register sheep, conduct daily counts, monitor health status, and schedule transports with improved accuracy and speed. Being linked to a comprehensive database such as AgroLedger also ensures real-time updates and good data management.

Central to the success of this initiative is the engagement of stakeholders, including farmers, livestock handlers, and regulatory bodies. The CSF should focus on the education of the system and provide comprehensive training programs to foster stakeholder adoption. By following the implementation Gantt chart (refer to to Appendix C) incorporate stakeholder training and support, the CSF can ensure a systematic and effective approach to adopting AI facial recognition technology. This way, the CSF can also ensure that all parties are equipped with the knowledge and tools needed to embrace and leverage this technology effectively.

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APPENDIX A - USE CASE NOTES

USE CASE 1: CREATE A NEW SHEEP PROFILE

Exception 1:

Regular updates and rescanning of sheep profiles are necessary to ensure accurate tracking of sheep development over time. A study conducted about the growth of sheep in relation to their biometric identification investigated the effect of weight gain and sheep maturation on recognition performance (Hitelman et al., 2022). The results of the study showed that the accuracy of the identification model varied depending on the age of the sheep. It showed that the accuracy of the model decreased as the sheep aged between ages 2-5 months. This emphasizes the need for regular updates and rescanning of sheep profiles to account for changes in facial features as the sheep mature and gain weight. Therefore, it is recommended to scan and update sheep profiles every month for the first 3 years of age, and every six months after 3. This way, farmers can ensure that the facial recognition system remains accurate and effective in identifying and tracking sheep.

USE CASE 2: AUTOMATED DAILY SHEEP COUNT

This use case automates the process of counting sheep on a daily basis to maintain accurate inventory records. Every day, farmers set up a mobile device at the front of the sheep's pen. As the sheep are let out, the farmer records a video capturing all the sheep passing through the fenced area. The system utilizes facial recognition technology to identify and count each individual sheep. The system compiles photos of all sheep into a daily count file, providing farmers with real-time updates on the total number of sheep present. This automated counting process saves time and ensures the accuracy of inventory management.

APPENDIX A – USE CASE NOTES

USE CASE 3: MAINTAIN SHEEP WELFARE

According to McLeannan (n.d.), you can recognize whether or not a sheep is in pain from 5 facial areas:

(1) eyes, (2) cheek area, (3) ears, (4) Lip and jaw profile, (5a) nostrils, (5b) philtrum

CSF can train the AI facial recognition software to be able to identify a sheep's welfare status based on visual facial detections. Farmers can then be notified of any sheep exhibiting signs of distress or illness, enabling fast intervention and treatment.

(McLeannan, n.d., page 9)

USE CASE 4: TRANSPORT SHEEP TO MARKET FACILITIES

Establish communication and profile transfers between the farm and the market facility to coordinate transportation schedules, provide updates on the shipment status, and address any issues or concerns that may arise during transit.

APPENDIX B – GANTT CHART #1

ANALYSIS & DESIGN

Task Name	Duration	Start	Finish	Predecessors	Resource Names
Project Initiation	**10 days?**	**Mon 1/22/24**	**Fri 2/2/24**		
Form project groups	4 days?	Mon 1/22/24	Thu 1/25/24		All
Define project scope and objectives	1 day?	Fri 1/26/24	Fri 1/26/24	2	All
Conduct preliminary research on CSF	1 day?	Fri 2/2/24	Fri 2/2/24	3	All
Research Vendors	**3 days?**	**Mon 1/29/24**	**Thu 2/1/24**		
Conduct market research to identify potential vendors specializing in animal AI facial recognition technology	1 day?	Mon 1/29/24	Mon 1/29/24	2,3	All
Identify and evaluate vendors	1 day?	Tue 1/30/24	Tue 1/30/24	6	All
Finalize potential vendors	0 days	Thu 2/1/24	Thu 2/1/24		
System Request	**28 days?**	**Fri 1/26/24**	**Wed 3/6/24**		
Conduct client introduction meeting (Asynchronous)	1 day?	Fri 1/26/24	Fri 1/26/24	2	Daisy,Heidi
Identify the business need and AI Facial Recognition's ability to create business value	1 day?	Mon 1/29/24	Mon 1/29/24	10	All
Analyze current processes and the RFID supporting system (as-is)	1 day?	Tue 1/30/24	Tue 1/30/24	11	Krystal
Identify system improvements from the RFID supporting system (as-is)	1 day?	Wed 1/31/24	Wed 1/31/24	12	Krystal
Analyze expectations of improvement to business processes (to-be)	1 day?	Thu 2/1/24	Thu 2/1/24	13	Nicole
Conduct second client meeting (Asynchronous)	1 day?	Fri 2/2/24	Fri 2/2/24	14	Krystal,Nicole
Sponsor Question Collection Cycle 1	1 day?	Mon 2/5/24	Mon 2/5/24	15	All
Conduct technical/organizational feasibility analysis	1 day?	Tue 2/6/24	Tue 2/6/24	16	Daisy
Conduct economic feasibility	1 day?	Tue 2/6/24	Tue 2/6/24	10,16	Daisy
Create formal system request draft	1 day?	Tue 2/6/24	Tue 2/6/24	11,16	All
Sponsor Question Collection Cycle 2	1 day?	Wed 2/7/24	Wed 2/7/24	19	All
Edit and finalize economic feasibility	1 day?	Thu 2/8/24	Thu 2/8/24	20	Daisy
Edit and finalize formal system request	0 days	Wed 3/6/24	Wed 3/6/24		All

APPENDIX B – GANTT CHART #1

ANALYSIS & DESIGN

Task Name	Duration	Start	Finish	Predecessors	Resource Names
Project Initiation	**10 days?**	**Mon 1/22/24**	**Fri 2/2/24**		
Form project groups	4 days?	Mon 1/22/24	Thu 1/25/24		All
Define project scope and objectives	1 day?	Fri 1/26/24	Fri 1/26/24	2	All
Conduct preliminary research on CSF	1 day?	Fri 2/2/24	Fri 2/2/24	3	All
Research Vendors	**3 days?**	**Mon 1/29/24**	**Thu 2/1/24**		
Conduct market research to identify potential vendors specializing in animal AI facial recognition technology	1 day?	Mon 1/29/24	Mon 1/29/24	2,3	All
Identify and evaluate vendors	1 day?	Tue 1/30/24	Tue 1/30/24	6	All
Finalize potential vendors	0 days	Thu 2/1/24	Thu 2/1/24		
System Request	**28 days?**	**Fri 1/26/24**	**Wed 3/6/24**		
Conduct client introduction meeting (Asynchronous)	1 day?	Fri 1/26/24	Fri 1/26/24	2	Daisy,Heidi
Identify the business need and AI Facial Recognition's ability to create business value	1 day?	Mon 1/29/24	Mon 1/29/24	10	All
Analyze current processes and the RFID supporting system (as-is)	1 day?	Tue 1/30/24	Tue 1/30/24	11	Krystal
Identify system improvements from the RFID supporting system (as-is)	1 day?	Wed 1/31/24	Wed 1/31/24	12	Krystal
Analyze expectations of improvement to business processes (to-be)	1 day?	Thu 2/1/24	Thu 2/1/24	13	Nicole
Conduct second client meeting (Asynchronous)	1 day?	Fri 2/2/24	Fri 2/2/24	14	Krystal,Nicole
Sponsor Question Collection Cycle 1	1 day?	Mon 2/5/24	Mon 2/5/24	15	All
Conduct technical/organizational feasibility analysis	1 day?	Tue 2/6/24	Tue 2/6/24	16	Daisy
Conduct economic feasibility	1 day?	Tue 2/6/24	Tue 2/6/24	10,16	Daisy
Create formal system request draft	1 day?	Tue 2/6/24	Tue 2/6/24	11,16	All
Sponsor Question Collection Cycle 2	1 day?	Wed 2/7/24	Wed 2/7/24	19	All
Edit and finalize economic feasibility	1 day?	Thu 2/8/24	Thu 2/8/24	20	Daisy
Edit and finalize formal system request	0 days	Wed 3/6/24	Wed 3/6/24		All

APPENDIX B – GANTT CHART #1

ANALYSIS & DESIGN

Gantt Chart	19 days?	Wed 3/6/24	Mon 4/1/24		
Identify all tasks necessary to complete project	1 day?	Wed 3/6/24	Wed 3/6/24		All
Identify time estimations for each task	1 day?	Thu 3/7/24	Thu 3/7/24	24	Heidi
Create Gantt Chart on MS Project	1 day?	Fri 3/8/24	Fri 3/8/24	25	Heidi
Finalize Gantt Chart on MS Project	0 days	Mon 4/1/24	Mon 4/1/24		Heidi
Write descriptions and learning key takeaways	1 day?	Mon 4/1/24	Mon 4/1/24	27	All
Requirements Determination	**11 days?**	**Fri 3/15/24**	**Mon 4/1/24**		
Conduct third client meeting (Asynchronous)	1 day?	Fri 3/15/24	Fri 3/15/24		All
Sponsor Question Collection Cycle 3	1 day?	Mon 3/18/24	Mon 3/18/24	30	All
Collect and compile sponsor question collection and meeting notes	1 day?	Tue 3/19/24	Tue 3/19/24	31	All
Outline non-functional and functional requirements of the to-be system	1 day?	Wed 3/20/24	Wed 3/20/24	32	Nicole
Create a finalized written description of the proposed system	0 days	Mon 4/1/24	Mon 4/1/24		All
Use Cases	**36 days?**	**Fri 2/9/24**	**Fri 3/29/24**		
Brainstorm potential use cases for the to-be system	1 day?	Fri 2/9/24	Fri 2/9/24	13,14	All
Create and complete 4 use case drafts of the to-be system	16 days?	Mon 2/12/24	Mon 3/4/24	36	All
Edit use cases to ensure consistency and compatibility	11 days?	Tue 3/5/24	Tue 3/19/24	37	All
Finalize use cases	0 days	Fri 3/29/24	Fri 3/29/24		All
Update requirements document	1 day?	Fri 3/29/24	Fri 3/29/24		Krystal
DFDs and ERDs	**7 days?**	**Fri 3/22/24**	**Mon 4/1/24**		
Create Level 0 DFD	3 days?	Fri 3/22/24	Tue 3/26/24		Krystal
Create conceptual ERD of proposed system	3 days?	Wed 3/27/24	Fri 3/29/24	42	Nicole
Edit DFD and ERD	1 day?	Mon 4/1/24	Mon 4/1/24	43	Krystal,Nicole
Finalize DFD and ERD	0 days	Mon 4/1/24	Mon 4/1/24		All

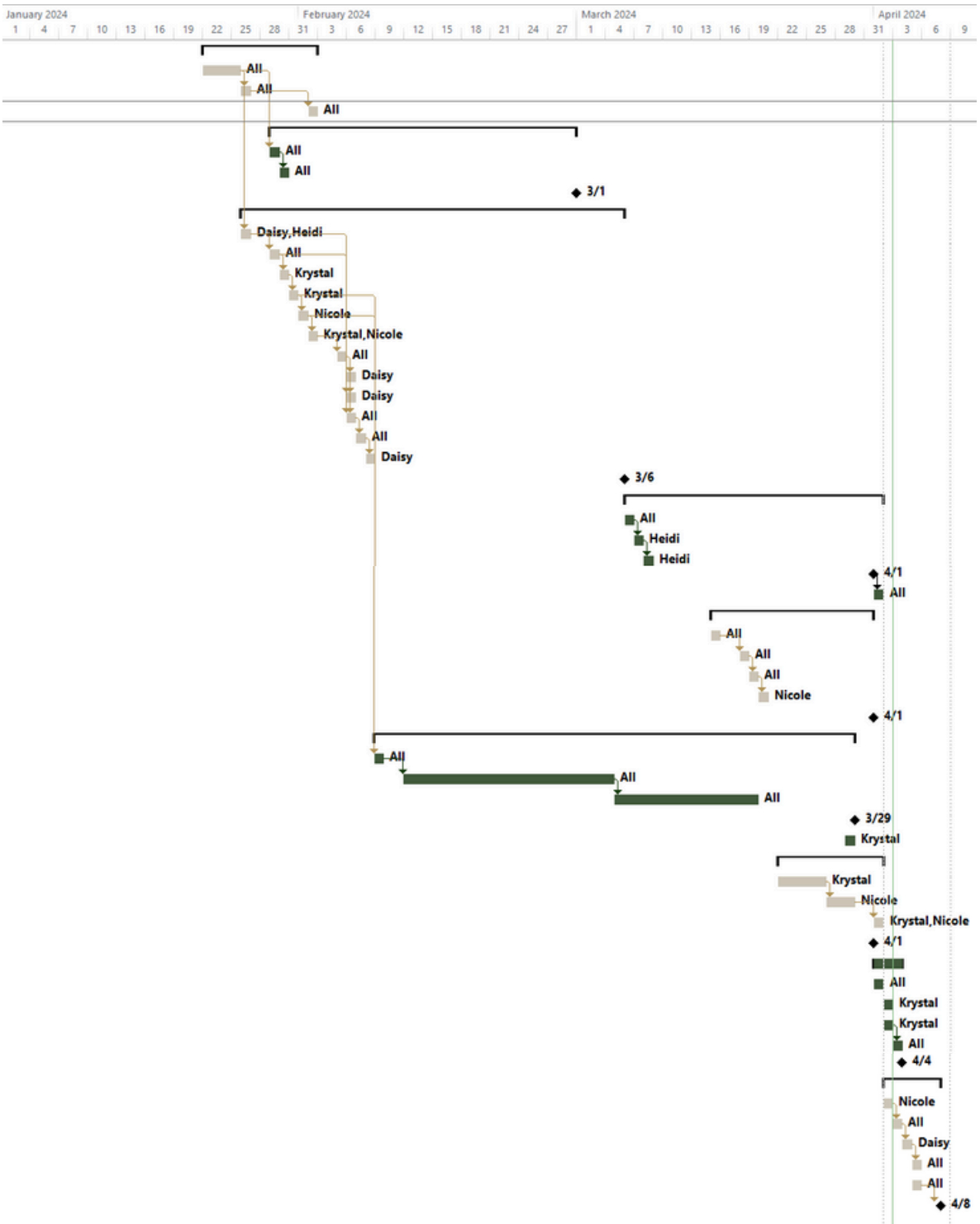
APPENDIX B – GANTT CHART #1

ANALYSIS & DESIGN

Final Term Project & Analysis Steps	3 days?	Mon 4/1/24	Thu 4/4/24		
Integrate all deliverables into the project plan	1 day?	Mon 4/1/24	Mon 4/1/24		All
Write introduction (Table of contents, executive summary, group biography)	1 day?	Tue 4/2/24	Tue 4/2/24		Krystal
Write conclusion	1 day?	Tue 4/2/24	Tue 4/2/24		Krystal
Review and update all deliverables as necessary	1 day?	Wed 4/3/24	Wed 4/3/24	49	All
Finalize Term Project & Analysis	0 days	Thu 4/4/24	Thu 4/4/24		All
Design Phase	4 days?	Tue 4/2/24	Mon 4/8/24		
Create logo	1 day?	Tue 4/2/24	Tue 4/2/24		Nicole
Design 3 key input interfaces	1 day?	Wed 4/3/24	Wed 4/3/24	53	All
Design the programs that will perform the system processes (program design specifications)	1 day?	Thu 4/4/24	Thu 4/4/24	54	Daisy
Design 3 key output interfaces	1 day?	Fri 4/5/24	Fri 4/5/24	55	All
Compile final system specifications	1 day?	Fri 4/5/24	Fri 4/5/24		All
Finalize the Design Project	0 days	Mon 4/8/24	Mon 4/8/24	57	All

APPENDIX B – GANTT CHART #1

ANALYSIS & DESIGN



APPENDIX C – GANTT CHART #2

IMPLEMENTATION

Task Name	Duration	Start	Finish	Predecessors	Resource Names
Vendor Collaboration	**6 days?**	**Tue 4/9/24**	**Tue 4/16/24**		
Schedule a kickoff meeting with the vendor to formally initiate the project	1 day?	Tue 4/9/24	Tue 4/9/24		All Teams
Establish protocols for data privacy and protection measures	3 days?	Thu 4/11/24	Mon 4/15/24	2	IT & Risk Team
Develop risk mitigation plan	1 day?	Tue 4/16/24	Tue 4/16/24	3	IT & Risk Team
Development and Testing	**1 day?**	**Wed 4/24/24**	**Wed 4/24/24**		
Conduct user acceptance testing to validate system functionality and integrates with existing farm systems	1 day?	Wed 4/24/24	Wed 4/24/24	4	IT Team
Deploy Pilot System	**10 days?**	**Thu 4/25/24**	**Wed 5/8/24**		
Roll out the facial recognition system in a limited area of the farm as pilot deployment	1 day?	Thu 4/25/24	Thu 4/25/24	6	Project Manager
Evaluate performance under various conditions, including different times of day, weather conditions, and angles of sheep faces	1 day?	Fri 4/26/24	Fri 4/26/24	8	Field Research Team
Validate the accuracy of facial recognition matches and identify any areas for improvement	1 day?	Mon 4/29/24	Mon 4/29/24	9	Quality Assurance Team
Monitor its performance and gather feedback from users to identify any issues or areas for improvement	1 day?	Fri 5/3/24	Fri 5/3/24	10	System Administrators
Scale up deployment across the entire farm	3 days?	Mon 5/6/24	Wed 5/8/24	11	Project Manager
IT Training and Support	**2 days?**	**Thu 5/9/24**	**Fri 5/10/24**		
Establish a maintenance schedule to ensure ongoing reliability and performance of the facial recognition system	1 day?	Thu 5/9/24	Thu 5/9/24		IT Team
Assign dedicated IT support personnel to provide on-site assistance and guidance to farmers when necessary	1 day?	Fri 5/10/24	Fri 5/10/24	14	IT Team

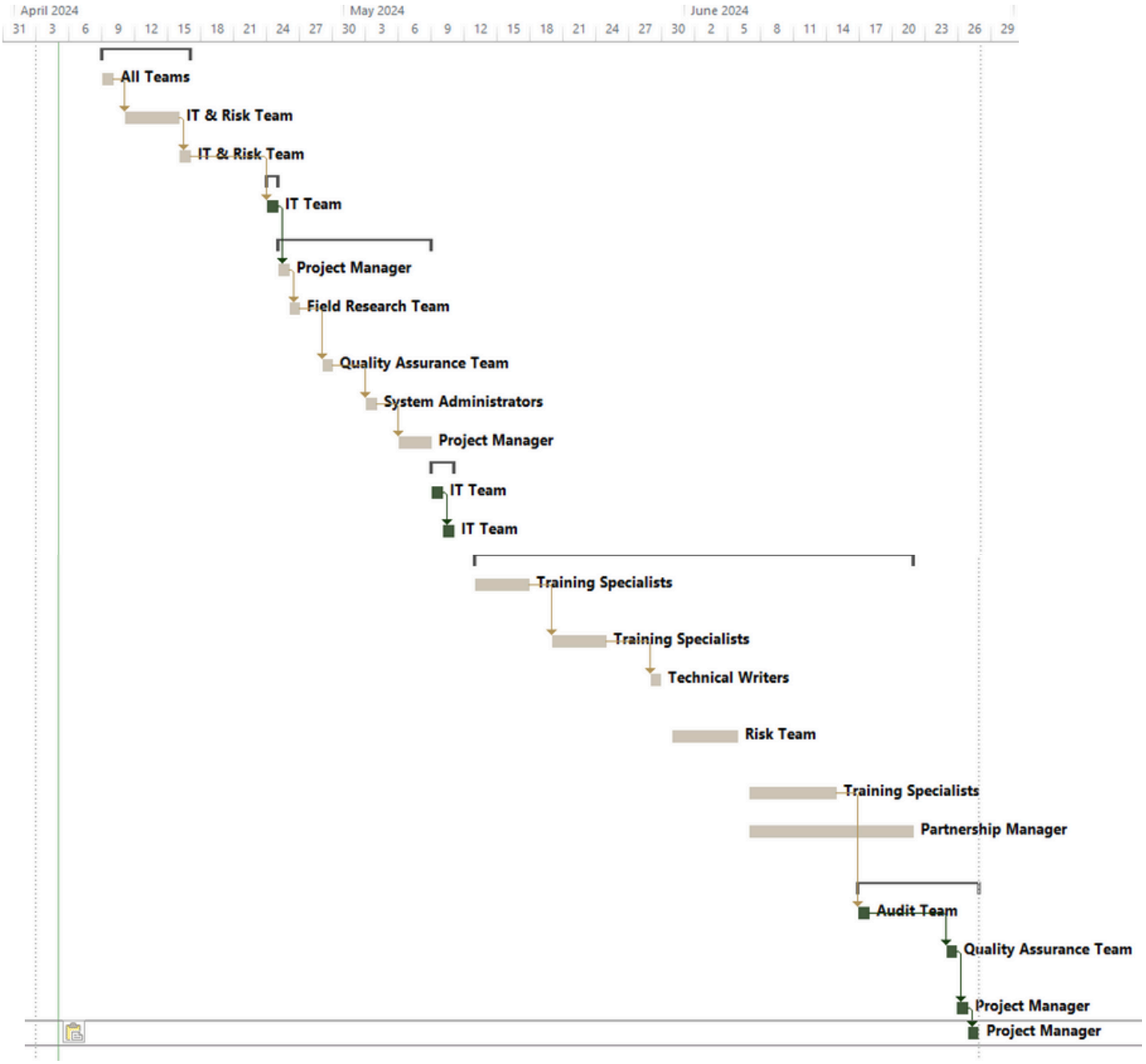
APPENDIX C – GANTT CHART #2

IMPLEMENTATION

IT Training and Support	**2 days?**	**Thu 5/9/24**	**Fri 5/10/24**		
Establish a maintenance schedule to ensure ongoing reliability and performance of the facial recognition system	1 day?	Thu 5/9/24	Thu 5/9/24		IT Team
Assign dedicated IT support personnel to provide on-site assistance and guidance to farmers when necessary	1 day?	Fri 5/10/24	Fri 5/10/24	14	IT Team
Stakeholder Training and Support	**30 days?**	**Mon 5/13/24**	**Fri 6/21/24**		
Provide instructor-led training sessions conducted in person or virtually to transition stakeholders from RFID to AI Facial Recognition	5 days?	Mon 5/13/24	Fri 5/17/24		Training Specialists
Provide 1-on-1 consultations with stakeholders to provide personalized support and guidance	5 days?	Mon 5/20/24	Fri 5/24/24	17	Training Specialists
Develop documentation, tutorials, and troubleshooting guides to assist farmers in effectively utilizing the technology for the long-term	1 day?	Wed 5/29/24	Wed 5/29/24	18	Technical Writers
Develop mitigation strategies to identify potential challenges and risks that arise during the transition process	4 days?	Fri 5/31/24	Wed 6/5/24		Risk Team
Create a feedback form to gather input from stakeholders on the transition to AI facial recognition systems	6 days?	Fri 6/7/24	Fri 6/14/24		Training Specialists
Partner with industry associations and government agencies to collaborate on outreach efforts and educational initatives	11 days?	Fri 6/7/24	Fri 6/21/24		Partnership Manager
Post-Implementation	**9 days?**	**Mon 6/17/24**	**Thu 6/27/24**		
Conduct a post-implementation audit to evaluate the success of the implementation.	1 day?	Mon 6/17/24	Mon 6/17/24	21	Audit Team
Gather overall feedback from all stakeholders (farmers, livestock handlers, regulators, producers, farm markets) on the new system	1 day?	Tue 6/25/24	Tue 6/25/24	24	Quality Assurance Team
Identify lessons learned and areas for improvement	1 day?	Wed 6/26/24	Wed 6/26/24	25	Project Manager
Update documentation and processes based on feedback	1 day?	Thu 6/27/24	Thu 6/27/24	26	Project Manager

APPENDIX C – GANTT CHART #2

IMPLEMENTATION

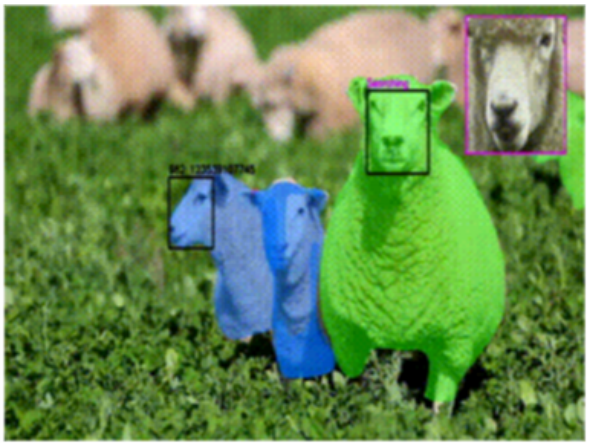


APPENDIX D – OUTSOURCING GENESMITH

Based in New Zealand, Genesmith is an Agriculture Technology company focused on developing AI facial recognition systems for sheep at commercial scalability through machine learning and in-field cameras (Genesmith, n.d).

BENEFITS

- Greatly improve counting accuracy
- Cost-effective and practical method for sheep identification
- Easy to set up and run
- Monitor sheep movement with minimal intervention from farmers
- Offers future scalability across farms and other applications within livestock management



RESULTS

Genesmith proves to offer an innovative and non-invasive approach that promises enhanced accuracy in tracking sheep. Its reliability, cost-effectiveness, and accessibility would help address challenges that farmers, livestock handlers, and regulatory bodies face when adopting new technology. As such, CSF can benefit from outsourcing Genesmith to transition from traditional RFID tags to AI-powered facial recognition.

APPENDIX E - REQUIREMENTS ELICITATION

METHOD #1: SPONSOR QUESTION COLLECTION CYCLES

Similar to the Questionnaire methodology, the project team sent a set of written questions to obtain information from the project sponsor, Corlena Patterson. To enhance our comprehensive understanding and the effectiveness of project delivery, the team participated in all 3 question collection cycles. This approach, initiated by the BUS 362 curriculum, helped extract valuable insights, validate information, and maintain alignment with CSF's objectives and requirements.

METHOD #2: ASYNCHRONOUS CLIENT MEETINGS

The team attended all 3 asynchronous client meetings which involved the Teaching Assistant (Chase Landa) and Corlena Patterson. Open-ended questions were asked to gather rich information regarding political, economic, social, and technological aspects of CSF. The asynchronicity component allowed our team to document information, reiterate timestamps, and ensure that all relevant considerations were taken into account.