DATE LABELLING AND STORAGE ADVICE

COLLECTIVE INTELLIGENCE WORKSHOPS

POSITION PAPER

ENDFOODWASTE COOPERATIVE RESEARCH CENTRE

RMIT UNIVERSITY

Australian Government
Department of Industry, Science and Resources

AusIndustry
Cooperative Research Centres Program

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Glossary of terms

This report uses specific terms and concepts used in the packaging design industry and in academic research that were used in this project to communicate key ideas. We encourage you to review these terms, which have been applied throughout the report to support clarity and consistency.

Term	Definition
2D barcode	Two-dimensional barcodes contain information in both horizontal and vertical axes, allowing them to contain more data than traditional vertical black and white line barcodes. QR codes are 2D barcodes.
Activity Theory	A conceptual framework to understand the activity systems of subjects, moderating tools, and objects and the inter-relationship between the different resulting activity contexts (Sannino & Engeström, 2018).
Augmented reality (AR)	A type of technology that enhances the user's view of the real world with superimposed computer-generated images. AR overlays digital content onto real-life environments and objects.
Blockchain	A decentralised and distributed public ledger technology that records transactions in an immutable and transparent manner (Yang et al., 2024). Blockchain enhances food traceability, reduces fraud, and ensures supply chain integrity by providing a verifiable record from farm to fork.
Clarity	The quality of a message to be easily understood.
Cold chain	The network of businesses that manufacture, transport, store, retail, and serve fresh, chilled, and frozen foods (Australian Food and Grocery Council, 2017).
Consumer group / Consumer	The consumer participants of this project involved in food purchasing in their households.
Consumer myopia	The focus on consumers to enact individual behaviour change to solve societal issues instead of taking a wider holistic systems-thinking approach (Brennan et al., 2016).
Designer group	The participants in the Stage 1 workshops comprised of packaging designers and representatives from packaging and food labelling companies.
Front-of-pack (FOP)	The main face / main panel of food packaging that faces the consumer when displayed on retail shelves. Subsequently, side-of-pack (SOP) and back-of-pack (BOP) refer to the panels in relation to the FOP.
Good-Better-Best	Choice options based on the fuzzy best-worst multi-criteria decision-making method (Guo & Zhao, 2017).
Hero	In visual design, means to make something visually prominent to indicate importance or hierarchy. Also, that which is prominent in visual design.
Hop, Skip, Jump	A design-thinking approach in concept exploration, starting with concepts with incremental changes through to more progressive ideas.

Term	Definition
If This Then That (IFTTT)	The decision workflow of a well-known automated task service of the same name. Rules defined by the 'If' statement trigger specific activities defined in the 'Then' statement (Hoy, 2015).
Industry Players	The subset of participants in this project from the Stakeholder group representing food producers/ manufacturers, retailers, packaging companies, and packaging designers.
Legibility	The quality of being clear enough to read.
Morphological table	A matrix where each column represents a parameter and each row contains different ways to address that parameter, allowing diverse combinations of solutions to be explored and showing interaction between different parameters (Pankratova et al., 2024).
On-pack	Packaging design elements 'on the packaging' real estate. In contrast, 'off-pack' are those not on the packaging.
Packaging company / Packaging provider	The participants representing packaging companies that either supply food packaging and labelling to food producers/manufacturers or provide full service including packing food products.
Packaging designer	The participants that work as designers in branding, marketing, and design agencies. Their focus is on the graphic design, branding, and visual communication on packaging and not structural packaging.
Pilot design concepts	High-level simplifications that guide strategic decision-making and inform detailed design. They involve the use of design elements (such as language, text, images, visualisations, diagrams, sketches, and gestures) that contain meaning in the context of what is being designed (Ylirisku, 2013).
Real estate	The area allotted on packaging for graphic design/packaging design to be printed on. For food packaging that uses labels, this refers to the label area (including front and back labels). For boxes, this includes all the panels that will be printed on.
Save Food Packaging	Packaging designed to help minimise or prevent food waste, using innovative and intuitive design features (Francis et al., 2023).
Sensory testing	The use of the senses (i.e., smell, look, feel) to assess food quality and make decisions about food consumption or disposal (Langley et al., 2021).
Smart and intelligent packaging	Emerging packaging technologies that can sense and provide real time information to suppliers, retailers, or consumers on product quality, safety, shelf-life, and logistics efficiency (Langley et al., 2020).
Stakeholder group / Stakeholder	The umbrella term for the various participant expertise groups comprised of academics, food producers/manufacturers, retailers, representatives of packaging companies, packaging designers, and policymakers.
Thematic synthesis	An inductive approach involving the systematic coding of qualitative data and generating descriptive and analytical themes (Thomas & Harden, 2008).
Think tank	Independent nonprofit organisations conducting policy research guide informed decisions by providing intellectual arguments, debate platforms, and resources while maintaining autonomy from government and societal interests (McGann et al., 2014).
Visual cue	Elements of packaging design that convey sensory attributes, and connotative and semantic meanings. For example, the colour green equals organic.
Visibility	Refers to how easy a design element can be seen, readily noticed, or found on packaging.
Visual standout / Standout	Refers to visual prominence (due to size, colour, or contrast) in comparison with the other design elements.

Executive Summary

Background

Food waste is a significant issue, both environmentally and economically. Effective packaging with clear, consistent date labelling and storage advice plays a crucial role in reducing food waste. However, the current systems for storage advice and date labelling in Australia are unclear and contribute significantly to household food waste. There is a clear need for better, more consistent date labels and storage advice to assist consumers in their food management.

This report presents findings from seven Collective Intelligence Workshops conducted with Consumer and Stakeholder groups as part of the End Food Waste Cooperative Research Centre (EFW CRC) Project 1.2.4, National Date Labelling and Storage Advice (Phase 1). This research aimed to explore how date labelling and storage advice systems could be improved to reduce food waste from both consumer and food industry perspectives. Additionally, this research examined barriers and facilitators for change, to better understand the wider changes needed to improve existing labelling systems.

Method

This project used a mixed-methods approach to evaluate pilot design concepts for date labels and storage advice through seven Collective Intelligence Workshops. Twenty pilot design concepts (10 date labels and 10 storage advice labels) were developed in an earlier stage of the project. The designs ranged from incremental changes (e.g., additional text cues like 'Do not eat after this date') to more disruptive changes (e.g., adding colour and QR codes).

The research was divided into two stages. Stage 1 involved six workshops with different participant groups: Academics, Designers, Retailers, Food producers/manufacturers, Policymakers, and Consumers. In each workshop, participants provided feedback on the design concepts, discussed strategies for packaging reform from their perspective, and identified barriers to implementation. Stage 2 was a Future Scenarios workshop, where representatives from the Consumer and Stakeholder groups came together to evaluate future scenarios developed from the insights of the first six workshops. Using a brainstorming format, participants shared their opinions on three potential pathways for addressing household food waste: consumer-centric change, policy-led change, and stakeholder-driven change. Thematic synthesis (Thomas & Harden, 2008) was used to synthesise the qualitative data, and Activity Theory (Sannino & Engeström, 2018) was used as a framework to draw out key insights.

Key findings

The Stage 1 workshops highlighted both areas of common ground and areas of major difference between Consumer and Stakeholder groups. Both groups preferred clear, concise, and visually distinct date labels and storage advice systems. They also agreed on the value of visual cues, such as icons and colours, to distinguish information and enhance clarity, making the labels easier to interpret. However, there were concerns from Stakeholders about consumers misinterpreting the meaning of the icons. Additionally, both groups recognised the limited 'real estate' on packaging as a challenge for implementing comprehensive solutions.

A key difference was that Consumers focused on label usability, food quality, and waste reduction, while Stakeholders were more concerned with compliance, food safety, costs of change, and logistical feasibility. As a result, many Stakeholders preferred more conservative, incremental solutions to improve food labelling systems, whereas Consumers were open to sensory testing and innovative approaches to improve food management. When discussing QR codes to improve packaging, Consumers said they associated them with marketing and often ignored them, while Stakeholders saw them as a potential tool for providing more information. However, they were uncertain about how such a solution would be implemented and managed.

In the Future Scenarios workshop (Stage 2), Consumers suggested an approach that combined elements from each of the proposed scenarios, while most Stakeholders preferred the policy-led approach. The Industry Players specifically emphasised the need for stability, consistency, phased implementation, and consumer education to ensure clarity and manage costs effectively. However, concerns about legal liability, limited label real estate, and the feasibility of technological solutions remain significant barriers. Additionally, the Industry Players tended to view household food waste as a consumer responsibility, reflected by their focus on consumer education campaigns rather than addressing systemic factors within their own industry.

Insights

The food system comprises a complex network of interactions between consumers and stakeholders, each with distinct roles and responsibilities. Through collective intelligence, the perspectives of both Consumer and Stakeholder groups helped identify root causes and highlighted feasible, scalable solutions to improving existing labelling systems. These groups share overarching goals of improving sustainability and reducing food waste, and all agreed on the importance of enhancing the clarity of date labelling and storage advice systems. However, their perspectives on how to achieve these goals differed, leading to misalignment in how solutions are interpreted and implemented.

To ensure a coordinated approach to crafting solutions that will improve date labelling and storage advice for all actors in the food system, three key requirements must be considered:

- Awareness of consumers' and stakeholders' diverse contexts and specific needs
- Aligning industry players' approaches across the food sector to achieve objectives
- Understanding the role of mediating tools (e.g., external factors such as technological solutions) in aligning objectives.

Additionally, the following needs for date labelling and storage advice systems were highlighted for future efforts:

- Clear, concise labelling that is easy to find, understand, read, and interpret
- Using colour and visual cues, like icons, to assist consumers from diverse backgrounds in distinguishing between labels and in comprehending information
- A packaging design standard and a design framework ensuring date labels and storage information are conveyed consistently across different food categories and product types
- Clear specifications for mandatory information on packaging, ensuring consumer decisions on food quality and safety are not compromised
- Access to off-pack information regarding date labels and various methods for extending food shelf life, complementing the information on packaging and enabling consumers to make informed decisions about food waste.

Our position

To effectively tackle household food waste, systemic change is necessary. This requires collaboration between consumers, organisations, and the food sector. It is crucial that each actor in the food system understands the important role they play in reducing food waste and takes responsibility for improving current systems.

This report makes a compelling case for clearer, more consistent labelling that meets consumers' information needs and helps them reduce food waste. Achieving meaningful change to existing food packaging systems in Australia requires an overarching strategy with support from federal, state, and local governments. However, relying solely on policy is insufficient. Collective action from industry players and policymakers, with a unified approach, is essential to effectively address Australia's food waste problem.

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1 Introduction

Food waste is a significant issue, both environmentally and economically. In Australia, approximately one-third of food produced for human consumption is lost or thrown away each year (FIAL, 2022). Food waste occurs at every stage of the supply chain, with households responsible for 40% of the total waste (FIAL, 2022).

Effective packaging with clear and consistent date labelling and storage advice plays a crucial role in assisting in mitigating food waste. However, the current date labelling and storage systems in Australia are unclear and contribute significantly to household food waste (Brennan et al., 2023). There is a clear need for better and more consistent storage advice for consumers (Parker et al., 2024). This information could be provided on the packaging, through digital tools or devices, or a combination of these means, offering clear advice on:

- how specific foods should be handled and stored
- the shelf life of various foods
- tips for assessing whether food is still safe to consume
- proper storage techniques, including recommended temperatures and storage methods.

Enhancing food packaging with clear, user-friendly information on date labels and storage advice can empower consumers to make informed decisions, ultimately helping to reduce food waste.

This research builds on key insights from three earlier stages of the End Food Waste Cooperative Research Centre (EFW CRC) Project 1.2.4, National Date Labelling and Storage Advice (Phase 1), using pilot design concepts as prompts to stimulate meaningful discussions with Stakeholders. Pilot design concepts are high-level simplifications that guide strategic decision-making and inform detailed design. They involve the use of design elements (such as language, text, images, visualisations, diagrams, sketches, and gestures) that contain meaning in the context of what is being designed (Ylirisku, 2013).

These pilot designs (Stage 1c) are concept explorations of date labels and storage advice informed by findings from: a) Stage 1a – Systematic Literature Review of existing research on date labels, storage advice, and food waste, and b) Stage 1b – Consumer Interviews that explored consumers' understanding of date labels and the type of information they need to reduce household food waste. The four stages of Project 1.2.4 are shown in Figure 1.

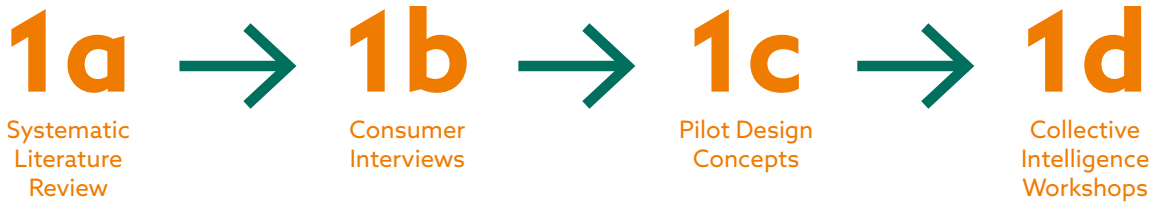

Figure 1. Stages of the National Date Labelling and Storage Advice project (Phase 1)

The goal of this research is to determine viable solutions to move beyond the current consumer-centric approach and to address consumer myopia (Brennan et al., 2016). It involves various Stakeholders across the supply chain through an online collective intelligence process conducted via a series of seven moderated workshops. Overall, the objectives of this research are:

- to gather general feedback on the pilot designs from Stakeholder groups, identifying both strong and weak ideas along with their underlying reasons, while ensuring the designs meet consumers' information needs with clear communication for informed decisions about food waste.
- to explore methods for achieving clarity, visibility, legibility, and standout qualities in date labels and storage advice information.
- to determine how to address consumer needs, wants, and expectations with date labels and storage advice information from each Stakeholder group's perspectives.
- to establish the barriers and facilitators for change around the issue of date labelling and storage advice systems.
- to identify Stakeholders' roles in creating barriers and facilitators for change in reducing consumer food waste.
- to provide clear insights into how Stakeholder groups perceive and interact with date labels and storage guidance on food packaging while making choices regarding purchasing, storing, consuming, and disposing of food products.

Overall, this stage aims to gain a better understanding of Project 1.2.4's underlying question:

How could date labelling and storage advice systems be improved in order to reduce consumer food waste?

2 Background

Date labelling, including terms like 'Use By' and 'Best Before', serves to inform consumers about food safety and quality. 'Use By' dates denote the last safe day for consumption, while 'Best Before' dates indicate when food is at its peak quality (Patra et al., 2022). Storage advice systems encompass the broader ecosystem of food storage, integrating food, packaging, appliances, and supporting information. These systems might involve passive storage in original packaging, repackaging for fridge or freezer storage, or even digital tools like apps that track storage duration, usage timelines, and suggest recipes. Research has shown a pressing need for improved, consistent date labelling and storage advice to help consumers reduce food waste (Fraser, 2018).

Consumer perceptions of date labels and storage advice reveal a complex interplay of trust, knowledge, and priorities. For high-risk foods like meat and seafood, consumers strictly adhere to 'Use By' dates, prioritising safety (Parker et al., 2024). In contrast, for low-risk foods, such as bakery items and produce, consumers rely more on sensory evaluations (e.g., appearance, smell, and texture), demonstrating confidence in self-assessment (Parker et al., 2024). This dual reliance highlights a gap in understanding and trust that varies based on food type and perceived risk.

Confusion about date labels remains a significant issue. Consumers often misinterpret 'Best Before' and 'Use By' dates, associating both with safety rather than quality (Brennan et al., 2021). This misinterpretation contributes to premature food disposal, exacerbating waste. Additionally, vague or inconsistent storage advice, especially regarding freezing and thawing, leaves consumers uncertain about proper practices, further complicating their efforts to reduce waste (Parker et al., 2024). The lack of precise, actionable guidance underscores a need for improvements in how storage advice is presented.

To address these challenges, storage advice and date labelling systems require significant design and infrastructure improvements. Current systems often lack clarity, specificity, and adaptability to different contexts, limiting usefulness (Langley et al., 2021). Improved systems should integrate intuitive, consumer-focused designs that combine clear visual communication, actionable text, and relevant technological features.

Previous studies have explored existing research on the influence of overall visual communication on packaging and how visual cues affect consumers' food choices and purchase intent (Fraser, 2018; Vermeir & Roose, 2020). These studies recommend that further research using rigorous and robust study designs be conducted, analysing how individual packaging design elements, such as visual cues, influence consumers' behavioural outcomes (Mehta et al., 2024). This highlights the complexity of navigating consumers' perceptions of food packaging and underlines the importance of understanding how visual cues, such as date labels and storage advice systems, influence consumer decisions.

3 Method and methodology

This study used a mixed-methods approach to evaluate pilot design concepts for date labels and storage advice through Collective Intelligence Workshops. The collective intelligence approach ensured that designs and strategies were tailored to real-world challenges, integrating insights from Stakeholders, including academics, food producers/manufacturers, retailers, packaging companies, packaging designers, and policymakers. These were, in turn, compared and contrasted with insights from a Consumer group. By combining these perspectives, the collective intelligence enabled the identification of root causes and the prioritisation of feasible, scalable solutions. Wallis Social Research oversaw participant recruitment and facilitated online workshop discussions. Ethical approval was granted by the RMIT University College Human Ethics Advisory Network (Project ID: 26653).

A total of seven workshops were conducted over two stages:

Stage 1: Consumer and Stakeholder groups workshops

In the first stage, six one-hour workshops were held: one Consumer group and five Stakeholder group workshops. The Stakeholder groups were Academics, Designers, Retailers, Food producers/manufacturers, and Policymakers, grouped by their areas of expertise. Each workshop involved reviewing design concepts and providing feedback to enhance their practicality and effectiveness (Phase 1c Pilot Designs). Discussions also explored barriers to implementation and potential strategies for packaging reform. The discussion objectives for each group were as follows:

- Consumers: To explore challenges with date labels and storage advice faced by consumers (in general and in relation to the concepts).
- Academics: To explore barriers to implementation and ways forward from a theoretical perspective.
- Designers: To explore packaging requirements and feasibility of change of the concepts.
- Retailers: To explore the feasibility of change and implementation at the retail/consumption stage of the supply chain (in general and in relation to the concepts)
- Food producers/manufacturers: To explore the feasibility of change and implementation at the production/distribution stage of the supply chain (in general and in relation to the concepts).
- Policymakers: To explore the feasibility of change from a regulatory and policy perspective.

Stage 2: Future Scenarios workshop

The second stage was a 90-minute Future Scenarios workshop, where representatives from the Consumer and Stakeholder groups were brought together to evaluate future scenarios developed from the insights from the first six workshops in Stage 1. Using a brainstorming format, participants were asked their opinions on and discussed three potential pathways for addressing household food waste: consumer-centric change, policy-led change, and stakeholder-driven change. See Appendix A for the details of each scenario.

Data from both stages included full transcripts of the recorded workshops, as well as transcripts of the debriefing sessions that were held after each workshop. In the debriefing sessions, workshop observer investigators reflected on the workshops using Activity Theory (Sannino & Engeström, 2018) as a framework for their observations and reflections. A structured discussion guide facilitated and focused responses during the debriefs.

3.1 | Participants

Thirty-seven participants from the key Consumer and Stakeholder groups were sourced through the professional network of the RMIT researchers; End Food Waste Australia; Green Industries SA; NSW Environment Protection Authority; Queensland Department of the Environment, Tourism, Science and Innovation; and Sustainability Victoria. Participants from the Consumer group were between 22 and 72 years of age and were involved in food purchasing in their households. Gender representation was an important consideration during participant recruitment, but given participation in workshops depended on specific roles, gender quotas could not be used. Each workshop did, however, have both female and male participants.

Stage 1: Consumer and Stakeholder groups workshops

- Consumers: Four participants (three females and one male) representing different age groups and living across various Australian states and territories. One participant was vision-impaired.
- Academics: Five participants from three universities in Victoria and Queensland. Their expertise included social marketing, food waste, sustainability, communication design, and quality management.
- Designers: Six participants comprising three packaging designers, and three representatives from packaging companies.
- Retailers: Six participants comprising four food retailers, and two retailers from food recovery and redistribution organisations. Their expertise included sustainability management, circular economy, product and packaging oversight, and regulatory compliance.
- Food producers/manufacturers: Four participants from food production and manufacturing companies. Their expertise included food technology, product development, and quality management.
- Policymakers: Four participants from federal and local governments, as well as from providers of technological solutions standards. Their expertise included regulatory frameworks, circular economy strategies, and technological solutions.

Stage 2: Future Scenarios workshop

– Eight participants representing the Consumer and Stakeholder groups, including one of each: consumer, academic, packaging company representative, packaging designer, retailer, food producer/manufacturer, policymaker, and food rescue expert.

3.2 | Pilot design concepts

The pilot design concepts for date labels and storage advice (Llagas et al., 2024) were the main research stimuli for the workshops (see Figure 2 and Figure 3 for visual reference of the pilot design concepts). The designs were informed by insights gathered from the previous Consumer Perceptions of the Role of Packaging and Food Waste project (Fight Food Waste Cooperative Research Centre Project 1.2.2, Brennan et al., 2023), a systematic literature review of existing date labelling and storage advice research (Llagas et al., 2025) and consumer interviews (Parker et al., 2024). This meant that the design concepts addressed real-world challenges and aligned with user needs. The designs followed a Hop, Skip, Jump approach and proposed solutions focused on three primary themes: 1) Improvement and enhancement, 2) Visibility, legibility, and standout features, and 3) Add-ons to improve understanding. Follow this link for the full presentation video explaining the methodology and the concepts.

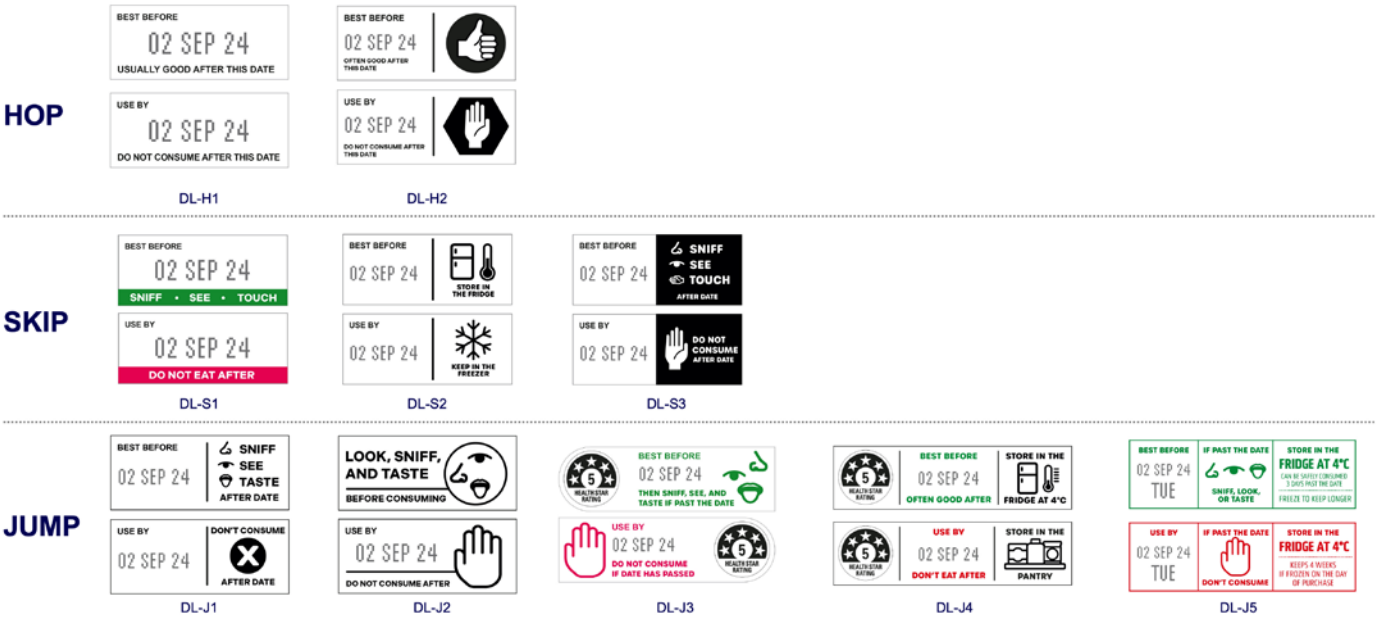

Figure 2. Date label pilot design concepts

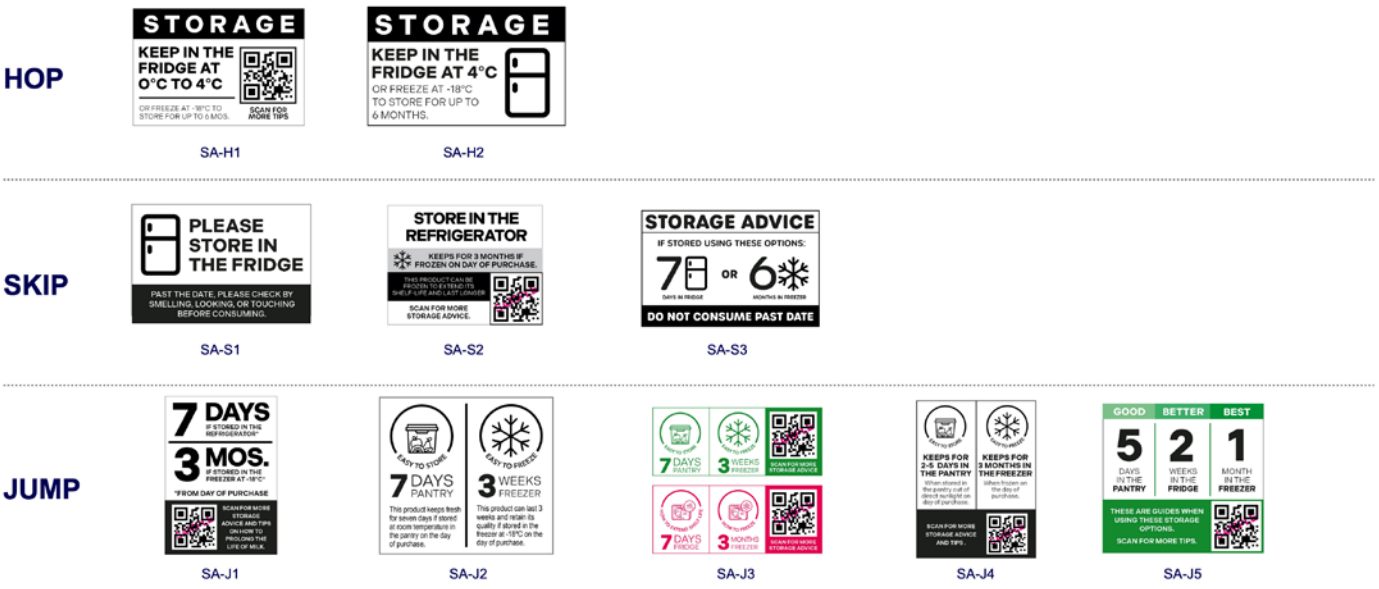

Figure 3. Storage advice pilot design concepts

The pilot designs incorporated several key ideas from the Consumer interviews Insights Report (Link to the full report) to address consumer confusion with date labels and storage advice. Visual cues, including icons, traffic light colour-coding, text-based cues, and innovative design elements, were employed to enhance food label accessibility and consumer understanding. Table 1 details the considerations behind these elements.

	**Icons** Different icons of hand gestures denoting 'Okay' or 'Stop' were used as additional messaging for date labels. Storage icons representing the fridge or freezer were used to complement storage advice.
	**Traffic light colour-coding** Traffic light colour-coded design elements were used as 'go' and 'stop' decision aids (Genschow et al., 2012; Grunert & Wills, 2007; Malam et al., 2009; Trudel et al., 2015). 'Best before' date labels were coloured green to accompany the message that it is okay to eat food after the date has passed. 'Use by' date labels were coloured red, utilising that colour's universal meaning for 'Stop'.
	**Sensory testing icons** Icons denoting eyes, nose, and mouth/tongue were used to represent the actions for sensory testing. The 'Picasso-style' icon represented by the asymmetrical face was explored as a way to get visual attention.
	**Text-based cues** Advisory and instructional language were added to standard date phrases to communicate what consumers should do for each date label type once the date has passed.
	**2D barcodes (e.g., QR codes)** These were incorporated in the storage advice panel, leading to a repository website or app with more storage advice information that cannot fit on the packaging.
	**Save Food Packaging icons** These icons were explored as AR triggers that consumers could scan and then receive information about storage advice.

Table 1. Exploratory design elements used in the pilot designs

3.3 | Data analysis

Thematic synthesis was used to bring together all the qualitative data from the workshops and debriefs. The data was first coded into categories, then organised into descriptive themes. These were then synthesised into emerging analytical themes of: Opportunities, Beliefs, Communication & Interpretation, Barriers, Problems & Concerns, and Challenges. Varying tensions and opportunities emerged from this analysis, and, after evaluating these, we created three Future Scenarios narratives and presented these to the participants of the Future Scenarios workshop. Lastly, Activity Theory (Sannino & Engeström, 2018) was used as a framework to analyse the data and to draw out final insights.

4 Findings and insights

In this section, we summarise the findings from both stages of the study. First, we present the insights drawn from the analysis of the six workshops from Stage 1, with the insights from each of the six groups compared and contrasted with each other. In turn, these insights are distilled and consolidated into several future scenarios where 'ideal conditions' for food waste reduction are in play. Finally, we present the findings from the Stage 2 Future Scenarios workshop, which reveals several challenges and barriers, as well as opportunities for how to achieve a whole-of-industry solution to reduce food waste with date labels and storage information.

4.1 Stage 1: Consumer and Stakeholder groups workshops

The following details the results from each Consumer and Stakeholder workshop, focusing on the opportunities, challenges, beliefs, communication considerations, and barriers that arose when discussing the date label and storage design concepts.

Consumers

When it comes to labels, the Consumers were typically more concerned about reducing food waste than about food safety, demonstrating openness to sensory testing. They also appreciated features like including the day of the week alongside date marks for better planning. Colours were valued for differentiating labels, enhancing visibility, and improving understanding. However, Consumers expressed reluctance toward QR codes, associating them with marketing and showing scepticism about their purpose. Black-and-white labels were seen as less effective because they don't stand out, and limited packaging space raised concerns about icon size and clarity. While they trusted the Australian cold chain system, Consumers focused more on food quality than safety. They emphasised clear, concise labels and disliked abbreviations due to the potential for misunderstanding.

Academics

The workshop with the Academics provided critical insights into the opportunities and challenges of addressing food waste through date labelling and storage advice. The integration of colour, text, and imagery was identified as a favourable approach, with black-and-white designs featuring clear signposting appreciated for their simplicity and visual clarity. However, participants expressed

scepticism about the effectiveness of date labels and storage advice as standalone solutions to the food waste problem, with the majority advocating for cautious, incremental improvements rather than disruptive innovations.

Each approach has its pros and cons, and neither can predict the outcome's success or failure. Incremental change delivers short-term, just-in-time improvements, but fails to deliver long-term transformational solutions. Conversely, while disruptive innovations can be transformational, navigating complex design systems can be a hurdle (Flavin & Quintero, 2020; Sim, 2001). The Academics' inclination to incremental change could be driven by current constraints around implementing change within existing systems. Key barriers identified by this workshop included cost implications, limited packaging space, and consumer disengagement with labels. These challenges highlight the importance of developing thoughtful, multifaceted solutions that balance innovation with practicality, and resonate with consumer behaviour.

Designers

The Designers highlighted the importance of simplicity and clarity in storage advice and date labelling, emphasising the role of icons in integrating visual and text-based cues effectively. Simple date labels and storage advice were identified as key tools for reinforcing messages. At the same time, many of them considered QR codes to be more commonly used for promotional and pricing purposes rather than to give storage advice. Challenges were noted, including uncertainty around the application of 'Best Before' and 'Use By' dates, the constraints of design briefs, and a reliance on the participants' assumptions about consumer behaviour due to limited consumer insights. Text-heavy and colour-dependent concepts were dismissed as impractical due to cost and limited space on labels, underscoring the importance of simplicity in design. Key barriers identified included cost implications, restricted packaging space, and low consumer engagement with labels.

Retailers

The Retailer participants demonstrated enthusiasm for innovative concepts, particularly those addressing food safety and engaging multicultural communities through colour and icons. They appreciated clear, simple, and visually striking designs, favouring icons combined with text-based cues like 'Sniff, Taste, Smell'. However, concerns emerged about the feasibility of implementation, logistical challenges, and potential consumer misinterpretation of icons, which could increase food waste. Additional challenges included limited space on packaging labels and some retailer participants not understanding the difference between 'Best Before' and 'Use By' date labels. The Retailers highlighted the need for an educational component to ensure consumers understand new concepts and the importance of practical, inclusive solutions.

Food producers/manufacturers

The Food producer/manufacturer participants expressed openness to change, aiming to reduce household food waste and exploring QR codes for additional consumer information. There were discussions around whose responsibility it would be to provide the extra information (i.e., individual manufacturers or an industry-wide effort). However, food safety and liability concerns dominated the responses of the Food producers/manufacturers, leading to resistance against disruptive changes

and a preference for safer, incremental solutions. They highlighted logistical challenges, resource constraints, and misinterpretation risks with visual cues (such as icons). The participants were sceptical about adding more information to packaging, citing limited consumer value, increased costs, and reduced branding space. Barriers included inherent cold chain management issues in Australia, such as geographical challenges and bottlenecks in the freezer supply chain, strained retailer relationships, and the perception of consumers' resistance to sensory testing for evaluating food safety quality. Smart packaging solutions and colour systems were largely dismissed due to cost and feasibility concerns.

Policymakers

The Policymakers showed openness to ideas and supported policy changes to improve date labelling and storage advice. They stressed the need for universally understood labels, particularly for multicultural communities, and favoured clear, simple designs with high contrast. Concerns included implementation challenges, limited packaging space, and potential consumer misinterpretation of information. Policymakers rejected traffic light systems and overly large icons, preferring nuanced advisory language and combining text and icons for clarity. The policymakers were concerned about consumer confusion if there were multiple QR codes on some food labels. Barriers included concerns that date labels and storage advice are taking up space on packaging that could be used for branding, as well as presenting information on packaging in a misleading way.

4.2 | Outcomes from the Stage 1 workshops

The data from the Stage 1 Collective Intelligence Workshops was synthesised through thematic synthesis. The resulting themes revealed tensions and opportunities within the Consumer and Stakeholder groups, including the interdependencies across these groups that affect decision-making and implementation regarding information on packaging. We created a morphological table based on these themes, allowing us to compare and contrast findings from the Consumer group and Stakeholder group, and identify key drivers for modelling future states of date labels and storage information systems.

Consumers and Stakeholders: A comparison

While the Stakeholders (academics, designers, retailers, food producers/manufacturers, and policymakers) and Consumers shared common goals around improving clarity and accessibility in date labelling and storage advice, their priorities diverged significantly. The Consumers focused on usability and waste reduction, while the Stakeholders concentrated on compliance, safety, and logistical feasibility. Bridging this gap requires balancing consumer-friendly innovations with the constraints stakeholders face, supported by education campaigns and collaborative solutions. For ease, the detailed morphological table was distilled into the diagram below, showing the focus areas for the Consumer group and the Stakeholders group. The blue and pink coloured boxes highlight comparison points between the two groups. For example, the Consumer group favoured the use of colour printing, while the Stakeholder group preferred black-and-white (b & w) printing (see Figure 4).

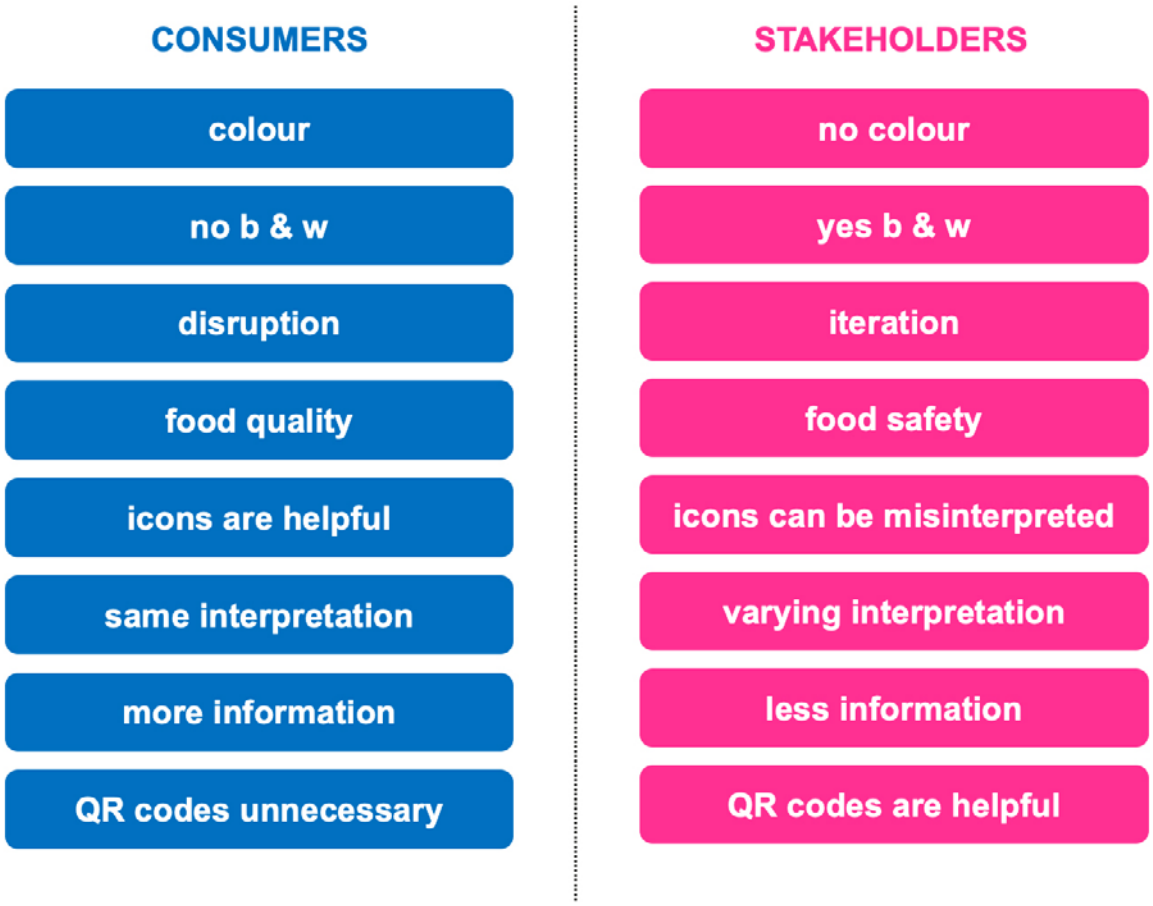

Figure 4. Comparison of non-alignment areas between Consumers and Stakeholders

Similarities

Preference over simplicity and clarity

Both the Consumers and Stakeholders emphasised the importance of clear, concise, and visually distinct date labels and storage advice. Colour and visual cues were considered helpful in distinguishing information and enhancing clarity.

Visual cues and accessibility

Both acknowledged the value of visual cues, such as icons and colours, in making information easier to interpret. However, concerns about misinterpretation were common.

Interpretation of visual cues

Both thought the 'Picasso-style' icon (see Table 1) for sensory testing looked 'weird' and 'strange'. However, the image caught their attention, which may be useful for attracting visual attention in future designs.

Limited label real estate

Both the Consumers and Stakeholders recognised the limited 'real estate' on packaging as a challenge for implementing comprehensive solutions.

Key differences

Conflicts between food safety, food quality, and food waste priorities

- The Consumers considered food quality and reducing food waste as more important to them than food safety, showing trust in the Australian cold chain system and retailers.
- The Stakeholders focused heavily on food safety concerns, liability, and regulatory constraints, often leading to suggestions of conservative and incremental solutions.

Engagement with QR codes

- The Consumers were sceptical of QR codes, associating them with marketing and often ignoring them.
- The Stakeholders viewed QR codes as a potential tool but highlighted implementation challenges and consumer disinterest.

Openness to innovation

- The Consumers were open to sensory testing and innovative approaches to improve food management.
- The Stakeholders leaned toward iterative, less disruptive changes due to cost, logistical, and regulatory constraints.

Interpretation of visual cues

- The Consumers displayed consistent interpretations of visual cues.
- The Stakeholders expressed varied interpretations of icons and voiced concerns about misinterpretation across diverse consumer groups.

4.3 | Three Future Scenarios of change

The focus areas identified, along with insights drawn from the morphological comparison table, helped us develop three Future Scenario narratives that illustrate possible futures for reducing household food waste through reforming date label and storage advice systems. These are: consumer-centric change, policy-led change, and stakeholder-driven change. These scenarios frame a desirable future outcome, with each focusing on addressing tensions and opportunities relating to Consumers, Industry Players (such as food producers/manufacturers, retailers, packaging companies, and packaging designers), and policy. Appendix A outlines the details of each scenario, with corresponding insight topics from the Consumer group and Stakeholder group accompanying each scenario narrative.

4.4 | Stage 2: Future Scenarios workshop

The discussions around possible future scenarios where consumer confusion with date labels and storage advice have been addressed reveal a myriad of opportunities, challenges, and barriers. The participants were open to innovative ideas and showed collaboration towards problem-solving. While most of the participants preferred the policy-led approach, the Consumer participant suggested an approach taking elements from each of the scenarios was more desirable. The Stakeholders

emphasised the need for stability, consistency, phased implementation, and consumer education to ensure clarity and manage costs effectively. However, legal liability concerns, limited label real estate, and technological solutions remain significant barriers for them. Additionally, they were inclined to view household food waste as a consumer responsibility, reflecting their response of running consumer education campaigns rather than addressing systemic factors that relate to them.

Opportunities

- The scenarios were well received, particularly by participants encountering the ideas for the first time, reflecting openness to diverse solutions and approaches. This openness was further demonstrated through polite, non-defensive dialogue and active participation as the group collaboratively shifted from uncertainty to an engaged problem-solving mindset.
- While the Consumer participant preferred the policy-led change scenario, they also suggested a solution combining elements from all three options. On the other hand, the Industry Players viewed legislation as necessary for tackling systemic food waste issues.
- The Industry Players valued stability, consistency, phased implementation, and consumer education. Stability and consistency provide consumers with uniform information on food packaging, phased implementation helps industries manage costs, and consumer education ensures people can understand and use the new date labels and storage advice effectively.
- Legislating date label and storage advice standards, creating packaging design standards, and implementing a design framework were ideas received positively. This indicates that the group understood that standards are necessary to achieve consistency and cohesiveness in the date label and storage advice systems.

Challenges, problems and concerns

- The Industry Players may feel resigned to inevitable change due to the nature of the National Date Labelling and Storage Advice project, with some preferring a policy-led solution as a safety net. This might indicate industry fatigue from a steady stream of policy-led labelling initiatives and changes in recent years (e.g., Australasian Recycling Labels, Health Star Ratings, etc.).
- The discussion revealed patterns in legal liability concerns about food safety, posing challenges for the Industry Players. This highlights their positive feedback on packaging design standards and a design framework providing clear instructions to promote stability and consistency in the food labelling information system, aiming to prevent future legal liability issues.
- The Industry Players were hesitant to lead efforts to address consumer confusion with date labels and storage advice, as they see no market advantage. Further, the cost of any changes would be passed on to consumers, potentially reducing purchases (and, therefore, profits).
- When discussing possibilities of technology-mediated solutions, the Stakeholders appeared unsure of how these solutions could be utilised to assist consumers with food decisions that reduce household food waste. This highlights the lack of understanding and awareness of smart and intelligent packaging solutions and the concept of blockchain solutions (e.g., cold chain transparency and accountability), leading participants to overlook them as potential solutions to assist consumers reduce household food waste.

Beliefs

- A consumer education campaign appeared to be the default Industry Player response to any changes to the system because they stated that they believe it's the consumers' responsibility to understand information on food packaging better. They did not feel that there was anything 'wrong' with the existing system as a form of communication to consumers.
- The Industry Players viewed household food waste as a consumer issue rather than their own responsibility, emphasising the need for consumer education. They believed consumers must better understand food packaging, including date labels and storage advice, to make informed decisions and reduce waste. This perspective is evident in their consistent focus on educating consumers rather than addressing systemic factors.

Communication and interpretation

- The Industry Players saw date labels and storage information as an issue of compliance with food safety and food quality regulations. This contrasts with this project's aim of focusing on consumer needs, which the Industry Players did not see as their issue. This is indicative of those that adopt a legal liability approach, where food date labels are legally correct according to the guidelines, despite being indecipherable to consumers.

5 What the findings and insights reveal

The findings show recurring themes around the Consumers' information needs, Industry Player challenges and barriers, and discussions around policy. The overarching motivation in packaging-related decisions for Consumers, Industry Players, and Policymakers is to understand information on food packaging. When interacting with this information, the Consumers, the Industry Players, and the Policymakers pursue three immediate goals around food safety, food quality, and food usage (i.e., to consume or discard food). To achieve these goals, they engage with mediating tools such as 'Best before' dates, 'Use by' dates, storage advice, visual cues (e.g., colour and icons), waste reduction advice, technology (e.g., QR codes, information websites), and their prior knowledge. Their interactions are shaped by the context of their activity, whether to assess, communicate, or regulate information on packaging, taking into account the rules, community, and division of labour of that specific context.

Using Activity Theory as a framework, we show how this plays out in Figure 5. The *Subject* interacts with the *Object* using *Mediating tool*s to achieve the *Outcome*. This interaction is an Activity specific to the Subject's context. Additionally, this Activity is influenced by the Subject's relationship with *Rules*, *Community*, and *Division of labour*. Our analysis revealed tensions due to interdependencies between Subjects (e.g., Consumers, Industry Players, and Policymakers) and opportunities on how Mediating tools can be used to help align their different activities to reduce consumer confusion.

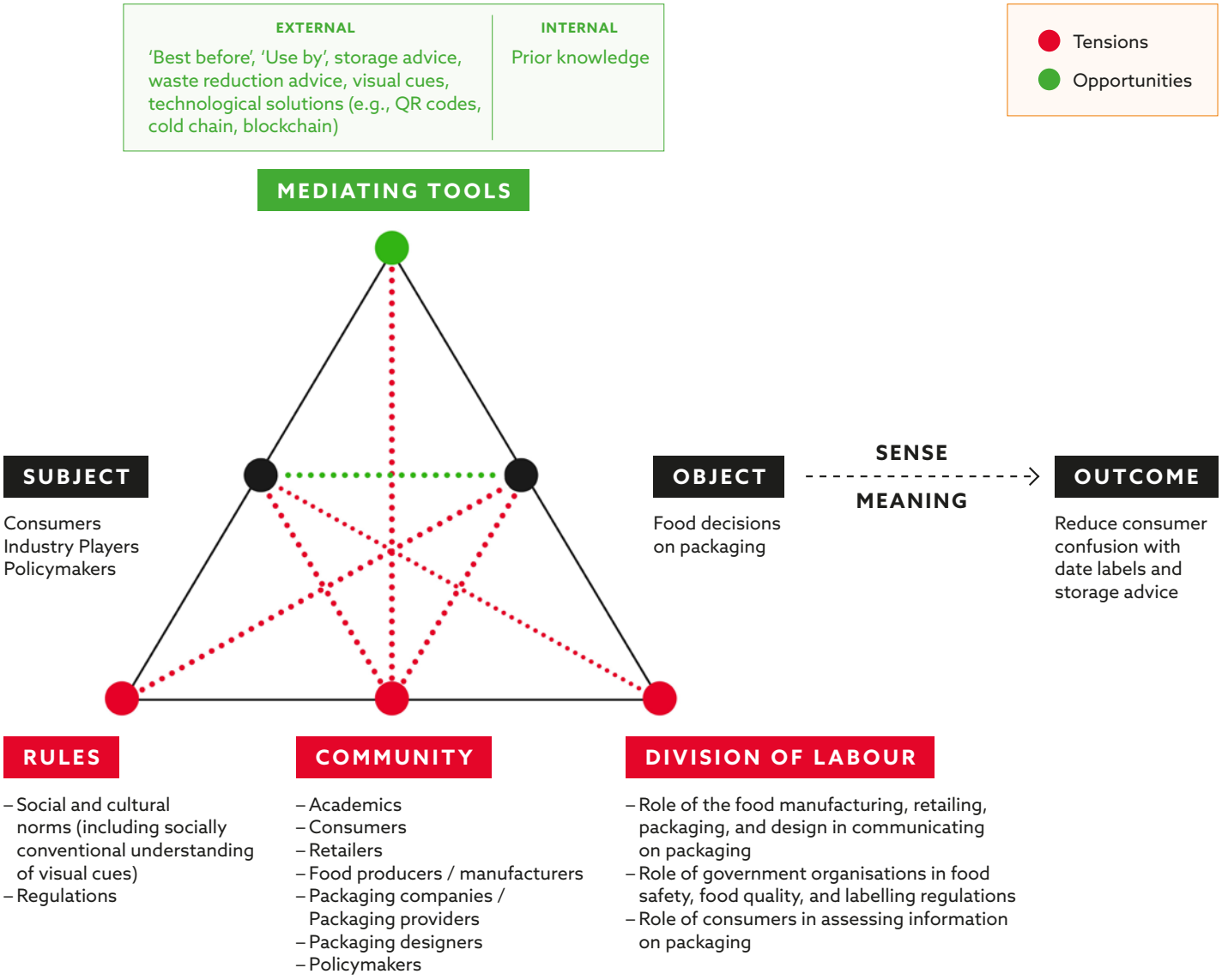

Figure 5. Activity Theory framework to address consumer confusion on food packaging

The activity context problem due to variable interpretation of the object by different subjects

Within the food system, each subject (consumers, industry players, and policymakers) interprets the mediating tools differently, depending on their distinct goals. This results in different activity contexts, where food decisions on packaging (Object) are interpreted differently by the consumers, industry players, and policymakers (Subject). Particularly, the focus of consumers (as the end users) is on assessing and interpreting date labelling and storage advice to ensure food safety, quality, and proper usage. On the other hand, industry players consider date labels and storage advice as tools to communicate information about food safety, usage, and quality to consumers. Their perspective is based on the production context, where the primary focus is on creating and delivering products that meet regulatory standards and consumer expectations. Policymakers, who oversee the entire system, consider mediating tools as a means to ensure compliance with food safety, quality, and usage standards. These variable interpretations demonstrate how mediating tools are shared, yet differently used across the food system, influenced by the specific goals and activities of each subject. See Figure 6.

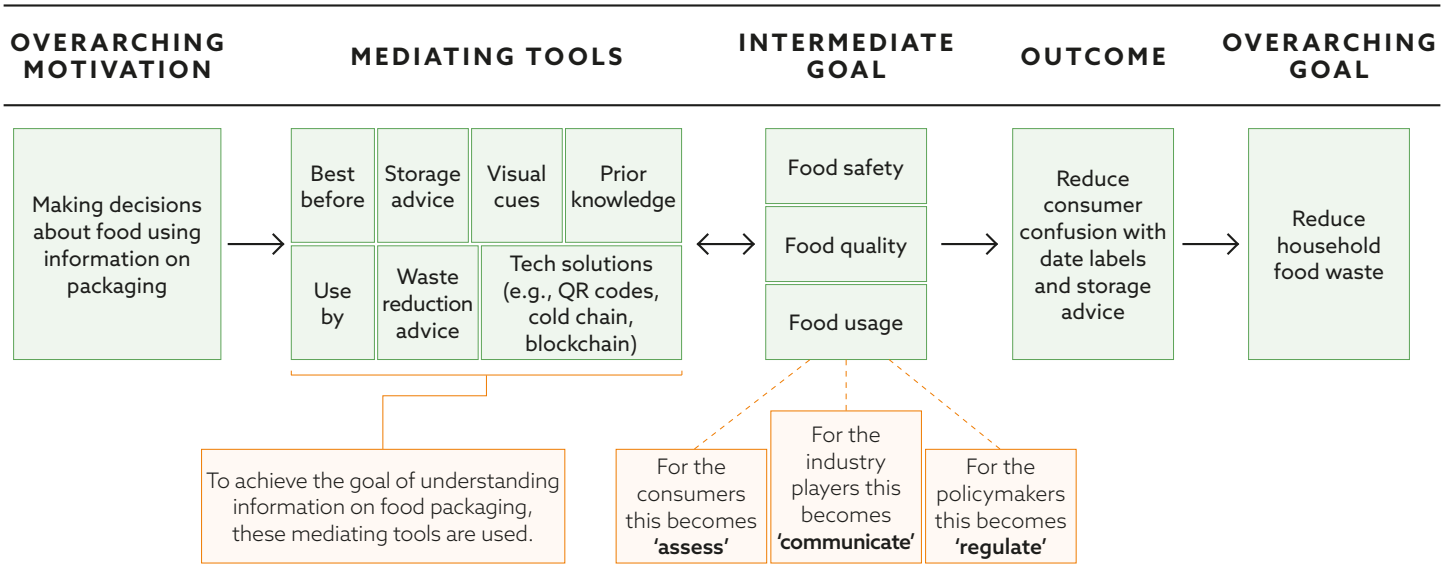

Figure 6. The shifting usage of mediating tools to achieve immediate goals in a food decision activity system. Adapted from Chu et al. (2020)

Different paths to the same goal

The food system comprises a network of interactions including consumers, industry players, and policymakers, each with distinct roles and priorities. While these groups share overarching goals of ensuring food safety, improving sustainability, and reducing waste, their differing perspectives on achieving these goals often lead to misalignment in how solutions are interpreted and implemented. This misalignment arises from their varied activity contexts and the ways they interact with mediating tools to achieve their immediate objectives. In particular:

- **Consumers** play a critical role as end users at the receiving end of the food system. Their goals focus on interpreting and assessing the information on packaging to make informed decisions about food safety, food storage, and food waste reduction. For them, clear and accessible communication is important to minimise confusion.
- On the other hand, **industry players** (manufacturers, retailers, and designers) focus on a production-oriented perspective. Their primary objectives are manufacturing and delivering products that comply with regulatory standards, communicating brand messaging on packaging, and maximising market appeal.
- **Policymakers**, overseeing the entire system, engage with these processes from a regulatory standpoint. Their focus is on ensuring compliance with food safety, quality, and sustainability standards. While they aim to create frameworks that support industry and protect consumers, their emphasis on mandatory information and compliance may not always align with the practical challenges faced by industry players or the communication needs of consumers.

Despite their shared recognition of the importance of clear and accessible food packaging, the three groups often approach the issue from different angles, creating tensions. These tensions manifest in how food decisions are influenced by visual communication and innovative solutions. For example, unclear date labels or overly complex storage instructions may meet regulatory or industry standards but can confuse consumers, ultimately undermining their ability to make informed choices. Addressing these challenges requires greater alignment and collaboration among all actors in the food system.

The underlying drivers of diverging objectives

The misalignment – and potential alignment – of consumers' and stakeholders' approaches in the food system is driven by three underlying factors: *Rules*, *Community*, and *Division of labour*. These factors shape how consumers, industry players, and policymakers interpret and interact with food packaging, influencing their priorities and decisions.

Rules

Rules serve as the regulatory backbone, encompassing compliance with food safety regulations, certification standards, and legal requirements. While they ensure consistency and safety, they can also create rigid boundaries that limit innovation or adaptability in packaging design.

Regulations governing food packaging, such as those enforced by organisations like Food Standards Australia New Zealand (FSANZ) and Australian Packaging Covenant Organisation (APCO), directly or indirectly shape the approaches of consumers, industry players, and policymakers. These regulations guide the baseline requirements for date labels, storage advice, and safety warnings. While these regulations aim to protect consumers and promote standardised information, they often contribute to tensions among industry players due to differing priorities and interpretations. The emphasis on regulatory detail can sometimes reduce practical usability, creating gaps in how effectively these rules align with consumer behaviour or industry needs.

When regulations prioritise standardisation over clarity, they risk alienating consumers. This alienation can also harm trust between consumers and industry players. If consumers repeatedly encounter packaging that appears unclear or contradictory, they may perceive the information as unreliable or irrelevant.

For industry players, there is a tension between complying with regulatory requirements and fulfilling branding and consumer communication objectives. FSANZ requirements, for instance, may mandate specific information formats that limit flexibility in packaging design. These challenges often highlight a disconnect between regulatory compliance and user-friendly communication.

Currently, there is an opportunity to harmonise packaging regulation reform with updated labelling and storage advice guidelines, as reported by the Department of Climate Change, Energy, the Environment and Water (2024). Such alignment could foster a more integrated strategy to address sustainability and food waste. However, regulatory responsibilities remain divided among bodies like APCO, FSANZ, and others, leading to fragmented efforts. This fragmented approach further exacerbates tension by forcing stakeholders to navigate trade-offs between regulatory compliance, clarity, and creativity. Addressing these tensions requires collaboration to harmonise the efforts of regulatory bodies, ensuring alignment between sustainability objectives, consumer usability, and industry innovation.

Community

Community represents the network of collaborative actors in the food system who collectively influence the development of food packaging. Their input, often shaped by business objectives, consumer insights, and market demands, plays a significant role in setting the agenda for design and communication priorities.

The absence of a cohesive community effort in addressing food packaging challenges stems from fragmented approaches, where various groups pursue similar goals independently, without meaningful collaboration. This lack of alignment diminishes the potential for impactful collective action, particularly in tackling complex issues like sustainability and reducing food loss and waste. A unified approach, rooted in collaboration and shared goals, is crucial to bring these stakeholders together and achieve substantial progress.

Food packaging is inherently multidimensional, encompassing materials, design functionality, and consumer interaction. Yet, current initiatives often isolate these elements, neglecting their interconnections and limiting their effectiveness. For example, efforts to develop sustainable materials focus on reducing environmental impact but may fail to address how consumers interact with packaging.

A holistic strategy would consider both the physical materials of packaging and the visual communication elements that consumers rely on. Features such as clear storage instructions, easy-to-understand date labels, and intuitive sustainability icons are crucial in influencing consumer behaviour. When these elements are designed to work in harmony, they can significantly enhance both environmental sustainability and consumer understanding. For instance, clear instructions on how to properly store food can help reduce spoilage and waste, while recyclable materials can ensure that packaging aligns with broader sustainability goals.

Consumers engage with food packaging on multiple levels – visually, cognitively, and practically – making it essential for stakeholders to align their efforts. Regulatory bodies, manufacturers, and consumers must work collaboratively to address the interconnected challenges of packaging and food waste. By fostering a unified community approach, stakeholders can overcome fragmented efforts, create innovative solutions, and advance progress toward sustainability. Ultimately, this alignment would not only improve outcomes for the environment but also empower consumers to make informed decisions and engage with packaging more effectively.

Division of labour

The **Division of labour** within the food packaging system is crucial in shaping the interactions, approaches, and responsibilities of consumers, industry players, and policymakers. This structure influences how they engage with food packaging challenges, often leading to tensions and fragmented efforts in addressing systemic issues like food waste and sustainability. It also highlights the structured roles and hierarchies within the food system. It determines how responsibilities are distributed and how power dynamics affect decision-making. For instance, the emphasis on branding or marketing by dominant stakeholders can overshadow the goal of clear and accessible communication for consumers.

A key challenge within the Division of labour is the disproportionate influence of food manufacturers/producers and retailers over packaging decisions. These stakeholders frequently prioritise business objectives, such as cost efficiency, marketability, and brand visibility, over consumer-centric goals like clarity and usability. For instance, packaging designers – tasked with ensuring that labels effectively communicate critical information – often find their efforts constrained by manufacturers' focus on branding or operational limitations. This power imbalance restricts opportunities for innovation and results in packaging solutions that meet production demands but fail to address consumer needs for clarity and accessibility.

The Division of labour also impacts how responsibilities for reducing food waste are distributed. Stakeholders often place disproportionate blame on consumers for household food waste. They assume that consumer education alone can resolve issues like confusion over date labels and storage advice. However, this approach overlooks the systemic nature of the problem, where multiple actors contribute to the outcomes of food decisions. Our research shows that stakeholders' reluctance to take responsibility for systemic changes reinforces this cycle of consumer blame-shifting, preventing meaningful progress.

The Division of labour also creates barriers to adopting innovative solutions. Smaller stakeholders, such as small and medium-sized enterprises (SMEs), often lack the financial resources to implement advanced technologies like smart packaging or QR codes. Larger entities, while more resource-capable, frequently resist taking responsibility for shared initiatives, such as managing centralised repositories for storage advice. Additionally, stakeholders' trepidation about legal liability further stifles innovation. Concerns about potential legal risks related to consumer misuse of labels lead to overly cautious decision-making, despite evidence showing that most food safety issues stem from handling practices rather than labelling errors.

EXAMPLE

The packaging designers' activity context illustrates how these three factors influence their design process. When packaging designers create food packaging labels, their primary objective is to ensure that the information is clear and easily understood by consumers. However, their work is shaped by multiple external factors, including:

- Rules: Compliance with mandatory information requirements, food safety regulations, and certification standards
- Community: Input from food manufacturers and producers through design briefs, specifications from packaging companies, and consumer insights from market research agencies
- Division of labour: Their role within the production chain, where their creative expertise must balance consumer needs with industry and business priorities

These constraints place significant pressure on packaging designers. Although they may want to prioritise clarity and accessibility for consumers, their efforts are often redirected or overshadowed by the objectives of food manufacturers or producers. For example, a manufacturer may prioritise branding and marketing over clear communication, requiring designers to emphasise visual appeal and promotional elements at the expense of user-friendliness. The unequal distribution of influence within the division of labour leaves designers with limited agency to align their work fully with consumer needs.

These factors act as mediating forces that either align stakeholders' goals or exacerbate misalignments, leading to tensions in achieving shared objectives such as sustainability, clarity, and food safety. When these forces are in harmony, they enable cohesive strategies; when they conflict, they result in fragmented efforts, producing packaging that meets standards but fails to address consumer needs effectively.

The role of Mediating tools in addressing the diverging objectives

Mediating tools play a critical role in bridging the gaps between the diverging objectives and approaches of consumers, industry stakeholders, and policymakers within the food system. These mediating tools, ranging from communication tactics to advanced technologies, can act as central points to address systemic challenges. These tools can be situated within the activity system, shaping the relationships between subjects (industry players, policymakers, and consumers); objects (goals); and centralising rules, community, and division of labour.

An example that was highlighted by participants (especially Consumers) in our research as an effective tool is colour-coded date labels. Colour-coded date labels provide an intuitive visual cue that simplifies consumer decision-making. The use of colour overcomes potential literacy or language barriers, making the information more accessible to diverse groups of consumers, including non-English speakers or individuals with limited literacy. Based on Activity Theory, we can examine the implications of colour-coded date labels (Mediating tool) on Rules, Community, and Division of labour:

Rules: These colour-coded labels comply with regulatory requirements from bodies like FSANZ, which mandate clear communication of date markings.

Community: Implementing colour-coded labels requires collaboration across the food system, including food producers/manufacturers, retailers, packaging companies, packaging designers, and policymakers. In particular, food producers/manufacturers work with packaging designers to ensure the proper application of colour-coded labels produced by packaging companies. Retailers incorporate colour cues in their stock rotation practices for better inventory management. Policymakers establish guidelines for consistent implementation across the industry.

Division of labour: Colour-coded labels shift some of the responsibility from consumers to industry stakeholders. Instead of relying solely on consumer education campaigns to explain date markings, the labels themselves provide immediate, intuitive guidance. This reduces the cognitive burden on consumers, while placing accountability on designers and manufacturers to integrate user-friendly solutions.

Table 2 shows suggested mediating tools, and the tensions and implications to stakeholders based on their activity contexts.

Mediating tools	Inhibitors	Implications	Stakeholders involved
Colour-coded date labels	– Cost of additional printing plates – Logistical issues with SMEs – Accessibility for colour-blind groups	– Redesign of existing packaging	– Food producers/manufacturers – Packaging providers – Packaging designers – Consumers – Retailers
More label real estate	– Mandatory information – Certification and regulatory compliance marks – Financial capability – Available label space on physical packaging	– More cost if larger labels are required – Update of labelling equipment / production process – Review of mandatory information on packaging	– Food producers/manufacturers – Packaging companies – Packaging designers
Smart and intelligent packaging	– Financial capability – Logistical issues with supply chains – Operational disruptions	– More cost for new packaging – Update of packaging equipment / production process – Additional food quality and food safety testing to update information on packaging	– Food producers/manufacturers – Packaging companies – Packaging designers
QR codes	– Label real estate – Consumer education – Financial capability	– Redesign of existing packaging label – Costs related to developing and managing information repository – Information campaign	– Food producers/manufacturers – Packaging companies – Packaging designers – Retailers – Consumers

Table 2. Enablers and inhibitors of change

6 Directions forward

Consumers and Industry Players desired better clarity and accessibility in date labelling, but their priorities differed. Consumers prioritised usability and waste reduction, while Industry Players focused on compliance, safety, and logistics. The Future Scenarios discussions revealed openness to innovation and collaboration, but issues regarding misaligned approaches, diverging objectives, and consumer myopia remain among the participants. The analysis highlighted three key points to consider when crafting solutions: 1) Awareness of consumers' and stakeholders' diverse contexts, 2) Aligning consumer and stakeholder approaches to achieve objectives, and 3) Understanding mediating tools' role in reconciling objectives.

Aside from the need for a more coordinated approach to labelling, the study underscores the following needs and considerations for a future date labelling and storage advice systems.

Date labelling and storage advice should:

- use colour and visual cues to help consumers differentiate between labels and understand information on food packaging.
- be easy to find, understand, read, and interpret. On-pack information should be compliant, legible, and understandable to all consumers.
- have consistent standards for date formats and storage information, ensuring consumers always engage with information on food packaging in similar ways.
- have a packaging design standard and a design framework that allow food manufacturers and retailers to create a flexible and consistent system that can be implemented across different food categories and product types.

Furthermore, the following should be considered to assist, complement and enhance on-pack information:

- Ongoing collaboration between industry players, policymakers, and academia to ensure decisions are based on rigorous theoretically-driven consumer behaviour research.
- Technology-mediated solutions (such as smart and intelligent packaging) to complement date labels and storage advice information.
- Cues to assist consumers with sensory testing, as another layer in decision-making about food.
- Clear specifications defining what information is mandatory on packaging and what types of information can be taken off the label while ensuring consumer decisions on food quality and food safety are not compromised.

– Access to off-pack information for consumers, accessed by QR codes or similar, regarding date labels and different ways to prolong the life of food so they can make smart food waste decisions. This off-pack information should complement on-pack information, provide extra information for those users with specialised needs and allow for greater accessibility for all users.

These insights present pain points, gaps in research, and opportunities to facilitate innovative, forward-thinking approaches to addressing consumer confusion in food packaging. To effectively tackle household food waste in Australia, systemic change across the sector is necessary. This research echoes the findings and recommendations of previous research – that collaborative action across individuals, organisations, and the sector is needed to enact change. Each actor in the food system has a specific role to play and a shared responsibility for reducing food waste. Meaningful changes to the food packaging system to help reduce household food waste require an overarching strategy requiring support from federal, state, and local governments. However, this research also highlights that relying solely on policy is insufficient, because collective action from stakeholders and consumers is critical to tackle the food waste problem effectively and present a united front.

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Find out more about End Food Waste Australia.

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Appendix A: Future Scenario settings

Scenario 1: Consumer-centric change

information	Consumers have all the information they need on food packaging to make **smart food waste decisions.**
interpretation, simple & clear	The date labels and storage advice on food packaging **are easy to find, understand, read, and interpret.**
colour, visual cues	They use colour coded date labels and/or storage advice to help them **differentiate** between labels and **understand information** on packaging.
disruption, icons	They have incorporated **sensory testing** in their food decisions.
cold chain, food quality	They **trust** that the food they buy **is safe and edible**, therefore, are less concerned about food safety and focus more on **food quality**.
QR codes, technological solutions	They use 2D barcodes on food packaging to find out **more information** about date labels and different **ways to prolong the life of food**.

Scenario 2: Policy-led change

disruption	Date labels and storage advice **standards have been legislated**.
real estate, logistics & implementation	Packaging design standards and **a design framework** allowed food manufacturers and retailers to create a **flexible and consistent system** that can be implemented across different food categories and product types.
information, interpretation	As a result, **consumers always engage with information** on food packaging in similar ways, helping **reduce** the possibility of **confusion** that leads to household food waste.
food quality, food safety	There are **clear specifications on mandatory information** on food packaging to ensure food quality and food safety.
QR codes, technological solutions	Consumers can **access additional information** about food on a **repository website**.
consumers	**Stakeholders** to ensure decisions are based on rigorous theoretically-driven **consumer behaviour research**.

Scenario 3: Stakeholder-driven change

cost, logistics & implementation	Stakeholders **have access to resources** to address cost implications, logistical issues, and legal liability.
disruption, consumers	A stakeholder-led solution has resulted in a **date label and storage advice system** that assists consumers make informed food waste decisions and also within the remit of food manufacturers and retailers.
technological solutions, food safety, food quality	**Blockchain processes** are used to ensure food safety and food quality.
cold chain, QR codes	**Smart & intelligent packaging** are used to complement date labels and storage advice information to help consumers make informed decisions on food waste.
information, interpretation, real estate, simple & clear	**Updated food packaging standards and requirements** have ensured consistency of information and flexibility across different food categories and product types.

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