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Definition of a Model-Based Engineering Framework for the Design, Organization, and Management of Local Agri-Food Systems

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Abstract

The objective of this project is to produce knowledge about hybrid food systems positioned between short and long circuits, addressing their economic, social, and environmental performances and the conditions of their sustainability, to co-construct with project partners a method and support tools for their sustainable development. These systems are particularly complex, with interactions between actors, interactions between performance indicators of various kinds, new vocabulary and new practices centered on human relationships, with very little formalization. To tackle this problem, we propose a new system engineering approach based on meta-modeling to consider the flow, the requirements and performance indicators. After presenting the problem, we will detail our approach and its implementation. We will end with a review and perspectives.

Keywords

Proximity Food System, Systems Engineering, Meta-Modeling, Requirements Diagram, Performance Indicators

1. Introduction—Issues

1.1. Context

"The issues surrounding the implementation of sustainable food systems are clear and no longer need to be presented" (Esnouf, Russel, & Bricas, 2011). It is with this perspective that the present article is written. The work presented here is from the SYAM project "SYstèmes Alimentaires du Milieu", For and About Regional Development in Auvergne-Rhône-Alpes[1] (Chazoule et al., 2020a). SYAM means "middle-sized food supply chain systems" (Belaid, Brulard, & Cung, 2017). This project aims to support hybrid food systems positioned between short and long circuits and committed to sustainable development (Chazoule et al., 2020b). The term SYAM allows us to characterize our research objects as economic organizations that are 1) intermediate (between short proximity circuits and long circuits), 2) hybrid (because they combine "alternative" and "conventional" actors and modes of organization), and 3) which seek to relocate, at least in part, their supply and/or marketing (Chazoule et al., 2019).

1.2. Stakes for the Actors and Working Hypothesis

Of course, we are not the first to take an interest in community-based food systems. The literature is full of references on this subject. Some have looked at the economic aspects (Muscio & Sisto, 2020) or focused on the life cycle (Harun, Hanafia, & Aziz, 2021). Some, like us, have looked at the contributions of information technology (Dospinescu & Dospinescu, 2018). Still like us, (Fèche, Noûs, & Barataud, 2020) have set up a full-scale laboratory. Others even go so far as to put Artificial Intelligence into it (Di Vaio et al., 2020). Our goal was to set up an approach able to produce knowledge about these systems, their economic, social, and environmental performance, and the conditions for their sustainability, to co-construct with the project's partners a method and tools to support the sustainable development of such food systems. For the partners, as well as for the Auvergne-Rhône-Alpes Region, the challenges of strengthening the relocation and territorialization of the agricultural and food economy are substantial. Through our project, we have contributed to meeting them.

Our working hypothesis is that methodologies from Industrial Engineering and Systems Engineering can be used here to propose a framework for the design, organization, and management of local agri-food systems. However, we are confronted with two major obstacles. First, methodologies have been proven for systems where decision-makers could afford to pay for heavy development and then use them. This is not the case here. Moreover, the approach we must propose must be aimed at people whose job is to cultivate the land or to process food products. The educational aspect is essential. Second, these systems are particularly complex, with interactions between actors, interactions between performance indicators of various kinds, new vocabulary and new practices centered on human relationships, with very little formalization.

[1]The SYAM (Système Alimentaire du Milieu) research project of the 2016-2020 research program For and About Regional Development in Rhône-Alpes has received funding from INRAE, the Auvergne-Rhône-Alpes Region and the European Union via the EAFRD in the framework of the European Partnership for Innovation (PEI-AGRI).

1.3. Methodology Issues

Although from a logistics point of view a SYAM is a long circuit, it does not fit into the dominant economic model of mass production of which the supermarket is the figurehead. If it had been, not only would our work have found known configurations, but we could have directly applied existing tools that have already proven themselves. Unfortunately, the marketing modes that are developing in the SYAMs are largely different from those that usually exist in the retail sector.

The fundamental dissimilarity comes from the difference between the concept of the "final customer" and the concept of the "beneficiary of the system". For large groups, the beneficiaries of the system are the shareholders. For SYAMs, the answer is more complex. To simplify, the beneficiaries are all the actors (including the client) and therefore the question of "how to share the value" is a fundamental one (Le Velly, 2017).

The same is true for the concept of performance indicators: in large groups, the main concern is to please the shareholders, so it is profit. For SYAMs, social, economic, and environmental performance is sought after. To limit oneself to financial indicators could lead to considering SYAMs as an integrated industry or a holding company; however, it is not a legal and economic entity. Moreover, this would be to ignore the differentiating ethical and environmental values that it promotes. In large groups, we speak of "mutual benefit"; in SYAMs we speak of "sharing values" (values being in the plural).

This leads to a few points where vigilance is recommended:

- Being attentive to the request that is formulated and reformulating it to consider the need expressed (more or less explicitly) in the request, the customer being the key point. This implies co-constructing the need and its response with the client (we then talk about the "efficiency" of the system), and therefore integrating producers and processors capable of meeting these needs.
- Being attentive to what makes the cohesion and the collective adaptability of the actors.
- Giving meaning: in addition to financial flows, products, and information, a SYAM conveys non-monetary, ethical, and environmental values. The respect of a specification including cultural elements gives meaning to the product (thus for the client) but also to the SYAM itself (thus for the employees so that they invest in the system (militant concepts, notion of commitment)). However, these elements only exist if the consumer and employees can perceive them, hence the vital notion of product labeling. This implies that a SYAM is a long-term project, constructed and continuously evolving thanks to the relationships established and the interdependence that is created between the actors. Therein lies the difference between short-term profitability and resilience.
- The militant character of the concept and of the approach that it guides and federates: all SYAMs appear as continually renewed projects demonstrating

societal maturity and a development dynamic of a system of actors in a progress dynamic.

For scientists with a modeling background, this is indeed the discovery of a new and particularly complex world: interactions between actors, interactions between performance indicators of various kinds, new vocabulary, and new practices.

It is true that systems engineering, and more particularly meta-modeling are methodological tools that were created with this aim but, to our knowledge, they have never been used in this domain and especially in a universe as complex as that of a SYAM, where nothing (or almost nothing) is formalized and where the human factor is predominant (Le Velly, 2017). Moreover, the method that we must develop, as well as the results that we must obtain, must be understandable for farmers, local elected officials, processors of agricultural products, etc. The modeling results obtained must also be adapted to their problems, which are themselves diverse between actors. There is also the challenge of creating a common language between players who did not necessarily know each other previously, or who spoke as customers/suppliers and not partners. Hence the need to develop a new approach to modeling and exploiting knowledge.

In this article we will present our approach and its implementation in the first part. In the following section we will detail each of the deliverables that our approach has generated in the case of SYAMs. We will then conclude by drawing up a balance sheet, both in terms of the contribution of our approach to SYAMs and in terms of the methodological contribution.

2. Proposed Approach

2.1. A New Systems Engineering Approach Based on Meta-Modeling for Genericity

To have a scientific modeling approach that will allow us to discover step-by-step an unknown world and to propose our results to a large audience, we will be inspired by the meta-modeling approach proposed by (Bézivin, 2005; Bézivin & Gerbe, 2001) and by (Naumenko & Wegmann, 2003) and more precisely by the vision of (El Haouzi, Thomas, & Pétin, 2008).

Let us take the definition of (Kleppe, Warmer, & Bast, 2003): a meta-model is a specification model for a class of the system to be studied where each system to be studied in the class is itself a valid model expressed in a certain modeling language.

For our approach (cf. **Figure 1** ontological levels used by (El Haouzi, Thomas, & Pétin, 2008)), the reference model (Level 2) is a catalog of validated examples that will be made available to all. The knowledge model or meta-model (Level 3) is the meta-model that synthesizes all the models of Level 2. The discovery of a new and particularly innovative example can enrich the meta-model. Moreover, to generate a new example (Level 2), we can draw on the theoretical knowledge stored in the meta-model (Level 3). This step is called instantiation.

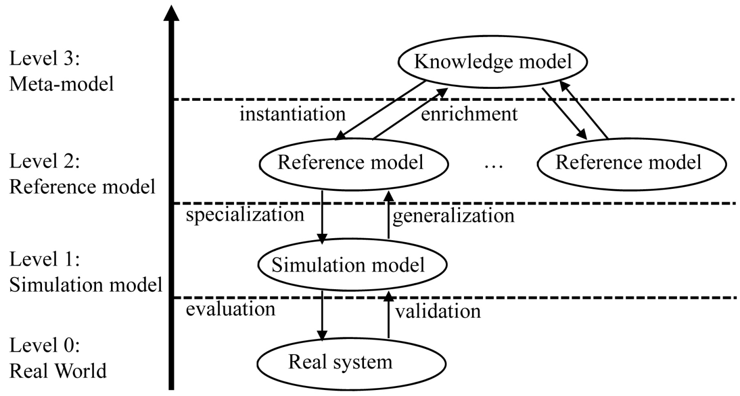

Figure 1. Ontological levels used by (El Haouzi, Thomas, & Pétin, 2008).

Let us imagine that a new group of actors decides to create a new SYAM. This team, probably as part of a coaching process, will consult the catalog of existing SYAMs and then select the SYAM that most closely resembles what this team needs to create and try to build on it. However, since no previous case will be the same as what is desired, the members of this team will have to find the necessary adaptations to their project (particularize). Once they have created their model on paper (Level 1 Simulation Model), they will implement it in the real world and test it (evaluation) against reality (Level 0: real world). After probably some adjustments, when the organization in the real world is satisfactory, the simulation model will be validated and then will be added to the catalog of examples (generalization).

The very notion of model is not necessarily conscious in this process. Being aware that we are modeling or that the examples are models is a considerable asset to take a step back and to understand that the model allows us to adjust the parameters more easily than to test possible evolutions.

This approach is part of a mechanism of innovation and continuous improvement: a new SYAM increases the catalog and can therefore give ideas to other actors, including actors who already have their own SYAM. A new example can bring new theoretical knowledge and thus enrich the meta-model.

In addition to this sequence, the approach we propose federates several tools that are usually used independently. This is what we will see in the following sections.

2.2. Implementation

The first step was to go into the field and analyze in detail the organization and performance of many SYAMs. This analysis phase generated twelve monographs that are available on the project website (https://blog.isara.fr/les-outils-innovants-des-syam/ and https://www.psdr-ra.fr/BOITE-A-OUTILS/Systemes-alimentaires-du-milieu/Un-livret-et-une-videopour-mieux-comprendre-les-SyAM-et-la-diversite-des-demarches-emergentes). Cf. Section 3.1.

In accordance with the approach outlined above, the next step will be to develop a generic model of a SYAM (Meta-model). To do so, we will adopt two points of view:

- A product flow and logistics point of view, where we have mapped the flows and the value chain. See Section 3.2.
- A specifications point of view, where we have identified, via an impact path and a requirements diagram, the nesting of the different functions that an ideal SYAM should fulfill. Cf. Section 3.3.

To evaluate the relevance of the organization of each SYAM studied, we will have to define a system of indicators. We will see in Section 3.4 however that this evaluation requires a particularly complex systemic approach.

What must also be understood is that each indicator or recommendation that we have highlighted participates in the continuous improvement of the SYAM: diagnosis via the performance indicators, reaction, and the implementation of new actions once the actors and their roles have been identified, all with the global vision that the requirements diagram enables.

3. Contributions

3.1. The Twelve Monographs

The first step in our approach consists in analyzing in detail a significant number of typical examples, which are as representative as possible, to create a first catalog of reference models. These analyses were performed in the real world, thanks to final year Masters or PhD students.

We identified five families of examples:

1) SYAMs created at the initiative of the production

- The case of the breeders of Saveurs Iséroises;
- Around the 100% Charolais network in Roannais;
- Around the heavy pig sector.

2) SYAMs created at the initiative of platforms and wholesalers

- Around the producers' platform Saveurs du Coin;
- RECOLTER: a platform of local producers;
- The National Interest Market of Grenoble.

3) SYAMs created at the initiative of processors

- Around AB Epluche, a vegetable shop selling local products;
- Around the LEZSAISONS complex.

4) SYAMs created at the initiative of the collective catering

- Case studies concerning the collective catering company Leztroy;
- Around the shared kitchens of Isère;
- Case studies on the Toque et Sens culinary workshop.

5) SYAMs created at the initiative of local authorities

- Around the agri-food cluster of Isère.

For each case, we summarized the history, the organization of the marketing, the scale of action, the governance, the qualification of the product, the difficulties encountered, the values defended and what makes it a SYAM rather than another type of organization.

3.2. Flow-Oriented Meta-Model: Flow Modeling and Its Value Chain

As shown in Figure 2 (several costs were identified in the work), graphic modeling is a powerful tool that allows us to reconstruct in a simplified way the actors, the value chains, the stages of production, processing, and value chains as well as the flows and links between operators. It allows us to better understand these systems in their complexity and to highlight the connections between the elements. It also sheds light on the articulation of the different production and marketing channels. It can therefore be particularly interesting for highlighting strengths and weaknesses, key players, and bottlenecks. Mapping is an important element in the support of these systems. This mapping is based on production systems analysis approaches, notably used at the G-SCOP laboratory of Grenoble-INP (Belaid, Brulard, & Cung, 2017). We suggest using it as a tool for discussion and networking between operators.

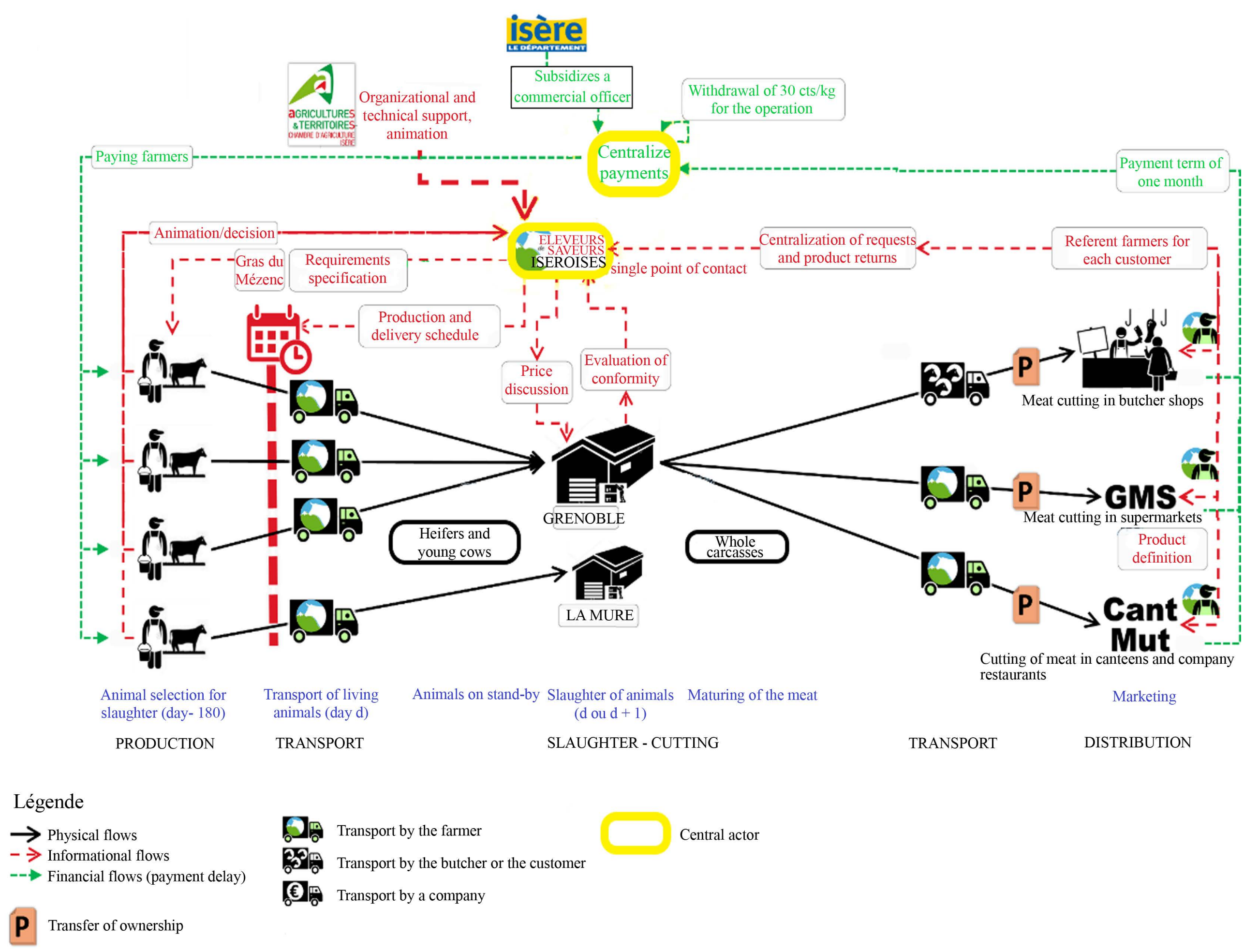

Figure 2. Several costs were identified in the work.

Thanks to its systemic and visual approach, it proves to be a tool for communication and sharing via the creation of a common language, a common vision, beyond the various professional realities. As such, it can also be an element in laying the foundations of a strategic partnership. We also suggest using it as a steering tool. Since we can only manage well what we know, becoming collectively aware of the approach enables it to improve its operation and viability. Mapping makes it possible to identify the points over which the actors have the most control and those on which they need help, to reveal areas of tension and to build a strategy for the future.

Mapping can also help identify various costs inherent to the process. It allows their identification at different stages. Identifying these costs has several advantages. Individually for operators, establishing a production cost makes it possible to think of an initial pricing grid. Collectively, reasoning about costs is important in SYAMs, since it allows them to be shared or mutualized, or at least provides the opportunity for discussion on the subject. It can also allow for the targeting of certain possible aids.

The identification of costs thus allows:

- Definition of the data to be collected to evaluate them.
- A better understanding of which costs are borne individually, and which can be shared or assisted.
- Identification of strategic costs at different stages of the process (and therefore enabling some of them to be anticipated or deferred).

Several costs were identified in the work:

- Production costs (farm scale, collective structure scale). These costs are often higher in local production approaches, especially when these are intended to be qualitative. It is therefore important for farmers to evaluate them. To face the difficulty that the diversity of these costs represents, collective actions can be performed to harmonize them.
- Investment, coordination, and management costs of a collective agricultural or agri-food structure. Grouping together within an association or a platform can have different costs depending on the infrastructure and investments required for the activity. It is therefore important to evaluate this. The management time of the collective activity is also to be considered, as is the management of employees. Finally, it seems particularly important for these costs to anticipate and to evaluate the overload resulting from the increase in volumes during the growth phases of these structures. These periods are indeed periods of tension for the structures.
- Processing costs. This cost can be borne by the collective structure, a SYAM partner or on their behalf by a service provider external to SYAM. Evaluating this cost allows us to understand how value is created throughout the chain and how margins are created and shared.
- Cost of setting up a strategic partnership. Here, the cost/benefit ratio is not

easy to evaluate. It is, however, costly in terms of learning and time spent on these new forms of governance. It requires the construction and application of new operating rules.

- Marketing costs. We can include here the costs involved in searching for commercial partners, those of setting up new contracts, those linked to the uncertainties of the arrival of new partners.
- Qualification costs. These costs are linked to the identification of products, production processes and the "values" conveyed by the approach, but also to the work of credibility and, if necessary, the control and certification of these specific characteristics (registration of a brand, management of an official of quality and origin).
- Cost of changing practices. SYAMs are innovative, uncertain systems in which practices evolve and constant adjustments must be made. The approach advances by trial and error. The cost of learning can therefore be high. It is important to take this into account.
- Supply chain management costs. These costs include much more than just the storage and transport of raw materials and products circulating in the SYAM. The costs of organizing the chain can be included in this category.
- Communication costs. The costs we are thinking of here are the costs of publicizing, informing, and making the process transparent.
- Support costs. These are the costs of finding "partners" who can help the process, their possible financing and the time and means devoted to the learning process. Indeed, when project leaders start structuring such approaches, they do not always know whom to contact for support.

The set of costs identified in these approaches is vast and evaluating them is often difficult. On the other hand, anticipating that they will arise and be met according to certain constraints is a factor of success. Associating the costs with a cartography makes it possible to better understand who is responsible for them and how to better share them. The evaluation of these costs is also necessary when applying for grants or traditional financial aid.

The interest of the proposed mapping also relates to logistical issues. By highlighting the diversity of distribution channels but also their coexistence, the number of retailers and their localization, the mapping will a better analysis of this issue. However, a question arises: what do we mean by logistics?

A common mistake when talking about logistics is to limit our thinking to the issue of transportation. Transportation consists in moving products from point A to a point B. Logistics is the organization of the whole production and distribution chain to bring to the consumer the product he needs with acceptable expectations of place, time, quality and competitiveness. Transport (material flows) is only one part of logistics. Logistics is composed of material flows (products) but also of information flows and financial flows which allow the flow of products (cf. **Figure 3** Agri-food supply chain representation from (Tsolakis et al., 2014)). All of these flows must therefore be taken into consideration.

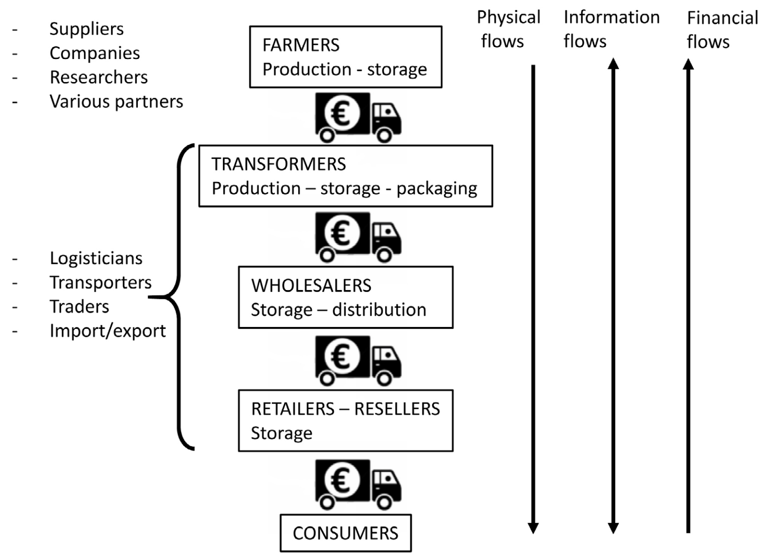

Figure 3. Agri-food supply chain representation from (Tsolakis et al., 2014).

In some cases, transportation will be a problem and last mile logistics, for example, will become a critical point in the system. For example, how to provide farmers with a large network of distributors (catering, mass and commercial catering, supermarkets) in a city far from their production sites? The question of transportation does not, however, seem to be the most challenging issue in a SYAM. This competence can be outsourced to a subcontractor, and the volumes transported often enable this. In other cases, it is the flow of information that will cause problems, for example, failures in the transmission between a distributor and its supplier. This can lead to supply disruptions, misunderstandings, conflicts and ultimately the loss of markets.

In SYAMs this difficulty appears frequently, even if the actors communicate on the values they want to share, on a qualification process or on the pricing of a product; difficulties related to supply, or quality are sometimes more difficult to express. Let us take an example in a long circuit: a farmer sells to intermediaries according to the quality of his animals, without any control over the downstream part of the chain and with little control over prices. The buyer makes a phone call and receives the quality he wants when he wants. In a SYAM, the breeder and the buyer recognize each other as partners to set up and develop their supply chain. Other actors, such as processors and wholesalers in the region, must also be involved and committed. Transparency is required regarding each other's objectives and margins, and this transparency fosters mutual trust. The quality of communication is at the heart of the process. All of this only works because there is a real desire for a local partnership. For this partnership to work, the flow of information must be fluid to tolerate imperfections in the implementation of the system, in a dynamic of continuous improvement. Taking an interest in logistics in SYAMs means doing much more than merely addressing the issue of transportation.

Here are some of those questions:

- A common definition of quality: do producers, processors and distributors have the same understanding of quality? How can this notion be made explicit, through contractual specifications?
- How to adapt the entire value chain to deliver the desired quality?
- How to organize communication within the group? How to centralize information, requests and offers?
- How to ensure a homogeneous quality for all the farms involved? How to pay for this quality?
- How to plan and ensure scaling up?

The tool we propose here is a diagnostic tool and indicates ways to progress according to the diagnosed situation. It is used from the creation of the SYAM and throughout its life, in the framework of continuous improvement.

The diagrams that we propose in the following are the result of several research studies and the findings of a statistical study of 88 companies from a panel of 5 sectors (automotive electronics, textiles, food processing, pharmaceuticals) (Estampe et al., 2010). The two major results are:

1) There is a very strong correlation between the maturity level of a supply chain (next section) and its performance.

2) 58 processes grouped into 7 categories contribute significantly to the creation of value for the entire chain. It is then sufficient to look at the status of each process to estimate the maturity, and therefore the efficiency, of the SYAM in terms of logistics.

Paché & Spalanzani (2007) propose five levels of logistics maturity:

- Level 1 intra-organizational maturity: The objective is to manage performance by associating the different functions of the company (design, marketing, production, etc.).
- Level 2 inter-organizational maturity: performance is managed more globally by integrating the company's close stakeholders (suppliers, service providers, direct customers etc.).
- Level 3 extended inter-organizational maturity: all the players in a chain are involved in the search for performance. This extended chain approach corresponds to the definitions of the Supply Chain.
- Level 4 multi-chain maturity: the company is integrated into a complex network of relationships where each company in the network can be the "pilot" or "pivot" of the relationship. This "multi-company" level allows each company to gain height by proposing inter-sector performance approaches; GMA (Mutualized Supply Management) is a good example (Efficient Customer Response, https://www.ecr-community.org/).
- Level 5 societal maturity: companies in a global network integrate the performance dimensions associated with sustainable development (environment, society) and seek performance that is valued in the wider environment of society. The work of the Déméter club (Déméter, 2009) in France, which brings together the various players of industry and distribution with the aim of

achieving global and societal performance, is an example of this.

A classic logistics chain develops by following the levels of maturity in chronological order (orange arrows in the **Figure 4** Logistics maturity and growth (Paché & Spalanzani, 2007)).

The essence of societal maturity is to move from "for me" to "for us" in a "doing together" mindset. Governance clearly has a crucial role with respect to the final objective of the SYAM and the commitment of all the actors of the process. It is a logic of performance optimization sought on several levels (SYAM) versus a logic of maximizing profits alone (large groups).

SYAMs, from their birth, are strong in societal maturity, which is their reason for being. Paradoxically, however, observations show that they are weak on the operational levels, which are fundamental to the survival of the SYAM.

For a SYAM, the stages of maturity are not chronological, contrary to the process in large groups. The tips of the star grow chaotically, independently of each other. It is therefore necessary to have a diagnosis for each level, enabling a measurement of where the SYAM is at, and this for all levels at the same time. Beyond this diagnosis, we need processes that allow the star to grow in a sustainable way.

Based on SCORE (Kaplan & Norton, 1996), Efficient Customer Response (Efficient Customer Response, 2008), Global Scorecard (Global Scorecard, 2008), SCALE (Estampe et al., 2010), Excellence Model (EFQM, 2009) in particular, we propose 58 processes grouped into 7 categories that contribute significantly to the creation of value to the whole chain. These seven categories are summarized in the following tables (**Tables 1-7**).

What must also be understood is that a SYAM does not have the resources of the industrial model and therefore cannot be efficient on each point of the diagnosis, nor a fortiori implement the necessary resources. On the other hand, the points highlighted here are good questions to ask. It should be noted that these questions should be answered collectively, which will energize the group, via brainstorming for example.

Table 1. Define a supply chain strategy.

Category 1: Define a Supply Chain Strategy
Define the Supply Chain (SC) policy and value creation elements.
Define Supply Chain management principles for the entire chain.
Select suppliers according to customer value creation criteria.
Participate in the choice and/or modification of production sites according to logistics criteria.
Define the distribution network according to logistics criteria.
Participate in the definition of the assortment policy according to logistics criteria.
Define a transport policy.
Participation in the definition of a packaging policy.

Table 2. Define objectives.

Category 2: Define Objectives
Define customer needs in terms of logistics; implement and monitor them.
Define objectives in terms of customer service during and after the purchasing act.
Define supply objectives.
Define production objectives.
Define distribution objectives.
Define the logistics characteristics of products.

Table 3. Establish procedures.

Category 3: Establish Procedures
Establish procedures for procurement.
Establish procedures for production.
Establish procedures for distribution.
Establish protocols between distributors, carriers, and suppliers.
Establish logistics procedures for customer management.
Establish procedures related to the logistics of promotional products.
Establish procedures for the management of new products.
Establish procedures for the return of unsold goods from customers and suppliers.
Establish procedures for the return, exchange, de-consignment, or processing of packaging materials.
Evaluate major risks and set up emergency procedures.

Table 4. Resource planning.

Category 4: Resource Planning
Establish sales forecasts.
Plan logistics investments.
Carry out the PDP (Master Production Plan)—supporting the production activity.
Carry out the DDP (Master Distribution Program)—supporting the distribution activity.
Plan promotional operations.
Plan transportation.
Plan after-sales service needs.
Map the customer network.

Table 5. Coordinating the different links in the chain.

Category 5: Coordinating the Different Links in the Chain
Establish a method of communication between partners for daily work and emergency situations.
Exchange information with clients.
Set up agreements in a customer—supplier relationship.
Define the stocking policy with main suppliers and customers in a concerted manner.
Integrate suppliers and/or customers in the development of new products.
Consider the after-sales service in the design and/or referencing of products.
Optimize sales and production plans with the various partners.
Ensure product traceability throughout the chain.

Table 6. Evaluate and monitor the performance of each partner and the entire supply chain.

Category 6: Evaluate and Monitor the Performance of Each Partner and the Entire Supply Chain
Audit the Supply Chain performance of each partner.
Monitor performance.
Financial reporting of expenses.
Set up a follow-up of emergencies.
Evaluate Supply Chain performance with logistic evaluation models.
Monitor the continuous progress process.

Table 7. Optimize the supply chain.

Category 7: Optimize the Supply Chain
Participate in the definition of the forecasting system.
Make the production tool flexible.
Optimize locations.
Optimize transport.
Optimize inventories.
Optimize the planning of distribution resources with the various actors.
Schedule reception.
Develop human resources and versatility.
Control and improve health and safety standards in logistics functions.
Optimize the exchange of information between the different links in the chain.
Optimize relations between partners.
Implement and maintain continuous progress.

Figure 4. Logistics maturity and growth (Paché & Spalanzani, 2007).

3.3. Specification-Oriented Meta-Model: Building Resilience

This section focuses on a set of recommendations that will lead to a guide of good practices aiming at the sustainability of a SYAM, i.e., strengthening its resilience. The resilience of a living system is defined by its capacity to quickly recover, after a disturbance, its initial structure, and initial functions. For an organization or an individual, resilience following a shock is a rebound, but the organization or the individual remains marked by the learning that it has acquired from it.

At first glance, in terms of sustainability, the economic, social, and environmental performances of a SYAM are strongly expected and participate in the resilience of these systems. But on a closer look it appears that if, for a SYAM, the diversity of operators, their complementarity and the quality of the established relationships are essential and contribute to its capacity for resilience, this capacity also requires the presence of other factors that deserve to be finely identified if we want to co-construct solutions adapted to each operator and each system. To build this resilience, it is necessary to define and identify, as early as possible, the conditions that must be met in the system and the requirements of the system to have the best chance of success. To do this, we propose to use two complementary methodological tools: the impact path to have a global vision, and the requirements diagram, which will allow us to refine the approach by going down to the level of concrete elementary actions.

The impact path is borrowed from the ImpresS method—Impact des recherches au Sud—proposed by the CIRAD (Blundo-Canto et al., 2019). This method allows the designers of an organizational system to formulate, from its conception, from existing resources, the potential paths of development and the interventions that will contribute to the achievement of expected objectives (final impact). This approach is necessarily co-constructed with all the actors of the system and enables them to:

- Share a representation of the sequence of actions and the results to be obtained.
- Identify the conditions necessary to obtain them.
- Highlight possible obstacles.
- Identify the levels at which support can or must act.

The impact path is represented by a diagram that highlights different elements linked together by causal relationships, represented by arrows that draw the path from the action to the expected final impact. The different items of an impact path are:

1) Actions: they are carried out thanks to resources and means that allow the development of the project. The actions and resources combined contribute to the production of results.

2) Boundary objects: these are the coordination tools that will facilitate the process of change or innovation.

3) Results: these are generated by the activities of the system and by the interactions between actors. These results contribute to initiating the process of innovation or change when they are used/appropriated/adapted by the actors.

4) Changes: they are linked to the appropriation of one or more results by the actors of the system. The generation of changes will promote the achievement of the expected impacts.

5) Impacts: these represent the long-term effects induced by the system. They can be economic, social, territorial, environmental, political, etc. A distinction is made between 1st- and 2nd-level impacts. The first level includes the direct impacts on the actors in the medium or long term. The second level brings together the indirect and long-term impacts on the actors, or the spin-offs in other territories, other sectors, etc.

Since this methodology has proven to be successful (Lidon et al., 2018; Faure et al., 2018; Barret et al., 2018; Blundo-Canto et al.; 2019), we will draw on it for application to the SYAM.

We have used it here to construct a typical ideal SYAM. The impact path presented here allows us to model the potential development of a SYAM, from the most global to the most specific level, to move towards a resilient system. In this approach, we propose a schema starting with the actions and resources that should be put into place for the SYAM to generate economic, social and environmental impacts that will ensure its resilience and sustainability. This scheme (**Figure 5** impact path applied to SYAM) was developed through twelve case studies within the framework of the SYAM project.

Based on this ideal-typical scheme, each collective can, *ex ante* or *ex post*, reflect on the impacts generated by the construction of its SYAM.

The elaboration of the impact path of a concrete SYAM can then allow the enrichment of its impact throughout the life of the studied system, following the identification of "weak links" in the impact path, following relations that are not or are only slightly made between actions and results or between results and changes. This reflection on the impact path benefits from being guided by organizational specialists (chamber of agriculture, consultant, system operational manager, etc.). The actors of this support will also have to propose coordination tools enabling the evolution of the system. The reflection and attention will be focused on the operators and on their role in this process of innovation leading to the desired economic, societal, and environmental impacts. The support should aim at realistic, shared, and measurable changes, based on the resources

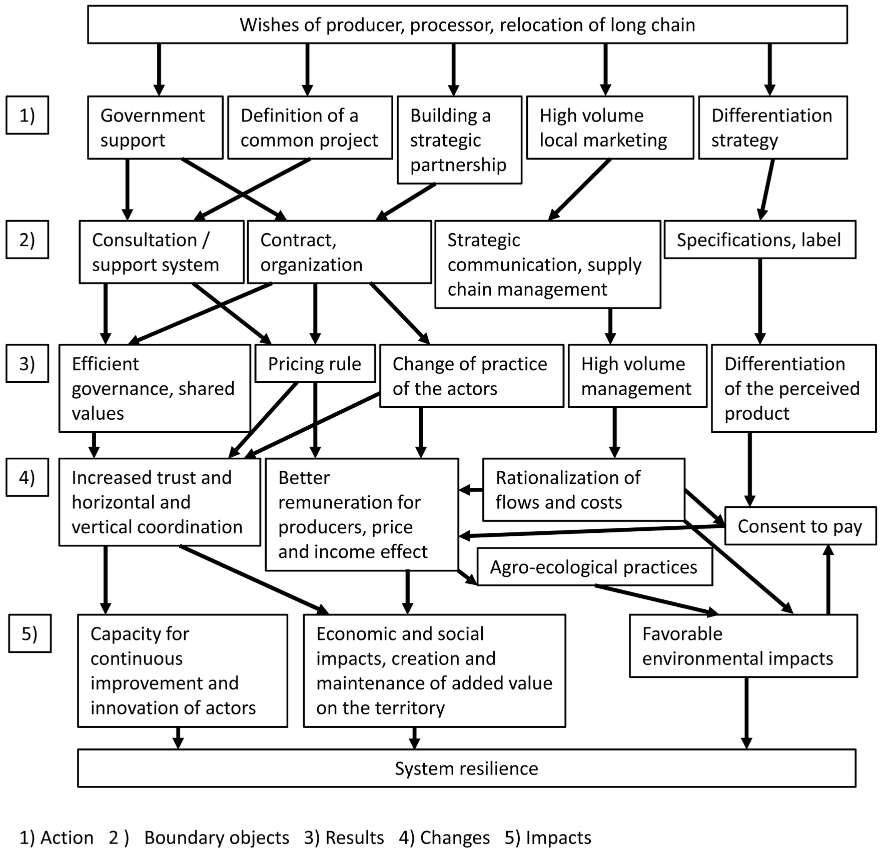

Figure 5. Impact path applied to SYAM.

and capacities that can be mobilized. It should also maintain the logic of a continuous improvement process, tending to strengthen the capacities of the various actors. To make this "ideal" or "theoretical" impact path operational, and to be able to describe more precisely which human actions to implement to cause such a system to evolve, we propose to enrich our approach by completing it with the use of the requirements diagram.

A requirement makes it possible to specify a capacity, a need, a rule... that must be satisfied by a system. It can also specify a function that the system must perform or a performance condition that must be met. The requirements diagram (or constraints diagram) belongs to the Unified Modeling Language (UML) approach. It graphically describes the requirements that the system must meet. It has been widely proven (Weilkiens, 2008; Grady, 2014) for example. This method allows the designers of a system to define a priori the condition to be reached (final objective), then to formulate and prioritize, from the objective sought, all the requirements and sub-requirements that the system must satisfy. The system requirements are organized and linked together; thus, a complex requirement can be broken down into a hierarchy of sub-requirements and in this case, for the complex requirement to be satisfied, all the sub-requirements must be satisfied. For our purposes, the final requirement is the sustainability of the SYAM (which assumes that each of the partners continues to find satisfaction).

The proposed requirements diagram was developed following a detailed analysis of the various monographs and interviews conducted during the SYAM project, i.e., the 12 case studies. For reasons of readability and future processing, the requirements diagram is presented here in the form of several tables which are linked together. The tables are read from top to bottom and from left to right, like paragraphs and subparagraphs. To satisfy a requirement, i.e., a "paragraph", all sub-requirements (sub-paragraphs) must be satisfied.

Thus, Table 1 can be understood as follows: to sustain a SYAM (expected final condition), one would need to "have a market" (requirement) and one would need to "control costs" and one would need to "have resources locally" and one would need to "have an effective network" and, possibly, one would need to "have support from institutions (at start-up)". See Table 8. Requirement's diagram, main requirement.

This reasoning is recursive; it thus applies to each non-terminal action. We therefore propose the following tables to refine the requirements diagram (see Tables 9-13).

3.4. Evaluation and Performance Indicators

What interests us here is the overall performance of the SYAM assessed by questioning what makes it a collective success. In this respect, the performance approach has led us to be interested in the development process and in the path taken, and not only in the result of the SYAM. This approach to global, multi-dimensional performance is much more difficult to measure technically, as it aggregates several performance fields. In addition, its assessment is different from one SYAM to another, and relies on many debatable criteria depending on the operators and the contexts. The various dimensions of overall performance were not assessed in a "conventional" way, i.e., based on predefined indicators. First, we did not have relevant indicators, as no research had identified any to evaluate such systems in their totality. Secondly, the approaches studied were too unstable to be able to measure performance satisfactorily. We opted for a qualitative approach to address the multidimensional performance of SYAMs. The latter can indeed make it possible to reconstitute the reasons for which such steps are initiated, the justifications given for the actions. We therefore tried to

Table 8. Requirement's diagram, main requirement.

TO SUSTAIN A SYAM
1—HAVE A MARKET
2—CONTROL COSTS
3—HAVE THE RESOURCES LOCALLY
4—HAVE AN EFFECTIVE NETWORK
5—HAVE HELP FROM INSTITUTIONS

Table 9. Requirement's diagram, "Have a Market" requirement.

1—HAVE A MARKET
KNOW THE MARKET
Conduct preliminary market research (customer behavior, needs and purchasing capacity)
Know the costs (production, transformation, logistics, hidden costs)
STABILIZE AND DEVELOP THE MARKET
Have fair and remunerative prices
Raise consumer awareness
Make consumers aware of the positive and negative consequences of their purchases
Make consumers aware of the concept of proximity
Make consumers aware of the seasonality of products
Educate children
Conduct marketing actions—animations
Take care of the image
Ensure traceability and quality label => differentiate to justify higher prices
Balance and play on the multi-market
Have short consumer/stakeholder feedback
Be trained in how public procurement works

Table 10. Requirement's diagram, "Control Costs" requirement.

2—CONTROL COSTS
Know the different costs and control them
Limit overproduction and waste
Be able to produce or transform quality products at acceptable prices
Be able to produce economically viable quantities
Produce what you can sell

Table 11. Requirement's diagram, "Have Resources Locally" requirement.

3—HAVE RESOURCES LOCALLY
Know the market (prior market research)
Know your own resources and their sustainability
Know the risks of failure and resilience plans in case of difficulties
Have an adequacy of resources/market/ambition
Identify missing needs
Strengthen and adapt existing resources as needed
Help the installation of new farms
Reorganize businesses by increasing added value

Table 12. Requirement's diagram, "Have Help from Institutions" requirement.

4—HAVE AN EFFECTIVE NETWORK
HAVE A REALLY COMMON PROJECT
Have the same strategy all together
Agree on efficient governance
Share the same values
HAVE ADEQUATE CONTRACTUALIZATION
Transparency of prices, costs, and margins
Equitable sharing of value
Stable prices
Reduced distances with intermediaries
HAVE A EFFICIENT SUPPLY CHAIN
Know the main levers of action of the logistics strategy
Know how to set up warehouses
Know how to operate warehouses, know how to manage stocks
Know how to manage a fleet of trucks
Know how to decide on outsourcing choices (make or buy)
Have a good supply chain information system
Have a good customer service
Have good distribution channels
Be able to model your supply c
In terms of organization
In terms of costs
Be able to calculate direct and indirect costs
Require delivery periodicity (often mentioned as a critical point)
Locate production and transformation facilities in a judicious way
Establish the right end points of sale
Ensure the presence of customers with the right buying potential
Have an attractive and practical infrastructure (parking)
Have an efficient reverse logistic (management of downgraded products)
BE SURE OF THE COMPLETENESS AND RESILIENCE OF THE NETWORK
Detect and remedy missing links
Detect weak links and plan for contingencies
Use collective mutualization
Price transparency
Have a good communication between actors
Have places for exchange and collective work

Table 13. Requirement's diagram, "Have an Effective Network" requirement.

5—HAVE HELP FROM INSTITUTIONS
STRUCTURE THE MARKET
Develop the four proximities
Proximity of production
Proximity of transformation
Proximity of purchase
Proximity of consumption
ALLOCATE TARGETED AND EFFECTIVE FINANCIAL AID
AWARD LEGISLATIVE GRANTS
Inform the actors about the general laws
Train the players in public procurement
Inform legislators about needs (lobbying)
Demand the adaptation of existing health laws
Have new laws proposed
HELP WITH TRAINING IN ALL AREAS OF THIS REQUIREMENT DIAGRAM
Help to find financing
Help to find trainers

understand what was of interest to SYAMs and what made it possible to say that the approach had a favorable cost/benefit ratio. In other words, we were interested in what the operators enrolled in SYAMs considered their "success". This work has also led us to propose some indicators and tools to accompany the development of SYAMs towards sustainable and resilient approaches. As much as the evaluation of a result or a global performance, it was therefore a question of working on the evaluation of a process.

This work has thus shown that beyond a classical perception of performance, what made a SYAM successful for the operators was the implementation of alternative models and rules of operation, because they were more collaborative than the dominant model. Thus, for example, the interest in creating value goes hand in hand with the interest in sharing it equitably. SYAMs must allow everyone to live from their work. Meeting each other, getting to know each other, sharing difficulties, understanding each other's constraints is another expectation. Building a project and collective actions also appears as a milestone and an important result. To succeed in developing a shared governance, to make it last over time especially in growth phases, and developing trust, solidarity and equity in relationships are also crucial. Communicating and informing about the values endorsed by the approach and about its specific features are also important. The aim is to create transparency in commercial relations. Without forgetting, too, everything in a SYAM that contributes to the development of its territory, from the pride of participating in health and safety initiatives and the preservation of the environment to the relocating of food. Listening to operators shows that the main performance of a SYAM lies in the development of an alternative way of working and a sum of different reconnections: between the operators, but also of the operators to their territory, to their products and to consumers. Reclaiming a meaning which is lost in longer systems appears finally as another of these factors of success. Building performance in a SYAM undeniably means obtaining better remuneration, but it also means developing more social and environmental performance, as well as territorial performance. It means moving towards greater equity, solidarity, and attention to the environment.

In SYAMs, collective operation is not limited to a single sector. Thus, for example, it is not a question of accompanying the grouping of a particular type of actor according to a sectorial or professional approach (farmers, processors, or restaurant owners). On the contrary, it is a matter of accompanying the development of a value chain, provoking, and maintaining a collective operation on a larger scale. In this respect, we suggest that discussions should very quickly include both distributors and consumers (or some of their representatives). The idea is to work to make these two actors' strategic partners in the process, to determine with them a price and a quality negotiated by all, while covering production costs. Bringing consumers into the process in one way or another makes it easier to work with distributors, who thus hear the demand directly.

While the collective aims to include all participants in the value chain, it must not forget the public sector. In the cases we studied that were the most successful and stabilized, public actors were present, and their roles were important. The Isère department and the Roanne conurbation have strongly encouraged the development of several SYAMs. For example, they have financed local processing tools, covered the costs of training when quality was not sufficient, set up calls for tender for collective catering, provoked meetings between operators (dating, internet site), helped to qualify between operators (dating, website), helped to qualify products by carrying a brand, had a role of reassurance and facilitating governance, etc. They have also made available skills for structuring, technical or commercial support, which have encouraged the emergence of more collaborative rules and the resolution of conflicts between actors.

Finally, we would like to emphasize one last point. The support of such value chains cannot be carried by a single support structure. We need to move away from sectoral support and the usual discrete approaches. The effectiveness of the SYAMs lies in the connections that they generate between different actors in the field of support. In Isère, for example, collaborations have been initiated between the various consular chambers to bring together farmers and the food industry. SYAMs are hybrid models, and this hybridization must also extend to the support structures to provoke new skills and collaborations. Reconnections must therefore also be made in this sector.

To question the performance of SYAMs, we propose five major areas: economic, social, product-related, environmental, and territorial. For each of these performances, we have put forward several questions that we believe are essential to evaluate the success of a SYAM.

We have remained at the "question" level because, as for the logistic recommendations, a SYAM and its actors do not have the means of the agri-food giants that are the main players in the mass market (large production, processing, distribution or catering companies) and therefore cannot be efficient on each indicator (we could ask ourselves the question "do these giants perform well on all these indicators?" But that is another debate.), nor a fortiori dispose of the necessary resources. Therefore, it is simply a list of "good questions to ask", with the resulting brainstorming effect.

Area 1: Economic performance

- Are production costs shared? Is the price considered fair?
- Are the costs identified? Are expenses shared?
- Are new rules negotiated collectively? Does the process allow for learning?
- Is supply chain management well thought out? Are the flows (financial, information, products, etc.) studied? Are they optimized?
- Does the economic performance allow a better profitability of the structures; does it allow improved revenues and greater confidence for all operators?
- Does the approach allow the formalization of new ways of exchanging? Are new coordination's being built? Are new economic models emerging?

Area 2: Social Performance

- Does work make more sense? Are working conditions not more difficult? Are agricultural and agri-food activities enhanced?
- Does the approach allow the creation of more links, solidarity, and transparency between operators?
- Does the approach allow for the emergence of a strategic partnership?
- Does the approach encourage more links, transparency, and inter-knowledge with consumers (does it make them supportive of the operators)?
- Does the approach lead to changes in practices?
- Does the approach create new social and ethical values shared by all?

Area 3: Product performance

- Does the product retain its specific characteristics? Has it been revalued?
- Is the product identifiable?
- Is the product reassuring and does it create a link between the consumer and the operators of the process?
- Is the product accessible (economically, socially, physically)? Do its distribution points increase in number?
- Does the product create learning/synergies and the purchase of other local or alternative products?
- Does the approach promote a transition to sustainable food?

Area 4: Territorial performance

- Are jobs being created or maintained in the territory? Are new structures (intermediary or distribution) emerging?
- Are new relationships or new links being created at the local level between economic operators but also between existing circuits, favoring a re-establishment of food production?
- Is there a capacity for collective action at the territorial level? Are new initiatives or innovations emerging because of the approach?
- Do the structures that accompany these approaches collaborate on a local scale?
- Does the approach contribute to a better knowledge of the territory, to a stronger attractiveness, to more tourism; does it allow for changes in image?
- Are new structures and methods of food governance being put in place and at what levels? On what scale?
- Does the approach contribute to greater sustainability and resilience for the territory?

Area 5: Environmental performance

- Does the approach lead to learning (and continuous improvement) towards practices that that respect the environment and animal welfare?
- Has the approach led to the establishment of a set of specifications? Has it aroused interest at all levels of the chain?
- What are the purposes, components, and scales of these practices?
- Does the approach adhere to pre-existing charters?
- Is information on changes in practice available for each sector (production, processing, distribution)?
- Does the approach create more environmentally virtuous practices in production, processing, and distribution?

As with the requirements diagram, this system of indicators will evolve as innovations are made during the implementation of new SYAMs.

4. Conclusions and Perspectives

4.1. Contributions to SYAM

SYAMs, since their beginnings, have been strong in societal maturity, i.e., very strong human relationships, which is their reason for being. However, the field observations we have made show paradoxically that they are weak on the operational levels, which are nevertheless fundamental to the survival of a SYAM. This observation justified our approach. By articulating knowledge from the field of research and that of practical action, we have produced new knowledge about the trajectory and organization of food systems to accompany them towards greater sustainability. We have also implemented a continuous improvement process for SYAMs via our ontological approach.

All the deliverables presented in this article are available on the following websites:
https://www.psdr-ra.fr/BOITE-A-OUTILS/Systemes-alimentaires-du-milieu and

https://blog.isara.fr/les-outils-innovants-des-syam/.

These supports are already being widely used by the actors and the Chambers of Agriculture of the AURA REGION. Other Chambers of Agriculture, notably in the Jura, have also shown a keen interest. Today, at the request of the CRAAURA, a training program will be deployed for project leaders accompanying the development of sustainable food systems in their territory. These tools are also of interest to those in charge of territorial food projects who wish, with these tools, to find solutions to reinforce local distribution channels.

4.2. Methodological Contributions

The problem we have tackled is particularly complex and is distinguished by the number and different natures of the actors involved and their interactions, by the extent and the nature of the performance indicators required to evaluate each actor and the system. To a lesser extent, this is a new field with very specific practices with a whole vocabulary, unknown to us in the engineering world. It should also be noted that we had a duty of education/simplification towards the actors involved. It was clear from this observation that existing modeling initiatives would be put to a tough test. Inspired by these existing practices, we proposed a new approach for the modeling and exploitation of knowledge:

- A new approach through its formal and operational ontological level.
- Implementation of a modeling approach.
  1) Actors/actions
  2) Generic models
  3) Resilience conditions
  4) Performance indicators
- Innovation and continuous improvement mechanism: a new SYAM increases the catalog and can therefore bring ideas to other actors, including actors who already have their own SYAM. A new example can bring new theoretical knowledge and thus enrich the metamodel. The actors involved in supporting the operators of such a system have a key role to play in the capitalization and valorization of this catalog.
- Continuous improvement for each indicator or recommendation that we have highlighted: diagnosis via performance indicators, reaction, and implementation of new actions since the actors and their roles have been identified, all with the global vision that the requirements diagram allows.
- Highlighting that the levels of logistics maturity proposed by (Paché & Spalanzani, 2007) were not necessarily incremental in a chronological manner. In doing so, it was necessary to ensure the presence of the fundamentals to guarantee the support of the level of societal maturity to which many organizations are driven by their ideal aspire.

4.3. Assessment, Limitations, and Future Work

Our scientific hypothesis, which was to draw inspiration from the methodologies of Industrial Engineering and Systems Engineering to propose a new methodological framework for the design, organization, and management of local agri-food systems, is thus validated.

Proximity food systems are very complex systems, especially because there are many non-formalized human interactions. Our modeling cannot therefore take everything into account. We just hope that the essential has been modeled and that this formalization approach will show the decision makers of these systems the interest of asking the right questions. In this sense, our approach will be able to help them because what we have proposed is evolutionary in the sense that each improvement will be integrated in the catalog of examples and in the knowledge model.

We see two areas for further work. The first is to refine our modeling of local food systems by enriching the different models as we carry out different studies. The most abstract contribution is in fact a methodology of discovery and exploration of a new world: finding significant examples and making them into a reference model, synthesizing this catalog of examples into a knowledge model and then building our own systems. The second axis of our work will be to use and refine this methodology to use it in other fields. We have also launched a research action in this sense in the Building Information Modeling.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

Barret, D., Blundo Canto, G., Faure, G., Hainzelin, E., Monier, C., & Triomphe, B. (2018). Impress ex ante: Une proposition de démarche pour construire ex ante les chemins de l'impact. *Montpellier*, *CIRAD*, 62 p. https://doi.org/10.19182/agritrop/00010

Belaid, M. S., Brulard, N., & Cung, V. D. (2017). Assessing and Analyzing Added Value on Middle Food Supply Chain Systems Using Value-Stream Mapping Tool—A Case Study in France. In *EFITA 2017: 11th Conference on Information Technology in Agriculture, Food and the Environment*.

Bézivin, J., & Gerbe, O. (2001). Towards a Precise Definition of the OMG/MDA Framework. In *Proceedings 16th Annual International Conference on Automated Software Engineering* (pp. 273-280). IEEE Computer Society. https://doi.org/10.1109/ASE.2001.989813

Bézivin, J., (2005). On the Unification Power of Models. *Software and Systems Modeling, 4,* 171-188.

Blundo-Canto, G., Triomphe, B., Faure, G., Barret, D., de Romemont, A., & Hainzelin, E., (2019). Building a Culture of Impact in an International Agricultural Research Organization: Process and Reflective Learning. *Research Evaluation, 28,* 136-144. https://doi.org/10.1093/reseval/rvy033

Chazoule, C., Désolé, M., Le velly, R., Fournier, S., Gombault, T., Lequay, P., Quenard, A., Rougeot, A., & Bardelli, J. (2020a). *Comprendre les SyAM et le rôle de ceux qui les portent. Fiches cas et analyse*, projet PSDR SyAM, ISARA, https://blog.isara.fr/les-outils-innovants-des-syam/

Chazoule, C., Lafosse, G., Brulard, N., & Crosnier, M. (2019). Produire et échanger dans le cadre de systèmes alimentaires du milieu: des incertitudes aux partenariats. *Pour*, *No. 234-235,* 143-150. https://doi.org/10.3917/pour.234.0143

Chazoule, C., Joyet, L., Brulard, N., Désolé, M., Devise, O., Fournier, S., Le Velly, R., Molegnana, F., Paris, J.L., Pegon, J., Tabaï S., & Trognon, L. (2020b). *SYAM*, *des outils pour développer la durabilité des systèmes alimentaires*. Projet PSDR4 SYAM.

Déméter (2009). http://www.club-demeter.fr

Di Vaio, A., Boccia, F., Landriani, L., & Palladino, R. (2020). Artificial Intelligence in the Agri-Food System: Rethinking Sustainable Business Models in the COVID-19 Scenario. *Sustainability, 12,* Article No. 4851. https://doi.org/10.3390/su12124851

Dospinescu, O., & Dospinescu, N. (2018). The Use of Information Technology toward the Ethics of Food Safety. *ecoforum, 7,* 70-81.

Efficience Customer Response (2008). https://www.ecr-community.org/

EFQM (2009). http://www.efqm.org

El Haouzi, H., Thomas, A., & Pétin, J. F. (2008) Contribution to Reusability and Modularity of Manufacturing Systems Simulation Models: Application to Distributed Control Simulation within DFT Context. *International Journal Production Economics, 112,* 48-61. https://doi.org/10.1016/j.ijpe.2006.12.067

Esnouf, C., Russel, M., & Bricas, N. (2011). *Pour une alimentation durable*. Réflexion stratégique duALIne, édition Quae.

Estampe, D., Lamouri, S., Paris, J. L., & Brahim-Djelloul, S. (2010). A Framework for Analysing Supply Chain Performance Evaluation Models. *International Journal of Production Economics, 142,* 247-258.

Faure, G., Barret, D., Blundo-Canto, G., Dabat, M. H., Devaux-Spatarakis, A., Le Guerroué, J. L., Marquié, C., Mathé, S., Temple, L., Toillier, A., Triomphe, B., & Hainzelin, E. (2018). How Different Agricultural Research Models Contribute to Impacts: Evidence from 13 Case Studies in Developing Countries. *Agricultural Systems, 165,* 128-136. https://doi.org/10.1016/j.agsy.2018.06.002

Fèche, R., Noûs, C., & Barataud, F. (2021). Building a Transformative Initiative for a Territorialized Agri-Food System: Constructing a Living-Lab and Confronting Norms? A Case Study from Mirecourt (Vosges, France). *Journal of Rural Studies, 88,* 400-409. https://doi.org/10.1016/j.jrurstud.2021.07.026

Global Scorecard (2008). https://gms.unocha.org/content/global-scoring

Grady, J. O. (2014). Chapter 7. Specification Content Standards. In Elsevier, *System Requirements Analysis* (pp. 557-636). Elsevier. https://doi.org/10.1016/B978-0-12-417107-7.00007-5

Harun, S. N., Hanafia, M. M., & Aziz, N. I. H. A. (2021) An LCA-Based Environmental Performance of Rice Production for Developing a Sustainable Agri-Food System in Malaysia. *Environmental Management*, 67, 146-161.

Kaplan, R.S., Norton, D.P., (1996) *The Balanced Scorecard: Translating Strategy into Action*. Harvard Business School Press.

Kleppe, A. G., Warmer, J., & Bast, W. (2003). *MDA Explained: The Model Driven Architecture: Practice and Promise.* Addison-Wesley Longman Publishing Co., Inc.

Le Velly, R. (2017). Dynamiques des systèmes alimentaires alternatives. In P. Lubello et al. (Eds.), *Systèmes agroalimentaires en transition* (pp. 149-158). Editions Quæ Update Sciences & Technologies.

Lidon, B., Lopez, J. M., Sosiawan, H., Kartiwa, B., Triomphe, B., Jamin, J. Y., Farolfi, S., Bourgeois, R., & Becu, N. (2018). Approach and Impact of a Participatory Process for the Reorganization of Irrigation Management: A Case study in Indonesia. *Cahiers Agricultures, 27,* Article No. 25006. https://doi.org/10.1051/cagri/2018015

Muscio, A., & Sisto, R. (2020). Are Agri-Food Systems Really Switching to a Circular Economy Model? Implications for European Research and Innovation Policy. *Sustainability, 12,* Article No. 5554. https://doi.org/10.3390/su12145554

Naumenko, A., & Wegmann, A. (2003). Two Approaches in System Modeling and Their Illustrations with MDA and RM-ODP. In *the 5th International Conference on Enterprise Information Systems* (pp. 398-402).

Paché, G., & Spalanzani, A. (2007) *La gestion des chaînes logistiques multiacteurs—Perspectives stratégiques*. Presses Universitaires de Grenoble (PUG).

Tsolakis, N. K., Keramydas, A. C., Toka, A. K, Aidonis, D. A., & Iakovou, E. Y. (2014). Agrifood Supply Chain Management: A Comprehensive Hierarchical Decision-Making Framework and a Critical Taxonomy. *Biosystems Engineering, 120,* 47-64. https://doi.org/10.1016/j.biosystemseng.2013.10.014

Weilkiens, T. (2008). *Systems Engineering with SysML/UML: Modeling, Analysis, Design*. Morgan Kaufmann/The OMG Press. https://doi.org/10.1016/B978-0-12-374274-2.X0001-6