VIRTUAL ECONOMICS

*Research article*

# EXAMINING THE MARKET POTENTIAL FOR SMART INTELLIGENT PACKAGING: A FOCUS ON ITALIAN CONSUMERS

*Iza Gigauri, Maria Palazzo, and Alfonso Siano*

**Abstract.** This study addresses the effect of smart intelligent packaging on consumers' perceptions and aims to explore new market opportunities for smart intelligent packaging. Based on a quantitative research methodology, this study is exploratory in nature and aims to determine consumer attitudes toward smart, intelligent food packaging. The research findings show that smart packaging offers new technologies that better satisfy consumers' needs. Italian respondents appreciate the monitoring and tracking functions of food packaging. In addition, different factors of food packaging that lead consumers to purchase are emphasized in our findings. This study confirms that packaging affects consumer purchase decisions. According to the results, although consumers' knowledge of smart packaging technologies was low, their interest in obtaining more information related to smart intelligent packaging was high. Findings indicate that integrating smart packaging with advanced storage systems and technologies designed to prolong product shelf life is a sought-after technological approach for reducing food wastage. However, the research highlights a lack of consumer awareness and understanding concerning intelligent active packaging, hindering its widespread adoption. Therefore, it is recommended to ascertain consumer preferences regarding packaging characteristics to uncover effective marketing strategies. Consumer expectations vary in terms of significance, ranking, and preferences for specific packaging attributes that influence purchasing decisions. The development of smart intelligent packaging solutions has the potential to meet consumers' requirements regarding the features of food packaging, thereby influencing future demand for innovative packaging functionalities.

**Keywords***:* smart packaging; intelligent packaging; marketing; survey; sustainability.

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## 1. Introduction

In recent years, new ways to efficiently manage the supply chain and business processes have necessitated the adoption of progressive technologies for food packaging [1]. Since consumer concern about the freshness and safety of food products has been growing [2], food packaging innovation has expanded towards intelligent packaging. Therefore, food producers, retailers, and other participants in the food supply chain require advanced packaging systems to maintain food quality and allow traceability of products [3]. From a marketing perspective, food packaging represents a communication tool for informing users about products [4]. Marketing affects consumers' perceptions of food, especially in terms of its effect on their health [5-6]. Consequently, food packaging can serve as part of marketing strategies to inform customers about food product attributes using specific symbols, design, and branding [7]. Intelligent packaging systems provide users with information about food conditions and their surrounding environment throughout the food supply chain [8].

Every year, one-third of all food is wasted worldwide, amounting to 1.3 billion tons a year. In the European Union, 131 kg of food waste is generated per inhabitant per year [9]. Food waste causes financial harm to food producers and retailers and urges packaging designers to develop food packaging to protect perishable food during transportation and storage, as well as to enhance its shelf life. In addition, plastic production has increased globally to reach 367 million metric tons by 2020, causing a burden on the ecosystem [10]. However, only 19% of the plastic waste is recyclable [11]. Manufacturing processes have been changing from a linear to circular economy from "produce - use - throw away," to "recycling - reduction - reuse- recovery" recycling-reduction-reuse-recovery [12]. Packaging materials should be biodegradable to comply with the circularity requirements [13]. In this context, smart, intelligent, and active packaging has emerged. Smart packaging systems for food products have evolved to respond to increasing demand from consumers and other actors in the food supply chain, as they promise a safer supply chain while decreasing food loss and avoiding excessive logistics processes [14; 15].

Smart packaging systems involve sensors, indicators and communication systems to monitor, gather and transmit information related to the quality and safety of a product [16; 17]. Smart packaging incorporates intelligent and active functions. Active packaging contains additives aiming at improving products' quality and increasing shelf-life [18] while intelligent packaging does not directly influence the product but enhances communication function by detecting, collecting, and communicating about the environment inside and outside of the packaging [19]. The European Commission describes intelligent food packaging as a material that aims to detect the quality of food inside the packaging to improve the environment around packaged food [20]. Legal regulations (EC No 450/2009) related to active and intelligent food packaging in the EU market provide a list of substances that can be contained in active or intelligent materials and articles [20]. The Commission Regulation (Article 3) also defines active and intelligent food packaging as "(a) materials and articles that are intended to extend the shelf-life or to maintain or improve the condition of packaged food; they are designed to deliberately incorporate components that would release or absorb substances into or from the packaged food or the environment surrounding the food; (b) 'intelligent materials and articles' means materials and articles which monitor the condition of packaged food or the environment surrounding the food" [20].

Food producers need to obey stricter legal requirements for smart intelligent packaging in the EU markets than in other parts of the world [21]. Brennan and Crandison concluded that while smart packaging was approved in the USA, Australia, and Japan, it was not established in Europe, perhaps because of the lack of knowledge of its benefits or characteristics [22]. Other scholars echoed this by stating that European customers were less interested in adopting intelligent food packaging [23], as consumers can be generally careful and restrained from accepting innovative solutions [24]. However, prior studies confirmed that the components associated with intelligent packaging, such as information on the ingredients, legislation, brand, and other technical features, also play a significant role for consumers [25–27].

The importance of the topic has also been confirmed by an increasing number of recent publications lately [3]. Italy is among the top five countries publishing smart food packaging (56 publications) in the Scopus database between 1986 and 2022 [28]. Thus, smart packaging is a vibrant research area with constant progress and commercialization. The smart packaging market represented USD 35.92 billion by 2022 and is estimated to increase to USD 60.49 billion in 2032 [29].

Notably, developing and manufacturing smart intelligent packaging can be challenging from a marketing standpoint because it involves high costs that increase its price and, consequently, make it difficult to commercialize [4]. Device malfunction is another serious issue to be solved, and incorrect signals or unforeseen responses of technologies must be controlled to increase the reliability of sensors [30; 31]. Therefore, this field requires comprehensive examination.

Similarly, scholars have highlighted the importance of studying innovative packaging systems from the consumers' point of view [32]. As consumption behaviour is constantly evolving under the conditions of globalization and digital technologies, consumer attitudes should be explored [33] concerning cultural, social, demographic, product, and industry differences [34; 35].

Therefore, this study is devoted to the smart intelligent packaging concept and its commercial potential in the Italian market. Our research aims to investigate consumers' perceptions, attitudes, and awareness towards smart intelligent packaging. The study intends to explore attributes and features of smart packaging systems, which influence consumers' choices of food packaging. Based on the research aims and literature review, the following research questions were formulated to guide this study.

RQ1. Are Italian consumers willing to accept smart, intelligent packaging for food products?
RQ2. Do Italian consumers have information about innovative packaging systems for food products?
RQ3. What attributes and features of smart, active, and intelligent packaging influence consumers' choices of food packaging?

The intelligent packaging market has a growing perspective. However, marketing activities are necessary to inform consumers about innovative solutions for food packaging systems. Therefore, our research explores the market perspectives of smart intelligent packaging for food products by applying a survey method in the Italian market as a case study.

This research contributes to understanding consumers' awareness and behaviour towards smart intelligent packaging and offers original insights related to the market potential of smart packaging systems. While examining packaging, previous studies neglected the market potential and consumers' expectations for smart intelligent packaging, which gave rise to our research. Since consumer expectations vary in terms of significance and preferences for certain packaging attributes that ultimately influence their buying behaviour, smart intelligent packaging has the potential to satisfy consumers' demands for food packaging features and functionalities. Moreover, as a marketing communication tool, smart intelligent packaging can meet consumers' needs for food packaging. In addition, raising consumer awareness of smart packaging solutions will increase demand and improve consumer experience.

This paper is structured as follows. Section 2 reviews the related literature. Section 3 presents the research methods, including sample selection, data collection procedures and survey process. Section 4 reports the empirical results. Section 5 discusses the findings and their implications. Section 6 provides concluding remarks, describes research limitations, and suggests future study avenues.

## 2. Literature Review
### 2.1. The emergence of smart intelligent packaging

Since its appearance, smart, active, and intelligent packaging has attracted the attention of consumers and manufacturers. Packaging plays a significant role in marketing as it affects consumer attitudes towards products and brands [36]. Although packaging is a well-known "silent salesman" and an increasingly used marketing tool [37], it has attracted limited studies as a communication tool in comparison to other communication channels [38].

Food packaging raises consumer interest by producing sensory or hedonic anticipation [39]. Shape, colour, design, and label influence consumer perceptions and buying intentions [40]. For this reason, marketers use food packaging to affect consumer expectations, thereby influencing their purchase decision-making [41]. Thus, packaging is viewed as a source of competitive advantage [42]. Companies persuade consumers through packaging to prefer their products; hence, packaging influences their buying decisions as a differentiation factor. The food packaging sector has developed along with new technologies that enable innovations to improve food quality and safety. Food products require tailored packaging that meets their unique requirements towards the physical, biological, and chemical environments [43]. To this end, food packaging must maintain food quality during storage or transportation and prevent physical, biological, chemical, and other contamination [44]. Therefore, food packaging must preserve food freshness. In addition, food packaging protects, covers, communicates, and enables the logistics of products [45]. Notably, different companies in a supply chain have different priorities. The main challenge is to align these packaging functions while balancing economic, ecological, ergonomic, and legal requirements [45]. Smart, active, and intelligent packaging systems enhance packaging performance by monitoring internal and external environments. The intelligent features detect, track, record, and communicate any changes in the food inside the packaging [46] Electronic devices monitor products to improve the quality and safety of foods until they reach end consumers and increase their shelf life [47] Smart intelligent packaging technologies are particularly applicable to perishable food products and are mostly used for fruits, vegetables, meat, poultry, and milk products [43]. In particular, meat

products are prone to spoilage because their environment attracts microorganisms that pose health risks to consumers [48]. It should be emphasized that smart packaging can contribute to the implementation of food management systems such as Hazard Analysis and Critical Control Points (HACCP).

Intelligent packaging gathers and maintains reliable information through indicators, sensors, and other devices about the product, its origin, expiry date, nutrients, transportation, and storage conditions, as well as microbial or chemical changes; consequently, it can prevent food waste while improving traceability [49]. Thus, intelligent technologies are considered communication tools. Smart, active, and intelligent packaging systems act not merely as a shield for foods to protect against damage, contamination, or hazards, but they can also monitor the product and inform users about its quality and freshness [43]. Furthermore, smart packaging not only allows consumers to receive product data but also informs them about how to store and dispose of the product [50]. Thus, innovative packaging systems expand consumers' experiences and satisfy their communication needs [43]. Moreover, packaging should avoid food waste, reduce packaging waste, and enable efficient logistics in the food supply chain [51]. In this regard, innovative packaging systems have the potential to reduce food and packaging waste.

## 2.2. Technological features in Smart Intelligent packaging

Smart intelligent packaging involves sensors, indicators, and data carriers to detect and transmit signals regarding the physical or chemical information in the packaging [31]. Food sensors monitor the quality and safety of food products, thereby reducing food loss and waste [4]. Intelligent packaging systems with sensors can prevent premature food spoilage while detecting potential damage. Using RFID (radio frequency identification (RFID) in packaging has recently increased the traceability of a product. This technology uses tags to automatically transmit real-time information. It intends to benefit food producers, distributors, and retail chains to ensure food quality and safety. Previous studies have demonstrated that RFID technology can be advantageous in the retail industry for food products [52-53], as well as for tracing a product [54], increasing productivity, reducing costs, and improving customer service, particularly for perishable foods throughout the supply chain [55-56]. RFID tags enable consumers to receive information about food production, which helps them make purchase decisions. Furthermore, smart technologies in food packaging can reduce consumer complaints, increase the fulfilment of food safety regulations, prevent product recalls, and improve quality and security [57].

## 2.3. Consumer preferences for food packaging

Recent studies have confirmed that consumers are mostly dissatisfied with existing food packaging [58]. Consumer demand for natural food without additives is growing, leading to the need for new packaging solutions that preserve food safety [43]. Packaging features, including design, label, capacity, transparency, sustainability, and usability, can increase consumer perceptions of food products [59]. Gandhi et al. [60], utilizing computational language models to explore the media coverage of superfoods, established an interest in the healing effects of foods. Their results showed that people pay attention to nutrients, health benefits, physical appearance, and retail strategies of food products, as there is constant discussion in online channels about diet [60; 61]. Therefore, packaging labels are important indicators of showcasing food properties and quality [61].

The packaging evaluation process must ensure the security of the packaging and the capability of product protection during distribution. This is cost-intensive, as sequences of different laboratory tests must be conducted for the packaging design. Esfahanian and Lee [62] examined packaging performance during distribution by analysing consumer review comments on e-commerce platforms using sentiment analysis. They suggested that packaging designers should use this method to identify packaging design issues and risks. Packaging designers should detect packaging failures at an early stage to ensure packaging performance. Intelligent packaging systems offer the opportunity to facilitate the design and evaluation process of packaging and hence enhance the efficiency of the assessment process of packaging [62].

The results showed that consumer awareness can facilitate the adoption of innovative packaging systems [32]. Informed consumers are more willing to adopt new packaging. Researchers have revealed that information about the advantages of innovative packaging systems positively influences consumer responses [32].  A survey conducted in Iran with a sample of 388 customers investigated the relationship between packaging elements such as shape, size, material, label, and colour on consumers' perception of the usability of packaging influencing impulse buying [25]. The researchers found that the material, shape, and labelling of packaging significantly affect and colour and size have no impact on consumers' perception of the reusability of packaging, while such perceptions positively influence impulse buying [25]. Interestingly, mood and time pressure impact impulse buying, whereas their role in consumer perception is insignificant [25].

### 2.4. Features and functions consumers appreciate in food packaging

Consumer attitudes depend on their evaluation of packaging attributes and perceptions of the importance of packaging features. Food packaging includes the following main functions [63]: containment–transportation, and storage; protection–against pollution, breaking, or damage; convenience–attributes such as size, easy-to-open and to-close, resealable, reusable; and communication–information about products, such as nutritional value and expiry date [64]. The size, shape, and type of food packaging serve various consumer needs [65]. The size and weight of packaging are significant features of transportation efficiency [66]. Earlier studies have shown the connection between packaging features and food purchase decisions. For example, packaging design is related to consumers' choice of food, as they trust packaging to make decisions [41], as packaging design and communication function influence consumers' perception of food quality [67]. The communication feature includes the track-and-trace capability of packaging systems, which can reduce costs and improve logistics [45].

Colour can influence consumers' assessments of food packaging and brand attitudes [36]. Packaging colours can encourage consumers to buy products. Sant'Anna et al. [68] studied the impact of packaging colour on consumer expectations through a cross-sectional study, in which 432 volunteers participated. They revealed that packaging colour can induce expectations and positive emotions among consumers, as colours can evoke consumers' associations with emotions related to a particular food product. Furthermore, prior research has illustrated that packaging colour acts as a visual incentive that influences consumer behaviour [69]. Food labelling allows consumers to receive information about products and to make decisions based on their health or safety requirements [70]. Packaging can signal quality [67], cost [71], and

environmental friendliness through eco-labels [72]. Overpackaging is perceived by consumers as better quality, and hence luxurious [73]. However, consumers are becoming increasingly informed about the waste they generate and appreciate ecological packaging. On the other hand, convenient packaging must protect products against damage, climate change, or contamination.

Djekic and Smigic [74] studied food labels and consumer attitudes in the Serbian market. They found that most food labels are hardly readable for consumers, and they include only basic nutritional information; however, the surveyed consumers require more information on food labels. Additionally, eco-labels are important communication instruments that inform consumers about products and raise awareness of environmentally friendly products and packaging [75]. Pålsson and Sandberg [45] investigated food packaging paradoxes through multiple case studies in Sweden and found that food supply chain companies prefer traditional basic packaging features, omitting convenience and environmentally friendly features, while prioritizing volume and protection functions. Thus, some packaging features are essential for consumers, whereas companies prioritize certain features for performance improvement.

### 2.5. Influence of food packaging on consumer purchase patterns

While some scholars have identified demographic characteristics as influential factors for purchase intention [76], others have found no relationship [77]. However, the literature maintains that age is one of the most important variables influencing buying patterns [78]. Musso et al. [79] studied the impact of consumers of different ages on the buying decisions of private-label food products. The study found that various age groups reacted differently to different factors. However, the price was important for all respondents. Research shows that the younger generation (18–24 years old) focuses more on the healthiness of food [79]. Additionally, the younger generation considers the match between the price and quality of a product [80]. For younger consumers, healthy products are more important, whereas origin and traceability are significant for experienced consumers [79]. The results revealed that the traceability of food products is important for consumers in the 35-54 age group [79]. Scholars argue that product traceability systems are an essential aspect for food retailers to choose suppliers [81]. Based on this criterion, the safety and quality of food can be evaluated [82]. Moreover, through traceability systems integrated into food packaging, retailers can communicate with consumers about brand value, which is particularly important for 33-44-year-old consumers [79]. Recent studies in the Slovakian market have demonstrated that smart packaging affects both younger and experienced consumers [83].

### 2.6. Consumer attitude towards intelligent components of food packaging

Consumer acceptance plays a crucial role in the commercialization of intelligent packaging systems. Studies have demonstrated consumers' concerns about potentially harmful components in smart packaging as well as altering their buying habits [84]. Freshness sensors in contact with food must be safe for food quality and human health [4]. Moreover, consumers should be informed about how to deal with intelligent packaging materials, as their throwing away can cause ecological risks [4]. A recent review of previous studies illustrated that consumer perception and acceptance of smart packaging technologies can be amplified by raising awareness and informing consumers about the benefits of smart intelligent packaging, while also improving packaging technologies [43].

Stoma and Dudziak [21] conducted a survey in Eastern Poland with a sample of 488 respondents and confirmed that the majority of consumers had never heard of innovative packaging systems for food products. Studies performed in Western Poland also demonstrated analogous findings, indicating that despite the availability of active intelligent packaging in the market, consumers' familiarity is still unsatisfactory [85]. Similar results were obtained in Slovakia, highlighting the low awareness of smart intelligent packaging, as the majority of the surveyed respondents claimed that they had never encountered such an idea [86]. Furthermore, researchers have indicated a limited understanding of new packaging technologies among Latvian consumers and have found that respondents possess scarce knowledge of active and intelligent packaging [87]. Concerning age groups, previous empirical studies discovered that people under 18 and over 60 years old reported a lack of awareness of intelligent and active packaging, while knowledge about the topic was higher among middle-aged groups - 26-40 years old and 41-60 years old) [21]. Equally, innovative packaging systems are accepted by 25-45-year-old consumers and millennials [88], while older people have a negative attitude towards smart intelligent packaging [89].

Previous studies have demonstrated that the preferences and attitudes of male and female customers vary [90]. Colours are more important for women than for men, and hence, their perception of packaging attractiveness differs [91]. Women notice food packaging more often than men and take into account information on it [92]. This ability to understand visual signals affects their perception of packaging and products [93]. Consequently, more women than men are informed about smart, active, and intelligent packaging according to the studies [21].

### 2.7. Potential of smart packaging to reduce waste and increase sustainability

Edible food is lost annually worldwide, requiring actions to improve packaging performance by integrating innovative solutions. Packaging systems can reduce food waste in supply chains by accelerating product safety and controlling temperature [94]. For example, innovative edible food packaging, without changing the taste or flavour of a food product, extends shelf life and is environmentally friendly as it reduces packaging waste [10]. On the one hand, more packaging materials are required to protect food as more materials ensure protection during transportation and storage; however, more materials involve increased packaging waste [45], which can cause conflicts between packaging functions when choosing or developing suitable food packaging. Overpackaging is one of the challenges for sustainable development. As packaging serves as a differentiation means for brands to influence consumer purchase intention, changing it may cause alterations in marketing positioning strategies. However, studies have demonstrated the importance of eliminating overpackaging for sustainable development [73].

Green marketing is heightening, and along with green or sustainable packaging, positively influences consumer purchase behaviour and company competitiveness [14]. Similarly, sustainable packaging is made of biodegradable materials, is lighter, and can be reused or recycled [95]. Consumers with sustainability concerns view food packaging as waste [96], whereas plastic, recyclable, and reusable packaging is associated with sustainability [97]. Consumers also value the environmental and social qualities of packaging [98]. Studies conducted by Ganczewski and Jemielniak [99] ascertain that consumers are becoming

increasingly aware of the impact of packaging waste, as the concept of Zero Waste is becoming a trend promoted by social media [99]. Their research confirmed public concern about packaging waste on social media. The researchers analysed 124,077 tweets through the Thick Big Data study and found that discussions about packaging and food packaging are popular with the #zerowaste hashtag. Among packaging materials, the most negative context is surrounded by plastics; positive sentiment occurs with glass and metal in a mixed context, with bioplastics and paper [99]. They revealed that tweets related to food packaging waste prevention mostly used notions of "Reuse" or "Recycling," and not "Refuse."

Retailers in European countries have strived to reduce packaging and food waste [73]. They try to gain customers' interest by promoting green products [100]. However, Jakomin et al. [100] revealed that green packaging is less represented in the Slovenian e-commerce market, although it can strengthen retailers' competitiveness. They concluded that the majority of respondents are eager to pay more for green products; green packaging is important for their purchase decisions; and material, environmental labels, and reusability of packaging are significant attributes for consumers [100]. Study results exploring food packaging showed that consumers are concerned about ecological and sustainability issues when discussing packaging [101-102]. Furthermore, packaging visualization, including its design and illustrations, is an important factor in attracting customer attention and incentivizing buying behaviour [103]. In addition, weight is more crucial for bottles, such as wine bottles, and its shape can signal quality [97]. For instance, a survey of Portuguese consumers showed that they connect a heavier bottle (i.e., packaging) to better wine quality, while there is limited awareness of sustainable light glass bottles [97]. In general, the glass industry is an example of a circular economy that encourages bottle reuse. Consumers have a positive attitude towards the circular design strategy of products using biodegradable materials [104]. Moreover, the cradle-to-grave product design approach represents a burden on the environment, as it depletes natural resources through its concept of "taking, making, and wasting" [3]. In contrast, the cradle-to-cradle approach uses eco-efficient strategies that focus on reducing negative environmental impacts by reusing and recycling materials [105]. However, active packaging materials (additives and coatings) and intelligent devices (indicators, sensors, and RFID tags) are not yet recyclable or reusable because cost-effectiveness is a priority for producers to prevent certain design possibilities [3]. It is expected that intelligent packaging will be developed towards this direction, allowing sustainable solutions for improved food monitoring and safety cost-effectively and sustainably.

### 2.8. Previous studies on packaging applied quantitative survey method

Vasuki et al. [43] suggest conducting surveys to analyse consumer requirements. Furthermore, Li et al. [58] used the employment, marital status, and demography of respondents to test variables concerning smart packaging and to evaluate the rate of acceptance. Jakomin et al. [100] conducted a survey of 134 Slovenian respondents on green packaging using a questionnaire. Musso et al. [79] used a convenience sampling method to collect data and a questionnaire to study consumers' perceptions of food products. Likewise, Sant'Anna et al. [68] and Coutinho et al. [106] applied an online-based questionnaire on the Google Forms platform to survey consumers about packaged food products.

Correspondingly, Table 1 summarizes prior studies investigating packaging that overlooked smart intelligent packaging, its marketing potential, and consumers' expectations, which makes our research a unique contribution.

**Table 1.** Packaging research focus in previous studies

| Authors | Research focus |
|---|---|
| McDaniel & Baker, 1997 | Impact of packaging design on customer acceptance of the product |
| **Underwood et al., 2001; Yang & Raghubir, 2005; Krishna, 2006; Vila & Ampuero, 2007** | Impact of specific packaging elements on purchase decisions |
| Silayoi & Speece, 2004, 2007; Boyce et al., 2008 | Impact of the set of packaging elements on buying decisions |
| Eckman & Wagner, 1994 | Communication function of packages |
| Wansink, 1996 | Packing size |
| Ampuero & Vila, 2006 | Consumer perceptions towards the design of product packing |
| Deliya & Parmar, 2012 | Influence of packaging elements on consumer buying behaviour |
| Gofman & Moskowitz, 2010 | Consumer-driven packaging design |
| Rettie & Brewer, 2000 | Perception of verbal and visual components of packaging design |
| Wang, 2013 | Consumer perception of product quality, product value and brand preference based on food packaging |
| Silayoi & Speece, 2004, 2007; Gallopel-Morvan et al., 2011; Koutsimanis et al., 2012; Azad & Mohammadi, 2013; Vilnai-Yavetz & Koren, 2013 | Packaging as a marketing tool |
| Holmes and Paswan, 2012 | Consumers' response to new packaging design. |
| Escursell et al., 2021 | Evaluation of e-commerce packaging, avoiding packaging waste through new packaging approaches including materials and technologies. |
| Wallenburg et al., 2021 | Impact of packaging on the return incidents in online retailing. |
| Li et al., 2020 | Integrating packaging for perishable food. |
| Ferrara et al., 2020 | Consumers' attitudes and willingness to purchase wine in different packaging are more sustainable than glass. |
| Świda et al., 2018 | Perceptions of older consumers regarding food packaging, in particular, factors that influence them and their purchasing patterns. |
| Zeng, 2022 | Consumer-perceived risks in eco-design packaging. |
| Syrjälä et al., 2020 | Consumers' perception of gamified food packaging and brand engagement. |

Source: Authors based on the literature review

## 3. Research Methods

To answer the research questions and achieve the study aims, this research is based on a quantitative research approach to survey consumer attitudes towards smart intelligent food packaging. The quantitative survey approach was considered the most appropriate for this research. The survey method has been used in recent studies exploring packaging and food products (e.g., [58; 68; 74; 79; 97; 100; 106].

The study is exploratory in nature and uses a pretest market survey approach [107] with a sample size of 80 respondents [108]. Pretests play a crucial role in marketing and management studies for several reasons, such as [109]: (i) they help researchers gauge the existing

knowledge level of participants before any intervention or study begins. This baseline understanding provides a benchmark against which changes or improvements can be measured; (ii) they can reveal areas where participants lack understanding or have misconceptions. This insight allows researchers to tailor interventions or study materials to address these gaps effectively; (iii) their results can inform the design of subsequent studies by highlighting areas of interest or indicating which variables may be most relevant to investigate further. This information can guide the development of hypotheses and research questions; (iv) they can help mitigate response bias by priming participants to think about the topic before engaging in the study. This preparation may lead to more thoughtful responses and a more accurate assessment of knowledge or attitudes; (v) Finally, their results can offer valuable feedback to participants, informing them of their current level of knowledge or skill in a particular area. This feedback can motivate participants to engage more deeply with the study materials or intervention.

Previous studies have illustrated the need for further research on smart-packaging systems [110; 111]. Therefore, this research explores consumer demand for intelligent features and characteristics of food packaging, their understanding and opinion towards smart packaging, and their willingness to pay for smart packaging if they are informed about its benefits. Consequently, the research results reveal the marketing activities required to promote intelligent packaging technologies.

This study was conducted in the following stages. First, the literature was reviewed, and previous studies were discussed. The concept of smart intelligent packaging systems has been explored comprehensively. Next, a quantitative research method was planned and applied. The online questionnaire was prepared in English and translated into Italian to be sent to the consumers (the questionnaire is presented in Appendix A). The results were translated back into English for analysis. Finally, the gathered data were analysed using the statistical program SPSS. A total of 80 valid responses were generated.

The survey was performed through the Internet. The structured self-administered online questionnaire included a cover letter that informed the Italian respondents about the purpose of the research. Informed consent was obtained in writing from all the participants involved in the study. The respondents expressed their consent to voluntarily participate in the survey, although it was anonymous. The link to the online questionnaire was distributed through social media channels. This pilot survey contained closed-ended questions encompassing dichotomous items, multiple-choice and multiple-response questions, as well as 5-point Likert scale items. A 5-point Likert scale is widely used in consumer research as it is easy for respondents to understand [112; 113].

The questionnaire included four parts: the first part collected demographic information; the second part covered questions related to the purchase behaviour of packaged food; the third part examined the items regarding various features of packaging and consumer preferences; and the fourth part asked about smart, active, and intelligent packaging. The respondents were provided with the definitions and pictures of such packaging systems.

Table 2 shows the sociodemographic profiles of the respondents. The majority of survey participants were women (62.5%), in the age group 26-35 (32.5%), and employed for wages

(48.8%). Most respondents have a bachelor's degree (26.3%) and live in cities (30%). Notably, the majority of survey participants buy packaged foods one or more times per week (65%).

**Table 2.** Demographics of respondents (N=80)

| Gender | Counts | % of Total | Employment Status | Counts | % of Total |
|---|---|---|---|---|---|
| Female | 50 | 62.5 % | Employed for wages | 39 | 48.8 % |
| Male | 30 | 37.5 % | Student | 27 | 33.7 % |
| | | | Self-employed | 14 | 17.5 % |
| **Age** | **Counts** | **% of Total** | **Residence** | **Counts** | **% of Total** |
| 18-25 | 22 | 27.5 % | Capital City | 8 | 10.0 % |
| 26-35 | 26 | 32.5 % | City | 24 | 30.0 % |
| 36-45 | 21 | 26.3 % | Large city | 10 | 12.5 % |
| 46-55 | 7 | 8.7 % | Rural area | 5 | 6.2 % |
| >50 | 4 | 5.0 % | Small town | 33 | 41.3 % |
| **Education** | **Counts** | **% of Total** | **How often do you buy packaged foods?** | **Counts** | **% of Total** |
| Undergraduate | 21 | 26.3 % | One or more times per week | 52 | 65.0 % |
| Master's degree | 17 | 21.3 % | One or more times per month | 22 | 27.5 % |
| Doctorate | 17 | 21.3 % | | | |
| High School | 18 | 22.5 % | Every 2 months or more rarely | 6 | 7.5 % |
| College | 7 | 8.6 % | | | |

Source: Devised by the authors.

## 4. Results

The survey results were analysed using descriptive statistics. Most respondents agreed that packaging is important for purchasing food products and foods based on packaging features (Table 3). It should be noted that younger respondents between 26 and 35 years of age agree with the statement that packaging influences their purchase decisions.

**Table 3.** Please rate to what extent you agree or disagree with the following statements (5 – Strongly agree, 4 – Agree, 3 – Neither agree nor disagree, 2 – Disagree, 1– Strongly disagree)

| N = 80 | Mean | Standard deviation |
|---|---|---|
| Packaging is important for purchasing food products | 3.8 | 0.978 |
| I consciously use the food packaging to make a purchase decision | 3.5 | 1.05 |
| I would purchase a food product due to its new packaging features | 3.4 | 1.04 |
| I am influenced by the packaging in my decision to purchase the foods | 3.3 | 1.10 |

Source: Devised by the authors.

Product quality was the most important factor for our respondents (Table 4). Respondents are attentive towards the sustainability of packaging, but the quality of the product is of utmost importance.

**Table 4.** Please rate the aspects of packaging you consider as important when purchasing a food product

| N = 80 | Mean | Standard deviation |
|---|---|---|
| Quality of product | 4.6 | 0.542 |
| Sustainability of packaging | 3.7 | 1.02 |
| Sustainability (eco-friendly) of the product | 3.7 | 1.00 |
| Packaging of product | 3.6 | 0.856 |

Source: Devised by the authors.

Moreover, the survey participants demanded thorough information about food products on packaging, from the expiry date and origin of the product to environmental performance (Table 5). Appearance and design of packaging is less important.

**Table 5.** Important packaging functions for respondents

| N = 80 | Mean | SD | N = 80 | Mean | SD |
|---|---|---|---|---|---|
| Info about the expiry date | 4.5 | 0.744 | Info about storage and transportation of food | 3.5 | 1.16 |
| Info about the origin of food | 4.4 | 0.789 | Size of packaging | 3.5 | 1.06 |
| Info about quality labels | 4.0 | 0.98 | Information about price | 3.4 | 1.11 |
| Easy opening and sealing | 4.0 | 1.12 | The original appearance of the packaging | 3.4 | 1.17 |
| Possibility of re-use | 3.9 | 1.08 | Graphic design | 3.4 | 1.18 |
| Content is easily taken out | 3.8 | 1.02 | Information about helpline | 3.0 | 1.18 |
| Environmental performance | 3.8 | 0.915 | Info about the HACCP system | 3.0 | 1.31 |
| Producer brand | 3.8 | 1.01 | Information about web | 2.9 | 1.19 |

Note: SD – Standard deviation.
Source: Devised by the authors.

The monitoring function and information on packaging about product quality and safety were the most significant for our respondents (Table 6).

**Table 6.** Please rate the following statements (5= strongly agree, 1= strongly disagree)

| N = 80 | Mean | Standard deviation |
|---|---|---|
| I would buy a product in packaging through which I can monitor the food conditions | 4.4 | 0.758 |
| I would buy a product in packaging that informs about the quality/safety of food | 4.4 | 0.675 |
| I would buy a product in packaging that generates less waste | 4.3 | 0.773 |
| I would buy a product in packaging that helps preserve the environment | 4.2 | 0.775 |
| I would buy a product in packaging through which I can track the origin of the food | 4.2 | 0.920 |
| I would buy a product in packaging that gives information on the storage and transportation of a food product | 4.1 | 0.868 |

Source: Devised by the authors.

When asking the direct question to survey participants whether they would purchase a food product in packaging with monitoring attributes, they reconfirmed that they would (Table 7). However, price also played a significant role in this decision.

**Table 7.** The attitude of consumers towards food packaging with monitoring attributes

| Would you purchase a food product in the packaging with monitoring attributes (that can monitor food quality)? | Counts (N=80) | % of Total | Cumulative % |
|---|---|---|---|
| Yes | 42 | 52.5 % | 100.0 % |
| No | 1 | 1.3 % | 47.5 % |
| Don't know | 7 | 8.8 % | 8.8 % |
| It depends on the price | 30 | 37.5 % | 46.3 % |

Source: Devised by the authors.

To evaluate respondents' attitudes towards innovative packaging systems, they had to indicate their level of knowledge on a scale ranging from 1 – 'I am not informed' to 5 – 'I know everything about it'. The results confirmed that the respondents were less aware of smart intelligent packaging solutions (Table 8).

**Table 8.** Knowledge of respondents about smart, active, and intelligent packaging

| N = 80 | Mean | Standard deviation |
|---|---|---|
| Smart packaging systems | 2.9 | 1.24 |
| Intelligent packaging | 2.7 | 1.27 |
| Active packaging | 2.7 | 1.26 |

Source: Devised by the authors.

Respondents agreed that, although they have never bought foods with smart, active, or intelligent packaging, they plan to buy them in the future (Table 9). Although they have less information about smart packaging systems, they prefer the features and functions that are offered by smart intelligent food packaging.

**Table 9.** Experience of respondents towards smart, active, and intelligent packaging *(N=80)*

| Statements to be rated | Mean | Standard deviation |
|---|---|---|
| I have never bought foods with smart, active, or intelligent packaging and I am thinking about buying it sometime shortly | 3.5 | 1.10 |
| I have never bought foods with smart, active, or intelligent packaging and I am definitely planning to buy it in the future | 3.4 | 1.12 |
| I have never bought foods with smart, active, or intelligent packaging because they are not available on the marketplace | 3.2 | 1.33 |
| I have never bought foods with smart, active, or intelligent packaging, and I am not thinking about buying it | 3.1 | 1.30 |
| I buy foods with smart, active, or intelligent packaging but do not regularly | 2.6 | 1.41 |
| I used to buy foods with smart, active, or intelligent packaging but I no longer buy them | 2.2 | 1.41 |

Source: Devised by the authors.

Thus, they consider buying foods in smart, active, or intelligent packaging. Thus, the market potential of smart intelligent packaging increases with the awareness of consumers. Moreover, the majority strongly disagree (n=38; 47.5%) or disagree (n=14; 7.5%) with the statement "I used to buy foods with smart, active, or intelligent packaging but I no longer buy them" confirming that they have no experience in smart packaging. In addition, the majority of the respondents strongly disagreed (n=24; 30%) and disagreed (n=16; 20%) with the statement "I buy foods with smart, active, or intelligent packaging but do not regularly," confirming that most respondents have no previous experience or awareness in smart packaging. Furthermore, they were not aware of whether such packaging is available in the marketplace (n=25; 31.3%). However, they would be interested in purchasing food using innovative packaging systems in the future.

The respondents assessed their attitudes towards smart packaging characteristics, such as RFID, Time-Temperature indicators, and barcodes. The survey included pictures of the mentioned features to assist the respondents in recognizing them. The questionnaire included only the three most known or widespread features of smart packaging systems with which respondents might be familiar. These packaging features could influence their purchase decisions, value perception, willingness to pay, and likelihood of purchase (Table 10). Although the impact is not high, the effect is still appreciable and important.

**Table 10**. Respondents' attitude towards the elements of smart intelligent packaging (N=80)

| Questions | Mean | Standard deviation |
|---|---|---|
| How much would this feature *(barcode)* on food packaging affect your likelihood-of-purchase? | 3.3 | 1.26 |
| How much would this feature *(Time-Temperature indicator)* on food packaging affect your willingness-to-pay? | 2.9 | 1.41 |
| How much would this characteristic *(RFID)* on food packaging affect your value perception? | 2.8 | 1.19 |

Source: Devised by the authors.


## 5. Discussion

Smart packaging integrating active and intelligent packaging enables the monitoring of changes in the product or its environment and reacting appropriately to maintain food quality. The research findings, in conformity with Vasuki et al. [43], show that smart packaging offers new technologies that better satisfy consumers' needs. Italian respondents appreciated the monitoring and tracking functions of food packaging. In addition, different factors of food packaging that lead consumers to purchase are emphasized in our findings. The research confirmed that packaging affects consumer purchase decisions, which is in line with the research results of Bezaz and Kacha [36].

According to our study results, although consumers' knowledge of smart packaging technologies was low, their interest in obtaining more information related to active and intelligent packaging was high, which is in agreement with the research conducted by [114]. Moreover, many respondents did not have an established opinion regarding the questions related to innovative food packaging (response: neither agree nor disagree), confirming their lower level of knowledge and the need for more information to increase their awareness of smart packaging systems. The lack of information explains the respondents' preferences towards more known features of packaging rather than innovative functions. Our results are in agreement with earlier studies reporting that the expiry date and information about food products on packaging is a significant factor for consumer response [115].

It should be noted that the manufacturing of smart intelligent packaging systems is accompanied by high costs that increase product prices. Thus, the expense of packaging is a major challenge for introducing innovative packaging systems in the market. Technological improvements and cost reductions can enhance the marketability of smart packaging. Furthermore, the low awareness of the important benefits of intelligent packaging systems hinders their marketing potential.

According to the findings, consumers are unwilling to pay more for food products in innovative packaging systems, but their acceptance can be increased after their understanding of the benefits of smart packaging technologies. This result supports the findings of previous studies [89]. In addition, consumers' ecological concerns and awareness of the increasing food and packaging waste create conditions for introducing new packaging technologies in the market. The results show that consumers prefer eco-friendly packaging that facilitates sustainability and waste prevention, which is consistent with previous research [3]. Earlier studies in Italy (along with Germany) explored food waste issues through online survey questionnaires and analysed technologies that help reduce food waste [116]. The results have

shown that smart packaging, together with smart cupboards and technologies aimed at extending the shelf life of products, are desired technological solutions to decrease food waste [116]. More recent surveys in Italy conducted in 2022 demonstrated that consumers reduced their food waste during the pandemic [117; 118].

As the findings show, insufficient information and knowledge regarding intelligent active packaging impede its acceptance and adoption by consumers. Accordingly, we suggest identifying consumers' expectations regarding packaging features and attributes to reveal marketing incentives [119]. Consumer expectations can differ in terms of importance, hierarchy, and priorities as well as specific packaging features based on which they make buying decisions. Smart intelligent packaging systems can satisfy consumers' needs regarding food packaging features and therefore shape the future demand for smart packaging functions.

## 5.1. Research implications

This study makes several contributions. It presents a significant insight into how smart packaging technologies influence consumers' decisions and how packaging fulfils communication functions, contributing to the marketing literature. This is essential given the changes in consumer purchase behaviour and the importance of studying the consumers' perspective for marketing decision-making. Moreover, this study enables us to understand consumer perceptions related to packaging features and attributes, reconfirming the significance of information on packaging and the importance of environmental products. This study contributes to the literature by examining the role of innovation in food packaging. This research emphasizes the ability of smart intelligent packaging systems to increase consumer value perception and improve the consumer experience.

At the managerial level, the results highlight smart packaging as an effective communication tool. These results have practical implications for the food, packaging, and consumer sectors. Providing an understanding of consumers' attitudes towards food packaging, their level of knowledge about innovative packaging systems, and their preferences regarding smart packaging features will improve business marketing efforts to reach consumers, create added value, and communicate with target markets. Promotion campaigns need to be implemented to improve consumers' understanding and spread information about the benefits of new packaging technologies, which, in turn, would increase the demand towards smart intelligent food packaging. Furthermore, our research contributes to packaging designers, food producers, and retailers by gaining knowledge regarding consumer demand towards innovative packaging.

Our study suggests that a communication campaign should focus on enlightening consumers about smart intelligent packaging, including how they should dispose of packaging materials. Similarly, marketing communication should be directed towards underlining the quality, safety, environmental friendliness, convenience, monitoring and tracking functions, innovativeness, and new technologies of smart packaging systems aiming to assist consumers in making informed decisions.

Moreover, our research will be beneficial for policymakers to introduce appropriate regulations to support innovations and advanced technologies in the packaging industry, as well as protect consumer rights by ensuring the quality and safety of food products.

## 6. Conclusions, limitations and future study directions

The purpose of this study was to explore the awareness, perception, and attitude of consumers from Italy towards the smart, active, and intelligent packaging of foods. Considering that food packaging is viewed as a communication tool, our research highlights the importance of analysing various aspects of smart packaging systems for consumers.

Food packaging affects consumer purchase decisions and they require relevant information about food products on the packaging. Our research emphasizes, that the lack of information related to smart intelligent packaging impedes its acceptance by consumers. Moreover, packaging systems are costly to produce causing the high prices, which can be a major barrier to its introduction and adoption to the market. The findings demonstrated that consumers are not ready to pay more for foods in smart intelligent packaging. However, their acceptance may increase if they are informed about the benefits of smart packaging technologies. While consumers show less knowledge of smart packaging, their interest in it is obvious. Consumers especially value the monitoring function of packaging which is included in smart intelligent packaging to maintain food quality. In addition, consumers' ecological and sustainability concerns lead to their growing awareness of food and packaging waste, which may boost the demand for intelligent features of food packaging. Thus, smart packaging systems can meet consumers' requirements regarding food packaging functions and therefore shape the market potential of smart intelligent packaging.

The contributions of our study are constrained by a few limitations and provide suggestions for further studies. The limitations of this study include a single-country case considering only Italian respondents. An evaluation of other European countries would be relevant to examine the attitude of consumers towards innovative packaging solutions, taking into account the cultural aspects of the country and the difference in the regulations on intelligent materials.

Despite the significance of our results, they are not necessarily predictive of consumers' buying behaviour towards food packaging. The survey method tests only the views and opinions of respondents but is unable to track actual behaviour. Similarly, purchase intention cannot be interpreted as a reflection of real behaviour. Furthermore, the research used a convenience sample that was not representative but could set the stage for future large-scale studies. While pretesting can provide valuable insights, it also has its limitations: (i) pretests involve a small and potentially unrepresentative sample of the target audience; (ii) results from pretests do not generalize well to the entire population; (iii) participants in pretests provide responses that they believe are socially desirable or align with the researcher's expectations, rather than their true opinions or behaviours; (iv) pretests only capture short-term reactions to a concept or product. Long-term effects, such as, for example, repeat purchase behaviour, may not be adequately assessed; (v) Finally, other external factors such as competitive actions, economic conditions, or unforeseen consumer trends in the packaging sector can influence the actual performance of the product or strategy.

Despite these limitations, our pretest remains a valuable tool in packaging studies, providing early feedback and helping to refine strategies before full-scale implementation of smart packaging. Moreover, the survey was based on a self-administered online questionnaire that made it impossible to determine the honesty of the responses. In addition, the study used

photographs of certain features of smart intelligent packaging. However, a real presentation of such packaging could generate valuable insights into consumer perceptions and intentions. Despite these limitations, the findings are worthy, as they describe consumers' understanding of food packaging features and attitudes towards smart intelligent packaging systems.

Further research exploring consumer requirements and market demand not only in the food market, but also in cosmetics, pharmaceuticals, and other products should be conducted in different countries. Moreover, studies related to improving packaging technologies should be extended to achieve cost-effectiveness, minimize risks, and refine systems. Although Smart intelligent packaging supports food safety and reduces food waste, it can increase packaging waste and the associated risks with intelligent materials. Future studies should address this issue from different perspectives. Further research can also focus on the commercialization issues of smart packaging technologies from different perspectives, ranging from packaging designers and manufacturers to retailers and consumers. In addition, replications of this study can be conducted for diverse product categories, such as cosmetics, pharmaceuticals, toys, and fashion clothing. Similarly, the potential of smart, active, and intelligent packaging in the service industry to enhance competitive advantage can be examined. Finally, positioning strategies and segmentation possibilities should be explored for intelligent packaging by analysing different variables such as lifestyle, habits, and social groups.

## Appendix A. Intelligent Packaging Survey

We invite you to participate in a research project conducted by Georgian and Italian researchers. The purpose of this survey is to explore Intelligent Packaging from Consumers' Points of View. If you decide to participate, you will be asked to complete an anonymous web-based survey. The survey includes 4 sections and should take no more than 8 minutes. The survey collects no identifying information from any respondent. Your participation in this survey is voluntary and you are free to withdraw your participation from it at any time. The survey results will be used for academic purposes. By completing and submitting this survey, you are indicating your consent to participate in this research. Your participation is greatly appreciated.
Thank you for your participation.

### Section 1. Demographics

| What is your gender? | What is your age? | Your place of residence: |
|---|---|---|
| Female | Under 18 | Rural area |
| Male | 18-25 | Small town |
|  | 26-35 | City |
|  | 36-45 | Large city |
|  | 46-55 | Capital City |
|  | Over 50 |  |

| What is the highest level of Education you have completed? | Employment Status |
|---|---|
| Graduated from High School | Employed for wages |
| Graduated from College | Self-employed |
| Professional Degree | Out of work |
| Bachelor's degree | Student |
| Master's degree | Other |
| Doctorate |  |

### Section 2. Packaging

How often do you buy packaged foods?
One or more times per week
One or more times per month
Every 2 months or more rarely
Other:

To what extent do you agree or disagree with the following statements? Please rate all questions: 5= Strongly agree, 4= Agree, 3= Neither agree nor disagree, 2= Disagree, 1= Strongly disagree
I consciously use the food packaging to make a purchase decision
I am influenced by the packaging in my decision to purchase the foods
Packaging is important for purchasing food products
I would purchase a food product due to its new packaging features

What aspects of packaging do you consider as important when purchasing a product? Please rate all questions: 5= Extremely important, 4= Very important, 3=Important, 2= Somewhat important, 1= Not at all important
Quality of product
Packaging of Product
Sustainability (eco-friendly) of the product
Sustainability of packaging

To what extent do you agree or disagree with the following statements? Please rate:
5= Strongly agree, 4= Agree, 3= Neither agree nor disagree, 2= Disagree, 1= Strongly disagree
I would buy a product in packaging that helps preserve the environment
I would buy a product in packaging that generates less waste
I would buy a product in packaging through which I can track the origin of the food
I would buy a product in packaging through which I can monitor the food conditions
I would buy a product in packaging that gives information on the storage and transportation of a food product

I would buy a product in packaging that informs about the quality/safety of food

**Section 3. Packaging functions**
What elements of packaging do you take into consideration during the purchase process of food products? Please rate:
5= Extremely important, 4= Very important, 3=Important, 2= Somewhat important, 1= Not at all important
Environmental performance
Information about the webpage
Information about the recommended price
Information about the helpline
Information about the HACCP system
Information about the expiry date
Information about quality labels
Information about the origin of the food product
Information about the storage and transportation of the food product
Producer brand
Content is easily taken out
Easy opening and sealing
Possibility of re-use
The original appearance of the packaging
Graphic design
Size of packaging

Would you purchase a food product in the packaging with monitoring attributes (that can monitor food quality)?
  Yes                          No                          Don't know                          It depends on the price

**Section 4. Smart, Active, and Intelligent Packaging**
Please indicate your level of knowledge on innovative solutions for packaging: 5= I know everything about it, 4= I am well informed, 3 = I am informed, 2= I am somewhat informed, 1= I am not informed
Smart packaging
Intelligent packaging
Active packaging

To what extent do you agree or disagree with the following statements? 5= Strongly agree, 4= Agree, 3= Neither agree nor disagree, 2= Disagree, 1= Strongly disagree
I have never bought foods with smart active intelligent packaging, and I am not thinking about buying it
I have never bought foods with smart, active, or intelligent packaging and I am thinking about buying it sometime shortly
I have never bought foods with smart, active, or intelligent packaging and I am definitely planning to buy it in the future
I used to buy foods with smart, active, or intelligent packaging but I no longer buy them
I buy foods with smart, active, or intelligent packaging but do not regularly
I have never bought foods with smart active intelligent packaging because they are not available on the marketplace

How much would this characteristic (on picture: RFID) on food packaging affect your value perception?
Will not affect (1) ------ Will affect (5)

How much would this feature (on picture: Time-Temperature indicator) on food packaging affect your willingness-to-pay?
Will not affect (1) ---------- Will affect (5)
How much would this feature (on the picture: barcode) on food packaging affect your likelihood-of-purchase?
Will not affect (1) ------- Will affect (5)

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