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A QR code as a communication medium for food companies: how to communicate sustainable practices through packaging.

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INTRODUCTION

This paper will explore the role of sustainability information in the food packaging industry. Despite the growing interest in sustainability, especially from younger generations, such as Gen Z and Millenials, and companies, the aspect of how it is displayed on packaging is still under-researched. In particular, it aims to investigate the most effective way to communicate sustainable claims and sustainable food certifications using the limited space available on packaging. In recent years, many food manufacturers have taken steps to make production processes in the supply chain more environmentally sustainable. The implementation of sustainable techniques is increasingly necessary in view of progressively worsening environmental conditions due to pollution. Moreover, the food, and food packaging, sectors are among the most environmentally harmful due to CO_2 emissions and the amount of different plastics used. The change is also dictated by the same demands of the "new" consumers, who claim to know the origin of products and manufacturing and distribution techniques. The study stems from the need to shed light on information regarding sustainability in an era when laws are constantly changing and consumers are overwhelmed by the amount of claims and certifications posted on packaging. In particular, a new packaging prototype with a widely applied techonological tool, the QR code, is studied as the most effective means of conveying sustainable initiatives. Therefore, this study will investigate whether the type of communication for sustainable information applied to packaging, causes different behaviors in consumers, specifically their purchase intention. The mediating effect of consumers' trust in sustainable communication (claims and certifications) in the food industry and in the companies themselves will also be considered. To summarize, this research examines whether packaging displaying a QR code containing relevant sustainable information positively influences consumers' purchase intention and whether this relationship is mediated by the latter's degree of trust toward sustainable certifications and the producing company.

The findings are drawn from a study conducted on a sample of 200 respondents and analyzed on SPSS software. The hypotheses were tested by empirical quantitative data showing that the majority of the sample perceived the information grouped in the QR code as clearer and more trustworthy, also increasing the level of trust towards food certifications. Clearer communication of the sustainable side was also found to support a higher propensity to purchase, reaffirming the also strategic relevance of green certifications within an increasingly confusing and competitive scenario. There are several implications, both theoretical and managerial, especially for SMEs seeking to rise to prominence in large-scale food retailing with restrained packaging interventions. Limitations of the paper that future research will need to overcome are also present.

CHAPTER 1: OVERVIEW OF THE FOOD SUSTAINABILITY SECTOR

Overview of packaging and its environmental impact

The climate has changed significantly over time, it is a global threat that has started to strain several industries. Climate change and biodiversity loss are two examples of the permanent environmental repercussions of human activity (Kan & Miller, 2022; Springle et al., 2022). In our day of rampant consumerism, a major portion of each person's ecological footprint is derived from their consumption of goods (Rezaei et al., 2019). Research on sustainability has recently switched its emphasis from the business level to the entire supply chain (Tay MY, 2015). Making all the decisions in a supply chain more sustainable is the result of considering sustainability. Many academics have concluded that taking sustainability into account while developing food-related goods is an extremely significant topic (Duizer et al., 2009; Lange & Wyser, 2003). To achieve more sustainable lifestyles, it is critical to produce and consume greener products. Concepts of sustainable packaging have developed in tandem with the growing application of sustainable development principles within industrial and organizational frameworks at various levels, because of the endorsement of the circular economy's tenets and the adoption of its production models in business (Rezaei et al., 2019). The execution of international policy efforts like Agenda 2030 which aim to spread the idea of sustainable development has also made a significant contribution in this area.

The Symbola Foundation and Unioncamere's 13th GreenItaly report demonstrates Italy's progress toward the green economy. As the nation began to recover from the Covid-19 pandemic in 2021, the proportion of businesses investing in the green economy increased by 2.9%, from 21.4% in 2020 to 24.3% in 2021. This represents 42.5% of *manufacturing* companies and 40.6% of businesses engaged in the *industrial* sector. There were 531,000 businesses focusing on environmentally friendly technologies and goods over the five-year period of 2017–2021, up 51% from the prior five years (2014 - 2018).

But from a worldwide standpoint, the National Geographic Society reports that in 2020 the availability and wide diversity of plastic packaging continue to be the recycling industry's main Achilles heel. More plastic garbage is produced by product packaging than by any other sector.

By weight, they make up 59% of all plastic garbage in Europe. According to experts, this percentage is likely closer to 65% in the United States. The 640 billion dollar sector of worldwide packaging is expanding at a rate of 5.6% annually.

Packaging is the largest market segment for plastics in the US, accounting for a third of this. The volume of plastic packaging and containers, particularly, in the United States, has gradually increased and reached 13 million tons in 2018. (United States Environmental Protection Agency, 2020). The production of packing creates a lot of waste and pollution since it consumes a lot of energy and water (Deshwai et al. 2019). Globally almost 40% of all plastic consumption is accounted for by packaging (Geyer et al., 2017).

The packaging sector is being impacted by plastic pollution, packaging waste, diminishing air, soil, and water quality, climate change, and other modern problems (Deshwal et al., 2019). Because most food packaging is single-use only and discarded after a short time, the current packaging waste management sector lacks circularity (Geueke et al., 2018). The sustainability of packaged foods is hampered by these environmental issues brought on by food packaging. Due to its fluidity, moldability, heat salability, ease of printing, and ability to be incorporated into manufacturing processes, plastic is a material that is still frequently used for food packaging (Marsh & Bugusu, 2007).

Indeed, introducing environmentally friendly food packaging is one way to address the waste issue, but obstacles like value chain complexity (Seuring & Müller, 2008) and unfavorable consumer perceptions (Norton, et al., 2022) due to economic, social, and environmental demands towards sustainable behavior, can prevent businesses from implementing more sustainable packaging. It is challenging to determine the market share of sustainable packaging because the field is still ill-defined, and its boundaries are still hazy. Moreover, there are misunderstandings about what constitutes sustainable packaging (Nordin & Selke, 2010). Yet, there is no widely accepted description for them, and terms like "eco-friendly," "sustainable," and "green packaging" are frequently used to refer to them (Orzan et al., 2018).

Blurred boundaries also emerge from a regulatory point of view because the laws themselves are not aligned on how levels of pollution in packaging are uniformly established. Businesses and policymakers have responded to rising consumer demand for sustainability initiatives by realizing a crucial common value. The Sustainable Packaging Alliance developed a goals database that listed the packaging sustainability objectives of numerous companies (SPC’s Goals Database, 2023). For instance, several businesses, such as McDonald's, Unilever, Nestlé, Kraft-Heinz, PepsiCo, and Coca-

Cola, established goals in action plans to increase their packaging sustainability by 2025 (Boz et al., 2020).

According to a Mckinsey study's results published in the article *True packaging sustainability: Understanding the performance trade-offs* (2021), attempts to create sustainable packaging frequently center on reducing leakage, enhancing circularity, lowering carbon footprints, or a combination of the three. There is no universal agreement on how brand owners, merchants, and regulators should practice sustainability, despite their awareness of the necessity. In order to enhance their overall corporate sustainability performance, major consumer-facing corporations recently announced bold goals to attain zero or drastically reduced greenhouse gas (GHG) emissions. Their packaging focus has, up until now, primarily been on increasing recycled content and boosting recyclability. It has become clear that there is not always a clear correlation between reduced emissions and more recyclability by using an end-to-end approach to the value chain and a scientific technique to assess emission profiles (Mckinsey, 2021).
One key finding, which is not always well understood by consumers, companies, and regulators, is that the lowest-carbon material does not always have the highest recyclability or use of recycled content, requiring a decision on which aspects of packaging sustainability get prioritized. (Mckinsey, 2021).

On the other hand, we have the consumers, the real players in the social action toward a more sustainable world (Otto et al, 2021). They are increasingly careful and demanding, and they tend to inform themselves more and more before purchasing, given that they are increasingly faced with prohibitive choices both from an economic and environmental point of view (Lin & Chang, 2012). Although there is an increasing focus on the environmental aspect of sustainability and sustainable packaging (Otto et al, 2021), not all food packaging falls under this umbrella. Magnier and Crie (2015), came to the specific conclusion that customers view environmentally friendly packaging as having a *"design that evokes clearly or implicitly the eco-friendliness of the package"*. Manufacturers' implementations towards more sustainable packaging must be matched by a positive attitude on the part of consumers (Rezaei et al., 2019). Customers anticipate sustainable packaging to be built on a circular economy, to be made of natural materials and designs, and to be viewed as being recyclable (Otto et al, 2021).

Another key contributor to global food pollution is the transport of food around the world. Transporting food from far-flung regions of the world emits greenhouse gases that contribute to at

least 30% of global pollution. This is the conclusion of a recent research study published in the Journal Nature Food (2022), which demonstrates how our eating habits, which are still based on products frequently imported from remote locations, are burdening our world disproportionately (Pradhan, 2022). According to a statement from the Food Nature report, *"...the global transit of commodities linked with eating fruit and vegetables produces 36% of the emissions of food miles, about twice as much as is generated during their production"*. The discussion that has taken hold in recent years on the consumption of locally sourced products stems not only from the need for higher quality food but also from a reduced environmental impact. Fuel combustion for domestic civil aircraft, ground transportation, rail travel, domestic waterborne navigation, and other modes of transportation results in emissions of CO_2, CH_4, and N_2O (Tubiello et al., 2021).

Tubiello et al. (2021) estimated these emissions per country during the period 1990-2018 as a fraction of the transport emissions reported by a version of the PRIMAP dataset with higher sectoral resolution (Gütschow et al 2021). Food transport activity data and emissions factors for the United States, China and the European Union represent roughly 50% of world-total transport emissions, according to PRIMAP (Gütschow et al 2021).

Consumers are confused by labels populated with green certifications, sustainable claims, mandatory nutritional values, and recycling claims. There are differences unknown to consumers between voluntary environmental, social or animal welfare and ecological certifications, PDO or PGI labels referring to the origin of food, and mandatory hygiene/health certifications. Retailers must find an effective way to convey the promise of sustainability and the use of sustainable practices to consumers.

This study aims to explore how retailers can communicate their efforts to achieve better levels of sustainability.

Sustainable Packaging

Packaging definition

Packaging should be viewed as a system with three levels (Garcia-Arca & Prado, 2008); the primary, or *consumer packaging* level, is the first and serves to safeguard the goods. The secondary level, sometimes referred to as *transport packaging*, is made to house and collect many primary packages. The third level of packaging is called *tertiary packaging*, and it consists of a number of primary or secondary packages stacked on a pallet or a road unit.

An enumeration of all possible functions could serve as another method of defining *packing* (Lutters & Klooster, 2008). The three main purposes of packaging are to *preserve the goods* within, *enable distribution*, and *provide information* about the product inside to all parties involved in the packaging process. In addition, packaging should improve our quality of life by making it safer (e.g., by being indestructible), more pleasant (e.g. user friendly), and healthier (e.g. bio-based raw materials). Hence, a crucial aspect of packing is that it be appropriate for purpose. Moreover, the level of materialization and any other duties that the package performs are crucial (Lutters & Klooster, 2008).

The following characteristics of packaging should be included in the definition, according to experts (Wyrwa & Barska, 2017):

- Protection of a product throughout use, storage, and transportation operations, as well as, in some situations, protection of the environment from the product's potential negative consequences
- Simplifying the process of producing, selling, and using goods
- Necessary details on a product, especially regarding its suitability for consumers
- Psychological effect on a potential buyer caused by effective product presentation.

Packaging, therefore, turns out to be the tool that allows the product to make itself available in space, reaching consumers' homes starting from the places of production, passing through the points of sale. In this, sometimes very long chain, packaging accompanies the product allowing it access to the goods circulation system (Rezaei, et al., 2018).
From a regulatory point of view, in Italy packaging is defined by Art. 218 of Legislative Decree of 3 April 2006, no. 152 - "Environmental Regulations" (ex. Legislative Decree 22/97) as: *"The product, composed of materials of any nature, used to contain and protect certain goods, from raw materials to finished products, to allow their handling and delivery from the producer to the consumer or user and to ensure their presentation, as well as disposable items used in the same way."*
Within this legislation it is clearly defined what can be considered packaging and what cannot through a number of further specific clarifications: *"Items which fall within the above definition are considered to be packaging, without prejudice to other possible functions of the packaging, unless such items are an integral part of a product and are necessary to contain, support and preserve that product throughout its life cycle and all items are intended to be used, consumed or disposed of. [...] Items designed and intended to be filled at the point of sale and disposable items sold, filled or designed and intended to be filled at the point of sale are considered to be packaging provided they fulfil a packaging function. [...] Packaging components and ancillary elements integrated into*

packaging are considered to be an integral part of the packaging. Ancillary elements directly attached or attached to the product, and which perform a packaging function are considered to be packaging unless they are an integral part of the product, and all elements are intended to be consumed together. [...]".

Packaging has positive and negative impacts on the environment. The negative impacts have already been discussed extensively and relate to resource use and the environmental effects of packaging-related waste and emissions. Packaging reduces waste in two important ways, stemming from its function as a processor (Kohan, 2000) and protector (Pongrácz, 2007). Firstly, it makes food processing more effective. This can be best illustrated with a straightforward example: When consumers went to the butcher for chicken 50 years ago, the butcher discarded 750 kg of feathers, viscera, and other garbage for every 1,000 chickens sold. Today, chicken farmers sell the portions that are edible while turning the remainder into byproducts like feed and fertilizer. The packaging needed to transport 1,000 chickens to grocery stores is only 7.7 kg. Instead of discarding the 750 kg of garbage, that 7.7 kg of packaging makes optimal use of it (Kohan, 2000). Secondly, it keeps food from decaying and necessitating disposal, which creates more trash. Before it reaches the customer, 2% of food in the UK is unfit for consumption; but, in underdeveloped nations, where packing is less common, this loss might approach 40% (Pongrácz, 2007). Food waste has greatly decreased as paper, metal, and glass packaging have increased, but plastic packaging has seen the biggest drops: altogether, for every 1% increase in packing, food waste falls by about 1.6%. (Saberi et al., 2015).
With regard to the environmental consequences of the development of packaging according to consumer needs, it is interesting to report a study by Löfgren and Witell (2005), which combined an empirical analysis of consumer experience of packaging for everyday products with a survey of the literature on the environmental impact of packaging and food. The literature survey showed that many judgments regarding the environmental consequences of packaging do not consider the function it has, to protect food or to decrease the amount of food loss; it is only in recent years that there have been research projects that have demonstrated the large amount of food waste in homes and food institutions avoided through packaging. This is remarkable given that packaging often makes up only a small percentage of the total environmental impact in the food packaging system (Hanssen, 1998). Food losses are between 15% and 30% of the food purchased in Europe and the United States (Quested & Johnson, 2009), but the numbers would be tripled without packaging.
The environmental effect of larger packages is always lower than that of smaller ones, while ideal packaging sizes ensure little product loss and optimum consumer usability (Boz et al., 2020).

Larger packages represent a solution which is not always applicable: recent trends in Finland (Zdunek at al., 2021) indicate an increasing number of one-and two-member households preferring smaller packages. Buying a large pack also carries the risk that the product will not be consumed within the guarantee time and will therefore be disposed of. Although the overall reduction of waste should be aimed at, packaging material cannot be saved at the expense of product deterioration and disposal (Zdunek at al., 2021).

Sustainable Packaging definition

In the European Union, 1130 billion pieces of packaging were used for food and beverages in 2018 (Fuhr et al., 2019). Since 2010, waste generation has grown at an annual rate of 4.2% and is expected to continue at the same rate until 2024. Rigid and flexible plastic is the packaging material with the largest market share, at 47% in 2015 (ALL4PACK, 2016). One way to address the waste problem is to introduce environmentally friendly food packaging (Geueke et al., 2018).

The market share of green packaging is difficult to estimate, however, as there is no common definition and there are many synonyms such as 'eco-friendly', 'sustainable' and 'green packaging' (Prakash & Pathak, 2017).

According to the comprehensive analysis of food packaging and future trends developed by Han et al. (2018) the definition of sustainable or green packaging covers three levels: *raw materials; production processes; and waste management.*

To reduce the usage of oil and its negative effects on the environment, the authors promote the use of recycled materials and renewable resources for raw materials. Energy-efficient manufacturing techniques should be used to create green packaging, and the packaging itself should be as light and thin as feasible. Packaging should be recyclable, reusable, or biodegradable at the end of its life cycle (Han et al., 2018).

According to Steenis, et al. (2017), packaging design involves a combination of structural (e.g., materials), graphical and verbal (informational) elements. Sustainable packaging can be defined as packaging that has a comparatively low environmental impact as assessed by life-cycle assessment models (Glavič & Lukman, 2007). From a consumer-perspective, sustainable packaging can be considered *a packaging design that evokes explicitly or implicitly the eco-friendliness of the packaging* (Magnier & Crié, 2015).

"Sustainable is that development which enables the present generation to meet its own needs without compromising the ability of future generations to meet theirs". This is the definition of the term

sustainable as cited by the original source, in the Report of the World Commission on Environment and Development, General Resolution 42/187, based on a 1987 UN report (Brundtland Report) of 11 December 1987. The question arises as to how this assumption has been interpreted within the packaging production chain, and food packaging in particular.

Coming to an understanding of a comprehensive and quantifiable definition of sustainable packaging is essential in order to be able to assess the relative sustainability of one packaging versus another. Companies such as Coca-Cola, McDonald's, Tesco and others define sustainability and sustainable packaging individually: this lack of agreement in the industry can be a partial cause of confusion among consumers, who therefore struggle to differentiate sustainable packaging from less sustainable packaging (Jerzyk, 2016).

A review of the literature shows that while there are many definitions of sustainability, only two 'official' ones deal specifically with packaging. Starting with these, the table below shows how the definitions of sustainable packaging have evolved (Boz et al., 2020):

Table 1. Evolution of the definition of sustainable packaging.

Origin of the Definition	Definition of Sustainable Packaging	Reference
Sustainable Packaging Alliance, Australia	1. Effective: "Reduces product waste, improves functionality, prevents overpackaging, reduces business costs, achieves a satisfactory return on investment (ROI)" 2. Efficient: "Improves product/packaging ratio, improves energy, material, and water efficiency, increases recycled content, reduce waste to landfill" 3. Cyclic: "Returnable, reusable, recyclable, biodegradable" 4. Clean: "Reduces airborne, waterborne, and greenhouse gas emissions, reduces toxicity and litter impacts"	[16]
Sustainable Packaging Coalition, USA	1. Beneficial, safe & healthy for individuals and communities throughout its life cycle 2. Meets market criteria for performance and cost 3. Is sourced, manufactured, transported, and recycled using renewable energy 4. Optimizes the use of renewable or recycled source materials 5. Is manufactured using clean production technologies and best practices 6. Is made from materials healthy throughout the life cycle 7. Is physically designed to optimize materials and energy 8. Is effectively recovered and used in biological and/or industrial closed loop cycles	[19]

[16] Lewis, H., Fitzpatrick, L., Verghese, K., Sonneveld, K., Jordon, R. (2007) Sustainable Packaging Redefined. Sustainable Packaging Alliance: Melbourne, Australia, p. 26

[17] Definition of Sustainable Packaging; Sustainable Packaging Coalition: Zurich, Switzerland, 2011.

Sustainable packaging was first defined as a result of a stakeholder survey study supported by the Sustainable Packaging Alliance (SPA) in Australia, which was formed to promote sustainable packaging and its implementation through science-based tools and strategies in the packaging industry (Lewis at al., 2007).

Another definition of sustainable packaging that has been widely accepted is that of the Sustainable Packaging Coalition® (SPC). The SPC is a stakeholder-based organisation that envisions *"a world in which all packaging is responsibly sourced, designed to be effective and safe throughout its life cycle, meets market criteria for performance and cost, is made entirely from renewable energy, and, once used, is efficiently recycled to provide a valuable resource for subsequent generations"* (Sustainable Packaging Coalition®, 2011).

Different from the SPA definition, the SPC's definition of sustainable packaging makes a link with renewable energy to produce more sustainable packaging. Specifically, the SPC defines more sustainable packaging as being produced using renewable energy sources including wind energy and hydro, biomass and geothermal sources.

The SPC also recognises the limits of a complete transition from fossil-based energy and materials to renewable counterparts: according to this concept, each definition criterion should be evaluated in relation to the principles of sustainable development and should provide available opportunities for improvement. For example, according to the definitions, recyclable packaging that has not been developed using effective material and energy optimisation and that does not meet market and profitability criteria cannot be considered sustainable, and its promotion as sustainable packaging would be misleading. A guide to assessing the level of sustainability of packaging, or sustainability commitments, can be obtained by referring to multiple organisations, in addition to stakeholder-based organisations such as SPC, and also initiatives such as the Ellen McArthur Foundation's New Plastics Economy, The Ocean Plastics Charter, Circular Economy goals of the American Chemistry Council (ACC), Plastics Division, Materials Recovery for the Future programme, etc. (Sustainable Packaging Coalition®, 2011).

Packaging materials

The environmental effects of bulk food items and food packaging composed of plastic, glass, metal, and paper/cardboard are summarized in this section. The main aspects of packaging materials are quickly described, the evaluation criteria are covered, and additional benefits and drawbacks are considered. It gives an overview of recent research in this field (Pasqualino et al., 2011).

Plastics

Polymers, composed of monomers connected by chemical bonds, are the building blocks of plastics. Depending on the mix, the polymers' structure and properties alter. Thermosets, thermoplastics, and

elastomers can all be categorized as a result of these unique differences. After shaping, thermoset plastics cannot be further distorted. The mechanical qualities of thermoplastics can be recycled and remelted without changing them (American Chemistry Council, 2018; Ensinger, 2018). Plastics made of elastomers can be distorted and then recovered to its original form (Ensinger, 2018).

For food packaging, a wide variety of thermoplastics are employed. Polypropylene (PP), polyethylene terephthalate (PET), and polylactic acid (PLA) are some of the most popular plastics (Muthu, 2016). In Europe, PP is the material that is most frequently utilized, and it is used for low strength structural applications such containers and wrappers (Hahladakis & Iacovidou, 2018; PlasticsEurope, 2018). The most widely used biodegradable plastic substitute for fossil-based plastics like PET is PLA (Madival et al., 2009).

One of the most widely used biodegradable plastic substitutes for plastics like PET is PLA (Madival et al., 2009). Furthermore, PET and PLA are frequently used for bottles, while PP is used for various kinds of packaging, like containers (Hahladakis & Iacovidou, 2018). PP-container manufacture has a GWP of 3.94 kg CO_2 eq./kg (Gallego-Schmid et al., 2019). In contrast, the manufacture of PLA bottles results in an average GWP of 3.05 kg CO_2 eq. and that of PET bottles is 2.95 kg CO_2 eq./kg (Madival et al., 2009). Reusable PET bottles have a GWP that is up to 70% lower and can be filled up to 25 times (Heimrich, 2019).

Up until recently, PET and PP were more prevalent than PLA (Mangaraj et al., 2018). As a result, Europe has not built consistent infrastructure and recycling systems for PLA (Burgstaller et al., 2018). Because PLA is currently not composted with organic waste or segregated for recycling, it frequently contaminates other plastics and degrades the quality of next plastics (Burgstaller et al., 2018; Hahladakis & Iacovidou, 2018; Orset et al., 2017). This illustration demonstrates how the variety of plastic materials can complicate recycling and make it challenging to guarantee a consistent level of quality (Kaiser et al., 2017).

Thus, a high recycling rate is not feasible with the current recycling technology. Only PET can be recycled at a high rate without introducing pollutants. In Europe, 11.5% of post-consumer plastic is exported while 19.6% is recycled domestically (PlasticsEurope, 2018). Given that landfills still account for 70% of worldwide garbage, the landfill ban is a crucial law (Periathamby & Law, 2020). Just 4% of these are landfilled under controlled circumstances, largely in high-income nations. Uncontrolled landfilling causes problems for the entire economy in low-income countries (Periathamby & Law, 2020). This includes damage to the environment, such as contamination of the surface and groundwater because of leachate brought on by metallic packing (Periathamby & Law, 2020).

Thus, the need for eco-friendly packaging is in a continuous growth (Seo et al., 2016). The adverse environmental impact associated with the life cycle of plastics and plastic packaging is increasing due to the rising waste volumes and the malfunctioning circular economy system.

Glass

Limestone, soda ash, sand, and soda are used to make glass containers (Holman et al., 2018). These raw materials are created with compressed air while they are molten at temperatures between 900 and 1600 °C (Holman et al., 2018). An annealing oven heats the hot glass to roughly 600 °C and then gradually cools it to 60 °C to achieve an equal cooling. A high GWP is caused by the high energy impact and the carbon dioxide that vaporizes out of the glass throughout the process.

A GWP of 0.296 kg CO_2 eq is produced during the manufacture of a single glass bottle with an average weight of 0.330 kg (Muthu, 2016). The influence of GWP varies between 42% and 82% when this GWP is analyzed in connection to the GWP of the entire bottling process. Other factors are to blame for this large percentage range because no rule can be derived from this ratio according to bottle weight (Vázquez-Rowe et al., 2013).

This can be facts like additional packaging materials or used machinery, which change the necessary amount of electricity and/or fuel and other inputs. Due to the high impact of the bottle production and the bottle weight itself on the LCA, a decrease of the GWP of glass can already be conducted by reducing the weight of glass containers. However, the reduction of weight is limited, because too thin glass bottles can brake faster.

Metal

Tinplate and aluminum are the most popular metals used for food packaging (Al). Al is one of the safest packing materials, although acidity affects it. As a result, it is coated with plastic and alloyed with steel (Muthu, 2016). Tinplate is additionally alloyed within and has an interior plastic coating. Both the corrosion of the can by foods with a high sulfide content (Muthu, 2016) and the migration of metal ions into the food are prevented by these manufacturing methods. One tin bottle's manufacture result in a GWP of 0.245 kg CO_2 eq./0.093 kg of emissions (Navarro et al., 2018). Also, because metal frequently needs to be pre-treated for food packaging, the processing of the food must be considered. The ineffective collection of the trash results in significant metal loss, which raises the GWP. Waste is processed, cleaned, melted, and cast to recycle the metal. Although the majority of it is recyclable, the metals and coatings provide challenges (Muthu, 2016).

Metal corrodes in nature by an electrochemical process brought on by a microbial biofilm (Muthu, 2016). One AL can take these bacteria around 200 years to decompose (Bertling, 2019). Paper and cardboard biodegrade more quickly since they are formed of organic materials.

Paper and cardboards

Paper and cardboards are made from wood, plants and recycled paper and cardboard waste (Muthu, 2016). Due to this, a lot of area is occupied, and the production takes a lot of energy overall. For food safety and quality, it is required to cover paper with other materials like plastic and aluminum because of its hydrophilic nature and porosity (Muthu, 2016).

In numerous investigations, a wide variety of CO_2 equivalent values for paper and cardboard manufacture were found. According to different studies, the values for producing 0.03 kg of corrugated board for butter are 0.032 kg CO_2 eq. (Finnegan et al., 2017), 0.14 kg CO_2 eq., or 0.38 kg CO_2 eq. Paper and paper-based packaging was the most recycled packaging in Europe in 2017, but recycling is often more difficult in food because there are multiple layers involving different materials for food preservation purposes. Sometimes the layers cannot be separated, sometimes consumers do not because it takes time (Muthu, 2016).

Baked foods

Baked foods, fruits, vegetables, nuts, and dried goods like noodles are the main food types that can be purchased without packaging (Beitzen-Heineke et al., 2017; Statista, 2017). Having said that, more supermarket retailers lately are opting to use zero packaging. The product can be filled into the customer's own containers there (Beitzen-Heineke et al., 2017). Furthermore, well-known supermarkets have started to provide customers with the option to purchase meat and cheese at the deli counter in private containers. The GWP of fresh veggies is not necessarily lower than that of their processed counterpart. For instance, if the canned tomatoes are imported and the fresh tomatoes are grown in greenhouses, the fresh tomatoes have a greater effect on GWP than the canned tomatoes. According to Frankowska et al. (2019), home garbage emits 0.38 kg CO_2 equivalent for every kg of veggies. As opposed to fresh onions, pickled onions have a 2.3 times greater impact (Frankowska et al., 2019).

Sustainable supply chain management

Considering the definition of packaging in section 2.1, it is necessary to introduce the concept of Sustainable Supply Chain Management (SSCM) as packaging is involved in the production techniques indicated.

In the 1980s, the idea of SSCM first emerged. *The management of material, information, and capital flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development, such as economic, environmental, and social, into account that derive from customer and stakeholder requirements*, according to Seuring and Müller (2008). The enhanced definition of SSCM provided by Carter and Rogers later in 2008 refers to SSCM as *the strategic, transparent integration and achievement of an organization's social, environmental, and economic goals in the systemic coordination of key interorganizational business processes for improving the long-term economic performance of the individual company and the supply chain.*

Triple bottom line (TBL) framework

A triple bottom line (TBL) perspective on sustainability, which uses the product-packaging construct and considers the entire life cycle of the product-packaging combination, can be useful in analyzing packaging in more depth (Lutters & Klooster, 2008). Many authors consider the definition of TBL provided at the beginning to be insufficient (Carter & Rogers D, 2008) and advocate supplementing it with the concepts of risk management, transparency, strategy and culture (Carter & Rogers D, 2008). Openness to wider public examination of a company's operations is referred to as transparency. The firm's sustainable practices should be in line with strategy and organizational culture in order for them to coexist and evolve together. The intersection marked by a question mark represents the reality that only environmentally and socially conscious businesses engage in such activities unless they are profitable (Carter & Rogers, 2008).

Sustainability in the food-packaging industry

The full Life Cycle Assessment is the method that has been used the most frequently to estimate sustainability in the food packaging business (LCA). It is an analytical technique used to assess how much resources are consumed and how much of an impact an activity or process has on the environment (Heller & Keoleian, 2003). In their work, Heller and Keoleian (2003), evaluate the viability of the American food system and make recommendations for ways to enhance this intricate system. They contend that a product life cycle perspective offers a framework for examining the connections between meeting social requirements, the natural and economic processes involved, and finally, the environmental consequences that result. From the start of the supply chain to the end, they divide the life cycle of a product in the food industry into five stages (Heller & Keoleian, 2003). For each stage, they take into account the parties involved in the procurement, production, and distribution

of the good as well as those who would be impacted by its sale and ownership. A number of critical performance indicators are also provided for each stage of the life cycle. These indicators outline how sustainability can be evaluated in light of the consequences the food product under consideration has on the economy, society, and environment.

It can be inferred that sustainability stretches the idea of SSCM to look at optimizing operations from a larger viewpoint by encompassing all a company's operations in the food packaging sector (Linton et al., 2017).

The standards by which a product is labeled as sustainably produced have already been outlined. These criteria can be approached in several ways. The Sustainable Packaging Alliance (SPA) in Australia, the Sustainable Packaging Coalition (SPC) in the United States, and the European Organization for Packaging and the Environment (EUROPEN) in Europe all publish three significant ones. These factors, which are shown in Table 1, could be used to determine which package design to use.

TABLE 1 Three schools of sustainable packaging criteria

Existing sustainable packaging criteria		
According to European Organization for Packaging and the environment (EUROPEN)	**According to sustainable packaging coalition (SPC)**	**According to sustainable packaging Alliance (SPA)**
1. Packaging should be designed holistically with the product in order to optimize overall environmental performance	1. Packaging should be beneficial, safe, and healthy for individuals and communities throughout its life cycle	1. Effective: packaging should have social and economic benefit
2. Packaging should be made from responsibly sourced materials	2. Packaging should meet market criteria for performance and cost	2. Efficient: packaging should be based on "doing more with less"
3. Packaging should be designed to be effective and safe throughout its life cycle, to protect the product	3. Packaging should be sourced, manufactured, transported, and recycled using renewable energy	3. Cyclic: packaging should optimize recovery
4. Packaging should meet market criteria for performance and cost	4. Packaging should optimize the use of renewable or recycled source materials	4. Clean/safe: packaging should contain nonpolluting and nontoxic materials
5. Packaging should meet consumer choice and expectations	5. Packaging should be manufactured using clean production technologies and best practices	
6. Packaging should be recycled or recovered efficiently after use.	6. Packaging should be made from materials healthy throughout the life cycle	
	7. Packaging should be physically designed to optimize materials and energy	
	8. Packaging should be effectively recovered and utilized in biological and/or industrial closed loop cycles	

Food Packaging sustainability parameters

Jagoda et al. (2023), conducted a study to develop a generalizable framework combining life cycle thinking with functional analysis for systematically and holistically comparing sustainable packaging design options, considering environmental, economic, and consumer preference dimensions.

Based on market demands and socio-technical dynamics, the criteria used in design for sustainability decision-making have changed over the past few decades (Ceschin & Gaziulusoy, 2016; Kannan et al., 2013).

Several pertinent parameters that can be associated to sustainability are presented in previous work. These variables can be divided into three categories, which are listed below:

Parameter 1: functional satisfaction of food packaging

Under this, protecting (Lindh et al., 2016; Yokokawa et al. 2020), communicating (Lindh et al., 2016; Allione et al., 2011; Harahap et al., 2020) and facilitating handling (Lindh et al., 2016; Yokokawa et al. 2020).

Parameter 2: life cycle impacts (LCI) of food packaging

Many of the research publications on life cycle impact of FP that are now available emphasize the importance of concentrating on limiting the impact made during all life cycle phases (Jagoda et al., 2023). The two primary strategies suggested for lowering the total environmental impact of FP in previous studies are improving the eco-friendliness of the packaging and reducing food waste and losses. The majority of research, however, have focused on the packaging's ability to reduce overall environmental impact. The necessity of employing low-impact materials and incorporating the circular economy into packaging design has thus been underlined by previous authors (Schmidt Rivera et al., 2019).

Depending on the mode and the distance travelled, transportation has a considerable impact (Zhu et al., 2022). According to some research, the influence of transportation is rather marginal (Qin and Horvath, 2022), whereas in others, it might reach 46%. (Choi et al., 2018). There are new methods for lessening the impact of transportation in addition to the traditional criteria for doing so, such as the distance travelled, the laden weight, and the mode of transit. One idea for raising packaging sustainability is to use the freight truck's volumetric capacity more effectively (Svanes et al., 2010).

Parameter 3: cost estimation of food packaging

In reality, the cost is possibly the most significant factor that affects the market viability of a sustainable packaging alternative when it comes to packaging design. But the connection between packaging designs and the overall financial burden attached to them is complicated. For instance, the packaging's actual economic impact is much more than its direct cost of production (Jagoda et al., 2023). The supply chain's storage and warehousing, transportation, inventory carrying and lot sizing, order processing and inventory costs are all

impacted by the packaging's design (Meherishi et al., 2019). The expenses associated with disposal may differ depending on the kind of material and design. Producers and consumers may incur additional costs because of wastage during the filling and use phases and problems with shelf life (Chan, 2022). An apparently inexpensive design choice may have large indirect costs for all parties involved in the supply chain.

Consumer perceptions of sustainable food packaging

Up to this point, an attempt has been made to establish a common, objective criterion for quantifying the sustainability of packaging and its relationship to the product throughout the entire value chain. Next, it will be necessary to identify the right communication strategies towards consumers. Examining the function of packaging in the value chain can help clarify customer confusion about sustainable packaging (Nordin & Selke, 2010). Although this is true, there is a gap between consumer perceptions and behavior when it comes to environmentally beneficial choices, which can be contradictory. From a consumer perspective, sustainable packaging is a packaging design that shows respect for the environment (Magnier et al., 2015). This stage is very sensitive because consumers' misconceptions and misinterpretations of packaging elements can prevent success in the market. Due to consumer misinterpretations, many label claims fail to convey the sustainability message of brands (Magnier et al., 2015). On the other hand, studies on actual LCAs and consumer sustainability assessments have shown discrepancies due to preconceived notions of sustainable packaging (Pauer et al., 2017).

Sustainability measured by criteria inconsistent with LCA

Customers typically rely on inference techniques to guide their decisions because they have insufficient information on sustainability. Consumers must be aware of the findings of the life cycle analysis (LCA) of packaging materials and processes for the packaging sector to grow sustainably. Steenis et al. (2017) compared subjective consumer assessments of sustainability to a more thorough sustainability gauged using LCA. The findings of the study revealed the decisions that shoppers make. A dry carton bag was determined to be the least sustainable based on consumer feedback but having the lowest LCA impact (5%). Parallel to this, people ranked glass as the second most sustainable packaging material (42%) even though a glass jar had a greater LCA impact. Comparing bioplastic cups—which have a relatively high LCA impact and are largely regarded by consumers as sustainable—also revealed the same paradox.

This discrepancy demonstrates that consumer perceptions of sustainable packaging are not always in line with a package's real sustainability. Similar to the results obtained in the aforementioned study

(Steenis et al., 2017), significant discrepancies have been found in the literature between LCA results and consumers' classification of sustainable traits (Terrachoice, 2010; Pancer et al., 2017). Consumers often rank the product by packaging, and therefore glass and cardboard packaging are ranked as the most sustainable, omitting how the product was sourced or produced, which therefore does not include the total environmental load. The production part of the packaging is neglected and the focus is only on how it is used after consumption to judge the sustainability of the packaging; reusable glass and plastic together with cardboard were ranked as the most sustainable, while non-reusable plastic, plastic and cardboard portions were perceived as the least sustainable (Boz et al., 2020).
In another study, plastic, metal and glass packaging all had higher environmental impact ratings from consumers, with metal and plastic packaging being the least sustainable options, which contradicts the LCA results (Tobler et al., 2011). This is a recurring result in consumer research and provides many indications.

Misinterpretations by consumers

Although efforts to increase the level of sustainability of packaging are well-known and popular among many buyers, most consumers have misconceptions about sustainability in general (Simpson & Radford, 2012). From a consumer perspective, sustainable packaging can be defined as *"packaging design that explicitly or implicitly evokes the eco-friendliness of packaging"* (Magnier & Crié, 2015, p. 49).

Although definitions of sustainable packaging continue to evolve in parallel with the principles of sustainable development, research has shown that sustainable packaging is not communicated well to consumers. For example, surveys have shown that consumers are unable to identify sustainable packaging or do not have a clear idea of what it means for a package to be sustainable (Lindh et al., 2016). Consumers place more emphasis on a preconceived notion of what makes packaging sustainable (e.g. recycling) while neglecting the other pillars of sustainable development such as social and economic impacts. Social aspects are often left out of this equation. The social impact of sustainable development in packaging can involve both social justice principles and consumer demands on the price, convenience and performance of packaging (Nordin & Selke, 2010).
For example, the concept of 'bio' in packaging that includes biodegradable and bio-based preparations in bioplastics is misinterpreted by consumers as being readily biodegradable in the environment, whereas most commercially available biodegradable polymers can only decompose in industrial systems under controlled conditions, and some bio-based plastics are not biodegradable (Guillard et al., 2018).

Greenwashing

The term "greenwashing" refers to the employment of a deceptive term (such as "eco-friendly"), a symbol (such as a "green leaf"), or a color (green) to indicate that a product's packaging is more ecologically friendly than an alternative packaging. In the field of packing, this is a common technique. For instance, a study by Terrachoice (2010) found that the amount of "greenwashing" promotion on labels grew by 200% between 2009 and 2010.

The fact that consumers may directly observe the actual disposal of packaging waste, whether it is done appropriately (by placing it in recycling bins) or incorrectly (by leaving it by the side of the road and in rivers), leads to a number of misconceptions (Van Birgelen et al., 2009). Therefore, even though they only make up a small portion of the packaging thrown away, plastic bags stuck in trees and fast-food cardboard cartons from packaging waste are the most noticeable, and the high environmental impact they cause overshadows any efforts made to develop sustainable initiatives like the collection and recycling of glass bottles.

The aesthetic of the packaging itself may influence consumers' impressions of sustainability, which is significant to observe given that the packaging material has a direct visible impact on the environment. In order to improve consumer decision-making and encourage them to make more sustainable choices, this awareness can be used to inform the design of innovative packaging solutions. The packaged food industry's sustainability efforts have been misdirected because of the ability to relate packaging sustainability to sales. Due to the apparent pushback from consumers who began to doubt the veracity of these statements and began to consider them as deceptive and inaccurate, greenwashing claims have been gradually removed from packaging (Terrachoice, 2010). Due to the actual observation of prior inaccurate and misleading claims, consumers started to sense a significant genuine risk regarding the validity of the sustainable packaging campaign.

This had the opposite effect: many businesses decided not to advertise their efforts for more environmentally friendly packaging to consumers in order to avoid charges of "greenwashing" and potential unfavorable consumer response. Genuine brands lost their competitiveness as a result of consumer mistrust and perceptions of greenwashing and became disheartened. For instance, the only use of the color green in packaging without related environmental statements had a detrimental impact on consumers' opinions of the effectiveness of the product (Pancer et al., 2017). Customers demand that brand affiliations, claims, and branding on product packaging reflect the company's commitment to sustainability.

Food industry pollution

Up to now, the topic of packaging, the protagonist of the paper, has been covered extensively; now the discussion will move on to two other pillars that are fundamental to this study, which are generic pollution of the food industry and food labeling. While packaging remains the main problem at the global pollution level, both in terms of the materials used and their disposal, the food production chain is also impactful on the environment. The production, preparation, and consumption of food results in significant amounts of solid and liquid waste, which is produced by the food-processing industry (Khedkar & Singh, 2018). In the upcoming years, food production is anticipated to increase, this is due to the expanding population's increased need for food (Springmann et al., 2018). However, increased food production is a major source of several contaminants in aquatic environments. Pesticides, heavy metals, pathogens and nutrients from fertilized fields end up in rivers as a result of overuse of chemicals and inadequate management practices in the agricultural production industry. A common source of nutrients, diseases, and antibiotics in rivers is intensified animal production (Ippolito et al., 2015). Multi-pollutant issues affect aquatic systems in many parts of the world. These wastes imply a loss of priceless biomass and nutrients as well as rising disposal and potentially serious pollution issues. The current need for sustainable industrial development is careful consideration of effective solid waste utilization and disposal (Jayathilakan et al., 2012). Source reduction through processing plant modifications, waste recovery, recycling, or waste treatment for value-added goods, and environmentally friendly detoxification or neutralization of the undesired components are the three categories under which industrial waste management strategies can be categorized. Efforts are often made within the food industry to limit waste and save food scraps, but the use and disposal of product-specific wastes is difficult due to their inadequate biological stability, potentially pathogenic nature, high water content, potential for rapid autoxidation, and high level of enzymatic activity (Jayathilakan et al., 2012). The cost of producing processed foods can be reduced, and the risk of pollution can be reduced, with effective waste management. Another important element before reaching the final discussion on labeling, which encapsulates all the issues addressed so far, is the safety of food for human health. To meet customer demand for nutrient-dense food, safe food production is essential (Garvey, 2019). From farm to fork, there are many steps in the manufacturing and distribution of food, and there is always a chance for food contamination along the way. Public health safety is seriously threatened by chemical pollution from agriculture and aquaculture, food packaging and disinfection, and biological contamination from dangerous organisms (Vogt et al., 2012).

The agricultural industry is among the most polluting in the world (Ritchie et al., 2022), 70% of global freshwater withdrawals are used for agriculture (FAO, 2011) and 78% of global ocean and freshwater eutrophication is caused by agriculture (Poore & Nemecek, 2018). There are three main ways that agriculture has a big impact on the environment. It first needs a lot of fresh water, which can put a lot of pressure on the environment in places where there is a shortage of water. It consumes water as an input and releases nutrients that contaminate rivers, lakes, and seas. It is a significant contributor to climate change, accounting for around a quarter of global greenhouse gas emissions (Poore & Nemecek, 2018). Finally, due to its extensive use of land, agriculture has a significant negative influence on the environment worldwide. In the world, agriculture occupies half of the livable land. The world's once-vast woods and untamed areas are now largely utilised for agriculture. The primary factor in the decline of the world's biodiversity has been this loss of natural habitat (Papaioannou et al., 2022).

Next comes the food industry, which is seeing a dramatic increase in consumer waste: in Italy a +15 percent in 2021 compared to 2020, with 31 kg of food wasted per person. Beef, lamb, fish (especially salmon), eggs, pork, chocolate, coffee, and dairy products (especially cheese and yogurt) are the foods that consume the most CO_2 to reach our table (Roukas & Kotzekidou, 2022). The main reason why labeling then takes over is the evidence in the literature regarding the increasingly precarious condition of our planet. Food producers find themselves obliged to adopt new sustainable production technologies (Grunert, 2011). Food certifications nowadays are undoubtedly necessary, but more importantly they are a point of difference from competitors on a strategic level to stand out in the market. The level of awareness among consumers is steadily increasing; they want to be made aware of the sustainable practices adopted by producers, and this is where food certifications step in to convey safety (Aprile & Punzo, 2022).

Labeling

The need for knowledge about the effects of the food we eat every day has increased as a result of society's growing concern over the social and environmental effects of food production and consumption, as well as increased awareness of the unintended negative effects of individual food choices on global food sustainability. At the same time, producers have adopted more sustainability food claims, certifications, messages, and other informational tools to distinguish their products in response to the rising demand for sustainable food items (Annunziata et al., 2019).

In the past three decades, a variety of public and commercial efforts have been informing customers about food sustainability through the introduction of labels and logos in-store and on-pack (Grunert

et al., 2014). Sustainability is impacted by all phases of the food chain, including fishing, food processing, and transport (Grunert, 2011). A growing demand for information on the different facets of sustainability affecting food products is being driven by consumer concern over the environmental and social effects associated with the way food is produced (Aprile & Punzo, 2022). According to Hashemi et al. (2019), adhering to sustainability principles may help reduce the impact of food production on the depletion of natural resources and increase the competitiveness of food processing (Grinberga-Zalite et al., 2021).

Labels on packaged food products contain the information necessary to identify a food. Indeed, EU Regulation 1169 of 2011 obliges manufacturers to state:

1. The name and condition of the food. Next to the name, the physical state or treatment undergone by the product can be specified, e.g. 'powdered', 'frozen' or 'smoked';

2. The ingredients, i.e. all the substances used to produce the food, listed in descending order by weight. If vegetable oils or fats are present, their origin must be indicated, e.g. 'palm', 'coconut' or 'hydrogenated fats';

3. Any ingredient or processing aid listed in Annex II or derived from a substance or product listed in Annex II causing allergies or intolerances used in the manufacture or preparation of a food and still present in the finished product, even if in an altered form.

4. The quantity of certain ingredients or categories of ingredients and the net quantity of the food;

5. The durability of the product. This information can be indicated with the words "Best before date", indicating the date after which the product is no longer safe and should not be consumed at all; or with the words "Best before date", indicating the date after which the product loses its organoleptic qualities, although it can still be consumed;

6. The conditions of storage and use, which explain how to use and maintain the food correctly so that it is safe at the time of consumption;

7. The country of origin. This information must be specified for certain products such as meat, fish, fruit and vegetables. The location of the production or packaging plant should always be indicated instead.

8. The nutrition declaration, i.e. information on the energy value of the product and the content of fat, saturated fatty acids, carbohydrates, sugars, protein and salt. The energy value of the food refers to 100 grams or 100 millilitres or a single portion.

Optional elements are claims; they can be added at the manufacturer's discretion and must also comply with the regulations. Claims, i.e. optional statements on nutritional properties and health effects. These are phrases that the manufacturer can voluntarily add to enhance their product, such as 'fat-free', 'high-fibre' or 'lowers cholesterol'. They must be substantiated by scientific studies, have received a favorable opinion from the European Food Safety Authority (EFSA) and have been included in the list of permitted claims.

EU Regulation 1169 of 2011 specifies in detail how optional claims are to be treated:
"In the interest of consistency and coherence of Union law the voluntary inclusion of nutrition or health claims on food labels should be in accordance with the Regulation (EC) No 1924/2006 of the European Parliament and of the Council of 20 December 2006 on nutrition and health claims made on foods."

According to a number of academics, sustainability labels help to reduce information imbalance between the supply and demand for knowledge on environmental and social issues (Nikolaou & Kazantzidis, 2016; Shao, 2016).
According to Aprile and Mariani (2015), the recent profusion of standards and labelling for social or environmental food items puts consumers at risk and may breed skepticism.
Nowadays, especially due to the rapidity with which laws change and with the differences in the transposition of directives in the different EU countries, it is increasingly difficult for consumers to be aware, even superficially, of existing sustainable labels.
One of the biggest problems in trying to recognize sustainable labels directly concerning food products or packaging is the underlying information asymmetry between labels and consumers (Nikolaou & Kazantzidis, 2016).
According to many academics, eco- and social-labels help to reduce knowledge asymmetry between the supply and demand sides of the market with regard to environmental and social issues (Delmas

& Grant, 2014). According to many, social and eco-labels lessen information asymmetry by sending a clear message to customers who are prepared to purchase products that are socially and ecologically responsible and by rewarding businesses that act in these ways (Morrow & Rondinelli, 2002). According to Heras-Saizarbitoria et al. (2011), ISO 14001 certified businesses outperform the norm in terms of profitability and sales growth.

A weakness in certain labels is that they don't appear on product packaging (Carrero & Valor, 2012), and it can be challenging for customers to find crucial information on company websites and annual reports. Food labeling is already complicated, and it becomes much more so because customers can't easily recognize environmental information while buying items due to a lack of expertise, time, and internet access. Additionally, this makes it more difficult for businesses to decide to implement policies that will enhance their environmental performance (Nikolaou & Kazantzidis, 2016).

Claim trends

According to the Nielsen GS1 Italy Immagino Observatory, in a press release of 25 February 2021, one in five FMCG products has at least one claim on its packaging related to environmental sustainability: from green resource management to CSR, from supply chain to organic to 'antibiotic-free'. A 9.2-billion-euro sell-out basket, growing by +5.5% annually.

Supporting this trend is above all demand (+4.5%), confirming the attention of consumers to products that declare on the label the sustainability of the product or its packaging and, more generally, the company's commitment to reducing the environmental impact along the supply chain.

According to the type of claim on the label, the Immagino Observatory has categorized the items that highlight sustainability-related characteristics into four clusters (Figure 1):

LE QUATTRO AREE TEMATICHE DELLA SOSTENIBILITÀ IN ETICHETTA

	N. PRODOTTI	% PRODOTTI	VENDITE IN VALORE (€)	% VENDITE IN VALORE	TREND % VENDITE IN VALORE A.T.* GIUGNO 2020 VS A.T.* GIUGNO 2019	PRESSIONE PROMO %
Totale prodotti sostenibili	24.073	20,9	9.190.483.624	24,4	5,5	33,2
Management sostenibile delle risorse	9.562	8,3	4.726.623.825	12,6	5,2	37,9
Agricoltura e allevamento sostenibili	12.066	10,5	2.674.312.868	7,1	6,1	22,9
Responsabilità sociale	5.099	4,4	2.561.309.039	6,8	7,1	31,0
Rispetto degli animali	981	0,8	433.027.185	1,2	3,8	49,2

Tutte le quote fanno riferimento al mondo dell'Osservatorio Immagino (115.429 prodotti)

*A.T. = anno terminante

Source: Immagino Observatory, GS1 Italy, ed. 2, 2020

- *Sustainable resource management*.

There has been a strong growth in the offer for products with claims referring to sustainability in packaging. Specifically, the claims 'recyclable', 'with recycled material' and 'biodegradable' registered significant increases in the percentage of product sales (Immagino Observatory, 2021).

- *Sustainable breeding and agriculture*.

The biggest sales and largest increases were recorded for goods with the EU organic logo, the word ‘organic’ on the label, and those mentioning the ‘supply chain’ and ‘traceability’, with 1.168 billion euros (+3.1%) and over 755 million (+15.2%), respectively. 'Antibiotic-free' on 124 goods and a rise in sales of +51.7% made this year's top sustainability claim (Immagino Observatory, 2021).

- *Social responsibility*.

Particularly positive performances were registered by FSC claims (+7.1%) and those of UTZ (+9.2%) and Fairtrade (+11.7%) (Immagino Observatory, 2021).

- *Respect for animals*

It was recorded +4.8% of products with Friend of the sea certification, which was offset by the decline in the 'cruelty free' claim, which was affected by the contraction in supply (Immagino Observatory, 2021).

GS1 Italy also released a “mini guide” of the main logos and certifications in the packaging world, grouping them into two sections:

1. The most commonly used certifications related to the quality of products

Attribute	Module	Description	Code value
Packaging Marked Label Accreditation Code	packagingMarking	DOP – Protected Designation of Origin (For food or agricultural products)	PROTECTED_DESIGNATION_OF_ORIGIN
Packaging Marked Label Accreditation Code	packagingMarking	IGP – Protected Geographical Indication (For regional foods)	PROTECTED_GEOGRAPHICAL_INDICATION
Packaging Marked Label Accreditation Code	packagingMarking	EU ORGANIC FARMING (EU organic logo)	EU_ORGANIC_FARMING
Packaging Marked Label Accreditation Code	packagingMarking	TRADITIONAL SPECIALTY GUARANTEED (Food)	TRADITIONAL_SPECIALTY_GUARANTEED

2. The most commonly used certifications related to the environmental Sustainability

Attribute	Module	Description	Code value
Packaging Marked Label Accreditation Code	packagingMarking	PEFC (Program for sustainable forestry through independent third-party certification)	PEFC
Packaging Marked Label Accreditation Code	packagingMarking	FSC label for sustainable forestry (Forest Stewardship Council)	FOREST_STEWARDSHIP_COUNCIL_LABEL
Packaging Marked Label Accreditation Code	packagingMarking	EU ECO-LABEL (EU Flower for the Environment)	EU_ECO_LABEL
Packaging Marked Label Accreditation Code	packagingMarking	RAINFOREST Alliance certified (for rainforest protection)	RAINFOREST_ALLIANCE

Packaging laws in Italy

With the entry into force on 26/09/2020 of Legislative Decree 116/2020, it became mandatory for the producer of packaging intended for the end consumer to provide information to enable proper collection, reuse, recovery and recycling and to inform consumers about the final destinations of the packaging. The obligation officially came into force on 1 January 2023 and requires the indication on the *environmental label* of how the waste is disposed of.

In order to be able to identify and classify packaging, producers must state the nature of the packaging materials according to Decision 97/129/EC.

The minimum information to be stated on packaging is:

- Type of packaging (e.g. bottle, tray, bottle, label, wrapper, etc.)
- Identification of the material (alphanumeric code from Decision 97/129/EC that can be supplemented with UNI EN ISO 1043-1:2002 or CEN/CR 14311:2002)
- Material family (steel, aluminum, plastic, paper, wood plastic, glass, etc.)
- Indications for collection (separate or undifferentiated)

Food certifications

The Social Responsibility Standard – ISO 26000 defines sustainable business as follows:

"Sustainable business for organizations means not only providing products and services that satisfy the customer, and doing so without jeopardizing the environment, but also operating in a socially responsible manner."

To stand out from the competition and meet the challenges posed by emerging international markets, quality has emerged as a crucial component in the Italian food industry (Sadilek, 2019). Consumers can use certification and brand to get information about a product's origin, relevant production methods, and other factors, such as safety, environmental impact, and ethical considerations. These factors together make up the core of the quality concept (Marino & Nobile, 2007). The origin of a product, pertinent production techniques, and additional aspects, such as safety, environmental impact, and ethical issues, can all be learned by consumers through certification. These are some of the many reasons why companies in recent years are increasingly investing in acquiring new voluntary certifications that do not limit them to mandatory safety and hygiene standards (Aprile et al., 2016).

Today, there are several certifications required by food manufacturers in the area of sustainability, both with regard to packaging and food production processes.

One of the most popular is ISO 140001, which is a voluntary international standard, applicable to any type of public or private organization, that specifies the requirements for an environmental management system. Global warming and long-lasting consequences on all ecosystem components are caused by the continued growth of industrial pollutants in the environment. To date, numerous models and methods have been created to reduce emissions and pollutants. One of them, the Environmental Management System (EMS) ISO 14001, was released by the International Organization for Standardization (ISO) in the middle of the 20th century (Ikram et al., 2019). ISO 140001 and many others in the field of sustainability are grouped under the Food Safety System

Certification Scheme, an international food certification standard established by the FSSC Foundation. ISO 22000 'Food safety management systems-Requirements' is the voluntary international standard for the certification of Food Safety Management Systems (FMS) (FSSC-22000, 2023). Another certification required in Italy is ISO 22005, an international reference document for the certification of agri-food traceability systems (Granja et al., 2021).

According to research (Zanoli et al., 2015), consumer purchase intent and the overall profitability of organic food are significantly influenced by consumer trust in organic certification. The main factors that can increase product trust and organic sales are raising awareness of the techniques used by organic farmers to grow/breed organic produce and the elaborate processes put in place to routinely inspect farms and test products to ensure the "organicness" of the produce (Padel, 2010). Another globally recognized certification appears, the EU leaf certification symbol for organic produce (EC 889/2008) has been implemented since Janssen and Hamm's data collection in 2012, and the EU organic market has experienced significant expansion (Rana & Paul, 2017). It is used by companies in the agri-food and livestock supply chain to demonstrate to consumers that they meet compliance requirements with EU Reg 848/2018 'European Union rules on organic production and labelling of organic products', which came into force in January 2022 to replace EC Reg 834/2007.

One of the most important private standards in the worldwide agri-food industry is the GlobalGAP standard. It is starting to become a requirement to enter a number of high-value markets (Fiankor et al., 2020). This has trade cost consequences; meeting GlobalGAP regulations necessitates passing multiple control points based on food safety, traceability, environmental sustainability, and employee occupational health (GlobalGAP, 2015).

Standards vary from country to country, in fact producers and processors are required to follow their criteria in order to gain access to the US and EU markets. The pangasius value chain has evolved varied governance styles as a result, with captive/hierarchal governance at the importer-processor level and, among other forms, modular governance at the processor-producer level. The Aquaculture Certification Council (ACC), for instance, sets the universal norm in the US retail market, whereas the EU retail market demands GlobalGAP and ASC certification (Nguyen & Jolly, 2020).

Life Cycle Assessment (LCA) has historically been utilized by branches and international corporations to increase consumer confidence in the environmental impact of their products. LCA has allegedly been utilized as a branding strategy to support consumers' choices and preferences for items. However, despite its informative value regarding impacts on the environment, society, and economy, such a classic process LCA has been overly expensive for businesses to conduct, which has led to a decline in its utilization as a sustainability metric tool for businesses (Curran, 2006).

LCA is the most comprehensive and process-relevant facultative certification that manufacturers can request, describes the environmental effects of a company's products or operational systems; more recently, it has also included the economic and social effects (Lauesen, 2019). By using a functional unit, such as 1 m^3 of packaged and delivered product, LCA generates an impact model with boundaries that can be compared to functional units used by other products or activities (Weidema, 2006).

The international regulatory reference for carrying out LCA studies is the ISO 14040 series of standards:

- UNI EN ISO 14040 Environmental management, Life cycle assessment, Principles and framework.
- UNI EN ISO 14044 Life Cycle Assessment, Requirements and Guidelines.

Information & willingness to pay

The goal of *sustainability label* is to make it easier for customers looking for environmentally friendly substitutes for conventional food items to find the goods that suit their demands (Weinrich & Spiller, 2016). Food producers need to understand consumer preferences and their readiness to pay for sustainability claims in order to meet market demand. In order to strengthen the compatibility of the food product with the environmental elements of sustainability, the application of sustainability labels entails substantial expenses for changing production processes and innovating technology systems and supplies (Consuelo, 2020).

In this regard, it is crucial to note that customers are prepared to pay more for foods with sustainability labels when comparing the identical goods with and without them (Annunziata et al., 2019; Lombardi et al., 2017). However, consumers typically exhibit a low inclination to adopt sustainability labeling in real-world scenarios.

Aprile & Punzo (2019) assessed customer preferences and willingness to pay for three distinct environmental sustainability labels (EU Organic Farming, Rainforest Alliance, and 'Per il Clima-Legambiente') and several clues about the origin that are visible on processed food products.

Sustainability labels provide customers the chance to take some environmental sustainability factors into account when selecting foods that suit their interests. According to Apostolidis and McLeay (2019), consumers can recognize domestically produced items that are more preferred than those that come from outside thanks to origin labels and this could be a further benefit for *Made in Italy* products.

Research shown that consumers' purchasing decisions are favorably impacted by the inclusion of environmental sustainability labels on food products. More precisely, when consumers are properly

informed about the meaning and content of the labels, preferences for the products bearing the environmental sustainability badge rise. Contrarily, a lack of awareness could prevent buyers from considering environmental sustainability claims while making purchases (Aprile & Punzo, 2022).

Literature research gap

In the above-mentioned literature review, the most generalised gap and limitation is certainly to argue that consumers nowadays have a clear idea of everything related to sustainability in food. Research demonstrated that a sizeable number of customers is still mostly uninformed and skeptical about environmental sustainability labeling (Grunert et al., 2014; Tobler et al., 2011). Consumers have shown increasing levels of interest in environmental sustainability, especially in the field of food, but this figure does not reflect an effective understanding of the relevant green information on labels (Grunert et al., 2014).

If more items came with point-of-purchase environmental effect information, consumers would have more opportunities to switch to more ecologically friendly products (Potter et al., 2021). Nudges in-store and educational efforts on the importance of making these changes to the environment could also improve consumer incentive to modify their buying habits (Crockett et al., 2018). Indeed, ecolabels can inform consumers about the environmental credentials of their diet to help them make informed decisions, but there is no standard format for ecolabels and scant research on which label may be most useful (Potter et al., 2021). To help consumers better understand the information about sustainability, other alternatives to ecolabels, presented on packaging, may exist. Specifically, a possibility could be to enclose the sustainability information in an ad-hoc QR code to help consumers decipher this information. However, to the extent of my knowledge, no studies have ever explored this implementation.

It is within this gap that the following research aims to obtain an innovative format to convey the right values and information about sustainability. Normally information on sustainability, such as claims, packaging materials or certifications, helps to reduce the information imbalance between supply and demand for knowledge on environmental and social issues (Nikolaou & Kazantzidis, 2016; Shao, 2016), but often there is little space and the information is misleading. The goal is to help both supply and demand reduce the information asymmetry with consumers and ensure a quick understanding of the optional and improved information that manufacturers choose to apply on the packaging. Several solutions have been proposed in the area of consumer information i.e., the adoption of information campaigns aimed at increasing consumers' knowledge of the environmental sustainability dimensions of food production and consumption or the placement of environmentally sustainable labelled foods in dedicated spaces in supermarkets to improve their visibility (Grunert et

al., 2014; Aprile & Punzo, 2022). There are studies that have investigated consumers' visual attention related to sustainability and the resulting WTP (Van Loo et al., 2015).

It has been ascertained that consumers evaluate environmental sustainability labels when they are provided with information on the meaning of such labels (Grunert et al., 2014), this study aims to investigate on a visual level, whether a digital tool, a two-dimensional barcode that can be scanned with any kind of smartphone, can generate an effective awareness of food sustainability, and change their purchasing behavior. Specifically the two-dimensional barcode is The QR (quick response) code, containing optional information applicable to a product's packaging, such as optional environmental, social and production certifications, specific claims or information on the sustainability of the packaging itself.

Research question

Given the analysis carried out so far, the aim of this thesis is to fill the main gap found in the literature on sustainable food-side communication strategies. Firstly, having realised the absolute importance of packaging as a marketing tool, it will play the role of the main argument around which any proposal must be based in order to be relevant from a managerial point of view. Another key component that is populating the front pages of different packaging are sustainable claims and certifications, which are often confused or ignored.

The alternative single scannable QR code applied on the packaging against the scattered display of sustainable claims will be explored. The main research question (RQ) is therefore the following:

RQ: *Does present sustainable information in a QR code on a packaging of a product (vs. presenting the same information using dispersed ecolabels and claims in the packaging) increase the consumers' purchase intention of that product?*

Considering the literature analysed so far concerning sustainable claims applied to packaging, individual consumer perceptions will be analysed concerning trust as a mediating variable between the introduction of the QR code element and the propensity to purchase. According to Sirdeshmukh, Singh, and Sabol (2002), consumer trust refers to the belief that the service provider, the one providing the nutrition and health claims, is reputable and capable of keeping its commitments. Consumer adoption of a food product with nutrition and health claims typically follows consumer trust (Strijbos et al., 2016). According to research by Ding et al. (2015), trust in the food system and control have a considerable explanatory power when it comes to decisions made about foods that

have nutrition and health claims. Consumers who trust the food industry are more likely to select and purchase items with nutrition and health claims than consumers who don't. Sociocultural and historical factors influence the level of trust in the food system (Dolgopolova et al., 2015). In a study conducted on chicken meat products, Samant and Seo (2016) showed that for consumers with a high level of understanding of label claims, the presence of some sustainability claims improves overall quality, confidence in quality and perception of freshness.

The second research question (RQ_2) then becomes:

RQ_2: *Does trust in sustainable information mediate the relationship between sustainable packaging with QR codes and purchase intention?*

CHAPTER 2: CONCEPTUAL FRAMEWORK

The impact of QR code with sustainability information introduction on purchase intention

Originally developed by Denso Wave in Japan in 1994 to track parts in the automobile industry, QR codes are two-dimensional bar codes that can be read by a smartphone camera and converted to content such as URLs, phone numbers, and text (Okazaki, 2009; Okazaki & Barwise, 2011). One of the most promising technologies to increase the amount of information offered to consumers and affect their purchasing behavior is smart packaging, which incorporates QR Codes (Rotsios et al., 2022). Albastroiu and Felea (2015) claim that QR Codes enable instant access to data via mobile devices, including website addresses, e-mail addresses, phone numbers, geographic coordinates, etc. Consumers can access their content with any mobile or smartphone with a built-in camera and QR Code reader software, and they can utilize them on product labels and advertising materials (Cunha et al., 2010). A QR code is a two-dimensional, dynamic image. If a QR code is linked to a URL and the URL changes at any moment, the underlying data of the URL can be changed without affecting the image of the QR code **(**Hossain et al., 2018). Pulliam and Landry (2010) claim that QR codes are publicly available and have been endorsed by the International Organization for Standardization (ISO). The acceptability of a QR code refers to the graphics being matched with the text, usable, providing information, costing the least amount of money, and being very suitable for the user. The feasibility of a QR code refers to the facilitation of appropriate and timely information, as well as practicality that functions properly in both offline and online contexts. The embedded QR code assist the marketer in achieving their objective. Because customers can quickly and easily scan the QR code provided by the marketer that influences customers' purchase intentions, embedded QR codes with advertising are very helpful to share and influence customer satisfaction and purchase intention. **(**Hossain et al., 2018). According to Chien-Ta Bruce and Jhong-Min Denis (2017), the purpose of QR codes is to enable consumers to access more comprehensive and pertinent product information.

Due to the enormous rise in consumer concerns about food safety in recent decades, this demand also shows up in the food industry (Zhang et al., 2018). A number of food safety disasters that have happened recently both in rich and developing nations around the world have fueled these worries and left customers doubtful about the quality of their food. The problem has gotten worse because of the Covid-19 epidemic (Verbeke, 2005). From the standpoint of the consumer, a food traceability system offers details on the complete food chain, from farm to fork, helping to allay worries about food safety. This kind of data is frequently contained in certificates that are obscure to consumers and would benefit from additional explanation. More specifically, a contemporary, standardized

traceability system can effectively track the whereabouts of any food and trace data on the whole life cycle of food in a supply chain, from producers to consumers (Yu et al., 2022). For these reasons, a QR code might be a better way to convey the complete traceability process.

In a study by Chowdhury & Morey, (2019) on intelligent packaging for poultry industry, was demonstrated that today's consumers do on-the-spot product research on their cellphones rather than trusting information they discover on product labels or store shelf signs. According to statistics, 84% of customers use their smartphones to research products either before or while they are in the store. With almost 2 billion users worldwide, there were 224.3 million smartphone users in the US in 2017 (Statista, 2018). In addition to QR codes, mobile marketing is often mentioned when discussing them. Mobile marketing has expanded quickly in part because it can provide highly individualized and interactive communications that are more relevant to a consumer's location or context than traditional advertising messages (Rohm & Sultan, 2006). This kind of mobile content, for instance, might target customers while they are shopping by providing in-store incentives or the chance to compare pricing (Atkinson, 2013). Push and pull mobile advertising are typically distinguished from one another (Bamba & Barnes, 2007). Pull advertising is the communication of promotional materials that is initiated by the consumer, as opposed to push advertising, which defines messages that are launched by the advertiser (Unni & Harmon, 2007). Individual customers receive push advertising from the marketer, typically after completing a single opt-in to receive such communications.

Consumers haven't had much incentive to participate in mobile pull advertising, though, until recently. Due to the small size of smartphone keyboards, entering a website URL or search query can be difficult. Consumers now find that process to be much more appealing thanks to the advent of QR codes (Okazaki & Barwise, 2011).

The use of QR codes in China has boomed in recent years and they have become part of everyday life both in payment (Jao, 2018) and packaging applications as an extension of product information (Soneji et al., 2017).

In a study conducted by Trimble et al. (2020), on QR codes on cigarette packets, it was observed that Chinese consumers make extensive use of this tool to access manufacturers' websites. The manufacturers provide a larger platform for marketing that do not face the same restrictions as the packages themselves, consumers can find promotions, coupons, surprises or more information about the product creation process, provenance etc. QR can thus increase engagement and purchase intent (Jao, 2018).

For instance, smartphone-compatible IP technology like the QR code has been adopted to deliver more information in the particular context of the chicken sector. This will increase customer interaction at the point of sale, which will affect their decision to make a purchase. Foster Farms, a

vertically integrated chicken firm with headquarters in California, recently unveiled DORI, a QR-coded virtual assistant that provides deals, recipes, and sustainability-related information for its customers. Customers can access a range of information on Foster Farm's chicken lines, such as simply-raised, fresh, and natural, as well as organic goods, fresh chicken recipes, coupons, and more, by scanning DORI with smartphones (Chowdhury & Morey, 2019).

The recent development of blockchain technology has a favorable effect on supply chains' profitability and/or return on investment. Through improved accessibility, availability, and information sharing along food chains, it increases extrinsic food quality attributes and supports better information management (Stranieri et al., 2021).

It might be difficult to decide what information should be printed on food labels because they are frequently small. A simple disclosure may misinform customers and have detrimental welfare effects, whereas a complex disclosure policy may burden consumers and have little or no impact (Bar-Gill et al., 2018).

If food labels are complicated or if consumers are overloaded with labels, the issue could be particularly problematic. Individuals may incur huge aggregate costs as a result of information overload (Sunstein, 2021). Due to the fact that they view grocery shopping as a routine activity, consumers are frequently unmotivated when doing it. The purchasing setting, which is significantly influenced by inertia, price awareness, and information overload, among other things (Eldesouky et al., 2019; Röös &Tjärnemo, 2011), exacerbates the already limited attention. Furthermore, codified (and challenging to change) heuristics strongly influence grocery shopping (Spaargaren et al., 2013). Consumers are still confused and suspicious of new certifications, for instance in the case of organic food. An excessive amount of information on packaging may further confuse buyers and prevent them from making their purchase (Chen & Lobo, 2012). The legal ramifications of organic food product manufacturing, inspection, and certification are generally poorly understood. The consumer is guaranteed that the product has been produced organically by a certification stamp or mark (Padel & Foster 2005). Labelling seems to be one of the important issues influencing consumers' attitudes and beliefs, inserting different types of information, such as sustainability, reduced fat content, packaging material, recycling information, can lead to reduced interest and thus to non-purchase (Chen & Lobo, 2012).

Having explained the relationship between IV and DV, the primary hypothesis, the one concerning the main effect and whose study is necessary to answer the RQ, can be formulated as follows:

H_1: The presence of sustainability information enclosed in the QR code available on a product's packaging, as opposed to the presence of the same information dispersed on the product's packaging, has a positive effect on the purchase intention of the product itself.

The Mediator effect of Trust

It will be examined whether the impact of trust could be used as a significant mediator between IV and DV. According to Nuttavuthisit and Thgersen (2017), consumer trust is a prerequisite for creating a market for credibility items (such as high-end green goods), and it has a significant impact on the likelihood that consumers will pursue organic goals. Self-declared purchase behavior is negatively impacted by a lack of trust in the monitoring system and the naturalness of goods labeled as organic. According to Ricci et al. (2018), consumer trust has a negative impact on consumer concerns about the environmental and health effects of agricultural practices while favorably influencing attitudes toward the purchase of convenience products with green features. According to Morgan and Hunt (1994), trust is the belief of one party in the dependability and integrity of a partner in a trade. In this case, trust can be interpreted as the consumer's expectations regarding the clarity, reliability, and orderliness of the information contained in the QR code and a consequent fulfilment of the promises made by the manufacturer. The idea proposed in this study aims to observe whether a more orderly arrangement of information through a now widely used tool can significantly increase levels of consumer trust and brand loyalty. In a study conducted by Parkes et al., (2010), on sustainable fishing, the fundamental role of retailers when it comes to trust emerged. Retailers increasingly must select and promote reliable ecolabels on behalf of their clients due to the amount and variety of ecolabels that are available and the general lack of consumer understanding of labels and fish sustainability issues.

Regarding QR Codes on packaging, previous studies have explored their effects on usage and consumers' attitudes. For instance, studies have looked at consumer knowledge and acceptability of QR Codes (Müge et al., 2014), while others have investigated how QR Codes might be used in a variety of commercial settings, including marketing (Dou & Li, 2008), supply chain (Tarjan et al., 2014), and commerce (Lawry & Choi, 2013). Additionally, a sizable number of surveys have been carried out to document consumer perceptions of the use of QR Codes in food products. The findings of a study conducted by Scanova (2021), named "QR Code statistics 2022" state that the newest use statistics and use scenarios worldwide:

(1) 57% scanned a food QR Code to get specific information about the product.

(2) 38.99% of respondents want to see QR Codes used more broadly in the future.

(3) 67% of the respondents agreed that these codes make life easier.

When trust is introduced as a mediator, one has to consider that often the consumers who frame the QR code are also the most distrustful. There are others who are skeptical about corporations' ability to oversee and regulate products. Retailers would be wise to keep away from the useless language and content that businesses are condemned for using, particularly the nebulous, empty terms that imply admirable sustainability attributes but offer nothing substantive (Consumer Reports, 2011).
The study by Atkinson (2013) examines customer trust in mobile media in general and situates the usage of mobile advertising in the broader context of consumer trust in all sources of product information. It makes sense that people rely on this advertising content as one of a wider range of information sources since they seek out advertising content to learn more about a potential purchase, especially when it comes to the trust statements common to sustainable products. The research confirms that consumers are more inclined to use QR codes when they have less faith in producers to ensure the safety of their products, adequate packaging, and consumer security.
Consumers turn to QR codes when they feel that the truthfulness of claims on packaging and compliance with the law by companies and manufacturers cannot be trusted (Okazaki & Barwise, 2011). The information offered by QR codes gives customers an immediate, pertinent, and helpful message and is accessible when they need it, at the exact moment they are considering making a purchase. This message may help shore up apprehensions' consumers have about corporate claims of sustainability. By being able to find additional information to back up or support otherwise simple and less credible credence claims, consumers may feel more confident in their decision to buy a particular ethical product (Bamba & Barnes, 2007).

The results of Okazaki et al. (2012) and Jung et al. (2012) studies, showed that perceived usefulness and usability of QR codes, as well as perceived attractiveness, may positively influence user attitude towards QR codes; a relationship between the type of product being marketed and expected QR use was discovered by Narang et al. (2012). Current developments in QR evolutions have concentrated on increasing their appeal, partially addressing the apparent lack of growth in client adoption of their use. Baharav and Kakarala (2013) present a novel picture-blending technique for enhancing the visual importance of QR codes for marketing reasons. It enhances QR code aesthetics and visual significance by incorporating images like company logos in full color, without having an adverse effect on mistake correction. Furthermore, Lin et al. (2013a), present a systematic framework for beautifying QR codes that enables a particular user to customize the QR code they make (for instance, a contact-information-only QR code intended to be printed on a business card) by choosing an aesthetically pleasing patterns. Unfortunately, all of these improvements to make QR codes more

appealing to users could also make them more attractive to hackers and other others who want to use them dangerously.

Like many other mobile applications, QR Codes were created with little consideration for security. While most of us will hesitate before opening a dubious email or going to a dubious website, we frequently have no hesitations while scanning a QR code. The majority of individuals are unaware that scanning an unidentified QR code poses significant security risks. Although the QR code itself is safe, unlike an email or website, there is no way to assess the site it will direct you to. An alert user might spot a URL that seems suspicious if the barcode application shows the URL (Petrova et al., 2016).

Research has shown that food traceability systems are successful because customers typically associate traceability with safety and quality characteristics (van Rijswijk et al., 2008; Papetti et al., 2012), fostering trust in both a specific food product and the food system (Chen & Huang, 2013). The need for QR codes on food packaging is specifically supported by the fact that an estimated 92% of consumers expressed a wish to obtain transparent information on product labeling. As a result, a number of well-known companies, including Nestle, recently affixed QR codes to several of its best-selling goods, including the instant Maggi noodles (Menon, 2021).

In the food industry, research have examined the connection between brand and trust (Delgado & Munuera, 2001). Comparing several European nations, Grunert et al. (2000) discovered a relationship between the labeling of organic products and customer trust. The use of the extrinsic attribute ‘generic brand’ is substituted for the use of other extrinsic signals in the purchasing context, such as the outlet or the advice of a specialist, depending on the degree of trust that consumers have in the label, according to these authors (Grunert et al., 2000). According to the literature, it was anticipated that the existence of a QR code would affect consumers' decision to buy because food packaging with less information is more appealing and is thought to be a higher-quality product. Another key element to consider when considering consumer confidence is the greenwashing factor. According to Parguel et al. (2011), "greenwashing" is the practice of deceiving customers about a company's environmental policies or the environmental advantages of a good or service. Green claims must be truthful, true, and transparent. However, a lot of environmental claims that highlight green characteristics are ambiguous and misleading (Chen & Chang, 2013). Previous literature argues that it is not enough to show generic sustainable claims because they risk taking on more the appearance of strategic marketing messages rather than claims driven by a real need to help the environment (Montero-Navarro et al., 2021). Green marketers struggle to persuade consumers of the superiority of their products without giving them reliable facts, which makes it possible for consumers to become

skeptical of their green promises (Chen 2008). According to Montero-Navarro et al. (2021), the negative correlation between greenwash and green trust might be mitigated by green consumer misunderstanding and green perceived risk. Companies need to methodically pinpoint the causes of customer ignorance about the environment and perceived risks associated with it, including greenwash, and address them.

This study will analyse the greater propensity to scan QR codes in the case of information concerning sustainability aspects, from packaging to ecolabels to claims, again with trust as a mediating element.

H_2: The higher propensity of consumers to purchase a product containing sustainable information within a QR code affixed on the packaging is explained by a higher level of trust consumers have in the information presented on the QR code compared to the information dispersed on the packaging.

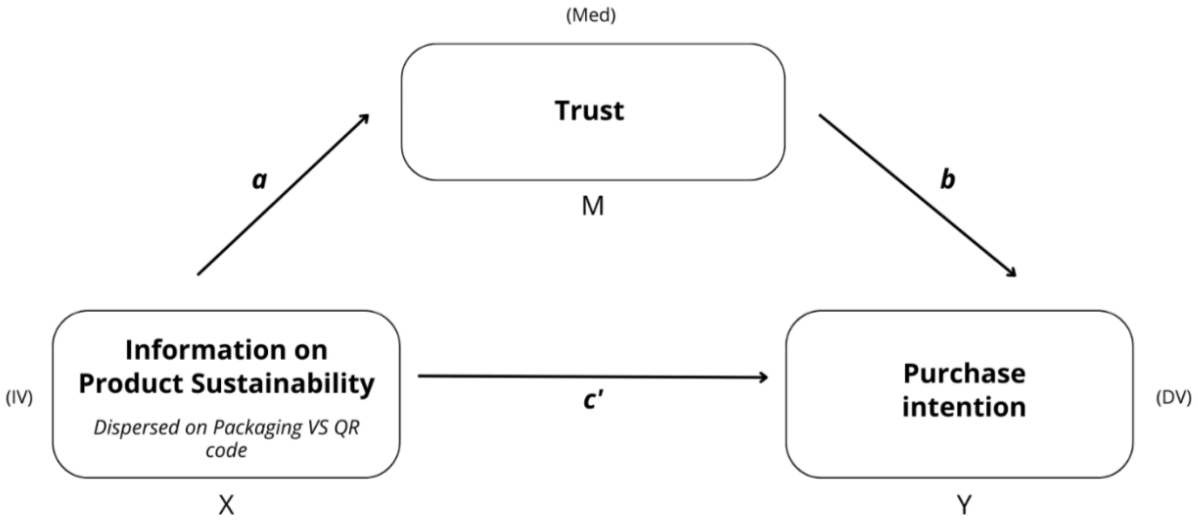


Fig 1. Conceptual model

Mediation model (How/Mediation design): the independent variable (X) consisting of the manipulation of the type of representation of sustainability messages on a food packaging (dispersed information vs. QR code) influences the dependent variable (Y) identified in the purchase intention through the mediation of the mediating variable of the degree of consumer trust (MED).

CHAPTER 3: STUDY AND GENERAL DISCUSSIONS

Content overview

The present experimental study consists of a conclusive causal between subjects 2x1 research design. The results of the experiment are comprised of responses to a questionnaire obtained through a survey conducted independently in Italy during the month of May 2023, using the online platform Qualtrics XM. The survey participants were selected by adopting a non-probabilistic sampling methodology. In particular, it was decided to use a convenience method, thereby exploiting the ease and speed of access and selection of the elements of the population. This technique, in fact, implies no economic cost and is advantageous both in terms of a high speed of data collection and a high response rate. Considering the target sample, it was decided to include respondents with an age range of 18-75, collecting data from both female and male individuals, as demographic variables were not expected to influence the results of the experiment in a statistically significant manner. Within the demographic data, the participants' occupation was also requested to gain a deeper insight into preferences.

The objective of this research is twofold: firstly, we intend to test H1 and thus the existence of a significant effect of the arrangement of the Sustainability on packaging (scattered information vs QR code), the manipulated independent variable, on Purchase intention, the measured dependent variable. Namely, the presence of a QR code clearly visible on the packaging and easily scannable by consumers, summarising the sustainability information in an orderly manner increases purchase intention. Next, to test the H2 hypothesis, the mediating effect of Trust (High vs. Low), measured through pre-validated scales, on the relationship between IV (scattered information vs QR code) and DV (Purchase Intention) will be tested.

As a preliminary step before the main study, it has been verified that the manipulation performed through two mock-ups of a rice package (with QR code and without QR code) was perceived correctly through a pre-test. The eco-labels and claims were selected following a review of food packaging, both by analyzing the type of food and the degree of comprehensiveness of food certification. In total there are three eco-labels going in order of notoriety and three dummy claims linked to each of the above. In the QR code version, the information has simply been grouped and arranged in a neater and accessible graphic view for the consumer without changing any data.

Regarding the main study, it is constructed as follows: each participant has been randomly assigned to one of the two scenarios having Sustainability information on packaging (scattered information vs QR code), then he/she had to express their Purchase Intention and then Trust towards food-related sustainability information using two pre-validated scalesFinally, the demographic data of the sample, in terms of gender, age and occupation, have be recorded.

METHODOLOGY

Pre-test: measuring sustainable packaging information design

To test the effective manipulation of the independent variable, Sustainability on packaging (scattered information vs QR code), a Pre-Test was constructed on Qualtrics.

The pretest was conducted on 55 participants, 5 responses were discarded because they were incomplete. The structure was divided into 3 main sections: an introduction, a randomized presentation of two packaging mockups with related questions about the content displayed, and the final part devoted to demographic data.

The introduction was devoted to presenting the topic of sustainable certifications applied on food packaging.

Next, respondents were randomly but uniformly assigned to one of the relevant scenarios constructed as indicated above, so in the case of Condition 1 each respondent was exposed to rice packaging with scattered sustainable claims and labels, while in Condition 2 the same packaging was presented with a prominently displayed QR code flanked by a cell phone displaying the same sustainability information in a more orderly manner. The ecological labels shown were as follows: Friend of the Heart, PEFC Certified and Fairtrade Certified. The associated claims in the respective order of the ecolables were "Sustainable controlled supply chain," "Forest-friendly packaging," and "Without exploitation of workers and the environment."

In the QR code version, the exhortation to frame the code was, "Want to know all about our sustainable practices? Frame me!"

(*Appendix 1*).

The questions following the two manipulations were about the ability to understand and process the sustainable information applied to the QR code, a scale prevalidated by “Alter A. L., Oppenheimer D. M. (2009). Uniting the tribes of fluency to form a metacognitive nation. *Personality and Social Psychology Review*, 13, 219-235”. The scale is called "processing fluency", it is a 7-point Likert scale consisting of 15 items, of which the 4 most significant ones were used.

(*Appendix 1*)

Finally, demographic data with age and gender were collected: average age of the respondents was found to be 27 years (M_{age} = 32.10, SD = 13.10), although the age range ranged from a minimum of 18 to a maximum of 75 years. The gender of participants is divided almost equally between men (20/50), women (26/50), nonbinary (3/50) and individuals who preferred not to declare (1/50).

The scale used had already been pre-validated in a previous study but a reliability analysis was still performed using SPSS software.

The resulting Cronbach's Alpha is .728, a value that the elimination of no items is able to increase. Therefore, the 7-point Likert scale thus composed can be said to be complete, reliable and comprehensive for measuring the independent variable.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.728	.727	4

Pre-test results

Group Statistics

	IV	N	Mean	Std. Deviation	Std. Error Mean
MCX	1.00	23	5.2609	1.00136	.20880
	.00	27	3.8611	2.07704	.39973

The objective of Pre-Test 1 was to test the actual manipulation of the independent variable, thus the existence of a different perception in terms of understanding the sustainability information on the packaging, specifically sustainable eitchettes and associated claims. An independent t-test was conducted to compare the averages of the two groups (Dispersed information vs QR code). As Levene's statistic shows, the averages are significantly different M_{C1} = 5.27 (SD = 1.00); M_{C2} = 3.87 (SD = 2.08); t(48)= -3.10, p = .004). In particular, condition 1, the one with the packaging with scattered information, was perceived as less clear (M_{C1} = 5.27, SD = 1.00) than the altered and modified one with QR code (M_{C2} = 3.87, SD = 2.08). Therefore, it can be said that the difference, in terms of Understanding the Sustainability Information reported on the packaging, was perceived correctly by the respondents, so the manipulation of the independent variable, due to the success of the Pre-Test, can be considered effective.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means							
						Significance				95% Confidence Interval of the Difference	
		F	Sig.	t	df	One-Sided p	Two-Sided p	Mean Difference	Std. Error Difference	Lower	Upper
MCX	Equal variances assumed	16.207	<.001	2.950	48	.002	.005	1.39976	.47450	.44571	2.35381
	Equal variances not assumed			3.104	38.717	.002	.004	1.39976	.45097	.48736	2.31215

MAIN TEST

Participants and sampling procedure

The survey was distributed to 266 individuals, of whom 201 respondents fully participated in the experimental study, answering fully and completely all the questions within the questionnaire. The remaining 65 incomplete responses were first selected and later discarded from the dataset during the data cleaning procedure. Specifically, 51 responses were not complete while 14 were invalid because the images were not displayed correctly.

Respondents were contacted through an anonymous link generated by the online platform Qualtrics and subsequently sent through instant messaging applications and social media networks as the main channels (Whatsapp or Instagram). The sample of the population reached by the survey included mainly university students and recent graduates located in different cities in Italy. Therefore, the average age of the respondents was found to be 27 years (M_{age} = 27.38, SD = 9.94), although the age range ranged from a minimum of 18 to a maximum of 75 years. Regarding the gender of the subjects, the prevailing gender was found to be female, represented by 63.7% (128/201), while the male gender was characterized by 34.8% (70/201).

The remaining 0.5% (1/201) of respondents selected the third gender option (0.6%, 1/176), or preferred not to identify with a specific gender 1.0% (2/201). The questionnaire was distributed in Italian to facilitate its comprehension and dissemination among the participants, consisted of 6 total blocks and lasted an average of 3-4 minutes (*Appendix 1*).

All graphs and tables relating to the demographic section can be found in *Appendix 2*.

Study 1: The effect of QR code with sustainability information on purchase intention

To measure Purchase Intention, the original 7-items pre-validated Likert scale from “Dodds, W. B., Monroe, K. B., & Grewal, D. (1991). Effects of price, brand, and store information on buyers’ product evaluations. *Journal of marketing research*, 28(3), 307-319” was used. From this scale, 3 items were considered most significant for the current analysis. There was no need to pour any items into positive significance to make the scale uniform.

To measure Trust in sustainability information, the Likert AD Trust (reliability) scale from "Soh, Hyeonjin, Leonard N. Reid, and Karen Whitehill King (2009), "Measuring Trust in Advertising: Development and Validation of the ADTRUST Scale," *Journal of Advertising*, 38 (2), 83-103." a 9-item, 7-item pre-validated scale, was used. This scale measures the degree of belief that information provided by an advertisement is unbiased and trustworthy; it has been adapted to the context of consumer trust in sustainability claims by companies and adopted eco-labels. Of these items, the 6 most significant for the study were considered and did not require modification of the reverse items (*Appendix 1*).

As with the Pre-Test, the analysis of the main test data began by verifying the validity and reliability of the scales used for the mediator and dependent variable through Factor Analysis and Reliability Analysis. Initially, it was decided to perform two exploratory factor analyses in order to examine and validate the items of the scales used in the conceptual research model. In particular, principal component analysis was performed as an extraction method, applying VARIMAX as a relation technique. To decide how many factors to extract, the total explained variance table was observed by verifying that, according to Kaiser's rule, the eigenvalues (Eigenvalues) were greater than 1 and that the cumulative variance as a percentage was greater than 60%. In addition, the table of commonalities and the component matrix were observed. Specifically, all items were found to have an extraction value greater than 0.5 and a loading score greater than 0.3. Therefore, it was decided to retain all items making up the scales and validate them.

With regard to the dependent variable “Purchase Intention”, however, the following emerges:

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.773
Bartlett's Test of Sphericity	Approx. Chi-Square	556.316
	df	3
	Sig.	<.001

The KMO test concerning the measurement of sampling adequacy was performed. For the first scale, relating to the DV, a value of 0.773 was found, the result is close to 0.80 so it can be considered acceptable. Thus, it can be stated that sufficient information is available for the Factor Analysis. Furthermore, by observing Bartlett's Test, it was possible to ascertain the absence of a diagonal matrix and therefore a strong correlation between the variables, as the p-value is equal to < 0.001 and therefore significant.

Analysing the table of commonalities (*Appendix 3*), it appears that all items are > 0.5. On the other hand, looking at the table of the total explained variance, it was possible to see, again, the presence of only one eigenvalue, which explains more than 70% of the variance.

All items of the scale allow Purchase Intention to be measured.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.700	90.007	90.007	2.700	90.007	90.007
2	.161	5.352	95.359			
3	.139	4.641	100.000			

Extraction Method: Principal Component Analysis.

Once the scale was valid, its reliability was also tested with Reliability Analysis.

Reliability Statistics

Cronbach's Alpha	N of Items
.944	3

From the reliability statistics table, it appears that the Cronbach's Alpha being 0.944, and greater than 0.9, is considered an excellent value for assessing the internal consistency of the scale. Furthermore, the item-total statistics table (*Appendix 4*) shows that no items should be eliminated because otherwise the value of the Cronbach's Alpha would decrease. Thus, the scale is also reliable.

Study 2: Trust as Mediator between IV and DV

With regard to the mediator "Trust", the following emerges:

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	.877

Bartlett's Test of Sphericity	Approx. Chi-Square	1052.830
	df	15
	Sig.	<.001

For this scale, too, it can be said that there is sufficient information for Factor Analysis, as the sampling adequacy measure is 0.877 which is very close to 0.90 so it is to be considered almost excellent. Furthermore, observing Bartlett's Test, it was possible to ascertain the absence of a diagonal matrix and therefore a strong correlation between the variables, as the p-value is <.001 and therefore significant.

Analysing the table of commonalities (*Appendix 5*), it appears that all items are > 0.5. On the other hand, looking at the table of the total explained variance, it was possible to see, again, the presence of only one eigenvalue, which explains more than 70% of the variance.

All items of the scale allow trust to be measured.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.541	75.691	75.691	4.541	75.691	75.691
2	.602	10.035	85.726			
3	.323	5.380	91.106			
4	.216	3.607	94.712			
5	.165	2.758	97.470			
6	.152	2.530	100.000			

Extraction Method: Principal Component Analysis.

Once the scale was valid, its reliability was also tested with Reliability Analysis.

Reliability Statistics

Cronbach's Alpha	N of Items
.934	6

From the Reliability Statistics table, it appears that Cronbach's Alpha being .934, and greater than 0.9, is considered an excellent value for assessing the internal consistency of the scale. Furthermore, the item-total statistics table (*Appendix 6*) shows that no items should be eliminated because otherwise the value of the Cronbach's Alpha would decrease. Thus, the scale is also reliable.

RESULTS

Final analysis and comments

Before testing weather mediation took place, affecting the relationship between IV and DV, a One-Way Anova Test was conducted. It consists of the analysis of variance and is a procedure that tests whether differences exist between two or more population means.
In this case, the comparison was between a manipulated independent variable, Sustainability on packaging (C_1 = scattered information vs C_2 = QR code) and a quantitative dependent variable, Purchase Intention (mean, 3-items, 7-Point Likert scale).

ANOVA

DV

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	90.659	1	90.659	45.152	<.001
Within Groups	399.568	199	2.008		
Total	490.227	200			

Group means are significantly different (F (199) = 45.152, p < 0.001). Thus, type of message framing has a differential impact on Purchase Intention mean.

After verifying the validity and reliability of the scales and calculating the averages ('purchase_mean' and 'trust_mean'), it was possible to proceed to the analysis of mediation. This can be calculated according to two models: (1) the traditional approach of Baron and Kenny (1986), i.e. through single regressions, or (2) according to a more modern approach, PROCESS. In this paper, mediation was calculated using PROCESS and model 4 (*Appendix 7*). The first step is to test the effect of the independent variable on the mediator. To test the success of the mediation effect, it was necessary to distinguish it into two different relationships: a first effect between the independent variable and the mediator (path a) and a second effect between the mediator and the dependent variable (path b). Specifically, to demonstrate the statistical significance of both hypotheses, a 95% confidence interval was adopted with an alpha reference value of 5%. In addition, it was necessary to ensure that the extremes of the confidence range (LLCI = Lower Level of Confidence Interval; ULCI = Upper Level of Confidence Interval) for each relationship complied with the sign concordance (both positive or both negative), so that there was no zero within. Finally, to assess the sign and magnitude of each effect, the β coefficients of the regression analysis of both relationships between the variables were examined.

As shown in the analysis, the effect of packaging type (dispersed information vs. QR code) (IV) on Trust (MEDIATOR) is positive and statistically significant, suggesting that the packaging version with the sustainable information grouped in the QR code increases consumer trust (path *a*). With regard to this first part of the indirect effect, a p-value of 0.0000, a favorable confidence interval (LLCI = 0.1493; ULCI= 0.8050) and a positive regression coefficient β of 0.4772 were noted by observing the SPSS output. Therefore, this section of the indirect effect was statistically significant, thus confirming pathway a (B = 0.4772; SE = 0.1663; t = 2.8699; p = 0.000). A clearer and neater display of information on Ecolabels and claims leads to a greater sense of trust on the part of consumers.

Moving on to analyse the effect of Trust (MEDIATOR) on purchase intention (DV), this also turns out to be positive and statistically significant (β = 0.7895; SE = 0.0639; t = 12.3483; p = 0.0000), suggesting that greater trust in sustainability information, such as food certifications and claims, increases consumer intention to purchase the product (path *b*).
The statistical significance of both paths *a* and *b* provides initial evidence of the mediating role of trust in the relationship between the independent and dependent variable. Whereas the statistical significance of path C_1, i.e. the significant direct effect of the type of packaging containing sustainable information on the purchase intention, suggests that trust partly mediates the effect of the IV on the DV. However, in order to check whether there is indeed mediation, it is necessary to analyse the indirect effect and check whether it is significant, as only then will there be mediation. The p-value is not observed, which is not indicated, but the values of the confidence intervals: if they contain zero, the effect is non-significant; if they do not contain zero, the effect is significant. One must therefore look at the signs of the two values, which must agree. In this case, BootLLCI = 0.5618 and BootULCI = 1.1986, the zero is not contained and the effect is significant. Therefore, there is mediation. Finally, since both the main effect and the indirect effect are significant, the mediation is said to be partial. (*Appendix 7*)

GENERAL DISCUSSIONS

Introduction

The concluding chapter is dedicated to analysing the results of this research from a theoretical and managerial perspective. The results of this quantitative experimental study confirm the two initial hypotheses: the presence of sustainability information encapsulated in the QR code available on a product's packaging, as opposed to the presence of the same information dispersed on the product's

packaging, has a positive effect on the purchase intention of the product. Furthermore, by introducing trust as a mediating element, it was found that this effect is explained by the fact that consumers trust more the brands that display their sustainable certifications and claims with QR codes rather than adding them directly on the packaging.

The aim of the paper is to highlight contributions not only to the literature, but also to provide managerial contributions for companies in the food sector, especially SMEs that want to marginalize within the large-scale retail trade. The results offer insights to support corporate decision making in order to implement more effective communication strategies regarding sustainable packaging information to establish strong and lasting relationships with consumers. One of the most difficult challenges for the future will be to effectively convey the importance and possibilities of social and environmental sustainability and to generate a positive attitude on the part of consumers who place their trust in the hands of food producers. Limitations to such a study are also explained.

Theoretical implications

From a theoretical point of view, this study makes an important contribution to the literature and rises the limited body of research on food brand communication on environmental and social sustainability issues through new communication strategies applied to packaging.

Previous research attests that packaging remains one of the most polluting factors globally (Deshwai et al., 2019), particularly the wide range of plastic wrappings that account for about 40 per cent of total plastic consumption worldwide (Geyer et al., 2017). Several trends are emerging in the food market today, these results build on existing evidence of previous research. Manufacturers are implementing an increasing number of sustainability claims, certifications, messages and other information tools to distinguish their products in response to the growing demand for sustainable food products and the increasing 'environmental competitiveness' between brands (Annunziata et al., 2019; Grunert et al., 2014). In turn, consumers, who are increasingly concerned about the condition of the planet, demand to be informed about how their food is produced, to the detriment of producers who are protagonists of greenwashing episodes (Aprile & Punzo, 2022). With regard to food labeling, mixed views emerge on the level of understanding attested to consumers: according to some scholars, sustainability labels help reduce the information imbalance between supply and demand for knowledge on environmental and social issues (Delmas & Grant, 2014; Nikolaou & Kazantzidis, 2016; Shao, 2016), according to Aprile and Mariani (2015), the recent proliferation of standards and certifications puts consumers at risk and may generate skepticism. This study confirms previous findings in the literature that attest not only to an increased consumer interest in sustainable packaging, but also to a willingness to fully understand the meaning of food labelling. This was

confirmed in the consumer's preference for packaging with the QR code, where information was more neatly located and higher values were recorded in the survey under the items 'reliable' and 'clear'.
Today, especially due to the speed with which laws change, it is increasingly difficult for consumers to be aware, even superficially, of existing sustainable labels, and often the crowding of packaging with claims and certifications causes overthinking and prior disinterest (Nikolaou & Kazantzidis, 2016). This study found an alternative solution to classical ways of informing consumers by reducing the amount of input displayed directly on the often very small packaging and introducing a widely used and popular technological tool such as QR code. The results of the following study are in accordance with those of other scholars, indeed, it has been shown that the use of QR codes is a viable method to help consumers access more complete and relevant product information (Chien-Ta Bruce & Jhong-Min Denis, 2017), as well as being very useful in sharing and influencing customer satisfaction and purchase intentions (Hossain et al., 2018). Although ecolables are often not fully understood by consumers, the willingness to pay a higher price for food products with certifications has risen in recent years (Annunziata et al., 2019; Lombardi et al., 2017), this is a significant finding for the following research because it lays the pillars for the consequent managerial implications. The specific choice of sustainable labels to be included in the packaging mock-ups of this experiment proved to be valid and in accordance with a 'mini-guide' published by GS1 Italy (2021) on the main logos and certifications known in the packaging world. In addition to PEFC (Programme for sustainable forestry through independent third-party certification), already reported by GS1 Italy, the Fairtrade label and Friends Of The Earth also proved to be effective for the purposes of the experiment as they were correctly transposed by the sample. Another key milestone that will lead to the conclusions of this study is the presence of consumer trust in the food system of certifications, sustainable claims, and especially toward brands that pursue green ways. When we refer to trust, we mean food traceability systems, which are successful because customers typically associate traceability with safety and quality features (van Rijswijk et al., 2008; Papetti et al., 2012), fostering trust in both a specific food product and the food system (Chen & Huang, 2013). Linking consumer trust with the proposal of QR codes in the independent variable, the need for these codes on food packages is particularly supported by the fact that an estimated 92% of consumers expressed a desire for transparent product labeling information (Menon, 2021). This was also the case for this study, which confirmed the key role of trust in increasing the propensity to purchase products. When consumers place trust in a brand's sustainable actions, they have a higher propensity to purchase the product itself, specifically preferring the QR code version for greater usability of information.

Managerial implications

Sustainable development, and the resulting communication, represents an opportunity to improve brand differentiation and corporate image, especially in light of the fact that consumers of grocery products are among the most socially and environmentally conscious and aware. However, as the most effective way of communicating social responsibility has not yet been identified, the study was carried out with the aim of investigating this issue. In particular, it demonstrates how QR can generate exponentially more understanding and engagement in consumers than the usual sustainability claims scattered on the packaging.

Indeed, by implementing an effective communication strategy, resorting to the use of a QR code to communicate environmental and social responsibility initiatives, food brands could overcome the apparent gap and detachment perceived by consumers by facilitating the establishment of a direct and lasting relationship. The QR code is a tool that is now highly popular, easy to use, and known even by audiences less familiar with technology. "This code continuously updates itself, allowing information to be updated and integrated (Hossain et al., 2018), thus making understanding increasingly linear. Demonstrating brands' social commitment to their neighbors allows consumers, who are increasingly sensitive to issues of sustainability and social responsibility, to know, understand, and identify with what a brand's brand values and mission are.

Previous literature states that consumers are more likely to use QR codes when they are more skeptical of manufacturers regarding the safety of their products, proper packaging, and consumer safety (Okazaki & Barwise, 2011; Atkinson, 2013). The results of this study are relevant for companies that have made mistakes in their communication strategies regarding sustainable environmental and social practices in order to restore their reputation and reactivate sales.

The use of a QR code allows for a more orderly display of content on a mobile screen as the sustainable claims are displayed next to the certification mark, in this way the consumer not only understands the scope of origin of the certification, but gradually increases their level of trust and affiliation with the brand. For example, in this study, the sustainable claim "packaging produced in respect of forests" was associated with the PEFC mark within the packaging containing QR codes, in C_1 they were instead in two separate places and may have increased the level of entropy in the cognitive process.

Crowding of information, moreover with very small fonts, is another issue that this study sought to address; a single statement as a call to action to scan the QR code, creates curiosity in the consumer and is the solution for the consumer who would otherwise be overwhelmed. Another important consideration is that, given the ability to continuously update the information contained in QR codes without the need to change the frame being scanned, producers can keep up with updates in laws

regarding certifications. They can also add relevant information regarding implementations with new sustainable technologies within the production chain that reduce food waste and emissions harmful to the environment. All of these expedients, which are easily integrable into QR technology, allow in the long run to increase the connection with consumers, generate loyalty, word of mouth and positive reviews.

Limitations and Future research

Despite the theoretical and managerial contributions made by the research, this study has some limitations that should be addressed by future research.

The main limitation of this study concerns the lack of certainty that consumers will choose to frame the QR code correctly when they are in the shops or may not display it correctly due to an absent internet connection. Future research could investigate strategies for engaging call-to-actions that can intrigue consumers while involving and empowering them on important issues such as environmental and social sustainability.

The second limitation concerns the sample. This, in fact, is represented by the not large number of respondents to the survey (201) and also by the chosen convenience sampling type. This type of non-probability sampling is not representative of the entire population and is easily subjected to bias. In fact, it is a type of sampling done according to certain practical criteria such as easy accessibility, geographic proximity, availability at a given time, or willingness to participate (Etikan et al.,2016). Convenience sampling is so called because it is convenient, easy and the subjects are readily available. In this case, for example, subjects who do not have adequate knowledge of social sustainability, or the food sector, participated in the questionnaire. In addition, it would be interesting to conduct a survey aimed exclusively at Generation Z and Millennials, who are the consumers most sensitive to issues such as social responsibility and sustainability, but at the same time least familiar with large retail outlets (supermarkets). Boomers and Generation Y, in fact, are the main stakeholders in the study as they are the ones who go most frequently to buy groceries.

Furthermore, future research, should continue to investigate the topic of social and environmental sustainability, not only as an abstract concept, but by analyzing its practical applications in food companies and implementations in food supply chains. The proliferation of food certifications could lead to two negative outcomes: on the one hand, increased confusion in the minds of consumers at the time of choice, and on the other hand, the implementation of greenwashing companies. Future research should review the most efficient control systems that companies could undergo in order to be perceived as authentic. Likewise, then, it should continue to investigate the most effective way of communicating sustainability initiatives and topics, overcoming the limitation of this paper, which

focused only on QR code mode. The literature should also analyze the change in consumer responses according to colors, text, font, packaging of different shapes and materials, and so on.

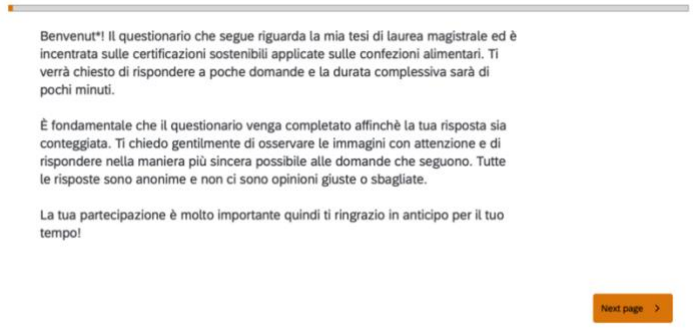
In addition, it would be interesting to conduct a study that instead of reporting only claims and associated sustainable certifications, increases the amount of material contained in the QR code, for example, provides a full description of the process to arrive at taking a green certification (including resources invested and time spent), or presents a rewards system for consumers who scan the QR code correctly. These ways make it possible to increase customer engagement and generate loyalty.

An additional limitation also concerns the studied sector, namely food, since the results cannot be extended to other industry sectors, for example household items (also provable in supermarkets). Therefore, it would be interesting to propose a comparison between the results obtained in this study and a hypothetical one on the household products sector considering that recent studies suggest that sustainability has now also become a strategic goal for companies of household products, such as synthetic cleaning cloths (Henry et al., 2019). Therefore, future literature could provide further input by investigating the role that social sustainability plays in this sector.

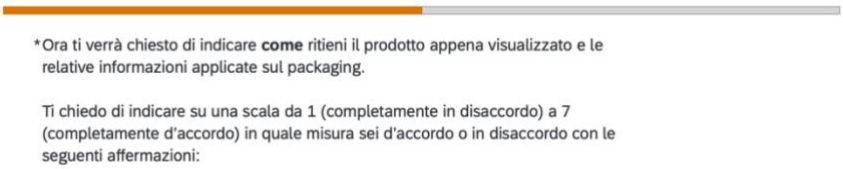
APPENDIX

Appendix 1: questionnaire

Block 1 – Introduction



Block 2 – Instructions



Block 3 – Conditions (IV)

- Condition 1

- Condition 2

Block 4 – Purchase Intention (DV)

*Dopo aver osservato i **contenuti raffigurati sul packaging**, ti chiedo gentilmente di valutare queste affermazioni.

Esprimi su una scala da 1 (completamente in disaccordo) a 7 (completamente d'accordo) in quale misura sei d'accordo o in disaccordo con le seguenti affermazioni:

	Completamente in disaccordo 1	In disaccordo 2	Abbastanza in disaccordo 3	Né d'accordo né in disaccordo 4	Abbastanza d'accordo 5	D'accordo 6	Completamente d'accordo 7
La probabilità di acquistare questo prodotto è molto alta	○	○	○	○	○	○	○
La probabilità che prenda in considerazione l'acquisto del prodotto è molto alta	○	○	○	○	○	○	○
La mia disponibilità ad acquistare il prodotto è molto alta	○	○	○	○	○	○	○

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Block 5 – Trust (MED)

*Ora ti verrà chiesto di indicare **come** ritieni il prodotto appena visualizzato e le relative informazioni applicate sul packaging.

Ti chiedo di indicare su una scala da 1 (completamente in disaccordo) a 7 (completamente d'accordo) in quale misura sei d'accordo o in disaccordo con le seguenti affermazioni:

	Completamente in disaccordo **1**	In disaccordo **2**	Abbastanza in disaccordo **3**	Né d'accordo né in disaccordo **4**	Abbastanza d'accordo **5**	D'accordo **6**	Completamente d'accordo **7**
Ritengo il prodotto appena visualizzato **onesto**	○	○	○	○	○	○	○
Ritengo il prodotto appena visualizzato **attendibile**	○	○	○	○	○	○	○
Ritengo il prodotto appena visualizzato **credibile**	○	○	○	○	○	○	○
Ritengo il prodotto appena visualizzato **affidabile**	○	○	○	○	○	○	○
Ritengo il prodotto appena visualizzato **accurato**	○	○	○	○	○	○	○
Ritengo il prodotto appena visualizzato **chiaro**	○	○	○	○	○	○	○

Next page ›

Blocco 6 – Demographics

1. Age

*Qual'è la tua età?

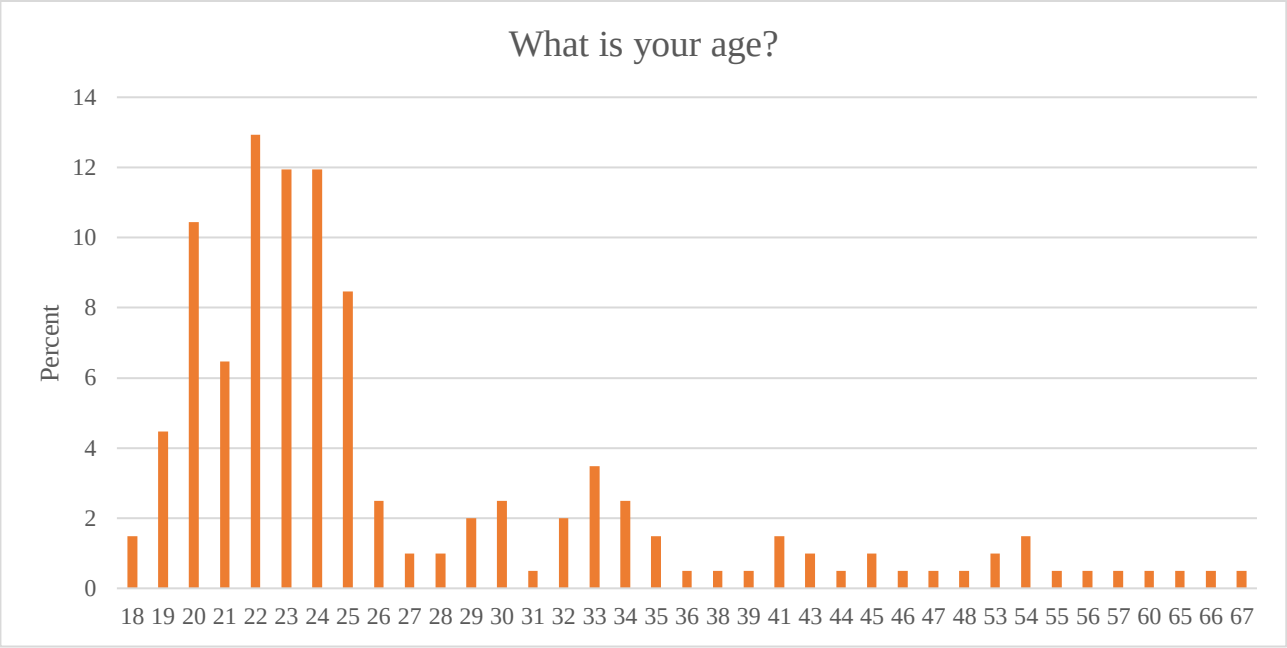
Next page ›

2. Gender

3. Occupation

Appendix 2: demographics

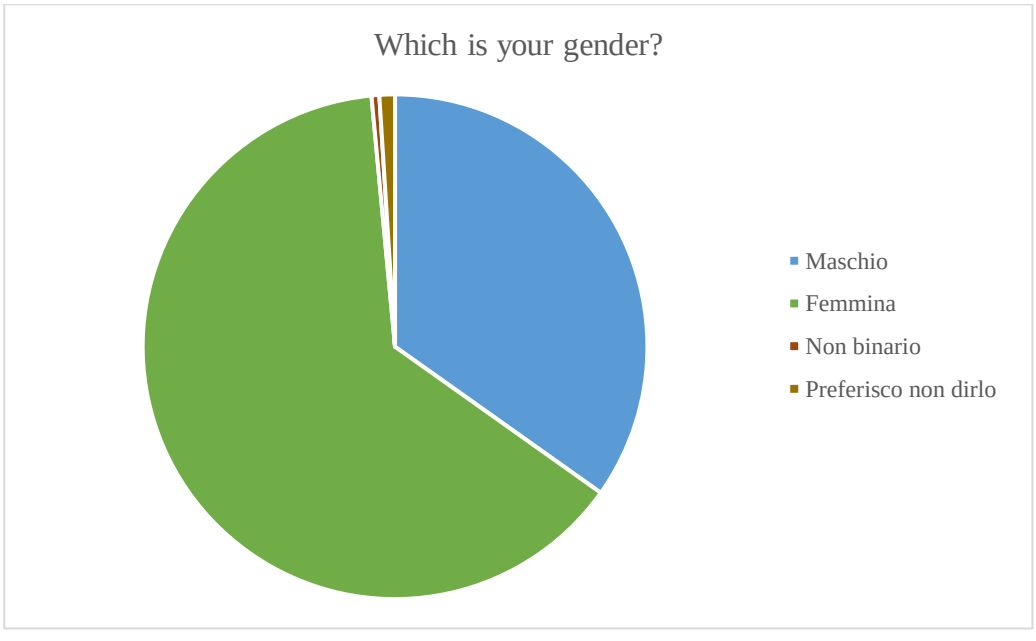
1.1 Age



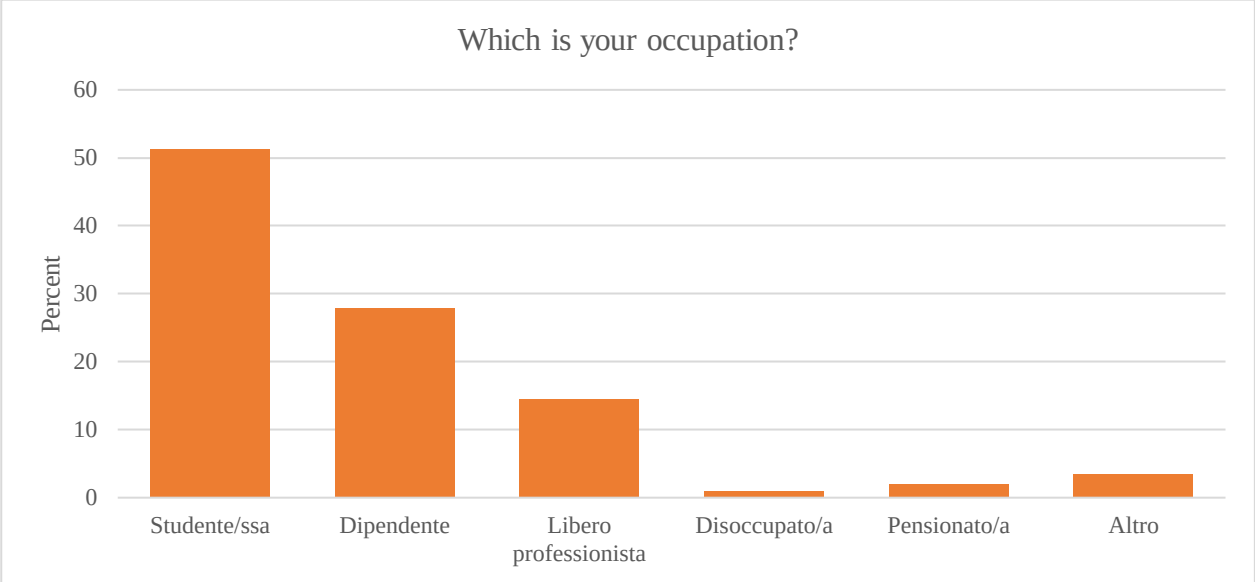
2.1 Gender

Which is your gender?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Maschio	70	34.8	34.8	34.8
	Femmina	128	63.7	63.7	98.5
	Non binario	1	.5	.5	99.0
	Preferisco non dirlo	2	1.0	1.0	100.0
	Total	201	100.0	100.0	



3.1 Occupation



Appendix 3: purchase intention Communalities

Communalities

	Initial	Extraction
Esprimi su una scala da 1 (completamente in disaccordo) a 7 (completamente d'accordo) in quale misura sei d'accordo o in disaccordo con le seguenti affermazioni: - La probabilità di acquistare questo prodotto è molto alta	1.000	.897
Esprimi su una scala da 1 (completamente in disaccordo) a 7 (completamente d'accordo) in quale misura sei d'accordo o in disaccordo con le seguenti affermazioni: - La probabilità che prenda in considerazione l'acquisto del prodotto è molto alta	1.000	.908
Esprimi su una scala da 1 (completamente in disaccordo) a 7 (completamente d'accordo) in quale misura sei d'accordo o in disaccordo con le seguenti affermazioni: - La mia disponibilità ad acquistare il prodotto è molto alta	1.000	.896

Extraction Method: Principal Component Analysis.

Appendix 4: purchase intention Item-Total Statistics

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted

Esprimi su una scala da 1 (completamente in disaccordo) a 7 (completamente d'accordo) in quale misura sei d'accordo o in disaccordo con le seguenti affermazioni: - La probabilità di acquistare questo prodotto è molto alta	9.73	10.037	.880	.921
Esprimi su una scala da 1 (completamente in disaccordo) a 7 (completamente d'accordo) in quale misura sei d'accordo o in disaccordo con le seguenti affermazioni: - La probabilità che prenda in considerazione l'acquisto del prodotto è molto alta	9.65	10.278	.892	.913
Esprimi su una scala da 1 (completamente in disaccordo) a 7 (completamente d'accordo) in quale misura sei d'accordo o in disaccordo con le seguenti affermazioni: - La mia disponibilità ad acquistare il prodotto è molto alta	9.68	9.918	.879	.922

Appendix 5: trust Communalities

Communalities

	Initial	Extraction
Ti chiedo di indicare su una scala da 1 (completamente in disaccordo) a 7 (completamente d'accordo) in quale misura sei d'accordo o in disaccordo con le seguenti affermazioni: - Ritengo il prodotto appena visualizzato onesto	1.000	.678
Ti chiedo di indicare su una scala da 1 (completamente in disaccordo) a 7 (completamente d'accordo) in quale misura sei d'accordo o in disaccordo con le seguenti affermazioni: - Ritengo il prodotto appena visualizzato attendibile	1.000	.774
Ti chiedo di indicare su una scala da 1 (completamente in disaccordo) a 7 (completamente d'accordo) in quale misura sei d'accordo o in disaccordo con le seguenti affermazioni: - Ritengo il prodotto appena visualizzato credibile	1.000	.804
Ti chiedo di indicare su una scala da 1 (completamente in disaccordo) a 7 (completamente d'accordo) in quale misura sei d'accordo o in disaccordo con le seguenti affermazioni: - Ritengo il prodotto appena visualizzato affidabile	1.000	.813
Ti chiedo di indicare su una scala da 1 (completamente in disaccordo) a 7 (completamente d'accordo) in quale misura sei d'accordo o in disaccordo con le seguenti affermazioni: - Ritengo il prodotto appena visualizzato accurato	1.000	.784

Ti chiedo di indicare su una scala da 1 (completamente in disaccordo) a 7 (completamente d'accordo) in quale misura sei d'accordo o in disaccordo con le seguenti affermazioni: - Ritengo il prodotto appena visualizzato chiaro	1.000	.689

Extraction Method: Principal Component Analysis.

Appendix 6: trust Item-Total Statistics

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Ti chiedo di indicare su una scala da 1 (completamente in disaccordo) a 7 (completamente d'accordo) in quale misura sei d'accordo o in disaccordo con le seguenti affermazioni: - Ritengo il prodotto appena visualizzato onesto	24.58	45.384	.743	.929
Ti chiedo di indicare su una scala da 1 (completamente in disaccordo) a 7 (completamente d'accordo) in quale misura sei d'accordo o in disaccordo con le seguenti affermazioni: - Ritengo il prodotto appena visualizzato attendibile	24.58	43.745	.815	.921
Ti chiedo di indicare su una scala da 1 (completamente in disaccordo) a 7 (completamente d'accordo) in quale misura sei d'accordo o in disaccordo con le seguenti affermazioni: - Ritengo il prodotto appena visualizzato credibile	24.45	43.109	.842	.917
Ti chiedo di indicare su una scala da 1 (completamente in disaccordo) a 7 (completamente d'accordo) in quale misura sei d'accordo o in disaccordo con le seguenti affermazioni: - Ritengo il prodotto appena visualizzato affidabile	24.48	42.811	.849	.916
Ti chiedo di indicare su una scala da 1 (completamente in disaccordo) a 7 (completamente d'accordo) in quale misura sei d'accordo o in disaccordo con le seguenti affermazioni: - Ritengo il prodotto appena visualizzato accurato	24.33	41.353	.837	.917
Ti chiedo di indicare su una scala da 1 (completamente in disaccordo) a 7 (completamente d'accordo) in quale misura sei d'accordo o in disaccordo con le seguenti affermazioni: - Ritengo il prodotto appena visualizzato chiaro	24.19	41.507	.761	.929

Appendix 7: Matrix

Run MATRIX procedure:

```
***************** PROCESS Procedure for SPSS Version 4.0 *****************
        Written by Andrew F. Hayes, Ph.D.       www.afhayes.com
    Documentation available in Hayes (2022). www.guilford.com/p/hayes3
**************************************************************************
Model  : 4
    Y  : DV
    X  : IV
    M  : MED
Sample
Size:  201
**************************************************************************
OUTCOME VARIABLE:
 MED
Model Summary
        R      R-sq       MSE         F       df1       df2         p
    .4222     .1783    1.4014   43.1723    1.0000   199.0000     .0000
Model
          coeff       se         t         p       LLCI      ULCI
constant   4.3574     .1161   37.5366     .0000    4.1285    4.5863
IV         1.0980     .1671    6.5706     .0000     .7684    1.4275

**************************************************************************
OUTCOME VARIABLE:
 DV
Model Summary
        R      R-sq       MSE         F       df1       df2         p
    .7345     .5395    1.1401   116.0008    2.0000   198.0000     .0000
Model
          coeff       se         t         p       LLCI      ULCI
constant    .7553     .2976    2.5379     .0119     .1684    1.3422
IV          .4772     .1663    2.8699     .0046     .1493     .8050
MED         .7895     .0639   12.3483     .0000     .6634     .9156

************************** TOTAL EFFECT MODEL ****************************
OUTCOME VARIABLE:
 DV
Model Summary
        R      R-sq       MSE         F       df1       df2         p
    .4300     .1849    2.0079   45.1517    1.0000   199.0000     .0000
```

Model

	coeff	se	t	p	LLCI	ULCI
constant	4.1955	.1389	30.1949	.0000	3.9215	4.4695
IV	1.3440	.2000	6.7195	.0000	.9496	1.7384

********** TOTAL, DIRECT, AND INDIRECT EFFECTS OF X ON Y **********

Total effect of X on Y

Effect	se	t	p	LLCI	ULCI
1.3440	.2000	6.7195	.0000	.9496	1.7384

Direct effect of X on Y

Effect	se	t	p	LLCI	ULCI
.4772	.1663	2.8699	.0046	.1493	.8050

Indirect effect(s) of X on Y:

	Effect	BootSE	BootLLCI	BootULCI
MED	.8668	.1622	.5618	1.1986

********** ANALYSIS NOTES AND ERRORS **********

Level of confidence for all confidence intervals in output:

95.0000

Number of bootstrap samples for percentile bootstrap confidence intervals:

5000

------ END MATRIX -----

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SUMMARY

OVERVIEW AND CONCEPTUAL FRAMEWORK

The climate has changed significantly over time, it is a global threat that has started to strain several industries. Climate change and biodiversity loss are two examples of the permanent environmental repercussions of human activity (Kan & Miller, 2022; Springle et al., 2022).

But from a worldwide standpoint, the National Geographic Society reports that in 2020 the availability and wide diversity of plastic packaging continue to be the recycling industry's main Achilles heel. More plastic garbage is produced by product packaging than by any other sector. By weight, they make up 59% of all plastic garbage in Europe. Packaging is the largest market segment for plastics in the US, accounting for a third of this. The packaging sector is being impacted by plastic pollution, packaging waste, diminishing air, soil, and water quality, climate change, and other modern problems (Deshwal et al., 2019). Because most food packaging is single-use only and discarded after a short time, the current packaging waste management sector lacks circularity (Geueke et al., 2018). Due to its fluidity, moldability, heat salability, ease of printing, and ability to be incorporated into manufacturing processes, plastic is a material that is still frequently used for food packaging (Marsh & Bugusu, 2007).

According to a Mckinsey study's results published in the article *True packaging sustainability: Understanding the performance trade-offs* (2021), attempts to create sustainable packaging frequently center on reducing leakage, enhancing circularity, lowering carbon footprints, or a combination of the three. Another key contributor to global food pollution is the transport of food around the world. Transporting food from far-flung regions of the world emits greenhouse gases that contribute to at least 30% of global pollution (Journal Nature Food, 2022). According to a statement from the Food Nature report, *"...the global transit of commodities linked with eating fruit and vegetables produces 36% of the emissions of food miles, about twice as much as is generated during their production".*

It is crucial to bear in mind that while packaging remains the main problem at the global pollution level, both in terms of the materials used and their disposal, the food production chain is also impactful on the environment. The production, preparation, and consumption of food results in significant amounts of solid and liquid waste, which is produced by the food-processing industry (Khedkar & Singh, 2018). In the upcoming years, food production is anticipated to increase, this is due to the expanding population's increased need for food (Springmann et al., 2018). The agricultural industry is among the most polluting in the world (Ritchie et al., 2022), 70% of global freshwater withdrawals are used for agriculture (FAO, 2011) and 78% of global ocean and freshwater

eutrophication is caused by agriculture (Poore & Nemecek, 2018). Next comes the food industry, which is seeing a dramatic increase in consumer waste: in Italy a +15 percent in 2021 compared to 2020, with 31 kg of food wasted per person. Beef, lamb, fish (especially salmon), eggs, pork, chocolate, coffee, and dairy products (especially cheese and yogurt) are the foods that consume the most CO_2 to reach our table (Roukas & Kotzekidou, 2022).

On the other hand, we have the consumers, the real players in the social action toward a more sustainable world (Otto et al, 2021). They are increasingly careful and demanding, and they tend to inform themselves more and more before purchasing, given that they are increasingly faced with prohibitive choices both from an economic and environmental point of view (Lin & Chang, 2012). Consumers are confused by labels populated with green certifications, sustainable claims, mandatory nutritional values, and recycling claims. There are differences unknown to consumers between voluntary environmental, social or animal welfare and ecological certifications, PDO or PGI labels referring to the origin of food, and mandatory hygiene/health certifications. Retailers must find an effective way to convey the promise of sustainability and the use of sustainable practices to consumers.

This study aims to explore how retailers can communicate their efforts to achieve better levels of sustainability.

Continuing to explore the packaging factor in the paper, a general definition of packaging is given, which is divided into three levels (Garcia-Arca & Prado, 2008): the primary, or *consumer packaging* level, is the first and serves to safeguard the goods. The secondary level, sometimes referred to as *transport packaging*, is made to house and collect many primary packages. The third level of packaging is called *tertiary packaging*, and it consists of several primary or secondary packages stacked on a pallet or a road unit.

The literature also brings out the positive side of packaging in addition to the polluting side that always emerges as primary; packaging reduces waste in two important ways, stemming from its function as a processor (Kohan, 2000) and protector (Pongrácz, 2007). Food losses are between 15% and 30% of the food purchased in Europe and the United States (Quested & Johnson, 2009), but the numbers would be tripled without packaging. There are different types of packaging, the main materials are reviewed, their respective pollution levels and the possibility of recycling, specifically plastic, glass, metal, paper and cardboards and baked foods. Then follows the consideration of the management of these materials, the concepts of Sustainable Supply Chain Management (SSCM) within the triple bottom line (TBL) perspective are introduced, which uses the product-packaging construct and considers the entire life cycle of the product-packaging combination, can be useful in analyzing packaging in more depth (Lutters & Klooster, 2008). At this point, the most effective tool

is introduced to estimate sustainability in the food packaging business, il Life Cycle Assessment (LCA). LCA has historically been utilized by branches and international corporations to increase consumer confidence in the environmental impact of their products. LCA has allegedly been utilized as a branding strategy to support consumers' choices and preferences for items. However, despite its informative value regarding impacts on the environment, society, and economy, such a classic process LCA has been overly expensive for businesses to conduct, which has led to a decline in its utilization as a sustainability metric tool for businesses (Curran, 2006). LCA is the most comprehensive and process-relevant facultative certification that manufacturers can request, describes the environmental effects of a company's products or operational systems; more recently, it has also included the economic and social effects (Lauesen, 2019).

Up to this point, an attempt has been made to establish a common, objective criterion for quantifying the sustainability of packaging and its relationship to the product throughout the entire value chain. Next, it will be necessary to identify the right communication strategies towards consumers. Customers typically rely on inference techniques to guide their decisions because they have insufficient information on sustainability. Consumers must be aware of the findings of the life cycle analysis (LCA) of packaging materials and processes for the packaging sector to grow sustainably. consumer perceptions of sustainable packaging are not always in line with a package's real sustainability. Similar to the results obtained in the aforementioned study (Steenis et al., 2017), significant discrepancies have been found in the literature between LCA results and consumers' classification of sustainable traits (Terrachoice, 2010; Pancer et al., 2017). Consumers often rank the product by packaging, and therefore glass and cardboard packaging are ranked as the most sustainable, omitting how the product was sourced or produced, which therefore does not include the total environmental load.

Although definitions of sustainable packaging continue to evolve in parallel with the principles of sustainable development, research has shown that sustainable packaging is not communicated well to consumers (Lindh et al., 2016).

The main reason why labeling then takes over is the evidence in the literature regarding the increasingly precarious condition of our planet. Food producers find themselves obliged to adopt new sustainable production technologies (Grunert, 2011). Food certifications nowadays are undoubtedly necessary, but more importantly they are a point of difference from competitors on a strategic level to stand out in the market. The level of awareness among consumers is steadily increasing; they want to be made aware of the sustainable practices adopted by producers, and this is where food certifications step in to convey safety (Aprile & Punzo, 2022).

The need for knowledge about the effects of the food we eat every day has increased because of society's growing concern over the social and environmental effects of food production and consumption, as well as increased awareness of the unintended negative effects of individual food choices on global food sustainability. At the same time, producers have adopted more sustainability food claims, certifications, messages, and other informational tools to distinguish their products in response to the rising demand for sustainable food items (Annunziata et al., 2019). According to Aprile and Mariani (2015), the recent profusion of standards and labelling for social or environmental food items puts consumers at risk and may breed skepticism. Nowadays, especially due to the rapidity with which laws change and with the differences in the transposition of directives in the different EU countries, it is increasingly difficult for consumers to be aware, even superficially, of existing sustainable labels.

One of the biggest problems in trying to recognize sustainable labels directly concerning food products or packaging is the underlying information asymmetry between labels and consumers (Nikolaou & Kazantzidis, 2016). Previous research does not all agree that eco-labels actually reduce entropy levels, according to some instead it leads consumers to be even more disoriented and overwhelmed by the amount of cues and information on packaging (Carrero & Valor, 2012). Food labeling is already complicated, and it becomes much more so because customers can't easily recognize environmental information while buying items due to a lack of expertise, time, and internet access. Additionally, this makes it more difficult for businesses to decide to implement policies that will enhance their environmental performance (Nikolaou & Kazantzidis, 2016).

This point of the paper provides an overview of the most popular claim trends and food certifications, as well as the laws concerning packaging in Italy. According to the type of claim on the label, the Immagino Observatory (2021) has categorized the items that highlight sustainability-related characteristics into four clusters: sustainable resource management, sustainable breeding and agriculture, social responsibility and respect for animals.

To stand out from the competition and meet the challenges posed by emerging international markets, quality has emerged as a crucial component in the Italian food industry (Sadilek, 2019). Consumers can use certification and brand to get information about a product's origin, relevant production methods, and other factors, such as safety, environmental impact, and ethical considerations. These factors together make up the core of the quality concept (Marino & Nobile, 2007). The origin of a product, pertinent production techniques, and additional aspects, such as safety, environmental impact, and ethical issues, can all be learned by consumers through certification. These are some of the many reasons why companies in recent years are increasingly investing in acquiring new voluntary certifications that do not limit them to mandatory safety and hygiene standards (Aprile et

al., 2016). One of the most popular is ISO 140001, which is a voluntary international standard, applicable to any type of public or private organization, that specifies the requirements for an environmental management system. Another globally recognized certification appears, the EU leaf certification symbol for organic produce (EC 889/2008) has been implemented since Janssen and Hamm's data collection in 2012, and the EU organic market has experienced significant expansion (Rana & Paul, 2017). A key element closely linked to certifications is the necessary increase in prices because they require substantial expenses for changing production processes and innovating technology systems and supplies (Consuelo, 2020). This is where consumers' willingness to pay comes in, closely linked to two other concepts that will form the pillars of the study: the quality of information and the way it is conveyed, together with the level of trust and awareness that consumers have about products. More precisely, when consumers are properly informed about the meaning and content of the labels, preferences for the products bearing the environmental sustainability badge rise. Contrarily, a lack of awareness could prevent buyers from considering environmental sustainability claims while making purchases (Aprile & Punzo, 2022). According to research (Zanoli et al., 2015), consumer purchase intent and the overall profitability of sustainable food are significantly influenced by consumer trust in certifications. The main factors that can increase product trust and organic sales are raising awareness of the techniques used by organic farmers to grow/breed organic produce and the elaborate processes put in place to routinely inspect farms and test products to ensure the "organicness" of the produce (Padel, 2010).

The bond between these variables gives rise to the Literature research gap of the paper. Indeed, ecolabels can inform consumers about the environmental credentials of their diet to help them make informed decisions, but there is no standard format for ecolabels and scant research on which label may be most useful (Potter et al., 2021). To help consumers better understand the information about sustainability, other alternatives to ecolabels, presented on packaging, may exist. Specifically, a possibility could be to enclose the sustainability information in an ad-hoc QR code to help consumers decipher this information. However, to the extent of my knowledge, no studies have ever explored this implementation.

It is within this gap that the following research aims to obtain an innovative format to convey the right values and information about sustainability. Normally information on sustainability, such as claims, packaging materials or certifications, helps to reduce the information imbalance between supply and demand for knowledge on environmental and social issues (Nikolaou & Kazantzidis, 2016), but often there is little space and the information is misleading. The goal is to help both supply and demand reduce the information asymmetry with consumers and ensure a quick understanding of the optional and improved information that manufacturers choose to apply on the packaging. It has

been ascertained that consumers evaluate environmental sustainability labels when they are provided with information on the meaning of such labels (Grunert et al., 2014), this study aims to investigate on a visual level, whether a digital tool, a two-dimensional barcode that can be scanned with any kind of smartphone, can generate an effective awareness of food sustainability, and change their purchasing behavior. Specifically, the QR code can contain optional information applicable to a product's packaging, such as optional environmental, social and production certifications, specific claims or information on the sustainability of the packaging itself. Given the analysis carried out so far, the aim of this thesis is to fill the main gap found in the literature on sustainable food-side communication strategies. Firstly, having realised the absolute importance of packaging as a marketing tool, it will play the role of the main argument around which any proposal must be based in order to be relevant from a managerial point of view. Another key component that is populating the front pages of different packaging are sustainable claims and certifications, which are often confused or ignored.

The alternative single scannable QR code applied on the packaging against the scattered display of sustainable claims will be explored. The main research question (RQ) is therefore the following:

RQ: *Does present sustainable information in a QR code on a packaging of a product (vs. presenting the same information using dispersed ecolabels and claims in the packaging) increase the consumers' purchase intention of that product?*

According to research by Ding et al. (2015), trust in the food system and control have a considerable explanatory power when it comes to decisions made about foods that have nutrition and health claims. Consumers who trust the food industry are more likely to select and purchase items with nutrition and health claims than consumers who don't. Sociocultural and historical factors influence the level of trust in the food system (Dolgopolova et al., 2015). In a study conducted on chicken meat products, Samant and Seo (2016) showed that for consumers with a high level of understanding of label claims, the presence of some sustainability claims improves overall quality, confidence in quality and perception of freshness.

The second research question (RQ_2) then becomes:

RQ_2: *Does trust in sustainable information mediate the relationship between sustainable packaging with QR codes and purchase intention?*

It is therefore now possible to deal with the innovative technological element contained in the packaging implemented in this study for the strategic communication of sustainability initiatives: the QR code. QR codes are two-dimensional bar codes that can be read by a smartphone camera and converted to content such as URLs, phone numbers, and text (Okazaki, 2009; Okazaki & Barwise, 2011). Consumers can access their content with any mobile or smartphone with a built-in camera and QR Code reader software, and they can utilize them on product labels and advertising materials (Cunha et al., 2010). Because customers can quickly and easily scan the QR code provided by the marketer that influences customers' purchase intentions, embedded QR codes with advertising are very helpful to share and influence customer satisfaction and purchase intention. **(**Hossain et al., 2018). It is a valid tool because, according to statistics, 84% of customers use their smartphones to research products either before or while they are in the store. With almost 2 billion users worldwide, there were 224.3 million smartphone users in the US in 2017 (Statista, 2018). The use of the QR code can be thought of not only with a view to the transmission of sustainability information, but also as a wide-ranging marketing tool. The manufacturers can provide a larger platform for marketing that do not face the same restrictions as the packages themselves, consumers can find promotions, coupons, surprises or more information about the product creation process, provenance etc. QR can thus increase engagement and purchase intent (Jao, 2018). This will increase customer interaction at the point of sale, which will affect their decision to make a purchase. It might be difficult to decide what information should be printed on food labels because they are frequently small. A simple disclosure may misinform customers and have detrimental welfare effects, whereas a complex disclosure policy may burden consumers and have little or no impact (Bar-Gill et al., 2018).

If food labels are complicated or if consumers are overloaded with labels, the issue could be particularly problematic. Individuals may incur huge aggregate costs as a result of information overload (Sunstein, 2021). Due to the fact that they view grocery shopping as a routine activity, consumers are frequently unmotivated when doing it. The purchasing setting, which is significantly influenced by inertia, price awareness, and information overload, among other things (Eldesouky et al., 2019), exacerbates the already limited attention. Labelling seems to be one of the important issues influencing consumers' attitudes and beliefs, inserting different types of information, such as sustainability, reduced fat content, packaging material, recycling information, can lead to reduced interest and thus to non-purchase (Chen & Lobo, 2012).

Having explained the relationship between IV and DV, the primary hypothesis, the one concerning the main effect and whose study is necessary to answer the RQ, can be formulated as follows:

H_1: The presence of sustainability information enclosed in the QR code available on a product's packaging, as opposed to the presence of the same information dispersed on the product's packaging, has a positive effect on the purchase intention of the product itself.

The other key element for the conceptual model of this study is the role of Trust as mediator between the independent variable (scattered information vs. QR code) and the dependent variable (purchase intention). According to Nuttavuthisit and Thgersen (2017), consumer trust is a prerequisite for creating a market for credibility items (such as high-end green goods), and it has a significant impact on the likelihood that consumers will pursue organic goals. The idea proposed in this study aims to observe whether a more orderly arrangement of information through a now widely used tool can significantly increase levels of consumer trust and brand loyalty. Consumers turn to QR codes when they feel that the truthfulness of claims on packaging and compliance with the law by companies and manufacturers cannot be trusted (Okazaki & Barwise, 2011). The information offered by QR codes gives customers an immediate, pertinent, and helpful message and is accessible when they need it, at the exact moment they are considering making a purchase. Research has shown that food traceability systems are successful because customers typically associate traceability with safety and quality characteristics (van Rijswijk et al., 2008; Papetti et al., 2012), fostering trust in both a specific food product and the food system (Chen & Huang, 2013). The need for QR codes on food packaging is specifically supported by the fact that an estimated 92% of consumers expressed a wish to obtain transparent information on product labeling. As a result, a number of well-known companies, including Nestle, recently affixed QR codes to several of its best-selling goods, including the instant Maggi noodles (Menon, 2021).

This study will analyse the greater propensity to scan QR codes in the case of information concerning sustainability aspects, from packaging to ecolabels to claims, again with trust as a mediating element.

H_2: The higher propensity of consumers to purchase a product containing sustainable information within a QR code affixed on the packaging is explained by a higher level of trust consumers have in the information presented on the QR code compared to the information dispersed on the packaging.

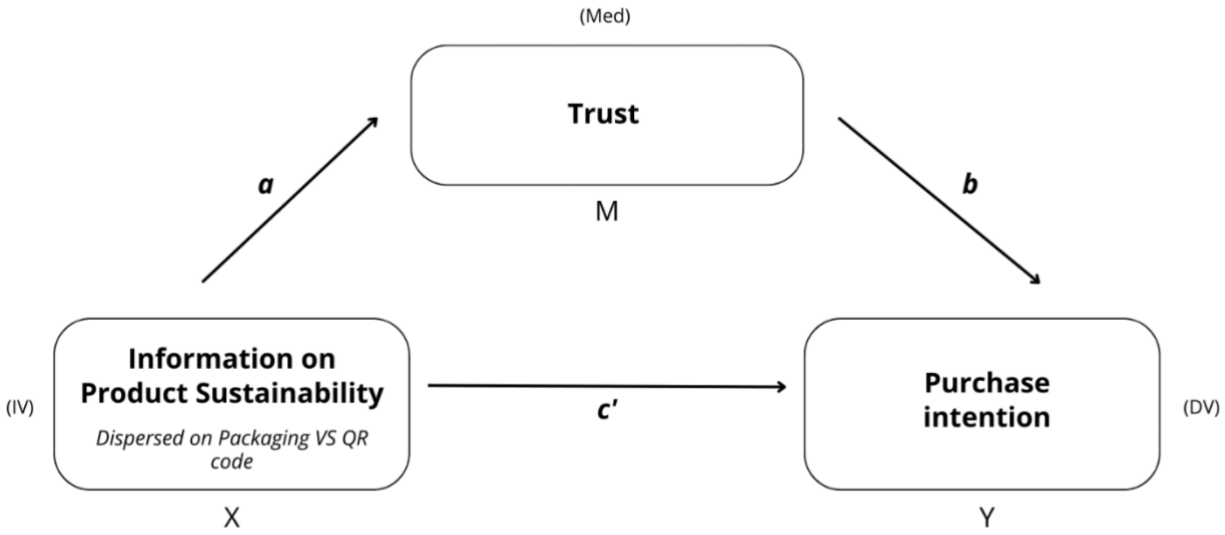

Fig 1. Conceptual model

Mediation model (How/Mediation design): the independent variable (X) consisting of the manipulation of the type of representation of sustainability messages on a food packaging (dispersed information vs. QR code) influences the dependent variable (Y) identified in the purchase intention through the mediation of the mediating variable of the degree of consumer trust (MED).

QUANTITATIVE RESEARCH

The present experimental study consists of a conclusive causal between subjects 2x1 research design. The results of the experiment are comprised of responses to a questionnaire obtained through a survey conducted independently in Italy during the month of May 2023, using the online platform Qualtrics XM. The survey participants were selected by adopting a non-probabilistic sampling methodology. Considering the target sample, it was decided to include respondents with an age range of 18-75, collecting data from both female and male individuals, as demographic variables were not expected to influence the results of the experiment in a statistically significant manner. The objective of this research is twofold: firstly, we intend to test H1 and thus the existence of a significant effect of the arrangement of the Sustainability on packaging (scattered information vs QR code), the manipulated independent variable, on Purchase intention, the measured dependent variable. Namely, the presence of a QR code clearly visible on the packaging and easily scannable by consumers, summarising the sustainability information in an orderly manner increases purchase intention. Next, to test the H2 hypothesis, the mediating effect of Trust (High vs. Low), measured through pre-validated scales, on the relationship between IV (scattered information vs QR code) and DV (Purchase Intention) will be tested.

Pretest

As a preliminary step before the main study, it has been verified that the manipulation performed through two mock-ups of a rice package (with QR code and without QR code) was perceived correctly through a pretest. The eco-labels and claims were selected following a review of food packaging, both by analyzing the type of food and the degree of comprehensiveness of food certification. In total there are three eco-labels going in order of notoriety and three dummy claims linked to each of the above. In the QR code version, the information has simply been grouped and arranged in a neater and accessible graphic view for the consumer without changing any data. It was therefore necessary to carry out a pretest on the independent variable in order to validate the stimuli created and to check whether Sustainability on packaging (scattered information vs. QR code) was perceived as such. Participants were selected according to the above criteria, 55 participants were found, 5 responses were discarded because they were incomplete. The structure was divided into 3 main sections: an introduction, a randomised presentation of two packaging mockups with corresponding questions on the content displayed and the final part dedicated to demographic data. The eco-labels shown were as follows: Friend of the Heart, PEFC Certified and Fairtrade Certified. The associated claims in the respective order of the ecolables were "Sustainable controlled supply chain," "Forest-friendly packaging," and "Without exploitation of workers and the environment". In the QR code version, the exhortation to frame the code was, "Want to know all about our sustainable practices? Frame me!". The questions following the two manipulations were about the ability to understand and process the sustainable information applied to the QR code, a scale prevalidated by "Alter A. L., Oppenheimer D. M. (2009). Uniting the tribes of fluency to form a metacognitive nation. *Personality and Social Psychology Review*, 13, 219-235". The scale is called "processing fluency", it is a 7-point Likert scale consisting of 15 items, of which the 4 most significant ones were used (*Appendix 1*).

Finally, demographic data with age and gender were collected: average age of the respondents was found to be 27 years (Mage = 32.10, SD = 13.10), although the age range ranged from a minimum of 18 to a maximum of 75 years. The gender of participants is divided almost equally between men (20/50), women (26/50), nonbinary (3/50) and individuals who preferred not to declare (1/50).

The scale used had already been pre-validated in a previous study but a reliability analysis was still performed using SPSS software. The resulting Cronbach's Alpha is .728, a value that the elimination of no items is able to increase. Therefore, the 7-point Likert scale thus composed can be said to be complete, reliable and comprehensive for measuring the independent variable. An independent t-test was conducted to compare the averages of the two groups (Dispersed information vs QR code). As Levene's statistic shows, the averages are significantly different M_{C1} = 5.27 (SD = 1.00); M_{C2} = 3.87 (SD = 2.08); t(48)= -3.10, p = .004). In particular, condition 1, the one with the packaging with

scattered information, was perceived as less clear (M_{C1} = 5.27, SD = 1.00) than the altered and modified one with QR code (M_{C2} = 3.87, SD = 2.08). Therefore, it can be said that the difference, in terms of Understanding the Sustainability Information reported on the packaging, was perceived correctly by the respondents, so the manipulation of the independent variable, due to the success of the Pre-Test, can be considered effective (*Appendix 2*).

Main study

The survey was distributed to 266 individuals, of whom 201 respondents fully participated in the experimental study, answering fully and completely all the questions within the questionnaire. The sampling criteria are identical. The sample of the population reached by the survey included mainly university students and recent graduates located in different cities in Italy. Therefore, the average age of the respondents was found to be 27 years (Mage = 27.38, SD = 9.94), although the age range ranged from a minimum of 18 to a maximum of 75 years. Regarding the gender of the subjects, the prevailing gender was found to be female, represented by 63.7% (128/201), while the male gender was characterized by 34.8% (70/201). The remaining 0.5% (1/201) of respondents selected the third gender option (0.6%, 1/176), or preferred not to identify with a specific gender 1.0% (2/201).

To measure Purchase Intention, the original 7-items pre-validated Likert scale from "Dodds, W. B., Monroe, K. B., & Grewal, D. (1991). Effects of price, brand, and store information on buyers' product evaluations. *Journal of marketing research*, 28(3), 307-319" was used. From this scale, 3 items were considered most significant for the current analysis. To measure Trust in sustainability information, the Likert AD Trust (reliability) scale from "Soh, Hyeonjin, Leonard N. Reid, and Karen Whitehill King (2009), "Measuring Trust in Advertising: Development and Validation of the ADTRUST Scale," *Journal of Advertising*, 38 (2), 83-103." a 9-item, 7-item pre-validated scale, was used Of these items, the 6 most significant for the study were considered and did not require modification of the reverse items (*Appendix 3*). As with the Pre-Test, the analysis of the main test data began by verifying the validity and reliability of the scales used for the mediator and dependent variable through Factor Analysis and Reliability Analysis. No items were discarded and both scales were considered reliable. Before testing weather mediation took place, affecting the relationship between IV and DV, a One-Way Anova Test was conducted. It consists of the analysis of variance and is a procedure that tests whether differences exist between two or more population means.

In this case, the comparison was between a manipulated independent variable, Sustainability on packaging (C_1 = scattered information vs C_2 = QR code) and a quantitative dependent variable, Purchase Intention (mean, 3-items, 7-Point Likert scale). Group means are significantly different ($F(199) = 45.152$, $p < 0.001$). Thus, type of message framing has a differential impact on Purchase Intention mean (*Appendix 4*).

After verifying the validity and reliability of the scales and calculating the averages ('purchase_mean' and 'trust_mean'), it was possible to proceed to the analysis of mediation. This can be calculated according to two models: (1) the traditional approach of Baron and Kenny (1986), i.e. through single regressions, or (2) according to a more modern approach, PROCESS. In this paper, mediation was calculated using PROCESS and Model 4 (*Appendix 4*). The first step is to test the effect of the independent variable on the mediator. To test the success of the mediation effect, it was necessary to distinguish it into two different relationships: a first effect between the independent variable and the mediator (path a) and a second effect between the mediator and the dependent variable (path b). Specifically, to demonstrate the statistical significance of both hypotheses, a 95% confidence interval was adopted with an alpha reference value of 5%. In addition, it was necessary to ensure that the extremes of the confidence range (LLCI = Lower Level of Confidence Interval; ULCI = Upper Level of Confidence Interval) for each relationship complied with the sign concordance (both positive, or both negative), so that there was no zero within. Finally, to assess the sign and magnitude of each effect, the β coefficients of the regression analysis of both relationships between the variables were examined. As shown in the analysis, the effect of packaging type (dispersed information vs. QR code) (IV) on Trust (MEDIATOR) is positive and statistically significant, suggesting that the packaging version with the sustainable information grouped in the QR code increases consumer trust (path *a*). With regard to this first part of the indirect effect, a p-value of 0.0000, a favorable confidence interval (LLCI = 0.1493; ULCI= 0.8050) and a positive regression coefficient β of 0.4772 were noted by observing the SPSS output. Therefore, this section of the indirect effect was statistically significant, thus confirming pathway a (B = 0.4772; SE = 0.1663; t = 2.8699; p = 0.000). A clearer and neater display of information on Ecolabels and claims leads to a greater sense of trust on the part of consumers.

Moving on to analyse the effect of Trust (MEDIATOR) on purchase intention (DV), this also turns out to be positive and statistically significant (β = 0.7895; SE = 0.0639; t = 12.3483; p = 0.0000), suggesting that greater trust in sustainability information, such as food certifications and claims, increases consumer intention to purchase the product (path *b*). The statistical significance of both paths *a* and *b* provides initial evidence of the mediating role of trust in the relationship between the independent and dependent variable. Whereas the statistical significance of path C_1, i.e. the significant direct effect of the type of packaging containing sustainable information on the purchase intention, suggests that trust partly mediates the effect of the IV on the DV. However, in order to check whether there is indeed mediation, it is necessary to analyse the indirect effect and check whether it is significant, as only then will there be mediation. The p-value is not observed, which is not indicated, but the values of the confidence intervals: if they contain zero, the effect is non-significant; if they do

not contain zero, the effect is significant. One must therefore look at the signs of the two values, which must agree. In this case, BootLLCI = 0.5618 and BootULCI = 1.1986, the zero is not contained and the effect is significant. Therefore, there is mediation. Finally, since both the main effect and the indirect effect are significant, the mediation is said to be partial (*Appendix 5*).

GENERAL DISCUSSIONS

The results of this quantitative experimental study confirm the two initial hypotheses:

> The presence of sustainability information encapsulated in the QR code available on a product's packaging, as opposed to the presence of the same information dispersed on the product's packaging, has a positive effect on the purchase intention of the product. Furthermore, by introducing trust as a mediating element, it was found that this effect is explained by the fact that consumers trust more the brands that display their sustainable certifications and claims with QR codes rather than adding them directly on the packaging.

The aim of the paper is to highlight contributions not only to the literature, but also to provide managerial contributions for companies in the food sector, especially SMEs that want to marginalize within the large-scale retail trade. The results offer insights to support corporate decision making in order to implement more effective communication strategies regarding sustainable packaging information to establish strong and lasting relationships with consumers. One of the most difficult challenges for the future will be to effectively convey the importance and possibilities of social and environmental sustainability and to generate a positive attitude on the part of consumers who place their trust in the hands of food producers.

From a theoretical point of view, this study makes an important contribution to the literature and rises the limited body of research on food brand communication on environmental and social sustainability issues through new communication strategies applied to packaging. With regard to food labeling, mixed views emerge on the level of understanding attested to consumers: according to some scholars, sustainability labels help reduce the information imbalance between supply and demand for knowledge on environmental and social issues (Delmas & Grant, 2014; Nikolaou & Kazantzidis, 2016), according to Aprile and Mariani (2015), the recent proliferation of standards and certifications puts consumers at risk and may generate skepticism. This study confirms previous findings in the literature that attest not only to an increased consumer interest in sustainable packaging, but also to a willingness to fully understand the meaning of food labelling. This was confirmed in the consumer's preference for packaging with the QR code, where information was more neatly located and higher values were recorded in the survey under the items 'reliable' and 'clear'. This study found an alternative solution to classical ways of informing consumers by reducing the amount of input displayed directly on the often very small packaging and introducing a widely used and popular technological tool such

as QR code. The results of the following study are in accordance with those of other scholars, indeed, it has been shown that the use of QR codes is a viable method to help consumers access more complete and relevant product information (Chien-Ta Bruce & Jhong-Min Denis, 2017), as well as being very useful in sharing and influencing customer satisfaction and purchase intentions (Hossain et al., 2018). Another key milestone that will lead to the conclusions of this study is the presence of consumer trust in the food system of certifications, sustainable claims, and especially toward brands that pursue green ways. When we refer to trust, we mean food traceability systems, which are successful because customers typically associate traceability with safety and quality features (van Rijswijk et al., 2008; Papetti et al., 2012), fostering trust in both a specific food product and the food system. Linking consumer trust with the proposal of QR codes in the independent variable, the need for these codes on food packages is particularly supported by the fact that an estimated 92% of consumers expressed a desire for transparent product labeling information (Menon, 2021). This was also the case for this study, which confirmed the key role of trust in increasing the propensity to purchase products. When consumers place trust in a brand's sustainable actions, they have a higher propensity to purchase the product itself, specifically preferring the QR code version for greater usability of information. From a managerial point of view sustainable development, and the resulting communication, represents an opportunity to improve brand differentiation and corporate image, especially because consumers of grocery products are among the most socially and environmentally conscious and aware. However, as the most effective way of communicating social responsibility has not yet been identified, the study was carried out with the aim of investigating this issue. It demonstrates how QR can generate exponentially more understanding and engagement in consumers than the usual sustainability claims scattered on the packaging.

Indeed, by implementing an effective communication strategy, resorting to the use of a QR code to communicate environmental and social responsibility initiatives, food brands could overcome the apparent gap and detachment perceived by consumers by facilitating the establishment of a direct and lasting relationship. The QR code is a tool that is now highly popular, easy to use, and known even by audiences less familiar with technology. Demonstrating brands' social commitment to their neighbors allows consumers, who are increasingly sensitive to issues of sustainability and social responsibility, to know, understand, and identify with what a brand's brand values and mission are.

Previous literature states that consumers are more likely to use QR codes when they are more skeptical of manufacturers regarding the safety of their products, proper packaging, and consumer safety (Okazaki & Barwise, 2011; Atkinson, 2013). The results of this study are relevant for companies that have made mistakes in their communication strategies regarding sustainable environmental and social practices in order to restore their reputation and reactivate sales.

The use of a QR code allows for a more orderly display of content on a mobile screen as the sustainable claims are displayed next to the certification mark, in this way the consumer not only understands the scope of origin of the certification, but gradually increases their level of trust and affiliation with the brand. For example, in this study, the sustainable claim "packaging produced in respect of forests" was associated with the PEFC mark within the packaging containing QR codes, in C_1 they were instead in two separate places and may have increased the level of entropy in the cognitive process.

Crowding of information, moreover with very small fonts, is another issue that this study sought to address; a single statement as a call to action to scan the QR code, creates curiosity in the consumer and is the solution for the consumer who would otherwise be overwhelmed. Another important consideration is that, given the ability to continuously update the information contained in QR codes without the need to change the frame being scanned, producers can keep up with updates in laws regarding certifications. They can also add relevant information regarding implementations with new sustainable technologies within the production chain that reduce food waste and emissions harmful to the environment. All of these expedients, which are easily integrable into QR technology, allow in the long run to increase the connection with consumers, generate loyalty, word of mouth and positive reviews.

Despite the theoretical and managerial contributions made by the research, this study has some limitations that should be addressed by future research.

The main limitation of this study concerns the lack of certainty that consumers will choose to frame the QR code correctly when they are in the shops or may not display it correctly due to an absent internet connection. Future research could investigate strategies for engaging call-to-actions that can intrigue consumers while involving and empowering them on important issues such as environmental and social sustainability. The second limitation concerns the sample. This, in fact, is represented by the not large number of respondents to the survey (201) and also by the chosen convenience sampling type. Furthermore, future research, should continue to investigate the topic of social and environmental sustainability, not only as an abstract concept, but by analyzing its practical applications in food companies and implementations in food supply chains. The proliferation of food certifications could lead to two negative outcomes: on the one hand, increased confusion in the minds of consumers at the time of choice, and on the other hand, the implementation of greenwashing companies. Future research should review the most efficient control systems that companies could undergo in order to be perceived as authentic. Likewise, then, it should continue to investigate the most effective way of communicating sustainability initiatives and topics, overcoming the limitation of this paper, which focused only on QR code mode. The literature should also analyze the change in

consumer responses according to colors, text, font, packaging of different shapes and materials, and so on.

In addition, it would be interesting to conduct a study that instead of reporting only claims and associated sustainable certifications, increases the amount of material contained in the QR code, for example, provides a full description of the process to arrive at taking a green certification (including resources invested and time spent), or presents a rewards system for consumers who scan the QR code correctly. These ways make it possible to increase customer engagement and generate loyalty.

An additional limitation also concerns the studied sector, namely food, since the results cannot be extended to other industry sectors, for example household items (also provable in supermarkets). Therefore, it would be interesting to propose a comparison between the results obtained in this study and a hypothetical one on the household products sector considering that recent studies suggest that sustainability has now also become a strategic goal for companies of household products, such as synthetic cleaning cloths (Henry et al., 2019).

APPENDIX

Appendix 1

Condition 1

Condition 2

Appendix 2

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.728	.727	4

Group Statistics

	IV	N	Mean	Std. Deviation	Std. Error Mean
MCX	1.00	23	5.2609	1.00136	.20880
	.00	27	3.8611	2.07704	.39973

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means							
						Significance				95% Confidence Interval of the Difference	
		F	Sig.	t	df	One-Sided p	Two-Sided p	Mean Difference	Std. Error Difference	Lower	Upper
MCX	Equal variances assumed	16.207	<.001	2.950	48	.002	.005	1.39976	.47450	.44571	2.35381
	Equal variances not assumed			3.104	38.717	.002	.004	1.39976	.45097	.48736	2.31215

Appendix 3

Appendix 4

ANOVA

DV

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	90.659	1	90.659	45.152	<.001
Within Groups	399.568	199	2.008		
Total	490.227	200			

Appendix 5

```
***************** PROCESS Procedure for SPSS Version 4.0 *****************
        Written by Andrew F. Hayes, Ph.D.       www.afhayes.com
   Documentation available in Hayes (2022). www.guilford.com/p/hayes3
**************************************************************************
Model  : 4
   Y  : DV
   X  : IV
   M  : MED
Sample
Size:  201
**************************************************************************
OUTCOME VARIABLE:
 MED
Model Summary
        R       R-sq        MSE          F        df1        df2          p
     .4222      .1783     1.4014    43.1723     1.0000   199.0000      .0000
Model
            coeff         se          t          p       LLCI       ULCI
constant    4.3574      .1161    37.5366      .0000     4.1285     4.5863
IV          1.0980      .1671     6.5706      .0000      .7684     1.4275

**************************************************************************
OUTCOME VARIABLE:
 DV
Model Summary
        R       R-sq        MSE          F        df1        df2          p
     .7345      .5395     1.1401   116.0008     2.0000   198.0000      .0000
Model
            coeff         se          t          p       LLCI       ULCI
constant     .7553      .2976     2.5379      .0119      .1684     1.3422
IV           .4772      .1663     2.8699      .0046      .1493      .8050
MED          .7895      .0639    12.3483      .0000      .6634      .9156

************************** TOTAL EFFECT MODEL ****************************
OUTCOME VARIABLE:
 DV
Model Summary
        R       R-sq        MSE          F        df1        df2          p
     .4300      .1849     2.0079    45.1517     1.0000   199.0000      .0000
Model
            coeff         se          t          p       LLCI       ULCI
constant    4.1955      .1389    30.1949      .0000     3.9215     4.4695
IV          1.3440      .2000     6.7195      .0000      .9496     1.7384

************** TOTAL, DIRECT, AND INDIRECT EFFECTS OF X ON Y **************
Total effect of X on Y
```

```
    Effect         se          t         p       LLCI       ULCI
    1.3440      .2000     6.7195      .0000      .9496     1.7384
Direct effect of X on Y
    Effect         se          t         p       LLCI       ULCI
     .4772      .1663     2.8699      .0046      .1493      .8050
Indirect effect(s) of X on Y:
       Effect     BootSE   BootLLCI   BootULCI
MED      .8668      .1622      .5618     1.1986

************************ ANALYSIS NOTES AND ERRORS ************************
Level of confidence for all confidence intervals in output:
  95.0000
Number of bootstrap samples for percentile bootstrap confidence intervals:
  5000

------ END MATRIX -----
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