Design at the intersection: Reconciling older consumers' practices with circular economy principles in ready-to-cook fish products

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Received 7 June 2024;

Accepted 19 April 2025

Abstract

The seafood industry faces increasing pressure to adopt sustainable practices while meeting consumer demands, presenting a significant design challenge. Designers must reconcile circular economy principles with the established practices of older consumers, who represent a significant market segment with unique needs and distinct consumption patterns. This article addresses the design challenge of bridging sustainable innovation with consumer acceptance through a practice-based investigation of older UK consumers' engagement with ready-to-cook fish products. Using an innovative qualitative approach combining in-person workshops and digital ethnography, we examined how material arrangements, competences and meanings shape seafood consumption practices among adults aged 55 and above. Our findings reveal critical design tensions that emerge when sustainable innovations intersect with established practices. While convenience and accessibility are valued, concerns about processing methods, additives and lack of transparency create barriers to adoption. Participants demonstrated awareness of sustainability issues but struggled to integrate environmental concerns with personal health considerations and established habits. Innovative circular economy approaches, such as algae-based packaging, generated interest but raised significant concerns about safety and practicality. From these findings, we derive four design principles for sustainable seafood product development: (1) designing for transparency to build trust, (2) incremental innovation that respects established practices, (3) leveraging trusted intermediaries in communication design and (4) creating multisensory experiences that reinforce sustainability benefits. These principles constitute a framework for designers seeking to create products that successfully integrate circular economy approaches while respecting the established practices of older consumers. This research contributes to the field of food design by demonstrating how practice

theory can inform product development that effectively balances sustainability imperatives with consumer acceptance, offering both theoretical insights and practical guidelines for designers working at this critical intersection.

Keywords: seafood, ready-to-cook, circular economy, participatory design, food futures, food design, older consumers

1 Introduction

Designing food products that simultaneously meet consumer expectations and address environmental imperatives presents one of the most significant challenges for contemporary food systems. The tension between established consumer practices and sustainability innovation is particularly evident in seafood products (De Borja et al. 2010; Kuijer 2014; Arcese et al. 2015), where traditional consumption patterns often clash with circular economy approaches to reducing waste and environmental impact. This tension creates a complex design problem requiring innovative approaches that balance consumer acceptance with sustainability goals.

Ready-to-cook (RtC) fish products represent a critical context for exploring this design challenge (Cui et al. 2024). These products occupy an intermediary position between fresh and fully processed options, offering convenience while still engaging consumers in food preparation. For older adults, defined in this study as those aged 55 and above, these products can be particularly significant, addressing age-related challenges such as reduced mobility and dexterity while potentially supporting nutritional needs (Shlisky et al. 2017; Baugreet et al. 2017). Yet the successful design of sustainable RtC fish products for this demographic requires deep understanding of how established practices and values shape product interactions and acceptance.

The lens of practice theory offers valuable insights for designers confronting this challenge. As conceptualized by Shove et al. (2015), social practices comprise three

interconnected elements: materials (physical objects, technologies and infrastructures), competences (skills, know-how and techniques) and meanings (symbolic associations, ideas and aspirations). This theoretical framework (Shove 2016) helps designers understand how material arrangements – including product packaging, formulation and presentation – influence what, when and how people consume seafood, rather than focusing solely on individual attitudes or stated preferences.

Despite growing research on sustainable food systems and older consumer preferences, there remains a significant gap in design research addressing how to reconcile sustainability innovations with the established practices of older consumers. Previous studies have explored either consumer preferences for seafood (Carlucci et al. 2015; Christenson et al. 2017) or technical aspects of sustainable packaging (Almeida et al. 2023), but rarely examine the interaction between these domains through a design lens. This gap hinders the development of products that successfully integrate circular economy principles while respecting consumer practices.

This study addresses this gap by examining how the design of sustainable RtC fish products can effectively bridge established older consumer practices with circular economy principles. Specifically, we aim to:

1. Identify how material arrangements, competences and meanings shape older consumers' interactions with RtC fish products.
2. Examine design tensions between established practices and sustainability innovations in seafood processing and packaging.
3. Develop design principles that reconcile consumer acceptance with circular economy approaches in seafood product development.

This research is situated within the EU-funded SeaFoodAge project, which aims to create innovative RtC fish products for ageing populations using circular economy principles.

The prototype incorporates several sustainable design features: it utilizes otherwise discarded local fish, employs seaweed as both packaging material and a nutritious sauce base, and features smart temperature-sensing labels that provide product provenance information and safety monitoring. These innovations aim to simultaneously address environmental concerns while meeting older consumers' needs for convenience, nutrition and food safety. The prototype serves as a case study for exploring the application of circular economy principles in seafood product design with consideration for consumer acceptance and market viability.

Through a qualitative approach combining in-person workshops and innovative digital ethnography, we investigated the complex interplay between established practices and sustainability innovations among UK adults aged 55 and above. This methodological approach allowed us to capture rich insights about the material, competence and meaning elements of seafood consumption practices, including responses to speculative sustainable product designs.

The primary contribution of this article is a design framework that addresses the central challenge of reconciling consumer practices with sustainability innovation in food products. By identifying key design tensions and principles, we provide both theoretical insights for design researchers and practical guidelines for food designers seeking to create successful sustainable seafood products for older consumers.

The remainder of this article is structured as follows: first, we review relevant literature on practice theory in food design, RtC products, older adult consumption patterns and sustainability approaches in seafood. The next section details our practice-based methodological approach. Then we present our findings organized around material, competence and meaning elements of practice. The following section discusses the design principles derived from these findings, and we conclude with implications for design research and practice.

2 Related work

This review examines key domains informing the design of RtC fish products that balance older consumers' established practices with circular economy principles.

2.1 Practice theory as a framework for food design

Practice theory provides a critical analytical lens for understanding how sustainable food products integrate into everyday life. Shove et al.'s (2015) framework of materials, competencies and meanings offers designers a systematic approach to understanding consumption beyond stated preferences. Unlike traditional consumer research focusing on individual attitudes, practice theory examines the situated, material and often tacit aspects of consumption (Shove 2016, 2022), revealing how food practices are embedded within broader systems of meaning and material arrangements. For designers, this means considering not just what consumers say they want, but how products integrate with existing routines, skills and values (De Borja et al. 2010; Kuijer 2014). This is particularly relevant for food design, where products must fit within established cooking and eating practices to gain acceptance (Tromp and Hekkert 2016).

The practice-oriented approach is especially valuable when designing for older adults, whose food practices may be deeply established and resistant to change (Watson et al. 2023). By examining the material elements (kitchen tools, packaging, food formats), competencies (cooking skills, nutritional knowledge) and meanings (cultural associations, values around food) that constitute older adults' food practices, designers can identify opportunities to introduce sustainable innovations in ways that align with, rather than disrupt, established routines (Shove 2016; Plessz 2016).

2.2 RtC and ready-to-eat foods as design solutions

RtC foods represent a strategic middle ground between convenience and engagement in food preparation. Unlike ready-to-eat (RtE) meals, RtC products maintain some cooking involvement while minimizing time and skill requirements (Cui et al. 2024; Sharma 2024).

From a design perspective, this balance positions RtC products as particularly suitable for bridging established practices with sustainability innovations, especially for older adults with diverse needs and capabilities (Rai 2021).

The distinction between these categories is especially important when designing for older adults, who have diverse needs and preferences based on their physical capabilities, living situations and cultural backgrounds. Understanding how these different product formats integrate with existing practices is essential for designing sustainable seafood options that will gain acceptance among older consumers.

2.3 Design considerations for older adult food consumption

Three key factors shape older adults' food interactions: sensory changes (Spence and Youssef 2021; Li et al. 2025), physical limitations affecting accessibility (Świda et al. 2018; Peura-Kapanen et al. 2017) and cultural embeddedness of food practices (Pagliarino et al. 2016; Brunsø et al. 2009).

More precisely, age-related sensory changes significantly impact how older adults interact with food products (Spence and Youssef 2021; Li et al. 2025). Products designed with sensitivity to age-related changes in taste and texture perception can enhance acceptance among older adults (Monteleone et al. 2017). For designers, this highlights the importance of considering sensory elements not just as marketing features but as fundamental aspects of product usability for this demographic.

In addition to this, barriers like hard-to-open packaging and complicated preparation instructions can limit food accessibility for older adults (Świda et al. 2018; Peura-Kapanen et al. 2017). Ease of preparation emerges as an essential design consideration, as it can enhance the appeal of products by addressing practical challenges faced by those with physical limitations (Chaffee and Ross 2023). For designers, this means considering the entire user

journey with the product, from purchase to preparation and consumption, with attention to potential physical limitations.

Food practices among older adults are deeply embedded in cultural traditions and social contexts, as well as regional influences (Brunsø et al. 2009). Mealtime for many seniors serves as a significant social event, fostering community bonds through shared experiences (Pagliarino et al. 2016). These cultural factors must be considered in design decisions about product formulation, presentation and marketing to ensure alignment with established food meanings and values.

2.4 Designing for sustainability in food systems

Designing sustainable food products requires balancing environmental imperatives with circular economy approaches that offer promising directions for sustainable seafood design (Kirchherr et al. 2023; Ruiz-Salmón et al. 2020). However, research reveals tensions between environmental imperatives and consumer acceptance. While older Europeans demonstrate interest in sustainable seafood (Zander and Feucht 2018; Fiorile et al. 2023), significant gaps remain in understanding and translating this interest into practice (Menozzi et al. 2020).

The challenge for designers lies in creating products that effectively communicate sustainability benefits while meeting other consumer priorities. This requires attention to how sustainability features are integrated into product design and how they are communicated through packaging, labelling and marketing materials.

2.5 Packaging design for older adults

Packaging for older adults must balance physical accessibility (Swida et al. 2019; Woodcock et al. 2002) with sustainability innovations. While sustainable materials may align with older adults' environmental values (Hollis-Sawyer and O'Neil 2019; Sudbury-Riley 2014), novel solutions can raise concerns about safety and usability (Young et al. 2020). This creates tension between sustainable innovation and established expectations around food packaging.

The design challenge lies in creating packaging that balances sustainability innovations with the practical needs and established expectations of older consumers. This requires attention to how new materials and formats integrate with existing practices and whether they require new competencies or challenge established meanings around food safety and quality.

2.6 Summary and research gap

Despite growing research in these domains, significant gaps remain in understanding how to reconcile established practices with sustainability innovations. Existing literature tends to address consumer preferences (Zander and Feucht 2018; Menozzi et al. 2020) and technical sustainability aspects (Ruiz-Salmón et al. 2020; Kirchherr et al. 2023) separately rather than examining their intersection through design. While practice theory offers valuable insights into food consumption behaviours (Shove et al. 2015; Shove 2016), it has been underutilized in designing sustainable food products for older adults (Watson et al. 2023; Plessz 2016). Similarly, research on older adults' food practices highlights important considerations regarding sensory changes (Spence and Youssef 2021; Li et al. 2025), accessibility needs (Świda et al. 2018; Peura-Kapanen et al. 2017) and cultural factors (Pagliarino et al. 2016; Brunsø et al. 2009), but rarely examines how these interact with sustainability innovations in packaging (Young et al. 2020; Hollis-Sawyer and O'Neil 2019). Our research addresses this gap by applying practice theory to examine how material, competence and meaning elements interact in older adults' engagement with sustainable RtC fish products (Cui et al. 2024; Sharma 2024), aiming to develop design principles that successfully bridge established practices with circular economy approaches (Tromp and Hekkert 2016; Kuijer 2014).

3 Methodology

3.1 Research design: A practice-based approach

Our research methodology was explicitly designed to capture the material, competence and meaning elements of food practices as conceptualized in practice theory (Shove et al. 2015). We adopted a qualitative, practice-focused approach that combined in-person workshops and digital methods to examine how older adults' established seafood consumption practices interact with sustainability innovations. This methodological approach was intended to go beyond traditional consumer research methods that focus primarily on attitudes and stated preferences, instead capturing the embodied, situated nature of food practices.

The study employed a two-phase design: (1) face-to-face participatory workshops and (2) digital ethnography using structured online conversations. This dual approach allowed us to capture both the physical materiality of food interactions through tangible product engagement and broader narratives about routinized practices through digital methods. The combination of methods was particularly valuable for understanding how the material elements of RtC fish products (packaging, product format) interact with competences (cooking skills, food safety knowledge) and meanings (values around health, sustainability and tradition) in shaping older adults' food practices.

When the COVID-19 pandemic necessitated methodological adaptation midway through our study, we deliberately designed our digital methods to maintain consistency with our practice-theoretical framework, ensuring that both phases contributed coherently to our research objectives.

3.2 Phase one: Participatory workshops

The first phase consisted of a half-day participatory workshop held at the Blackpool Carers Centre in the United Kingdom in March 2020. This location was strategically selected for three reasons: (1) Blackpool's coastal location and historical ties to the fishing industry provided contextual relevance for seafood consumption; (2) the Active Minds group at the centre offered access to our target demographic of adults aged 55+ who were responsible for food preparation

and (3) the established community environment facilitated trust and openness in discussions about everyday practices.

The Active Minds group is a community initiative that supports older adults through social activities and learning opportunities, with participants who regularly meet at the centre. We approached the group coordinators, who facilitated recruitment based on our criteria of participants being 55+ years old and involved in household food preparation.

The workshop design was informed by participatory design principles (Heron and Reason 2008), with activities specifically structured to elicit the three elements of practice identified by Shove et al. (2015):

1. **Material elements exploration**: A product tasting session using various RtC and canned fish products served as tangible prompts to discuss material interactions with packaged seafood. Participants handled and sampled products, generating discussions about packaging usability, product appearance and sensory aspects. This embodied engagement with materials is central to understanding practice as conceptualized by Shove et al. (2015).
2. **Competence articulation**: A recipe-sharing exercise using a custom-designed proforma prompted participants to articulate their cooking knowledge, techniques and routines. This activity was designed to surface both explicit and tacit knowledge related to fish preparation.
3. **Meaning exploration**: Visual prompts including images of local seafood landmarks and historical photographs stimulated discussions about the cultural and personal significance of fish consumption, helping to uncover the symbolic meanings attached to these practices.

Figure 1: Blackpool workshop and tools used.

A workshop session at a wooden table with participants wearing lanyards. The table is covered with various materials including black-and-white photographs of buildings, paper plates with food remnants, canned food items, coffee mugs, cutlery and what appears to be research or discussion materials. Participants are partially visible at the edges of the frame, engaged in what seems to be a collaborative research activity or focus group related to food consumption. Colourful patterned cushions are visible in the background.

These workshop activities (see Figure 1) were audio-recorded and photographed (with participant consent), capturing not just verbal data but also physical interactions with products and non-verbal reactions. This multimodal data collection approach aligned with our practice-theoretical focus on embodied knowledge and material engagement.

3.3 Phase two: Digital practice ethnography

As the pandemic unfolded, we developed an innovative digital ethnography approach using a private Facebook '*Social Learning*' Group platform. This digital method was deliberately designed to maintain our practice theory focus while accommodating social distancing requirements.

The Facebook Social Learning Group platform (see Figure 2) was selected specifically because it offers structured content organization features beyond standard social media groups. This platform enabled us to create sequential learning units (what we termed 'thematic guides') that systematically explored different elements of seafood consumption practices. Each guide was a structured set of visual and textual prompts with specific activities for participants to engage with, visible as distinct modules within the Facebook group interface.

Figure 2: Facebook Social Learning Group Page.

Screenshot of a Facebook group titled 'Seafood-AGE – Sharing experiences of fish & seafood product consumption'. The image shows the group's header with a colourful abstract banner of product containers, and displays the About section explaining the group's purpose

as part of a pan-European EU research project on seafood consumption. Group navigation tabs show About, Discussion, Guides, Topics, Members, Events and Media sections.

The five thematic guides (see Figures 3 and 4) were sequentially structured to build from current practices to responses to innovation:

Guide 1: Material memory elicitation – Participants were presented with images of various seafood products and packaging and asked to share memories and associations. This guide focused primarily on the material dimension of practice.

Guide 2: Practice documentation – Participants documented their most recent seafood meal, describing preparation methods, contexts and experiences. This captured the integration of materials, competences and meanings in everyday practice.

Guide 3: Kitchen inventory – This guide asked participants to inventory seafood products in their homes and discuss what they might discard and why. This revealed how materials are incorporated into domestic spaces and routines.

Guide 4: Values and meaning exploration – This guide explored participants' broader food values and how these connect to their everyday seafood practices, focusing on the meaning element of practice.

Guide 5: Design speculation – The final guide presented a speculative sustainable RtC fish product incorporating circular economy features (algae-based packaging, use of fish that would otherwise be discarded, smart labelling) and elicited responses. This guide was specifically designed to examine how innovations might integrate with or disrupt established practices.

Figure 3: Overview of Facebook guides (1–4)

Side-by-side comparison of four Facebook guides for seafood research. Guide 1 'Word Association' shows fish product images with instructions to associate words with pictures. Guide 2 asks participants to describe their last seafood meal. Guide 3 'Your Kitchen Cruise'

instructs users to inventory seafood products in their home. Guide 4 displays a grid of personal values like authenticity, curiosity and justice for participants to select important values.

This final guide was particularly important for our research objectives as it allowed us to explore reactions to the algae-based packaging and other circular economy innovations that were central to our investigation of how sustainable design could integrate with established practices. The speculative product was visually presented as if it were a store brand item found in ASDA (a major UK supermarket), deliberately contextualizing the innovation within familiar retail environments (see Figure 4).

Figure 4: Facebook guide 5: design speculation of new Seafood Ready to Cook fillet prototype. Multi-part visual guide about ASDA's sustainability initiatives and seafood products. Shows the exterior of an ASDA sustainability store in Middleton, Leeds (Part 1), plastic reduction strategies (Part 2), a recycling hub (Part 3), the seafood aisle (Part 4), packaged fish products (Part 5) and an ASDA Minced Fish Fillet Patty with cooking instructions and product information (Part 6). The guide explores how sustainability initiatives are integrated into the supermarket shopping experience.

Each participant engaged in a one-hour, one-on-one conversation with a researcher, using these guides as a structured framework. To ensure inclusive participation, we developed alternative methods for those uncomfortable with Facebook. These alternatives consisted of:

1. PDF versions of the same visual guides emailed to participants.
2. Video call platforms (Zoom or Microsoft Teams) where the researcher shared screens showing the guide content.
3. Telephone conversations with mailed printed guides for those with limited digital access.

These alternatives maintained the same structured progression through the thematic guides, ensuring methodological consistency while accommodating different technological capabilities.

The shift to online methods expanded our geographical reach, including participants from North Lancashire, London and Warwickshire. This broader geographical scope provided insights into regional variations in seafood practices while maintaining our focus on UK consumers.

3.4 Sampling strategy and participants

We employed purposive sampling throughout both phases, targeting adults aged 55 and above who were responsible for some or all household cooking and who consumed fish products. This criterion ensured participants could provide rich insights into the practices we were studying from the perspective of older consumers. While our primary demographic focus was adults 55+, we included some participants under this age threshold who had significant caregiving responsibilities for older adults, as they offered valuable perspectives on preparing food for this demographic.

For the workshop phase, recruitment was facilitated through the Blackpool Carers Centre networks. For the online phase, we used a combination of snowball sampling from initial workshop participants, targeted recruitment through community organizations serving older adults and social media invitations in groups focused on food and cooking.

This approach yielded a diverse sample of seventeen participants for the Facebook Tool phase (see Table 1), representing various household compositions, geographical locations and digital literacy levels. While our sample included some participants under 55, the majority (59 per cent) fell within our target demographic, with 41 per cent being 65+.

Table 1: Facebook tool participant demographics.<?Note To TS: Double?>

Participant<?Note To TS: Char=Mixed?>	Age<?Note To TS: Char=Mixed?>	Gender<?Note To TS: Char=Text?>	Household<?Note To TS: Char=Text?>
Participant 1	45	Male	Couple with children
Participant 2	43	Female	Couple with children
Participant 3	55	Male	Couple with children
Participant 4	63	Female	Couple with no children
Participant 5	36	Female	House share
Participant 6	72	Female	Couple with no children
Participant 7	34	Female	Couple with no children
Participant 8	68	Male	Couple with no children
Participant 9	61	Female	Couple with children
Participant 10	76	Male	One person
Participant 11	38	Female	Couple with children
Participant 12	46	Male	Couple with children
Participant 13	65	Male	Couple with no children
Participant 14	54	Female	One person
Participant 15	78	Female	Couple with no children
Participant 16	67	Male	Couple with no children
Participant 17	58	Female	House share

Prior to participation, all participants received detailed information about the study objectives, methods and data handling. Following ethics approval from our institution, informed consent was obtained from all participants.

3.5 Data analysis

Our analysis was guided by thematic analysis principles (Braun and Clarke 2006), which we selected specifically for its compatibility with our practice theory framework. Thematic analysis offered the flexibility to identify patterns across the dataset while maintaining sensitivity to the three elements of practice (materials, competences and meanings) that structured our inquiry.

The process began with thorough familiarization, where researchers immersed themselves in workshop transcripts, online conversations and visual materials to understand participants' articulated practices across contexts.

Using NVivo 12, we conducted two coding rounds: an initial inductive approach allowing themes to emerge organically, followed by a theoretically driven round specifically coding for material, competence and meaning elements of practice (Shove et al. 2015). We then developed preliminary themes capturing patterns in how participants engaged with RtC fish products and responded to sustainability innovations, paying particular attention to tensions between established practices and novel sustainable elements.

These themes underwent rigorous review against both coded extracts and the complete dataset, often requiring us to return to original data to ensure accurate representation while illuminating our research questions. Theme refinement involved defining each theme's essence and its contribution to understanding the design challenge of integrating sustainable innovations with older adults' established practices.

Regular team discussions throughout the analysis process challenged interpretations and ensured analytical rigor, maintaining focus on practice-theoretical dimensions and design implications. The resulting analysis structure directly addresses our research objectives by examining how established practices shape product interactions and revealing tensions with circular economy approaches.

4 Results

Our analysis revealed four key design tensions that emerge when attempting to reconcile older consumers' established seafood practices with circular economy innovations. These tensions manifest across the material, competence and meaning elements of practice, creating both challenges and opportunities for sustainable product design. Here we present these tensions

and their implications for designing RtC fish products that can successfully bridge consumer acceptance with sustainability goals.

4.1 Material design tension: Convenience vs. perceived quality

A fundamental tension emerged between participants' desire for convenience and their concerns about quality in RtC fish products. This tension was particularly evident in how participants described their material interactions with different product formats.

4.1.1 Material elements supporting convenience

Material features that enhanced convenience were highly valued, particularly by those with caregiving responsibilities or physical limitations. These features included:

Extended shelf life: The ability to store RtC products for longer periods was particularly valued for reducing food waste and managing unpredictable schedules: 'I don't throw away fish […] because of either buying and eating the same day or putting in the freezer. The tinned tuna will probably outlive me' (Male, 76, one person household).

This remark reveals how deeply extended shelf life is tied to waste reduction practices and economic efficiency for older adults living alone, highlighting the importance of designing products with appropriate preservation methods.

Simplified preparation: Participants appreciated product formats that minimized preparation steps and cooking complexity:

> Yeah, it's convenient to cook from frozen isn't it? […]I tend to buy the packs of frozen like white cod fillets or haddock fillets frozen because it is quite convenient. […] I don't like to see the skin so much […] it reminds me too much that it's actually a fish.
>
> (Female, 54, one person household)

This quote reveals not the convenience value and how product design can address psychological barriers by minimizing visual cues of the fish's origin. The aversion to visual reminders of the fish's animal nature represents an important design consideration that goes

beyond functional convenience to address emotional and psychological aspects of food preparation.

4.1.2 Material elements associated with quality concerns

Despite valuing convenience, participants expressed significant concerns about material aspects they associated with lower quality.

Processing and additives: Many participants viewed processing methods and additives as diminishing the natural qualities of fish:

> There is a lot of preservatives in these fish foods and now they do keep longer which takes the original taste out the fish. Fresh fish tastes like fresh fish but the frozen one, it could be frozen for years, and you don't know that.
>
> (Male, 68, caregiver)

This perception reflects a broader tension between technological preservation and sensory authenticity, suggesting designers must consider how processing methods can maintain or mimic the sensory qualities associated with freshness, while still achieving extended shelf life.

Packaging transparency: Participants preferred packaging that allowed visual inspection of the fish, connecting visibility with quality assessment:

> I buy both the frozen and fresh fillets. Sometimes it's a bit like buying chicken products. You have to really read the label to make sure you're getting proper fillets and not mashed up bits. If you want the fillet flakes, you have to be careful and look. We just don't like mashed up bits. We want to see the filleted flakes. We want to see the fish steak.
>
> (Female, 63, couple with no children)

This detailed description of product assessment practices demonstrates how visual transparency functions as a quality verification mechanism, suggesting that sustainable packaging solutions must find ways to maintain visibility of the product even while using alternative materials.

This design tension creates a challenge for developing sustainable RtC products that must balance convenience with material qualities that signal freshness and minimal processing. Successful designs must consider how material elements can simultaneously address practical needs while maintaining connections to quality perceptions.

4.2 Competence design tension: Simplification vs. skill preservation

Our analysis revealed a second key tension around cooking competence between participants' desire for simplified preparation and their valuing of traditional fish preparation skills. This tension manifested in how RtC products interact with existing cooking competences and potentially develop new ones.

4.2.1 Simplification of competences

Many participants, particularly those with caregiving responsibilities, valued RtC products precisely because they reduced competence requirements.

Removing skill barriers: Several participants described lacking confidence in preparing fresh fish, seeing RtC products as a way to circumvent this skill gap: 'I'd like to be capable of [just smelling and looking at food to see if it's OK] but I'm not a good cook so I don't trust my judgement' (Male, 62, caregiver).

This self-assessment reveals the anxiety that surrounds food safety judgments for less confident cooks, positioning RtC products as not just convenience items but as risk-reduction tools that provide certainty in an area where many feel inadequate.

Time-constrained cooking: Participants with caring duties specifically valued products that allowed them to prepare meals quickly without requiring extensive preparation skills:

> We had fish and chips on Friday […] [and we] would wait until holiday to have shellfish. […] We used to go to Scarborough for our holidays. […] There used to be stalls on the front with cockles and mussels and shrimp. […] You had to eat [it] on the same day. Fresh tasted better.

(Female, 72, couple with no children)

This quote reveals a nostalgic preference for fresh seafood despite the practical reliance on more convenient options, suggesting an experienced loss of connection to traditional preparation practices. The juxtaposition of holiday seafood consumption with everyday practices highlights how special occasions serve as repositories for more traditional food experiences that are no longer practical in daily life.

4.2.2 Preservation of traditional competences

Interestingly, even while valuing simplified preparation, many participants expressed concern about losing traditional fish preparation competences.

Sensory assessment skills: Several participants valued their ability to assess fish quality through sensory cues, skills they feared were being lost: 'Even if you use the freezer [or] the fridge, [the fish] will be deteriorating in taste […] if you keep it too long. It might be safe but. […] It's going to steadily be less and less nutritious' (Male, 65, couple with no children).

While this statement contains misconceptions about nutritional loss, it reveals the importance participants placed on sensory assessment competences. The perceived connection between sensory qualities and nutritional value demonstrates how deeply intertwined material properties and health meanings are in consumers' understanding of food quality.

Recipe knowledge: Many participants, particularly older ones, took pride in their fish recipe knowledge and saw this as important cultural knowledge to preserve.

> I like something that's got a slight tanginess and taste. […] You wouldn't eat salmon and chips [because] they wouldn't go together [so] we all have cod and chips […] [but] the salmon and the pichards and the sushi, they all have that tang taste.
>
> (Male, 55, couple with children)

This tension highlights a design opportunity for sustainable RtC products that simplify preparation while still engaging consumers in meaningful parts of the cooking process, allowing them to maintain and express valued competences.

4.3 Meaning design tension: Health values vs. environmental values

A third significant tension emerged between the meaning elements of health and sustainability, with participants often struggling to reconcile these sometimes competing values in their seafood consumption practices.

4.3.1 Health meanings and priorities

Health considerations strongly shaped how participants evaluated seafood products.

Nutritional perceptions: Fresh and minimally processed fish was consistently associated with higher nutritional value:

> Adding stuff worries me. Why do you need to have to add stuff in if it's clean and nutritious already? It's like vitamins. If I am eating well, I shouldn't need extra vitamins. I want to be in complete control of what I'm putting in my body. I should be getting what I need from the fish already.
>
> (Female, 58, health-focused consumer, house-share)

This quote reveals scepticism towards nutritional enhancement and additives, emphasizing the meaning of 'natural' as healthier. The strong language around bodily control suggests that nutritional enhancement may be perceived as an intrusion on personal autonomy, indicating that transparency and choice are critical aspects of designing acceptable enhanced products.

Safety concerns: Participants expressed heightened food safety concerns with seafood compared to other foods: 'With seafood cocktail and calamari, I'd be concerned with storage and bacterial growth. I go for the stuff with the longest sell by dates. Careful to check and go for the longest date' (Male, 67, couple with no children).

This thorough approach to date checking reflects the special status of seafood as a high-risk food category in consumers' risk hierarchies, suggesting that safety assurance

features may be particularly important design elements for seafood products compared to other food categories.

4.3.2 Environmental meanings and values

Many participants also expressed strong environmental values that influenced their seafood choices.

Sustainability awareness: Participants demonstrated growing concern about sustainability issues in seafood production:

> We need to look after the planet. It's nice to have happiness and health but if we keep plundering the planet, it's not sustainable. To get what we want, we have to be responsible about what we do on this planet. […] What can I do to help that will matter? Am I shouting into the wind? Eating sustainably would help – eat less beef.
>
> (Female, 78, couple with no children)

The emotional language and rhetorical question in this quote reveal the moral weight that sustainability considerations carry for some older consumers, as well as the sense of helplessness that can accompany environmental concerns, suggesting that design should not only incorporate sustainable elements but also clearly communicate their impact to provide a sense of efficacy.

Conflicting values: Several participants explicitly acknowledged tensions between health and environmental considerations: 'There's a bit of a tension there but I feel like I need to eat fish because it's being kind to me to give myself what I need nutritionally, but not kind to the fish' (Male, 67, health-conscious consumer, couple with no children).

This articulation of moral conflict demonstrates the sophisticated ethical reasoning that consumers engage in when making food choices, weighing personal health benefits against environmental impacts in ways that can create discomfort and cognitive dissonance that product design could potentially help resolve.

This tension represents a significant design challenge: creating products that consumers perceive as both healthy and environmentally sustainable, without requiring compromise between these values.

4.4 Innovation design tension: Sustainability benefits vs. unfamiliarity risks

The final tension emerged around participants' responses to circular economy innovations, particularly the algae-based packaging featured in our design speculation. This tension revealed the complex interplay between openness to sustainability benefits and caution regarding unfamiliar materials and processes.

4.4.1 Attraction to sustainability benefits

Participants expressed interest in sustainable innovations presented in our design speculation, particularly when benefits were clearly communicated.

Waste reduction appreciation: Many participants valued the waste reduction aspects of circular economy approaches: 'While in principle, I think the idea is fantastic, the whole idea of entirely sustainable, zero waste, using bits that usually get thrown away, sounds great' (Male, 65, couple with no children).

The distinction between principled support and practical acceptance revealed in this quote highlights the gap between abstract environmental values and concrete consumption practices, suggesting that design interventions need to bridge this gap by making sustainability benefits tangible and relevant to everyday concerns.

Smart labelling acceptance: The smart temperature-sensing labels received particularly positive responses for their potential to reduce waste and improve safety: 'I like where it's going. The children at my school struggle with use by and best before – I usually just smell it and they'd be over-cautious' (Female, 43, urban, teacher, couple with children).

This professional perspective reveals how smart labelling could serve educational purposes beyond individual consumption, indicating potential broader social benefits that could be emphasized in design communication to increase acceptance.

4.4.2 Concerns about unfamiliar technologies

Despite recognizing potential benefits, participants expressed significant concerns about unfamiliar aspects of the innovations, particularly the algae-based packaging.

Hygiene worries: Many participants questioned the hygiene aspects of biodegradable packaging, especially in the context of seafood:

> I like the idea of no waste and no plastic but the idea that this product having stay on the shelf and maybe been picked up and prodded with their fingers. […] I don't know why I think this because vegetables are like this but somehow with fish it's different […] the idea this all gets absorbed I find a bit off putting.
>
> (Female, 58, house share)

The participant's self-reflection on the inconsistency between accepting unwrapped vegetables but not fish highlights how deeply ingrained category-specific expectations are, suggesting that sustainable packaging design must take into account not just functional requirements but also these deeply held categorical distinctions.

Practicality questions: Participants raised detailed concerns about the practical implementation of algae-based packaging:

> And then you slide it off the cardboard? How is it kept hygienic? From rats in storage and trucks or in the delivery – lots of risk of cross contamination. […] Can you wipe it down if you spill something on it? How would you wipe it down without putting chemicals on it and absorbing the algae?
>
> (Male, 65, rural resident, couple with no children)

The vivid scenario-building in this quote demonstrates how consumers mentally test innovations against worst-case scenarios drawn from their everyday experiences. This

indicates that successful sustainable packaging design must anticipate and address these practical concerns through both design features and clear communication.

This tension between sustainability benefits and unfamiliarity risks suggests the need for design approaches that incrementally introduce innovations while addressing practical concerns and building trust.

4.4.3 Design strategies for navigating innovation acceptance

Our analysis revealed several potential strategies for increasing acceptance of sustainable innovations.

Gradual introduction: Participants suggested introducing innovations alongside familiar elements rather than all at once:

> So that's one innovation, with the algae. And then eat the package, and then eat the minced fish – it's a triple jump for people to make. If it was in Booths or Waitrose or M&S and was a normal fish to test the algae – like a 'why not try this algae with your seabass' – that marketing would get me comfortable.
>
> (Female, 61, suburban resident, couple with children)

The participant's reference to specific high-end supermarkets reveals how retail context functions as a trust mechanism. This suggests that strategic partnerships with trusted retailers could be a crucial element in introducing sustainable innovations to older consumers.

Trusted intermediaries: Participants indicated that endorsements from trusted sources could overcome resistance to unfamiliar innovations.

> If a chef in a restaurant introduced it to me and said 'Look, here is something very innovative and we think it's the future'. And they described it to me and it's on offer, then I would say yes. Served on a nice plate. That looks a bit more posh!
>
> (Female, 61, suburban resident, couple with children)

The emphasis on presentation and setting in this quote highlights how contextual elements contribute to the meaning of innovations, suggesting that the aesthetic and experiential

dimensions of product introduction are as important as the functional benefits in gaining acceptance.

Transparency and honesty: Clear communication about product composition and processing was consistently valued. 'If you buy a bag of Quorn mince and the mince relates to its texture and consistency – you should make it not try to be something that it isn't' (Female, 58, vegetarian, house share).

This reference to meat alternatives draws a parallel between different types of food innovation. Lessons from one domain of sustainable food design could inform approaches in another, particularly regarding the value of authenticity over imitation.

These insights provide concrete design strategies for introducing sustainable innovations in ways that can overcome resistance and build consumer acceptance.

4.5 Summary of key design tensions

The four key tensions identified in our analysis – (1) convenience vs. perceived quality, (2) simplification vs. skill preservation, (3) health values vs. environmental values and (4) sustainability benefits vs. unfamiliarity risks – represent the central design challenges in reconciling older consumers' established practices with circular economy innovations in RtC fish products.

These tensions operate across material, competence and meaning elements of practice, creating a complex design space that requires attention to how products integrate with existing routines while introducing sustainable innovations. Understanding these tensions provides a foundation for developing design principles that can successfully bridge consumer acceptance with sustainability goals, which we explore in the discussion section.

5 Discussion

Building on the design tensions identified in our findings, this section develops a framework of design principles for creating sustainable RtC fish products that successfully integrate with

older consumers' established practices. Here we focus specifically on how these principles can guide design practice at the intersection of consumer acceptance and sustainability innovation.

5.1 Designing for transparency: Building trust through material design

Our findings reveal that perceived quality and transparency are central concerns for older consumers engaging with RtC fish products, especially when considering sustainability innovations. This aligns with Bryant et al'.s (2019) observation that 'clean label' trends reflect broader desires for transparency in food systems. For designers, this necessitates specific strategies for creating transparent material interactions.

5.1.1 Visible product quality

The strong preference for visual verification of fish quality identified in our study suggests that sustainable packaging solutions must maintain product visibility while achieving environmental goals. When designing algae-based or other alternative packaging for RtC fish products, incorporating transparent viewing windows becomes essential rather than optional. Participants consistently expressed the desire to visually verify that products contained proper fish fillets rather than processed pieces.

This extends Woodcock et al.'s (2002) findings on older adults' packaging interactions by highlighting how visual assessment serves not merely as information-gathering but as a trust-building practice. For designers, this means creating sustainable packaging that enables this established verification practice rather than disrupting it.

5.1.2 Communicating processing methods

The widespread concerns about processing methods and additives expressed by our participants indicate the need for explicit communication about how circular economy innovations affect the product. This goes beyond ingredient lists to revealing production processes, addressing concerns about preservatives affecting taste and quality.

This principle builds on Jacobs et al.'s (2018) work on information provision in seafood consumption by suggesting that information about processing methods is particularly critical for establishing trust in sustainable innovations. For RtC fish products incorporating by-catch or otherwise discarded fish, designers should create communication elements that frame these as quality ingredients rather than allowing them to be perceived as lower-quality alternatives.

Design applications of this principle could include QR codes linking to processing videos, illustrated timelines of the product journey, or packaging elements that reveal rather than conceal processing steps. The emphasis should be on making sustainable processing methods transparent rather than invisible.

5.2 Incremental innovation: Respecting established practice elements

Our findings highlight the importance of designing innovations that allow for gradual integration with existing practices rather than requiring radical changes. This principle addresses the tension between innovation and established competences identified in our results.

5.2.1 Hybrid preparation formats

The tension between simplification and skill preservation suggests opportunities for hybrid product formats that reduce barriers while maintaining meaningful engagement. Participants with limited cooking confidence expressed desire for products that would help them develop food assessment skills without risking safety.

Sustainable RtC fish products could be designed to incorporate guided preparation elements that scaffold cooking experiences rather than eliminating them entirely. This approach would build on Rai's (2021) identification of RtC foods as occupying a strategic middle ground between convenience and engagement, extending this to consider how sustainable products can preserve meaningful competences while removing barriers.

Design applications might include partially prepared products with simple finishing steps, RtC formats that incorporate traditional preparation elements while removing difficult

aspects or preparation instructions that build confidence while teaching sustainable cooking techniques.

5.2.2 Familiar-to-novel innovation pathways

Our findings revealed a preference for gradual introduction of innovations alongside familiar elements. Participants suggested that sustainable innovations would be more acceptable if introduced through trusted retailers and alongside conventional products.

This extends Elzerman et al.'s (2013) work on meat substitutes to the seafood domain, suggesting that sustainable innovations should be introduced through strategic pathways from familiar to novel rather than as complete replacements. For circular economy innovations like algae-based packaging, this might involve initial introduction alongside conventional packaging before transitioning to full implementation.

Design applications include creating product families that progress from minimally to more substantially innovative, introducing sustainable elements as optional additions before making them standard, or creating visual and tactile connections between familiar and novel elements to ease transition.

5.3 Leveraging trusted intermediaries: Designing communication ecosystems

Our findings highlight the significant role trusted sources play in the acceptance of sustainable innovations, suggesting that design should extend beyond the product itself to consider the communication ecosystem surrounding it.

5.3.1 Trust transfer through retail contexts

Participants' references to specific high-end retailers reflect how retail contexts function as trust mechanisms. Our findings suggest that strategic partnerships with trusted retailers could

facilitate the introduction of sustainable innovations, particularly with brands recognized for quality and ethical standards.

This builds on Zander and Feucht's (2018) work on willingness to pay for sustainable seafood by highlighting how retail context not only influences purchasing decisions but actually transfers trust to unfamiliar innovations. For designers, this means considering retail placement as an integral design element rather than a post-design distribution decision.

Design applications include creating retail-specific packaging variations that leverage brand associations, developing in-store educational materials that connect innovations to trusted retail values or designing products specifically for introduction through trusted retail channels before wider distribution.

5.3.2 Expert endorsement integration

Our findings show that participants would be more receptive to innovations introduced by chefs or other experts, suggesting opportunities for integrating expert endorsements into the design process. Restaurant settings and chef recommendations were cited as contexts where unfamiliar innovations would be more readily accepted.

This extends Caraher et al.'s (2000) findings on the influence of celebrity chefs to specifically address their potential role in facilitating acceptance of sustainable innovations. For designers, this suggests involving culinary experts early in the design process rather than seeking endorsements after product development.

Design applications include co-creating products with recognized experts, incorporating preparation techniques associated with respected chefs or developing packaging that integrates expert narratives about the product's sustainability benefits.

5.4 Creating multisensory experiences: Reinforcing sustainability benefits

Our findings reveal the importance of addressing perceptual and experiential aspects of sustainability innovations, particularly for older adults whose sensory perceptions may influence their food practices (Spence and Youssef 2021).

5.4.1 Bridging health and environmental values

The tension between health and environmental values identified in our study suggests opportunities for design elements that explicitly connect personal health benefits with sustainability features. Participants expressed conflict between eating fish for nutritional needs and concerns about overfishing.

This extends Oken et al.'s (2012) work on seafood consumption decision-making by suggesting that design can help resolve the cognitive dissonance between personal and planetary health concerns. Rather than asking consumers to prioritize one value over another, sustainable products should be designed to make these values mutually reinforcing.

Design applications include packaging that communicates both personal and environmental benefits side-by-side, product formulations that enhance nutritional content through sustainable ingredients (like the seaweed sauce in our prototype) or sensory cues that signal both health and sustainability.

5.4.2 Sensory signalling of sustainability

The hygiene and safety concerns expressed about algae-based packaging suggest that sustainable materials must be designed to provide appropriate sensory signals that align with expectations for food-safe materials. Participants noted category-specific expectations, finding unwrapped fish more concerning than unwrapped vegetables.

This builds on Young et al.'s (2020) research on consumer perceptions of smart packaging by highlighting the need for multisensory design approaches that address not just functional requirements but also sensory expectations. For sustainable packaging innovations,

this means considering how texture, colour and scent might influence perceptions of safety and hygiene.

Design applications include developing sustainable packaging with tactile properties that signal cleanliness, creating colour schemes for sustainable materials that evoke freshness and safety or incorporating subtle aromatic elements that reinforce perceptions of product quality.

5.5 Design framework: Bridging established practices with sustainability innovation

The four principles outlined above: transparency, incremental innovation, trusted intermediaries and multisensory experiences, together form a design framework for reconciling older consumers' established practices with circular economy innovations in RtC fish products.

Rather than treating these principles as separate guidelines, we propose they be implemented as an integrated framework addressing the material, competence and meaning elements of practice identified in our theoretical approach (see Figure 5). This framework provides a structured approach to analysing existing practices and identifying intervention points for sustainable design.

Figure 5: Design framework: bridging established practices with circular economy innovations. This diagram visually represents how your four design principles interact with the three elements of practice theory, creating a comprehensive framework for designing sustainable RtC fish products that successfully integrate with older consumers' established practices. The colour-coding helps identify relationships between principles and practice elements, while the directional arrows show how each principle primarily addresses specific elements of practice. The solid arrows show primary connections, whilst the dotted arrows illustrate secondary connections.

Triangular diagram showing design principles for sustainable innovation. Three coloured nodes represent Materials (blue), Competences (green) and Meanings (orange), connected by arrows. Four key principles are shown in coloured boxes: 'Incremental innovation' (gradual introduction of new elements), 'Designing for Transparency' (clear communication about products), 'Multisensory Experiences' (creating coherent sensory signals) and 'Trusted Intermediaries' (using familiar contexts to build trust). Each principle connects to different elements of the framework.

The framework integrates four design principles with the three elements of practice theory (materials, competences and meanings), showing how sustainable design interventions can address multiple practice dimensions simultaneously. The framework's value lies in its ability to guide designers beyond merely understanding consumer preferences to actively shaping products that can successfully bridge established practices with sustainability innovations. By addressing both the practical and symbolic dimensions of food consumption, it offers a pathway for designing RtC fish products that can gain acceptance among older consumers while advancing circular economy goals.

5.6 Limitations and future research directions

While our study provides valuable insights for designing sustainable RtC fish products for older consumers, several limitations should be acknowledged. Our focus on UK consumers limits generalizability to other cultural contexts, where different practices and meanings may influence product interactions. Additionally, the adaptation to online methods during the pandemic, while innovative, may have limited our ability to capture the full sensory dimensions of food practices.

Our sampling strategy, while purposive and appropriate for our research aims, resulted in a relatively small sample that may not represent the full diversity of older consumers. Future research could employ mixed-method approaches with larger, more diverse samples to provide

a more comprehensive understanding of how sustainable RtC fish products might integrate with various practice contexts.

Building on our findings, we identify three key directions for future design research:

1. **Participatory design approaches**: Future research should involve older consumers directly in co-designing sustainable seafood products, moving beyond eliciting preferences to active participation in the design process. This could help identify innovative solutions that address the tensions identified in our study.
2. **Longitudinal studies of practice adaptation**: Research examining how practices evolve over time in response to sustainable innovations could provide valuable insights into the process of practice transition. This could involve tracking households as they incorporate new sustainable products into their routines.
3. **Cross-cultural practice comparisons**: Comparative studies examining how seafood practices vary across different cultural contexts could help identify both universal and culturally specific design considerations for sustainable RtC fish products.

Despite these limitations, our practice-based approach has yielded valuable insights that can inform the design of sustainable RtC fish products that successfully reconcile older consumers' established practices with circular economy principles. By addressing the tensions between convenience and quality, simplification and skill preservation, health and environmental values, and sustainability benefits and unfamiliarity risks, designers can create products that support the transition to more sustainable food systems while respecting the established practices of older consumers.

6 Conclusion

This study examined the design challenge of reconciling older consumers' established practices with circular economy principles in RtC fish products. Through our practice-based investigation of older UK adults' engagement with seafood, we identified key design tensions and developed principles to guide sustainable product design that aligns with consumers' everyday practices.

Our findings demonstrate that the successful design of sustainable seafood products requires attention to both environmental imperatives and the material, competence and meaning elements of older consumers' established food practices. While participants showed interest in circular economy approaches and expressed environmental values, they simultaneously articulated significant concerns about unfamiliar innovations, particularly regarding algae-based packaging and products incorporating fish that would otherwise be discarded. These concerns were not simply resistance to change but reflected sophisticated reasoning about how innovations might integrate with or disrupt valued aspects of their food practices.

The four design principles we developed: transparency, incremental innovation, trusted intermediaries and multisensory experiences, offer a practical framework for designing at this critical intersection. Rather than approaching sustainable design as merely a technical challenge, this framework acknowledges the socially embedded nature of food practices and offers pathways for integrating sustainable innovations in ways that respect established routines and meanings. Our findings suggest that designers should focus not only on creating sustainable products, but also on designing the transition pathways through which these products become integrated into everyday practices.

This research contributes to the field of food design by demonstrating how practice theory can inform product development that effectively balances sustainability imperatives with consumer acceptance. The design tensions and principles identified provide both

theoretical insights for researchers and practical guidelines for designers working to create sustainable RtC fish products for older consumers.

Future research should build on this work by engaging older consumers in participatory design processes, examining how practices evolve in response to sustainable innovations over time, and investigating how these design principles might be applied in different cultural contexts. By continuing to explore the intersection of established practices and sustainability innovation, design researchers and practitioners can contribute to the development of food systems that are both environmentally sustainable and socially embedded.

While there are significant challenges in reconciling older consumers' established practices with circular economy principles, our research reveals opportunities for thoughtful design interventions that can facilitate this reconciliation. By addressing the specific tensions we have identified and applying our design principles, food designers can create products that successfully bridge consumer acceptance with sustainability goals, contributing to more sustainable food systems while respecting the established practices of older consumers.

Acknowledgements

The authors would like to thank the participants who have kindly given their time to test and help develop the research methods described in this article. The authors would also like to thank the Seafood Age Project partners for the opportunity to contribute to this important work, and for helping to guide and inform the research method development documented in this article. A full list of the project partners together with links to more information on the project can be found online at http://seafoodage.eu/partners. Seafood Age project is co-financed by the Interreg Atlantic Area Programme through the European Regional Development Fund.

Disclaimer

This article covers activities implemented with the financial assistance of the European Union. The views expressed herein should not be taken, in any way, to reflect the official opinion of

the European Union, and the European Commission is not responsible for any use that may be made of the information it contains.

Ethical statement

Ethical approval was granted by members of the Lancaster University's Faculty of Arts and Social Sciences and Lancaster Management School Research Ethics Committee on 25 June 2019. Reference No: FL18177.

Funding

The Seafood Age project is co-financed by the Interreg Atlantic Area Programme through the European Regional Development Fund.

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Further reading

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SUGGESTED CITATION

Tsekleves, Emmanuel and Pollastri, Serena (2025), 'Design at the intersection: Reconciling older consumers' practices with circular economy principles in ready-to-cook fish products', *International Journal of Food Design*, 10:1, pp. 00–00, https://doi.org/10.1386/ijfd.