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FINAL REPORT

Save Food Packaging Criteria and Framework

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Panel Review Statement

End Food Waste CRC recognises the value of knowledge exchange and the importance of objective peer review. It is committed to encouraging and supporting its research teams in this regard. The author(s) confirm(s) that this document has been reviewed and approved by the Project Leader and Industry Partner.

This project has also been evaluated by the End Food Waste CRC publication review panel. These reviewers evaluated its:

- Methodology articulated clearly
- Positioning of findings within the current literature
- Acknowledged compliance with food safety standards
- Conclusions against results
- Relevant human and/or animal ethic approvals obtained

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Industry Partner Foreword

When the AIP developed this project, the Institute realised that 'Save Food Packaging' and the role that packaging plays in minimising food loss and waste was a very limited discussion topic for the wider industry and the academic community across not only Australia, but also New Zealand, and other parts of the globe. In fact, most of the stakeholders had never even thought about Save Food Packaging as a design discipline within their sustainable packaging design principles until we started this project.

One of the objectives of this project was for the AIP to establish a voice for Save Food Packaging within the greater realm of sustainability and packaging design. The AIP wanted to start talking to the industry about 'Getting the Balance Right' between Food Waste and Packaging Waste when discussing environmental impacts of product and packaging.

'Getting the Balance Right' has now become a cornerstone of the AIP, and the Institute is extremely proud to see multiple industry players using the same discussion within their networks and using our 'scale image' in their presentations. We have even seen the scale image used in other parts of the world, which is an incredible achievement from this project. Sitting in conferences and workshops and leading stakeholders talk about the balance is a positive step.

Another outcome of this project was that the AIP wanted the 'science' and the 'research' to be able to talk with credibility and validity about Save Food Packaging. The development of the two industry insight reports was a great milestone of this project. These findings have enabled the AIP to speak to the topic with the backing of research. The findings also enabled the AIP to showcase the underutilised areas within Save Food Packaging that needed to be further enhanced in the future such as Active & Intelligent Packaging, improvement of date labelling, increased consumer education, embedding on-pack/off-pack labelling and improved use of lifecycle assessment within brands.

As the project grew the AIP were able to talk to the Save Food Packaging Guidelines, showcase Best Practice award-winning case studies, encourage entries into the Australasian Packaging Innovation & Design (PIDA) Save Food Packaging awards and design a new training course that was launched in December 2023. This training course will be rolled out not only in Australia, but also New Zealand and other countries. The framework can be applied to any country and will ensure that we have consistent design standards across the globe. The goal is that every packaging technologist or designer in the world uses the 5x Save Food Packaging Design Principles when they develop new packaging.

A key outcome of this project is that the AIP now lead the way as one of the global packaging experts in the role that packaging plays in minimising food waste. The AIP and RMIT and the project are now recognised in all corners of the globe for being leaders in this subject. An unexpected outcome was that the AIP became subject matter experts in not only Save Food Packaging, but also more general understanding on food loss and waste.

Since inception of the project the AIP has been able to represent the voice for Save Food Packaging at close to 60 events across the world including the AIP Australasian Packaging Conference, the National Food Waste Summit, WA DPIRD Conference, Food SA Conference, AIFST conference, Waste Expo, FoodTech PackTech New Zealand packaging forums, ProPak Asia (Thailand) Global Packaging Forum, Australasian Waste & Recycling Expo, National Retail Association workshops, APCO webinars, ProPak Philippines Packaging Forum, the FAO Impact Webinar, World Packaging Organisation webinars and events, Sri Lankan Institute of Packaging webinar, an environmental workshop in Saudi Arabia, Singapore Packaging Federation webinars, European conferences and more. Other highlights include multiple interviews, podcasts and articles on the subject.

One of the main Highlights was being invited to speak at Interpack 2023 in front of FAO, UN and Save Food Org, about our project. This presentation then led to speaking at an FAO impact webinar and work with UNIDO and the World Packaging Organisation. These opportunities continue to this day and the AIP will always be the voice of Save Food Packaging wherever possible. In March

2024 as an example the AIP will be speaking at a newly developed Food Waste conference about Save Food Packaging in Hungary.

The AIP will continue to present this topic at all available events and being able to now take the Save Food Packaging Guidelines into training and workshops is critical to raise the voice within industry.

The project has exceeded initial expectations, and the final guidelines, checklists and case studies enable the AIP to lead from the front, supported by science and evidence. In the next few years, the AIP would like to see even more entries into the Save Food Packaging awards, more ANZ WorldStar award winners and continued development of case studies and Best practice examples of intuitive and innovative packaging.

The next step is for the AIP to help guide businesses into embedding the 5x Save Food Packaging principles into their own business.

This project is just the start of the AIP continuing to be the subject matter experts in Save Food Packaging design and raising the voice for such an important topic.

Nerida Kelton FAIP

Executive Director, AIP

Vice President Sustainability & Save Food, WPO

Executive Summary

Whilst the primary functions of packaging are to contain, protect and provide information about the product, the overall role of packaging in reducing food waste needs to be better understood by food producers, manufacturers, brand owners, retailers, government and consumers. Finding the right balance between minimising the use of packaging without increasing food waste is a key challenge. Enhancing packaging's role in reducing food waste is the next challenge for packaging technologists, designers, and engineers.

The aim of this project was to develop Save Food Packaging (SFP) design criteria and communication material that would lead to better packaging design, material selection and format selection using appropriate portioning, sealability, resealability features, date labelling, extend shelf life and provide the information required to assist retail, food service and consumers to minimise food waste. Thus, it aimed to provide industry with access to guidelines and tools to assist them in their design, selection, and use of packaging materials for food.

The four-year project comprised a multi-faceted methodology: a desktop literature review (briefing paper), industry analysis and insights, an industry survey, and industry interviews to identify the current state of play and understanding of SFP terminology, levels of interest and engagement, and information and resources that industry were seeking to make more informed decisions in their food-packaging designs. The findings from the project have informed the development of the SFP Design Criteria that is founded on the synthesised research reviewed across academic peer-reviewed articles, globally recognised reports, and Australian Packaging bodies that promote mitigating food waste through packaging strategies. It is accompanied by communication materials such as case studies, and training course materials. These have been presented across a range of industry seminars, workshops, conferences and training courses both here in Australia and around the world.

A PhD project was also embedded into the project providing deeper insight into packaging opportunities specific to reducing household food waste. This PhD identified opportunities for specific actors and key decision makers within the food/beverage–packaging industry to implement SFP solutions more effectively to reduce household food waste. Stage 1 of the PhD identified packaging drivers and solutions for household food waste across 28 food categories, mapped across the packaging functions of communication, convenience, apportionment and protection. Stage 2 identified differences between the household food waste packaging solutions mentioned in the research literature and those advertised in industry press releases, highlighting opportunities for researchers and industry actors to bridge this gap. Stage 3 involved a qualitative study that explored the interplay between industry packaging decisions, consumer–packaging interactions and household food waste. This interplay was explored through the case of reclosable and resealable packaging in relation to consumers' household food storage practices and food waste. This stage identified barriers and opportunities for specific actors within industry to design and implement SFP to reduce house food waste more effectively.

The terminology and categories defining SFP strategies were mapped, tabulated, and cross-referenced to identify synergies, gaps, and misalignments. Strategy definitions were clustered through their frequency-of-use creating grouped sub-categories. All icons focused on the “Service” to intended users and stakeholders e.g. ‘Easy to open’ or ‘Easy to reseal’, rather than the packaging function referred as ‘Openability’ or ‘Resealability’. The outcome incorporates award winning Case Studies, co-developed with industry and endorsed by the Australian Institute of Packaging (AIP), that overlays how the Criteria can be adopted and modelled for best practice examples. The Resource Booklet also provides a simplified 1-page all-inclusive Criteria Checklist, reviewed by industry, that can be printed at large scale as a wall poster for easy referencing to aid in industry adoption. The SFP icons were developed for open-source access for either informing best practice and/or promoting through communication on pack design.

Overall, 5 key functional criteria categories were identified to align the 68 scoped SFP strategies as visual icons. The Criteria promotes:

- 1) Design to contain and protect the product.
- 2) Design to preserve and extend shelf life.
- 3) Design to provide consumer convenience.
- 4) Design to communicate to consumers.
- 5) Design to balance food and packaging waste targets.

The purpose of the Criteria is to align terminology between and across academic and industry fields of practice and increase awareness of the available strategies afforded to all Australian Food Packaging industry members including key stakeholders including CEOs, Marketers, Designers, Packaging Technologists, Retailers, and Consumers.

The project was led by the Australian Institute of Packaging (AIP), with research partner RMIT University and an extensive multi stakeholder Save Food Packaging Consortium, partners, and an extension network to deliver the project. The Save Food Packaging Consortium comprised ZipForm Packaging, SEE (formerly Sealed Air), Multivac and the Australian Packaging Covenant Organisation (APCO). Project partners were Plantic Technologies, Result Group and Ulma Packaging. The extension network included the Australian Food Cold Chain Council (AFCCC), Australian Food and Grocery Council (AFGC), and Australian Institute of Food Science and Technology (AIFST).

The foundation for SFP definitions, strategies, criteria, and resources have been established through a co-designed method between industry and researchers. The momentum is only gaining traction, and with bodies such as the AIP and SFP Consortium members promoting and sharing knowledge and experience, those working in the food and packaging industry should be embracing this collective knowledge to make a difference to designing and producing food packaging that minimises the environmental impacts and that of food waste across the entire supply chain.

1. Introduction

The Australian Institute of Packaging (AIP) was established in 1963 in response to a need for packaging technologists to interact and provide a professional identity for individuals within the packaging industry. Over the past sixty years, it has grown to be the peak professional body for packaging education and training in Australasia, shaping the careers of packaging technologists, and those working in sales and marketing, purchasing, production and environment.

Through engagement with industry leaders and members, the AIP facilitates technical seminars and forums, and annual conferences. They are the exclusive partners for Australasia for many internationally recognised Degrees and courses including the Diploma in Packaging Technology, The Certificate in Packaging and the Certified Packaging Professional Designation. The AIP coordinates the Australasian Packaging Innovation & Design (PIDA) Awards that are designed to recognise companies and individuals who are making a significant difference in their field in Australia and New Zealand. The PIDA Awards are the exclusive award program for all Australian and New Zealand entries into the prestigious WorldStar Packaging Awards coordinated by the World Packaging Organisation (WPO). In 2016, the AIP established the inaugural Save Food Packaging Design Award which in recent years has expanded to other WPO member countries and is a WorldStar Packaging Award category.

Whilst the primary functions of packaging are to contain, protect and provide product information, the overall role of packaging in reducing food waste needs to be better understood by food producers, manufacturers, brand owners, retailers, government and consumers. Finding the right balance between minimising the use of packaging without increasing food waste is a key challenge. Enhancing packaging's role in reducing food waste is the next challenge for packaging technologists, designers, and engineers.

Through the support of the AIP, the aim of this project was to develop Save Food Packaging (SFP) criteria and communication material that will lead to better packaging design, material selection and format selection using appropriate portioning, sealability, resealability features, date labelling, extend shelf life and provide the information required to assist retail, food service and consumers to minimise food waste. Thus, it provides industry with access to guidelines and tools to assist them in their design, selection, and use of packaging materials for food.

The project used a desktop literature review (briefing paper), industry analysis and insights, an industry survey, and industry interviews to identify the current state of play and understanding of SFP terminology, levels of interest and engagement, and information and resources that industry were seeking to make more informed decisions in their food-packaging designs. The findings from the project have informed the development of SFP criteria and framework, accompanied by communication materials such as case studies, and training course materials. These have been presented across a range of industry seminars, workshops, conferences and training courses both here in Australia and around the world.

A PhD project was also embedded into the project providing deeper insight into packaging opportunities specific to reducing household food waste. This PhD identified opportunities for specific actors and key decision makers within the food/beverage-packaging industry to implement Save Food Packaging (SFP) solutions more effectively to reduce household food waste.

The End Food Waste CRC (EFW CRC) supported a partnership led by the AIP, with research partner RMIT University and an extensive multi stakeholder Save Food Packaging Consortium, partners and an extension network to deliver the project. The Save Food Packaging Consortium comprised ZipForm Packaging, SEE (formerly Sealed Air), Multivac and the Australian Packaging Covenant Organisation (APCO). Project partners were Plantic Technologies, Result Group and Ulma Packaging. The extension network included the Australian Food Cold Chain Council (AFCCC), Australian Food and Grocery Council (AFGC), and Australian Institute of Food Science and Technology (AIFST). This project was undertaken over a four-year period (2019-2023) and this document reports on the findings and implications of 'Save Food Packaging Design Criteria and Framework' project (EFW CRC Project 1.2.1).

1.1 Previous Research & Literature

The desktop review for the project — the briefing paper (Francis et al. 2021) — presented a summary review of academic literature and commercial ‘grey’ literature, along with recommendations to help inform the review of the current SFP design criteria being used in the Packaging Innovation and Design Awards (PIDA). It consisted of a systemized review of both peer-reviewed literature and grey literature scoping academic and industry knowledge on the research topic for the period 2014-2019. Academic literature comprises academic publications, book chapters, books and academic conference papers. Grey literature comprises ‘landmark’ publications, white papers and high-profile reports on the topic.

The definition of Save Food Packaging, defined by the Australian Institute of Packaging for the PIDA Awards (PIDA 2020), adopted by this research is: “To minimise or prevent food waste from paddock to plate through packaging design”. In addition, ‘Save Food Packaging’ is an umbrella category that encompasses any product and/or packaging function or feature that assists in food waste reduction (Francis et al. 2020).

As defined by the Food and Agricultural Organisation (FAO), “food refers to any substance, whether processed, semi-processed or raw, intended for human consumption” (FAO 2019, p. 5). Food Loss and Waste (FLW) refers to “the decrease in quantity or quality of food along the food supply chain” (FAO 2019, p. 4).

1.1.1 The fundamentals of Packaging

The fundamentals of packaging have been well categorised and defined. Packaging can be discussed at a systems level specifying the functional categories of their respective packaging features. There are three levels of product-packaging systems with consideration given to sustainability practices: Level 1: packaging materials, Level 2: product packaging systems and Level 3: consumer practices. Another way of looking at packaging is the three key levels of packaging — primary, secondary, and tertiary.

1.1.2 The Role of Packaging

The move towards mass trading and the growth of distributing products away from the production site to remote areas for purchase and consumption, called for the greater need to protect, transport and extend the shelf life of raw and processed products through packaging. Packaging today plays a more significant role than ever to meet the specific needs of production and supply through to retailers and end-consumers.

Two effects that packaging has on sustainability are Direct and Indirect (Lindh et al. 2016):

- Direct effect: the effect that occurs during the production of packaging materials, transport and recycling. This has been the most addressed type of environmental effect over the last two decades.
- Indirect effect: the effect linked to the services that packaging provides for the content and the users in the supply chain including consumers. The value-adding services related to indirect effects of packaging, such as reducing product waste, are often less obvious and have not been explored to the same extent as the direct environmental effects.

Packaging, and its multifaceted purposes and roles, have also been categorised under their primary functions and respective design features (Lindh et al. 2016):

- Function: ‘an assigned duty or activity or a specific role’. A packaging function is what the packaging does.
- Feature (or property): ‘a prominent or distinctive quality or characteristic’. Packaging ‘features’ are the more specific characteristics that a package must have to fulfill its ‘functions’. Features are more context specific and highly dependent on the product the package contains, whereas the packaging functions are general and more comprehensive.

1.1.3 Packaging Related Food Loss and Waste

Packaging-related food loss and waste (FLW) have been identified over defined areas of the food supply chain with combined specific conditions identified from the literature (Table 1). Identifying the causes of food loss and waste at various stages, including from both retail and household generated waste, aids in identifying key opportunity areas for innovation within new product-packaging developments.

Table 1. Packaging-related Food Loss and Waste areas and opportunities along the food supply chain and the household (adapted reference (Verghese et al. 2015; Wohner et al. 2019). Source: Francis et al. (2020)

Packaging related Food Loss and Waste
• Inadequate protection or environmental conditions^(a) • Damage of products due to contaminants, sharp edges or splinters of field containers^(b) • Over-packing of field crates ^(b)
• Problems in the filling process^(b) • Contaminated packaging^(b) • Packaging failures while sealing^(b) • Packaging changes due to marketing reasons^(b) • Doesn't meet retail quality specifications^(a)
• Packaging failure in distribution and transit^(a) • Food perishing in distribution and after sale^(a) • Confusion about shelf life and food safety^(a)
• Lacking mechanical protection (material, stackability, or with no packaging at all)^(b) • Excess stock^(a) • Poor stock rotation^(a) • Damage to barcodes^(b) • Multiple handling of fresh produce^(b)
• Difficult to open packaging^(b) • Excess stock^(b) • Difficult to empty packaging^(b) • Inappropriate packaging size^(b)

Note: (a) Verghese et al. 2015; (b) Wohner et al. 2019

Key functions of packaging are: (1) Contain, (2) Protect, (3) Preserve, (4) Promote and Communicate, (5) Handling/Transport, and (6) Convenience (Verghese et al. 2015). SFP's aim is to overcome future recurrences of FLW. Packaging-related FLW can be mitigated by considering the areas of FLW risk and addressing them with purposeful designs and systems. Though there will be 'trade-offs' that need to be made between packaging material wastage and packaging related food wastage. Businesses and

designers alike require open access to case studies, equipping them for informed decision making on the best outcomes for the business, the consumer and the environment.

1.1.4 Industry Knowledge and Expertise

Industry experts have accumulated knowledge on the role of packaging and the areas of opportunity for impacting FLW. Managerial representatives from industry are often consulted for perceptions concerning business practices exposing actions, gaps and opportunities. AMERIPEN (2018) undertook a survey of leading packaging designers and food scientists to compare their appraisals on packaging effectiveness on food waste reduction (Figure 1). The results indicate that “existing technologies and minor adjustments to optimise existing packaging may be more impactful than investment into new technologies, suggesting the optimal use of packaging as a food waste strategy require less effort and investment than previously reported” (AMERIPEN 2018, p. vi). Increased shelf life was nominated as the most effective, followed by decreased leakage/spillage, improved portion control and decreased damage.

Additional findings suggest the 45 respondents to the AMERIPEN survey showed greater interest in packaging attributes that were less difficult to apply, cost effective and oriented around shelf-life extension. Options with increased involvement within materials, functions and/or technologies may have been less understood, or the complexity of adoption may have deterred their appeal. However, the attributes are ranked in order of perceived effectiveness which indicates a correlation with complexity of use.

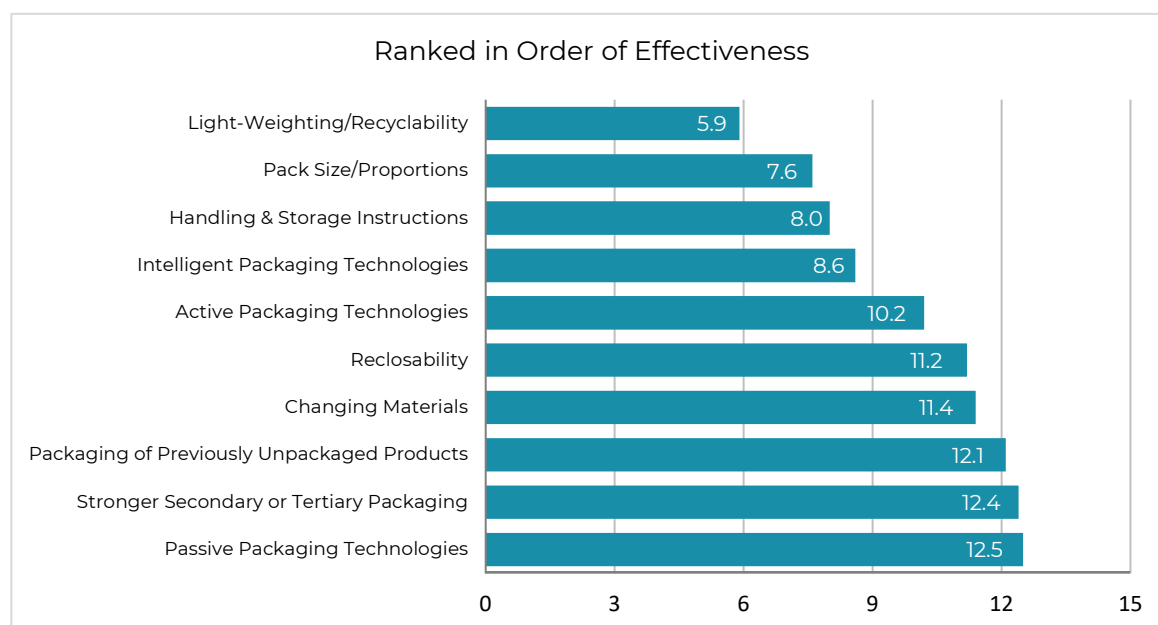


Figure 1. Voice of the Industry Matrix: Best Attributes to Apply to Packaging to Reduce Food Waste (Ranking Scale) (AMERIPEN 2018, p. 10)

1.2 Gaps in Current Knowledge – Save Food Packaging Review

1.2.1 Introduction

Food packaging that targets food loss and food waste reduction has been referred to as “Packaging-related FLW reduction” (Wohner et al. 2019) and also as “Save Food Packaging” (SFP) (AIP 2023; PIDA 2020; Wikström et al. 2018), which is the term used for this research endeavour. Packaging sophistication is advancing in waste reduction strategies through shelf-life extension, improved structural designs and resealabilities. Active and intelligent technologies are expanding the physical, chemical, sensory and microbiological barrier innovations beyond standard packaging protections (Gutierrez et al. 2017; Verghese et al. 2014; Wikström et al. 2018; Zhang et al. 2015). Packaging functional features are well recognised and explored within literature in the fields of shelf life extension, functional protection and communication features (Gutierrez et al. 2017; Manfredi et al. 2015; Møller et al. 2016; Verghese et al. 2014; Wikström et al. 2018; Yildirim et al. 2018; Zhang et al. 2015).

However, literature dedicated to categories pertaining to food waste reduction through packaging (“Save Food Packaging”) is still emerging. Save Food Packaging is a design practice that targets food waste reduction. Numerous design approaches and attributes have been discussed and recognised through literature however with terminologies being fluid and categories cross-pollinated. This section sets out to identify and collate the key terminologies and definitions used within literature that are internationally recognised on the topic of SFP Design Criteria.

1.2.2 SFP Classified by Primary-Packaging Features

Primary-packaging is seen to have the greatest impact on food waste reduction. Design features can include reclosable packs, smaller packs, subdivided packs, and detailed storage label advice as shown in Table 2 (Verghese et al. 2015).

Table 2. Example of primary-packaging design to reduce food waste in the home (Verghese et al. 2015)

Design feature	Description	Potential impact on food waste
Reclosable packs	Examples include zip-lock bags and pouches, resealable cheese, and cereal bags, and ‘fridge packs’ (plastic screw-top jars) for products like baked beans.	Being able to reseal packs help to keep food fresh for longer.
Smaller packs	Examples include half loaves of bread and single serves of yoghurt.	Allow smaller households to only buy what they need.
Subdivided packs	Packs divided into portions, e.g., sliced meat in sperate compartments.	Allow consumers to use what they need and keep the remainder sealed in the packaging.
Detailed storage advice on the label	This could include where to store the food, e.g., whether or not it should be stored in the fridge or encouraging consumers to ‘freeze before the date’.	Could improve food storage practices and extend shelf life in the home.

1.2.3 SFP Classified by Functions and Features

Researchers have identified numerous design strategies recommended for SFP and have been discussed within literature using varied descriptive terminologies for both the individual features as well as the way they are classified into purposeful functions (Heller et al. 2019; Silvenius et al. 2014; Verghese et al. 2014). A call for a globally recognised definition is an ideal target for future international collaborations. Some categories for SFP functions have been proposed, discussed and are growing in acceptance

within academic and industry (Conte et al. 2015; Lindh et al. 2016; Wikström et al. 2018), however many remain that are referred by mixed terminologies that can cause confusion of definitions and purpose.

Conte et al. (2015) groups the food waste reductive features into levels of high-barrier, multi-layer, biodegradable attributes. Whereas, other leading researchers including Verghese et al. (2015) summarise an earlier model of the higher level 'functions' of packaging into seven headings of: "(1) Protection, (2) Promotion, (3) Information, (4) Convenience, (5) Utilisation, (6) Handling, and (7) Waste Reduction" with all functions clearly working together holistically and are not mutually exclusive of each other.

Lindh et al. (2016) adapts these classifications further and introduces a higher order, again classifying the numerous references of SFP features under three types of functions, (1) Protect, (2) Facilitate Handling and (3) Communicate. Through Lindh and colleagues (2016) study, the three main "Decreased Product Waste (DPW)" attributes (known in this research as Save Food Packaging (SFP) Design), with sub-features include: 1. 'protective' attributes: "mechanical, barrier, thermal and sealing properties"; 2. 'facilitate handling' functions: "appointment (dosage), processability, openability, resealability, unpacking/emptying and gripability"; and 3. The 'communication' elements: "information located on-packaging concerning the food product, packaging and the product-packaging interaction (for example, smart packaging)" (Lindh et al. 2016, pp. 235-238).

1.2.4 SFP Classified by Waste-, Logistics-, Materials- Related Properties

An alternative approach to (holistically) viewing wastage is offered by Molina-Besch (2016) who discuss waste reduction strategies at three levels: (1) Product waste-related, (2) Logistics-related, and (3) Packaging material-related. The results highlight that companies regularly reported use of green packaging strategies with a focus on enhancing economic benefits. However, it was evident that they lacked the guidance to fully benefit from the theoretical knowledge base on green packaging environmental benefits. Recommendations were for businesses to invest in packaging solution developments that focus on environmental impact reduction from the consumer phase. Therefore, user-centred SFP Criteria are recommended for implementation. This project is aimed at addressing this dimension.

1.2.5 SFP Classified by Industry

The Australian Institute of Packaging (AIP) represents industry partners that are promoting packaging targeting food waste reduction. The institute also advocates change through the Packaging Innovation and Design Awards (PIDA 2020), which is scheduled annually. AIP has initiated the world's first award dedicated to packaging-related food-waste reduction titled the Save Food Packaging Design Award. The specific criteria for entry is shown in Figure 2 which is an adapted reference list taken from Wikström et al. (2014).

DESIGN INNOVATION

1. Opportunities for packaging design to reduce or eliminate food waste can include:
 - Better facilitation or communication around portioning;
 - Expiry date/best before extension or Better clarification; and
 - Left over storage solutions and recipe ideas.
2. The application may highlight a wide range of design factors that have helped to prevent food waste including*:
 - Mechanical protection.
 - Physical-chemical protection.
 - Resealability.
 - Easy to open, grip, dose and empty.
 - Contains the correct quantity and serving size.
 - Food safety features/freshness information.
 - Expiry Date and Best Before information
 - Information on storage options
 - Improved communication on packs including open, reseal, close and dispense.
 - Sustainability of the packaging design (aligning with APCO/SPG principles, ISO Certification and company credentials, Best Practice Standards).
 - The packaging should facilitate sorting of household waste — easy to clean, separate and fold.

**Wikström, F, Williams, H, Verghese, K, Clune, S (2014). The influence of packaging attributes on consumer behaviour in food-packaging*

Figure 2. PIDA Save Food Packaging Design Award Criteria (PIDA 2020)

To satisfy entry to the award, the 6-point entry criteria is to be met (Figure 3). Additional information outlines the importance of careful design considerations to ensure packaging is significant in food waste reduction attributes that enhance containment, protection, dispensement and resealability (PIDA 2020). The four categories open for entry are 1. Agriculture – Industrial, 2. Food Services, 3. Food E-Commerce, and 4. Retail (primary packaging).

SAVE FOOD PACKAGING DESIGN CRITERIA 1:

Design to contain and protect the product from spoilage & damage through manufacture, warehouse and the various stages of distribution. Provide details of primary, secondary and tertiary packaging involved. Consider palletisation & stabilisation; transport packaging & load stabilisation and the positive impact in reducing waste & spoilage from damage as a result of shocks, vibrations, temperature, moisture, infestation and chemical contamination. In this criteria, please include pack design aspects such as tamper evidence and other forms of pack design that would restrict human contamination.

SAVE FOOD PACKAGING DESIGN CRITERIA 2:

Design to preserve, enhance product appeal and extend shelf life. Provide details of improved barrier packaging & processing, i.e. Skin (vacuum), MAP & EMAP packaging format that extends shelf life and retains nutritional values. In this criteria, active and intelligent packaging can be included.

SAVE FOOD PACKAGING DESIGN CRITERIA 3:

Design to provide convenience and to not waste food in handling. Include in this criteria details of 'portion control packaging', 'easy opening and effective resealable packaging' and 'controlled dispensing and enabling the removal of the entire product from the pack'.

SAVE FOOD PACKAGING DESIGN CRITERIA 4:

Design to promote and communicate to consumers how to handle, store, prepare and reuse food products. Provide details of 'usage & storage instructions', 'explanation of how the packaging is reducing food waste'. Also provide details specific 'on pack information covering preparation & left-over ideas and if improvement have been made to 'Best Before' and 'Use By' communication.

SAVE FOOD PACKAGING DESIGN CRITERIA 5:

Design to meet the 2025 National Packaging Targets & Global Sustainable Packaging Targets. Include in this section what aspects of the 2025 National Packaging Targets have been included in the new packaging design? Indicate if the APCO Sustainable Packaging Guidelines (SPG's), or the PREP tool or the Australasian Recycling Label (ARL) have been applied in the development and design of the product/ packaging? Outline the positive and negative changes to the environmental impacts of the packaging design as a result of the new design aspects.

SAVE FOOD PACKAGING DESIGN CRITERIA 6:

Design to meet the 2030 National Waste Targets & Global Sustainable Packaging Targets. Outline how the new packaging design aspects have been contributing to reducing or preventing food waste. Provide specific information identifying the amount or percentage reduction in food waste associated with the new design relative to a replaced packaging design or a competitor's design.

Figure 3. Save Food Packaging Design Criteria (PIDA 2020)

1.2.6 SFP Review with a Service Lens – Creating the Criteria

SFP strategies, currently available, were referenced from literature and grey literature and the way they were categorised and described were comparatively analysed. The goal of the review was to identify industry and academic recognised, and less recognised, common terms along with their descriptive benefits to the stakeholders of the supply chain and end-users; overall to generate a plain language Criteria resource for ease of industry adoption. Facilitating food waste reduction is a primary aim. Wikström et al. (2014) states that “by taking a ‘Service’ perspective, the focus can move from the product itself, to the process it is used for”. They state that “each attribute provides prerequisites for the service to occur and be experienced and assists to script individual behaviour and experiences, and potentially the environmental outcome e.g. the amount of food waste generated” (Wikström et al. 2014, p. 102). Therefore, to contribute greater meaning and identify, the descriptive benefits for each identified strategy (including functional, educational, awareness benefits), the ‘service’ it provides must be presented. The SFP strategies are summarised initially against the three ‘Function’ categories or high level criteria proposed by Lindh et al. (2016) being “Protect”, “Facilitate Handling” and “Communicate” which were extended into a 5 Criteria model to accommodate the reviewed and additional SFP strategies identified (refer to Figure 6 in Section 2.5 this document).

The 5 Criteria being:

1. Design to Contain and Protect the Product
2. Design to Preserve and Extend Shelf Life
3. Design to Provide Consumer Convenience
4. Design to Communicate to Consumers
5. Design to Balance Packaging Targets and Food Waste

SFP Criteria is relevant to numerous food industries and must be reviewed through the lens of the service to the respective food category. For example, the Meat and Seafood category have different SFP needs compared to the Fresh Fruit and Vegetable category and thus, each SFP strategy is to be considered against the food category at hand. The Criteria cites leading researchers in the field of SFP design (Hellström and Olsson 2017; Vergheze et al. 2014; Wikström et al. 2014; Wohner et al. 2019) and compares these terminologies against industry SFP language and ways of usage to ensure the proposed ‘service’ is relevant and impactful.

1.2.7 Challenges

In relation to SFP design, the packaging industry faces the following challenges according to Porpino (2016):

- Lack of adequate training and progress monitoring
- Poor consumer awareness
- Absence of pressure for a widespread adoption of green supply chain management
- Ever increasing and evolving demands on the role of packaging and ensuring SFP design criteria is a priority for businesses and packaging designers.

A challenge remains to shift consumer perceptions and current practices of food waste. Aschemann-Witzel et al. (2015, p. 6463) state that much food waste results from consumers propensity to waste and cite a report by WRAP (2015) in their literature review of consumer-related food waste that one of the most common reasons for food waste is because:

- Expired before time of use
- Over prepared or served
- Taste preferences of dislike resulting in food disposal.

The World Resource Institute offers ten scaling interventions for FLW reduction to meet the 2030 Global Targets, of which 'Intervention 6 – Shift social norms and behaviours' is noted here as a challenge for businesses, packaging developers and marketers. The challenge will be overcome by working together through "leveraging the latest findings of behavioural science, engage grassroots campaigns, social media, religious communities, and others to make 'wasting food' as unacceptable as littering now is in many countries" (Hanson et al. 2019, p. 11). Adopting the SFP design criteria and adhering to the outcoming guidelines will direct the Australian food industry towards a less wasteful future.

From the review conducted in this research, it has been reported that many researchers point to the importance of packaging in playing a role in reducing food waste. The challenge is to empower businesses, packaging developers and suppliers with the strategies to achieve consumer acceptance of packaging innovations that are impactful and meaningful for stakeholders and end consumers alike.

1.2.8 Gaps

Identified gaps in the desktop literature review dealing with packaging and food waste include:

- Terminology and descriptions of functions and features that frame SFP design criteria have areas of misaligned uses within academia, and also between academia and industry. However, this research aims to address this gap by identifying and synthesising the various terms from the review.
- The indirect environmental benefit of packaging is insufficiently considered by stakeholders (Molina-Besch et al. 2019).
- More research is required investigating ways to integrate SFP criteria into the NPPD processes of organisations.
- More research is required to understand the barriers, from an economic and technical perspective, e.g., changes to capital equipment, that currently hinder organisations to adopt new packaging designs that incorporate save food features and functions.
- Food loss that occurs prior to packaging, with product damage caused by insect bites, microbiological breaches, and unsatisfactory moisture and temperature environments (Raak et al. 2017).
- More research is required on consumers understanding and perceptions of unknown packaging technologies such as Active and Intelligent packaging (Verghese et al. 2015, p. 612) and their acceptance or distrust of them.
- Greater communication and education of the role of packaging in minimising food waste and SFP criteria is needed, across industry, government and to consumers.
- More research is required to investigate if the designed save food packaging features and function save food in households; do consumers recognise them; and to modify design by codesign with consumers.
- Greater research is required to strengthen reported figures between consumer-reported food waste amounts and the actual food waste quantities generated in the household (FFW CRC 2019), with self-perceptions vulnerable to biases.

More research was required to investigate the barriers for organisations to adopt Save Food Packaging design in regard to capital equipment and infrastructure constraints, procurement contracts, and willingness. Wikström et al. (2019) identifies that the “question of how packaging functions influence food waste on a product level remains largely unexplored” however, they state the gaps in literature include the lack of consideration for food being discarded within original packaging, hindering recyclability and food residue management which is not accounted for in environmental evaluations of packaging. Additional gaps noted include consumer perceptions of new packaging materials and technologies as “the lack of demand from consumers might also hamper investments in new packaging materials and equipment (Wikström et al. 2019).

2. Methodology

Approved Ethics:

- Ethics ID: 22445 Stakeholder Review (On-line Survey and Interviews) of Product-Packaging Design Processes
- Ethics ID: 23593 Case Study Interviews of PIDA and WPO WorldStar Winners
- Ethics ID: 23746 Piloting of the Save Food Packaging Criteria and Framework

The four-year project comprised a range of activities, the methodology used for each described below:

- Desktop literature review (briefing paper)
- Stakeholder online survey — reviews expert knowledge and perceptions of 95 industry stakeholders in the Australian food industry gathered via an online survey by assessing their current organisational roles and practices regarding food waste concerns and save food packaging (SFP) strategies.
- Stakeholder interviews — reviews the expert knowledge and perceptions from 12 stakeholder interviews, representing a range of organisations from the Australian food industry, evaluating current save food packaging (SFP) design and system implementation techniques.
- Case study development — all Save Food Packaging award winners from the PIDA awards were interviewed with a series of questions reading their packaging design and the role that it plays in minimising food loss and waste. The case studies are available on the AIP website and are used on the training course and presentations on the topic.
- Criteria development, including design, Consortium feedback/ input, refinement and publication, including:
 - Criteria Resource Booklet
 - Criteria Icons
 - Criteria Checklist Sheet
- Training material and workshop. The AIP re-wrote the existing training course that was developed at the start of the project to include the latest statistics, research, findings, reports and data from a global perspective, then regionally within Australia and New Zealand. The detailed checklists and Save Food Packaging guidelines are the foundation of the training framework and all best practice case studies are used as examples and discussion points within the training.
- Embedded PhD Research – that identified opportunities for specific actors and key decision makers within the food/beverage–packaging industry to implement SFP solutions more effectively to reduce household food waste. Interplay

explored through the case of reclosable and resealable packaging in relation to consumers' household food storage practices and food waste.

2.1 Desktop review (briefing paper)

The desktop literature review (Francis et al. 2020) methodology adapts multiple elements from the recognised 'systematized review' (Grant and Booth 2009), who identify the following stages:

- a comprehensive search of both peer-reviewed literature and grey literature scoping academic and industry knowledge on the research topic,
- executing a systematic search strategy with pre-defined keyword enquiries with quantified results,
- assessing the literature on measures of quality according to a recognised hierarchy of evidence, and
- summing the analysis of results.

What follows is a summary overview of the methodology employed for the Save Food Packaging Design Criteria and Guidelines Research Literature and Industry Knowledge Review (i.e., desktop literature review) (Francis et al. 2020) — see also for a fuller overview and description.

The RMIT University Library database was the primary Search Platform for collating the search results using the 'expanded beyond library collections' feature. The databases included for assessment were Science Direct (Elsevier), Google Scholar and Scopus. Search parameters were based on:

- Relevance (direct connection to the search topic),
- A published date range between 2014 – 2019 (exceptions were allowed based on highly relevant and widely cited articles),
- Published in English language,
- Searches expanded beyond library collections,
- The publication type included peer-reviewed (PR) academic publications, book chapters, books, and academic conference papers; excluding opinion pieces, letters to the editor and book reviews. In terms of grey literature, emphasis was given to 'landmark' publications, white papers and high-profile reports on the topic,
- Anonymous authors were omitted from the results.

Search terms were collated from both the project industry expert panel (Consortium members) and from a preliminary search of published literature to gather recognised keywords depicting fields of research relevance. All search inquiries used the three-tier search protocol inclusive of Tier 1: "Food Packaging"; Tier 2: "Development"; and Tier 3: "Food Waste". All tier searches were conducted in parallel with the Boolean "AND" to ensure all results related to the tiered topics. The introduction of a fourth-tier further filtered the results into sub-categories. For example, the fourth-tier search term "Packaging Design" returned 45 PR articles, representing over 50% of the total 81 third-tiered results. All articles were assessed on peer-reviewed status, journal quality (based on Impact Factor), relevance and contribution to the topic, as well as the number of citations recognised.

The initial search inquiry using the search parameters and the three-tiered levels, resulted in a total of 81 peer-reviewed (PR) articles. Of the 81 articles, highly relevant articles were identified with their bibliographies cross-referenced, to identify additional

relevant publications that were not captured from the initial search results. This 'snowballing' approach expanded the results to a total of 104 results for review.

To further visualise the recognised terminology used for publications (based on the initial 81 results), Figure 2 orders the Boolean search terms at the fourth-tier level to illustrate the categories with the most-to-least citations within these peer-reviewed articles focusing on 'food packaging', 'development' and 'food waste'.

The process of comparing search terms and their results aids in the scoping of widely recognised terminologies and category definitions. It also supports the elimination of less recognised terms and prompts further investigation for the more recognised branches. The ultimate gain from this research is to identify internationally recognised definitions that categorise key criteria that list SFP functions and features.

2.2 Stakeholder Online Survey

The desktop literature review (see Section 2.1) was conducted to inform the 'Stakeholder Online Survey' (Francis et al. 2021), which referenced both academic peer-reviewed articles and industry grey literature in the form of globally recognised flagship reports and studies (Francis et al. 2020). The review identified that save food packaging (SFP) serves multiple stakeholder's needs and food waste reduction roles. The research distilled the common definitions and terminologies used across industry and academia to discuss SFP design criteria and highlighted the need for consensus on packaging functions and features for global rollout and adoption.

This enabled the research team to pose the following research question for the online survey: How do food industry stakeholders consider current product-packaging design and development processes with the consideration of designing packaging to save food, focusing on barriers, gaps, and opportunities?

A total of nine research questions were asked (outlined in the Appendix in Francis et al. (2021)). Australian based participants were recruited through an opt-in invite link. Participation was voluntary and was advertised through the Australian Institute of Packaging (AIP) database, via bulk email and social media and Fight Food Waste Cooperative Research Centre communication channels. Of the 120 responses, 25 were omitted from the analysis based on an incomplete survey status, leaving 95 responses for analysis. The remaining 95 responses included 62 completed surveys and 33 partially completed surveys. All surveys are included in this analysis and are separately indicated in each reported analysis. The survey was conducted from the 24th October to the 7th December 2019. The analysis results are reported in percentages of the total n=95 sample. The data focuses on organisational roles, and where applicable, references the role colour profiles (see Figure 4 overleaf).

See *Save Food Packaging Design Criteria. Stakeholder Online Survey of Product-Packaging Design Processes* (Francis et al. 2021) for a fuller overview and description.

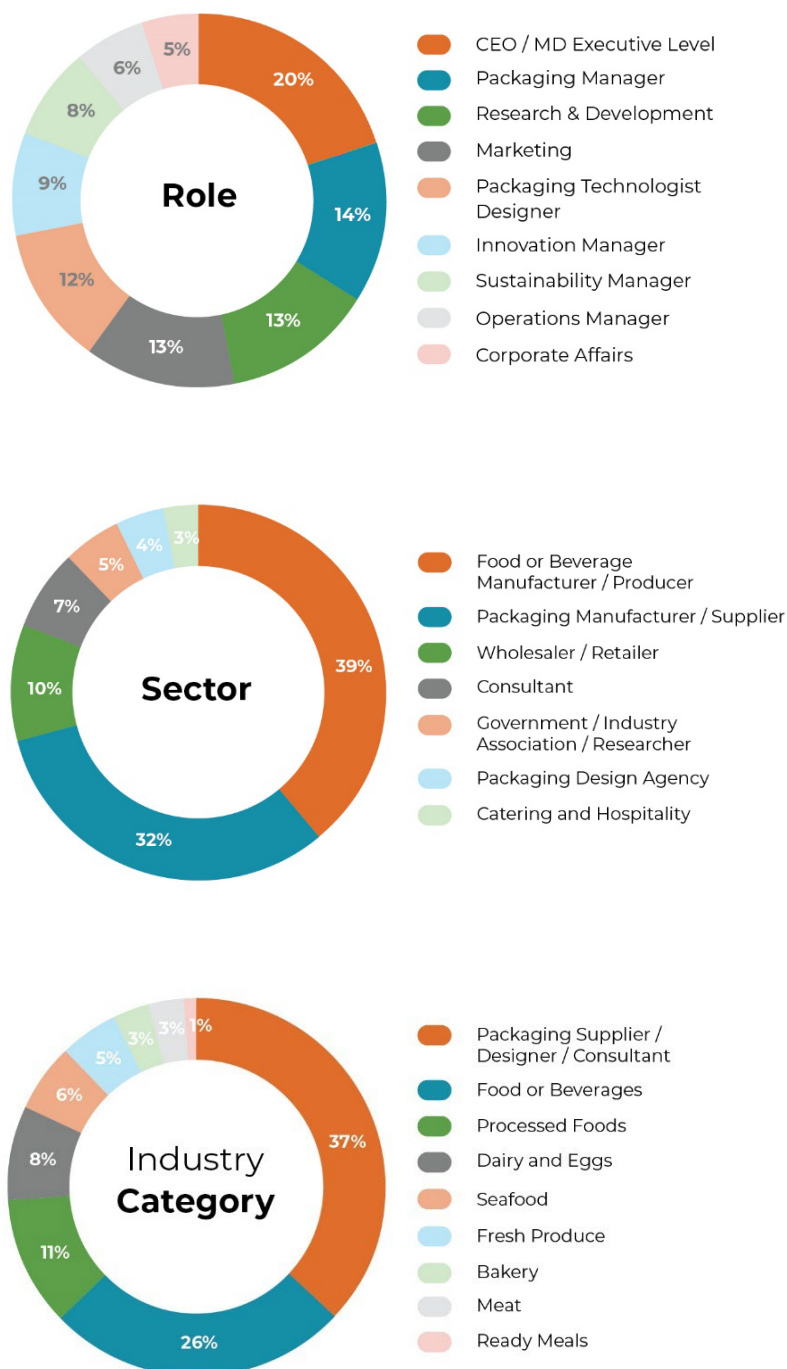


Figure 4. Participants per Role in Organisation (top); per Sector (middle); and per Industry Category (bottom), (n=95) (Francis et al. 2021)

2.3 Stakeholder Interviews

The design of the stakeholder interviews (Ryder et al. 2021) were informed by previous stages of the project – the desktop literature review (Francis et al. 2020), and the analysis of the stakeholder online survey (Francis et al. 2021). The main research question posed for the stakeholder interviews was: What are the barriers and opportunities for new product packaging developments (NPPD) and existing packaging products to implement food loss and waste reduction strategies? A total of 48 supporting questions were asked during the interviews, as outlined in the Appendix in Francis et al. (2021). Participation was voluntary and a list of potential Australian based invitees from the following food categories, meat, seafood, dairy and eggs, bakery, fresh produce, packaged and processed foods, and food and beverages were compiled by the Australian Institute of Packaging (AIP). Recruitment of 12 participants from a variety of organisations was achieved through an opt-in email invitation. The interviews were conducted online during June-July 2020. The interview audio was recorded and transcribed. Members of the research team then read through transcripts and compiled detailed notes and insights. These were further refined into the key insights presented in this report.

Of the 12 interviews conducted, seven participants represented food manufacturers and brand owners and five represented packaging material suppliers. Of the food manufacturers and brand owners, the roles of interviewees included packaging process, development, and application managers and innovation and procurement managers. The role of interviewees of packaging material suppliers included a broader selection of persons, ranging from special projects and sustainability managers to CEO/managing director at the executive level. Food categories that were presented included meat, seafood, dairy and eggs, bakery, fresh produce, packaged and processed foods, and more broadly food and beverages.

2.4 Case Studies

Case study development — all Save Food Packaging award winners from the Australasian Packaging Innovation & Design (PIDA) awards were interviewed with a series of questions regarding their packaging design and the role that it plays in minimising food loss and waste.

The interviews were then transposed and then detailed case studies were written by the AIP team that have been developed to showcase Best Practice award-winning examples for the wider industry to be able to learn from.

The award-winning examples were also developed into slide decks for all of the AIP Save Food Packaging presentations, workshops and training.

The case studies are available on the AIP website and are used in the training course and presentations on the topic.

2.5 Criteria Development

The Save Food Packaging Design Criteria is founded on the synthesised research reviewed across academic peer-reviewed articles, globally recognised reports, and Australian Packaging bodies that promote mitigating food waste through packaging strategies (Figure 5).

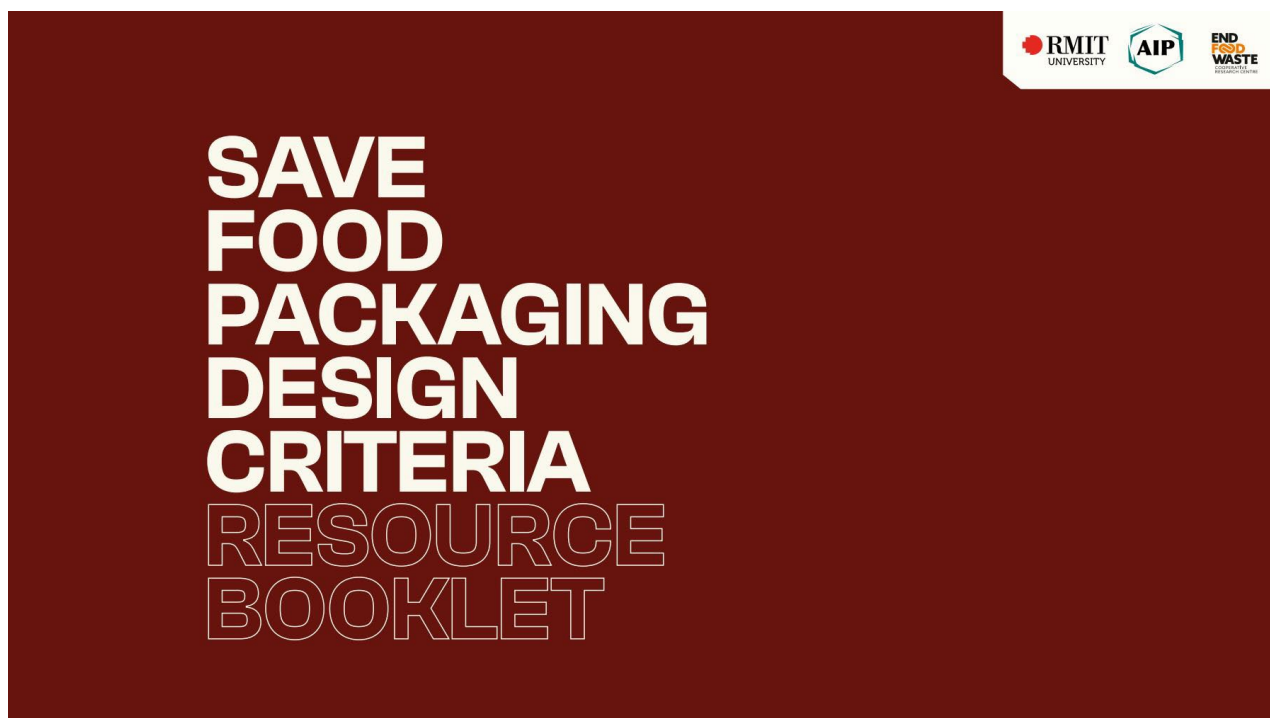


Figure 5. Save Food Packaging Design Criteria Resource Booklet (Francis et al. 2023)

The terminology and categories defining Save Food Packaging strategies were mapped, tabulated, and cross-referenced to identify synergies, gaps, and misalignments. Strategy definitions were clustered through their frequency-of-use creating grouped sub-categories. An independent Communication Designer reviewed the sub-categories on usability and clarity of purpose, converting each strategy into a unified common layout that consisted of 1x pictorial icon and a short clear description, together summarises each criteria strategy. All icons focused on the “Service” to intended users and stakeholders e.g. ‘Easy to open’ or ‘Easy to reseal’, rather than the packaging function referred as ‘Openability’ or ‘Resealability’. The *Save Food Packaging Design Criteria Resource Booklet* was peer-reviewed by the Save Food Packaging Consortium members for appraisal and amendments. The outcome incorporates award winning Case Studies, co-developed with industry and endorsed by the Australian Institute of Packaging, that overlays how the Criteria can be adopted and modelled for best practice examples. The Resource Booklet also provides a simplified 1-page all-inclusive Criteria Checklist, reviewed by industry, that can be printed at large scale as a wall poster for easy referencing to aid in industry adoption. The Save Food Packaging icons were developed for open-source access for either informing best practice and/or promoting through communication on pack design. Overall, 5 key functional criteria categories were identified to align the 68 scoped Save Food Packaging strategies demonstrated in Figure 6 as visual icons. The Criteria promotes:

- 1) Design to contain and protect the product;
- 2) Design to preserve and extend shelf life;
- 3) Design to provide consumer convenience;
- 4) Design to communicate to consumers;
- 5) Design to balance food and packaging waste targets.

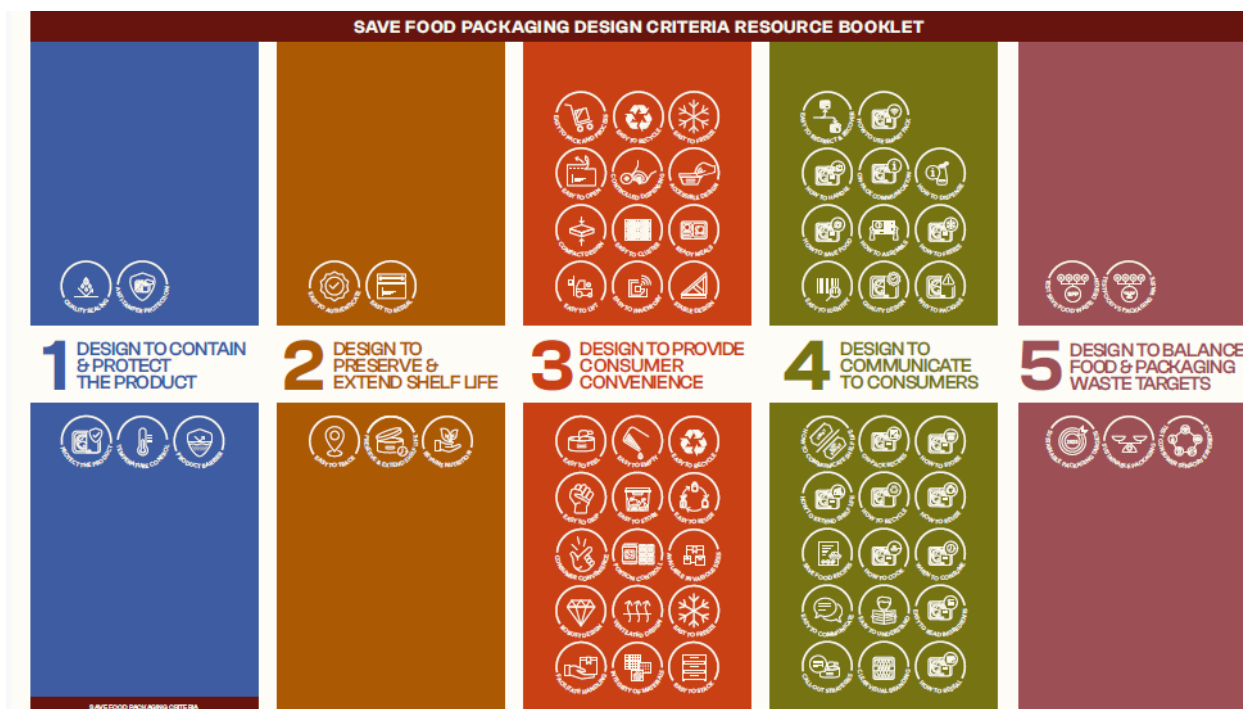


Figure 6. Five Key Criteria Categories (Francis et al. 2023)

The purpose of the Criteria is to align terminology between and across academic and industry fields of practice and increase awareness of the available strategies afforded to all Australian Food Packaging industry members including key stakeholders including CEOs, Marketers, Designers, Packaging Technologists, Retailers, and Consumers.

2.6 Training Material and Workshop

The AIP re-wrote the existing training course that was developed at the start of the project to include the latest statistics, research, findings, reports and data from a global perspective, then regionally within Australia and New Zealand. The detailed checklists and Save Food Packaging guidelines are the foundation of the training framework and all best practice case studies are used as examples and discussion points within the training.

The training course notes were peer reviewed by the AIP education team and experts and were developed in partnership with FAO, Friends of Champions 12.3, End Food Waste Australia, New Zealand Friends of Champions 12.3 group, Australian Food Pact, the World Packaging Organisation and other key stakeholders. This collaborative approach ensures that all stakeholders are a part of the training. Guest lecturers will be from these organisations in future training courses so that they can bring their voice to the discussion.

The first workshop/training was held in December and was very positively received. The AIP brought in multiple experts and voices to the event. Attendees received three 3x detailed booklets from the training course. The lecturer received a 5.20 out of six for the training course from the attendees. A mini version of this course is being developed. The AIP plan to increase the training availability in 2024 and beyond.

2.7 PhD Research

The PhD research was a three-stage research process conducted by Dr Ruby Chan, that considered industry and consumer factors identified from academic literature, industry publications, and interviews with consumer and industry participants (Chan 2023b).

Each research stage was published as an open-access, peer reviewed paper, referred to as Paper 1, Paper 2 and Paper 3 respectively. Table 3 shows the bibliographic information for each paper and corresponding research stage. Collectively, these papers help to answer the PhD research question: How can packaging solutions be better matched to household food waste drivers?

Table 3. Corresponding research stage for each paper and bibliographic information, adapted from Chan et al. (2023)

PhD Research Stage / Paper	Paper Bibliographic Information
PhD Research Stage 1 / Paper 1	CHAN, R. B. Y. (2021). A review of packaging-related studies in the context of household food waste: Drivers, solutions and avenues for future research. <i>Packaging Technology and Science</i> , 35(1), pp. 3–51. https://doi.org/10.1002/pts.2611 .
PhD Research Stage 2 / Paper 2	CHAN, R. B. Y. (2022). Packaging solutions for household food waste in the context of the food/beverage–packaging industry: A comparative review of empirical literature and industry press releases. <i>Resources, Conservation & Recycling</i> , vol. 185, article no. 106479. https://doi.org/10.1016/j.resconrec.2022.106479 .
PhD Research Stage 3 / Paper 3	CHAN, R. B. Y. (2023). Drivers of divergent industry and consumer food waste behaviors: The case of reclosable and resealable packaging. <i>Journal of Cleaner Production</i> , vol. 412, article no. 137417. https://doi.org/10.1016/j.jclepro.2023.137417 .

A summary of the methodology for each paper is presented below. The PhD insights and recommendations have also been consolidated into an industry insights report (Chan et al. 2023).

2.7.1 PhD Research Paper 1: A review of household food waste and packaging research

Paper 1 (PhD research stage 1) involved a systemised review of academic and industry research literature on packaging related household food waste drivers and solutions. The review included analysis of 43 research studies published globally in English between 2006–2020. The 15-year timespan of this review commences with the initial publication of relevant research studies, for a comprehensive overview the field. The review identified packaging drivers and solutions for household food waste across 28 food categories, mapped across the packaging functions of communication, convenience, apportionment and protection.

The review highlights specific food categories that relate to specific packaging reasons for household food waste, revealing opportunities for food/beverage brands and packaging companies to develop or tweak packaging design to reduce such waste. These opportunities are detailed in Section 3.7 of this report. Refer to Paper 1 (Chan 2022b) for further information on the research method used and detailed results.

Figure 7 shows a breakdown of the examined academic literature comprised of 32 journal articles (74%) and 2 conference papers (5%). The examined industry literature comprised of 9 industry reports (21%). Together, this provided a 15-year snapshot of research insights pertaining to packaging related household food waste.

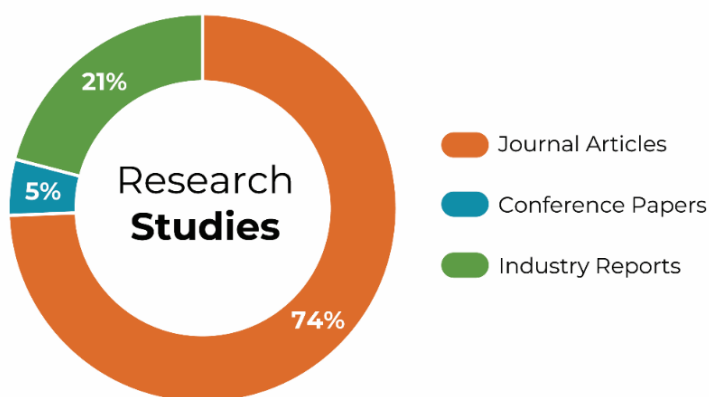


Figure 7. Breakdown of the research studies examined in the literature review for Paper 1 (n=43), adapted from Chan et al. (2023)

2.7.2 PhD Research Paper 2: A comparison of packaging solutions from research and industry

Paper 2 (PhD research stage 2) involved a comparative review of research literature (academic and industry) and press releases from food/beverage–packaging industry magazines to identify SFP solutions for household food waste. The review included 60 research studies and 412 industry press releases published globally in English between the 16-year timespan of 2006-2021. The 16-year timespan of this review covers the initial publication of relevant research studies and reflects available archive access of industry press releases. The review identified differences between the household food waste packaging solutions mentioned in the research literature and those advertised in industry press releases, highlighting opportunities for researchers and industry actors to bridge this gap. These opportunities are detailed in section 3.7 of this report. Refer to Paper 2 (Chan 2022a) for further information on the method used and detailed results.

Figure 8 shows a breakdown of the research and industry literature examined. The research studies (13%, n=60) comprised of 47 journal articles, 2 conference papers, and 11 industry reports. The industry press releases (87% n=412) were gathered from 23 food/beverage and packaging industry magazine platforms. Together, this provided a 16-year snapshot of the key developments within research and industry.

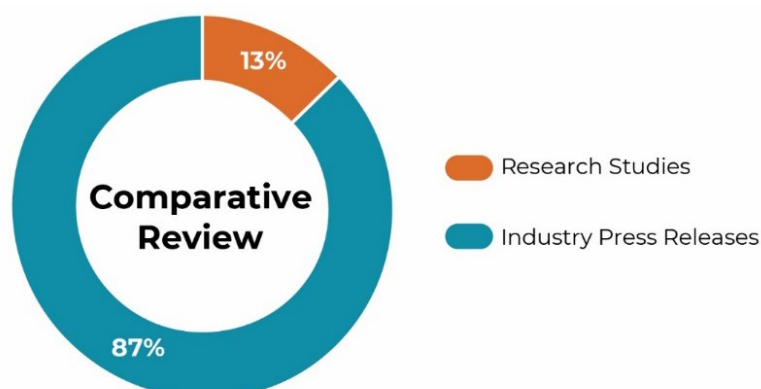


Figure 8. Breakdown of the publications examined in the comparative review in Paper 2 (n=472), adapted from Chan et al. (2023)

2.7.3 PhD Research Paper 3: An investigation of how industry's packaging decisions can impact household food waste

Paper 3 (PhD research stage 3) involved a qualitative study that explored the interplay between industry packaging decisions, consumer–packaging interactions and household food waste. To gather context-specific information, this interplay was explored through the case of reclosable and resealable packaging in relation to consumers' household food storage practices and food waste. This context was chosen due to the link between consumers' food storage practices and household food waste, of which packaging can play a role (Chan 2023a; Lockrey et al. 2020). There is growing recognition that packaging can play a more central role in helping consumers to optimise food storage and minimise food waste, which is reliant on industry action to design and implement appropriate SFP (Hebrok and Heidenstrøm 2019; Ryder et al. 2021; WRAP et al. 2017).

The research for this paper included interviews with industry and consumers. 20 consumer participants were engaged through a context mapping process that included a pre-interview worksheet and semi-structured interviews. Next, 11 food/beverage–packaging industry participants from small and medium enterprises (SMEs) and multinational companies were engaged through semi-structured interviews. Insights from the consumer interviews in relation to consumers' packaging needs informed the interview questions for industry participants.

The data were analysed to identify key factors affecting consumer packaging needs and industry packaging decisions. The analysis also included a systems map of the relative packaging decision-making influence of different actors across the food/beverage–packaging industry by role (e.g. marketing, packaging technologist) and sector (e.g. food/beverage brand, packaging company). This map offers insights into the industry-wide complexities of implementing SFP to reduce household food waste and suggest SFP recommendations accordingly.

Finally, these consumer and industry factors were combined into a diagrammatic model showing how packaging decisions by food/beverage brands can affect household food waste. The role of food/beverage brands was highlighted in the diagrammatic model because they determine the product-packaging that consumers use and consumers associate packaging experiences with the brand, providing a link between industry perspectives of packaging design and consumer packaging experiences (Chan 2023a). This research stage identified barriers and opportunities for specific actors within industry to design and implement SFP to

reduce house food waste more effectively, detailed in Section 3.7 of this report. Refer to Paper 3 (Chan 2023a) for further information on the method used and detailed results.

3. Results

The insights for each stage of the project are described below.

3.1 Desktop literature review

This is summarised in Section 1.1 — Previous Research & Literature; and Section 1.2 — Gaps in Current Knowledge — Save Food Packaging Review.

3.2 Industry Survey

What follows is a summary overview of the findings of the Stakeholder Online Survey of Product-Packaging Design Processes (Francis et al. 2021) with Figure 9 depicting the breakdown of 95 surveyed stakeholder participants. See also Francis et al. (2021) for a fuller overview and analysis of those findings. Key insights include:

1. Key executive and management levels are not claiming responsibility for food waste reduction (Figure 9). An opportunity exists to engage marketing management levels, who play a significant role in brief criteria development, design direction, product release, and promotion, to improve food waste reduction strategies being planned and executed within industry. There is a clear need to equip designers with SFP design education, and to educate managerial roles on the need for such strategies. Both a bottom-up and top-down approach is required to work towards permanently embedding SFP design criteria into new product packaging development (NPPD) processes.

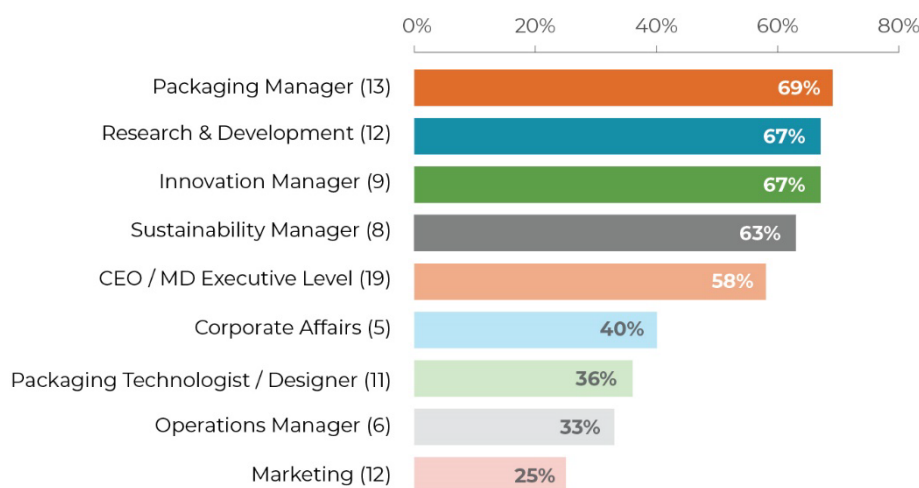


Figure 9. Percentage of stakeholders (n=95) responding 'yes, often' per role, for considering packaging design as a strategy to reduce food waste (Francis et al. 2021)

2. Food waste mitigation considerations are mostly made in the early stages of the new product development (NPD) process and significantly less in the later stages (Figure 10). More consideration is made on food waste reduction within the earlier stages

of the NPPD process. The visible drop in consideration of food waste reduction strategies as organisations move through the NPPD process can be seen across the roles of 'executive', 'R&D', 'packaging manager', 'innovation manager', 'marketing', and 'sustainability manager' levels, some moreso than others. This trend raises the question that if food waste reduction strategies are considered in the early stages of the NPPD process, are the solutions being implemented in the later stages, such as the consumer trialling and launch stages? These findings also suggest that the consumer facing stages of consumer trialling, marketing and Commercial stages, vital for consumer education on SFP benefits, may not be acted upon.

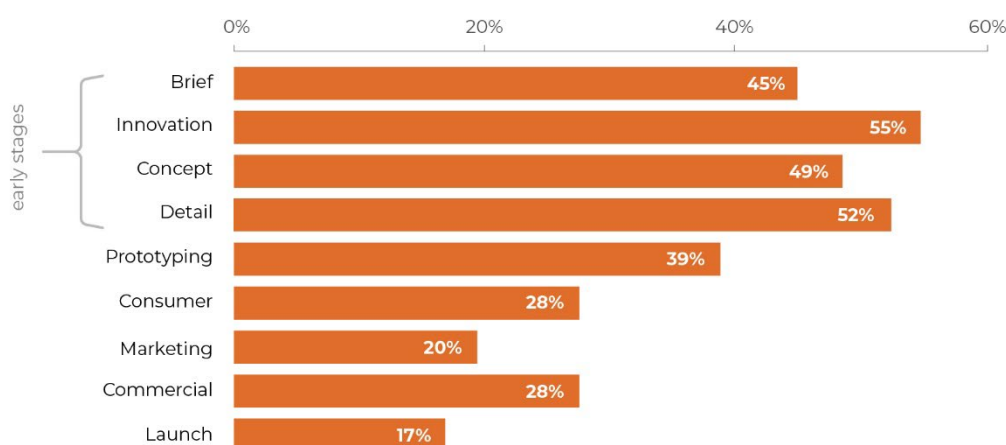


Figure 10. Percentage of stakeholders (n=95) responding yes to 'currently using' Save Food Packaging Strategies per stage. Alternative responses: 'not currently using', or 'N/A, often' per role (Francis et al. 2021)

- Approximately 30% of stakeholders are unwilling to redesign a product's packaging to save on food waste. Industry will only act on this if it does not increase cost (this was also supported by the business case). The top positions that reported they would consider re-designs were 'innovation manager' and 'corporate affairs' (both 100%), whereas the next role ranked dropped 23%, with 77% of 'packaging managers' willing to act on re-designing. 'Marketing' and 'operations managers' were less inclined to re-design a product's packaging to reduce food waste. In addition, respondents did not believe that food waste was 'relevant to their industry' or 'not their responsibility', indicating a clear apathy to the issue, or lack of understanding of managerial roles in advancing processes and packaging innovations in this field.
- Terminology and definitions of SFP design features is still unclear and not fully recognised within the industry. There are a number of Save Food Packaging features: 'portion control'; 'openability'; 'resealability'; 'controlled dispensing'; 'on-pack communication'; 'date labelling'; 'usage and storage instructions'; 'shelf-life extension & barrier'; 'active & intelligent packaging'; and 'retaining nutrition' (Hellström and Olsson 2017; Lindh et al. 2016; Verghese et al. 2012; Wikström et al. 2018). We were interested to know which were currently being used in the product-packaging development process (Figure 11). 'Usage and storage instructions' and 'shelf-life extension & barrier' were collectively the most commonly selected features (both at 43%), followed by 'openability' (41%) and 'on-pack communication' and 'date labelling' (40%). These five features were utilised by approximately two fifths of respondents. In contrast, 'controlled dispensing' (15%) and 'active and intelligent packaging' (17%) were the least selected SFP features.

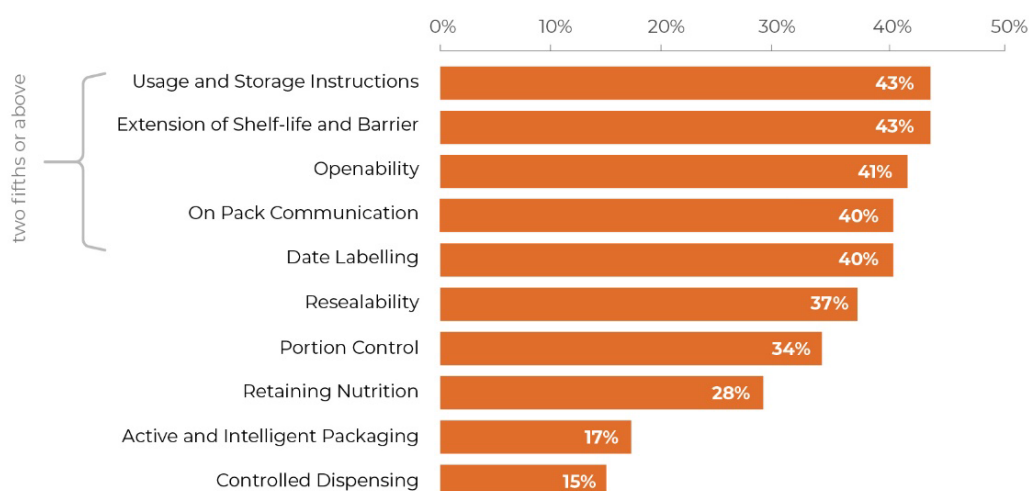


Figure 11. Percentage of stakeholders (n=95) responding 'currently using' SFP features (Francis et al. 2021)

- Greater SFP adoption within the food industry requires leaders to promote and give 'case study' examples of SFP value.
- The greatest perceived barriers to SFP adoption is that it adds cost and time to production and organisations lack resources (Figure 12). This demonstrates the importance of the need to develop educational case studies that demonstrate how leading organisations have benefited from the SFP investment through either increased market share or reduced food waste levels. The second more common barriers were 'lack of resources' and that it 'adds time' (each at 27%), closely followed by 'lack of stakeholder alignment' (24%). These three factors all related to clients or in-house management who do not value SFP strategies and their benefits. As a result, resources and time are not dedicated to develop and implement food waste design reduction strategies.

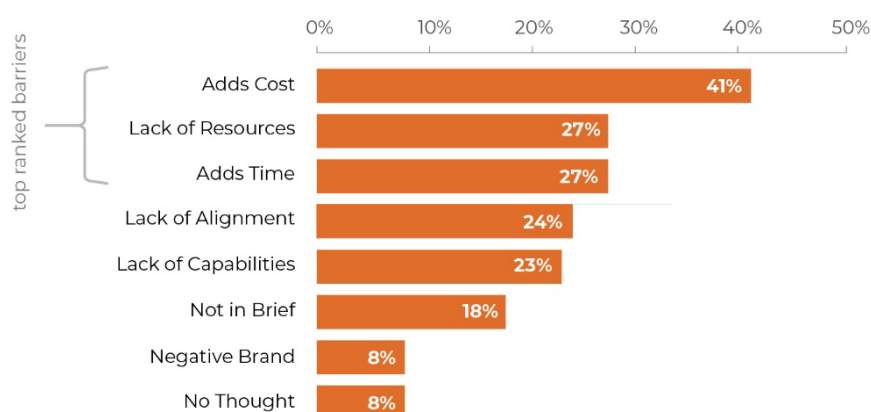


Figure 12. Percentage of stakeholders (n=95) responding 'a barrier' per listed factor (Francis et al. 2021)

- Sustainability is also perceived by industry to be a SFP function.

8. Most participants are willing to access the SFP design criteria, which are being developed through the Fight Food Waste CRC Save Food Packaging Design Criteria and Guidelines project, when available.

3.3 Industry Interviews

What follows is a summary overview of the findings of the Stakeholder Interviews of Product-Packaging Design Processes (Ryder et al 2021) - see also for a fuller overview and analysis of those findings. Key insights include:

1. Considerations of SFP are currently occurring primarily at the beginning of the new product packaging development (NPPD) process, where decisions are made on formats, materials, shelf life etc. This includes setting the minimum shelf life for the product at the very beginning, and this factor has heavy influence on subsequent decisions such as packaging format, material selection, and the level of barrier protection. Regarding consumer communications, some of the participants' organisations include features such as on-pack communication, date labelling, and usage and storage instructions at later stages of the design process or as defined by clients/retailers.

Interviewees were involved in all stages of their organisation's NPPD processes. This included working with consumer research and marketing teams, managing teams of packaging technologists, ensuring packaging allowed for the required minimum shelf life, and managing customer interaction and information development for marketing. Packaging suppliers identified that they play a critical role in providing appropriate information to food manufacturers and brand owners regarding packaging material performance, identifying opportunities to support their clients' NPPD process such as advice on compatibility of materials, and background technical and engineering information. Maintaining shelf life was identified as a priority, with potentially conflicting decisions needing to be made with the selection of appropriate materials.

2. Shelf life of a product is the first and most important consideration within NPPDs. Participants described differences in packaging formats and requirements regarding shelf life for perishable foods and processed foods. Each has its unique characteristics and requirements. Other examples provided included scavenger, barrier, and moisture absorption. Resealability and portion size/control were the two most mentioned strategies. There are, however, trade-offs between consumer demand for smaller serves and the increased amount of packaging per unit this requires.
3. Consumer food waste data is relatively unknown within the industry, relying heavily on feedback and complaints for packaging design improvements. In many organisations, SFP strategies are measured for success through real time testing and trialling; such as through feedback from retailers through shrink loss rates, or utilising consumer complaints to re-design product-packaging formats and on-pack communication to consumers through storage guidance.
4. Consumer demands and trends change quickly, making it difficult for the food industry to design appropriate products. As reported by some organisations, consumer patterns also generated support for broader options in pack sizes including single serves. Driving change towards implementing SFP strategies was reported as both a response to consumer feedback and to extend shelf life in existing and new markets.
5. There is a need for enhanced consumer education on food waste versus packaging waste. Current trends show a consumer focus that demonises packaging rather than food waste and these preferences influence decision making. These participants indicated this presents an opportunity for consumer education.
6. Organisations were divided in their marketing of SFP to consumers; some deeming it unnecessary and others essential by others. Discussing whether marketing SFP features to consumers is required within the industry demonstrated a divide between the food manufacturers and brand owners interviewed. Participants from two companies expressed directly marketing these features is not required, as their consumers already expect high quality and safe food products, listing this as a selling

point that encourages consumer brand loyalty. Participants from other food manufacturers and brand owners observed the benefit of marketing SFP to consumers to encourage returning customers and develop brand loyalty. Packaging suppliers stated they commonly distribute information about the benefits of their packaging to their clients, including food waste reduction techniques. This is also used as a selling point of the product. However, it is up to the discretion of the brand owner whether this information is then relayed to the consumer. Some packaging suppliers said they present their food saving technologies on their own website and social media platforms, acting as an additional form of communication with consumers. Although conscious of the importance of consumers understanding SFP features of food packaging, for packaging suppliers, the design of product-packaging is centred around the products distribution through the supply chain, rather than how consumers interact with their products.

7. Interviewees reported a trade-off between achieving packaging targets by 2025 and food waste targets of 2030. Recyclability of packaging materials at the end of a product's life is another consideration; food packaging businesses are required to align with the 2025 National Packaging Targets of 100% reusable, recyclable or compostable packaging. Food manufacturers, brand owners, and packaging suppliers must constantly deal with the trade-off between reducing food waste and minimising packaging. Some participants voiced that they are struggling to find this balance. There was broad agreement across interviewees that financial benefits and consumer feedback were key triggers for redesign. Food safety, sustainability, the desire to increase brand awareness, and a commitment to the 2025 National Packaging Targets and 2030 food waste targets were also mentioned.

8. Case studies and training modules were developed which are discussed in the next section.

3.4 Case Studies

Case studies and training modules for roles and sectors were identified as the most appropriate form of SFP design criteria to be implemented into organisations. All five criteria elements (interactive online tool, best practice award-winning examples and case studies, briefing documents for roles and sectors, guidelines and checklists, training and education modules for roles and sectors) were mostly accepted by participants. The developed case studies presented best practice of the industry adopting food waste reduction strategies through packaging. These case studies participants were selected based on their awarded innovations through the AIP's PIDA Awards. The Case Studies will continue to be developed and expanded on as more award winners are acknowledged each year. The Case Studies are continuously promoted through the AIP through their memberships and their public websites and industry publications. The Case Studies are included in the Criteria as APPENDIX C – Save Food Packaging Criteria.

3.5 Criteria

The Criteria presents impactful Save Food Packaging strategies that are flexible in use and adaptive for all food category industries across Australia. It offers insights into best practice which can be expanded as new innovations emerge. Considering a circular economy approach to balance food waste and packaging waste, the Criteria highlights packaging's significant role in meeting global and national sustainability targets. The Criteria is designed to be a visually stimulating and compelling industry resource. It summarises and aligns available Save Food Packaging strategies through intuitive service-driven descriptions complimented by visual icons. The icons can be adopted where appropriate such as on-pack communication to inform consumers of added packaging design value. The Criteria is an open-source resource that aims to inform R&D teams, enhance New Product Development models, and be the foundation for training material for Industry workshops promoted and facilitated by the Australian Institute of Packaging. The Criteria is included as APPENDIX C – Save Food Packaging Criteria.

3.6 Training material and workshop

Training and education modules for roles and sectors were seen as the most beneficial to contributing to skills, knowledge, and culture. Participants showed an interest for specific guidelines and checklists to provide product category information and general information that can be embedded into existing company processes. The presented case studies were well received as they demonstrated current award-winning applications of the Criteria and examples of food waste reduction through SFP strategies. All interviewees were aware of the existence of the Australasian Packaging Innovation & Design (PIDA) Awards and WorldStar Packaging Awards. They responded to invest future efforts into participating in these awards by adopting the Criteria as a go-to resource in their organisation and implement into their new product packaging development processes.

3.7 PhD Research

What follows is a summary overview of the findings of the PhD research by Dr Ruby Chan (Chan 2023b) — see also the industry report by Chan et al. (2023) for a fuller overview and analysis of those findings. The findings have been divided into three key themes or factors, as visualised in Figure 13:

- Ensuring that packaging solutions meet consumers' needs to reduce household food waste.
- Encouraging industry to prioritise SFP to reduce household food waste.
- Fostering increased communication and collaboration between researchers, consumers and industry to design and implement SFP to reduce household food waste.

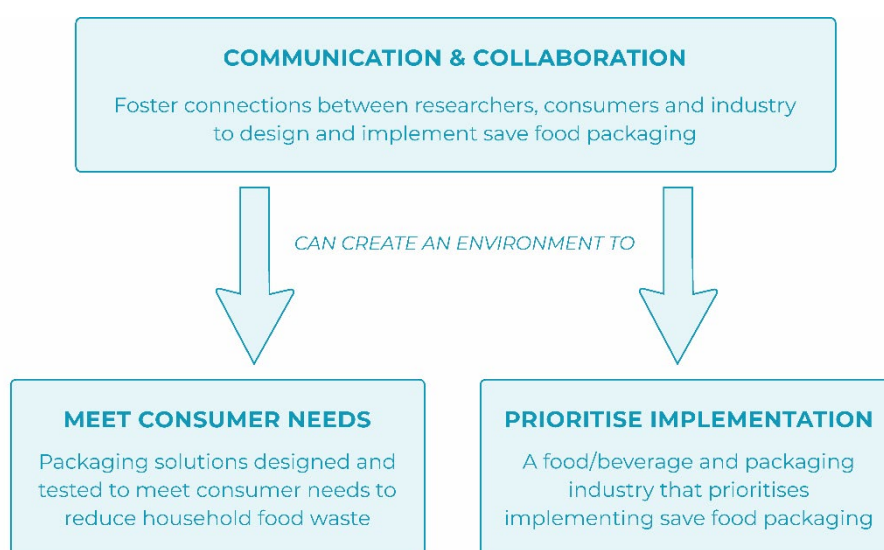


Figure 13. Key factors that create an environment conducive to designing and implementing SFP to effectively reduce household food waste (Chan et al. 2023)

These themes or factors are important for industry to keep in mind because when they are interconnected, they represent an ideal environment conducive to designing and implementing SFP to reduce household food waste effectively. These themes or factors are summarized below.

3.7.1 Ensuring that packaging solutions meet consumers' needs to reduce household food waste.

Packaging can drive or reduce household food waste depending on the features it contains and whether these features meet consumers' needs through the different stages of consumption.

The following sections below presents packaging reasons for household food waste as opportunities for industry to innovate and develop solutions:

- Section 3.7.2 — Expand SFP considerations for household food waste beyond shelf-life extension
- Section 3.7.3 — Design and implement packaging to address reasons for household food waste

These sections also highlight the importance of industry personnel engaging consumers for product–packaging feedback to better understand how the way consumers perceive and use packaging can affect household food waste. The suggestions presented in these sections can help industry to design and implement SFP solutions that are more attuned to consumers' needs and more likely to minimise household food waste.

3.7.2 Expand SFP considerations for household food waste beyond shelf life extension

The research presented in Paper 2 (Chan 2022b) suggests that packaging companies are focussing on SFP solutions to reduce food waste through the food/beverage supply chain and also marketing these packaging solutions as useful to reduce household food waste (Chan 2022b; Ryder et al. 2021). This industry focus on designing product-packaging around supply chain distribution instead of how consumers interact with packaging is indicative of industry priorities (Chan 2023a; Ryder et al. 2021). The versatility of SFP solutions is necessary given the many roles that packaging is expected to fulfill across the supply chain. However, the most marketed SFP solutions for household food waste by industry are unaligned to the most mentioned packaging reasons for household food waste, so it is unclear how useful consumers will find these solutions in practice (Chan 2022a).

Packaging solutions that can extend food/beverage shelf life through the supply chain are the most marketed by packaging companies, but the effectiveness of these solutions depends on the product packaging remaining sealed. This constraint limits the save food benefits consumers can reap from packaging to the early pre-opening storage stage of food consumption, which is inadequate if SFP is to be specifically effective to reduce household food waste. Existing research shows that packaging-related food waste is generated at all stages of consumer food consumption, including after packaging is opened (Brennan et al. 2023; Chan 2022b). Consumer inability to reseal a package for food storage is connected to household food waste opened (Brennan et al. 2023; Chan 2022b, 2023a), yet resealable and easy-to-store packaging are relatively less marketed by packaging companies (Chan 2022a). Beyond issues of perceived food quality and safety that arise from suboptimal storage, transferring food out of a package can lead to consumers losing access to on-pack product information that can assist with portioning and cooking — all of which can affect household food waste (Chan 2023a). To improve packaging's potential to reduce household food waste effectively, there is an opportunity for industry (i.e. packaging technologists within food/beverage brands, those that manage them, and packaging companies) to market and implement SFP to focus more on consumers' specific needs across all stages of food consumption (Chan 2022a; Francis et al. 2021).

Food/beverage brands can conduct product–packaging trials to verify whether consumers recognise implemented SFP features, how consumers interact with these features, and whether consumers benefit from using these features (Chan 2023a; Francis et al. 2021). The End Food Waste CRC conducted an assessment of how packaging features and SFP solutions or strategies are understood and used by consumers; the related industry report Brennan et al. (2023) is a resource that industry can consult during

product-packaging design. Moreover, Paper 1 (Chan 2022b) presents packaging reasons associated with household food waste, also summarised as an industry report (Chan et al. 2023) as another resource that industry can consult.

3.7.3 Design and implement packaging to address reasons for household food waste

Packaging can be a valuable tool to support consumers to reduce household food waste. It is important that packaging is designed and implemented thoughtfully with consideration for consumers' needs across all stages of consumption because otherwise, packaging can contribute to food waste. The academic literature documents a variety of packaging-related reasons for household food waste, presenting innovation opportunities for food/beverage and packaging companies to develop packaging solutions in response (Chan 2022b). Companies that take this opportunity can distinguish themselves from competitors through product-packaging solutions that directly addresses research-documented reasons for household food waste.

To improve the effectiveness of SFP to reduce household food waste, there is a clear opportunity for food/beverage brands and packaging companies to design and implement packaging to address specific reasons why consumers waste food. This includes considerations for packaging format, features, and use context. The industry report by Chan et al. (2023) presents packaging-related reasons for household food waste by food category. This report is intended as a resource that food/beverage brands and packaging companies can use to review their own packaging solutions and action iterative amendments or changes where necessary.

3.7.4 Encouraging industry to prioritise SFP to reduce household food waste.

SFP solutions that are suitable for reducing household food waste in theory cannot reduce food waste in practice unless industry personnel including key packaging decision makers are willing to prioritise implementing them. It therefore important for SFP solutions to be developed and implemented in consideration of the views of different people within the food/beverage–packaging industry, and how the decision-making influence of different industry players can shape product–packaging design. External influences including consumer demand and government legislation can also affect whether the industry prioritises implementing SFP to reduce household food waste.

The food/beverage–packaging industry is made up of a range of companies that perform various roles across the supply chain to produce packaged food/beverage products ready for sale to consumers. These roles include packaging design and implementation, packaging manufacture, food/beverage manufacturing, package filling, and consumer testing and marketing. Given the variety of these roles, it is unsurprising that the industry stakeholders who perform these roles each have different views and needs when it comes to packaging. These different views and needs across the various food/beverage–packaging industry sectors and roles can affect whether SFP solutions are implemented, and whether the chosen solutions are appropriate or effective to support consumers to reduce household food waste (Chan 2023a).

The following sections below presents the key factors that affect the willingness or ability of different stakeholders in the food/beverage and packaging industry to prioritise implementing SFP:

- Section 3.7.5 — Encourage greater buy-in by key decision makers to reduce household food waste through packaging
- Section 3.7.6 — Specify reducing household food waste in the packaging brief and follow it through
- Section 3.7.7 — Develop more 'off the shelf' save food packaging for existing production lines
- Section 3.7.8 — Emphasise save food packaging's role in a sustainable food system

These sections also present suggestions to help encourage increased industry action to implement SFP to support consumers to reduce household food waste.

3.7.5 Encourage greater buy-in by key decision makers to reduce household food waste through packaging

The research presented in Paper 3 suggests that executive level personnel at packaging companies and packaging technologists within food/beverage brands appear eager to implement packaging solutions to support consumers to reduce household food waste (Chan 2023a). This is positive, as the packaging expertise of these stakeholders highlight their value in helping to implement suitable packaging solutions to reduce household food waste. However, these specific stakeholders are rarely the key decision makers during the product-packaging design process within food/beverage brands. Rather, they are often tasked by key decision makers within food beverage brands (i.e. executive level personnel and marketers) to deliver a product-packaging design brief that does not specify reducing household food waste, limiting their actions to implement SFP features into product-packaging to reduce household food waste (Chan 2023a). Given the top-down approach to decision-making within food/beverage brands and the client-supplier relationship between food beverage brands and packaging companies, implementing SFP to reduce household food waste requires buy-in by key decision makers within food beverage brands. This would enable other staff within the product-packaging design process — including packaging technologists within food/beverage brands and packaging companies — to implement SFP more readily. In reality, this may require a shift in organisational strategy, often defined and/ or managed by such decision-makers.

Understanding and addressing barriers that hinder the willingness of key decision makers within food/beverage brands to implement SFP is important to encourage buy-in. At the basic level, key decision-makers within food/beverage brands — including executive level personnel and marketers — perceive that implementing to help consumers reduce household food waste competes with their core business priorities of selling food/beverages. There is an opportunity for a greater industry-wide effort to engage key decision makers within food/beverage brands on the potential business benefits of implementing packaging solutions to reduce household food waste, including encouraging repeat purchases and building brand loyalty (Chan 2023a; Francis et al. 2021; Hanson and Mitchell 2017; Ryder et al. 2021). An econometric study by WRAP reports that approximately 50% of the money saved by consumers purchasing less food from reducing food waste is spent again in retail stores, often on higher-value foods — called 'trading up' (Britton et al. 2014). There is also the potential for food/beverage brands and retailers to sell higher margin goods which require less volume to make the same profit. Overall, this supports a business case for food/beverage brands to support consumers to reduce food waste (Chan 2023a; Hanson and Mitchell 2017).

Communicating the business benefits of SFP through case studies and training materials could help to address concerns over the costs of implementing SFP and the returns on investment, as these concerns are key barriers to the adoption of SFP design by food/beverage brands (Chan 2023a; Hanson and Mitchell 2017; Ryder et al. 2021). Encouraging greater buy-in by key decision makers in food/beverage brands through could lead to increased industry-wide action to implement SFP to support consumers to reduce household food waste. Simultaneously, there is an opportunity for food/beverage retailers and government to coordinate food waste reduction campaigns to increase consumer awareness on food waste and motivation to reduce it (Hanson and Mitchell 2017), important to support consumer purchase and use of SFP as a way to minimise household food waste. See Section 3.7.9 for a discussion on the role of communication and collaboration to reduce food waste.

3.7.6 Specify reducing household food waste in the packaging brief and follow it through

The PhD research suggests that food/beverage brands rarely specify SFP features to reduce household food waste as part of product packaging design briefs (Chan 2023a). As a design brief dictates what features or key aspect the packaging will meet,

there is a clear opportunity for food/beverage companies to specify reducing household food waste on a greater number of product-packaging design briefs. Ideally, this would assist stakeholders within food/beverage brands to appropriately prioritise and budget for SFP features. This may require adjustments at a strategic level by executives and decision-makers. Presenting case studies of the benefits SFP could also encourage greater 'buy in' or practical support from key decision-makers in the product-packaging design process (including marketers and executive level personnel within food/beverage brands) to more frequently specify SFP features to reduce household food waste (Chan 2023a; Francis et al. 2021). However, specifying SFP as part of the product design brief is only a start. Insights from the 1.2.1 research project suggests that SFP considerations during the early stages of the product-packaging design process are not always be carried out during the later stages (Francis et al. 2021). This highlights an opportunity for further research to identify additional barriers within the product-packaging design process that prevent SFP features from being implemented (Francis et al. 2021), especially in the context of household food waste.

3.7.7 *Develop more 'off the shelf' save food packaging for existing production lines*

The research suggests that food/beverage brands view using off-the-shelf packaging as a more favourable option that developing packaging 'from scratch' due to budget constraints for research and development and a preference to minimise capital expenses (Chan 2023a; Francis et al. 2021). Off the shelf packaging is used for the confidence that it can readily integrate into existing manufacturing lines and reduce project lead times. However, depending on the manufacturing set-up or specific machines used, off-the-shelf packaging can mean limited options that are suitable to meet consumers' needs to reduce household food waste (Chan 2023a). There is an opportunity for packaging companies and machinery companies to develop a greater number of 'off-the-shelf' SFP suitable for commonly used machinery on existing production lines (Chan 2023a; Leenders et al. 2021). This would provide food/beverage brands a variety of SFP options aligned to both production and consumer needs, increasing the chance that SFP can reduce household food waste (Chan 2023a). The Fight Food Waste CRC conducted an assessment on the opportunities and barriers for Australia's packaging and processing machinery sector to tackle food waste; the related industry report (Leenders et al. 2021) is a resource that industry can consult during product-packaging design.

3.7.8 *Emphasise save food packaging's role in a sustainable food system*

In recent years, conversations on packaging sustainability have increased within the food/beverage-packaging industry, consumers, researchers and government (Chan 2022a, 2022b). This conversation has primarily focussed on the long-term physical polluting impacts of packaging, resulting in a focus on lightweighting, recyclability, compostability, and other ways to increase the 'material sustainability' of packaging. This is reflected in the 2025 National Packaging Targets established in 2018 and made mandatory in 2023 as part of legislation to reduce waste (Plibersek 2023). Consumers are increasingly aware about the 'material sustainability' impacts of packaging but less so about the environmental impacts of wasting food. This lack of awareness can impede industry action to implement SFP (Langley et al. 2020). Within this context, the food/beverage-packaging industry has reported trade-offs between achieving the 2025 National Packaging Targets and the 2030 target to reduce food waste by half (Chan 2023a; Francis et al. 2021; Ryder et al. 2021). As the conversation on packaging sustainability continues, there is an opportunity for researchers and industry bodies (including the AIP) to continue emphasizing to industry and consumers that packaging has a role to play in increasing the sustainability of the food and beverage supply and consumption chain. Ideally, designing packaging to increase material sustainability should not come at the expense of increased food waste if this means greater overall environmental impacts according to many life cycle assessment (LCA) studies (Wikström and Williams 2010, 2023; Williams and Wikström 2011; Wohner et al. 2020). Industry training sessions on LCA of product-packaging can help in this regard. Consumer educational campaigns can also play a role to encourage greater acceptance and use of SFP, important to ensure SFP is effective to reduce household food waste.

3.7.9 *Fostering increased communication and collaboration between researchers, consumers and industry to design and implement SFP to reduce household food waste*

Key information needed to start addressing the barriers associated with the design and implementation of SFP to reduce household food waste effectively is present, but not currently put to full use. This is supported by a disconnect between the insights researchers have recommended based on consumer research on household food waste and the action the food/beverage–packaging industry are taking to reduce food waste through packaging — also known in this research as a ‘research–practice’ gap (Chan 2022a). It is hoped that the insights and recommendations presented in this report can help to reduce this disconnect. There is an opportunity for increased communication and collaboration between researchers, consumers and industry on matters pertaining to household food waste and suitable packaging solutions (Chan 2023a; Hanson and Mitchell 2017). This would help to put the suggestions presented in this report into practice.

Good communication between consumers and food/beverage brands or retailers is important for the full value of SFP to be realised. Consumer ability to benefit from SFP depends on a willingness by food/beverage brands to invest in SFP, which in turn partially depends on consumers demonstrating willingness to purchase. Moreover, consumer willingness to purchase SFP relies on consumers being convinced that they will benefit from SFP and being able to identify this SFP. Food/beverage retailers and brands can play a key role to communicate this information to consumers. There is therefore an opportunity for food/beverage brands and retailers to coordinate ways to communicate relevant information to consumers. Food/beverage retailers could focus on the benefits of reducing food waste, priming consumers to receive information on how SFP can help. Taking a broader view, there is also an opportunity for government to simultaneously support a consumer campaign on reducing household food waste; Stop Food Waste Australia (now End Food Waste CRC) is working toward a national behaviour change campaign as a coordinated step to do this (Stop Food Waste Australia 2021). While the challenge of achieving such coordinated communication and collaboration is acknowledged, in the United Kingdom a success in doing so has played a part in significantly reducing household food waste in ways that have benefitted food/beverage brands, retailers, consumers and even local governments (Hanson and Mitchell 2017). Synergy in communication and collaboration between consumers, food/beverage brands, retailers, and government in promoting and adopting SFP can pave the way for a more sustainable future with significantly reduced food waste.

To effectively reduce household food waste through SFP, it is important for food beverage brands to listen to consumers' packaging needs and demonstrate a willingness to act upon them. Given the many functions that packaging needs to fulfil across the food and beverage supply and consumption chain, it remains a challenge for industry actors to design and implement packaging that aligns with both industry and consumer views and needs (Chan 2023a). Researchers can play a mediating role by gathering and combining insights from consumers and industry to communicate practical opportunities to reduce food waste through packaging, as demonstrated by the research presented in this industry report. When researchers, consumers and industry come together, there is a potential to develop greater understanding and common ground. This connection is beneficial in that it can generate holistic and syncretic insights to drive forward SFP innovations.

4. Conclusions & Recommendations

The Save Food Packaging project has enabled the development of:

- Awareness of the topic within the industry
- A balanced discussion about food waste and packaging waste
- Improved science and research into Save Food Packaging
- Collaboration between industry stakeholders and academia

- Consumer Insight Reports and Findings
- Identifiable underutilised areas within Save Food packaging for the industry to focus on
- Save Food Packaging Guidelines — checklists and resources
- Save Food Packaging Awards — for the ANZ region and globally
- Best Practice award-winning case studies in Save Food Packaging
- Save Food Packaging technical articles, media and podcasts
- AIP Training course on Save Food Packaging design guidelines
- Research and PhD published papers on the subject
- Improved industry knowledge and training within the subject

Recommendations:

- The AIP to use the Save Food Packaging guidelines, checklists and resources to train the industry to embed the 5x principles into their Sustainable Packaging Design guidelines.
- The AIP to continue to showcase new best-practice award-winning examples of Save Food Packaging for the industry to see.
- The AIP to continue to work with RMIT on a new project to further enhance the science and research already developed such as through lifecycle assessment mapping.
- The AIP and RMIT to continue to speak on this topic locally and globally.

5. Impact and Ongoing Monitoring

The expected impacts of this project are that:

- the packaging criteria for reducing food waste meet the needs of and is used by packaging and food technologists/designers/marketers/sustainability managers.
- communication, education and training programs are delivered to industry to demonstrate how to use the criteria and integrate within product-packaging development processes.
- food producers, manufacturers, retailers, and packaging companies are designing innovative save food packaging and communicating this to customers and consumers.
- companies are recognised for their save food packaging innovations through the Australian/New Zealand Packaging Innovation & Design Awards (PIDA) and the international WPO WorldStar Packaging Awards.
- revision occurs, where required, of the criteria for the Australian/New Zealand PIDA Save Food Packaging Special Award.
- contributions are made to consumer education and engagement projects to change the narrative around packaging's role in minimising food waste.
- that ongoing training is provided by the AIP in the Save Food Packaging guidelines
- that ongoing research is developed between RMIT and AIP into the topic as new innovations and designs are developed.

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APPENDIX A – Project Summary

‘Save Food Packaging Criteria and Framework’ Project

KEY POINTS

- The terminology and categories defining Save Food Packaging (SFP) strategies were mapped (across academic and industry publications), tabulated, and cross-referenced to identify synergies, gaps, and misalignments.
 - Surveyed and interviewed industry stakeholders regarding their perceptions of SFP strategies and uptake. Baseline gained across different organisational roles and across different food categories.
 - Development of Save Food Packaging (SFP) design criteria and framework, guidelines, and icons, accompanied by SFP case studies, resources and training materials to support informed food-packaging design to reduce food waste.
 - Completed PhD research that identified opportunities for specific actors and key decision makers within the food/beverage–packaging industry to implement SFP solutions more effectively to reduce household food waste.
- Interplay explored through the case of reclosable and resealable packaging in relation to consumers’ household food storage practices and food waste.

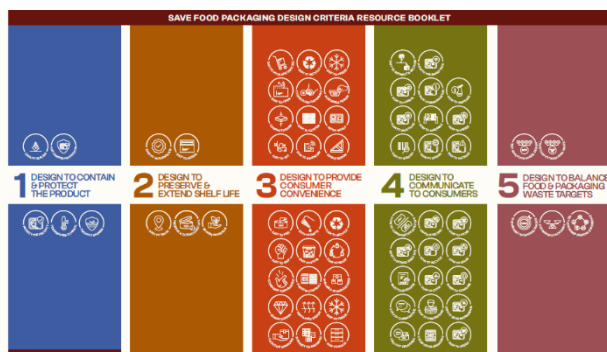


Figure 1. Five Key Criteria Categories (Francis et al. 2024)

THE CHALLENGE

Whilst the primary functions of packaging are to contain, protect and provide information about the product, the overall role of packaging in reducing food waste needs to be better understood by food producers, manufacturers, brand owners, retailers, government and consumers. Finding the right balance between minimising the use of packaging without increasing food waste is a key challenge. Enhancing packaging's role in reducing food waste is the next challenge for packaging technologists, designers, and engineers.

THE OPPORTUNITY

Our project integrated academic research with industry knowledge and experience to develop SFP design criteria and communication material, case studies and training materials. These have been tested by industry stakeholders and provide food and packaging stakeholders with access to guidelines and tools to assist them in their design, selection, and use of packaging materials for food, including appropriate portioning, sealability, resealability features, date labelling, and extend shelf life. In addition it provides the information required to assist retail, food service and consumers to minimise food waste.

OUR RESEARCH

The project was led by the Australian Institute of Packaging (AIP), with research partner RMIT University and an extensive multi stakeholder Save Food Packaging Consortium, partners and an extension network to deliver the project. The Save Food Packaging Consortium comprised ZipForm Packaging, SEE (formerly Sealed Air), Multivac and the Australian Packaging Covenant Organisation (APCO). Project partners were Plastic Technologies, Result Group and Ulma Packaging. The extension network included the Australian Food Cold Chain Council (AFCCC), Australian Food and Grocery Council (AFGC), and Australian Institute of Food Science and Technology (AIFST).

Key activities of the project are summarised below.

Desktop literature review (briefing paper) presented a summary review of academic literature and commercial 'grey' literature, along with recommendations to help inform the review of the current SFP design criteria being used in the Packaging Innovation and Design Awards (PIDA).

Stakeholder online survey - reviewed expert knowledge and perceptions of 95 industry stakeholders in the Australian food industry gathered via an online survey by assessing their current organisational roles and practices regarding food waste concerns and SFP strategies.

Stakeholder interviews - reviewed the expert knowledge and perceptions from 12 stakeholder interviews, representing a range of organisations from the Australian food industry, evaluating current SFP design and system implementation techniques.

Case study development – all SFP award winners from the PIDA awards were interviewed with a series of questions reading their packaging design and the role that it plays in minimising food loss and waste. The case studies are available on the Australian Institute of Packaging (AIP) website and are used on the training course and presentations on the topic.

SFP Criteria development, including design, SFP Consortium feedback/ input, refinement and publication, including: Criteria Resource Booklet, Criteria Icons and Criteria Checklist Sheet.

Training material and workshop - The AIP re-wrote the existing training course that was developed at the start of the project to include the latest statistics, research, findings, reports and data from a global perspective, then regionally within Australia and New Zealand. The detailed checklists and SFP guidelines are the foundation of the training framework and all best practice case studies are used as examples and discussion points within the training.

Embedded PhD Research - provided deeper insight into packaging opportunities for specific actors and key decision makers within the food/beverage–packaging industry to implement SFP solutions more effectively to reduce household food waste. The interplay was explored through the case of reclosable and resealable packaging in relation

to consumers' household food storage practices and food waste.

OUTCOMES

AIP, as Project Leader, have established a voice for SFP within the greater realm of sustainability and packaging design. They are talking to the industry about 'Getting the Balance Right' between Food Waste and Packaging Waste when discussing environmental impacts of product and packaging. 'Getting the Balance Right' has now become a cornerstone of the AIP, and the Institute is extremely proud to see multiple industry players using the same discussion within their networks, including across the world.

Another outcome of this project was that the AIP wanted the 'science' and the 'research' to be able to talk with credibility and validity about SFP. The development of the two industry insight reports was a great milestone of this project. These findings have enabled the AIP to speak to the topic with the backing of research. The findings also enabled the AIP to showcase the underutilised areas within SFP that needed to be further enhanced in the future such as Active & Intelligent Packaging, improvement of date labelling, increased consumer education, embedding on-pack/off-pack labelling and improved use of lifecycle assessment within brands.

The AIP now lead the way as one of the global packaging experts in the role that packaging plays in minimising food waste. The AIP and RMIT and the project are now recognised in all corners of the globe for being leaders in this subject. An unexpected outcome was that the AIP became subject matter experts in not only SFP, but also more general understanding on food loss and waste.

IMPACT

Since inception of the project the AIP has been able to represent the voice for SFP at close to 60 events across the world including the AIP Australasian Packaging Conference, the National Food Waste Summit, WA DPIRD Conference, Food SA Conference, AIFST conference, Waste Expo, FoodTech PackTech New Zealand packaging forums, ProPak Asia (Thailand) Global Packaging Forum, Australasian Waste & Recycling Expo, National Retail Association workshops, APCO webinars, ProPak Philippines Packaging Forum, the FAO Impact Webinar, World

Packaging Organisation webinars and events, Sri Lankan Institute of Packaging webinar, an environmental workshop in Saudi Arabia, Singapore Packaging Federation webinars, European conferences and more. Other highlights include multiple interviews, podcasts and articles on the subject.

One of the main Highlights was being invited to speak at Interpack 2023 in front of FAO, UN and Save Food Org, about our project. This presentation then led to speaking at an FAO impact webinar and work with UNIDO and the World Packaging Organisation.

NEXT STEPS

The AIP will continue to present this topic at all available events and being able to now take the SFP Guidelines into training and workshops is critical to raise the voice within industry.

The project has exceeded initial expectations, and the final guidelines, checklists and case studies enable the AIP to lead from the front, supported by science and evidence. In the next few years, the AIP would like to see even more entries into the Save Food Packaging awards, more ANZ WorldStar award winners and continued development of case studies and Best practice examples of intuitive and innovative packaging.

The next step is for the AIP to help guide businesses into embedding the 5x SFP principles into their own business.

This project is just the start of the AIP continuing to be the subject matter experts in Save Food Packaging design and raising the voice for such an important topic.

PROJECT TEAM

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The Save Food Packaging Consortium has had the following members and we wish to thank everyone for their extensive industry knowledge, expertise and contributions to discussions, workshops, input into the criteria and guidelines throughout the multi-year project: (in alphabetical order) Alan Adams, Warwick Armstrong, John Bigley, David Chacon, Keith Chessell, Barry Cosier, Michael Dossor, Fiona Fleming, David Kilpatrick, Dr Carol Kilcullen-Lawrence, Stuart Lay, Greg Picker, Kylie Ruth, Sophie Sumner, and Tony Whelan.

PROJECT REPORTS/PUBLICATIONS

Francis, C., Ryder, M. & Verghese, K. (2020). Save Food Packaging Design Criteria and Guidelines: Research Literature and Industry Knowledge Review: Briefing paper (unpublished), Fight Food Waste CRC, Adelaide.

Francis, C., Ryder, M., Verghese, K., Lockrey, S., Kelton, N., Save Food Packaging Consortium and Fight Food Waste CRC (2021) Save Food Packaging Design Criteria. Stakeholder Online Survey of Product-Packaging Design Processes. Industry Insights Report. Fight Food Waste Cooperative Research Centre, Adelaide, Australia.

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Francis, C., Kelton, N., Lowenstern, B., Ryder, M., Lockrey, S., and Verghese, K., (2024) Save Food Packaging Design Criteria and Guidelines, End Food Waste Cooperative Research Centre, Adelaide. Australia.

PROJECT WEBPAGE

<https://endfoodwaste.com.au/projects/save-food-packaging-criteria-and-framework/>

APPENDIX B – Supporting Material(s)

Articles regarding the project and Save Food Packaging

<http://aipack.com.au/misconceptions-of-food-packaging-aggravates-food-waste-problem/>

http://aipack.com.au/wp-content/uploads/PKN_Tech_Speak_MA21.pdf

<https://www.packagingnews.com.au/latest/industry-report-lack-of-responsibility-on-food-waste>

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APPENDIX C – Save Food Packaging Criteria

The Save Food Packaging Criteria Resource Booklet is available for access on the End Food Waste Australia website under the "Outputs/Resources/Publications" section of the Save Food Packaging Criteria webpage.

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COOPERATIVE RESEARCH CENTRE

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