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Reimagining Corporate Food Museums as Living Labs: A Heritage-Driven Model for Sustainable, Inclusive, and ICT-Enhanced Food Innovation

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Abstract

Corporate food museums are increasingly recognised as strategic heritage infrastructures capable of mediating between industrial memory, territorial identity, and contemporary societal challenges. This paper proposes a conceptual shift that repositions corporate food museums from static repositories of brand heritage to Living Labs for sustainable, inclusive, and participatory food innovation. Drawing on the EU-funded GNAM project, the study adopts a qualitative methodology combining the mapping of Italian corporate food museums with an analysis of European Living Labs in the food and agri-food domain. The comparative framework informs the development of a heritage-driven Living Lab model articulated around three interconnected dimensions: cultural heritage valorisation, community engagement, and sustainable food system innovation. The model is empirically grounded through a series of design-driven workshops, technology-transfer activities, and digital engagement initiatives conducted within corporate museums and academic laboratories in Southern Italy. These include co-creation processes involving students, citizens, companies, and researchers; experimentation with food waste valorisation, biodegradable and hybrid materials, and 3D food printing; and the deployment of digital platforms and immersive virtual environments. The paper contributes to heritage studies by advancing a replicable framework in which corporate food museums act as active agents of sustainable transformation, linking cultural heritage, technological experimentation, and community participation.

Keywords: corporate food museums; living labs; cultural heritage innovation; sustainable food systems; participatory design; community engagement; food waste valorisation; technology transfer; digital heritage

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1. Introduction

Achieving sustainable, inclusive, and culturally grounded food systems represents one of the most pressing challenges of the twenty-first century. Rising environmental pressures, socio-economic instability, and global health concerns demand systemic innovation capable of supporting both producers and consumers. While food companies struggle to adopt sustainable models under increasing market volatility and resource constraints, citizens often lack access to opportunities to participate meaningfully in shaping innovation processes [1]. Existing outreach, educational, and communication strategies frequently fail to

create durable behavioural change or foster the collective engagement required to address such complex challenges, highlighting the need for more immersive, participatory, and experience-based approaches to sustainability engagement [2]. In parallel, recent research in heritage studies highlights how food practices and culinary traditions are increasingly recognised as dynamic forms of cultural heritage that can support sustainable development and community engagement [3,4]. Participatory heritage approaches, particularly in museum and ecomuseum contexts, demonstrate how food-related knowledge can be mobilised to foster social innovation, environmental awareness, and local identity [5]. The GNAM project (Growing Novel food Living lAbs in corporate Museums) [6] proposes a paradigm-shifting response by transforming corporate food museums—traditionally custodians of industrial heritage and corporate identity—into Living Labs (LLs). The project involved two universities, a pasta factory, a restaurant, and two corporate museums Gias experience [7] owned by Gias, an Italian company that is a leader in the frozen food sector, and Museo della Carta [8] owned by Rubbettino, a company specializing in the printing, paper converting, and publishing sectors.

Corporate museums are a contemporary phenomenon increasing in the last few years with a growing interest as tourism destinations [9]. It is estimated that between 2009 and 2023, 5.8 million Italian people have visited a corporate museum in Italy [10].

This transformation promoted by the GNAM project positions museums not merely as repositories of memory, but as active infrastructures for participatory experimentation, co-creation, and technology transfer. Leveraging the symbolic, cultural, and educational value of corporate museums, GNAM aims to activate new forms of collaboration between companies, communities, researchers, and institutions, thereby strengthening food system resilience.

Central to the project is the idea that corporate museums represent a unique intersection between heritage, identity, and innovation. By embedding Living Labs (LLs) within these heritage spaces, the project enables real-life prototyping of technologies, materials, services, and behavioural strategies. The LLs respond to four strategic domains—technology transfer, education, product and service innovation, and communication—creating a distributed ecosystem that integrates business needs with societal objectives. Activities such as co-design workshops, multisensory educational initiatives, digital fabrication demonstrations, and participatory events foster new forms of engagement and enrich food literacy among diverse publics [11,12]. In this context, corporate food museums can be reinterpreted not only as spaces for the preservation and communication of industrial heritage, but also as active cultural infrastructures capable of supporting participatory innovation processes. Recent developments in heritage studies have increasingly emphasised the shift from heritage as a static representation of the past to heritage as a dynamic, socially constructed and future-oriented practice [13,14]. By framing corporate museums as Living Labs, this research contributes to this debate, exploring how heritage institutions can act as platforms for co-creation, knowledge exchange, and sustainable innovation within contemporary food systems.

The present paper situates the GNAM initiative within the broader landscape of cultural heritage infrastructures and European Living Labs. It offers a comparative analysis of Italian corporate food museums and European food-domain LLs, presents the workshop-driven Living Lab model developed within GNAM, and argues for a new cultural heritage framework that redefines corporate museums as participatory hubs for sustainable transformation. Through this approach, the paper contributes to ongoing discussions in the heritage field on how cultural spaces can expand their social, cultural, and economic impact while supporting innovation and community resilience.

2. Materials and Methods

This study initially adopts a qualitative and exploratory research design to map and compare Italian corporate food museums and European Living Labs operating in the food and agri-food domain [15]. The methodological approach integrates desk research, mapping analysis, and comparative interpretation to investigate the cultural heritage value, functional roles, and innovation potential of these two models, with particular attention to opportunities for cross-fertilisation between heritage infrastructures and participatory innovation ecosystems [16].

The second part of the research (Section 3) adopts participatory design and innovation to ideate and concretely experiment with a model for evolving corporate museums in living labs.

To improve clarity and provide an overview of the research design, Figure 1 presents the methodological workflow, summarising the sequential phases of mapping, analysis, co-design, implementation, and evaluation.

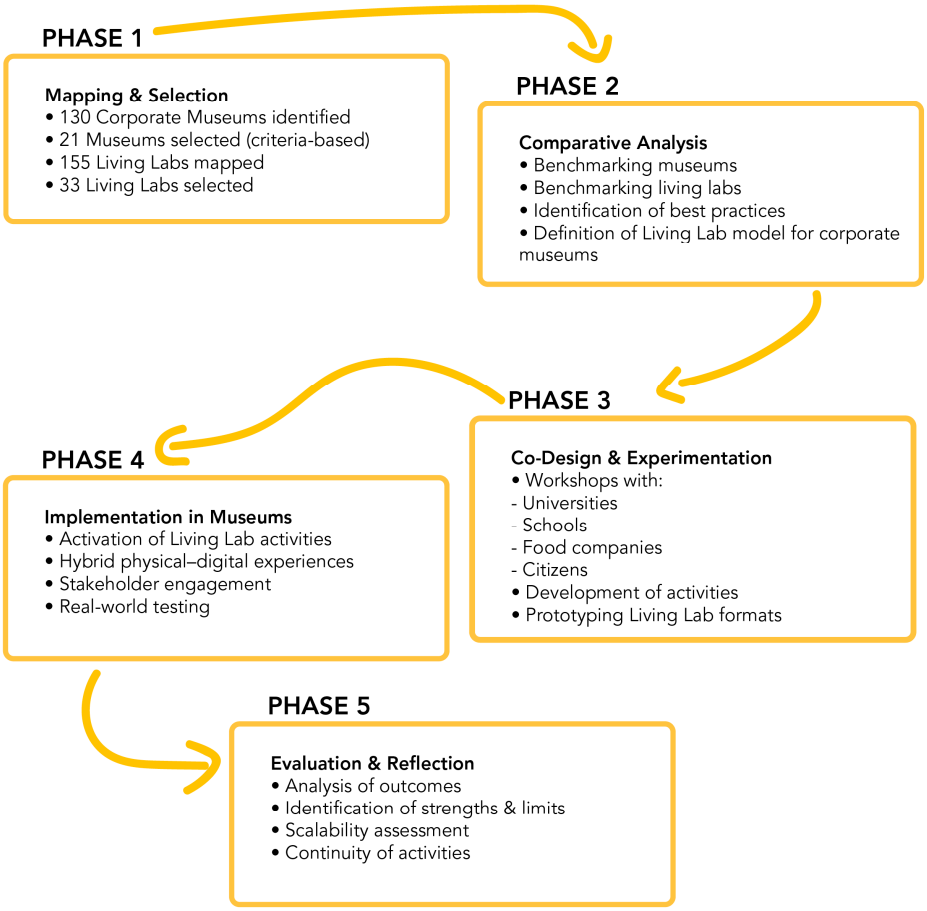

Figure 1. Research methodology workflow illustrating the sequential phases of the study, from mapping and selection of corporate museums and Living Labs to co-design, implementation, and evaluation of Living Lab activities within corporate food museums.

2.1. Mapping Corporate Food Museums in Italy: Cultural Heritage Value and Functions

Corporate museums have emerged over recent decades as a distinctive category within the broader field of industrial and cultural heritage. Developed by companies to preserve, interpret, and communicate their history, values, and production culture, corporate museums function at the intersection of heritage preservation, corporate communication, and territorial identity. Unlike traditional public museums, they are closely linked to industrial processes, brand narratives, and entrepreneurial trajectories, often located within or near

production sites and embedded in local socio-economic contexts [17,18]. In the Italian context, corporate museums play a particularly significant role due to the strong connection between manufacturing, craftsmanship, and regional cultural identity, especially in sectors such as food, design, and publishing.

Scholars have highlighted that the corporate museums not only safeguard material and immaterial heritage—such as machinery, recipes, know-how, and narratives—but also act as mediators between companies and the public, contributing to experiential learning, cultural tourism, and place branding [19]. However, their role has traditionally remained largely representational, focusing on storytelling and exhibition rather than on participatory knowledge production or innovation. This limitation has prompted recent calls to reconceptualise corporate museums as active cultural infrastructures capable of supporting social engagement, sustainability-oriented practices, and innovation processes [20,21]. Within this evolving framework, corporate food museums represent a particularly fertile domain for experimentation, as they combine industrial heritage with everyday practices, dietary cultures, and contemporary challenges related to food systems.

Despite their growing relevance as cultural and tourism infrastructures, corporate museums remain institutionally characterised by a dual mission that can generate structural tensions. On the one hand, they are designed to communicate brand identity, corporate memory, and industrial excellence through curated narrative strategies. On the other hand, the transformation of these institutions into participatory Living Labs requires a shift toward openness, co-creation, and the redistribution of epistemic authority to visitors and external stakeholders. Harmonising brand storytelling with active participation therefore represents a critical challenge. Rather than replacing narrative functions, the Living Lab approach proposed in this paper suggests a process of institutional hybridisation in which corporate museums evolve into mediating platforms capable of balancing representational heritage functions with experimental and socially embedded practices. In this perspective, museums are not merely spatial hosts of activities but become governance actors facilitating dialogue between companies, communities, researchers, and policy stakeholders.

For the purposes of our research, the mapping of Italian corporate food museums was conducted through a structured desk-based analysis supported by targeted data collection from institutional networks, official museum documentation, and scientific literature. The initial sample was drawn from the *Museimpresa* network [22], which includes approximately 130 corporate museums in Italy [23]. From this population, 21 museums operating in the agri-food domain were selected as the focus of the analysis, based on their relevance to food production, culinary heritage, and regional agri-food systems.

Data sources included museum websites, annual reports, sustainability reports, codes of ethics, archival descriptions, and publicly available statistics on visitors and activities, complemented by peer-reviewed literature on corporate museums, industrial heritage, and cultural tourism. The analysis aimed to identify the cultural heritage value of these institutions in terms of their contribution to regional identity, craftsmanship, and the transmission of culinary traditions.

Corporate food museums were classified according to their dominant typologies, including product museums, factory museums, and brand or archive-based museums. Attention was paid to their declared and implicit functions, such as heritage preservation, corporate communication, experiential marketing, tourism development, education, and brand storytelling. Additional variables included geographic distribution, target audiences, stakeholder networks, and declared commitments to social responsibility and sustainability, with reference to the United Nations Sustainable Development Goals (SDGs).

2.2. Mapping European Living Labs in the Food and Agri-Food Domain

Living Labs have emerged in Europe as a prominent innovation model for addressing complex societal challenges through user-centred, participatory, and real-life experimentation. Initially developed within the field of information and communication technologies, the Living Lab approach has progressively expanded to domains such as sustainability, urban development, health, and food systems, where multi-stakeholder collaboration and contextualised testing are essential [16]. Living Labs are generally characterised by the active involvement of users and communities as co-creators, the integration of experimentation into real-world settings, and the alignment of technological innovation with social, environmental, and economic objectives [24].

In the food and agri-food domain, European Living Labs have been increasingly adopted to support sustainable production, circular economy practices, food literacy, and behavioural change across the food value chain [25]. These initiatives often operate as open innovation ecosystems that connect research institutions, companies, public authorities, and civil society, enabling the co-design and evaluation of products, services, and policies under realistic conditions. As such, Living Labs represent a relevant analytical benchmark for this study, providing methodological and organisational insights that can inform the transformation of corporate food museums into participatory and innovation-oriented heritage infrastructures. Mapping European food-related Living Labs, therefore, allows the identification of recurring practices, governance models, and engagement strategies that are transferable to heritage-based contexts.

In our research, a mapping of European Living Labs operating in the food and agri-food sector was carried out using data from the European Network of Living Labs (ENoLL) [26]. From a total of 155 active Living Labs, 33 were selected based on their explicit focus on food systems, agriculture, nutrition, or related sustainability challenges.

The analysis relied on official Living Lab profiles, project descriptions, ENoLL documentation, and secondary literature on Living Lab theory and practice. The mapping focused on identifying the methodological frameworks adopted by these LLs, particularly their use of co-creation, real-life experimentation, and multi-stakeholder engagement. Core principles such as value creation, realism, openness, sustainability, and user influence were used as analytical dimensions.

Participatory approaches were systematically examined, including hands-on workshops, sensory experimentation, community-based prototyping, educational programmes, and field experimentation. In addition, mechanisms for value generation across the food chain were identified, encompassing technology transfer, capacity building, behavioural change, social innovation, and policy influence. The geographical distribution, organisational structure (public vs. private), and stakeholder composition of the LLs were also documented to contextualise their operational environments.

2.3. Comparative Analysis and Cross-Fertilisation Opportunities

A qualitative comparative analysis was conducted to identify convergences and divergences between Italian corporate food museums and European food Living Labs. The comparison was structured around key dimensions: institutional mission, spatial and cultural assets, stakeholder engagement, participatory practices, innovation capacity, and sustainability orientation.

Corporate food museums were analysed primarily as cultural heritage infrastructures with strong territorial roots, symbolic capital, and experiential resources, but limited mechanisms for user-driven experimentation. Conversely, Living Labs were examined as innovation-oriented ecosystems characterised by participatory methodologies and

real-life testing, yet often lacking deep connections to cultural heritage and long-term narrative continuity.

Based on this comparison, opportunities for cross-fertilisation were identified, particularly in relation to the activation of food heritage as a driver for experiential learning, citizen engagement, and sustainable innovation. The analytical framework informed the conceptual positioning of corporate museums as potential Living Labs, capable of integrating heritage-based storytelling with participatory innovation practices. This comparative approach provides the methodological foundation for the GNAM project model, which seeks to transform corporate food museums into hybrid spaces for cultural heritage valorisation, community engagement, and sustainable food system innovation.

3. Results: From Comparative Analysis to a Transformative Model for Corporate Food Museums as Living Labs

The comparative analysis between Italian corporate food museums and European food Living Labs highlighted a set of structural convergences and divergences that informed the definition of a model to guide the transformation of corporate museums into Living Labs. While corporate food museums are characterised by strong cultural heritage assets, spatial infrastructures, and narrative capacities rooted in territorial identity, they often lack structured mechanisms for participatory experimentation and user-driven innovation. Conversely, European food Living Labs demonstrate robust methodologies for co-creation, real-life testing, and multi-stakeholder engagement, yet frequently operate without deep connections to cultural heritage, historical continuity, or symbolic meaning.

Building on these insights, the proposed model integrates the complementary strengths of the two systems and is articulated along three interconnected dimensions: (i) cultural heritage valorisation, (ii) community engagement, and (iii) sustainable food system innovation. Together, these dimensions provide a conceptual and operational framework to reposition corporate food museums as hybrid heritage–innovation infrastructures. In the following, we report the actions ideated and concretely experimented to operationalise the framework. For the sake of clarity, the three dimensions are presented separately even if the principles and methods that inspired them are closely interconnected.

3.1. Cultural Heritage Valorisation Through Experiential and Sensory Design Practices

The first dimension of the model focuses on cultural heritage valorisation, understood not only as preservation and narration of the past, but as the activation of heritage through contemporary practices of learning, experimentation, and creativity. The comparative analysis revealed that while corporate food museums excel in storytelling and the exhibition of artefacts, Living Labs offer methodologies capable of transforming static heritage into dynamic, experience-based knowledge.

To operationalise this dimension, a co-design activity was conducted within the GNAM project involving high school students and professional practitioners, aimed at designing food products that enhance the texture and sensory qualities of plant-based ingredients. The activity took place at *La Tavernetta*, a restaurant made available by the BLEC partner and located in Camigliatello Silano (Cosenza, Italy), within the natural and cultural landscape of the Sila region. The choice of this location reinforced the link between food experimentation, local gastronomy, and territorial identity, aligning with the heritage-oriented mission of corporate food museums (Figure 2).

(**a**) (**b**) (**c**)

Figure 2. Co-design activity with high school students and professional practitioners conducted at *La Tavernetta*: (**a**) Ideation activity through collaborative brainstorming; (**b**) Co-creation of food products with plant-based ingredients; (**c**) Critical reflection as a final phase of tasting and discussing the food products.

The co-design activity conducted within the GNAM project exemplifies this approach. The participant group consisted of 15–20 individuals selected to ensure diversity in gender and expertise, including professional chefs, teachers, and non-professional participants such as fourth- and fifth-year students from a hotel management school. This heterogeneous composition was a deliberate methodological choice, fostering interaction between experiential knowledge, professional skills, and emerging competencies.

The workshop structure combined introductory sessions, thematic framing, collaborative brainstorming, hands-on experimentation, and collective evaluation. Students were actively involved in designing dishes with strong visual impact, nutritional balance, and layered textures, using graphic tools, group discussion, and iterative feedback from chefs. This participatory process transformed the learning environment into a space of shared authorship, where knowledge was co-produced rather than transmitted unidirectionally.

During the workshop activity, sustainability principles were embedded throughout the process, from the selection of fresh, seasonal vegetables to the full utilisation of plant components, including offcuts. Waste reduction strategies were explored through techniques such as pickling, drying, maceration, juicing, emulsification, and foaming, enabling participants to reflect on resource efficiency, circularity, and conscious cooking practices. The use of local herbs and spices further reinforced the connection between sustainable innovation and territorial identity.

The final phases of tasting, evaluation, and critical discussion allowed participants to assess sensory effectiveness, design innovation, and potential future developments, including the possibility of translating the designed components into digitally fabricated forms such as 3D-printed sauces or textures, to experiment with additive manufacturing that has emerged as a promising and environmentally sustainable solution to address the global issue of food loss [2]. This demonstrated how Living Lab methodologies can be embedded within heritage-based environments to prototype future-oriented food solutions while remaining accessible and educational.

The workshop was designed as a replicable methodology for Living Labs embedded in corporate museums, with the specific objective of stimulating sensorial creativity and promoting food education, particularly among younger generations and individuals less inclined to experiment with taste. By working on local ingredients, traditional aromas, and regional culinary references, the activity demonstrated how heritage can serve as a fertile

ground for innovation, rather than a constraint. In this sense, cultural heritage becomes an enabling infrastructure that supports experimentation while maintaining continuity with local identity and knowledge.

A further example of cultural heritage valorisation within the GNAM project is represented by the collaboration between the University of Siena and the Astorino pasta factory in Crotone (Italy), which focused on reinterpreting Italian pasta as a living asset of the Mediterranean diet through food technology and industrial innovation. Pasta is widely recognised as a cornerstone of Mediterranean food heritage, not only for its nutritional balance and affordability, but also for its deep cultural significance as a symbol of conviviality, regional identity, and culinary continuity. Building on this heritage value, the activity aimed to enhance pasta's functional and experiential qualities while preserving its traditional role within everyday diets.

The initiative combined advanced agronomic experimentation with industrial production techniques. Basil and tomatoes were cultivated at the hydroponic laboratory of the University of Siena using controlled micro-stress protocols—such as variations in light spectra, temperature, and humidity—to stimulate the natural synthesis of bioactive compounds, particularly polyphenols [27]. Tomato peels and basil leaves, typically considered by-products, were subsequently harvested, dried, and pulverised, and then incorporated into pasta dough formulations together with water and flavouring agents (Figure 3). This process allowed the valorisation of plant components rich in antioxidants while aligning with circular and sustainable production principles.

(**a**) (**b**)

Figure 3. Experimentation to reinvent Italian pasta and basil. (**a**) Cultivation of basil in the hydroponic laboratory at the University of Siena, using micro-stress protocols to stimulate the synthesis of bioactive compounds; (**b**) Production of ink using the basil leaves and preparation of the pasta dough.

The dough was shaped through 3D printing into an original pasta format named *Lilies*, inspired by the morphological resemblance to the lily flower. The geometry was intentionally designed to respond to contemporary consumer needs, enabling rapid cooking (approximately three minutes) and immediate consumption without additional toppings, as the pasta itself delivers tomato or basil flavour (Figure 4). Importantly, the integration of polyphenol-rich ingredients ensured that the bioactive components remained largely intact, contributing to the nutritional and health value of the final product.

(**a**) (**b**) (**c**)

Figure 4. 3D-printed *Lilies* pasta, inspired by the morphological resemblance to the lily flower: (**a**) 3D printing using the dough enriched with basil; (**b**) Drying the pasta; (**c**) Final packaging by Astorino.

The subsequent production of *Lilies* within the Astorino pasta factory demonstrated effective technology transfer from academic research to industrial practice, embedding innovation within a heritage-based production context.

The *Lilies* pasta was subsequently showcased during the final public event of the GNAM project within a temporary exhibition hosted by the Museo della Carta, a corporate museum partner involved in the initiative (see Section 4. Discussion below). The exhibition functioned as a space of cultural mediation in which the outcomes of research, design, and industrial experimentation were translated into an accessible and narrative-driven experience for a broad audience. By presenting *Lilies* alongside other prototypes developed within the project, the exhibition highlighted the continuity between heritage, material innovation, and sustainable food practices, reinforcing the role of corporate museums as active infrastructures for knowledge transfer and public engagement.

Within the museum setting, *Lilies* was not displayed merely as a finished product but as the result of an integrated process linking hydroponic cultivation, food technology, digital fabrication, and industrial manufacturing. This process-oriented exhibition approach enabled visitors to understand how traditional food heritage—in this case, Italian pasta as a pillar of the Mediterranean diet—can be reinterpreted through contemporary technological practices without losing its cultural authenticity. The placement of the pasta prototype within the Museo della Carta further strengthened the dialogue between different forms

of industrial heritage, connecting food production with material regeneration [28], and circular economy principles explored elsewhere in the exhibition.

By embedding the *Lilies* pasta within a museum-based narrative and experiential framework, the GNAM project demonstrated how corporate museums can act as Living Labs that extend innovation beyond production sites into cultural spaces. This public presentation reinforced the project's overarching vision of cultural heritage valorisation as a participatory and future-oriented process, in which industrial traditions are continuously reactivated through experimentation, education, and community engagement.

This activity exemplifies the GNAM vision by positioning corporate food heritage not as a static legacy, but as a dynamic resource capable of generating sustainable, health-oriented, and culturally meaningful food innovation through the convergence of design, technology, and industrial know-how.

3.2. Community Engagement Through Co-Design and Participatory Learning

The second dimension of the model addresses community engagement as a central mechanism for transforming corporate museums into Living Labs. The comparative analysis showed that Living Labs systematically involve users as active co-creators, whereas corporate museums tend to position visitors primarily as spectators or consumers of curated experiences, privileging exhibition and brand narration. In response, the proposed model positions community engagement as a core operational dimension, redefining the corporate museum as an open platform where knowledge, skills, and practices circulate bidirectionally between companies, researchers, and citizens. This shift was operationalized through a series of Living Lab activities that transformed museum spaces into environments for shared learning, experimentation, and social interaction around food sustainability.

One of the actions reinforcing the community engagement dimension of the proposed Living Lab model was the workshop held at the Gias experience corporate museum [7] in Mongrassano Stazione, Cosenza (Italy), involving a class from a local middle school. The initiative aimed to introduce younger generations to plant-based food innovation while fostering awareness of sustainability, nutrition, and food design through experiential learning. By situating the activity within the company museum, the workshop leveraged the museum's dual role as both a heritage space and an experimental environment, transforming it into a Living Lab where education, creativity, and food innovation could converge.

The workshop adopted a hands-on and collaborative methodology, engaging 25 students who were divided into three working groups, each seated at a different table to stimulate interaction, dialogue, and the exchange of ideas. The physical setup of the space was intentionally designed to support co-creation, with baskets of seasonal vegetables placed at each table to serve as both sensory stimuli and conceptual prompts. Students were invited to visually express their ideas of an "ideal vegetable burger," using drawing as a tool to articulate preferences related to shape, colour, composition, and perceived taste. This initial design-oriented phase encouraged participants to externalize their imagination and prior knowledge, emphasizing the role of visual thinking in food-related decision-making.

Following the drawing session, the company's chef partner of the GNAM project prepared a series of vegetable burgers using different ingredients, shapes, and textures, accompanied by three vegetable-based sauces characterized by distinct colours and flavour profiles. This transition from conceptualization to tasting marked a crucial moment in the Living Lab experience, enabling students to directly compare their imagined products with real, edible prototypes. The tasting activities were structured to promote sensory awareness and critical reflection. During the "Guess What's Inside" session, students sampled the burgers and attempted to identify the ingredients, fostering attentiveness to flavour, texture, and aroma. Subsequently, they experimented with pairing the burgers

with different sauces, exploring how colour, contrast, and combination influenced their overall sensory perception (Figure 5).

Figure 5. Workshop on plant-based food innovation with primary school students at the Gias experience museum who designed their "ideal vegetable burger".

Each group was then invited to present its findings in a short oral presentation, explaining which burger–sauce combinations were considered most appealing and why. This collective sharing phase reinforced communication skills and encouraged peer-to-peer learning, while also generating qualitative insights into young consumers' preferences and perceptions of plant-based foods. The workshop concluded with a moderated discussion focusing on the influence of visual appearance and form on taste expectations, as well as on participants' willingness to consume vegetables when presented in innovative and playful formats.

Overall, the workshop demonstrated the effectiveness of corporate museums as platforms for participatory education and social innovation in the food domain. Beyond stimulating creativity and teamwork, the activity contributed to reshaping students' attitudes toward plant-based cuisine, highlighting the potential of design, colour, and texture to make sustainable food choices more attractive to younger audiences. Within the broader framework of the project, this experience exemplifies how Living Labs embedded in corporate food museums can foster food literacy, encourage behavioural change, and strengthen the relationship between industrial heritage, contemporary food innovation, and community engagement.

A further example of community engagement within the Living Lab framework was represented by the workshop conducted at the Santa Chiara Lab, a research centre for interdisciplinary innovation of the University of Siena. This initiative was conceived as an

experimental environment to explore and develop sustainable practices through hands-on experimentation and design-led innovation.

The workshop involved 14 participants characterized by significant diversity in terms of age, professional background, and educational level. This heterogeneity was intentionally sought, as it enabled the convergence of different perspectives, experiences, and interpretative frameworks, enriching the collective ideation process. For the creative phase, participants were divided into three working groups distributed across three tables, with group sizes of five, five, and four individuals, respectively. The composition of each group was balanced to ensure internal variety in skills and personal backgrounds, thus promoting dialogue and cross-fertilisation of ideas.

The activity was structured around an initial introduction phase, during which the GNAM project was presented, followed by an explanation of the materials made available for experimentation and the objectives of the workshop. Participants were then guided through a sensory-based ideation process centred on the use of "Sensations" and "Situations" as creative prompts. Each participant was invited to write notes corresponding to perceived sensory qualities and potential usage contexts, which were subsequently drawn and shared within the groups.

It is important to note that the materials used for exploration and inspiration during the Santa Chiara Lab workshop originated from a previous GNAM activity coordinated by the University of Calabria, which involved the two corporate museum partners: the Gias experience [7] and the Museo della Carta [8]. In that earlier phase, vegetable waste generated during Gias's industrial food production processes was combined with paper scraps supplied by Rubbettino Editore, an Italian publishing house and owner of the Museo della Carta. Through a series of material experimentation and regeneration processes, these heterogeneous waste streams were transformed into a set of versatile hybrid materials characterised by different textures, densities, degrees of flexibility, and sensory qualities.

These regenerated materials—situated at the intersection of food waste valorisation, paper recycling, and design-driven experimentation—were subsequently transferred to the University of Siena and employed as tactile, visual, and sensory prompts during the Santa Chiara Lab workshop (Figure 6).

Figure 6. Set of regenerated materials obtained from food waste valorisation and paper recycling, with diverse textures, densities, degree of flexibility, and sensory qualities.

Their use reinforced the continuity between different Living Lab activities within the GNAM ecosystem, enabling participants to engage with materials that embodied both industrial heritage and circular economy principles. By working with artefacts derived from real production residues and museum-linked contexts, participants were encouraged to reflect on material life cycles, sustainability, and the potential for cross-sector innovation. This inter-university and inter-museum material flow further exemplifies the GNAM approach to community engagement, where co-design and participatory learning are grounded in shared resources, collaborative knowledge production, and the tangible outcomes of previous experimental activities.

This method encouraged participants to reflect on material properties not only in functional terms but also through embodied, experiential, and emotional dimensions.

During this phase, several notes related to sensory perceptions emerged compared to those referring to situational contexts, highlighting the central role of sensory engagement in stimulating creative thinking. Each participant contributed two notes for each category, ensuring balanced participation. The groups then developed their ideas according to different organizational logics that emerged spontaneously during discussion. One group adopted a thematic clustering approach, grouping ideas by shared concepts or values; another initially organized ideas based on material characteristics before transitioning to thematic clusters; while the third group shifted from a material-based classification to a functional one, identifying application domains such as personal care, cooking, furniture, and play.

This iterative process of clustering, discussion, and selection allowed participants to explore a wide range of possibilities before converging on the most promising concepts. Among the resulting prototypes were ideas such as a disposable bio-based band-aid, a beauty mask to hydrate the skin, a raincoat, a cover for the inside of the cycling helmet to absorb sweat, elements to keep the soil in pots humidified (Figure 7) and a sensory memory card game designed for children, in which smell and texture derived from vegetable-based materials played a central role.

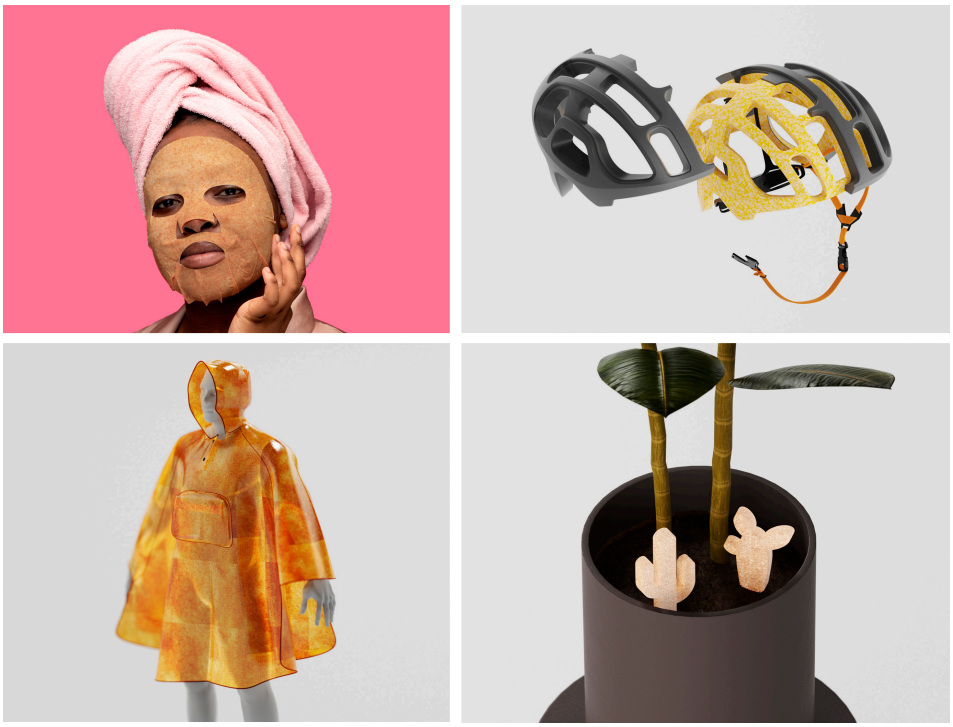

Figure 7. Rendering of the concepts emerged during the workshop: (top left) beauty mask to hydrate the skin; (top right) cover for the inside of the cycling helmet to absorb sweat; (bottom left) raincoat; (bottom right) elements to keep the soil in pots humidified.

These concepts exemplify how sensory properties and sustainability considerations can be integrated into playful and educational artefacts, reinforcing awareness of material origins and environmental impact.

The workshop was conducted within the scheduled timeframe, with effective management of both the ideation and design phases. Notably, no artificial intelligence tools were used at any stage of the process, underscoring the value of human-centred, sensory-driven creativity. Participants reported highly stimulating impressions, emphasizing how the direct engagement with materials, combined with sensory observation and imaginative interpretation, encouraged them to think beyond conventional solutions. One of the main challenges encountered concerned the unpredictability of material behaviour when exposed to water or external environmental conditions, which required careful observation and iterative experimentation. This difficulty, however, became a valuable learning opportunity, reinforcing the importance of prototyping and material testing in sustainable design processes.

The workshop shows the effectiveness of Living Labs as spaces for community-driven innovation, where diverse participants can collaboratively explore sustainable material futures. By combining sensory exploration, design thinking, and hands-on experimentation, the activity highlights the potential of museum-adjacent and academic environments to function as catalysts for social learning, creativity, and the co-creation of sustainable solutions.

Together, the variety of experiences conducted to realise this workshop demonstrate how corporate museums, when reconfigured as Living Labs, can act as catalysts for community engagement by embedding experimentation, education, and co-creation into their core functions, strengthening their social role and reinforcing their relevance within local and regional innovation ecosystems.

In addition to in-presence workshops and co-creation activities, community engagement within the Living Lab framework was further strengthened through the activation of an online public engagement platform and the development of immersive digital environments. This hybrid approach was adopted to ensure continuity of participation beyond the temporal and spatial limits of physical events, expanding access to project outcomes and fostering sustained interaction among stakeholders.

To this end, a commercial digital platform was employed as a central digital hub for collaboration, knowledge sharing, and public engagement. Conceived as an open and participatory environment, the platform connects businesses, researchers, cultural institutions, and communities, supporting the co-creation of innovative and sustainable solutions, particularly within the food and agri-food sectors. Within the scope of the project, the platform hosted detailed documentation of events held in corporate museums and university settings, including methodological descriptions, results achieved, and lessons learned. This content-oriented approach transformed individual Living Lab activities into transferable knowledge assets, facilitating replication and adaptation in other contexts.

The platform also provides access to practical resources such as guidelines, toolkits, and best practices specifically developed to support the implementation and scaling of Living Lab activities within corporate museums. These tools were designed to be modular and adaptable, allowing institutions with different missions, scales, and resources to adopt and tailor the methodologies according to their specific needs. By embedding these materials within an open access digital ecosystem, the project reinforced its commitment to inclusivity, transparency, and long-term impact.

A key component of the digital engagement strategy was the development of 360° virtual tours of university laboratories and partner venues, including corporate museums, restaurants, and research facilities. These immersive virtual environments were created

using high-resolution panoramic imagery and interactive hotspots, enabling users to navigate spaces remotely while accessing contextual information, multimedia content, and technical descriptions. The virtual tours offer an experiential layer to the online platform, allowing users to explore the settings in which Living Lab activities take place and to better understand the spatial, technological, and cultural dimensions of the experimentation.

Six virtual tours [29] played a strategic role in showcasing interdisciplinary research infrastructures dedicated to sustainability, design, and food innovation. By making these spaces digitally accessible, the project extended opportunities for remote learning, training, and inspiration, engaging stakeholders regardless of geographical constraints.

The integration of online platforms and immersive virtual tools complemented the in-person Living Lab activities, reinforcing community engagement as a continuous and scalable process. This blended model enhanced the resilience and inclusiveness of the Living Lab approach, positioning corporate museums and university laboratories not only as physical sites of experimentation but also as interconnected nodes within a broader digital ecosystem for sustainable innovation and cultural heritage activation.

3.3. Sustainable Food System Innovation Through Real-Life Experimentation

The third dimension of the model concerns sustainable food system innovation, which emerged as a key convergence point between corporate museums and Living Labs. While Living Labs provide structured approaches for real-life experimentation and iterative testing, corporate museums offer authentic contexts in which sustainability narratives can be grounded in tangible practices and culturally meaningful settings.

A first concrete example of this approach is represented by the technology-transfer activities developed with Gias, focused on the valorisation of vegetable processing waste through the design of food "inks" suitable for 3D printing. Starting from food loss and food waste still rich in nutrients, the process involved the systematic study of formulations, rheological characterization, and optimization of preparation protocols to ensure printability, stability, and sensory quality.

Importantly, the formulation that most closely approached the rheological behaviour of the commercial benchmark was subsequently used in participatory Living Lab activities, including tasting sessions and educational workshops held within the corporate museum. In this way, rheology functioned not only as a technical validation tool but also as an enabling factor for community engagement, allowing scientifically sound materials to be safely and effectively employed in co-creation, education, and sensory exploration activities.

The study of ink preparation and rheological properties illustrates how advanced food engineering techniques can be embedded within Living Lab environments hosted by corporate museums. By making these processes visible and experientially accessible, the model fosters a deeper understanding of the materiality of food innovation among non-expert participants, while simultaneously ensuring that sustainability-driven experimentation remains grounded in rigorous scientific principles.

These technically complex processes were not confined to laboratory settings but were translated into the participatory experiences within the company museum described in paragraph 3.2 above, where young participants were involved in tasting and evaluating plant-based burgers produced using the optimized formulations. By making visible and accessible the transformation of waste into innovative food products, the museum functioned as an interface between scientific research, industrial practice, and public awareness, fostering a shared understanding of sustainability challenges and solutions along the food value chain.

A further example of technology transfer supporting the transformation of corporate museums into Living Labs is represented by the *Materia Seconda* initiative, which focused

on the regeneration of printing waste and food processing by-products into novel hybrid materials for applications in packaging and product design. The primary objective of this experimentation was to translate accumulated knowledge—derived from documentary research, stakeholder mapping, waste cataloguing, and technical testing—into tangible design outcomes, enabling the activation of museum spaces as environments for applied research, prototyping, and public engagement.

Materia Seconda functions both as a conceptual framework and as an operational platform in which regenerated paper is redefined as a "potential material," capable of evolving beyond its traditional role as a two-dimensional support. Through refibering practices and design-driven interventions, paper waste is reactivated as an adaptive and expressive material, open to transformation and hybridisation. The model developed through this initiative operates along two complementary axes.

The material axis concerns the reassembly of pulped paper fibres derived from typographic waste supplied by Rubbettino Editore, combined with organic food matrices—such as baby cabbage residues from the Gias supply chain—to obtain a hybrid compound compatible with modelling and forming processes.

The form axis involves the application of digital engraving and modelling technologies, which enable the transformation of the regenerated pulp into functional artefacts, narrative surfaces, and design prototypes. These technologies are gradually pervading the food realm [30,31].

A distinctive feature of the *Materia Seconda* initiative lies in its integration of material experimentation with cultural heritage interpretation. The formal and graphic language of the prototypes was informed by historical–anthropological research conducted in the initial phase of the project, drawing on proverbs, dialect expressions, decorative motifs, and food-related references embedded in local culture. In particular, the work of Giovanni Sole (*Pane nero o fame nera*, Rubbettino, 2018) [32] provided a rich textual and iconographic repertoire used to personalise the artefacts through engraving. In this way, regenerated paper became a narrative medium capable of conveying the food identity of the territory, translating memory, language, and heritage into material form and contemporary design expressions.

The prototyping phase resulted in the production of a diversified range of objects, including coasters, personalised tasting placemats, trays, and containers, all manufactured from regenerated pulp composed of typographic fibres and plant residues.

From a Living Lab perspective, *Materia Seconda* exemplifies how corporate museums can host advanced technology transfer processes while remaining accessible to diverse audiences. By making visible the transformation of waste into functional and culturally meaningful objects, the initiative fosters awareness of circular economy principles and sustainable material innovation. Moreover, the potential introduction of scalable technologies, such as paper thermoforming lines, opens pathways from experimental prototyping to micro-production and pre-industrial applications. This positions the museum not only as a site of heritage preservation but also as an active infrastructure for sustainable innovation, capable of linking material science, design, and territorial identity within a participatory and future-oriented framework.

Through this case study, the Museo della Carta emerged as an active site of experimentation rather than a passive exhibition space. The combination of paper and food processing waste enabled participants to directly engage with material transformation processes, fostering awareness of waste valorisation and sustainable production. This technology-transfer activity demonstrates how corporate museums can mediate between scientific research and public participation, transforming industrial by-products into culturally meaningful objects while reinforcing the museum's role as a Living Lab for sustainable innovation.

The experimental activities conducted within the GNAM project provide insight into the potential transformation of corporate food museums from primarily narrative heritage environments into participatory infrastructures for innovation and learning. This is in line with recent scholarship in museum studies and heritage innovation which highlights an increasing shift toward participatory, socially embedded, and future-oriented institutional roles [33]. Within this evolving landscape, the museums involved in the project progressively assumed the role of mediating platforms capable of facilitating dialogue between diverse territorial stakeholders, including research institutions, schools, food companies, and local policy actors. This repositioning reflects broader transformations in heritage practices, in which museums are increasingly understood as active agents in knowledge co-production and social innovation processes [13,34].

As a critical reflection on the model described above, it is important to highlight that while the experimental activities conducted within the GNAM project demonstrate the feasibility of transforming corporate food museums into Living Labs for sustainable innovation, their implementation requires the active involvement of a dense network of territorial stakeholders. Research institutions, schools, local food companies, cultural organisations, and policy actors play a crucial enabling role in activating participatory processes and sustaining them over time. This multi-actor governance model represents both a strength and a limitation of the proposed framework. On the one hand, it ensures contextual relevance and social embeddedness; on the other, it implies that replication cannot rely solely on the internal resources of museums. The scalability of the model therefore depends on the capacity of corporate museums to position themselves as facilitators within regional innovation ecosystems.

4. Discussion

The model of activities experimented during the project was consolidated, shared, and critically discussed during a final public event culminating in an exhibition hosted at the Museo della Carta. This event represented a pivotal moment in the research process, functioning not only as a dissemination activity but also as an extension of the Living Lab methodology itself. By transforming the museum into a hybrid space for exhibition, dialogue, and digital exploration, the event enabled a broad audience to engage with the project's outcomes and to reflect on the potential of corporate museums as infrastructures for sustainable innovation and public participation.

Within the Museo della Carta, an exhibition was set up featuring interactive digital screens and totems that allowed visitors to explore the laboratories and partner venues involved in the project through virtual tours (Figure 8).

This immersive tool enabled visual navigation of university laboratories, corporate museums, and experimental spaces reconstructed through high-resolution 360-degree photography. Beyond simple visualization, the tours integrated interactive points of interest embedded within the virtual environments, providing textual explanations and multimedia content illustrating the activities carried out, the methodologies adopted, and the functioning of laboratory equipment and machinery. In this way, complex research and innovation processes were rendered transparent and accessible to non-expert audiences, reinforcing the educational and communicative role of the museum.

One of the digital totems provided direct access to the GNAM project website, offering an overview of the project's objectives, activities, and results, and redirecting visitors to the public engagement platform through which participants could access detailed documentation of the Living Lab activities, including practical guidelines and methodological tools designed to support the replication of the proposed model in other corporate museums or Living Lab contexts. This digital continuity between the physical exhibition and the

online platform strengthened the project's long-term impact, positioning dissemination as an active process of knowledge transfer rather than a one-off communication effort.

Figure 8. *Materia Seconda* exhibition at Museo della Carta with interactive digital screens and totems that the visitors used to explore the virtual tours.

A dedicated section of the museum was reserved for a temporary exhibition that will remain open to the public for several months. This space showcased prototypes made from eco-sustainable materials derived from paper and food processing waste, designed by students from the University of Siena as part of the project's experimental activities. The display highlighted both finished artefacts and raw or semi-processed materials, including recycled paper from the Rubbettino paper mill, allowing visitors to visually trace the transformation of waste into functional and narrative objects. This material-based storytelling reinforced the project's core themes of circularity, design-driven innovation, and heritage activation.

The public event was structured to encourage dialogue between academia, industry, institutions, and local communities. In the opening session, the organisers presented the project, illustrating the research framework, methodologies adopted, and key results achieved. The afternoon session featured contributions from university professors and local institutional representatives. Their interventions addressed the role of design, networks, and territorial development, highlighting how new development models can emerge by leveraging local industrial, artisanal, and social resources. The discussion was further enriched by testimonies from local entrepreneurs who reflected on the transformation of local craftsmanship into a nationally recognized enterprise, reinforcing the link between heritage, innovation, and economic development.

Importantly, this event was conceived not as a conclusive moment but as an experimental and replicable model of public engagement. The participatory and interactive structure—based on the integration of research, industry, and community actors—reflects a methodology aimed at fostering constructive dialogue and shared ownership of innovation processes. The tools employed, including virtual tours, digital totems, and the online

platform, functioned as enabling infrastructures that made innovation processes tangible, understandable, and transferable. The successful implementation of this model at the Museo della Carta in has already laid the groundwork for its replication in other contexts in Calabria to offer an opportunity to further test the flexibility and scalability of the model, engaging new stakeholders and territorial contexts while amplifying the impact of research and innovation activities. By sharing best practices and adapting methodologies to local specificities, the project demonstrates how collaboration between universities, businesses, cultural institutions, and public authorities can act as a catalyst for sustainable development. In this sense, the discussion emerging from the final exhibition underscores the potential of corporate museums and Living Labs to function as strategic platforms for technological transfer, cultural valorisation, and inclusive growth, not only in Calabria but across southern Italy and beyond.

Such formats illustrate how corporate museums, when reconfigured as Living Labs, can move beyond educational outreach toward community-based knowledge ecosystems, reinforcing their social role and relevance. Engagement is thus not limited to attendance but becomes a sustained form of participation that strengthens the relationship between heritage institutions and their territories. Importantly, several Living Lab activities initiated during the project continued beyond its formal conclusion. Educational programmes originally offered within museum contexts were subsequently integrated into the regular outreach activities of local schools, while participating food companies maintained collaborative exchanges through follow-up events hosted by the museums. These continuities suggest that the Living Lab model can generate medium-term institutional learning and network consolidation, reinforcing the museum's role as a catalyst for territorially grounded innovation processes.

The case study highlights that the transformation of corporate museums into Living Labs is not limited to opening spaces for experimentation but involves a redefinition of the museum's institutional role. Museums act as intermediaries capable of translating industrial knowledge into publicly accessible experiences, facilitating trust-building among stakeholders, and anchoring innovation processes within culturally meaningful narratives.

Although the model has been developed and tested within corporate food museums, its underlying methodological structure—based on co-creation workshops, technology-transfer activities, and hybrid digital–physical engagement—can be adapted to corporate museums operating in other industrial domains. Further empirical experimentation is required to validate the model across different thematic sectors and institutional configurations.

The results of this study contribute to and extend existing research on participatory heritage and Living Lab approaches by demonstrating how corporate food museums can be repositioned as hybrid infrastructures for innovation. Previous studies have highlighted the shift from traditional museum models toward participatory and community-oriented practices, where visitors are actively involved in knowledge co-production [14,34,35]. Similarly, Living Lab literature has emphasised the role of real-life environments in fostering user-driven innovation and multi-stakeholder collaboration [12,16,36]. More recent contributions have further explored the integration of cultural heritage and innovation ecosystems, underlining the potential of heritage institutions to support sustainable development and social engagement [5].

However, the findings of this research advance the literature in three key ways. First, while previous studies have examined participatory museums and Living Labs as largely separate domains, this paper proposes and empirically tests a model that integrates corporate museums and Living Lab methodologies, thus positioning corporate heritage as an active driver of innovation rather than a purely representational space. Second, the study

provides evidence that corporate food museums can act as territorial mediators, facilitating sustained collaboration among research institutions, schools, companies, and policy actors—an aspect that remains underexplored in both museum and innovation studies. Third, the research contributes to the emerging debate on heritage as a future-oriented practice by demonstrating how Living Lab activities can generate continuity beyond project timelines, supporting long-term behavioural change and knowledge exchange within local ecosystems. In this sense, the proposed model moves beyond existing literature by offering a replicable yet context-sensitive framework that connects heritage, design, and sustainability transitions, while also acknowledging the structural limitations and scalability challenges associated with multi-stakeholder engagement.

5. Conclusions

This study demonstrates that corporate food museums can evolve beyond their traditional commemorative and communicative functions to become active Living Labs supporting sustainable, inclusive, and territorially grounded food innovation. By integrating heritage narratives with participatory design methodologies, real-life experimentation, and technology transfer, the proposed model redefines corporate museums as hybrid cultural–innovation infrastructures. The GNAM project shows that such spaces can effectively host co-creation processes, foster food literacy across diverse audiences, and translate complex sustainability challenges—such as food waste, circular materials, and plant-based diets—into tangible, experiential practices. The combination of physical workshops, material experimentation, and digital platforms further enhances accessibility, scalability, and long-term impact. From a heritage perspective, the findings suggest a shift from heritage as preservation toward heritage as an enabling resource for social innovation and community resilience.

The project shows that a productive reconciliation between corporate brand narration and participatory engagement can be achieved by reframing corporate museums as mediating infrastructures in which storytelling is not replaced but reconfigured as an open, processual, and multi-voiced practice. Rather than presenting brand identity as a fixed and authoritative narrative, museums can curate it as a dynamic framework within which visitors are invited to interpret, question, and extend corporate histories through situated experiences and co-creative activities. In this perspective, brand narration operates as a scaffold for participation, providing coherence and legitimacy while enabling multiple forms of engagement that incorporate external knowledge, user experiences, and societal concerns. Participatory formats—such as Living Lab activities, co-design workshops, and experiential installations—do not dilute corporate identity; instead, they enrich it by embedding it within broader socio-cultural and territorial contexts, thus enhancing its relevance and credibility. This hybrid model allows corporate museums to maintain their institutional role as custodians of heritage and brand values, while simultaneously evolving into platforms for dialogue, learning, and innovation. Ultimately, the alignment between narration and participation lies in recognising that contemporary brand meaning is not only communicated but co-produced, and that enabling visitors to actively contribute to this process strengthens both the experiential quality of the museum and the long-term cultural legitimacy of the brand.

Nevertheless, the present research is based on a limited number of experimental contexts and focuses primarily on corporate museums in the food sector. Further comparative studies are needed to assess the transferability and scalability of the proposed model in other industrial heritage domains and geographical settings. Future research should therefore investigate governance mechanisms, resource requirements, and long-term institutional transformations associated with the Living Lab approach.

The Living Lab activities implemented in the museums were designed to activate collaborative knowledge exchange through co-design workshops, technology transfer experiments, and hybrid digital–physical engagement formats. In the GNAM case, these initiatives enabled visitors and external participants to move from passive reception of curated narratives to active involvement in exploratory processes related to sustainable food innovation. In doing so, the museums became sites where industrial heritage, contemporary design research, and local socio-economic dynamics intersected, thus supporting emerging interpretations of heritage institutions as laboratories for societal transformation [14,28].

At the same time, the implementation of the Living Lab model revealed structural dependencies that condition its replicability. The success of participatory programmes relied heavily on the sustained involvement of external stakeholders, particularly universities providing scientific expertise, schools acting as multipliers of educational impact, and food companies contributing practical knowledge and innovation needs. This multi-actor configuration reflects systemic approaches to innovation, which emphasise the importance of collaborative governance networks and distributed capabilities [37]. While the integration of diverse partners enhances contextual relevance and fosters long-term institutional learning, it also implies that the transformation of corporate museums into Living Labs cannot be achieved through internal organisational change alone. Instead, it requires the development of territorial innovation ecosystems in which museums operate as intermediaries between cultural heritage, research infrastructures, and industrial actors.

Evidence emerging from the case study suggests that the Living Lab activities generated forms of continuity beyond the formal duration of the project. Educational initiatives initially introduced as experimental programmes were subsequently integrated into the regular outreach activities of local schools, while participating companies continued to engage in knowledge-sharing events organised by the museums. These developments resonate with studies highlighting the capacity of participatory heritage initiatives to produce lasting social and institutional impacts through community engagement and capacity building [38,39]. In this sense, corporate museums can contribute to regional innovation dynamics by fostering learning environments that extend beyond exhibition spaces and project timelines.

Although the model was tested primarily in the context of corporate food museums, its methodological structure—based on co-creation, experiential learning, and hybridisation between heritage interpretation and technological experimentation—may be adaptable to corporate museums operating in other industrial sectors. Nevertheless, the transferability and scalability of the approach remain contingent upon further empirical validation. Differences in thematic focus, institutional resources, stakeholder networks, and territorial innovation cultures may significantly influence implementation outcomes. As argued in systemic design literature, innovation models embedded in local socio-material contexts cannot be simply replicated without adaptive processes [28]. Consequently, the present study should be understood as an exploratory contribution that outlines a replicable framework while acknowledging the need for comparative research to assess its broader applicability across corporate heritage domains.

By foregrounding both opportunities and limitations, the GNAM Living Lab experience demonstrates that corporate museums can evolve into hybrid cultural–innovation infrastructures. Such transformation requires not only programmatic experimentation but also a redefinition of institutional identity, in which brand narration, participatory engagement, and collaborative knowledge production are strategically integrated. In this perspective, corporate museums emerge as dynamic actors capable of shaping sustainable innovation processes through culturally grounded and socially distributed learning environments.

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Abbreviations

The following abbreviations are used in this manuscript:

ENoLL	European Network of Living Labs
GNAM	Growing Novel food Living lAbs in corporate Museums
LLs	Living Labs
SDGs	Sustainable Development Goals

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