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Design Thinking Approach to Create Impact Assessment Tool: Cities2030 Case Study

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Abstract: This paper presents the development and testing of an impact assessment tool for the Cities2030 project aimed at transforming city-region food systems to align with the European Union's Food2030 policy and the European Green Deal. This study highlights the importance of sustainable urban food systems, focusing on food security, environmental sustainability, and public health. Using a design thinking approach, this research emphasizes co-creation, stakeholder engagement, and iterative refinement, developing a flexible, multi-dimensional framework adaptable to diverse city-region contexts. Through collaboration with 65 stakeholders, this tool was tailored to meet the socio-economic and environmental needs of different regions. Case studies from Cities2030 partner cities demonstrate its effectiveness in fostering cross-sectoral collaboration, enhancing community participation, and driving food system innovations. Key findings reveal measurable impacts across social, environmental, and economic dimensions, while addressing challenges like regional disparities in data collection and the need for improved long-term tracking of sustainability metrics. This study concludes by underscoring the role of adaptive, inclusive strategies in assessing urban food systems' sustainability and resilience and suggests that the tool's framework could be applied to other urban sustainability areas, such as energy and water management.

Keywords: design thinking; impact assessment; Cities2030; methodology

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1. Introduction

In the context of increasing global urbanization and the pressing need to address climate change, city-region food systems (CRFSs) have become a focal point for sustainable development efforts. These systems are central to achieving several Sustainable Development Goals (SDGs), particularly those related to food security, public health, environmental protection, and economic resilience [1]. Urban areas are projected to house 68% of the world's population by 2050, making it imperative that cities transition towards more sustainable and resilient food systems that address not only the needs of urban populations but also the environmental and social challenges posed by industrialized food production and distribution [2,3]. Strategic urban design interventions have been shown to significantly impact health and well-being, particularly when holistic [4] and localized [5] methodologies are employed. The European Union's Food2030 policy underscores this urgency, framing food systems as integral to the health of both people and the planet. Effective sustainable food systems are also key to the success of Positive Energy Districts [6]. The policy advocates for transforming food systems to become more sustainable, inclusive, resilient, and innovative, aligning with broader EU goals such as the European Green Deal and the Farm to Fork Strategy [7].

However, climate change is predicted to increase the risk of crop failure, potentially reducing global food production by 10–25% by 2050, exacerbating the strain on food security [8]. Urban food systems are particularly vulnerable to climate-induced weather extremes, geopolitical conflicts, and pandemics, which have revealed fragilities in global food supply chains [9]. Inefficient supply chains and rising greenhouse gas emissions further compound these issues, making urgent solutions necessary [10]. As climate change

accelerates, the ability of urban food systems to adapt to evolving challenges will become increasingly critical [11]. Therefore, building resilient urban food systems that can withstand environmental shocks is a major challenge for sustainable urban development.

Assessing the impact of food system transitions poses significant challenges. Traditional impact assessment frameworks often struggle to account for the complex interconnections between food, environment, and socio-economic factors within diverse urban contexts [12]. Existing tools for impact measurement tend to be rigid, focusing on a limited set of indicators and failing to capture the dynamic and evolving nature of food systems [13]. Moreover, they lack the capacity to incorporate the perspectives of diverse stakeholders, including policymakers, businesses, civil society organizations, and local communities [13]. Given the unique nature of each city-region, the need for more adaptable, inclusive, and context-specific assessment methods has become increasingly apparent [14,15]. Static models of food systems have also struggled to cope with shifting environmental or social dynamics, highlighting the need for more adaptable and context-sensitive frameworks [16].

For instance, conventional tools often overlook critical variables such as urban green spaces, which significantly contribute to public health and overall environmental sustainability in cities [17]. Additionally, these frameworks often fail to address the complexities associated with long-term uncertainties such as changing climate conditions, shifts in political priorities, and emerging technologies in food production and distribution [18–20]. Thus, a robust impact assessment framework for urban food systems must be capable of evaluating these complexities.

In recent years, the design thinking approach has emerged as a promising framework for addressing these challenges. Originating from the product design and innovation fields, design thinking emphasizes human-centered solutions, iterative development, and collaborative problem-solving, making it particularly suited for complex, multi-stakeholder environments such as city-region food systems [21]. Unlike static, linear models, design thinking has proven successful in addressing complex environments like healthcare and public policy, further validating its applicability to urban food systems [21]. By promoting flexibility and continuous refinement, design thinking allows for the development of adaptable impact assessment frameworks that can be tailored to the specific needs of diverse city-regions [22,23].

Despite its promise, applying design thinking to impact assessment in food systems is still a relatively new endeavor, and several challenges remain. One major challenge is balancing the diverse interests and priorities of different stakeholders while maintaining a coherent and actionable assessment framework [24]. Another challenge is ensuring the scalability and transferability of solutions across different city-regions, given the unique cultural, economic, and environmental contexts of each region [25]. For example, it is necessary to characterize sustainability in a manner that captures the complexity of these environments [26]. Moreover, assessing long-term impacts requires addressing the uncertainties inherent in system transitions, such as changing climate conditions, shifts in political priorities, and emerging technologies in food production [18] and distribution [19,20], as well as the land and biodiversity impacts [27–29]. Diverging hypotheses also exist regarding the best metrics and indicators for assessing food system sustainability, with some experts advocating for a focus on environmental outcomes, while others prioritize social and economic factors [28,30].

The Cities2030 project adopts a design thinking methodology to engage a broad range of stakeholders, from policymakers and food producers to community organizations and researchers, in the co-creation of an adaptable impact assessment tool. This diversity of stakeholders ensures that the tool is relevant across different regions and sectors, making it more grounded in practical needs [31]. Through iterative testing and refinement, the tool is designed to accommodate various urban contexts and complexities, thereby filling the gaps left by traditional impact assessment frameworks [21]. By incorporating real-time feedback, this framework remains dynamic and responsive to unforeseen challenges like natural disasters or economic shifts.

This paper seeks to explore the development and application of a design thinking-based impact assessment framework within the Cities2030 project, a European initiative aimed at guiding city-region food systems towards the Food2030 policy goals. This study is guided by two primary hypotheses:

Hypothesis 1. *The design thinking approach can lead to the development of flexible, adaptable, and effective impact assessment frameworks for urban food systems.*

This hypothesis is rooted in the principles of design thinking, which emphasize co-creation, stakeholder engagement, and iterative development to create solutions that are both innovative and responsive to complex, multi-dimensional challenges. The iterative nature of design thinking ensures that solutions evolve with stakeholder input, allowing for continuous refinement, which is critical for developing impact assessment frameworks that must remain responsive to dynamic urban environments [21,32].

Hypothesis 2. *A holistic, multi-dimensional approach to impact assessment is more effective in capturing the complex dynamics of city-region food systems.*

Theoretical foundations for Hypothesis 2 stem from research on multi-dimensional impact assessments. Researchers like Kremen and Miles (2012) argue that a holistic approach is essential for understanding the broader impacts of sustainability initiatives, particularly in systems as interconnected as food systems [30]. By incorporating a broad set of indicators, such as food security, public health, and environmental impact, a multi-dimensional framework offers a comprehensive understanding of the sustainability outcomes across CRFSs [17,30].

The primary objective of this research is to investigate how design thinking can be used to create a more effective, adaptable, and inclusive impact assessment framework for city-region food systems. By integrating stakeholder feedback at each stage of development, this study contributes to a growing body of knowledge on food system transitions by demonstrating the value of a design thinking approach in enhancing the assessment of impacts across diverse urban contexts. Additionally, the tool's design allows for scalability and broader applications beyond food systems, making it adaptable to other urban sustainability challenges such as waste management, energy systems, and transportation [33].

This research ultimately supports the broader goal of building sustainable, resilient, and inclusive urban food systems that are aligned with global policy frameworks like the European Green Deal and the UN Sustainable Development Goals [34].

2. Background of Case Study and Methodology

This research employs a single case study method to explore the development and testing of an impact assessment tool for CRFSs as part of the Cities2030 project. According to Yin (2018), this approach is particularly well-suited for conducting an in-depth analysis within real-world contexts, enabling a detailed examination of the co-creation process and its role in transitioning urban food systems towards sustainability [35]. By focusing on a single instance, the case study provides rich, context-specific insights into stakeholder engagement, particularly in terms of design thinking and collaboration, making it an appropriate choice for investigating the complex dynamics of the project.

The case study centered on the co-creation process, a key element of the Cities2030 framework. This process involved active collaboration between multiple stakeholders, including policymakers, urban planners, community representatives, and technology innovators. Data were collected using a combination of qualitative methods, including focus group design thinking workshops and document analysis of project-related materials. These qualitative methods ensured a comprehensive exploration of the diverse perspectives and interactions that shaped the development of the impact assessment tool.

The use of multiple qualitative data sources is consistent with best practices in case study research [36], allowing for a more robust understanding of the subject matter. By incorporating a range of stakeholder perspectives, this research provided deeper insights into

the complexity of urban food systems and the co-creation process essential for developing effective assessment tools.

2.1. Theoretical Research and Strategy Development

The development of the Cities2030 impact assessment tool began with an extensive theoretical research process aimed at establishing the foundational framework that would guide the tool's structure and functionality. The theoretical research focused on synthesizing insights from both scientific literature and strategic project documents, ensuring that the impact assessment tool was built on robust, evidence-based principles.

The following research tasks were undertaken to ensure a comprehensive approach to building the impact assessment framework:

1. Managing research in scientific databases to explore literature about impact and effectiveness;
2. Gathering all relevant information about impact from the project proposal;
3. Analyzing impact indicators from strategic documents mentioned in the project proposal;
4. Creating measurement lists and their application;
5. Describing strategy verification methodology;
6. Creating conclusions and suggestions for future research.

2.1.1. Literature Review and Strategic Document Analysis

The theoretical research underpinning this study aimed to develop the Project Impact Action Strategy (PIAS) as the core framework for evaluating the impact of CRFSs. The PIAS was constructed through a comprehensive literature review which spanned 130 scientific publications over 47 years and the strategic analysis of Cities2030 project-related documents.

The breakdown of literature sources across the databases is presented in Table 1 below.

Table 1. Count of the literature sources in stages.

	Stage 1-In Article Title or/and Keywords Mentioned Terms	Stage 2-Directly About (Full Text Available)	Stage 3-Unique Sources
Scopus	16,592	36	133
ScienceDirect	78,381	24	
Google Scholar	23,700	15	
Sage Journals	54,575	34	
Ebsco	832,645	33	
Emerald	23,456	25	
Web of Science	52	8	
Sum:	1,029,401	175	

The objective was to build a robust foundation to inform the structure and functionality of the impact assessment tool, ensuring alignment with both scientific and strategic insights. The review was conducted in four stages:

- Stage 1: An initial search yielded over 1,029,401 sources by filtering for terms such as "impact" and "effectiveness" in article titles and keywords.
- Stage 2: Relevant sources were selected based on their full-text availability, narrowing the selection to 175 publications.
- Stage 3: Duplicates were removed, and further refinement resulted in 133 unique sources which formed the basis of the analysis.
- Stage 4: The final stage focused on categorizing and analyzing the literature, identifying key criteria and models that would be used to build the impact assessment framework.

2.1.2. Project Impact Action Strategy (PIAS)

The PIAS framework integrated findings from both scientific publications and strategic project documents, focusing on four multi-dimensional impact areas: Sustainability Metrics, Social Impact Indicators, Environmental Performance Measures, and Economic Viability Criteria. This strategy not only provided a comprehensive overview of impact areas but also served as a blueprint for creating an adaptable assessment tool that could be customized for diverse urban food system contexts.

During the literature review, several key theories and approaches were identified that provided a strong theoretical foundation for the PIAS. These theories influenced the development of the framework and the selection of appropriate models for the impact assessment tool. Commonly referenced theories and approaches include classical theory [36], social capital theory [37,38], human relations, culture-excellence approaches, contingency theory [36], and organizational theory [39].

Additionally, the literature explores various aspects related to impact and effectiveness, such as creativity [40], job satisfaction [41,42], employee engagement [39,43], knowledge management [44–47], organizational commitment [48,49], the organizational affective commitment subscale [50], organizational culture [46,51–53], and organizational citizenship behavior [54,55]. Information culture [56], leadership [57,58], and non-profit organizational effectiveness [59–66] also feature prominently. These diverse theoretical perspectives provided a multi-dimensional view that helped shape the PIAS, ensuring it addressed the complexities of urban food systems and their sustainability challenges.

Despite extensive research, there remains no universal consensus on how to define or measure impact and effectiveness, leading to the development of various models. Two frequently applied models, the Goal Attained Model and the Competing Values Model, were considered for the Cities2030 project. Ultimately, the Goal Attained Model was chosen for its emphasis on measurable outcomes, making it particularly well-suited to evaluating the progress of sustainability initiatives [23,41,50,54,67–76]. This model allowed the project to track progress toward specific goals while embracing a multi-dimensional approach that acknowledges the complexity of impact evaluation.

Other models, such as the Structural Functional Model, which examines a system's ability to prevent harmful external actions, and the Organizational Development Model, which focuses on problem-solving and renewal [77], were also considered during the theoretical analysis. Contingency models [78] were evaluated but found less adaptable to the project's multi-dimensional needs. Ultimately, the Goal Attained Model was selected due to its flexibility in integrating various dimensions of impact, ensuring that the framework could address social, environmental, and economic factors simultaneously.

Figure 1 illustrates the structured approach, showing how the PIAS, built around the Goal Attained Model, provided a robust and adaptable framework. The PIAS not only offered a strategic overview of how impact could be assessed but also guided the design of the impact assessment tool, ensuring that it remained adaptable across different urban food system contexts.

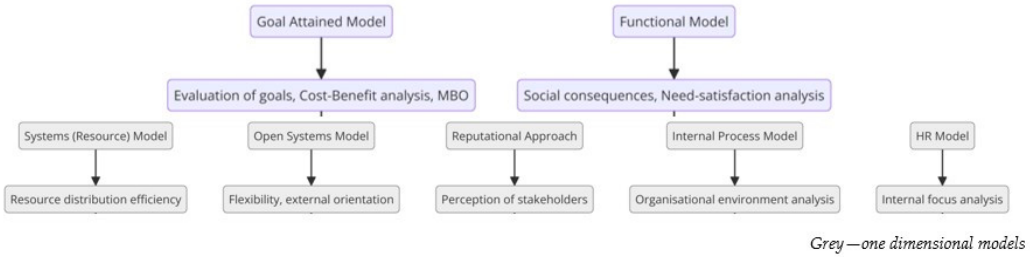

Figure 1. Model.

While the theoretical foundation was extensive, certain limitations were acknowledged. The reliance on seven specific databases constrained the breadth of the literature, and the inclusion of project-specific documents could introduce a bias towards Cities2030's strategic

priorities. Despite these limitations, the PIAS offers a versatile and context-sensitive strategy for assessing multi-dimensional impacts, serving as the groundwork for the subsequent development and refinement of the impact assessment tool.

2.2. Data Collection Methods

To capture a comprehensive understanding of stakeholder engagement and the development of the impact assessment tool for the Cities2030 project, data were collected using a combination of qualitative and quantitative methods. This multi-method approach ensured that a broad range of perspectives and inputs were considered, making the tool adaptable and robust across various urban contexts.

- Focus Groups: Focus groups were chosen to capture the collective insights and group dynamics among stakeholders, following the approach outlined by Krueger and Casey (2015) [37]. This method allowed participants to discuss priorities, challenges, and opportunities, providing a nuanced understanding of the diverse viewpoints within the Cities2030 project. The use of focus groups was essential for identifying key stakeholder needs and aligning them with the objectives of the impact assessment tool.
- Design Thinking Workshops: Design thinking workshops were used to facilitate collaborative problem-solving and co-creation. The workshops included diverse stakeholders such as policymakers, urban planners, community representatives, and food system experts, ensuring that the criteria for the impact assessment tool were co-developed and refined to address the practical challenges faced by urban food systems. This iterative, human-centered approach, following the principles outlined by Brown (2009), was critical for creating a tool that is flexible and responsive to real-world conditions [21].
- Document Analysis: A systematic document analysis of project-related materials and strategic documents, including those aligned with the European Green Deal and Farm to Fork Strategy [7], was conducted. This analysis ensured that the framework was grounded in broader policy objectives and that the assessment tool aligned with high-level sustainability strategies. By cross-referencing the tool's criteria with policy documents, the methodology ensured that the tool supported the overarching goals of food system sustainability, resilience, and circularity.

This holistic, multi-dimensional approach is essential for understanding the broader impacts of sustainability initiatives, particularly in complex systems like food systems, where social, environmental, and economic dimensions are deeply interconnected [30]. By integrating qualitative insights from focus groups and workshops with policy-driven analysis from strategic documents, the tool was designed to meet the real-world challenges faced by urban food systems.

2.3. Data Analysis Techniques

The data collected through the qualitative and quantitative methods were subjected to rigorous analysis to ensure methodological rigor and robustness. Two key qualitative techniques—thematic coding and triangulation—were employed to thoroughly analyze the data and provide a comprehensive understanding of stakeholder engagement and the tool's development.

- Thematic Coding: In line with Braun and Clarke (2006), thematic coding was employed to systematically identify recurring themes across focus group discussions, workshop transcripts, and document analysis [38]. This technique helped organize and interpret the data, particularly in the exploratory case study of Cities2030, where the aim was to uncover underlying patterns in stakeholder contributions. Key themes that emerged included the flexibility required in the design thinking process, the challenges of integrating diverse stakeholder perspectives, and the role of co-creation in fostering innovation and adaptability within the tool. Thematic coding is widely recognized in qualitative research for its utility in organizing complex datasets and revealing critical insights.

- Triangulation: To further validate the findings and mitigate the risk of bias from any single data source, methodological triangulation was applied, following Denzin's (1978) framework [39]. Triangulation involved cross-referencing data from focus groups, interviews, and document analysis, ensuring a comprehensive and multi-dimensional view of the co-creation process and its impact on the tool's development. This approach enhanced the validity of the findings and confirmed that the tool was contextually relevant and methodologically sound, adaptable to varied urban settings. Triangulation is critical in qualitative research for ensuring that findings are robust and reflective of multiple perspectives, thereby reducing potential methodological bias.

The use of both thematic coding and triangulation ensured that the analysis was thorough and aligned with best practices in qualitative research, providing robust insights into the co-creation process in the Cities2030 project.

2.4. Integration of Quantitative Data

While the study primarily focused on qualitative methods, quantitative data were integrated where appropriate to complement and enrich the qualitative findings. Quantitative data play an essential role in enhancing the overall understanding of sustainability, as they provide measurable insights that can validate and support qualitative results [79]. In this study, specific indicators related to food security, sustainability, and urban resilience were incorporated into the assessment to quantify the impact of interventions developed through the co-creation process.

Ingram, Ericksen, and Liverman (2010) emphasize the critical role that food security plays in understanding the broader impacts of environmental change on sustainability, highlighting the need to include such indicators in comprehensive assessments [10]. By incorporating these quantitative metrics, this study was able to provide a more nuanced understanding of the effectiveness of the interventions and their implications for sustainable urban food systems.

The integration of both qualitative and quantitative data aligns with a mixed-methods approach, as outlined by Creswell and Plano Clark (2017) [40]. This approach allows for multiple perspectives on the research problem, enriching the depth and breadth of the findings. By using both qualitative insights and quantitative metrics, this study was able to assess the multi-dimensional aspects of the impact assessment tool, ensuring a more robust evaluation of its outcomes.

2.5. Validity and Reliability of the Findings

To ensure the validity and reliability of the findings, several strategies were employed throughout the data collection and analysis phases:

- Triangulation: Methodological triangulation was utilized to ensure consistency and reduce potential bias by cross-referencing data from multiple sources, including focus groups, workshops, and document analysis. This approach ensured that the findings were not reliant on any single data source, thus enhancing the robustness of the conclusions.
- Extended Partner Reviews: The tool's applicability in real-world settings was further validated through extended partner reviews, involving the analysis of 20 practical documents [36]. These external reviews were essential in addressing both internal and external factors influencing urban food systems. The feedback provided by partners across diverse contexts was instrumental in refining the tool, ensuring its practicality, usability, and adaptability to various urban settings.

2.6. Methodological Contribution

This study presents a novel methodological framework that applies a design thinking approach to impact assessment within CRFSs. The methodology integrates theoretical grounding, iterative tool development, and stakeholder co-creation, making it robust and adaptable to capture the multi-dimensional impacts of sustainability interventions. By combining qualitative and quantitative methods, thematic analysis, and triangulation

techniques, the framework offers a deeper understanding of how collaborative approaches enhance the effectiveness of impact assessment tools in complex urban systems.

The process, depicted in Figure 2, highlights key stages, starting from initial stakeholder engagement to the final deployment of the tool. This structured yet dynamic process ensured real-time adaptability, where each step built upon the outcomes of the previous phase. The iterative nature of the framework facilitated continuous improvement, promoting the tool's long-term relevance and utility.

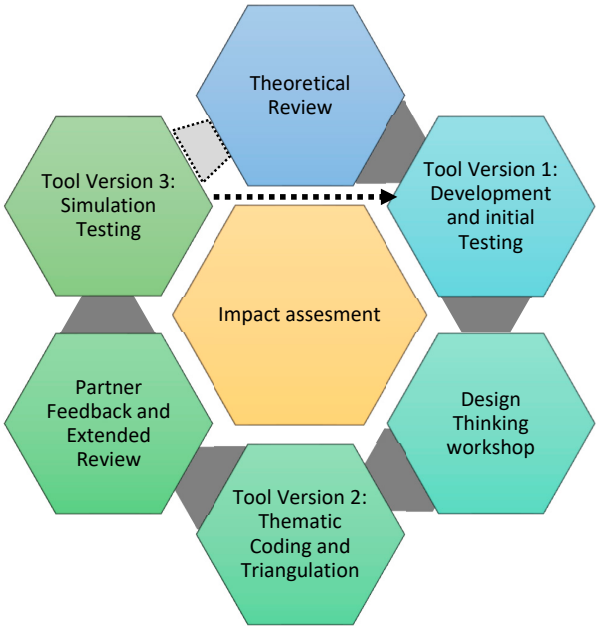

Figure 2. Methodological framework for impact assessment in Cities2030.

The Cities2030 impact assessment tool, as illustrated in the diagram, exemplifies how findings and feedback were continuously integrated to refine the framework. This methodology offers a replicable model for future studies and real-world applications, providing a foundation for assessing sustainability impacts in diverse urban food system settings. This contribution is particularly valuable for researchers and practitioners seeking to implement multi-stakeholder impact assessment tools that remain responsive to the evolving challenges of urban food systems.

Steps in the Methodological Process:

1. Theoretical Review and Strategy Development. The process begins with an extensive review of the relevant literature and policy frameworks to establish the core metrics for assessing social, environmental, and economic impacts. This stage sets the foundation for the initial design, ensuring that the tool is grounded in both theory and practice.
2. Tool Version 1: Development and Initial Testing. The initial version of the tool is developed based on insights from the theoretical review. It undergoes preliminary testing to evaluate its usability and alignment with the Cities2030 objectives. Early-stage feedback is critical at this point to identify areas for refinement and validate the relevance of the metrics used.
3. Design Thinking Workshop. A design thinking workshop is conducted with a diverse group of 65 stakeholders, including policymakers, food system experts, and community representatives. This workshop enables the co-creation of impact criteria and refines the focus areas of the tool, ensuring that it addresses the practical needs and priorities of the stakeholders involved.
4. Tool Version 2: Thematic Analysis and Refinement. The second iteration of the tool is developed using thematic analysis and triangulation methods to incorporate insights from the workshop. This version addresses gaps identified during the workshop, enhancing the tool's ability to capture complex, multi-dimensional impacts in diverse urban settings.

5. Partner Feedback and Extended Review. Extended reviews and consultations with partners provide further insights into the tool's applicability. This stage involves testing the tool across different settings, ensuring that it is contextually relevant and adaptable to a wide range of urban food systems. Inputs from practical assessments are integrated to refine the tool's structure and usability.
6. Tool Version 3: Simulation Testing. The third version of the tool undergoes simulation testing, which helps validate its robustness in various hypothetical scenarios. This phase tests the tool's capability to handle complex data and accurately measure impacts, confirming its readiness for broader deployment.
7. Full-Scale Data Collection. The final version of the tool is implemented in multiple regions, where it is used to collect comprehensive data on sustainability, food security, and resilience metrics. This stage provides a full-scale evaluation of the tool's effectiveness and generates valuable insights for further refinement.

The iterative process employed in this study demonstrates how a flexible and adaptive methodology can enhance the robustness and applicability of impact assessment tools in diverse contexts. By documenting each stage in detail, this research offers a replicable model for future studies and practical applications in urban food system sustainability.

The Cities2030 tool thus not only serves as a practical assessment framework but also contributes to the broader literature on design thinking and co-creation in sustainability research. Its methodological contributions lie in the successful integration of theoretical, empirical, and practical components, making it a valuable resource for policymakers, researchers, and practitioners working to achieve sustainable urban food systems.

3. Results

This chapter presents the key findings from the development, testing, and implementation of the Cities2030 impact assessment tool. The iterative design process, shaped by stakeholder collaboration and co-creation, resulted in a refined tool capable of evaluating complex, multi-dimensional impacts across diverse CRFSs. Initial results from the 2023 implementation phase are also discussed, showcasing the tool's effectiveness in measuring social, environmental, economic, and technological outcomes.

3.1. Development Process of the Impact Assessment Tool

The development of the Cities2030 impact assessment tool followed a structured, iterative process that combined extensive theoretical analysis, collaborative design thinking workshops, the creation and testing of multiple tool versions, and continuous stakeholder feedback. This iterative approach was essential in refining the tool's functionality and ensuring its adaptability across various urban food system contexts.

Each phase of development and refinement played a crucial role in shaping the final tool, leading to a robust and flexible framework capable of addressing diverse challenges within CRFSs. The iterative nature of the process is depicted in Figure 3, which outlines the key steps involved in the development of the assessment tool.

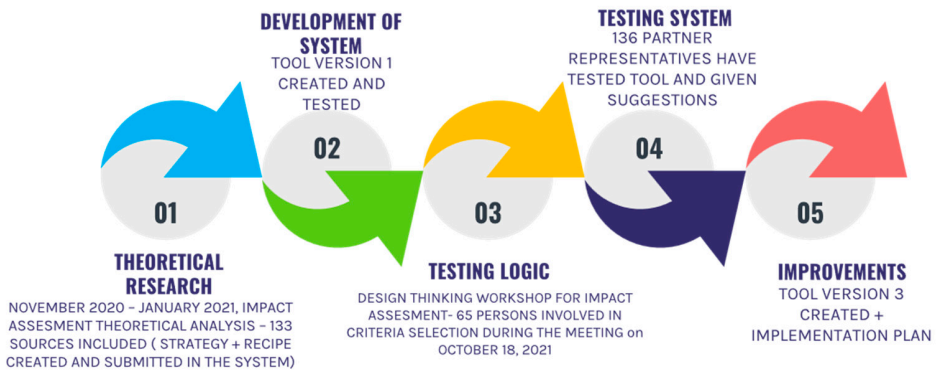

Figure 3. Development process of impact assessment tool.

3.1.1. Theoretical Analysis and Strategy Development

The theoretical analysis, conducted between November 2021 and January 2022, played a crucial role in shaping the impact assessment framework by identifying key dimensions of impact that informed the PIAS. Unlike conventional frameworks, the PIAS emphasized a multi-dimensional approach, addressing the complexity and contextual variability of CRFSs.

The research highlighted that impact is inherently multi-dimensional and varies across contexts. A total of 199 potential dimensions of impact were identified and categorized as subjective/objective, internal/external, financial/non-financial, and universal/context-specific. These dimensions were further grouped into six key categories: social, environmental, economic, legal, security and policy, culture and values, and technological. This classification was shared with project partners, allowing them to select the most relevant dimensions for their respective CRFSs. This collaborative process ensured that the tool remained highly customizable, addressing the unique challenges faced by different regions.

Key findings from the theoretical analysis include:

- In total, 74% of the dimensions were non-financial, underscoring the importance of non-monetary impacts such as social and environmental outcomes, highlighting the need to assess social and environmental outcomes, rather than focusing solely on monetary measures.
- Only 36 financial indicators and 21 mixed indicators were identified, emphasizing the focus on non-financial metrics in sustainability assessments.
- Of the dimensions, 40% were considered universal, while 58% were context-specific, with the universality of four dimensions depending on the application, underscoring the necessity for a flexible tool that could accommodate diverse urban food systems.

These findings shaped the early versions of the impact assessment tool by providing a robust framework for testing its adaptability and relevance across different urban contexts.

In summary, the PIAS and the Goal Attained Model provided a robust, adaptable framework for assessing the effectiveness of interventions within the Cities2030 project. These theoretical insights laid the groundwork for a flexible and multi-dimensional impact assessment tool capable of addressing the diverse challenges and priorities of CRFSs.

3.1.2. Design Thinking Workshop and Stakeholder Engagement

The Design Thinking Workshop, held on 18 October 2022, was a pivotal moment in the development process of the Cities2030 impact assessment tool. The workshop brought together 65 stakeholders, including policymakers, food system experts, community representatives, and urban planners, to co-create the most relevant impact assessment criteria. Through this collaborative process, the tool was shaped to reflect the diverse needs and priorities of urban food system stakeholders, ensuring that it would be adaptable across various contexts.

The workshop's main objective was to break down the identified criteria into distinct impact categories, ensuring that each criterion was allocated to its appropriate category based on its nature and relevance. The goal was to classify the criteria under broad categories such as social, environmental, economic, legal, security, policy, culture and values, and technological, with each category having a specific number of criteria that would guide the evaluation process.

Key steps and outcomes of the framework development:

1. Initial Planning and Alignment. The design thinking workshops involved 65 stakeholders who collaborated to define the scope and purpose of six key impact categories: social, environmental, economic, legal, security, policy, and technological. This was done via several steps:
    - Design Thinking Workshops: Initial workshops were organized to align key stakeholders and ensure a shared understanding of the categories to be developed. During these sessions, the importance of categorization was communicated, and

participants prioritized criteria based on their relevance to different urban food systems. This process enhanced the tool's flexibility and scalability across various city-region contexts.

- Defining Categories: The pre-defined categories were presented to the participants, and consensus was established on their definitions and relevance. Stakeholders provided input on additional categories and suggested modifications, ensuring that the tool addressed the diverse needs of each region.
- Goal Setting: The purpose of categorization—whether for evaluating performance, impact, or compliance—was clarified, and specific goals were established to guide the assessment process. Stakeholders reached an agreement on these primary goals, ensuring the criteria would drive comprehensive performance and impact assessments aligned with local priorities.

2. Collaborative Workshops to Define Criteria. The workshop's collaborative nature directly influenced the evolution of Tool Version 3, shaping its criteria and enhancing its usability and relevance. The key stages of the workshop process were structured as follows:
   - Breakout Groups: Participants were divided into smaller working groups based on their areas of expertise or interest. Each group was assigned to a specific category (e.g., social, environmental, economic, etc.).
   - Facilitated Brainstorming: Each group engaged in brainstorming sessions to generate potential criteria for their assigned category. Participants identified key areas and indicators based on their collective experience and expertise.
   - The first two steps of the process were facilitated using a MIRO board (See Figure 4), which allowed participants to interact in real-time, streamline collaboration, and enhance the visualization of their ideas.
   - Criteria Refinement: Through group discussions, the identified criteria were refined by removing overlaps, merging similar elements, and prioritizing the most significant metrics. This stage focused on reaching a consensus within each group on the finalized set of criteria.
   - Group Presentations: Each team presented their finalized criteria to the larger group. Cross-group feedback, suggestions, and questions were encouraged to promote alignment and ensure coherence across all categories.
3. Consensus Building and Framework Finalization. A voting and ranking process (see Figure 5) was used to prioritize the most relevant indicators within each category. This process ensured that the finalized criteria were measurable, adaptable, and applicable across various urban food system contexts. During the final review, criteria were further refined based on feedback, with some being clarified, split, or merged for better precision.

Group Agreement and Approval. The finalized set of criteria was shared across all teams for final approval. Achieving consensus was critical in ensuring that all stakeholders agreed on the impact areas and the criteria defined within them.

This participatory approach ensured the tool remained contextually grounded and responsive to the dynamic needs of urban food systems. The collaborative nature of the workshop also fostered a sense of shared ownership and commitment among stakeholders, further contributing to the tool's long-term success and applicability.

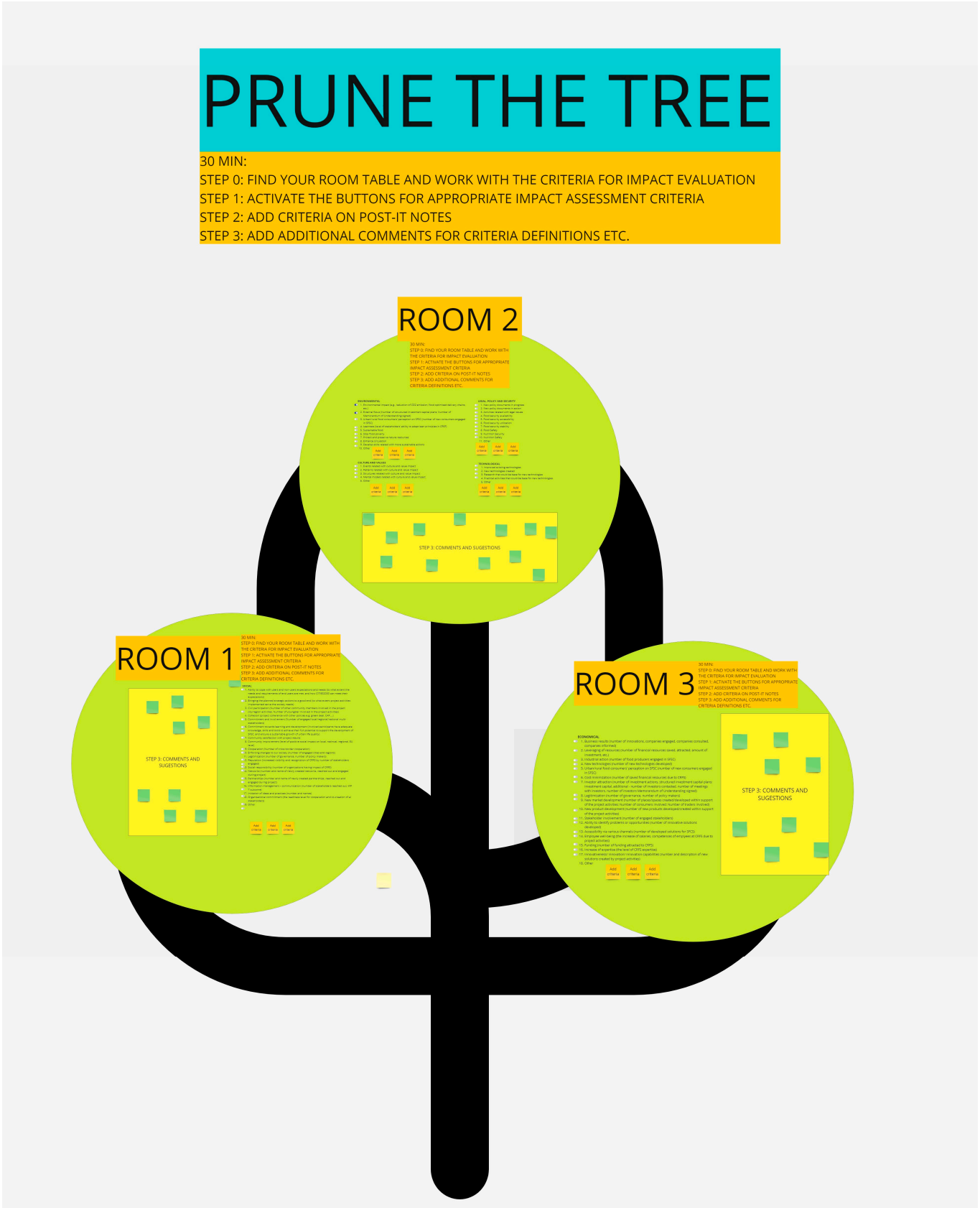

Figure 4. Step 1 and 2 in MIRO.

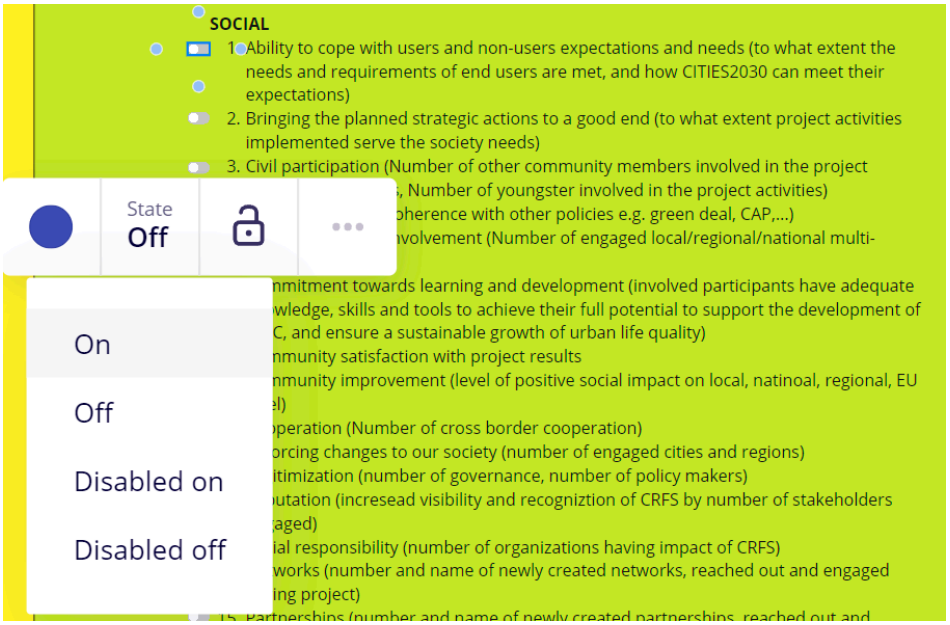

Figure 5. Step 3 in MIRO: voting (if 'on' then appropriate according to the focus group).

3.1.3. Tool Versions and Testing

Following the foundational theoretical work, Tool Version 1 was developed as the first iteration of the Cities2030 impact assessment tool. This version was based on insights from the literature review and the PIAS and was designed to capture key metrics across the social, environmental, economic, and sustainability dimensions. In early 2022, Tool Version 1 underwent its initial round of testing to evaluate its functionality and alignment with the goals of the Cities2030 project.

Initial Testing and Feedback

Tool Version 1 underwent its first testing phase in early 2022, with feedback collected from a diverse range of stakeholders, including policymakers, community representatives, and food system operators. The testing revealed several areas for improvement, particularly in terms of enhancing the tool's adaptability and usability to accommodate the diverse urban contexts and priorities of different stakeholders.

Key areas identified for refinement included:

- Improving the flexibility of metrics to better capture regional variations in urban food systems.
- Enhancing the user interface to simplify data entry and interpretation for non-expert users.
- Adjusting the criteria weights to reflect stakeholder priorities more accurately.

These insights were used to guide the development of Tool Version 2, which incorporated adjustments to better align with the varied needs of CRFSs.

Tool Version 2: Refinement and Testing

Building on the feedback from the initial phase, Tool Version 2 was developed. This iteration incorporated additional co-created criteria contributed by stakeholders during the Design Thinking Workshop. Version 2 addressed the usability challenges identified in the first version and improved the tool's adaptability across different regional and urban food systems.

By the end of this refinement phase, Tool Version 2 was significantly improved, aligning more closely with the Cities2030 objectives. It became a more flexible tool capable of capturing a broad range of impact metrics relevant to various regions.

Tool Version 3: Simulation and Full-Scale Testing

The next step in validating the tool was the development of Tool Version 3, which incorporated further refinements based on previous feedback. To ensure its robustness, a simulation test was conducted on 17 May 2022. This simulation allowed stakeholders to trial the tool in a controlled environment by submitting data for a hypothetical case.

The results of the simulation confirmed the robustness and adaptability of Tool Version 3, leading to its full-scale deployment. In 2023, the tool was rolled out across multiple regions to assess the impact of interventions in CRFSs. Data were collected on a range of key indicators, including:

- The number of new partnerships formed
- Levels of community engagement
- Innovations in product development
- Reductions in CO_2 emissions and transport emissions

The successful implementation of Tool Version 3 during the 2023 test year marked a significant milestone in the Cities2030 project, showcasing the tool's capability to adapt to diverse urban contexts and to support the transition toward sustainable food systems.

3.2. Cities2030 Impact Assessment: Performance Evaluation

The 2023 test year provided a comprehensive evaluation of the Cities2030 impact assessment tool, with its deployment across various regions offering critical insights into its performance. This section analyzes the full-scale data collection, evaluates the tool's effectiveness in transitioning urban food systems towards sustainability, and identifies both key successes and areas for improvement.

3.2.1. Evaluation of Full-Scale Data Collection 2023

During the 2023 test year, the Cities2030 impact assessment tool was implemented across a diverse range of urban and peri-urban regions. The primary objective was to measure the impact of interventions on CRFSs, focusing on key sustainability metrics such as social engagement, environmental sustainability, and economic viability.

To ensure a holistic evaluation, partners used a structured survey form to input both quantitative and qualitative data. The survey framework facilitated partner engagement through a consistent reporting structure. This structure was used to capture data on six main impact areas: social, environmental, economic, legal/policy, culture/values, and technological, as well as alignment with the Milan Urban Food Policy Pact (MUFPP) criteria. Each partner's data submission included a mix of numerical indicators and contextual descriptions, creating a holistic and multi-dimensional view of their impact.

Key Findings from Initial Testing and Feedback

The initial testing phases played a crucial role in refining the tool's structure and functionality. Feedback gathered from stakeholders across 136 partner organizations, as well as extended reviews and practical assessment documents, led to the categorization of the impact criteria into six primary areas:

- Social (13 Criteria)
- Environmental (nine Criteria)
- Economic (16 Criteria)
- Legal, Security, and Policy (eight Criteria)
- Culture and Values (four Criteria)
- Technological (four Criteria)

This collaborative refinement process ensured the tool remained contextually relevant and capable of addressing diverse priorities across different urban food system contexts. The iterative development process also led to the creation of Tool Version 3, which integrated co-created criteria and stakeholder feedback from design thinking workshops, making the tool more flexible and user-friendly.

Data Collection and Process Overview

A visual overview of the data collection process, including how partners integrated the six key impact areas and the Milan Urban Food Policy Pact (MUFPP) criteria into the tool, is presented in Figure 6.

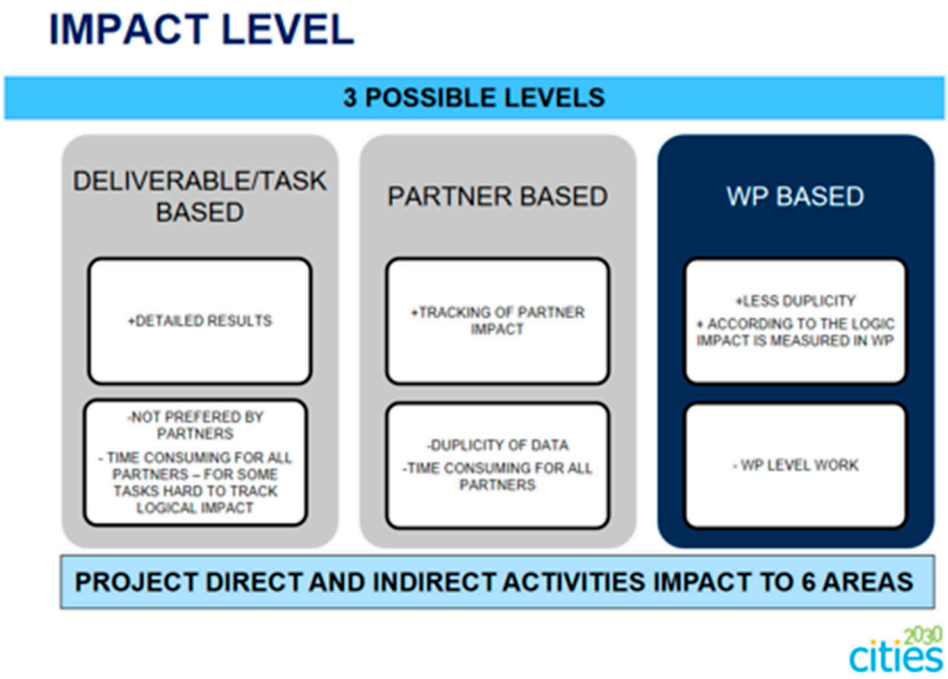

Figure 6. Impact collection level.

The tool utilized two primary impact evaluation methods: verification and measurement. Verification assessed progress related to Cities2030's scope, while measurement captured variables of impact level across six key areas: social, environmental, economic, legal/policy, cultural/values, and technological. See Appendix A.

A simulation final test was conducted before full-scale implementation to validate the tool's functionality in real-world conditions. Figure 7 illustrates the tool testing process through an imaginative case, allowing stakeholders to explore the tool's ability to handle diverse data inputs.

Figure 7. Tool testing with simulative case.

The data collection process for both quantitative and qualitative indicators is visually outlined in Figures 8 and 9, with Figure 8 showing the submission of basic information and Figure 9 detailing how partners selected impact criteria for the six key areas and MUFPP criteria.

Figure 8. Filling the basic info (partners were guided to submit basic info on their progress with Cities2030 themes and impact levels at various stages).

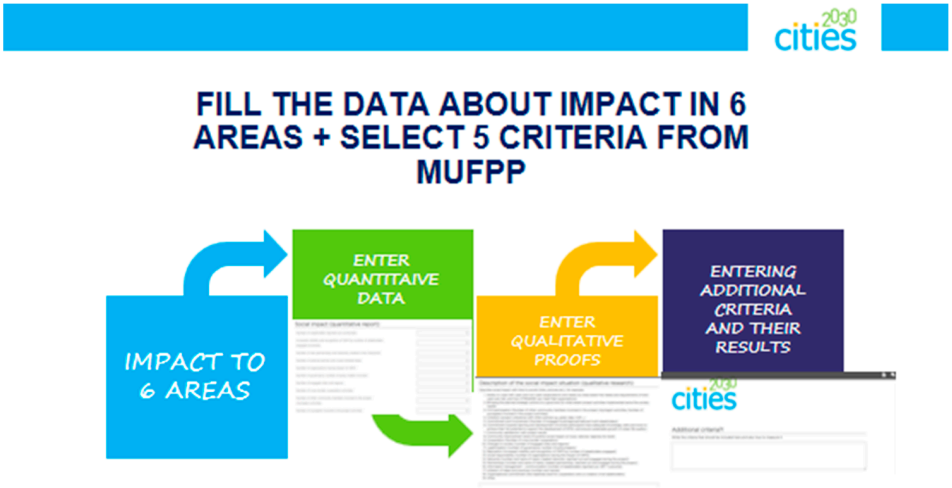

Figure 9. Impact in 6 areas and 5 MUFPP criteria (partners were able to select relevant MUFPP criteria according to their work packages. This visualization shows the submission process for both quantitative and qualitative data.).

The tool gathered data from over 11,704 community members, facilitated 296 new partnerships, and tracked numerous sustainability initiatives related to food security, waste reduction, and circular economy practices. This data allowed stakeholders to assess the effectiveness of their interventions and make data-driven decisions about future sustainability efforts.

During the first reporting period of Cities2030, several notable accomplishments were recorded across multiple areas of social, environmental, economic, technological, legal, and cultural impact. These results highlight the project's commitment to transforming CRFSs through collaboration, innovation, and sustainable practices.

According to the general data, all Cities2030 scope elements were impacted, especially support cities and their peri-urban interfaces (CPUI), which develop and implement urban food systems policies (UFSP) to meet Food2030 and the establishment of Food2030 living labs (see Figure 10).

The greatest impacts internally in Cities2030 partnerships were made in the themes of production and processing (see detailed data below in Figure 11).

The greatest impact on local regions and cities was made in the themes of production and processing (see in Figure 12).

Question: Progress related with Cities2030 identified scopes (self- evaluation)

**Not related - partner is not involved in the activities related with the scope *Regress - activities behind the scheldue *More regress than progress - activities behind the scheldue but planned to implement in the next reporting period (in the next year) *Neutral- no acitivities planned or implemented in the reported period related with the scope *More progress than regress - activities planned but not implemented in the reported period related with the scope *Progress - activities implemented in the reported period related with the scope*

Type:311 - Standard matrix 1

QUESTION:	NOT RELATED (1)	REGRESS (2)	MORE REGRESS THAN PROGRESS (3)	NEUTRAL (4)	MORE PROGRESS THAN REGRESS (5)	PROGRESS (6)	TOTAL	AVERAGE VALUE	MISSING* A	MISSING* B
v_947: Support cities and its peri- urban interfaces (CPUI) develop and implement urban food systems policies (UFSP) to meet FOOD 2030	17.65% (9)	1.96% (1)	0.00% (0)	19.61% (10)	37.25% (19)	23.53% (12)	51	4.27	0	68
v_948: Deployment of CPUI concrete actions	16.67% (8)	2.08% (1)	0.00% (0)	29.17% (14)	27.08% (13)	25.00% (12)	48	4.23	0	71
v_949: Establishment of FOOD 2030 living labs	17.65% (9)	1.96% (1)	5.88% (3)	5.88% (3)	25.49% (13)	43.14% (22)	51	4.49	0	68
v_950: Draw key learnings from the MUFPP	21.28% (10)	0.00% (0)	6.38% (3)	25.53% (12)	23.40% (11)	23.40% (11)	47	4.00	0	72
v_951: Engagement of a wide diversity of cities	19.57% (9)	6.52% (3)	4.35% (2)	21.74% (10)	23.91% (11)	23.91% (11)	46	3.96	0	73
v_952: Engagement of cities with 'good track record' in food systems transformation (FST), others aiming at prioritizing their policy agenda on FST	36.17% (17)	0.00% (0)	2.13% (1)	17.02% (8)	21.28% (10)	23.40% (11)	47	3.57	0	72
v_953: Urban participatory policy processes to meet RRI/gender engaging actors of the whole food system	31.91% (15)	6.38% (3)	2.13% (1)	21.28% (10)	17.02% (8)	21.28% (10)	47	3.49	0	72
v_954: Generate political commitment and institutionalising food policy for long-term deployment	16.67% (8)	2.08% (1)	2.08% (1)	22.92% (11)	33.33% (16)	22.92% (11)	48	4.23	0	71
v_955: Deploy a compelling communication and dissemination strategy	2.13% (1)	4.26% (2)	0.00% (0)	14.89% (7)	44.68% (21)	34.04% (16)	47	4.98	0	72
v_956: Resources to attract investments/opportunities for long-term sustainability	24.44% (11)	2.22% (1)	0.00% (0)	24.44% (11)	31.11% (14)	17.78% (8)	45	3.89	0	74
v_957: Strong centralized professional coordination	17.02% (8)	6.38% (3)	0.00% (0)	23.40% (11)	21.28% (10)	31.91% (15)	47	4.21	0	72
v_958: Synergies (other EU funded projects) to align with the FOOD 2030 framing	6.52% (3)	0.00% (0)	0.00% (0)	30.43% (14)	17.39% (8)	45.65% (21)	46	4.89	0	73

Figure 10. Progress related to Cities2030 scopes.

Question: Determine the impact level to Cities2030 themes (self-evaluation)

**Very poor impact - no impact created*Poor impact - minimal indirect impact through activivities implemented by other partners *Fair impact - indirect impact through activivities implemented by other partners but results will occure after the time*Good impact - direct impact created with your WP partners but clear results will occure after the time*Excellent impact - direct impact with some results in the reporting period*

Type:361 - Drop-down matrix

scale: Internally in Cities2030 partnership

	VERY POOR (1)	POOR IMPACT (2)	FAIR IMPACT (3)	GOOD IMPACT (4)	EXCELLENT IMPACT (5)	TOTAL	AVERAGE VALUE	MISSING* A	MISSING* B
v_959: Production	7.32% (3)	14.63% (6)	43.90% (18)	31.71% (13)	2.44% (1)	41	3.07	0	78
v_963: Processing	16.67% (6)	8.33% (3)	50.00% (18)	19.44% (7)	5.56% (2)	36	2.89	0	83
v_967: Distribution	21.21% (7)	12.12% (4)	27.27% (9)	27.27% (9)	12.12% (4)	33	2.97	0	86
v_971: Markets	22.58% (7)	6.45% (2)	32.26% (10)	25.81% (8)	12.90% (4)	31	3.00	0	88
v_977: Consumption	11.76% (4)	5.88% (2)	38.24% (13)	32.35% (11)	11.76% (4)	34	3.26	0	85
v_991: Waste	19.35% (6)	9.68% (3)	32.26% (10)	25.81% (8)	12.90% (4)	31	3.03	0	88
v_1009: Security	29.03% (9)	9.68% (3)	32.26% (10)	16.13% (5)	12.90% (4)	31	2.74	0	88
v_1027: Ecosystem services	12.50% (4)	6.25% (2)	37.50% (12)	34.38% (11)	9.38% (3)	32	3.22	0	87
v_1045: Live hood	9.38% (3)	9.38% (3)	43.75% (14)	31.25% (10)	6.25% (2)	32	3.16	0	87
v_1061: Inclusion	6.06% (2)	15.15% (5)	27.27% (9)	39.39% (13)	12.12% (4)	33	3.36	0	86

Figure 11. Impact internally in Cities2030 partnerships.

scale: Local regions and cities

	VERY POOR IMPACT (1)	POOR IMPACT (2)	FAIR IMPACT (3)	GOOD IMPACT (4)	EXCELLENT IMPACT (5)	TOTAL	AVERAGE VALUE
v_960: Production	14.63% (6)	9.76% (4)	48.78% (20)	24.39% (10)	2.44% (1)	41	2.90
v_964: Processing	22.22% (8)	5.56% (2)	44.44% (16)	22.22% (8)	5.56% (2)	36	2.83
v_968: Distribution	15.15% (5)	12.12% (4)	36.36% (12)	21.21% (7)	15.15% (5)	33	3.09
v_972: Markets	22.58% (7)	6.45% (2)	35.48% (11)	25.81% (8)	9.68% (3)	31	2.94
v_979: Consumption	8.33% (3)	5.56% (2)	41.67% (15)	33.33% (12)	11.11% (4)	36	3.33
v_996: Waste	15.15% (5)	9.09% (3)	33.33% (11)	30.30% (10)	12.12% (4)	33	3.15
v_1012: Security	28.12% (9)	9.38% (3)	37.50% (12)	12.50% (4)	12.50% (4)	32	2.72
v_1032: Ecosystem services	15.15% (5)	9.09% (3)	39.39% (13)	24.24% (8)	12.12% (4)	33	3.09
v_1049: Live hood	11.76% (4)	11.76% (4)	41.18% (14)	29.41% (10)	5.88% (2)	34	3.06
v_1064: Inclusion	5.71% (2)	14.29% (5)	28.57% (10)	37.14% (13)	14.29% (5)	35	3.40

Figure 12. Impact on local regions and cities.

The greatest impact at the EU level was made in the themes of production and processing (see in Figure 13).

	VERY POOR IMPACT (1)	POOR IMPACT (2)	FAIR IMPACT (3)	GOOD IMPACT (4)	EXCELLENT IMPACT (5)	TOTAL	AVERAGE VALUE
v_961: Production	29.73% (11)	8.11% (3)	43.24% (16)	16.22% (6)	2.70% (1)	37	2.54
v_965: Processing	29.41% (10)	2.94% (1)	52.94% (18)	11.76% (4)	2.94% (1)	34	2.56
v_969: Distribution	37.50% (12)	6.25% (2)	25.00% (8)	21.88% (7)	9.38% (3)	32	2.59
v_973: Markets	33.33% (10)	6.67% (2)	33.33% (10)	23.33% (7)	3.33% (1)	30	2.57
v_983: Consumption	32.26% (10)	6.45% (2)	41.94% (13)	12.90% (4)	6.45% (2)	31	2.55
v_1000: Waste	32.26% (10)	9.68% (3)	35.48% (11)	12.90% (4)	9.68% (3)	31	2.58
v_1017: Security	32.26% (10)	9.68% (3)	35.48% (11)	9.68% (3)	12.90% (4)	31	2.61
v_1037: Ecosystem services	26.67% (8)	10.00% (3)	40.00% (12)	13.33% (4)	10.00% (3)	30	2.70
v_1053: Live hood	31.03% (9)	10.34% (3)	37.93% (11)	13.79% (4)	6.90% (2)	29	2.55
v_1068: Inclusion	26.67% (8)	6.67% (2)	43.33% (13)	13.33% (4)	10.00% (3)	30	2.73

Figure 13. Impact at EU level.

The greatest impact at the global level was made in the themes of production and processing (see in Figure 14).

scale: Global level

	VERY POOR IMPACT (1)	POOR IMPACT (2)	FAIR IMPACT (3)	GOOD IMPACT (4)	EXCELLENT IMPACT (5)	TOTAL	AVERAGE VALUE
:_962: Production	33.33% (12)	16.67% (6)	36.11% (13)	8.33% (3)	5.56% (2)	36	2.36
:_966: Processing	33.33% (11)	6.06% (2)	51.52% (17)	6.06% (2)	3.03% (1)	33	2.39
:_970: Distribution	41.94% (13)	6.45% (2)	35.48% (11)	9.68% (3)	6.45% (2)	31	2.32
:_975: Markets	39.29% (11)	7.14% (2)	35.71% (10)	14.29% (4)	3.57% (1)	28	2.36
:_986: Consumption	35.48% (11)	12.90% (4)	38.71% (12)	6.45% (2)	6.45% (2)	31	2.35
:_1005: Waste	46.67% (14)	6.67% (2)	30.00% (9)	10.00% (3)	6.67% (2)	30	2.23
:_1022: Security	40.00% (12)	6.67% (2)	40.00% (12)	0.00% (0)	13.33% (4)	30	2.40
:_1041: Ecosystem services	40.00% (12)	10.00% (3)	36.67% (11)	6.67% (2)	6.67% (2)	30	2.30
:_1057: Live hood	36.67% (11)	10.00% (3)	43.33% (13)	3.33% (1)	6.67% (2)	30	2.33
:_1074: Inclusion	41.94% (13)	12.90% (4)	25.81% (8)	9.68% (3)	9.68% (3)	31	2.32

Figure 14. Impact at global level.

3.2.2. Tool Performance Analysis

The performance of the Cities2030 impact assessment tool was evaluated based on its adaptability, usability, and effectiveness in real-world applications across CRFSs. Key aspects of the tool's performance were highlighted through stakeholder feedback:

1. Adaptability Across Regions: The tool's strongest feature was its ability to be customized for different regional contexts. Stakeholders across urban centers and smaller peri-urban areas confirmed its flexibility in addressing local challenges, such as CO_2 emissions tracking in production-focused regions and evaluating socioeconomic equity in areas prioritizing community engagement. This adaptability ensured that the tool provided accurate and context-specific insights into sustainability interventions.
2. Iterative Refinement for Enhanced Usability: Iterative refinement, based on feedback from 136 partners and design thinking workshops involving 65 stakeholders, resulted in significant usability improvements. By incorporating co-created impact criteria, Tool Versions 2 and 3 were optimized to handle a diverse range of stakeholder needs, from policymakers to urban planners. The result was a tool that evolved into a user-friendly system capable of capturing complex sustainability metrics efficiently.

3. Effectiveness in Practical Applications: During the 2023 test year, the tool's practical utility was evident through its data visualization and reporting capabilities. Stakeholders used these features to generate reports on CO_2 reduction, waste minimization, and social engagement, facilitating evidence-based decision-making at the local government level. This capacity to translate data into actionable insights was a key factor in supporting the sustainability transitions within CRFSs.

The 2023 test year thus confirmed the tool's value in enabling robust impact measurement and supporting strategic planning for sustainable, resilient, and inclusive urban food systems.

3.2.3. Key Analytical Results and Findings

The 2023 test year provided a comprehensive evaluation of the Cities2030 impact assessment tool across social, environmental, economic, technological, and policy dimensions. This section presents the detailed analytical findings, demonstrating how the tool influenced CRFSs and its effectiveness in supporting sustainability initiatives. These results highlight the tool's capacity to facilitate both qualitative and quantitative impact assessments, offering actionable insights that align with broader policy objectives and sustainability frameworks.

1. Social Impact
    - Two hundred and ninety-six new partnerships were formed, fostering collaboration among local governments, food producers, community organizations, and private enterprises within CRFSs.
    - Two hundred and forty-nine external partner and crowd-initiated ideas were contributed, showcasing the engagement of stakeholders beyond the immediate project scope.
    - Eleven thousand, seven hundred and four community members participated in various activities, with a notable three thousand, seven hundred and seventy-four young people engaged, highlighting the focus on youth participation.
    - Three hundred and fifty-two food system experts provided guidance, enhancing the overall initiative.
    - In total, 61.6% of user and non-user expectations were met, showcasing the tool's effectiveness in addressing diverse needs.
    - There was a 64% coherence with key policies such as the European Green Deal and Common Agricultural Policy (CAP) was achieved, aligning project outcomes with broader sustainability goals.
    - Overall, 58% of participants demonstrated a commitment to learning and development, supporting ongoing knowledge transfer and capacity building.

Through these activities, the tool played a pivotal role in building social capital, fostering collaboration, and promoting public awareness of sustainable food systems. The partnerships and networks established through the project are expected to have long-term benefits, particularly in advancing urban food system sustainability.

2. Environmental Impact
    - One thousand, three hundred and fifty-six stakeholders were actively involved, increasing visibility and recognition of CRFSs across regions.
    - Of these, 43 stakeholders initiated carbon or sustainability reports aimed at reducing emissions.
    - Further, 60 stakeholders adopted lean principles, improving resource efficiency in food systems.
    - One hundred and nineteen cities and regions participated, expanding the project's geographic reach.
    - Seventy-nine activities enhanced circularity and 35 events addressed food poverty and waste reduction.
    - Four hundred and forty sustainable food practices were promoted, with 17 natural resources protected or preserved.

The Cities2030 tool proved critical in enabling stakeholders to measure environmental progress, particularly in relation to CO_2 reduction and food waste management. The tool's ability to track and quantify these initiatives helped stakeholders align their efforts with European Green Deal and Farm to Fork Strategy targets. By enabling urban regions to monitor their environmental contributions, the tool supported informed decision-making and the prioritization of sustainability goals.

3. Economic Impact
    - Forty-eight product innovations and 11 process innovations were introduced, driving economic growth within CRFSs.
    - Eighteen existing products or services were improved, supporting regional economic development.
    - One hundred and fifty-six companies were consulted, leading to the engagement of 20 new employees in food systems.
    - One hundred and fifty-seven food producers and 7719 new consumers participated in short food supply chains (SFSC), increasing market opportunities for sustainably produced goods.
    - Ten meetings with investors were facilitated and 46 events were organized to boost CRFSs expertise among companies.

The tool's impact on the economic viability of CRFSs was particularly notable. By promoting innovation and supporting financial sustainability, the tool helped stakeholders identify opportunities to reduce operational costs, streamline supply chains, and increase market access for local food producers. The emphasis on short food supply chains also played a crucial role in enhancing the resilience of local economies.

4. Technological Impact
    - Twenty-nine new technologies were created and another twenty-nine technologies were improved through project partnerships.
    - Seventeen research projects were identified as foundational for future technological advancements in urban food systems.

The tool supported the development and improvement of technologies that contributed to more efficient and sustainable food systems. The collaboration between academic, public, and private entities facilitated technological innovations that are expected to drive future advancements in urban food systems.

5. Legal, Policy, and Security Impact
    - Ten urban food deserts were identified, leading to actions aimed at improving access to sustainable food retail points.
    - Forty public policy documents now mention food-related issues, reflecting growing recognition of food systems in urban governance.
    - Two hundred and twenty-two actions in schools promoted sustainable food education.
    - Eleven cities engaged in the Milan Urban Food Policy Pact (MUFPP), demonstrating their commitment to sustainable food policies.
    - Five hundred and thirteen activities focused on implementing key EU policies, including Food2030, the UN's New Urban Agenda, and the Sustainable Development Goals (SDGs).
    - Ninety governance- and policymakers were involved in CRFSs' governance, with 45 practices examined and three policy documents currently in progress.

The tool's ability to integrate policy and governance considerations into sustainability efforts enabled cities to address regulatory challenges and align their actions with international and regional frameworks, such as Food2030 and the SDGs. Its contribution to public policy development underscores its role in shaping sustainable food system governance.

6. Cultural and Value Impact
    - A total of 25,540 citizens were engaged through various cultural and value-driven activities.
    - One hundred and ten events were organized to promote culturally appropriate food systems.
    - Five hundred and twenty-six activities focused on making culturally appropriate food available in schools, workplaces, and neighborhoods.
    - Ninety-one Food Systems Dialogues (FSD) were conducted, fostering discussions on the future of food systems.
    - Twenty-one cross-border cooperation sessions facilitated knowledge sharing and innovation across regions.

The Cities2030 project's emphasis on cultural and value-driven impacts highlighted the importance of local traditions and practices in shaping sustainable food systems. By engaging a diverse range of stakeholders in cultural dialogues and cross-border cooperation, the tool contributed to the creation of inclusive and culturally relevant food systems.

Overall, the 2023 test year confirmed the effectiveness and adaptability of the Cities2030 impact assessment tool across diverse urban contexts. The tool's multi-dimensional approach, combined with iterative refinement and stakeholder collaboration, enabled it to capture comprehensive impacts across social, environmental, economic, and policy dimensions. While the tool proved highly effective, future developments could focus on enhancing long-term data tracking and usability through training programs, especially in regions with limited technological infrastructure.

4. Discussion

The Cities2030 project has made significant strides in advancing the sustainability, resilience, and inclusivity of urban food systems through the development and deployment of a multi-dimensional impact assessment tool. This tool, underpinned by design thinking methodologies and co-creation processes, provided a comprehensive framework for evaluating interventions across social, environmental, economic, and technological dimensions. The project aimed to align with broader European policies such as Food2030 and the European Green Deal, positioning CRFSs as critical levers for urban sustainability.

The insights gained from the 2023 test year have provided a wealth of data that can be interpreted within the context of prior research, working hypotheses, and the evolving landscape of urban food systems. This section delves into the key findings, comparing them to existing research, revisiting the working hypotheses, and exploring the broader implications for policy and future applications. The discussion highlights the project's contributions to global sustainability agendas while addressing areas of success, challenges, and potential directions for future research.

4.1. Key Findings and Interpretation in the Context of Previous Studies

4.1.1. Design Thinking for Impact Assessment

Previous research has suggested that traditional impact assessment tools often lack the flexibility to address the complex and interconnected nature of urban systems. Sonnino et al. (2019) argue that rigid, predefined frameworks fail to capture the nuanced dynamics of food systems in urban contexts [14]. Similarly, Godfray et al. (2010) highlight the limitations of conventional tools in adapting to evolving environmental and socio-economic conditions [21].

The Cities2030 project addressed these gaps by applying a design thinking approach which fosters adaptability through co-creation, stakeholder engagement, and iterative refinement. This methodology allowed the framework to be continually updated based on stakeholder feedback, making it more responsive to the dynamic nature of urban food systems. These findings align with those of Kolko (2015) and Brown (2009), who emphasize that design thinking can facilitate innovation in complex, multi-stakeholder environments by centering human needs and promoting continuous iteration [21,22]. The project's

outcomes support the argument that such an approach fosters flexibility and innovation, ensuring more effective adaptation to real-world urban food system challenges.

4.1.2. Multi-Dimensional Impact Measurement

The Cities2030 project's holistic evaluation of impacts across six dimensions—social, environmental, economic, legal/security, cultural, and technological—aligns with the frameworks advocated by Kremen and Miles (2012), who emphasize the importance of considering a broad range of factors in sustainability assessments [30]. The integration of the Goal Attained Model and the Competing Values Model into the Cities2030 impact assessment tool reflects the growing recognition in the literature that multi-dimensional models are essential for capturing the full scope of sustainability outcomes in CRFSs [41,67].

The practical application of these frameworks in Cities2030, through a combination of indicators measuring the interplay of social, environmental, and economic factors, extends beyond theoretical constructs to real-world implementations in diverse urban settings. This approach not only validates the effectiveness of multi-dimensional models in sustainability research but also demonstrates their practical value in supporting decision-making within city-region contexts.

4.1.3. Community Engagement and Co-Creation

Research on sustainable development frequently emphasizes the critical role of community engagement and co-creation in successfully implementing sustainability initiatives. Scoones (2016) and Benton et al. (2021) argue that involving diverse stakeholders in decision-making processes leads to more equitable and effective outcomes [18,28]. The Cities2030 project exemplifies this by actively engaging 11,704 community members and establishing 296 new partnerships, which led to tangible outcomes such as reductions in food poverty and enhancements in circular food systems.

The project's emphasis on inclusive governance supports Marsden and Morley's (2014) argument that co-creation and community participation are essential for achieving long-term sustainability in food systems [17]. By incorporating diverse perspectives and fostering stakeholder ownership, Cities2030 not only enhanced participation but also strengthened social capital within the regions involved. These findings highlight the transformative potential of co-creation for building resilient, community-driven urban food systems.

4.1.4. Technological Innovation in Urban Food Systems

The development of 29 new technologies and the enhancement of 29 existing technologies within the Cities2030 project underscore the importance of technological innovation in advancing sustainable food systems. Ingram (2011) suggests that technological advancements, particularly those aimed at improving food security, are critical for addressing global environmental challenges [13].

The project's focus on technology-driven solutions, including digital tools, artificial intelligence, and data analytics, aligns with broader trends in agritech and foodtech sectors, where technological innovations are increasingly viewed as pivotal for enhancing the efficiency and resilience of urban food systems. The success of these innovations within the Cities2030 context supports the view that integrating technology is crucial for advancing sustainability goals and ensuring food system adaptability in complex urban environments.

4.2. Addressing Key Successes and Areas for Improvement

The Cities2030 project produced several notable achievements in advancing sustainable urban food systems, largely due to the effectiveness of its multi-dimensional impact assessment tool. Below are some of the most significant successes:

- Formation of New Partnerships: The project facilitated the establishment of 296 new partnerships across diverse CRFSs. These collaborations involved local governments, food producers, community organizations, and private enterprises, creating networks that not only supported immediate project goals but also laid the

groundwork for ongoing collaboration and innovation. This outcome is particularly relevant to the objectives outlined in the European Green Deal and Farm to Fork Strategy, where multi-stakeholder partnerships are considered crucial for sustainable urban food system transformation.

- Promotion of Innovation and Circular Economy Practices: The tool enabled participating cities to track and report innovations in urban agriculture, CO_2 reduction, and food waste management. By enhancing supply chain efficiency and promoting the localization of food production, the tool contributed to both economic resilience and environmental sustainability. For instance, the adoption of circular economy practices not only supported environmental goals but also generated economic value for stakeholders by reducing operational costs and creating new market opportunities for sustainably produced goods.
- Tool Adaptability: A major success factor was the tool's adaptability across different regions. Stakeholder feedback highlighted its ability to be customized according to the unique sustainability challenges and priorities of each region. Whether applied in densely populated urban centers or in smaller peri-urban areas, the tool proved flexible enough to assess interventions tailored to specific local contexts. This adaptability ensured that the tool remained relevant and scalable, demonstrating its potential for broader application within Europe and in diverse global contexts.

These successes underscore the utility of the Cities2030 tool in supporting data-driven decision-making, fostering innovation, and promoting collaborative governance in urban food systems. Several challenges emerged during the 2023 test year which offer insights for improving future iterations of the tool:

- Addressing Regional Disparities: Some regions, particularly those with limited technological infrastructure, faced challenges in data collection and tool implementation. Stakeholders in these regions struggled to gather accurate and comprehensive data, which affected the overall effectiveness of the tool in those contexts. This highlights the need for better integration of low-tech solutions or alternative data collection methodologies, such as mobile-based surveys or simplified data entry forms, that can be employed in regions with limited access to advanced digital infrastructure.
- Enhancing Training and Usability Support: Although the tool was designed to be user-friendly, stakeholder feedback indicated that additional training and capacity-building initiatives would significantly improve its implementation. In regions with less experience in data collection or impact assessment, the provision of workshops, online tutorials, or dedicated support teams would help stakeholders fully leverage the tool's capabilities. Ensuring adequate training will be essential for expanding the tool's application in a wider range of socio-economic and technological contexts.
- Long-Term Data-Tracking Capabilities: Another area for improvement is the tool's capability for long-term monitoring and evaluation. While the tool performed well in capturing impacts during the 2023 test year, stakeholders emphasized the need for enhanced features to track sustainability metrics over extended periods. Improving the tool's longitudinal tracking capabilities would enable users to monitor ongoing progress and make data-driven adjustments, ensuring the long-term sustainability and resilience of interventions.

Addressing these areas for improvement will help future iterations of the Cities2030 tool to become even more effective in supporting sustainable transformations of CRFSs. By incorporating more adaptable, long-term, and context-sensitive solutions, the tool can better accommodate diverse global contexts and provide deeper insights into the evolving dynamics of urban food systems.

4.3. Working Hypotheses Revisited

The Cities2030 project was guided by two key hypotheses that shaped its design and implementation. The findings from the project strongly support both hypotheses,

demonstrating the effectiveness of the design thinking approach and the value of a multi-dimensional impact assessment framework for CRFSs.

The Cities2030 project validated this hypothesis through an iterative design process that emphasized continuous stakeholder engagement, co-creation, and adaptability. The design thinking approach facilitated the development of an impact assessment framework that evolved based on real-time feedback and could be tailored to different city-region contexts. This adaptability was highlighted by stakeholders and evidenced by the tool's successful application across diverse urban regions, demonstrating that design thinking fosters innovation and flexibility in addressing urban food system challenges [21,22].

The framework's capacity to incorporate diverse stakeholder perspectives, adapt to evolving challenges, and remain effective across varied urban environments is central to the successful transformation of urban food systems. These findings align with broader arguments by Buchanan (1992), who posits that design thinking is particularly useful in addressing complex, "wicked" problems like those encountered in urban food systems [80].

This hypothesis was also validated through the Cities2030 project's multi-dimensional impact assessment tool, which measured outcomes across social, environmental, economic, legal, and technological dimensions. The tool's ability to integrate a wide range of indicators allowed it to capture the full complexity of CRFSs, supporting the argument by Kremen and Miles (2012) that multi-dimensional sustainability frameworks are essential for accurately assessing urban systems [30].

The Cities2030 tool's alignment with theoretical models like the Goal Attained Model and the Competing Values Model further demonstrated that holistic approaches are crucial for addressing the multifaceted challenges of sustainability in urban contexts [81]. The tool's practical application in diverse settings, along with its capacity to measure complex outcomes such as food security, circular economy practices, and social resilience, substantiated the effectiveness of multi-dimensional assessment models in real-world urban food systems [14].

4.4. Implications for Policy and Urban Food Systems

The results from the Cities2030 project present significant implications for urban food system policy and governance, with potential applications for broader sustainability strategies. The project's multi-dimensional impact assessment tool, grounded in empirical data and stakeholder input, offers a new perspective on how urban regions can align local actions with larger sustainability goals.

- Alignment with EU Strategies: The Cities2030 tool directly supports key EU policy frameworks, including the European Green Deal, Farm to Fork, and Food2030 strategies. By integrating metrics such as CO_2 reduction, food waste management, and community engagement, the tool enabled urban regions to quantify their contributions to these overarching goals. This alignment underscores the tool's value in helping cities meet EU-wide sustainability targets, ensuring that local actions contribute to broader policy outcomes.
- Policy Development and Evidence-Based Decision-Making: One of the primary strengths of the Cities2030 tool is its capacity to generate multi-dimensional, data-driven insights. Policymakers can utilize these detailed metrics to understand the varied impacts of interventions, enabling more nuanced and targeted sustainability policies. Additionally, the tool's robust data visualization capabilities foster enhanced communication between stakeholders, making it easier to advocate for and implement evidence-based policies.
- Potential for Broader Urban Applications: Although initially tailored for CRFSs, the Cities2030 framework has potential applicability in other urban sustainability contexts. Its adaptable structure can be modified to evaluate the sustainability performance of different urban sectors, such as energy, water, and waste management. The tool's cross-sectoral potential makes it a strong candidate for developing integrated urban strategies that can tackle multiple aspects of urban resilience and sustainability concurrently.

4.5. Future Research Directions

- While the Cities2030 project has made significant contributions to urban sustainability research, further studies are needed to address emerging challenges and enhance the tool's applicability in varied contexts. Future research should focus on refining and expanding the tool's capabilities in the following areas:
- Long-Term Impact Assessment: Future research should prioritize the development of methods for the longitudinal tracking of sustainability and resilience in CRFSs. Long-term evaluations would provide a deeper understanding of the lasting effects of interventions and allow for more comprehensive assessments of their contributions to environmental, social, and economic sustainability.
- Scalability and Transferability to Global Contexts: The adaptability of the Cities2030 tool should be tested in diverse socio-economic and environmental contexts, including urban areas outside Europe. Investigating how the tool can be tailored to meet the specific sustainability needs of different regions would assess its scalability and global transferability, making it a potentially valuable resource for cities worldwide.
- Integration of Advanced Technologies: Exploring the integration of advanced technologies such as artificial intelligence (AI), blockchain, and the Internet of Things (IoT) could significantly enhance the tool's functionality. These technologies would improve real-time data collection, increase transparency, and allow for more dynamic monitoring of sustainability interventions. Additionally, AI and machine learning could offer predictive capabilities, helping stakeholders identify trends and make more informed decisions based on complex data patterns.
- Cross-Sectoral Policy Integration: Further research should explore the applicability of the tool beyond food systems to include other urban sectors, such as energy, water, and waste management. Developing cross-sectoral impact assessment models would enable cities to address multiple dimensions of urban resilience and sustainability in a holistic manner. This would support the creation of integrated policies that break down silos and promote synergies between different urban systems, fostering more resilient and sustainable cities.
- By addressing these research gaps, future iterations of the Cities2030 tool can be enhanced to provide even more comprehensive, long-term, and scalable solutions for promoting sustainability across urban systems globally.

5. Conclusions

The Cities2030 project has successfully developed an adaptable and robust impact assessment framework for city-region food systems (CRFSs) by leveraging a design thinking approach, iterative development, and extensive stakeholder engagement. This comprehensive framework addressed key challenges identified in the initial stages of the project, including the need for flexibility, multi-dimensionality, and stakeholder inclusivity, thereby aligning local actions with broader EU policies like the European Green Deal, Farm to Fork, and Food2030 strategies.

- The developed Methodological Framework for Impact Assessment, structured through iterative stages—ranging from theoretical review and design thinking workshops to thematic coding and simulation testing—ensured a comprehensive approach to tool development. This structured framework enabled the integration of diverse stakeholder inputs and facilitated real-time adaptability across different city-region contexts, highlighting the framework's effectiveness in creating an evidence-based and scalable assessment tool.
- The use of a design thinking methodology proved crucial in overcoming the limitations of traditional, rigid assessment frameworks that often fail to capture the complexities of urban food systems. The iterative, human-centered approach fostered cross-sectoral collaboration and enabled the tool to evolve based on real-time feedback, ensuring it remained responsive to the dynamic needs of diverse urban contexts. This adaptive capacity directly addressed the challenge of developing an impact assessment tool that

could handle the varied socio-economic and environmental conditions of different city-regions.

- The project successfully addressed the challenge of ensuring inclusivity and stakeholder alignment by involving 65 stakeholders in the co-creation process. This participatory approach facilitated consensus on the most relevant criteria for impact assessment, ensuring that the tool accurately reflected the priorities of policymakers, community members, and urban planners. By engaging stakeholders in multiple iterations, the tool strengthened ownership and ensured alignment with local, regional, and international sustainability goals.
- The iterative tool development process, incorporating input from 136 partner representatives and extensive theoretical and practical testing, overcame the challenge of balancing theoretical robustness with practical applicability. This approach ensured that the tool was thoroughly vetted and could be effectively deployed across real-world scenarios, making it versatile enough to be applied to both densely populated urban centers and smaller peri-urban regions.
- The framework's capacity to evaluate impacts across six dimensions—social, environmental, economic, legal/policy, culture and values, and technological—addressed the need for a comprehensive assessment model that captures the full complexity of CRFSs. This multi-dimensionality allowed stakeholders to evaluate the interplay of various factors, ensuring a holistic understanding of sustainability interventions. It addressed a core challenge of traditional models, which often fail to account for the interconnected nature of urban systems.
- The initial application of the tool yielded significant outcomes, including 296 new partnerships, engagement of over 11,000 community members, 48 product innovations, and 29 new technologies. These results highlight the tool's effectiveness in fostering collaboration, driving innovation, and promoting circular economy practices, ultimately contributing to sustainable urban food system transitions. This demonstrated success confirms that the tool is capable of generating meaningful, multi-dimensional impacts in diverse city-region contexts.
- The ability of the framework to be tailored to specific local contexts while maintaining alignment with broader European strategies was a key achievement. This adaptability addressed the challenge of creating a one-size-fits-all tool and ensured its relevance across diverse geographic, socio-economic, and political landscapes, thereby supporting localized solutions without losing sight of overarching sustainability goals.
- Despite its successes, challenges remain, particularly in enhancing the tool's scalability and long-term applicability in regions with limited technological infrastructure. Addressing these challenges will require ongoing iterations and additional training programs to build capacity in less-developed regions. Further refinement will focus on integrating long-term tracking capabilities and exploring the potential of emerging technologies like artificial intelligence and IoT to further enhance the tool's predictive capabilities.

These conclusions underscore the success of the Cities2030 project in creating a flexible and inclusive framework that supports sustainable, resilient, and context-sensitive transitions in urban food systems. By aligning local interventions with broader EU policies and demonstrating tangible multi-dimensional impacts, the Cities2030 impact assessment tool provides a replicable model for future urban sustainability initiatives across various sectors.

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Appendix A

Variables of impact in six areas:

1. Social impact selected indicators:
    - Number of new partnerships and networks created in the Cities2030;
    - Number of external partner and crowd-initiated ideas;
    - Number of other community members involved in the project city/region activities;
    - Number of youngsters involved in the project activities;
    - Number of food system experts involved;
    - Ability to cope with users and non-users expectations and needs (to what extent the needs and requirements of end users are met, and how CITIES2030 can meet their expectations) (evaluate in scale of 100%);
    - Project coherence with other policies e.g., green deal, CAP, etc. (evaluate in 100%);
    - Commitment towards learning and development (participants involved have adequate knowledge, skills and tools to achieve their full potential to support the development of SFSC, and ensure a sustainable growth of urban life quality (evaluate in 100% scale).
2. Environmental:
    - Increased visibility and recognition of CRFSs by number of stakeholders engaged (involved);
    - Number of stakeholders that put out carbon or sustainability reports, limits harmful pollutants and chemicals or seeks to lower greenhouse gas emissions;
    - Number of stakeholders that adapt lean principles in CRSFs;
    - Number of cities and regions involved in CRFSs (in Cities2030 activities);
    - Number of activities to enhance circularity and local food belts;
    - Number of events to reduce CO_2 emission, transport emissions by all actors in the chain at different stages;
    - Number of events to stop food poverty, generation of surpluses and waste;
    - Number of activities related to sustainable food;
    - Number of optimized food delivery chains;
    - Number of protected and preserved nature resources.
3. Economical:
    - Number of product innovations (new products or services);
    - Number of process innovations (new production or delivery methods);
    - Improved existing products or services;
    - Number of companies consulted about CRFSs;
    - Number of new employees involved (from partner companies) in CRFSs;
    - Number of saved financial resources due to CRFSs (EUR);
    - Incomes generated for stakeholders from CRFSs activities (EUR);
    - Number of financial resources attracted (the amount of investment) to CRFSs (EUR);
    - Number of food producers engaged in SFSC;
    - Number of new consumers engaged in SFSC;
    - Number of structured investment capital plans;
    - Number of investors contacted;
    - Number of meetings with investors;
    - Number of investors' Memorandum of Understandings signed;
    - Number of events for companies to increase of expertise (the level of CRFSs expertise;

- Number of activities to increase salaries, expertise, competencies of employees at CRFSs due to project activities;
- Number of exploitation plans;
- Number of good practices (generated);
- Number of business plans for innovations.

4. Technological:
   - Number of new technologies created in project or partnerships;
   - Number of technologies improved in the project or partnerships;
   - Number of research projects that could be a base for new technologies;
   - Number of developing transportable units with new technologies, for farmers and schools to teach STEM;
   - Number of digital learning platforms.
5. Legal, Political, Security:
   - Number of CRFS-PL (policy labs);
   - Number of CRFS-LL (living labs);
   - Number of urban food deserts: distances home/sustainable food retail points;
   - Number of public policies documents mentioning food stakes;
   - Number of actions in schools, education;
   - Number of cities engaged in MUFPT;
   - Number of activities related with implementation of EU policies > Food2030, UN's NUA and SDD-11, and consorts;
   - Number of scientific papers related to Cities2030 legal, policy or security aspects;
   - Number of practices (examined) in WP field;
   - Number of interviews realized in WP field;
   - Number of new policy documents in progress;
   - Number of new policy documents in action;
   - Number of governance- and policymakers involved.
6. Cultural and Values:
   - Number of citizens touched by Cities2030 activities (culture and value impact);
   - Number of events organized or participated in (culture and value impact);
   - Urban/rural food consumers' perception on SFSC (number of new consumers engaged in SFSC);
   - Number of activities related to culturally-appropriate food available in neighborhoods, in schools, in the work place, etc.;
   - Number of Food Systems Dialogues (FSD);
   - Number of cross-border cooperation sessions.

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