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Transitioning Design-Orienting Scenarios for Food Systems: A Design Contribution to Explore Sustainable Solutions and Steer Action

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Abstract: This article explores how design, as a disciplinary field, can play a role in conceiving and supporting transition strategies within complex food systems where multiple actors are involved and sustainability is a priority. The work builds on the methodology of Design-Orienting Scenarios (DOS), which are future-oriented narratives motivated, illustrated, and visualized through specific solutions. DOS are applied here to contribute to the ongoing transformation of the Milano Food System, which is at the intersection of dynamics influencing the activities of its various 'nodes'—pivotal points in the supply chain. A specific scenario is then co-designed with relevant actors, combining two influencing factors: governance and sustainability strategy. The aim of this scenario is to highlight areas of multi-actor collaboration and spark transformative projects while also defining roles, values, and capabilities. This article further introduces the evolution of DOS into Transitioning Design-Orienting Scenarios (T-DOS), designed to facilitate outcome-oriented transitions. Characterized by a multi-actor and relational perspective, T-DOS engage stakeholders through a structured process, leveraging local challenges, resources, and actors to ensure the relevance and applicability of practical futures. The T-DOS methodology is finally discussed as a tool to guide systemic design-oriented conversations within the food system and, more broadly, within complex systems.

Keywords: food system; design-orienting scenario; service design; alternative food networks; codesign; transition; sustainability

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1. Introduction: Tackling the Complexity of Food Systems

Where to start in making a food system more sustainable?

A radical transformation of food systems is claimed by several entities to be an indispensable step toward sustainability to achieve Agenda 2030 [1–4]. General policies that acknowledge the interconnectedness of different systems, prioritize synergistic collaboration over conflict, and implement strategies that address the intersections of various Sustainable Development Goals, as well as the impact of food systems on climate and natural resources, are considered to be essential for any effective action. At the same time, context-specific policy solutions tailored to address diverse challenges are recognized as being crucial.

Without claiming to solve such a complex issue with a single tool or perspective, this article presents a contribution from the discipline of design and discusses it in relation to a specific local food system.

1.1. Local Food Systems: A Perspective to a Problem and Related Opportunities

A food system is the combination of activities, actors, and elements involved in the production, processing, transport, and consumption of food within a given context, and the output of these activities, including socio-economic and environmental outcomes [5]. It

is well known that the sustainability of (food) systems depends on several interconnected issues and requires, indeed, a systemic approach for highly complex situations [6–8].

Several intertwined trends, in fact, affect food systems and their outcomes, such as the following: climate change and resource degradation, agricultural and data-driven technologies, market expansion or disruption, concentration in supply chains, changing demand, limited access to resources for small-scale producers, increasing inequality and poverty, population change, and urbanization. Together, these trends drive food system transformations.

So, as are all systems, food systems are complex and adaptive. Complexity means that system's components are interdependent and that the interactions between them are dynamic. Adaptivity means that systems change behavior in response to their environment, but the behavior of the whole may not be predictable according to the behavior of its components.

In the effort to make any system more sustainable, these two characteristics lead to uncertainty in decision-making. Hence, "rehearsing plausible options" for the future [9] might be more meaningful and accurate than attempting to generate precision results with early and uncertain data. For these kinds of "wicked problems" (namely, issues that are ill-formulated, confusingly intertwined within systems, and are subject to conflicting interests and indeterminacy), design, as a discipline, aims to be an *integrative* factor. That is, to quote a well-known essay by Buchanan, a discipline that explores the relationships between "signs, things, actions and thoughts" [10] and that moves forward through experimental problem-solving, where knowledge emerges as a step-by-step interaction among players.

Design, thus, addresses food systems through an integrative and relational approach that begins with interpreting ongoing situations, aims at sense-making, and ends up with solutions. The inspiration may come from what is observed in the present, is guided by values and aspirations, and leads to generating visions for the future [11–13]. Assuming that tomorrow will result from what we produce starting now, designers start imagining the future by selecting and giving coherence to the present signals considered to be most favorable. Then, they define an image of the world as it would be "if" possible futures were realized, even when this seems to be a leap from fragile foundations. This design practice is called scenario building, where scenarios are 'rehearsing spaces' to "highlight central elements of possible futures and draw attention to important key aspects that will affect future developments" [9] (p. 2145).

1.2. Research Hypothesis and Objectives

The research presented in this article, coordinated by the Polimi DESIS Lab of the Design Department of Politecnico di Milano in collaboration with scholars from other departments and disciplines (Involved universities: OnFoods' project SCIN_GO (Scientific Innovation, Technology and Sustainability: Governance and Regulation) Università degli Studi di Milano, Università di Pisa, Università di Catania, Università degli Studi di Parma; On Foods' project FAI_FRU (Fair and efficient wholesale market for improving fruit and vegetable consumption) Università di Catania, Università degli Studi di Parma. In such projects, Politecnico di Milano in involved through the Departments of Design and the Department of Management, Economics and Industrial Engineering), aims to investigate, through scenarios, the possible evolutions of the food system of the City of Milano in Italy, toward environmental, social, and economic sustainability. For doing so, it highlights and discusses areas of opportunity for innovation and collaboration between the different stakeholders, and co-designs, orients, and supports a transitioning strategy of some specific actors. The research operates within the framework of a national research program titled titled "OnFoods—Taking Action on Food Systems, Focused on Sustainability, Working on Safety, Security and Health" and, in particular, its sub-focus on "Scientific Innovation, Technology and Sustainability: Governance and Regulation".

The research group has an extensive track record of projects on sustainable food systems and food services, applying strategic and service design methodologies to the

field of food. The project Nutrire Milano (Feeding Milan), which ran from 2009 to 2015 in collaboration with Slow Food Italia and the University of Gastronomic Sciences, was a pioneering experience in applying design to the field of food [14]. Design thinking was employed to envision a future where short food supply chains could become effective alternatives to the conventional industrial system in Milan. An ambitious narrative of the future was co-created with key stakeholders, connecting people and places of local food production in an urban and peri-urban vision. Accordingly, several specific food chains were considered, and various stakeholders, including citizens, were engaged to co-design and experiment with new, interconnected services. These services were then prototyped and tested over time. Some of them became established, such as a farmers' market (named 'Earth Market'), which has since expanded and grown.

The experience of this project generated significant momentum in designing for the food system, producing various outcomes. More recently, adopting the same systemic approach, an applied project focused on the redistribution of surplus food for charity, while also providing real support to local groceries and harnessing the potential of neighborhood solidarity (www.sospesanolo.it).

The methodology of designing specific interconnected solutions within a vision that embraces the whole system has various roots. One of them traces back to Gregory Bateson, who, in his seminal work on ecology and evolution [15], interprets innovation as something that can only emerge from "chaos". He claims that, since evolution is the learning of a species and a perpetual innovation based on trial and error, what matters is the power of an idea and its potential to work, not its current numerical relevance. Therefore, a small accidental fact emerging from chaos can create a discontinuity and become, if it fits into a particular environment, the driver of the system's evolution. In other words, no matter how few people are doing something today, if it is made appealing and feasible, it can shape the future. He also argues that the minimum unit of survival in evolution is never simply an individual organism or species, but always species-plus-environment.

This research is based on two hypotheses that stem from Bateson's studies:

- The first one is that seizing weak yet promising signals of sustainable ways of producing, processing, or consuming food (namely, the Alternative Food Networks—AFN), and elaborating on them can be a way to shape the future, if properly designed.
- The second one is that players' efforts to innovate can be driven not only by selfish reasons, but also by understanding that favoring the system's interests can strategically benefit their own ones.

Strategic designers are in the position of facilitating this evolutionary learning by building scenarios that activate conversations among the system's players and with wider society [11,16,17].

These hypotheses lay the basis of a method and a process to build a contextualized scenario for the transition of the Milanese food system to a more sustainable future and to develop a vision that emphasizes the relationships between the actors of the system in view of a common interest.

1.3. A Need for Change in a Food System

The work on the scenario comes at a time when the Milano food system has expressed a need for change within a broader framework of policy transformations. It must be noted that the city has a Food Policy and a Food Policy Pact since 2015, when the mayor launched an international protocol aimed at tackling food-related issues at the urban level, to be adopted by as many world cities as possible. The Pact was signed during the Milan international EXPO 2015 by more than 100 cities (https://www.milanurbanfoodpolicypact.org/). It is a working tool to implement sustainable food policies, and has brought in to implement a specific food policy for the city of Milano, too. After a decade, this policy has brought several projects and pilot actions involving different public and private actors across the city (https://www.milanurbanfoodpolicypact.org/mufpp-projects/, accessed on 25 October 2024).

Recently, two transformation trajectories under the umbrella of the food policy have been affecting the entire system and involve some of its main actors: the wholesale market and the network of neighborhood food waste hubs, an infrastructure established in 2019 to combat food waste by redistributing surplus food.

The wholesale market of the city is undergoing a radical and extensive renovation to update its spatial and technological infrastructures, accommodate the municipal school's catering kitchen, modernize logistics, optimize circular processes for surplus food recovery and redistribution, and create space for food labs and training initiatives (https://www.sogemispa.it/progetto_foody_2025, accessed on 25 October 2024). These transformations do not happen in isolation and have an impact on the entire ecosystem. Additionally, the wholesale market company is gradually taking on the responsibility of managing the network of indoor neighborhood markets on behalf of the Municipality. The new responsibility represents a significant challenge for the company, requiring not only a vision for the consumer markets, but also new organizational competencies.

The food waste hubs, following the successful proof of concept demonstrating their effectiveness in reducing food waste and redistributing it to the most vulnerable populations, are now in the process of consolidation, evolution, and expansion [18]. To this end, the Municipality initiated an extensive co-design and co-planning process with key stakeholders, not only to optimize processes and logistics, but also to better integrate the hubs into the neighborhoods, train managing actors, and complement food aid with social policies to avoid the risk of welfare dependency. Ultimately, one goal is also to achieve medium- to long-term economic sustainability. This evolution is envisioned as being closely connected to other actors in the system, namely neighborhood indoor and street markets, large-scale retail distribution, and the wholesale market.

These two strategies are, per se, drivers for the actors to engage in a systemic process of rethinking their activities within a shared vision for the future. The work presented in this article is situated within this context.

2. Background: Scenarios and Design-Orienting Scenarios

In all fields, scenarios are conjectural artifacts widely used to think about the future evolution of some hypothetical situation, the alternatives to it, and the process to get there [19]. They may take different forms of narrative description of a possible state of development over time [20,21], often integrated with visual elements and other supporting information. They are aimed at stimulating and framing some strategic conversation on the future, elicit feedback, and stimulate imagination by involving different parties, considering different perspectives, connecting different issues, and several variables [22,23]. The literature on scenarios is vast and falls under the umbrella of "future studies".

According to Börjeson et al. [23], scenarios can be broadly classified into three main typologies, each corresponding to different techniques, and offering different usefulness: explorative, predictive, and normative.

Explorative scenarios respond to the question "What can happen?", they explore what might happen in the future, regardless of beliefs or desires. They consider, from various perspectives, situations that could occur. These scenarios are typically organized in sets, that is, reasonable numbers of possibilities in the medium to long term. Then, they explicitly explore structural and deep transformations that may affect a target group, starting from a present situation. Thus, they allow for the exploration of the consequences of alternative developments.

Predictive scenarios respond to the typical question "What will happen (if. . .)?", where the response is conditional to a certain fact happening.

Normative scenarios respond to the question "How can a specific target be reached?" and take a target as a starting point to be, in fact, achieved.

Almost all these typologies might be both quantitative and qualitative; additionally, some of them might consider internal or external influencing factors, which are factors controllable (or not) by the actor(s) in question.

Scenario building, then, is a well-known method for engaging multiple and diverse stakeholders in commonly relevant projects and securing their commitment [24–26]. For instance, public administrations can engage social parties in scenario co-design to commit to new visions and converge social creativity and innovation.

When it comes to design, scenarios are intended as narrative and visual stories of the future, characterized by distinctive factors, forces, and values that shape alternative possible directions. Scenarios, thus, are qualitative and actionable tools to enable speculative or pragmatic thinking, aimed at identifying and exploring design opportunities. They are neither predictions nor forecasts, but explorations aimed at achieving some value. Therefore, scenarios are design proposals generated through abductive thinking [27] and result from so-called "productive reasoning" [28], which builds on observed characteristics, previous knowledge, and models. They are parts of wider creative processes that trigger design conversations about the future, and thus they are often based on a 'relational worldview' [8], namely, they shift focus from things and materials to relationships and structures within the considered contexts and systems.

Design-Orienting Scenarios (DOS) [11] are stories of the future that are motivated, illustrated, and visualized through specific solutions. Based on actionable opportunities organized in a consistent way, DOS can help to identify, define, and co-design transformative projects, while outlining roles, values, and capabilities of the different actors. Therefore, they are processes rather than fixed artifacts, and are collaborative processes. The nature of DOS is intrinsically explorative, yet they are processes often complemented by predictive parts linked to specific "what if questions", and integrated by normative parts, whose aim is to define specific targets to reach. The scenario described in this article is precisely a mixed typology in which the sequence of types responds to the reason why for the different parts in the process, oriented towards a sustainable transition of the system.

Regardless of the field of application, scenarios have meta-features—transversal common traits (sometimes referred to as 'aspects' or 'characteristics')—that can be used to describe them and are influenced by their typology. Based on an analysis of the literature and case studies, these meta-features can be summarized into ten points (Table 1) that provide a quick comparative overview of different scenarios. The methodology for identifying the meta-features of scenarios was based on a twofold approach involving a review of the literature and an analysis of case studies. The literature review spanned among three main disciplinary fields, futures studies, scenario building, and design research, with a focus on methodologies like Design-Orienting Scenarios, to identify recurring meta-features and the structural components of scenarios. These fields were chosen because they offer insights into a scenarios' role, short-, medium-, and long-term perspectives, and innovative approaches to scenario (co-)creation, particularly in contexts where human-centered and sustainability-oriented factors are key. This interdisciplinary approach ensured a broad understanding of the meta-features that consistently appear across different scenario typologies. Simultaneously, an extensive analysis of existing case studies was conducted, including projects developed by the authors' research group and a wide array of initiatives from the DESIS network (The Design for Social Innovation and Sustainability (DESIS) network consists of 68 DESIS Labs around the world: academics, researchers and students belonging to higher education institutions or universities in the field of design, who orient their design and research activities towards social innovation.), offering insights and validating the identified meta-features across various contexts.

The ten points presented in Table 1 lay the groundwork for comparing different scenarios, so as to help understand which types can effectively aid in a food system toward environmental and social sustainability.

As an expansion of the list of meta-features, the scenario's structure can be further detailed. However, the aforementioned cases allow the authors to find recurring elements in the way scenarios are structured and presented:

- The title and key words, which briefly explain the contents.
- The narrative, which provides a description of the contents.

- The trends, which refers to the macro/micro external or internal factors considered when building the scenario.
- The presence of pioneering solutions, seeds, or weak signals, which refer to cases and solutions existing in the present time that can be seen as anticipations of the scenario and/or their inspirations.
- The opportunities the scenario identifies for innovative solutions.
- The enablers, which might be factors, people, or organizations that may favor the scenario to happen.

Table 1. Scenario's meta-features as transversal common traits.

Scenario's Meta-Features	Explanation
Approach	The system's main structure, contemplating (or not) alternatives
Scale and scope	The extension and the reach of the scenario, including the focus on a systemic or a specific topic
Timeframe	Short (<10 years), medium (10–30 years), or long (30–50 years)
Actors involved	Who is involved in the generation, co-design, and development of the scenario
Actors targeted	The scenario's intended users and, therefore, the perspective that the scenario adopts
Reason why	The purpose and usefulness of the scenario for the target users
Method and process	The method used to gather data, generate ideas, elaborate them, and check them with contexts, people, and relevant factors
Focus on internal or external factors	What is within or beyond the control of the relevant actors
Structure	The way the scenario is organized to present contents clearly and effectively
Distinctive and original contents	The knowledge the scenario conveys and the message it intends to give; this feature is intrinsically connected to the previous one

The following paragraph presents an analysis and a comparison of two food system scenarios selected for their alignment with the mentioned design approach and systemic perspective. This comparison aims to highlight elements that underscore the distinctiveness of the designer's approach in creating food scenarios and their potential to drive system transformations. These elements are then used to present the DOS developed for the Milano food system, discuss similarities and differences, and describe the specific evolutions of DOS for transitioning towards sustainable futures.

3. Scenarios in and for the Food Systems

The two scenarios, "Preferable Future of Food" and the "MUSAE" project, were selected through a targeted research process focused on identifying food system scenarios where design played a pivotal role in shaping their development. A key criterion for selection was their emphasis on sustainability within food chains and systems, aligning with the broader goal of addressing pressing environmental and social challenges. An additional criterion was that they were developed in the recent period, following the COVID-19 pandemic, which introduced new challenges, exacerbated existing ones, and significantly influenced how we envision the future of food systems. Moreover, the two analyzed scenarios on the future of food have been selected because:

- Their value lays in the exploration of thought-provoking possible alternative directions, generated through an abductive design approach, with a clear involvement of design experts and methodologies and in using design tools;
- Their focus is on systems, thus understanding and addressing the complex interrelationships within a system rather than just individual components, focusing on how parts interact and influence each other. In the context of food systems, a systemic approach would aim at considering the entire food supply chain from production and distribution to consumption and waste management.

The selected scenarios are initially presented through their main characteristics and are then compared in terms of meta-features and structure.

3.1. Preferable Future of Food

The first selected scenario, named the "Preferable Future of Food" [29], was developed by SALLY–EY Doberman's future lab, in collaboration with Gullspång Re investment firm, to address pressing issues in the food system like sustainability, food security, and health. The initiative focuses on inspiring people in creating a more sustainable, localized, and community-oriented food system. Part of a bigger initiative by the future manifestation lab SALLY, it runs around creating positive change within the food industry by showing an emerging system that has yet to come to fruition and by manifesting "these preferable futures through the lens of digital products, services, and business models that could enable and accelerate key transformational shifts across business and society" [29].

Structured as a story from the future looking back in time to 2023 when the old, broken food system still was the main source of food, it introduces three primary shifts bringing into life preferable alternatives to the status:

- "One-hour food system" for localized food production proposes a shift from industrialized global supply to food circles, de-intermediating the relation with producers, enabling local food economies, increasing the access to fresh foods nutritionally matched to the individual, and valuing waste.
- "Community food revolution" boosts urban agriculture and social connections, adopting data-driven urban planning to reveal spaces and synergies for food production, and imagining a new ecosystem of tech-driven services and tools that allows everyone to produce food.
- "The impact plate" utilizes technology to promote health and environmental consciousness in food choices as AI-supported tools showing the true impact of food and integrating data to detect sustainable patterns and draft personalized services.

Each shift presents a series of concepts illustrating future products and services using the same narrative structure: a leap into the past to highlight unsustainable behaviors and processes, an explanation of the innovative solution, a series of enablers in the form of events, behavioral changes and technological advancements that have occurred to achieve this, and finally a set of existing case studies, named pioneers.

The scenarios are set in a near future that is not explicitly stated, nor is the region or place for which they are designed, although a European context seems the most plausible one. The target group is generically people working in the food system: farmers, entrepreneurs, academia, and businesspeople. This is in line with the purpose of the scenarios, which serve as a source of inspiration and as a manifestation of possible innovations that, if amplified, could generate the imagined change in an ideal food system with common and generic elements of unsustainability.

3.2. MUSAE Project

The second selected scenario is within the "MUSAE" (https://musae.starts.eu/) project (funded by S+T+ARTS initiative, European Commission, 2022–2025), part of the S+T+ARTS initiative, which envisions a future where digital and industrial technologies are ethically developed to enhance food systems and human well-being. This ongoing project, run by a consortium that includes Politecnico di Milano and other European institutions, adopts the Design Future Art-driven (DFA) method [30], an approach that combines elements of design, future thinking, and art to envision and explore possible future scenarios. This method leverages artistic creativity and design principles to create immersive, thought-provoking representations of the future and serves as a tool for artists and SMEs to stimulate the innovative and creative uptake of technologies in society.

The overall project is organized in two art-tech residency calls and a prototyping phase. The first phase involved 12 artists who produced 12 scenarios and corresponding artworks based on identified trends: (1) reducing the carbon footprint in dietary behavior,

(2) the role of food in holistic human well-being, and (3) rethinking the food chain in our environment. The second art-tech residency program will pair the artists with 12 SMEs to collaboratively develop concepts based on the previously created scenarios and on the use of one or more of these technologies: artificial intelligence, robotics, or wearables. Finally, the prototyping phase will focus on mentoring the teams to develop industrial prototypes of their concepts. During the first phase, artists went through a defined sequence of step that included a scenario building's training phase, a thematic and technological immersion to explore opportunities, trends, and potentialities, an ideation moment, and a series of mentoring and assessment meetings with the consortium partners.

The 12 scenarios cover a timeframe between 7 and 20 years from now (2030–2040), even though the content and esthetics of AI-generated visualizations and proposed solutions suggest a more distant future. Although the scenarios take the European context as the background scene, only a few of them identify a specific place, while the majority refer to a context depicted through its generalist features and unsustainable patterns. The focus is on emerging opportunities for companies (SMEs and startups, not only in the food system) in terms of available technologies and scientific advances that enable new solutions, interactions, and behaviors.

Each scenario includes a narrative, key words, images, opportunities for companies, emerging trends, and a set of ad hoc designed elements, such as artifacts, services, and personas, that contribute to defining the future landscape. Each one is also accompanied by a video that guides the viewer into the future and by an artwork, being physical or digital, that acts as a touchpoint for the scenario.

3.3. Comparison of the Scenarios

Table 2 presents a succinct comparison of the scenarios through their meta-features, making emerge commonalities and distinctive factors.

Looking at these scenarios, some common elements and peculiar features of the two projects can be noticed and provide an initial interpretation on how the diverse meta-features can orient and address the use of scenarios.

The first element is the exploratory character of both scenarios, which look to the future as a field of possibilities and opportunities to be seized, enabled by a series of mainly technological solutions that envision a change towards a more sustainable system. In the case of the Preferable Future of Food (PFoF), the imagined future is made available by the integration or adoption of technologies that are already present or rapidly spreading and act mainly as a response to unsustainable patterns, behaviors, or external events that took place in the past (in 2022). Conversely, looking at the MUSAE project, the technology is much more pervasive and outlines the features of both the scenarios and the opportunities presented to companies. In addition, existing solutions and the adoption of such emerging technologies push the future much further ahead, while claiming a timeframe of 10 years. Each MUSAE scenario, in fact, while imagining a strong evolution on the technological side, represents this shift in images and artworks generated using AI, thus reproducing contexts, tools, and spaces that appear far from the present time, even esthetically. Conversely, the PFoF project presents touchpoints and solutions (in the form of outlined apps, websites, services, and stories) whose esthetic and design sound familiar and immediately available. This aligns with the inspirational goal of the scenario that aims at "manifesting" change as an initial spark of a possible strategic conversation.

Another common trait is that both projects chose not to specify a particular geographical context. Indeed, both scenarios are not situated and lack detailed elements that might include specific actors, resources, and regulations or cultural norms at play. On one hand, this abstraction allows for the themes to be broadly relevant to a wide range of stakeholders within a hypothetical food system. On the other hand, it places the effort on the potential stakeholders themselves to adapt the proposed content to their own specific contexts and system of relationships and to foresee a roadmap for the adoption of the solutions. An effort that, for the PFoF project, is initially supported by the link to existing pioneers,

which are selected case studies that exemplify a practical avenue for change, while, for the MUSAE project, the second and third phase will match artists and companies to explore relevant opportunities and interests and to develop prototypes within the chosen scenario, thus moving from a wider systemic scope to a more focused one, related to the selected company and context.

Table 2. Comparison of the two scenarios throughout their meta-features and structure.

Scenarios' Meta-Features	The Preferable Future of Food	MUSAE Scenarios
Approach	Structured in three key transformational shifts across business and society that could accelerate change towards a more sustainable food system. The shifts thoroughly inform different elements of each vision.	Three thematic areas and three technologies guiding the scenario generation in the shape of twelve alternative futures. Each scenario is independently developed by an artist, focused mostly on a specific technology, a specific topic, and solution.
Scale and scope	Regional scale. Systemic scope: outline of a whole system in its general elements + illustrative solutions.	Local and regional scale. Transversal scope: combination of technological systems and food systems for a main topic + illustrative solutions.
Timeframe	Short (<10 years).	A claimed timeframe of 10 years (short), but solutions and visualization target a medium/long timeframe.
Actors involved	Design experts. Experts in different fields.	Artists. Design experts for scenario methodology. Supported by generative AI.
Actors targeted	People operating in the food system: farmers, entrepreneurs, academia, and businesspeople.	Small–medium enterprises and startups.
Reason why	Manifesting and showing an emerging system to inspire and accelerate change.	Presenting new forms of transdisciplinary collaboration aimed at helping SMEs and startups explore future technology applications of TRL5, through artistic practice.
Method and process	Speculative design. Developed by the design agency Sally leveraging on internal data. No evidence of co-design actions.	DFA method (Design Futures + Art): training on scenario building, thematic immersion, ideation, mentoring and assessment with consortium partners, scenario showcase.
Focus on internal or external factors	Internal and external factors.	Internal factors to each scenario. External factors are mainly embedded in thematic areas, common to more than one scenario.
Structure	Three shifts, each one with three or four concepts as illustrative solutions, related enablers and selected pioneers among existing solutions.	Twelve alternatives, expressed with a narrative and video, emerging opportunities (specific technologies, contexts of application, industries), embedded trends, and distinctive elements (artifacts, objects, personas) that outline solutions.
Title and key words	A general title and three evocative subtitles for each shift.	A title and a set of keywords for each scenario.
Narrative	Flashback to 2023 as a corrupt system and flashforward to today's sustainable (future).	Flashforward to 10/20 years describing a future context and related solutions. Complemented by a video.
Trends, which refers to the macro/micro external or internal factors considered in building the scenario	Technological and digital solution (AI, 3D printing, matching and trading platforms, APIs, precision technologies, and more) became mainstream and available.	Three thematic areas considered as emerging trends to be coupled with technologies (AI, robotics, wearables). An additional series of topic related and micro trends have been added by artists in each scenario.
Presence of pioneering solutions, seeds or weak signals	A set of three or four examples of pioneering solutions for each concept and shift.	Existing case studies related to technologies and solutions are included in each scenario and often made explicit in the narrative.
Opportunities the scenario identifies for innovative solutions	Elaborated in the form of concepts.	Elaborated in form of potential innovation opportunities and strategic development for companies mainly in tech or food sectors.
Enablers, which might be factors, people or organizations that may favor the scenario to happen	Enablers emerged in the past (2022/23) as technological and digital advancements, but also policies and norms, behavioral changes, products, and services.	Enablers as digital and technological solutions, expressed within the written and video narrative.
Distinctive features of the scenario that make it original and thought-provoking	The connection with available and almost known digital tools and technologies encourages an immediate action and identification within the future situation.	The combination of art and advanced technologies in the development of future scenarios generates futuristic visions. Visualizations, artifacts, and artworks are presented in a suggestive manner.

4. The Design-Orienting Scenario (DOS) for the Milano Food System

As discussed, scenarios can facilitate open conversations about visions and solutions among system's actors. One goal of the OnFoods is to specifically use scenarios to catalyze strategic conversations among local actors and to investigate emerging collaborative actions for further designs and prototypes.

In the following paragraphs, a DOS for the Milano food system is presented; named "Milano Sustainable Food System Scenario", it is described through the same meta-features of the comparative scenarios, highlighting its distinctive contents.

4.1. The Milano Sustainable Food System Scenario

Approach. The overall approach adopted to generate the scenario emphasizes a systemic view, connecting individual actors' perspectives with the broader context. This approach integrates various scales, from individuals, local communities, and stakeholders to broader systemic impacts and trends. Likewise, it also considers different possible strategies toward sustainability at the city and regional scale so that the totality of services it considers can be seen as a food service masterplan [24] for the city. By doing so, the scenario aims to reflect on the interdependence and complexity of food systems, acknowledging how local actions and decisions can influence and be influenced by larger socio-economic, environmental, and technological forces. This perspective, which has generated four alternative directions, helps to identify leverage points for achieving systemic impacts and recognize cause-and-effect linkages that influence different parts of the system.

Scale and the scope. The scenario is contextualized within the Milanese food system, embracing both urban and peri-urban scales. For the main relevant stakeholders, it analyzes challenges and barriers, as well as relationships, interdependencies, and potential converging interests. In so doing, it outlines collaborative, integrative, and inclusive solutions.

At the micro level, the focus is on local practices, community engagement, and behavior changes. At the macro level, the emphasis is on policy frameworks, national and international trends, and global environmental changes. At the meso level, the focus is on the actors and organizations populating the local food system and on their system of relationships. By integrating these perspectives, the scenario offers insights into how local actions can align with and support broader goals, such as sustainability, resilience, and social equity. This integration highlights the importance of multi-level governance and the need for coordinated efforts across different scales.

Timeframe. The scenario envisions Milan in 2035. A 10-year timeframe allows for innovative ideas while maintaining a connection with the present time. This timeframe also aligns with local strategies and policies on climate neutrality, mobility, and participative processes outlined by the municipality.

Actors involved. The scenario has been generated by design experts in collaboration with experts in various other fields and disciplines from to the authors' institution.

Actors targeted. The targeted actors are local stakeholders, identified as 'nodes' of the food system. A node is a pivotal point in the food supply chain (a combination of spatial, digital, physical, and human elements) where significant activities and interactions related to food production, transformation, distribution, and consumption occur [31]. Some nodes in the scenario are part of Alternative Food Networks—AFNs—whereas others are conventional actors of the industrial food system. Examples of the nodes are as follows: the wholesale market, indoor and outdoor markets, farmers' markets, and food waste neighborhood hubs [32].

Reason why. The scenario aims to steer and inspire the food system's nodes in transitioning to a more sustainable, fair, accessible, and healthy food system by identifying priorities and solutions in terms of integrative and collaborative product service systems, governance models, and related roadmaps.

Method and process. The scenario's method and process can be summarized in three macro-phases: (1) the scenario generation—explorative; (2) the scenario development—predictive; (3) the scenario prototyping—normative.

1. Phase 1. The scenario-generation phase is explorative, abductive, and diverging, and is comprised five main steps:
    - Context analysis: Through desk and field research, interviews, internal problem-framing workshops, and a series of local case studies, the output was a Milanese Food System Map describing the relevant nodes in the food sector and a series of challenges for each of the node.
    - Desk research around trends, drivers, and policies related to the challenges and critical topics emerging from the previous phase related to both the food sector and to sustainable practices (as punctual solutions) and domains.
    - Generation of the DOS, with the method of the 2 × 2 matrix, through the identification of polarities and the generation of four alternative directions.
    - Validation and refinement of the scenarios with researchers from OnFoods and disciplinary experts, collection of local case studies, ongoing projects or initiatives, and gatekeepers and unusual actors to be involved in the scenarios.
    - Design of a series of draft service concepts that populate each alternative direction as future solutions to be delivered by and with actors involved in codesign sessions. Each concept emerged by combining an alternative direction with the nodes and the food chain steps (from production to waste management).

This initial generative phase brought about the definition of the full set of four alternatives as possible directions of transformation and their articulation in illustrative solutions.

2. Phase 2. Then, the scenario moved into development, becoming the focus of strategic conversations and co-design workshops with the actors of the relevant nodes, such as the wholesale market and the network of the food waste neighborhood hubs. This following phase is a predictive one, that is, a progressively converging process in which design experts started to discuss alternative directions with stakeholders and policymakers. To do this, designers used the "what if" method that questions participants, and thus local actors, on what might happen on the condition of "some specified near future events of great importance for future development" [23]. This article presents the development of the scenario up to this phase, which is key to create, or not, the basis for the progressive transformation of the food system, since it works on the opportunities for the engagement and collaboration of the stakeholders. As an output, solutions are developed in-depth with service design methods and tools, while the scenario is re-oriented or refined. This development is aimed at growing awareness in actors of the possible future transformations of their activities and of the entire system around them.
3. Phase 3. The final phase is planned as a progressive convergence towards the implementation of some solution that makes use of roadmaps and pre-prototyping activities, which are draft and partial field-tests of the solutions, involving stakeholders, users, and policymakers. This phase is a normative one that investigates how to reach the targets set in the scenario by adjusting or transforming the current situation. Therefore, the focus of interest is on the expected future situations and how these could be realized.

Focus on Internal or External Factors. The external factors are common to the four alternatives of the scenario and have been embedded in the chosen polarities, deriving from policy frameworks, national and international trends, driving forces, and global environmental changes.

The internal factors relate to the characteristics of the individual actors and existing collaborations and emerge from the analysis of the context and node. They mostly refer to resources, competences, relationships, and technology available to each actor.

Both internal and external factors were identified in close alignment with the actual conditions and constraints local actors are or will be facing. This decision was made to anticipate their potential dilemmas.

Structure. The structure of the Design-Orienting Scenario is organized around a 2 × 2 matrix (Figure 1), which defines four quadrants to be considered as four alternative futures for the Milano Food System.

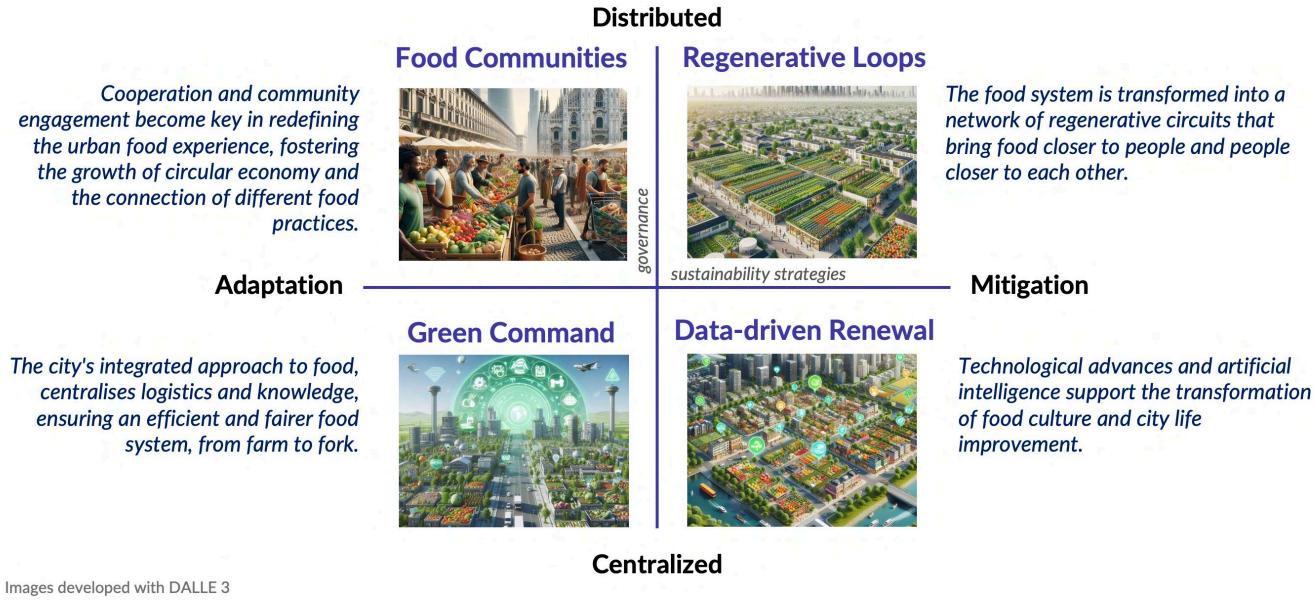

Figure 1. DOS for the Milanese Food System. The 2 × 2 matrix and related polarities define four alternative quadrants described through a title, a visualization, and a short narrative.

The first axis refers to governance structures, focusing on the distribution of power and decision-making processes, thus reflecting mainly an internal factor or strategy. This leads to two polarities:

- Centralized governance, where power and the management of infrastructures and technologies are concentrated in a single point or a limited group. This can lead to more uniform policies and regulations, potentially enabling the swift implementation of strategies and ensuring compliance across a broader area. However, it can also result in a lack of local adaptability and responsiveness to specific community needs, and often leads to top-down approaches.
- Distributed governance, spreading decision-making authority and control across various levels/units within the system or node. This structure encourages autonomy and decision-making, often leading to more flexible and responsive operations. It empowers local actors to take ownership of food system initiatives and supports tailored solutions that are more responsive to local contexts and needs, but may face challenges in the coordination and consistency of policy implementation.

The second axis focuses on societal and institutional approaches to environmental issues, thus considering a combination of external factors/policies and internal strategies, therefore distinguishing between the following:

- Adaptation strategies that address the effects of phenomena and focus on enhancing resilience and reducing vulnerability by adjusting existing systems to the impacts of climate change;
- Mitigation strategies that tackle their root causes, preventing effects and exploring regenerative practices, thus necessitating a more comprehensive and systemic change and a significant shift in production practices, consumption patterns, and technological innovations.

These alternative strategies might be regarded as macro trends that are likely to be progressively introduced by local and global policies to tackle climate change.

Accordingly, the scenario comprises four interconnected alternatives: the combination of the two axes generates four directions of "meaning", developed through abductive

reasoning from observed characteristics of the system, promising practices of Alternative Food Networks (AFNs), case studies, and previous knowledge.

Social sustainability was integrated into the scenario through inputs from selected regenerative practices of AFNs, which can be regarded as pioneering solutions proven to benefit both people and the environment [33–35]. As for the initial hypothesis, these AFNs are valued for their promising nature and inspiring capacity rather than for their actual diffusion.

Each alternative direction is described by a title, an AI generated evocative image, a narrative describing the future context, and a set of keywords. To make sure to emphasize the social and environmental sustainability qualities of the scenario, an additional set of design criteria was considered in the generation and development phases; these were connected to social innovation qualities and circular economy strategies, while technology was regarded as an enabler (Table 3) [35].

Table 3. Main description and elements of each alternative direction.

	Food Communities	**Regenerative Loops**	**Green Command**	**Data-Driven Renewal**
	Adaptation approach + Distributed governance	Mitigation approach + Distributed governance	Adaptation approach + Centralized governance	Mitigation approach + Centralized governance
Description of the alternative directions	Cooperation and community engagement are key for redefining the urban food experience, fostering the growth of circular economies and closing the loop in food practices	The food system transforms into a web of regenerative loops that bring food closer to people and people closer to each other; food-related practices are used to address urban challenges, aiding in city healing and revitalization	The city's integrated approach to food centralizes logistics and insights, ensuring a streamlined and fairer food system from farm to table	Technological advancements and AI transform the food culture and improve city living
Keywords	Bottom-up initiatives, neighborhood-scale, engaged citizens, low-tech, sharing	Production, care, capillarity and connection, specialization, future generations, 15 min city	Technology-driven, normative, monitoring and tracking, optimization	High-tech, prediction, anticipation, rapid response
Integration of the services between each other	High	High	High	High
Capacity building across the society	Medium	High	High	Medium
Collaboration among actors	Medium	High	Low	High
Engagement and self-organization of actors	High	High	Low	Medium
Technology integrated in the solutions	Low	Low	High	High
Relevant nodes	Farmers market, food waste hubs, indoor markets	Farmers market, indoor markets, food waste hubs	Wholesale market, farmers	Wholesale market, farmers, food waste hubs

For each node of the food system, an evolved role is drafted, describing its transformation in terms of purpose, activities, and relationships enabled by the scenario. Accordingly, and considering the relationships with the other actors, opportunity areas and connected possible solutions are drafted to explore how the scenario translates into viable solutions that match identified nodes and food chain steps (from production to redistribution, transformation, consumption, waste management, education and training).

The distinctiveness of this scenario lies in the balance between the leap ahead in the sustainable qualities of the proposed innovative solutions and their adherence to the local context and actors. The tension between these features makes the scenario perceived as not

too far from being achievable via a proper strategy. This perception is, then, leveraged to engage stakeholders in a conversation about their future.

5. The Co-Design of the DOS with Stakeholders, and Its Outputs

The Milano Sustainable Food System Scenario was conceived as an envisioning tool, an "interaction platform", and a springboard for generating design-driven conversations with different food system actors through co-design workshops (Figure 2). These conversations, on the one side, helped to identify opportunities and enablers for enhancing food access and sustainability in the city from various perspectives; on the other hand, they acted as catalysts for envisioning potential solutions to be prototyped, thus highlighting possible evolutions of the Milanese food system.

Figure 2. Co-design sessions with local stakeholders.

The following paragraphs describe the outputs of these co-design conversations, conducted with some of the nodes of the local food system, namely the wholesale market and some food waste hubs, with their network of actors.

5.1. Emerging Directions of Possible Actions

During the co-design workshops conducted in separate sessions with different actors, the Milano Sustainable Food System Scenario was discussed through the following sequence of interactive activities: After a brief presentation of the scenario and its alternatives, participants were engaged to review and discuss the specific draft solutions, adding comments or brand new solutions. For each one, a "what if" reflection was carried out, figuring out how to adopt and make it. Additionally, for the most-relevant ones, the dialog was steered toward identifying the drivers that might enable the practice, the barriers that might hinder it, and its gatekeepers.

Each solution was then contextualized within the scenario, its external and internal factors, and thoroughly discussed moving forward and backward from the scenario to the challenges of the local food system and nodes. This allowed the authors to connect sustainability strategies, governance logics, and food-related opportunities for each actor of the network.

Although reviewing the co-design process around the Milano Sustainable Food System Scenario is beyond the scope of this article, it is worth introducing some elements of the debate. While, as expected, not all solutions were considered to be plausible by the actors, all of them raised an issue and provided the chance to discuss an opportunity that was not, or was seldom, considered in the past. Viability issues related to economic and organizational factors and social issues connected to the social purpose of the initiatives, besides the environmental one, were the foremost arguments that emerged. The former is tied to the

governance factors and business models of the different stakeholders. In addressing this, one goal was to avoid prioritizing a business-as-usual logic in favor of more evolutionary perspectives, emphasizing future inevitable constraints and opportunities from a systemic viewpoint before engaging in a specific business model design. The latter relates to the principles of mitigation and adaptation used in the scenario, borrowed from the European framework strategy against climate change. Despite being aware of the limitations of these principles, which mainly concern environmental issues, researchers decided to adhere to them to comply with a broader and systemic logic, while also agreeing to embrace a more comprehensive approach that considers social and ecological aspects together.

For both arguments, co-designers converged on the need to embrace a wider perspective where different actors might collaborate and complement each other in carrying out their missions within a shared vision. This collaborative approach is seen as essential for the transition of the entire system toward more sustainable performance, as individual efforts alone can only have a smaller impact compared to the creation of a collaborative design infrastructure between the different nodes. Further co-design workshops are planned to extend the conversation to other actors of the local food system and to design a more comprehensive strategy for its sustainability. This will include the public administration and the local food policy team to converge on what might happen if common strategies were undertaken.

As an outcome of the co-design workshops with the stakeholders, the two strategic directions described below emerged.

5.1.1. A Widespread and Capillary System for Distributing and Selling Fresh Food

The first direction points to a widespread fresh food distribution and sales system that integrates and connects the wholesale market to the 21 indoor municipal markets scattered around the city, leveraging the forthcoming political strategy of shifting governance from a fragmented and uneven logic to a more centralized one.

This outlines an integrated, connected, and optimized system that sees the wholesale market organization (a public company) as the system's managing and enabling actor and the markets as a new, hybrid, proximity node that combines the following:

- Service functions: from sales to Business to Business—B2B—and Business to Consumer—B2C—transactions, shared distribution platforms, and catering, cultural, and social activities.
- Local governance and involved actors: producers, intermediaries, vendors, restaurateurs, associations, activists, and citizens.
- Social and environmental strategies: adaptation, mitigation, and regeneration.

This vision emerged in relation to the wholesale market, together with three priorities:

1. A service model for innovative, hybrid, and diffuse accessibility of fresh food integrated into the market's food system;
2. A collaborative micro-logistics platform for preventing and reducing emissions, and for improving the traceability of produce;
3. An exploration of hydro/aeroponic food production technologies for indoor markets and the wholesale market.

In a nutshell, this strategic direction is characterized by the following:

- Sustainability strategies: a transition from adaptive to mitigation strategies.
- Governance: a tension between a centralized system (the organization of a wholesale market) and a distributed one (the indoor municipal markets network).
- Addressed challenges: (i) sustainable intra-city transportation solutions for food recovery, distribution, and delivery to prevent and reduce food waste in all steps of the food chain; (ii) setup of a widespread and proximity B2C and B2B distribution system for fresh food, integrated with businesses and social, cultural, and welfare services; (iii) zero-mile production and distribution.

- Actors involved and targeted in co-design and co-production: the wholesale market, indoor markets, food producers, social delivery ventures, local food shops, local organizations, and citizens.

5.1.2. An Efficient System for Regenerating Food and People

The second direction points to a collaborative service to regenerate surplus food and to empower individuals and local communities. Its objective is to strengthen the collaboration between the system actors for the common purpose of recovering food, places, and people. Accordingly, stakeholders, businesses, and NGOs are called to innovate their service delivery and to develop solutions for the inclusion and integration of beneficiaries.

This strategy follows the principle that empowering beneficiaries, and, more generally, people, could be a way to mobilize them and take them out of a welfare-oriented service [36], therefore facilitating job placement and learning processes. Practically, this could happen involving the people assisted by a service in its co-design and co-production, as experimented in some virtuous AFNs [37].

Additionally, this direction aims to optimize the collection and redistribution processes within and between hubs, enabling the experimentation with new services, such as food processing and provision, and the use of shared platforms.

This vision emerged in relation to the food waste neighborhood hubs, together with three priorities:

1. An upskilling and training service for job inclusion, tailored to the food recovery and redistribution system;
2. A collaborative micro-logistics platform for improving the collection of surplus food;
3. A collaborative and co-produced service of food redistribution and sale (food cooperative).

In a nutshell, this strategic direction is characterized by the following:

- Sustainability strategies: A transition from adaptive to mitigation strategies.
- Governance logic: distributed.
- Addressed challenges: (i) Integration of food redistribution initiatives with relevant and complementary services, such as welfare and social services; (ii) provision of quality food to vulnerable people while ensuring fair treatment of all actors; (iii) increases and improvements in the collection and redistribution of surplus/end-of-life food for charity and social purposes.
- Actors involved and targeted in co-design and co-production: food waste hubs, welfare organizations, beneficiaries, indoor markets, social delivery ventures, grocery stores, local shops, and canteens.

6. Discussion: The Distinctiveness of the Milano Sustainable Food System Scenario and the Transitioning DOS

The comparative analysis of the three scenarios raises a first set of reflections on the role of likewise processes and outcomes to drive systemic change towards sustainability. The analysis, moreover, helps to focus the purpose of the Milano ones and crafts its method accordingly by envisioning possible evolutions of the local food system and co-designing with stakeholders potential pathways toward sustainability. Unlike the other two scenarios, it targets specific actors within a specific context and ecosystem, aiming to collaboratively design a food service masterplan for the city that can integrate the urban masterplan through a service-oriented approach.

6.1. Key Elements of the Scenario Structure and Targeted Actors

Specific and actual challenges. A first reflection concerns the general approach to the scenario-building and its structure; the DOS for the Milano Food System is generated around governance and sustainability challenges, which are relevant factors stakeholders must deal with in the present time or soon. Both are less about technologies and more about the organization's strategy in dealing with top-down/bottom-up forces. Technology, instead, is an element that can enable this strategy. Given the nature of the actors targeted

by the scenario and their role at the intersection of public and private sector and welfare within the local institutional landscape, this approach was considered to be more likely to spur action than a more future-oriented one. The PFoF and MUSAE scenarios, instead, privilege a more visionary approach that moves from general principles, business models, technological opportunities, and artistic sensitivity. They depict alternative futures as tangible opportunities to "reduce the pain and increase the speed of change" [29]. As a result, the proposed scenarios are highly suggestive and intrinsically detached from any local cultural and institutional landscape with its urgencies, rules, and constraints.

Following Morelli [38], the 'institutional landscape', is a system of values, rules, and social, cultural, economic, and political foundations that guide change, promoting developments that align with this framework while obstructing those that do not. The more actors are intertwined with one another and connected to the public system, the more they must navigate this landscape, which evolves very slowly and through gradual changes influenced by concurrent factors. For service designers, working at this level involves addressing a large and systemic scale of intervention, which entails geographical and operational variability. As such, the researchers involved in the project have shaped their role as steering agents toward more integrated actions for the sustainability of the entire food system by transforming the behavior and relationships of the stakeholders.

Although recognizing the impossibility of kicking-off actual action or controlling any resulting transformation, the research agenda was to explore and visualize potential changes in which each actor could see their role within the larger system, both at the place-scale and in relation to others. Reflecting on the evolution of their current best practices, integrating them with prospective illustrative solutions was a key part of this transformation scenario. A timeframe of ten years was then considered to be the most appropriate, being not too far from today's actions. Likewise, technologies were introduced with a progressive approach, from re-considering recent, discarded, experimentations to introducing established or low-tech solutions (digital and more) in conventional processes.

Multi-actor and relational perspective. Another set of reflections concerns the targeted actors. The scenario identified specific actors within a specific place, allowing each to recognize themselves and others in the local ecosystem. Conversely, the PFoF and MUSAE scenarios generically target people operating in the food system or/and small–medium enterprises and startups that can find inspiration in the scenario and take over some challenges and opportunities. MUSAE envisions a second stage of research to collaborate with SMEs in transforming one scenario into future-driven concepts and prototypes at Technology Readiness Level 5 (TRL5) [30] (p. 2). Yet, there is no mention or intention to leverage the collaboration of the targeted actors.

While the approach used for the Milano Sustainable Food System Scenario ensures greater stakeholder activation and reduces resistance, it may limit visionary breakthroughs and revolutionary changes, perpetuate a conservative stare, and result in incremental innovations, it can also reveal new opportunities for collaboration and synergy among stakeholders, as well as help identify potential partnerships and understand relational opportunities.

In circular strategies, such synergy is essential to make the outputs of one process the inputs of another, compensating emissions and integrating decarbonization technologies—all within a proximity logic. For example, surplus food from the wholesale market can support solidarity redistribution chains. Similarly, social sustainability can be achieved by combining conventional food services with social impact actions by third-sector actors, such as including vulnerable people in transformation or delivery services.

Through this explicit relational and collaborative strategy, this research aims to inspire the food system's nodes to uplift their sustainability by identifying common priorities, integrating strategies, and sharing solutions. It also aims to initiate a multi-actor and design-driven commoning process, a collective decision-making dialog that can bring about value for the system and generate interest in starting-up initiatives [24]. This process can also bring about collaborations with external actors, whose competencies are required to meet emerging needs and opportunities. The competencies, ambitions, and motivations

of stakeholders are indeed crucial factors that can either hinder or drive transformation. Given the transformation trajectories outlined by the Milano Food Policy and described in the introduction of this article, the system's nodes are in a position where rethinking their activities and addressing new challenges is necessary. Innovating processes and services are not in question; it is already happening, and this research aims to subtly integrate into this process and critically contribute to it.

Contextualization. Both of these distinctive elements in the Milano Sustainable Food System Scenario, the compliance with actual challenges and the consideration of the actual system's nodes, are intended to make the scenario contextualized and therefore more relevant to the targeted actors, tailoring it to the specific cultural, social, economic, and environmental conditions. The scenario is then built leveraging local and international AFNs as seeds of change that can inspire, work, and, finally, scale. This approach involves extensive fieldwork, stakeholder engagement, and local data analysis, resulting in solutions that are relevant, co-designed, and likely co-produced by local stakeholders, and, therefore, are also flexible enough to adapt to emerging local conditions and changes. In contrast, the PFoF and MUSAE scenarios rely on broader, generalized frameworks that do not consider the granularity of specific local challenges, potentially missing out on unique local actors, needs, and resources. This can make the scenario more malleable to different conditions, yet be perceived as distant from what really matters for a local system.

As mentioned, the idea behind the Milano Sustainable Food System Scenario is to simulate interactions between different nodes and spur changes in the behaviors of actors within the system by "rehearsing plausible options" for the future. It is also argued that this scenario is a mixed typology [23]; an explorative phase generating different plausible alternatives is followed by a predictive one in which specific "what if" developments are deployed in a conversation with the actors. The final step will be designing context-specific roadmaps for the implementation of improved or new services. Given the transformation targets, roadmaps should outline how the current situation can be adjusted or changed.

Outcome orientation. Compared to the PFoF and MUSAE scenarios, the Milano Sustainable Food System Scenario can be defined as explicitly outcome-oriented, committed to initiating the transition from a known present situation to some preferable alternatives in the future. In this effort, the different scenario typologies are articulated in a sequence, each one theoretically effective in moving from the exploration of possibilities to their selection, development, and prototyping in a relational logic that requires field work, early stakeholder engagement, and co-design. Despite the importance of the process of transition as a collective and relational journey of the actors (not only the targeted ones, but also those involved in the development), the Milano Sustainable Food System Scenario places emphasis on making things happen in a specific system, place, and institutional landscape. Thus, it reaches an outcome by building on observed facts, the characteristics of a system, and on previous knowledge.

6.2. Transitioning Design-Orienting Scenarios

The last reflection on the comparison of the scenarios in the effort to drive a systemic change towards sustainability regards the three-phases method adopted for building and developing the scenario presented in Section 4.1. This reflection, together with the distinctive elements abovementioned, led us to formulate an evolution of a DOS into a Transitioning DOS (T-DOS) specifically designed to facilitate outcome-oriented sustainability transitions within a particular context or system and in a medium-term perspective. Characterized by a multi-actor and relational perspective, T-DOS engage stakeholders through a structured, contextualized process, leveraging local challenges, resources, and actors to ensure the relevance and applicability of practicable sustainable futures and roadmaps, attainable within existing institutional landscapes.

The T-DOS can be streamlined as in Figure 3, briefly showing the stages of the process, each one articulated in the following:

- Research activities that cut across the three phases;

- Scenario's content generation, discussion, and development;
- Relevant actors.

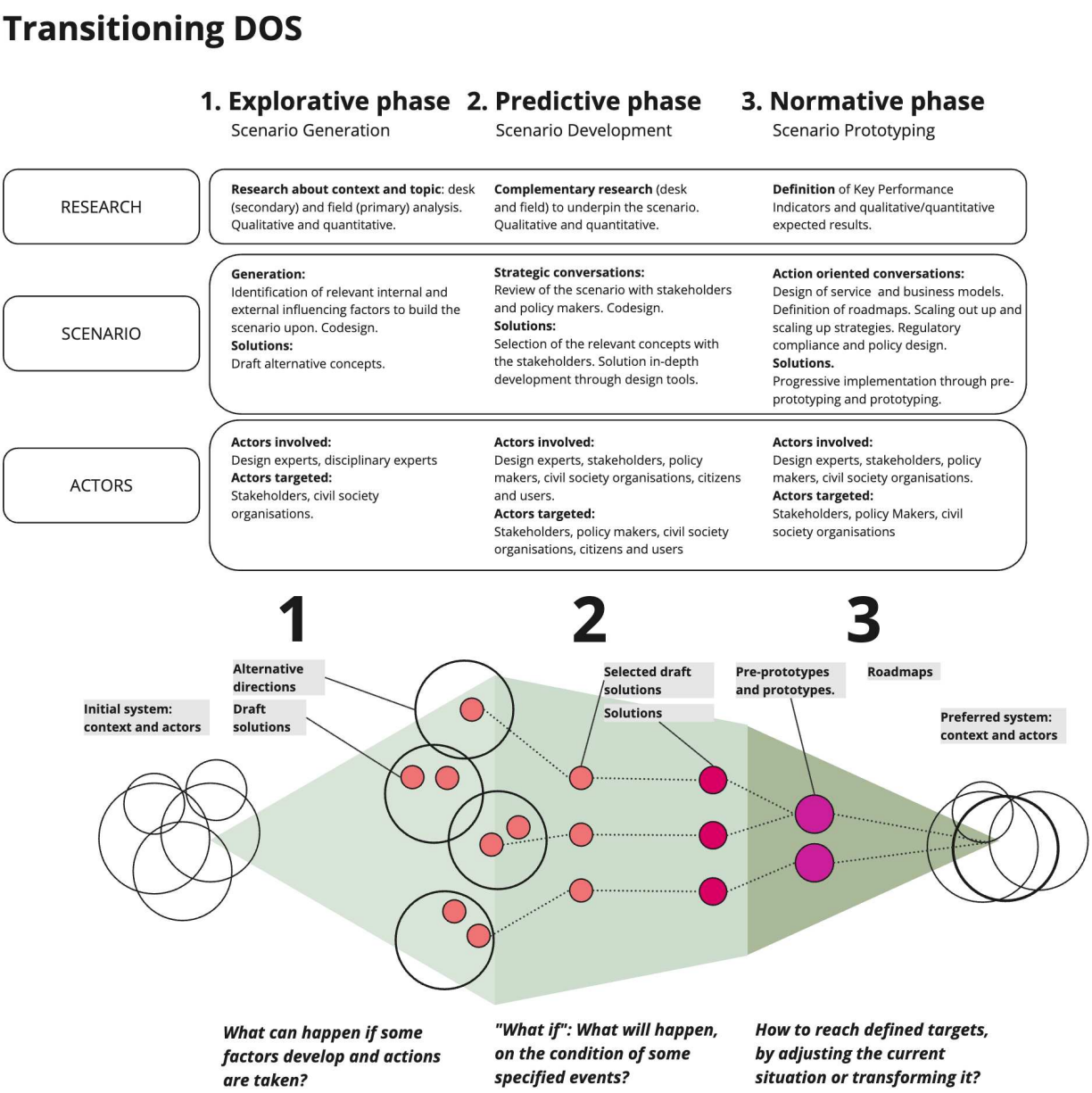

Figure 3. Transitioning Design-Orienting Scenarios' main phases and structure.

The figure highlights, also, the main elements and artifacts that are designed for and within each phase, and supporting codesign activities, such as alternative directions, draft solutions, prototypes, and roadmaps.

7. Conclusions

This article presents and discusses the use of scenarios to steer outcome-oriented sustainability transitions in a local food system. The following paragraphs present a summary of the main finding discussed, as well as the limits and future steps of this work.

7.1. Summary of the Findings

This article proposes the ways in which design can play a role in developing, orienting, and supporting transitioning strategies within complex and adaptive food systems, and how scenarios can be considered both as creative processes and actionable tools that facili-

tate strategic conversations and steer outcome-oriented sustainability transitions. Building on these premises, this work defines a set of ten transversal meta-features, along with recurring elements in the scenarios' structure and presentation formats, that describe key elements, laying the foundation for building scenario types that can effectively contribute to environmental and social sustainability, regardless of the field of application.

Within this framework, the Design-Orienting Scenarios (DOS) methodology proves instrumental in co-designing transformative solutions while maintaining a systemic perspective. DOS enable a comprehensive understanding of the complexities involved, offering future-oriented narratives visualized through specific solutions. Applied to the Milano Food System, the DOS here presented contribute to ongoing transformations by engaging relevant actors in co-design processes that integrate governance and sustainability strategies, aiming to foster multi-actor collaboration and launch transformative projects.

The evolution of DOS into Transitioning Design-Orienting Scenarios (T-DOS) offers a framework for creating innovative and contextually relevant solutions that account for both the specific characteristics of local food systems and broader sustainability goals. In particular, the development of scenarios tailored to the Milanese food system highlights the importance of fostering relationships among stakeholders, ensuring that the proposed solutions are meaningful as well as operational and capable of activating local assets and actors, and are thus designed to support outcome-oriented transitions.

In addition to their relevance for food systems, the applicability of T-DOS extends to broader complex systems. When applied in different contexts, the multi-actor and relational approach of T-DOS offers a promising framework for navigating complexity. By bringing together diverse stakeholders, these scenarios facilitate the exploration of innovative systemic solutions that can address a wide range of societal challenges. The focus on collaboration and co-design, combined with the adaptability of T-DOS to various contexts, makes them a tool for fostering transformative change across different domains.

7.2. Limits of the Study and Future Steps

The research presented in this article is still ongoing; it is intended as a process in which the scenario is a design artifact to steer a medium-term transition. The present stage of the research corresponds to phase 2 of the T-DOS, in which different alternative directions and relevant possible solutions are co-designed with the actors targeted. From this phase, which is progressively addressing specific "what if" questions, two strategic directions have emerged through co-design and now serve as starting points for future progress. While there is no guarantee that the process will continue as hoped, there is evidence that multi-actor conversation groups have formed around the inputs of this scenario.

The next challenges for the project are to develop phase 2 and, therefore, a range of possible solutions that engage the system's actors, ultimately leading to the pre-prototyping of services (approximately five) to verify their validity. Depending on the outcomes, this could result in the definition of key performance indicators and creation of implementation roadmaps.

Given the project's assumptions and its emphasis on a multi-actor and relational perspective, for the positive outcome of the project, ensuring a series of cross-cutting milestones throughout the whole process will be crucial. These milestones will be collective moments of debate, involving multiple nodes of the system, such as workshops of mutual update, system adaptation, and alignment of the behaviors, which involve also external experts and new actors. Likewise, aligning the local food policy and regulations with on-the-ground practices will be key, since social and business innovativeness often collides with current regulations and policies [39].

Besides the challenge of the continuation of the project, the main questions about the T-DOS concern the scalability of its method and of the food directions that have come out from the Milano context.

This method is a design process that can be replicated with the involvement of professional designers who are familiar with creative abduction, employ envisioning techniques, conduct field research, and possess thematic knowledge, in this case about sustainable

food practices. This is part of the design culture and of what Manzini defines as "expert design" [40]. Yet, design knowledge and systemic thinking can become relevant only if activated by institutional agents, being actors of the system or governments, through regional or local policies [41]. The T-DOS for the Milano Food System was developed in a city recognized internationally for its Food Policy, with a dedicated Food Policy Office that, over the years, has implemented several actions and won several grants. The city has started to be pivotal across the world for sustainable food policies [17,41,42], designed under the key principles of evidence-based, multi-actor collaboration, and cross-sectoral synergies, and with the involvement of established local institutions.

While this may not apply to all contexts, a food T-DOS has better chances of success in environments where resources are directed toward activities supporting sustainable practices and participatory food governance. Particularly, the food sustainability directions (namely, *A widespread and capillary system for distributing and selling fresh food* and *An efficient system for regenerating food and people*) can be scaled under certain conditions, which are primarily policy conditions that enable actors to share knowledge, collaborate, and act effectively. Among these conditions, the key ones include the presence of the following: an institutional landscape that has *infrastructured* a dialog among the local system's actors; participatory food governance structures that can enhance ownership, relationships, collaboration, and co-investment among multiple stakeholders; a city or regional policy that encourages circular economy and social innovation that require multi-actor collaboration; a favorable environment for alternative food networks, counterbalancing the large retail system; and finally, a culture of innovation and experimentation with a systemic perspective, where multiple stakeholders (including research bodies and citizens) are engaged in food initiatives and policy-making processes [42–45].

The specific contents of the Milano Sustainable Food System Scenario cannot be directly replicated elsewhere, unless they are streamlined and shaped as theoretical service models, which are structures of interaction between service providers, users, and supporting processes to deliver a solution for a need. Yet, the distinctive internal and external factors chosen to build the scenario (Governance—centralized/distributed, and Sustainability strategies—adaptation/mitigation) are scalable in other contexts where multi-actor systems are faced with the need of transitioning, together, to more sustainable configurations.

Research on design scenarios is vast and fascinating, as it deals with the future and the imagination of what the future could be. Despite the T-DOS presented in this article being limited in terms of visionary breakthroughs, they are designed to be operational and pragmatic in activating stakeholders and assets. The effectiveness of this approach needs to be measured and demonstrated through multiple applications and over the long term, especially in comparisons with more visionary and thought-provoking scenario methodologies. Further research should address this issue and explore the conditions that can effectively increase the success of their application, including the accountability of designers in engaging with and influencing systemic innovation processes.

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