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14th Model-driven Requirements Engineering Workshop

Towards a Method for Modelling Socio-technical Process Transformation in Digital Agriculture

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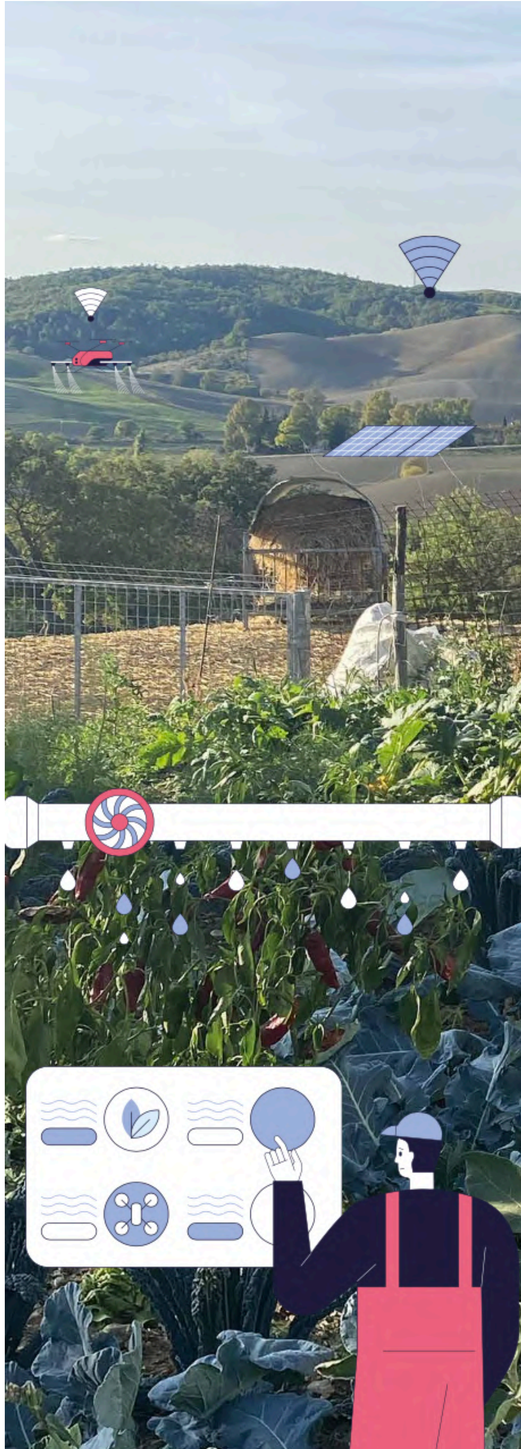
Research context

- Digitalisation of agriculture as a ***socio-technical process***
- Need to early anticipate the impacts of digitalisation
- Research in real agricultural contexts, e.g., *living labs*



CODECS

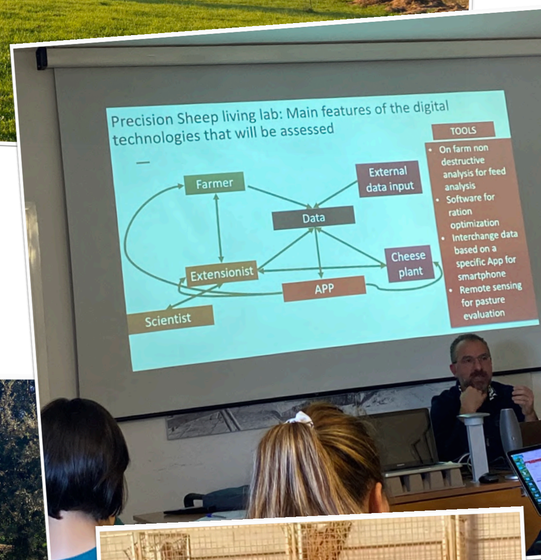
Maximizing the co-benefits of agricultural digitalisation through conducive digital ecosystems

Co-funded by the European Union

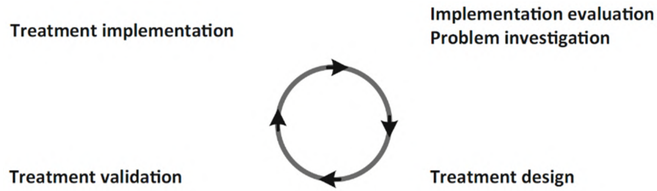
Living Labs

Pecorino Toscano
Manciano, Tuscany

- sheep breeding and pecorino cheese production
- *Participants*: farmers, technical advisors, cheese-making factory, consortium Tutela Pecorino Toscano, farmers association, University of Pisa
- TECHNOLOGY: FMIS + APP to monitor animals' health and food ratio optimisation; smart collars; blockchain-based system for farm-to-fork traceability; technology for the evaluation of feed (near infrared spectrum)



Research challenge



METHODOLOGY: design science (Wieringa, 2014)

1. Input from the community of local practices

- Information exchange issues between stakeholders
- Understand how current processes are re-engineered
- Drive further analysis, e.g., cost-benefit analysis
- Elicit requirements for human-centric digital solutions

2. Input from the research community

- MoDRE techniques (MoDRE) techniques are adopted to represent various aspects of the systems requirements
  e.g. functionalities, structure, goals, data, processes, workflows
- **Little empirical evidence on the use of MoDRE techniques in real-world environments with a relevant *social* component**
- **Lack of studies for modelling transformation of socio-technical systems**

RQ

How can MoDRE techniques be successfully applied in co-design contexts for the representation of a process transformation?

Socio-technical Process Modelling method

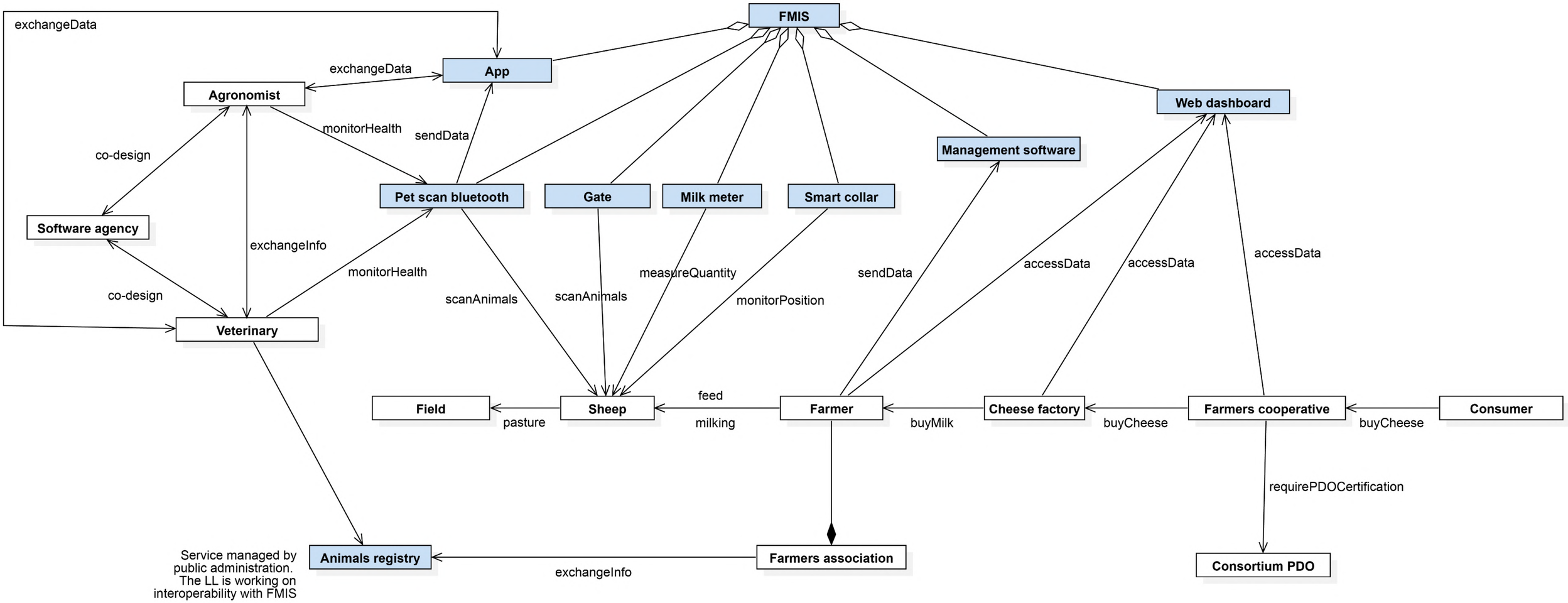
- The method applies MoDRE techniques to **represent the process transformation** *process as-is* and *process to-be*

- A set of diagrams:
  - Structure > UML class diagram
  - Goal > iStar diagram
  - Process > BPMN diagrams

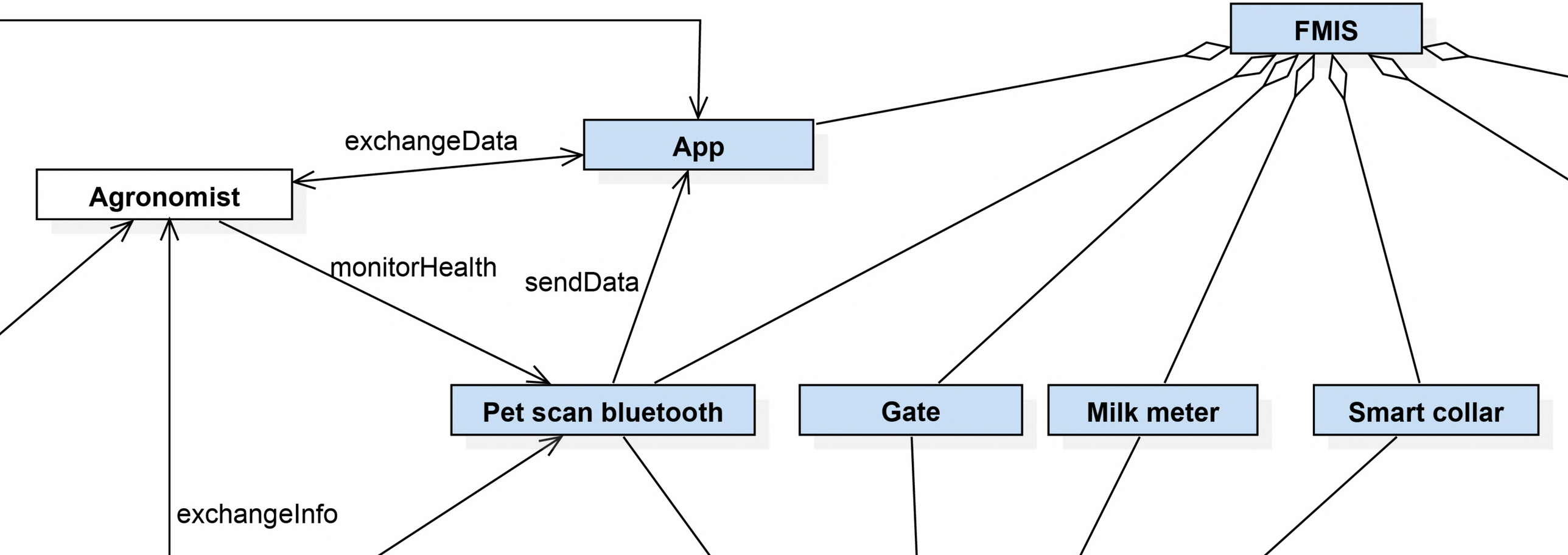
- A procedure based on guidelines to co-create the models within the Living Labs

- Implementation and evaluation within 20 Living Labs in Europe

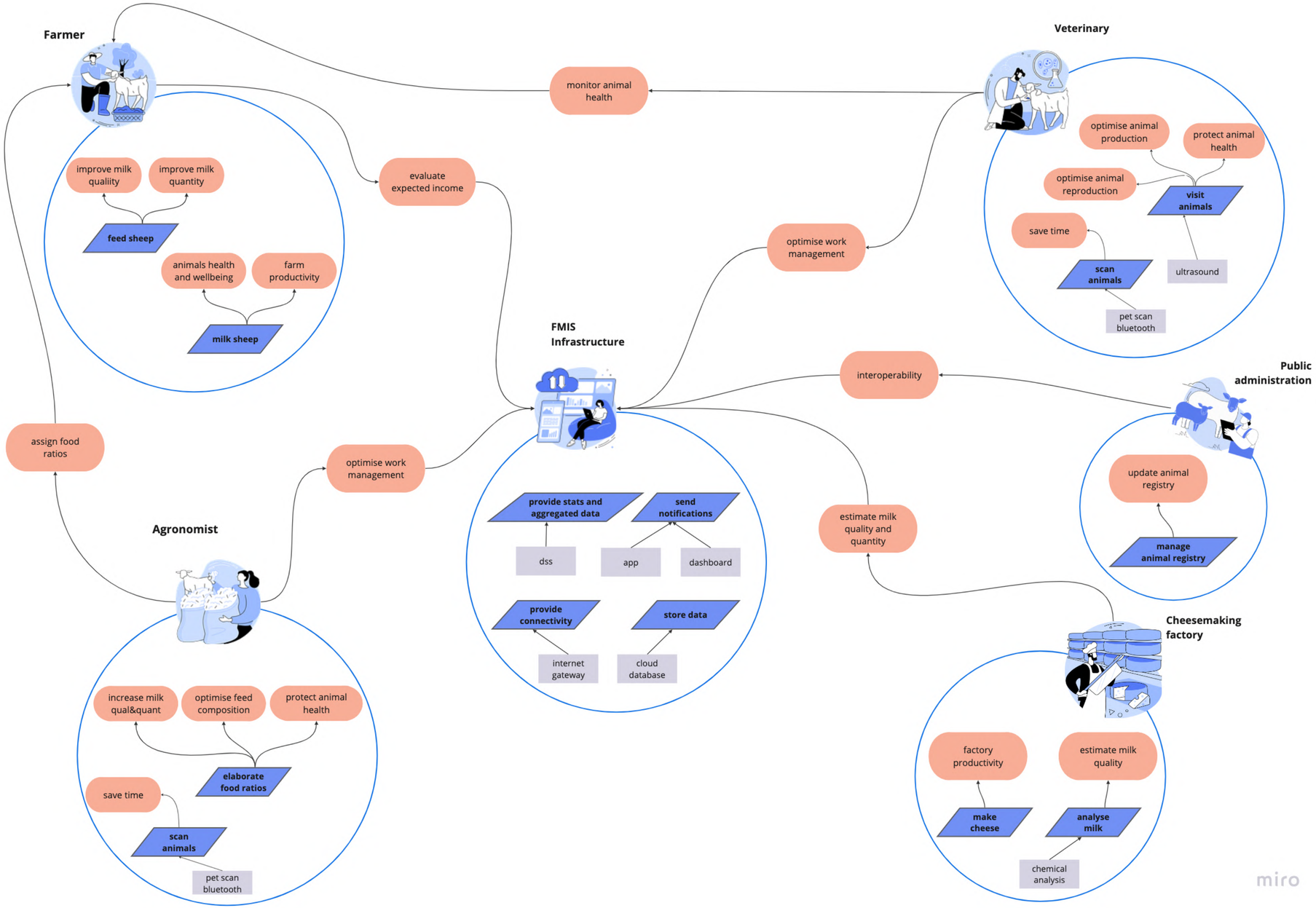
Pecorino Toscano - structure diagram UML



Pecorino Toscano - structure diagram UML



Pecorino Toscano - goal diagram iStar



assign food ratios

optimise work management

provide stats and aggregated data

send notifications

dss

app

dashboard

provide connectivity

store data

internet gateway

cloud database

Agronomist

increase milk qual&quant

optimise feed composition

protect animal health

elaborate food ratios

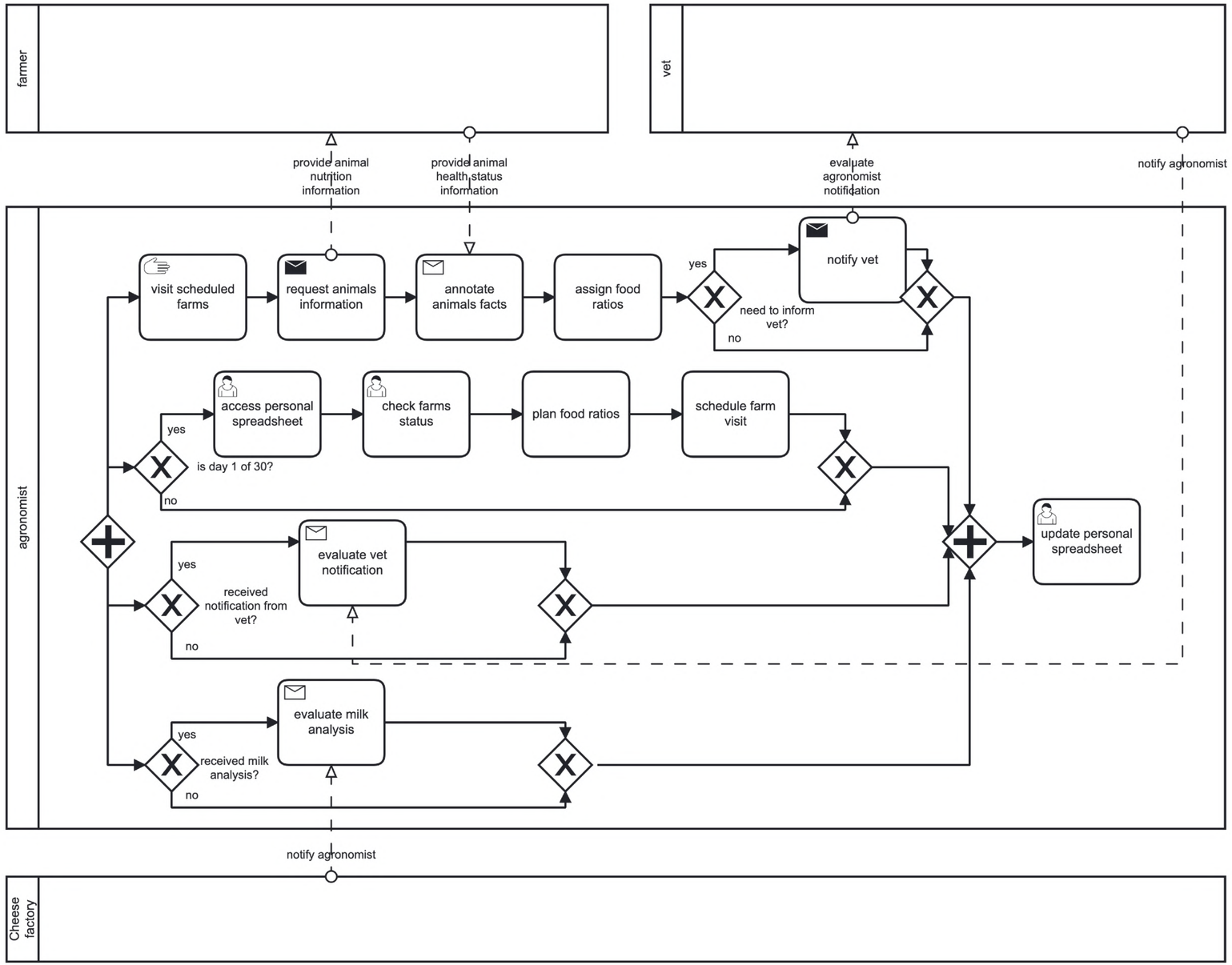
save time

scan animals

pet scan bluetooth

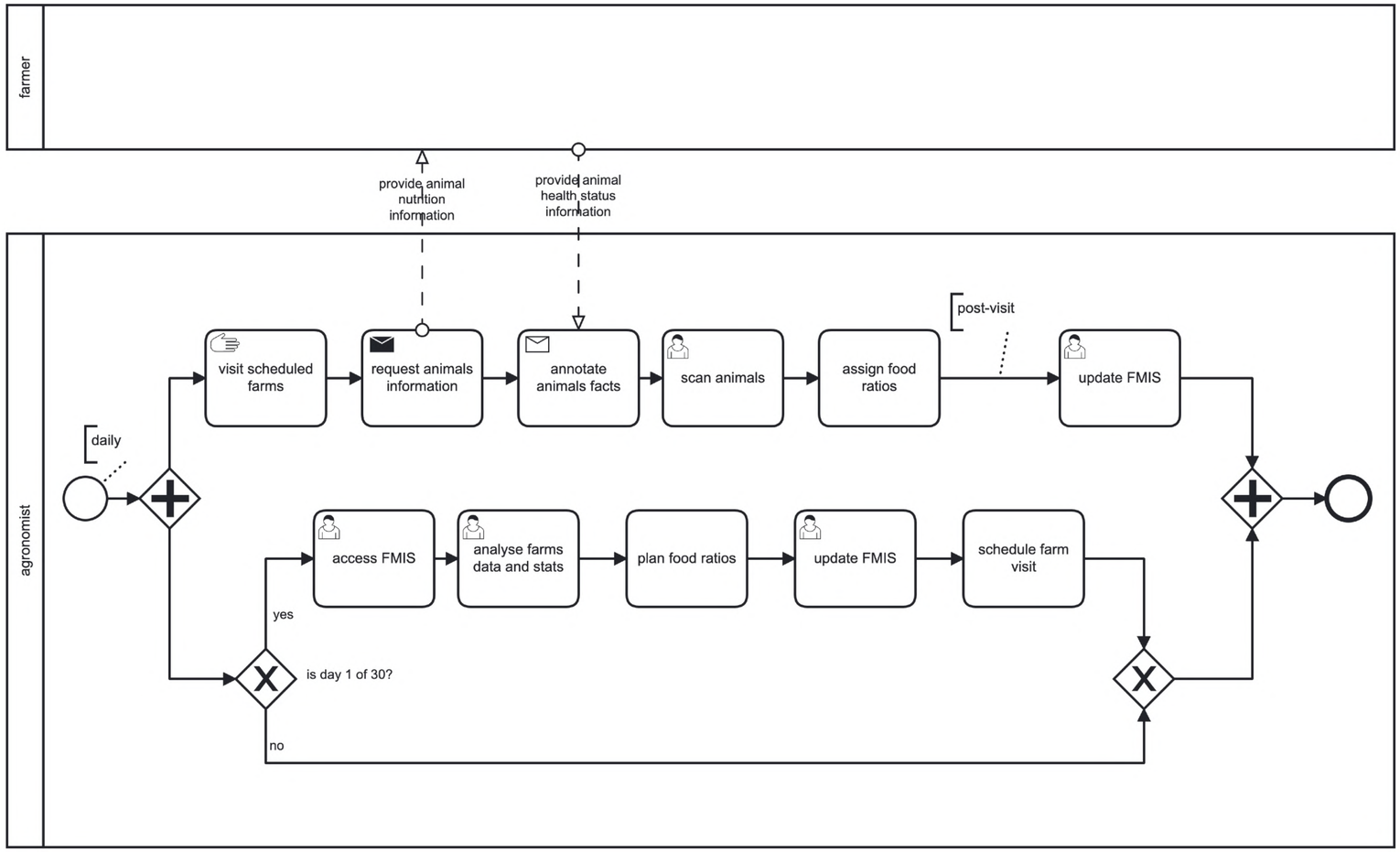
Pecorino Toscano - process diagram BPMN

Process as-is



Pecorino Toscano - process diagram BPMN

Process to-be

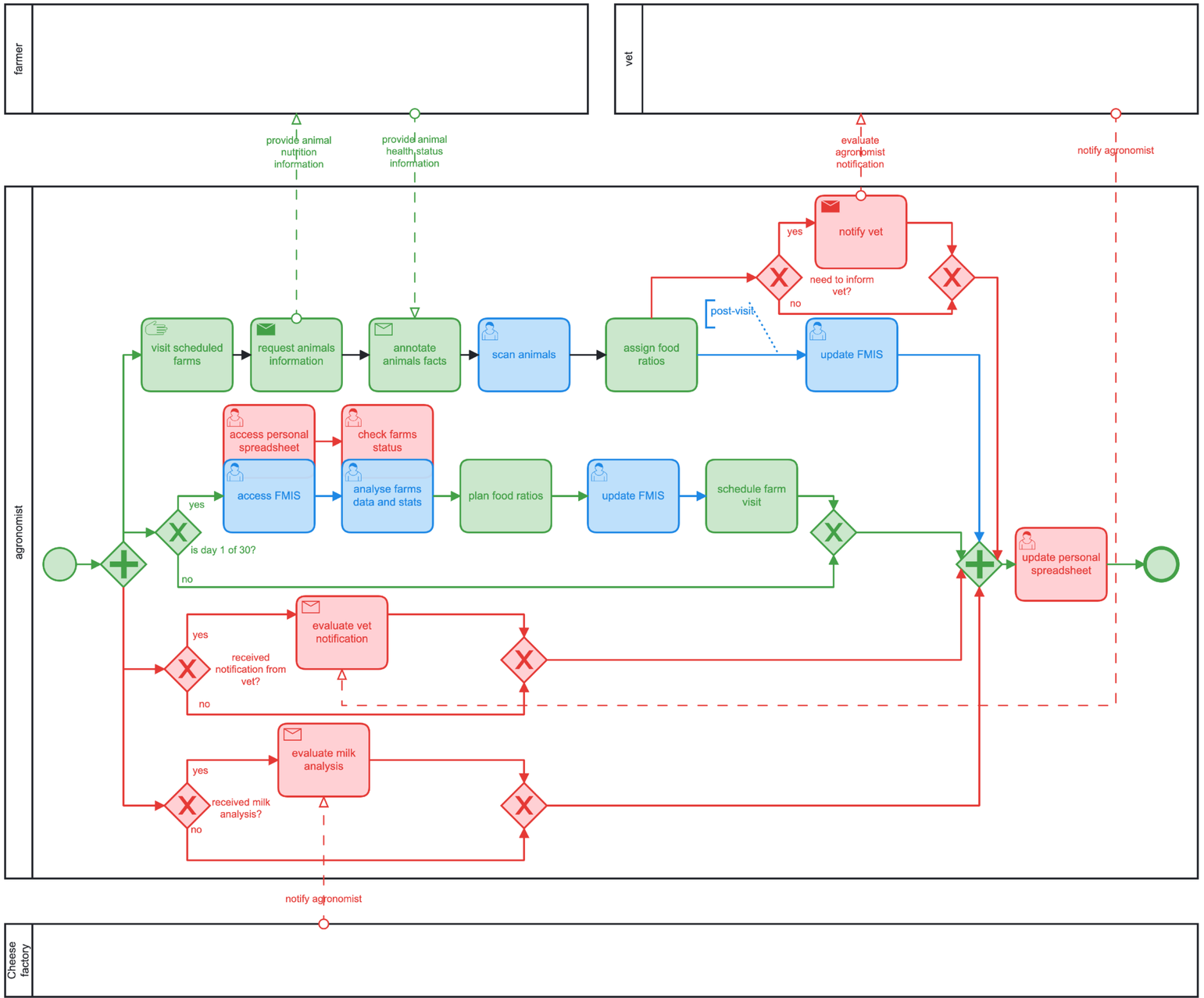


Pecorino Toscano - process diagram BPMN

Processes overlap

green+red = process as-is

green+blue = process to-be



Evaluation with domain experts

- **3 focus groups** within the Pecorino Toscano Living Lab (October - December 2023)
- 10 participants: 7 agronomists, 3 software engineers
- Different specialisations: agricultural economics, animal production, agronomy, veterinary, agritech, formal notations
- Two practitioners included, i.e., technical advisors

OUTCOME OF THE EVALUATION

- Improvement of the diagrams
- Fine-tuning of the method
- Requirements refinement

Thematic analysis

	Question	*Theme*
1	***UML Understandability***	Useful colouring, Hard symbols interpretation
2	***UML Effectiveness***	Useful for comparison, Reuse and adaptation, Consistency with the scientific body of knowledge
3	***iStar Understandability***	Keep the representation simple, Hard symbols interpretation
4	***iStar Effectiveness***	Monitoring policies and interoperability
5	***BPMN Understandability***	Linearity, Useful colouring, Consistency, Hard symbols interpretation
6	***BPMN Effectiveness***	High level of detail on the process workflow, Multiple objectives of the representation, Immediate detection of advantages
7	***Method and procedure***	Tool for analysis, Effectiveness of visual representations, Reuse of the models, Procedure for co-creation of the diagrams

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Understandability

- **Useful colouring**

  BPMN *"I really like the idea of using the colours, I think this is very intuitive."* (P5 in FG3)

- **Keep the representation simple**

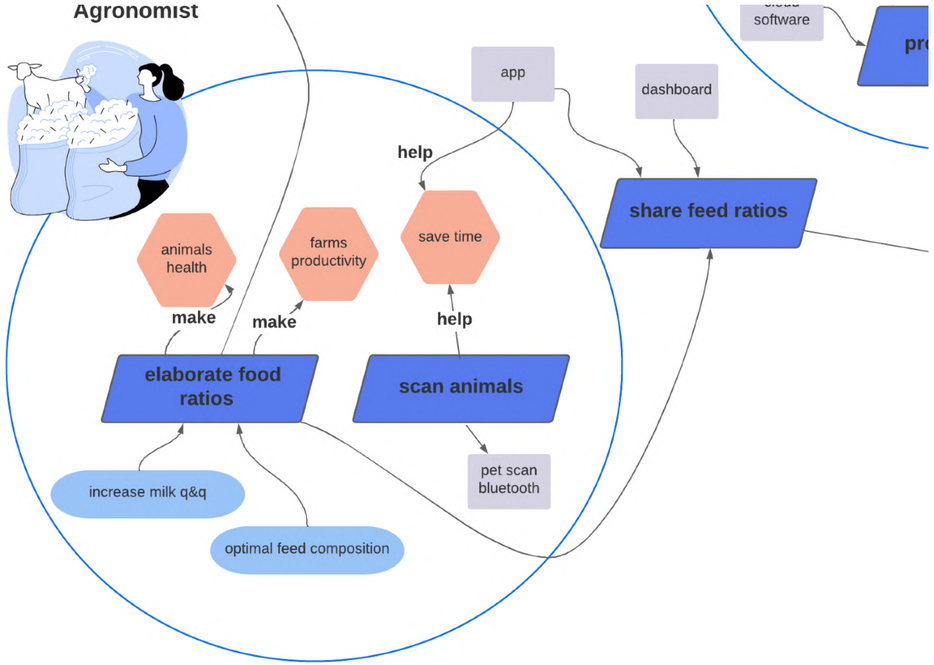
  iStar "We could deviate a bit from the standard of the notation in favour of readability"(P14 in FG3)

- **Hard symbols interpretation**

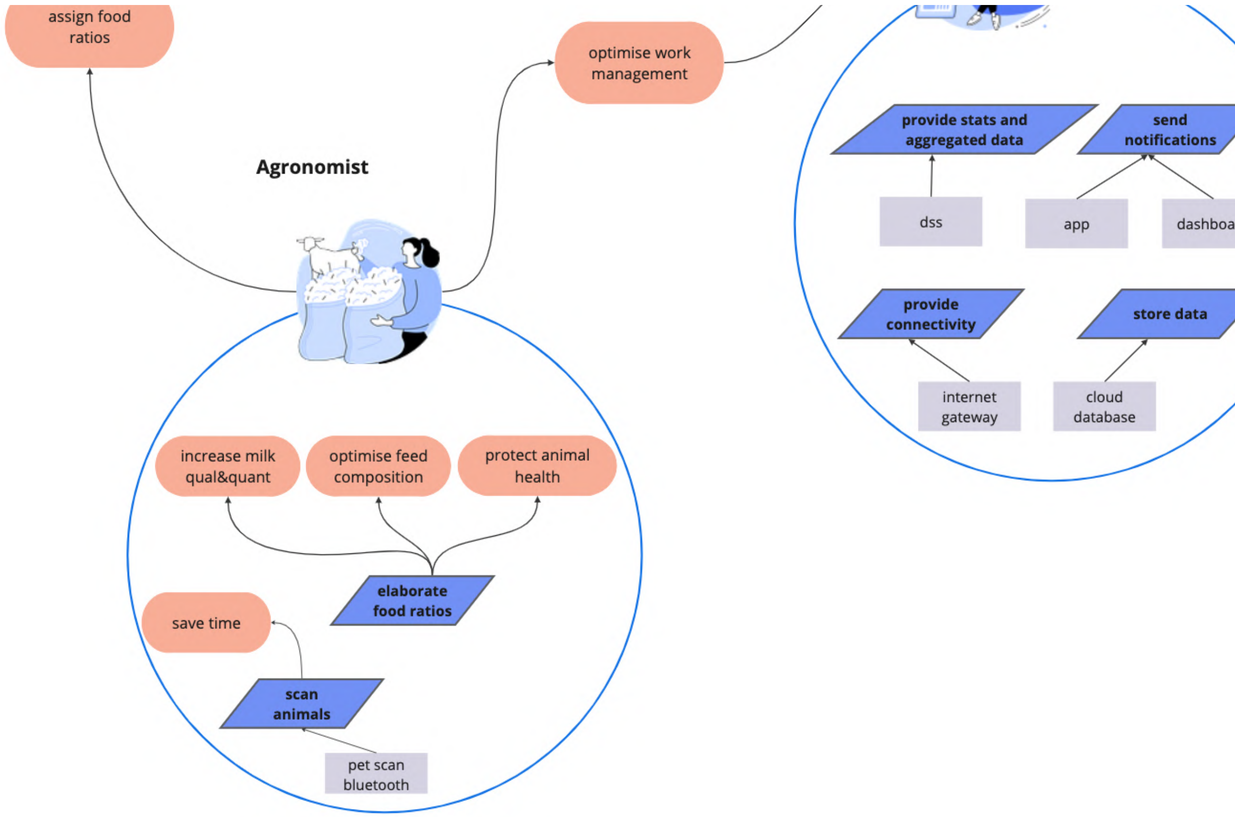
  UML: difficulties in understanding fine-grained symbols such as attributes, aggregations, compositions, arrows directions

Example of iteration - iStar

Version 1 (before focus group)



Version 2 (after focus group)



Effectiveness

- **Useful for comparison**

  UML *"It could be useful for every one of us to see the differences among LLs"* (P1 in FG1)

- **Monitoring policies and interoperability**

  iStar: add a boundary with the public institution responsible for the Animal Registry with a main dependum task "Share animals data."

- **Immediate detection of advantages**

  BPMN: "the diagram really shows who has the costs, who has the benefits" (P1 in FG1)

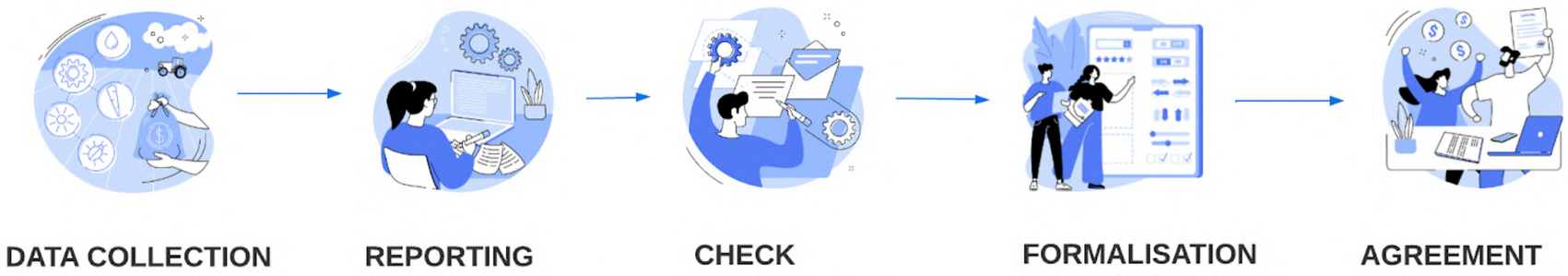
Method

- **Procedure for co-creation of the diagrams**

  “Will the other LLs do the diagrams on their own?” (P1 in FG1)

  challenging task
  experts in the notations are required

  initial proposal of a procedure based on guidelines for LL coordinators and a template for data collection



Conclusions

- **Overall feedback: positive**

  Researchers are willing to use the method as an analysis tool and to support the practitioners in decision-making

  Researchers and practitioners can complement the information through direct discussion of the diagrams

- **Tensions between understandability and effectiveness**

There is a need to simplify the notation while maximising the completeness of the representations

- **Limitations**

Need to familiarise with the notations, e.g., through a legend or short training

- **Need to expand the method with a procedure for data collection and co-creation of the models**
  Next research steps...

We greatly appreciate your feedback!

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