Requirements engineering for Eco-feed concepts

D3.1 PPP RENEW (LWV20147)

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Project context (summary)

The PPP RENEW (side- and residual streams for Eco-feed application in the Netherlands, with specific attention for the design of circular food systems and consumer acceptance) was launched in February 2021. The project is a public-private partnership, and its aim is to design and valorise Eco-feed concepts. Eco-feed is conceptualized as a circular feed product for non-ruminant animals, based on side- and residual streams collected from retail and foodservice outlets. In this project, we consider only Eco-feed for pigs and poultry (layers and broilers).

The research focuses on 3 main research questions (RQs):
RQ.1) Which conditions are necessary to create a positive business case for Eco-Feed in the Netherlands, from economic, environmental and animal welfare point of view?
RQ.2) Which conditions are necessary to create consumer and food value chain acceptance of Eco-feed products?
RQ.3) Which scenarios contribute to the development of Eco-feed concepts?

RQ3 is sub-divided into three tasks:
T3.1 Operational requirements for Eco-feed chains for pigs and poultry
T3.2 Example chain concepts Eco-feed
T3.3 Optimization of chain concepts in circular food systems

This report presents the findings from task 3.3.2 in RENEW (related to RQ.3), building on the earlier reports on task 1.1 (Castelein & Vissers, 2022), 2.1 Critical elements for consumer acceptance of Eco-feed concepts (Sijtsema, van der Haar, Janssen, Bos-Brouwers, 2022).
and addresses user requirement for parties involved in Eco-feed concepts,

Summary

- This report describes requirements analysis for a decision support system for using Eco-Feed.
- For the requirements analysis user stories were developed through interviews with various chain partners.
- With the help of these user stories, the information needs for a decision support system were mapped out, both for the input of the system and for the possible output.
- To visualize this, mock-ups of possible screens of the tool were made and the coherence of the information was mapped.
- Requirements Engineering has proven to be an appropriate tool for identifying user needs so that we can use the resulting user stories as the basis for the decision-making tool.
- The outcomes of this research, can be a starting point to build a decision support system in a follow-up.

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5. Conclusions

1. Introduction Requirement Engineering
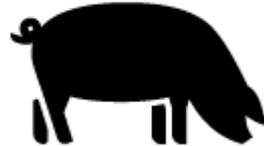
1.1 The RENEW project

PPP RENEW aims to generate insights on the **use of side- and residual streams from retail and food service outlets as feed for non-ruminant animals (pigs, chickens),** currently not allowed under EU-regulation.

Where other research focuses on nutritional and food/feed safety aspects of valorisation towards animal feed, RENEW focuses on the business case for Eco-feed, its acceptance by consumers & business stakeholders and how it contributes to a more circular food system.

This report presents the findings on task 3.3.2 to draw up design requirements based on selected side flows, with attention to technical, economic, environmental and social (consumer) aspects, and modelling optimal scenarios with regards to sustainability and circularity.

WP1: Business case Eco-feed
1. Economic feasibility
2. Climate & environmental footprint Eco-feed
3. Integrated business case Eco-feed

WP2: Integral acceptance chain and consumers
1. Design and acceptance insights of consumers
2. Chain- and stakeholder dialogue; support and acceptance
3. Relevant policy development at NL and EU level

WP3: Design of chain concepts Eco-feed
1. Operational requirements for Eco-feed chains for pigs and poultry
2. Example chain concepts Eco-feed
3. Optimization of chain concepts in circular food systems
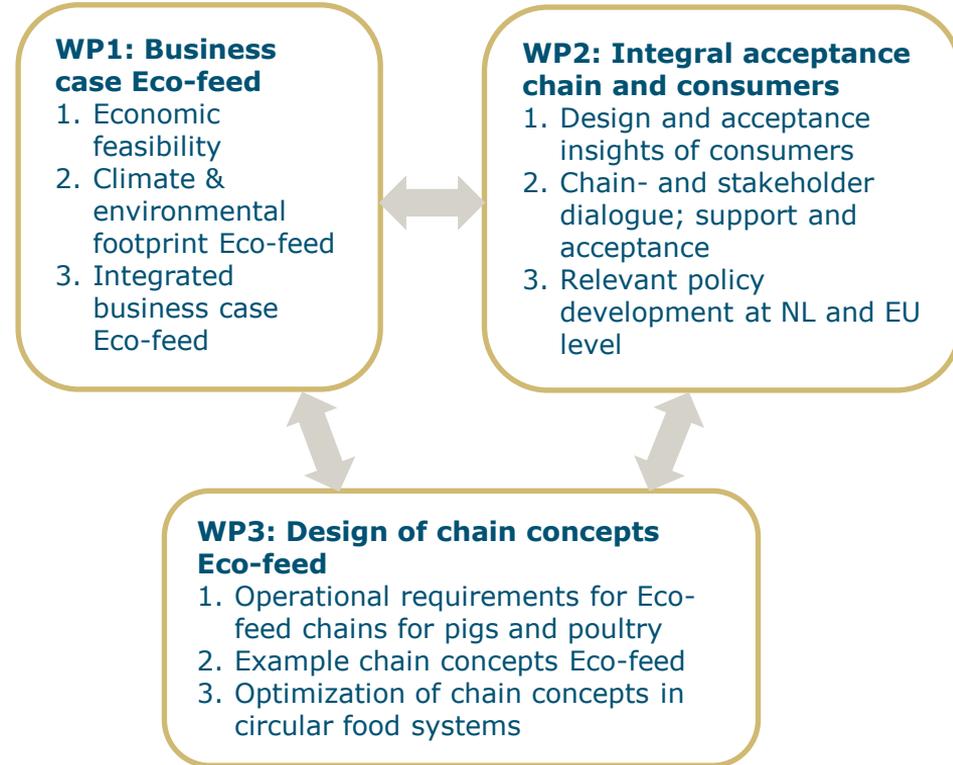
1.2 Introduction

Optimization of chain concepts in circular food systems

Aim: To draw up design requirements based on selected side flows, with attention to technical, economic, environmental and social (consumer) aspects, and modelling optimal scenarios with regards to sustainability and circularity.

Stakeholders might need to make decisions based on information from different sources. Through requirement engineering and interviews with chain participants, we try to uncover the important inputs and outputs for the decision support tool to support the chain participants to make an informed decision on Eco-Feed.

→ The results of this task will provide insights for the design process of the decision support tool, illustrated with a mock-up visualization of the selected possible functionalities of this tool.

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2. Method

Requirements engineering

Requirements engineering is the area of systems engineering that deals with the process of developing and verifying the system requirements.

Following good requirements engineering practices helps achieve the primary objective of making sure that the delivered system meets the customer's needs.

The requirements engineering process starts with requirements formulation, which is followed by validation, and then by verification.

(Chris Hersman, Kim Fowler, Mission-Critical and Safety-Critical Systems Handbook, 2010)
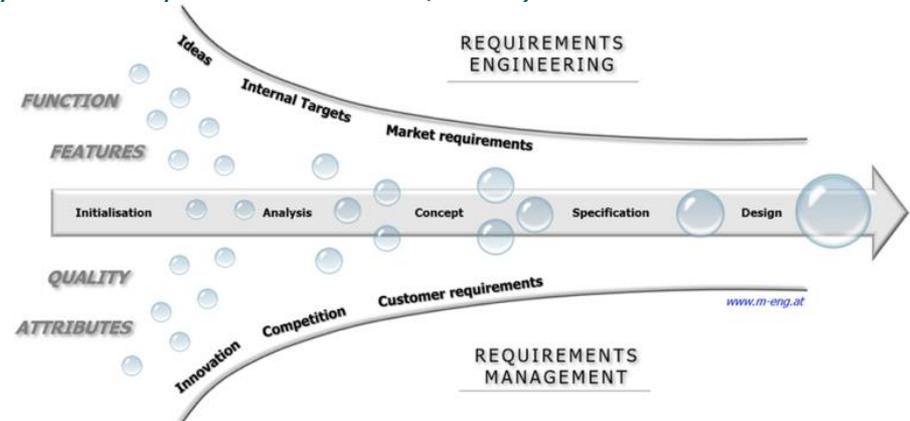
Methodological explanation

- Requirements engineering was used to collect as many requirements as possible to clarify what information is needed as input for a decision support system to come to a well-informed advice concerning Eco-Feed

- User stories will explain what the requirements are for the different parties to come to a good decision

- A Process Schema and Mock up will visualize the inputs and outputs of the decision tool

Method

- Based on the result in WP1 and WP2 basic user story drafts were created for each chain participant as stakeholder to give direction in the interviews.

- We used interviews with these stakeholders to complete the user requirements. Focus groups are considered, but for certain stakeholder groups that would still be an interview

- In addition to the stakeholders, researchers from WP1 and WP2 were also participants in the interviews

Chain Participants

- Chain participants for whom user stories have been prepared and interviewed for verification are shown below.

Provider side flows	Feed Processor	Livestock Farmer	Food service	Consumer

Vermaat Groep
De Clique

Nijssen Company
Nevedi (AgriBusiness Services)

Kipster
Hamletz
AVINED
Dierenbescherming

Vermaat Groep
De Clique

Dierenbescherming
Natuur en Milieu
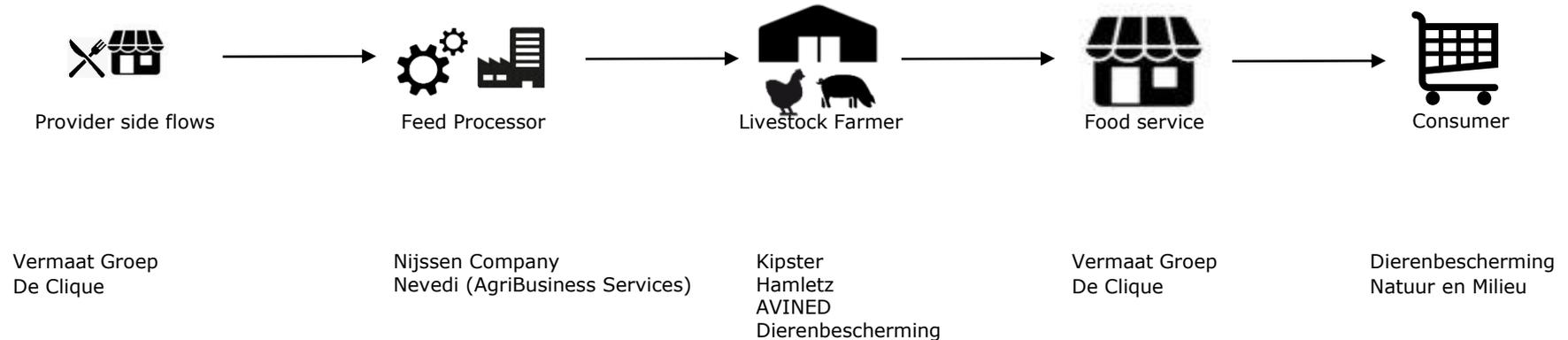
Interviews

- Interviews were free flow but we had three main questions for all participants representing all stakeholders involved in the project :

    o Do you agree with the user stories?

    o Can you provide a showcase/example of how these user stories could apply?

    o Do you have any additional user stories? Are there any omissions?

- Based on the results of the interviews the user stories are completed, reordered and grouped.

3. User Stories

As a \<role\>
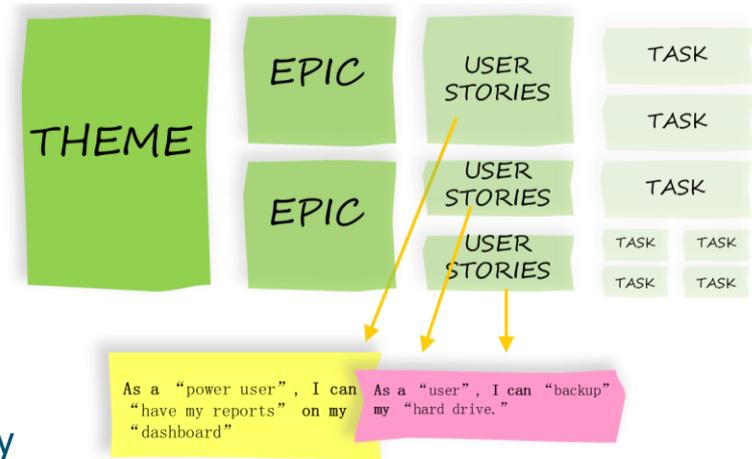**I want** \<goal\>
so that \<benefit\>

User stories

In software development and product management, a user story is an informal, natural language description of features of a software system. They are written from the perspective of an end user or user of a system. Depending on the product, user stories may be written by different stakeholders like client, user, manager, or development team. (Dimitrijević et al., 2015)

An example of a user story could be:
 'As a processor, I want to know what the most efficient way is to collect the residual flows from   the suppliers, so that I can optimize my logistics process.'

In the next pages you will find the validated user stories for each chain participant. Where needed for the decision tool the user stories are grouped by function and operational/strategic level.
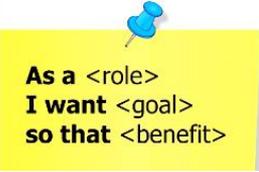
User stories: *Provider side flows*

As a <role>
I want <goal>
so that <benefit>

- *As a provider, I want to know whether I can have my residual flows processed in a sustainable way,*
  so that I can determine whether Eco-feed is an option for my company. (strategic)

- *As a provider, I want to know what the economic consequences are if I have the residual flows processed as raw material for Eco-feed,*
  so that I know what this means for my cost structure. (strategic)

- *As a provider, I want to know whether there are other requirements for my staff for Eco-feed,*
  so that I know whether I need retraining or other certification for this. (strategic)

- *As a provider, I would like to know what the sustainability effects of Eco-feed are,*
  so that I can distinguish myself with my company (strategic)

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User stories: *Provider residual flows*

- *As a provider, I want to know what the spatial consequences are of offering it as an Eco-feed, so that I know whether my location is suitable for this.* (strategic)

- *As a provider, I want to know which raw materials are suitable and not suitable for Eco-feed, so that I know what extra I need to separate* (operational)

- *As a provider, I want to know whether I can continuously dispose of my residual flows to Eco-feed, so that I can be sure that I am not left with waste* (strategic)

- *As a provider, I want to know what extra work this entails, so that I know if I need to adjust my processes* (strategic)

User stories: *Feed Processor (quality)*
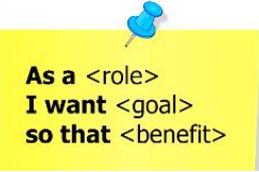
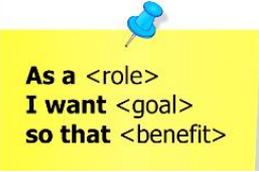- *As a processor, I want to know the origin of the residual flows and the ingredients, so that I can normalize the nutritional value and require less laboratory effort.* (operational/strategic)

- *As a processor, I want to know how to deal with the differences in the supply of raw materials, so that I can maintain the same nutritional value when producing Eco-feed.* (operational)

- *As a processor, I would like to know whether pesticides or herbicides have been used in fruit and vegetables, so that I know whether I meet the legal requirements and can take this into account in the destination of the product.* (operational/strategic)

- *As a processor, I would like to know which potential allergens occur in my raw materials, so that I can make a choice as to which raw materials should be used in which feed.* (operational)

- *As a processor, you would like to know whether vitamins are retained so that I know what requirements I have to set for the premix* (operational)

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User stories: *Feed Processor (process)*

- *As a processor, I want to know what the most efficient way is to collect the residual flows from the suppliers, so that I can optimize my logistics process.* (operational)

- *As a processor, I want to know how to sort the residual flows, so that I can treat animal-based products differently to meet legal requirements.* (operational)

- *As a processor, I want to know how to store the residual flows, so that I know how to deal with e.g. hygroscopic products* (operational)

- *As a processor, I would like to know what is legally tolerated in terms of packaging residues, so that I can adjust my process accordingly.* (operational)

- *As a processor, I want to know what the effect of Eco-feed is on my energy consumption, so that I can determine whether I need to adjust processes for this, e.g. use residual heat* (strategic)

User stories: *Feed Processor (*guarantees*)*

As a <role>
I want <goal>
so that <benefit>

- *As a processor, I want to know whether Eco-feed has different requirements for my staff, so that I know whether I need retraining or other certification for this* (strategic)

- *As a processor, I want to know whether other audits or controls are mandatory for Eco-feed, so that I can organize my HACCP process accordingly* (operational)

- *As a processor, I want to know what the effects are of replacing the ingredients with Eco-Feed on the carbon footprint of the final feed, so that I can provide this information with my product to my customers* (strategic)

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User stories: *Livestock Farmer (economics)*

As a <role>
I want <goal>
so that <benefit>

- *As a livestock farmer, I want to know what Eco-feed will cost me,*
  so that I can calculate my cost price (strategic)

- *As a livestock farmer, I want to know what the consumer and/or retailer will pay extra for my products,*
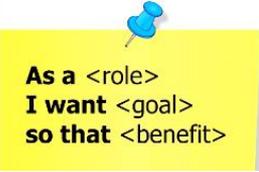 *so that I know what my selling price is* (strategic)

User stories: *Livestock Farmer (quality)*

As a <role>
I want <goal>
so that <benefit>

- *As a livestock farmer, I want to know what the continuous nutritional value/quality of the Eco-feed product is (especially proteins, vitamins, energy, shape and color),*
  so that I know whether it is comparable to the nutritional value/quality of conventional livestock feed (strategic)

- *As a livestock farmer, I want to know how the Eco-feed product affects animals in a positive/negative sense,*
  so that I know what my animals remain healthy and exhibit the same natural behavior (strategic)

- *As a livestock farmer, I want to know whether a continuous supply of Eco-Feed is possible,*
  so that I can feed my animals as consistently as possible (strategic)

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User stories: *Livestock Farmer (guarantees)*

- *As a livestock farmer, I want to know the effect on the environment, CO2 and promotion of circularity of Eco-feed,*
  so that I know how much I know about my environmental impact and what sustainability claims I can make (strategic)

- *As a livestock farmer, I want that Eco-feed complies with a certain standard/guideline (e.g. PEFCR),*
  so that I can be sure that the sustainability claims are well substantiated. (strategic)

- *As a livestock farmer, I want to know what the effect of Eco-feed is on the manure,*
  so that I know what consequences this has for my mineral accounting (strategic)

- *As a livestock farmer, I want to be sure that Eco-Feed contains no animal products,*
  so that it meets current legal requirements (strategic)

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User stories: *Livestock Farmer (process)*

As a <role>
I want <goal>
so that <benefit>

- *As a livestock farmer, I want to know whether Eco-feed can be used on my farm with my current feeding system,*
  so that I know what adjustments need to be made in my farm. (strategic)

- *As a livestock farmer, I would like to know which suppliers offer Eco-feed in their feed,*
  so that I know where to get Eco-feed from. (strategic)

- *As a livestock farmer, I would like to know which ingredients I can replace with this,*
  so that I can fit it into the feeding schedule of my animals. (operational)

- *As a livestock farmer, I want to know whether Eco-feed has the same shelf life as normal feed,*
  so that I know how long I can store it. (strategic)

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User stories: *Food service*

As a <role>
I want <goal>
so that <benefit>

- *As a Food Service I want to know what the effects of Eco-feed are on the quality, taste, appearance of the product,*
  so that I can guarantee that it meets the same standards as regular products

- *As a Food Service, I want to know what the additional costs are of the food product produced with Eco-feed,*
  so that I know what the financial consequences are.

- *As a Food Service, I want to know the consumer's willingness to pay for Eco-feed products,*
  so that I know how I can market this product.

- *As a Food Service I want to know which sustainability claims I can link to the product,*
  so that I know how I can profile the product.

User stories: *Consumer*

- *As a consumer, I want to know whether animals with Eco-feed receive healthy food, so that I know that the animals are fed food that suits their natural diet and behaviour*

- *As a consumer I want to know the impact of my purchase on e.g. Carbon food print/sustainability/food waste, so that I can make a conscious choice*

- *As a consumer, I want to know whether the use of Eco-feed affects the taste and taste experience of the food product, so that I can put a tasty meal on the table.*

- *As a consumer, I want to be sure that the products produced with Eco-feed are healthy, so that I can be sure that there are no fungi/viruses or other pathogens in the food.*
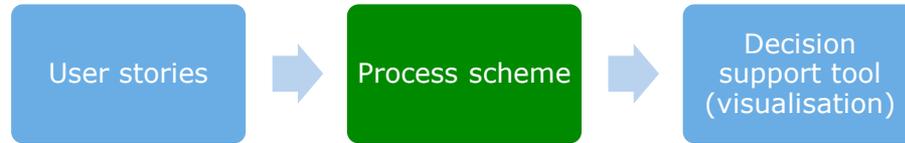
As a <role>
I want <goal>
so that <benefit>

User stories: *Consumer*

- *As a consumer, I want to have enough information about Eco-feed and animal feed, so that I can make a conscious and well-considered choice*

- *As a consumer, I want to know what ingredients have been used as Eco-feed, so that I know that the food product meets my specific wishes*

- *As a consumer, I want to have insight into the assurance of safety and quality in the chain, so that I can be sure of the quality*

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4. Process Scheme and Visualization Decision Tool

From user stories to visualising the decision support tool

```
┌─────────────────┐      ┌─────────────────┐      ┌─────────────────┐
│                 │  ►   │                 │  ►   │    Decision     │
│   User stories  │      │ Process scheme  │      │  support tool   │
│                 │      │                 │      │ (visualisation) │
└─────────────────┘      └─────────────────┘      └─────────────────┘
```

- Now that we have the user stories, we can determine what the user needs to know to come to a well-informed decision. Based on this information, we can determine which user stories are suitable to be used in a decision support model, mainly based on level (from strategic decisions to daily operations) and data availability (collection & validity).

- Based on the results of the interviews, a choice was made for which stakeholders a decision support tool has the most added value. These are the Provider of side flows and the Feed processor

- There is a difference in tooling for strategic decisions to daily operations. These both are supporting decisions by stakeholder. Strategic decisions focus on concept design and operation decisions focus on implementation. In the context of this project, we chose to focus on designing tooling to support the strategic decisions.

- The user stories are then grouped into functional groups and used to determine input and output parameters. This is visualized in a process scheme where we also show the relationship between the parameters. The process scheme identifies the important questions that shape the decision tools, which items influence the outcome, and which data is needed for the outcome of the decision tool (most).
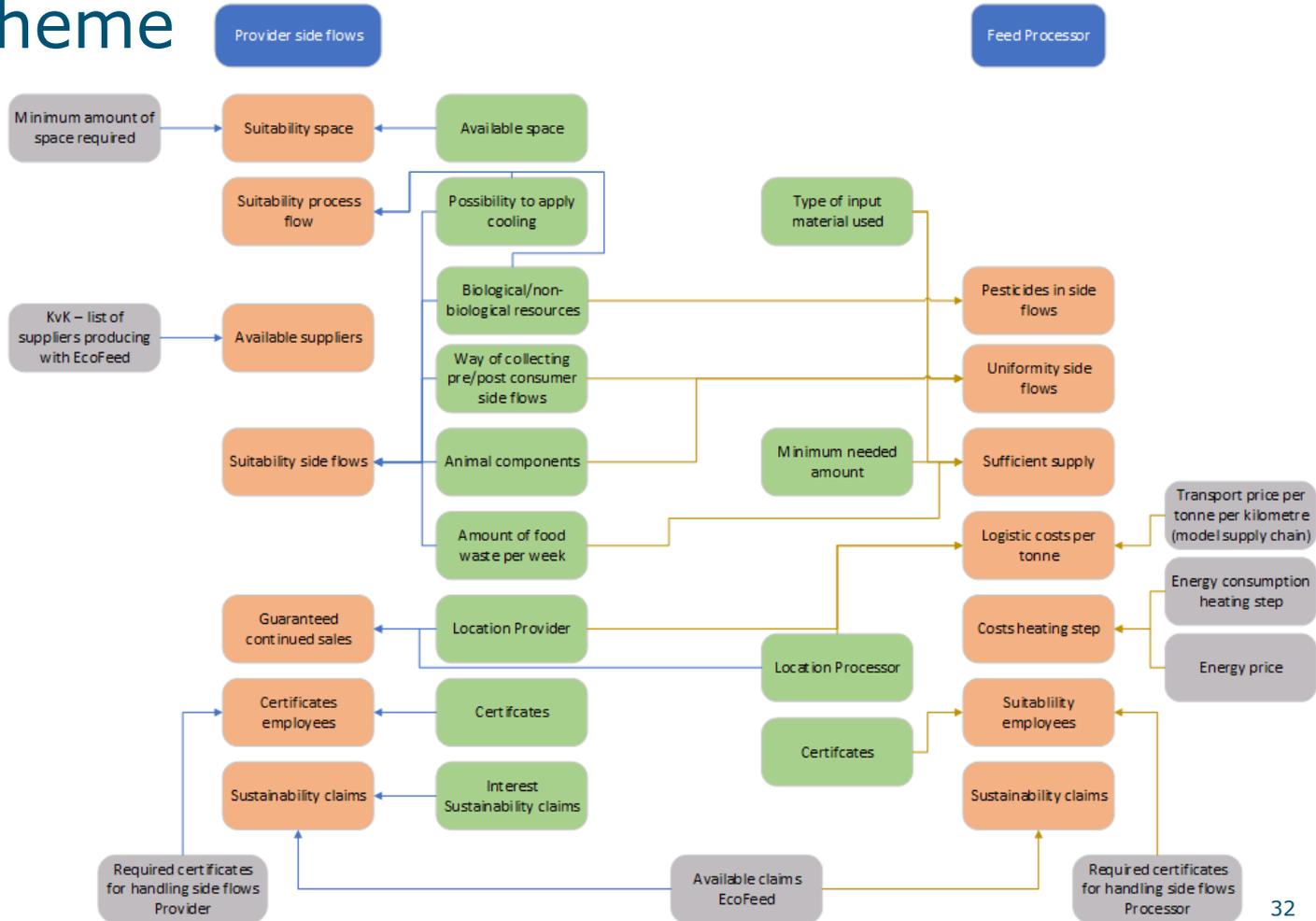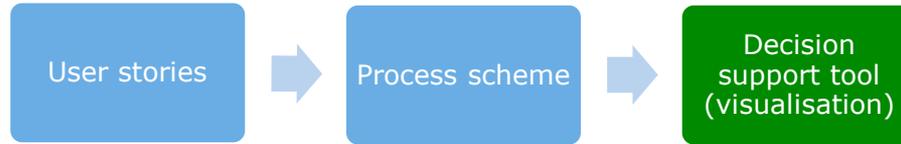
Process scheme

From user stories to visualising the decision support tool

```
┌─────────────────┐     ┌─────────────────┐     ┌─────────────────┐
│                 │     │                 │     │   Decision      │
│   User stories  │ ──▶ │  Process scheme │ ──▶ │   support tool  │
│                 │     │                 │     │  (visualisation)│
└─────────────────┘     └─────────────────┘     └─────────────────┘
```

- To go from process scheme to decision support tool, you need to allocate priorities/importance of certain outcomes, which guide the choices that can be made. Within each node, an underlying calculation will determine which choice best fits the desired outcomes.

- We will demonstrate this tool with a selection of mock-up results.
  Further research will be needed to make the tool operational.

- The mock-up shows how a user can describe his/her situation, then the tool indicates how suitable the situation is for processing the side flows into Eco-feed. A good explanation is provided for each input parameter.
  Also, for each output value, the user will get an explanation on how the value is, and what the relationship of the inputs and outputs is.
  In addition, the tool will present a roadmap to improve the suitability for using Eco-feed.

Explanation decision tool – Provider side flows

- The tool uses a number of questions to determine the suitability of the location for storage of side streams. Some requiring a number and some allowing selection from a predefined value from a drop-down list. These questions include the space available for storage, any possibility of refrigerated storage, quantity and type of side streams, and the extent to which they are now stored separately. There are also questions about staff training and company motivation. It also asks about the company's location to suggest possible cooperation and to perform a transportation cost calculation. The screen provides extensive information with each question.
- As a result, a visual display shows the results of the answers to the (sometimes combined) questions. In the end, an overall opinion is given on the suitability of this location to participate in Eco-feed, and advice is given on how to improve this suitability

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Visualisation decision tool – Provider side flows: Input

Left web page:
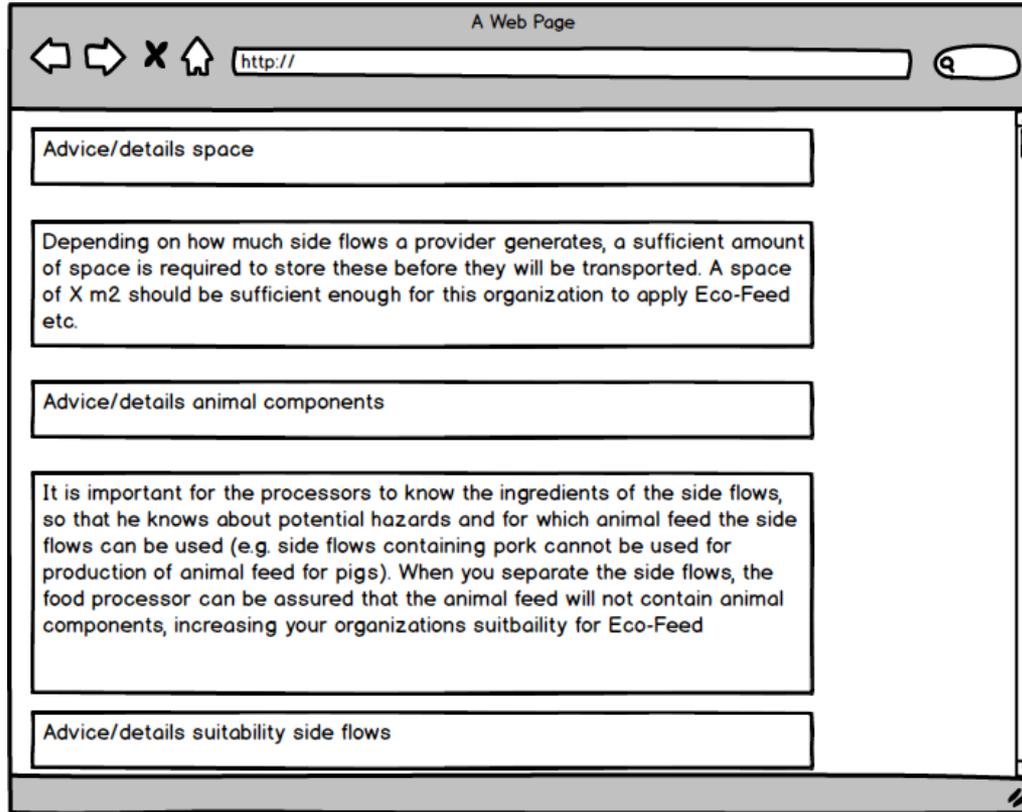
Estimation suitability Eco-Feed for provider of side flows

ⓘ How much extra space is available to separate specific side flows in your kitchen? [____] m2

ⓘ Which animal components do you use in the kitchen? [Chicken ▼] [Add]
Dairy
Eggs

ⓘ Where is/are your branche(s) located [Wageningen ▼]

ⓘ How do you collect pre-consumer side flows at the moment? [I separate plastic and food ▼]
[I do not separate any side]

Right web page:

ⓘ Which certificates does your organization/personnel have? [Certificate X ▼] [Add]

ⓘ Do you want to distinguish your company with sustainability claims? ☐ Yes ☐ No

ⓘ How much kg side flows do you expect per week? [____] kg
How much part of this is pre-consumer? [____] kg
How much part of this is post-consumer? [____] kg
How much of the pre-consumer side flows contain chicken? [____] kg

ⓘ Do you have the opportunity to store side flows at a cooling temperature for four days? ☐ Yes ☐ No

ⓘ Do you use 100% organic products? ☐ Yes ☐ No

[Continue]

Visualisation decision tool – Provider side flows: output

Visualisation decision tool – Details/advice

Explanation decision tool - Processor

- The tool asks questions about the location of the company, the amount of side streams the company expects to process and whether there are any special requirements for these side streams. Some requiring a number and some allowing selection from a predefined value from a drop-down list. In addition, the educational levels of the personnel are asked. Together with the results which the tool has already saved from potential side stream suppliers, the conclusions are determined.

- As a result, a visual representation of the results of the questions is presented. Here, explicit use is made of the results that the tool has already retrieved from individual side stream suppliers.

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Visualisation decision tool: Processor side flows

Input

Output

5. Conclusions

Conclusions

- Requirements Engineering has proven to be an appropriate tool for identifying user needs so that we can use the resulting user stories as the basis for the decision-making tool.

- Based on literature review, a number of user stories for each chain participants have been prepared in advance. This proved to be a good approach to serve as a basis for the interviews with the chain participants involved and to familiarize the parties with this working method.

- Offering these user stories in an interview provided a lot of additional information and also helped to make the interviews more effective.

- The user stories offer more insight on the information needs of chain participants. Therefore, they also indicate the requirements for the input and output of a decision tool to be built.

- The result is that a decision-making tool can be made, which will provide well-founded advice to the chain participants on their decision on Eco-feed.

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Suggestions for future research

This research has provided starting points for the construction of a decision support system for the application of Eco-feed. It also indicated possible inputs and outputs of the tool and the relationship between them.
Based on these starting points, inputs and outputs, it is possible to build a decision support system in a follow-up project. In addition, an important part of the necessary calculation rules have already been provided by earlier results of this research.

This research mainly looked at decisions at strategic level. A follow-up project could also include information needed for operational decisions. This will then lead to a second tool to support these operational decisions. Existing information infrastructures and systems of providers and processors of side flows will have to serve as input for this.

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