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RESEARCH ARTICLE

The imperative of communication signals in boosting business strategies of the bioplastic packaging industry

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Abstract

Despite the rapid growth of sustainable innovations in bioplastics for packaging industries, their diffusion into established markets has so far been hampered by ambiguous and asymmetrical communication between bioplastics producers and consumers (both businesses and end consumers), particularly related to bioplastics materials and their waste disposal procedures. This study looks into the communication processes, identifies barriers and investigates business strategies that can be adopted by bioplastic packaging industries to influence consumer adoption and proper disposal behaviour of bioplastic packaging. Based on a systematic review of 68 journal articles and guided by the signalling theory, the study found that connections with various signallers at the end-of-life of bioplastic packaging materials are required beyond the purview of the industrial sectors utilising the packaging. The paper proposes a conceptual framework incorporating new signal constructs specific to consumer-facing sustainable innovation. The framework extends the signalling theory to be used as part of the bioplastic packaging industry's business strategy. The paper also emphasises the importance of altering the communication mechanisms in order to boost bioplastics industrial practices, which will subsequently contribute to the reduction of the detrimental impacts of fossil-based plastics on the environment.

KEYWORDS
business strategy, communication, consumer adoption, signalling theory, sustainable packaging

1 | INTRODUCTION

The versatile attributes of plastics have created a fruitful market environment for production and consumption, but at the same time, they have had an appalling impact on living ecosystems. A large portion of plastics is derived from fossil fuels, a valuable non-renewable resource whose production uses large amounts of energy and produces dangerous greenhouse gases (Hamilton et al., 2019). It is projected that by 2050, the annual carbon dioxide emissions from plastics production and incineration will reach 2.75 billion Mt (Hamilton et al., 2019). In

2016, the annual plastic flows to the ocean were expected to grow to 11 million Mt, and they will nearly triple to 29 million Mt per year by 2040 (PEW, 2020). In a business-as-usual scenario, it is projected that by 2040, the societal burden of plastic waste could reach USD 7.1 trillion (WWF, 2021), and by 2050, there will be more plastic waste in the ocean than fish (MacArthur et al., 2016).

Responding to the negative impact of petroleum-based plastics, innovative bioplastic materials have been commercially introduced to the market (PlasticsEurope, 2018). Bioplastics are plastic materials that are either biobased, biodegradable or have both properties (European Bioplastics, 2016). The World Economic Forum (WEF) championed bioplastics material as one of the top ten emerging technologies that will significantly impact the global social and economic order through its potential contribution towards the goal of a circular economy (Di Bartolo et al., 2021; WEF, 2019). Society perceives bioplastics as environmentally friendly materials compared with conventional plastics (Dilkes-Hoffman et al., 2019).

Bioplastics, although still accounting for less than 1% of the total plastic production of over 390 million Mt annually, are gaining momentum (European Bioplastics, 2022). According to the latest market data, the global production capacity of bioplastics is expected to rise from 2.2 million Mt in 2022 to 6.3 million Mt in 2027, while the global bioplastics market, valued at USD 15.8 billion in 2022, is projected to reach USD 30.06 billion by 2027 (European Bioplastics, 2022; Precedence Research, 2022). The packaging sector is the largest market segment for bioplastics applications, accounting for almost 48% of the total bioplastics market in 2022. This indicates that bioplastics are gaining recognition by the packaging industry as a viable substitution for conventional plastics (European Bioplastics, 2022).

The environmental impact of bioplastic packaging depends on various factors such as chemical structure, feedstock input, manufacturing process and end-of-life scenario (Rosenboom et al., 2022). Additionally, due to the vast variety of bioplastics, the lifecycle analysis has yet to be conclusive (Di Bartolo et al., 2021; Orset et al., 2017; Zhu & Wang, 2020). Nonetheless, it was assumed that some bioplastics are a sustainable option for packaging, based on information that biobased biodegradable plastics require significantly less energy to manufacture than fossil-based plastics and contribute to lower greenhouse gas emissions (Eerhart et al., 2012; Harding et al., 2007; Shaikh et al., 2021).

Despite established companies and well-known consumer brands starting to incorporate bioplastic materials into their products, service-ware and packaging (Arikan & Ozsoy, 2015; Iles & Martin, 2013; Yeh et al., 2015), the uptake of this material is still considered slow if it is intended to compete with petroleum-based plastics (Ncube et al., 2020). Besides improving the technical aspect of bioplastics, understanding the social aspect is critical for market acceptance of bioplastics (Brockhaus et al., 2016; Evans et al., 2020). Indeed, studies have reported unclear communication with consumers regarding bioplastics (Arikan & Ozsoy, 2015).

Consumers have low awareness (Dilkes-Hoffman et al., 2019; Lynch et al., 2017) and are often confused with certain terms used in the messages or labels promoting bioplastics (Arikan & Ozsoy, 2015;

Blesin et al., 2017; Boesen et al., 2019; Yeh et al., 2015). Moreover, the market is also sceptical about the environmental-friendly message from companies (Brockhaus et al., 2016; Zhu & Wang, 2020). Furthermore, with a wide variety of bioplastics, there is more than a single route for their proper end-of-life path, which could leave consumers confused, thus contaminating the waste stream input for the waste processor (Alaerts et al., 2018; Kakadellis et al., 2021; Ottoni et al., 2018).

Nevertheless, the discourse of communication as a part of business strategy among bioplastic packaging consumers is arguably limited. This study aims to understand the communication process, barriers and influence of bioplastic packaging on consumers, particularly in adoption and disposal practices. Consequently, several research questions (RQs) are proposed and stated as follows:

- **RQ1**. What are the most appropriate marketing communication processes for bioplastic packaging consumers?
- **RQ2**. What are the communication barriers to bioplastic packaging adoption and disposal practices for consumers?
- **RQ3**. What factors influence the mechanism of adoption and disposal of bioplastic packaging in the context of consumer communication?

This study attempts to respond to those research questions by conducting a systematic literature review (Tranfield et al., 2003), gathering information within the existing literature on bioplastic packaging to unearth the communication process, communication barrier and communication mechanism. This approach was taken because a thorough literature review was essential to addressing the knowledge gaps surrounding bioplastic packaging communication for consumer adoption and proper disposal, as there has been a lack of comprehensive research in this area. We hope to synthesise findings from a large number of studies in this area in the form of a conceptual framework consisting of the research propositions (Liliani et al., 2020). This will ensure our future study is well-informed and produces meaningful results to advance the field.

Theoretically, this research contributes to an improved understanding of the dynamics of communication processes and the identification of communication barriers that are critical to the development of business strategies for the bioplastic packaging industry. Thus, it contributes to the literature by synthesising constructs based on signalling theory (Connelly et al., 2011; Spence, 2002) to reveal its relationship with consumer adoption and proper post-consumption discarding decisions. Furthermore, this study highlights the existing knowledge gap and suggests future research avenues for the bioplastic packaging communication field. Practically, this study contributes to the bioplastic packaging industry by proposing a business strategy on how to communicate effectively with end consumers.

We proceed as follows: First, we describe the contextual background and research method. Next, we present the thematic analysis results, propose propositions and develop a conceptual framework. Then, we conclude the discussion, suggest the implication and advise future research avenues. Supplementary information is provided in Appendix A.

2 | CONTEXTUAL BACKGROUND

2.1 | Bioplastics material

According to European Bioplastics (2016), a plastic material is described as bioplastic if it is either biobased, biodegradable or has both of those properties. Other definitions suggest bioplastics are biobased polymers, which means they are derived from biomass or generated through monomers that derive from biomass (Vert et al., 2012). However, the latter definition is not the consensus in the bioplastics literature. Typically, bioplastics can be categorised into three main groups (Hann et al., 2018): (1) biodegradable fossil-based, for instance, polybutylene adipate terephthalate (PBAT) and polybutylene succinate (PBS); (2) biodegradable biobased, for instance, polylactic acid (PLA) and starch blends; and lastly, (3) non-biodegradable biobased, for instance, biobased polyethylene (bio-PE) and polytrimethylene terephthalate (PTT).

Hence, to ensure clarity, three common terminologies are often used in the bioplastics material: *biobased plastics* refer to 'a plastic made from renewable resources, namely biomass or waste' (Filiciotto & Rothenberg, 2021, p. 59); *biodegradable plastics* refer to 'a degradable plastic in which the degradation results from the action of naturally-occurring micro-organisms such as bacteria, fungi, and algae' (ASTM, 2004, p. 2); and finally, *compostable plastics* refer to 'a plastic that undergoes biological degradation during composting to yield carbon dioxide, water, inorganic compounds, and biomass at a rate consistent with other known compostable materials and leaves no visually distinguishable or toxic residues' (ASTM, 2004, p. 3). Another study emphasises that compostable plastics are required to meet the EN13432 standard or other comparable standards for compostable packaging (WRAP, 2020). There are two types of compostable plastics: home compostable and industrial compostable (European Bioplastics, 2009, 2018).

2.2 | Bioplastic packaging adoption and proper disposal

There is optimistic hope that the adoption of bioplastic packaging could mitigate ecological issues that are strongly connected with disposable and single-use product consumption behaviour (Cheng et al., 2021). Indeed, consumer choice for sustainable packaging and the post-consumption disposal decision are important (Martinho et al., 2015), as there is a certain correlation between them to some degree (Van Birgelen et al., 2009). According to Van Birgelen et al. (2009), consumers who are inclined towards purchasing environmentally friendly packaged products also tend to recycle and return used packages to support their environmental values. Conversely, those who place importance on properly disposing of their used packages may feel compelled to purchase environmentally friendly packaged goods.

Alternatively, research by Martinho et al. (2015) was unable to demonstrate that consumers' internal consideration for buying a product in an environmentally friendly package is also driving their intention for proper disposal, which in this case is package recycling. They suggest that more factors may influence consumer disposal behaviour, such as distance to recycling drop-off or accessibility to recycling systems (Martinho et al., 2015). A holistic approach is necessary to address the issues of green purchasing and green disposal to achieve sustainability (McDonald & Oates, 2006). Consequently, studies on sustainable packaging adoption behaviour and the disposal decision are considered inadequate and need further research (Martinho et al., 2015; Rodriguez-Sanchez & Sellers-Rubio, 2021; Van Birgelen et al., 2009).

Regarding the disposal action, the sustainability aspect of bioplastics is influenced by the accuracy of the end-of-life disposal of the packaging materials (Di Bartolo et al., 2021). In theory, downstream routes for bioplastic packaging are composting, anaerobic digestion, recycling, landfilling and incineration (Di Bartolo et al., 2021; Fredi & Dorigato, 2021; Rahman & Bhoi, 2021). While plausible, sending biodegradable plastics to landfills or incineration plants will have a greater negative impact on the environment than anaerobic digestion, recycling or composting; therefore, the option of landfills and incineration could be considered an improper disposal approach (Rahman & Bhoi, 2021). If biodegradable plastics degrade in landfills, it will lead to greenhouse gas emissions, for example, by releasing methane gas, which has greater global warming consequences than carbon dioxide (Zhu & Wang, 2020).

There are rising concerns about the contamination of biodegradable plastic packaging in the recyclable plastic waste stream (Alaerts et al., 2018). Improper disposal of biodegradable plastics may lead to contamination of recycled plastic batches and cause damage to the recycling infrastructure (Cho, 2017; Hann et al., 2018). For example, if PLA contaminates the PET (polyethylene terephthalate) plastic bottle recycling, it will result in an agglomeration of plastic flakes, yellowing of the resulting product and fouling of the drying machinery, thus hampering further operations (Alaerts et al., 2018). Therefore, ensuring that consumers dispose of their bioplastic packaging waste in the right waste stream bins is important yet challenging (Hann et al., 2018; Taufik et al., 2020).

2.3 | Signalling theory

Signalling theory is a theory that explains the effective form of the signal from the sender, to represent the quality of the product that cannot be directly observed by the receiver (Spence, 1973). Although originally developed in the field of information economics, it has since been widely used to analyse various phenomena across disciplines, including business strategy (Karasek & Bryant, 2011). After Michael Spence's work, the signalling theory was significantly developed by Connelly et al. (2011), who identified its essential elements and constructs by examining its application in the field of organisational management.

Ample studies have employed the signalling theory to understand communicating environmental commitment as a part of business strategy. Gupta and Gupta (2020) suggest that signalling

environmental sustainability positively influences a firm's vital functional performance dimensions, including economic performance. Tang et al. (2012) discovered that communicating environmental governance fosters a firm's green reputation and benefits customer satisfaction, leading to improved economic performance. Dögl and Holtbrügge (2014) found that strategic communication of environmental activities, goals and performance has a more positive effect on environmental reputation in developed economies than in emerging ones.

The greenwashing effect is analysed favourably with the signalling theory. According to Seele and Gatti (2017), greenwashing is based on external accusations and is therefore constituted in the eye of the beholder. This accusation is a distortion factor that alters the reliability of green messages. Torelli et al. (2020) highlight the significance of taking into account the industry's environmental sensitivity in all communication aspects to prevent stakeholder suspicions of greenwashing and the subsequent loss of legitimacy.

Research by Djupdal and Westhead (2015) suggests that environmental certification can function as a safeguard against the potential drawbacks of being a nascent and small enterprise. However, contrasting findings by Heras-Saizarbitoria et al. (2020) demonstrate that having environmental certificates is not always beneficial as a communication signal, due to the high saturation of certification schemes in the sector and the possible difficulty in gaining recognition by consumers.

Although the signalling theory has been used to study environmental communication strategies, there is a dearth of research examining how product packaging material signals environmental commitment that can subsequently be used as a business strategy. By conducting the literature review, we hope to benefit from the state-of-the-art on the topic and the synthesis of findings from a large number of literature studies in this domain. We thus argue that our systematic literature review constitutes a significant contribution to the field in the form of theory development that provides a theoretical perspective to guide our future empirical research endeavours.

3 | RESEARCH METHOD

3.1 | Data collection

The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) approach (Moher et al., 2009) was utilised for collecting and curating the data in this paper. Scopus, ProQuest and EBSCO databases are used with consideration of the present research context in the domains of business management, sustainability and social science. The search strings were arranged in three groups accordingly that are related to communication, bioplastic packaging and consumers (see Table 1). The search criteria aim to find articles from the literature that are peer-reviewed academic papers, published in scholarly journals within 20 years (from January 2002 to November 2021) and written in English.

From the three databases, a total of 1115 articles were collected. Then, an automatic duplicate removal process in EndNote X9

TABLE 1 Search strings and search formula used for data collection.

Code	The formula for search query
SS1	communicat* OR advert* OR campaign* OR marketing OR brand* OR informati* OR label* OR nudge* OR ecolabel* OR eco-label* OR symbol* OR educat* OR regulation* OR standard* OR sanction*
SS2	"bioplastic* packag*" OR "compostab* packag*" OR "biodegradab* packag*" OR "oxo-biodegradable" OR "oxobiodegradable" OR "green packag*" OR "bio-based packag*" OR "biobased packag*" OR bioplastic* OR "compostable plastic" OR "biodegradable plastic" OR "sustainable plastic*" OR "environmental* friendly plastic*" OR "environmental-friendly plastic*" OR "green plastic*" OR "biopolymer* packag*" OR (biodegradab* AND plastic) OR (biobase* AND plastic) OR (bio-base* AND plastic)
SS3	consumer* OR customer* OR societ* OR market OR home* OR house* OR people*
SF	SS1 AND SS2 AND SS3

Abbreviations: SS, search strings; SF, search formula.

TABLE 2 Inclusion–exclusion criteria.

Title & abstract screening	Full-text screening
Inclusion: • Articles from the peer-reviewed scientific journal • Related to the research question Exclusion: • Articles with incorrect publication types (such as trade journal articles, conference proceedings, etc.) • Not containing information related to answering the research questions.	Inclusion: • Only articles that could be fully accessed • Had information as follows: communication process for consumers; the impact of communication on consumers; factors that influence consumers on adoption and end-of-life phase; the barriers of communication related to consumers; suggestions to improve communication for consumers. Exclusion: • Full article cannot be accessed • Do not have the required information

(The EndNote Team, 2013), coupled with manual removal, resulted in 859 articles remaining for the next step. The online platform Rayyan. ai (Ouzzani et al., 2016) was utilised to curate the title and abstract selection, leaving 124 articles. In the next step, two researchers conducted a full-text assessment to select articles that meet the inclusion–exclusion criteria set (see Table 2). A third researcher compared the results of the two researchers, and any differences were discussed and resolved.

Finally, the selected additional articles related to communication to the consumer from peer-reviewed high-impact marketing and management journals were added to the final results because these articles were considered relevant but not captured through a systematic

search process (see Figure 1). This procedure resulted in 68 articles as the final set to be examined (see Tables A1 and A2).

3.2 | Data analysis

The final retrieved set of articles was analysed through thematic analysis, focusing on the extent to which consensus was formed across possible diverse themes (Tranfield et al., 2003). This thematic analysis utilised NVIVO 1.5 (Richards, 2021), to develop and manage the codes during the research. The type of thematic analysis used was the template analysis approach because it allowed the researcher to develop a set of themes derived from research questions before conducting the coding session, which were recognised as a priori themes; nonetheless, it was sufficiently flexible to be deleted or merged for the process of theme development or added due to newly found codes (Brooks & King, 2014). Figure 2 provides an example of how the template analysis process for a theme is carried out. The initial codes obtained from a priori themes and newly identified codes during the coding process were then reflected, reorganised and some renamed to create a more coherent structure. The result is the final template, which reflects the final arrangement of codes and themes after the analysis (see Table A3).

3.3 | Synthesis

The process of research synthesis involves summarising, integrating and cumulating the results of multiple studies on a particular topic (Tranfield et al., 2003). This can help researchers recognise patterns, identify gaps and generate new insights and knowledge. In this section, a theoretical lens is employed to explain the phenomena observed in bioplastic packaging communication. Relevant cases from the literature were outlined using the theory's construct to understand the specific relationship between them. Here, a construct is defined as 'a broad mental configuration of a given phenomenon' (Bacharach, 1989, p. 500). Finally, propositions and a conceptual

framework were presented to depict the communication mechanism interpreted from the text corpus (Liliani et al., 2020).

4 | FINDINGS

4.1 | Communication process

To answer RQ1, we look at the existing literature to find evidence regarding the communication process. The key components of the communication process are the sender (the individual or organisation that initiates sending the message), the channel (the communication medium through which a message is delivered), the message (the conveyed information) and the receiver (the individual who receives the message and tries to understand what the sender intended to convey) (Ottoni et al., 2018). As we have predefined that the receiver is the consumer and the messages are related to adoption and disposal, the communication process describes the dynamics of other components.

4.1.1 | Communication medium

The majority of research focuses on reporting or experimenting with communication formats and activities of commercial entities, such as bioplastics producers, brands and retailers. Their marketing communications as a business strategy are mainly delivered through advertising, campaigns, packaging and labels (Boesen et al., 2019; Ford et al., 2012; Purohit, 2012; Trivedi et al., 2018). In the case of advertising, television and print advertisements were the conventional mediums for brand positioning and promoting the product (Purohit, 2012). More recently, internet-based advertising media have been used by companies, such as social media (Tudu & Yadav, 2019) and websites (Nazareth et al., 2019; Shahrasbi, 2019). Communications through a campaign are more thematic and time-bound, such as activation campaigns or environmental education campaigns (Scarpi et al., 2021; Trivedi et al., 2018). An example is the introduction of
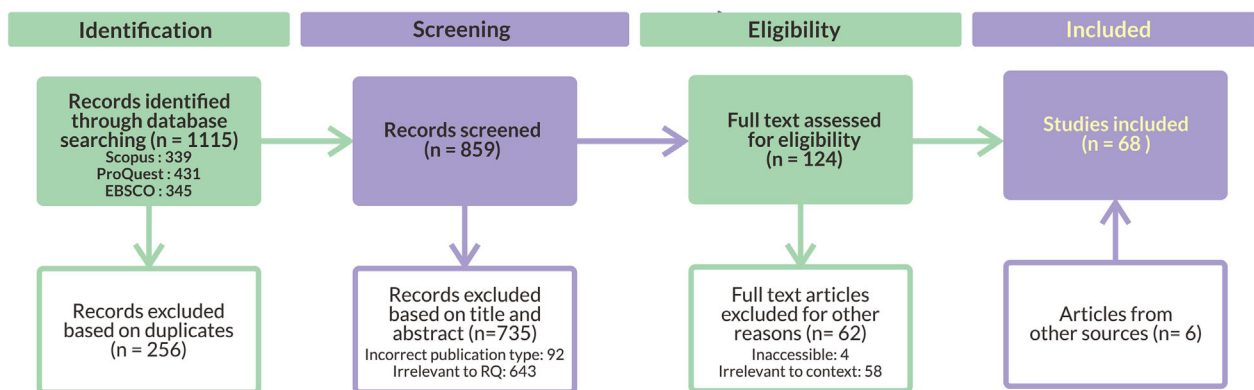

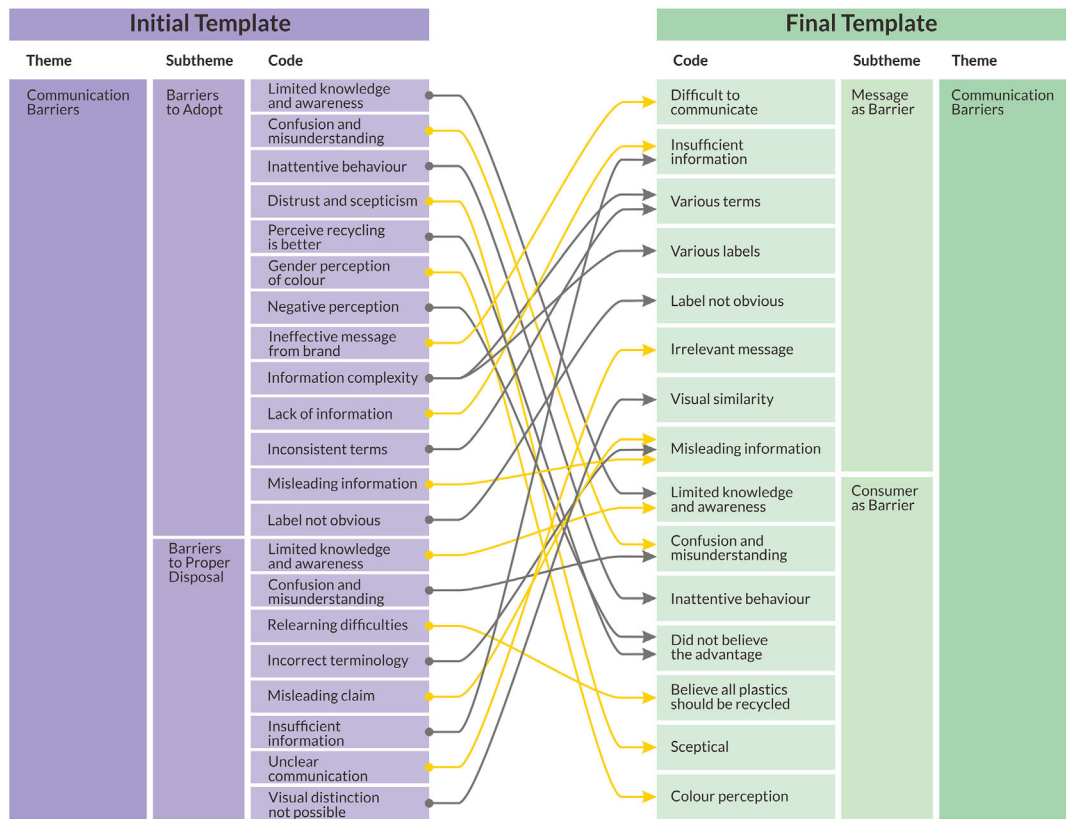**FIGURE 1** PRISMA flow diagram of the study.

FIGURE 2 Example of coding process for a theme.

Sunchips compostable plastic packaging launched on Earth Day 2010 (Evans et al., 2020). A label could act as a communication medium for consumers (Purohit, 2012). While most labels are published by certification bodies, self-proclaimed labels also exist (Petljak et al., 2019). Primarily, labels are displayed on product packaging; nevertheless, they could also be used in other communication mediums such as advertising (Bhagwat et al., 2020; Nazareth et al., 2019). Communication messages could also be conveyed through packaging, which will be discussed further in the next subsection.

4.1.2 | Packaging as communication medium

Product packaging is one of the important communication mediums for the communication process from the brand to the consumer (Evans et al., 2020; Ottoni et al., 2018). A package can convey verbal information through written text (Aagerup et al., 2019; Taufik et al., 2020). This is reported by Aagerup et al. (2019), who modified green claim messages on the existing packaged coffee brand and suggest that brand managers should articulate their product's 'greenness' whenever possible as a business strategy for increasing consumers' purchase propensity. Further, Wensing et al. (2020) experimented by giving consumers green nudges in the form of an ecolabel on vegetable packaging (containing symbols and text) along with other stimuli and revealed that certain communication medium arrangements are

an effective strategy to improve consumers' willingness to pay for bio-based plastics packaging.

In addition, communication could take the form of both written and visual forms, such as on a label containing a symbol and accompanied by a text (Boesen et al., 2019; Taufik et al., 2020). Packaging could also send information through non-verbal communication utilising colour (Felix et al., 2021), size, shape (Ford et al., 2012) and materials (Karana, 2012). For example, Seo and Scammon (2017) examined the influence of green colour in 'green packaging' for consumers, discovering that it enhances the visual appeal of packaging and assists consumers in comprehending the message when the colour matches the message, thus indicating that colour is more than a visual cue. The material's texture also communicates certain perceptions about the product (Karana, 2012); for instance, Starbucks employs the use of environmentally friendly plastic packaging and paper materials as a tactic to convey its dedication towards environmental sustainability (Auliandri et al., 2018).

4.1.3 | Communication actors

Besides commercial entities, there are also the government, academics and civil organisations, yet information about their communication is very limited (Goel et al., 2021; Keränen et al., 2021; Mahadi et al., 2021). Several states and local governments in Malaysia have

started to enforce the use of bioplastic carrier bags for traders and producers; they give notice before imposing a fine and publish guidelines for SMEs and retailers (Mahadi et al., 2021). Regarding academia, introductory knowledge about the lifecycle of fossil-based and bio-based plastics is experimented with at several Dutch secondary schools across different regions in the Netherlands (de Waard et al., 2020). In another case, retailers and brand owners are involving universities and environmental organisations, which reported delivering sustainability education, including bioplastic materials, aiming to impact the environmental behaviours of consumers who use food packaging (Keränen et al., 2021).

4.1.4 | Communication purpose

Brand owners and other commercial entities typically use communication processes with consumers as a business strategy for market adoption (Keränen et al., 2021), as customers of the brands are looking for environmentally friendly plastic packaging and biobased materials, which are perceived positively among consumers. Generally, communication strategies for bioplastic packaging are partially reported, such as highlighting a label or marketing claim written on the bags (Nazareth et al., 2019). However, there is one case study that reveals a bioplastic producer's communication strategy in a fairly sufficient manner, which before launching bioplastic bags on the market, had already passed various tests and been granted certification from international and national certifying bodies (Tudu & Yadav, 2019).

4.1.5 | Communicating sustainability claims

Many products labelled as biodegradable or compostable on the market do not meet accepted international standards, and those claims often cannot be verified (Goel et al., 2021). The literature reports several cases of greenwashing practices where companies promote more environmental benefits than their products actually offer (Nazareth et al., 2019). For example, Nazareth et al. (2019) examined the environmental claims used by six bioplastics producers or sellers in Canada, the United States and Brazil and found that four producers could not prove their claims.

Vaverková et al. (2014) tested seven samples of plastic bags from retail chains in the Czech Republic and Poland, whose producers declared that the products are biodegradable in nature or compostable. After 12 weeks of home composting, only one showed signs of partial degradation (Vaverková et al., 2014). In India, the Central Pollution Control Board stated that at least 12 companies had been found using fake certificates to promote their 'compostable plastics' products (Goel et al., 2021). Similarly, the Federal Trade Commission in the United States investigated the marketing communication of ECM Bio-Films, which claimed biodegradability without scientific evidence, hence leading to a court case (Shahrasbi, 2019).

4.1.6 | Regulating communication

Within the communication process of bioplastic packaging, there is a certain medium of communication that is guided by certain international and national bodies. This is particularly true for a label, the standards of packaging materials and also for marketing communication. From the literature reviewed, the bodies that regulate or control the form of communication in the bioplastic packaging industry are recognised as follows (see Table 3).

According to Bhagwat et al. (2020), adherence to a standard can be mandatory or voluntary in a country; however, obtaining an independent standards certification of compliance requires a product to undergo testing and examination by an independent certification

TABLE 3 Institutions regulating the communication medium.

Medium	Institution	Country origin
Standard	International Organization for Standardization (ISO)	International
	European Committee for Standardisation (CEN)	Europe
	American Society for Testing and Materials (ASTM)	United States
	Australian Standard (AS)	Australia
Certification and Label	German Institute for Standardization (DIN)	Germany
	Bioplastic Product Institute (BPI)	United States
	Japan Bioplastic Association (JBPA)	Japan
	DIN Certco	Germany
	Vincotte	Belgium
	TUV	Austria
	GreenPLA	Japan
	Australasian Bioplastics Association	Australia & New Zealand
	United States Department of Agriculture	United States
Marketing Communication	Federal Trade Commission (FTC)	United States

body. For example, compliance with standard certifications for bioplastic products is voluntary in the UK (Goel et al., 2021). Additionally, the possibility of voluntary or mandatory adherence to a bioplastics standard supports the United Nations' observation regarding the absence of global unity (Bhagwat et al., 2020).

Several companies market their products under certain labels that specify their biobased or biodegradable quality (Di Bartolo et al., 2021; Ottoni et al., 2018). Some of the certified labels depicted in the literature are displayed in Table 4.

For marketing communication, the literature suggests that the United States Federal Trade Commission (FTC), as a regulating body, successfully demonstrated enforcement of regulation regarding the misleading marketing of bioplastics by bringing the responsible company to justice (Shahrasbi, 2019). Nonetheless, cases demonstrating law enforcement like this appear in only one article and only in the jurisdiction of the United States.

4.2 | Communication barriers

We look further at the text corpus to find the answer to RQ2 regarding communication barriers. From the literature, a certain kind of communication reports misunderstanding, confusion and even scepticism among consumers (Allison et al., 2021; Fletcher et al., 2021; Mehta et al., 2021; Philp et al., 2013). The main barriers reported in the literature that could impede the successful adoption of bioplastic packaging come from the message itself and also from the consumer perspective.

TABLE 4 Various labels found in the literature related to bioplastics packaging.

Label Visual	Description
	The label by European Bioplastics, which represents a seedling, indicates that the product is industrially compostable and complies with EN 13432 standard (A).
	The DIN CERTCO labels for a product that is: (B) industrially compostable; (C) home compostable; and (D) biodegradable in soil, respectively.
	The TÜV Austria labels for a product that is: (E) home compostable; (F) biodegradable in a freshwater environment; (G) industrially compostable; (H) biodegradable in a marine environment; (I) biodegradable in soil; and (J) labels for biobased content in the product.
	The USDA certification label displays the proportion of biobased content in a product (K).
	The International Sustainability and Carbon Certification System has a certification scheme encompassing food, animal feed and various other forms of bioenergy (L).
	The Carbon Footprint of Products (CFP) label indicates the product's carbon footprint (M). The specific appearance may vary in different countries.

Source: (Di Bartolo et al., 2021; Ottoni et al., 2018)

4.2.1 | Message as a barrier

The message issue implies ineffectiveness in creating and delivering information transmitted by the sender to the receiver (Ottoni et al., 2018). Such a situation was reflected in the brands surveyed in the study of Gaffey et al. (2021), which found it *difficult to communicate* the positive environmental benefits of their products to their potential customers. There was also *inadequate information* not only on the packaging (Ottoni et al., 2018) but in the commercial environment as well, such as in the supermarket (Fletcher et al., 2021) and likewise in the e-commerce retail shop, where it was difficult to obtain sufficient information concerning the packaging material or degradability (Allison et al., 2021). Furthermore, the lack of sustainable packaging information in public communication spaces was reported to hinder consumers from adopting it (Orzan et al., 2018).

Insufficient information is also relevant for proper end-of-life treatment (Orzan et al., 2018). Currently, compared with plastic recycling promotion, there is no general procedure for consumers across countries or regions regarding how and where to properly dispose of compostable plastic packaging (Bhagwat et al., 2020; Taufik et al., 2020). One major root cause of this problem is inconsistencies in available waste processing facilities in different municipalities or countries (D'Adamo et al., 2020).

Fletcher et al. (2021) and Philp et al. (2013) further indicated *plenty of terms* are being used in the communication message from the brand promoting the bioplastic packaging to communicate materials and biodegradation quality, such as 'bio-based', 'bio-derived', 'ready' and 'inherent'. For the majority of consumers, those various terms are not sufficiently clear (Allison et al., 2021; Boesen et al., 2019; Fletcher et al., 2021). Further, this can lead to consumer uncooperativeness in sorting the solid waste (Ottoni et al., 2018).

Similarly, *plenty of labels* in different countries further complicate the information on bioplastic packaging for the consumer (Bhagwat et al., 2020; Philp et al., 2013). Additionally, the message on the label could also be misunderstood by the consumer; for instance, some consumers expressed that certain compostable labels should clearly state that they meant hot composting rather than cold composting (Allison et al., 2021). In other cases, there was a situation where the *label was not obvious* or not displayed in a way that consumers could see it prominently, for instance, due to its size or relative position on the packaging (Allison et al., 2021).

A certain message could be *irrelevant* for a certain customer segment. Aagerup et al. (2019) revealed that written green emotional claims on packaging proved a suitable business strategy to persuade potential customers with low environmental commitment and low information processing ability, but not for customers with high environmental commitment and high cognitive processing ability.

The other challenge for proper disposal sorting reported is that the *visual similarity* makes it difficult to differentiate between conventional plastics and bioplastics because both plastic materials have very similar physical characteristics (Alaerts et al., 2018). Indeed, the similarity gives way to the practice of providing false or *misleading information* with ambiguous claims without sufficient evidence (Allison et al., 2021; Goel et al., 2021; Nazareth et al., 2019; Vaverková et al., 2014). In many situations, the use of inaccurate terms such as 'biodegradable' or 'green' is reported to reduce consumers' obligations to dispose of it properly (Bhagwat et al., 2020; Fletcher et al., 2021; Zhu & Wang, 2020).

4.2.2 | Consumer as a barrier

From the consumer's perspective, consumers generally have *limited knowledge and awareness* regarding bioplastic packaging (Allison et al., 2021; Filho et al., 2021; Herbes et al., 2018). Consumers do not fully understand terms related to biodegradability and their environmental impact, despite those segments who expressed the intention to purchase bioplastic packaging (Allison et al., 2021; Boesen et al., 2019). This is also true for the end-of-life treatment of bioplastics, where consumers lack sufficient knowledge about proper disposal, including the waste collection options provided by their local municipality and the composting treatments (Allison et al., 2021; Fletcher et al., 2021).

Consumer *confusion and misunderstanding* of the message from the companies are also partly responsible for the slow uptake of bioplastic packaging (Fletcher et al., 2021; Keränen et al., 2021). For instance, there is confusion between biobased and biodegradable plastic packaging (Yeh et al., 2015; Zwicker et al., 2021). Further, there is a crucial misunderstanding that leads to the perception that biodegradable plastics can be disposed of in an open environment and will vanish after being littered (Shruti et al., 2020; Yeh et al., 2015). While the producers or brand owners of bioplastic packaging might have already sent the information, some consumers reported not noticing the packaging labels displayed on bioplastic packaging products (Allison et al., 2021). Such *inattentive behaviour* might decrease the willingness to purchase (Cheng et al., 2021).

Some consumers *did not believe that bioplastic packaging was better* than conventional plastic. A respondent from Allison et al. (2021) is concerned that biodegradable plastic packaging has a high carbon footprint and will break down into toxic microplastics. Furthermore, some consumers *believe that plastics should always be recycled*. A study by Taufik et al. (2020) among German consumers revealed that they could not picture such plastics as compostable in the first place. On the other hand, the promotional effort of bioplastic packaging advantage as a business strategy is reported to raise consumer *scepticism*, which is suspicious of greenwashing (Allison et al., 2021; Fletcher et al., 2021). Likewise, a study found that a consumer segment is sceptical of producers' messages regarding the environmental benefits of their water bottles (Orset et al., 2017).

Lastly, packaging colour could influence how consumers perceive the brand (Seo & Scammon, 2017). Felix et al. (2021) revealed that consumers agree that the green packaging colour fits the environmentally friendly products but may also give the impression of feminine

attributes. Therefore, *colour perception* could become a hindrance for the consumer that requires a 'masculine' perception (such as motor oil) when purchasing a certain environmentally friendly product (Felix et al., 2021).

5 | SYNTHESIS OF NEW KNOWLEDGE

5.1 | Theoretical perspective

Through the analysis of the included articles, there are three distinct characteristics that exist in communication across the bioplastic packaging supply chain.

5.1.1 | Unobservable quality

Consumers reportedly have difficulty differentiating bioplastics from conventional plastics, as the biobased and/or biodegradable attributes are not easily recognisable to the human vision (Alaerts et al., 2018). The unobservable quality could be defined as the attribute possessed by the signaller's product that cannot be directly known by the receiver except after being consumed or experienced (Connelly et al., 2011). However, this unobservable quality of bioplastic packaging is essential to be identified because it will enable consumers to make better-informed decisions on the environmental performance of the packaging and ensure that the packaging genuinely fulfils the claims of sustainability (Cheng et al., 2021).

5.1.2 | Costly signalling

Some firms allocate considerable resources towards educating consumers about their environmentally sustainable practices by acquiring an ecolabel or an environmental performance certification for their product packaging (Goel et al., 2021). However, adhering to environmental certification standards is challenging, as it requires the

technical knowledge to understand the standards and the financial capability to conduct validity tests and thus obtain official certification (Fletcher et al., 2021). Communicating the environmental benefits through campaigns or ecolabels can serve as an effective signal of a firm's environmental performance, as some consumers are willing to pay a premium for eco-friendly products (Zwicker et al., 2021).

5.1.3 | Information asymmetry

There is an imbalance of knowledge regarding the actual biobased and/or biodegradable attributes of bioplastic packaging between commercial entities and consumers (D'Adamo et al., 2020; Fletcher et al., 2021). In several cases, producers exploited this information asymmetry to their advantage by making misleading claims about their products or packaging material. Further evidence of information asymmetry between the commercial entities and the consumers is displayed in Table 5 in which consumers cannot directly verify the biobased and biodegradability attributes of the packaging; therefore, they will rely on certain signals, such as labels and advertisements, to authenticate claims, thus reducing the asymmetry of information.

The aforementioned 'unobservable quality', 'costly signalling' and 'information asymmetry' as characteristics are crucial evidence that leads the researcher to choose signalling theory as a foundation to better understand the phenomenon. Signalling theory is useful to explain the behaviour of two parties when the concerned product quality is unobservable directly and one party has more information than the other. It focuses on analysing and reducing the information asymmetry in a transaction (Karasek & Bryant, 2011).

Adapting from Connelly et al. (2011), several elements build the signalling theory. The signaller is the party with knowledge of the unobservable quality that the receiver does not have. The signal is the form of communication chosen by the signaller to inform on its unobservable quality. The receiver is the party that captures the signal to ascertain the unobservable quality of the signaller. Feedback is a form of the receiver's response to the received signal. Feedback is essential to knowing the effectiveness of the signal sent by the signaller. Lastly,

TABLE 5 Information asymmetry that exists in bioplastics packaging communication.

Commercial entities	Consumers
• Positive perception in biobased packaging. Those who have not yet switched are planning to switch in the future (Gaffey et al., 2021) • Have information about its packaging biodegradability (Blesin et al., 2017; Tudu & Yadav, 2019) • Leveraging packaging compostability with the certified label (Bhagwat et al., 2020; Goel et al., 2021) • Indication of misleading biodegradability claims (Goel et al., 2021; Nazareth et al., 2019; Shahrasbi, 2019; Vaverková et al., 2014)	• Unfamiliar with materials and labels (Boesen et al., 2019; Dilkes-Hoffman et al., 2019; Filho et al., 2021) • Confused about various biodegradability terms (Fletcher et al., 2021; Philp et al., 2013) • Cannot distinguish between fossil-based and biobased plastics (Alaerts et al., 2018) • Cannot distinguish the misleading claims (Allison et al., 2021; Fletcher et al., 2021) • Lack of knowledge of how to properly dispose of bioplastics waste (Ansink et al., 2022; Taufik et al., 2020) • Believe plastics should be recycled (Taufik et al., 2020) • Litter due to a wrong understanding of biodegradability (Bhagwat et al., 2020)

the signalling environment is the surrounding in which the signalling process occurs (Block et al., 2018; Fan et al., 2021). These elements correspond well with the communication process that has been described previously in Section 4 in which the sender (e.g., firms) is the signaller, the message is the signal, the receiver is the consumer, and the channel or medium is the signalling environment.

Furthermore, Connelly et al. (2011) reviewed ample studies in the management literature and proposed the key constructs of the signalling theory. In the signaller's element, there is *integrity*, which is defined as the signaller genuinely having the underlying quality related to the signal being sent, and *reliability*, which refers to the combination of both the signaller's honesty and the suitability of the signals that are being sent (Connelly et al., 2011).

Within the signal, there are several constructs. Signal *cost* is described as a transaction cost that is incurred when implementing a signal (Connelly et al., 2011; Truong et al., 2021). Signal *visibility* is defined as the observability of a signal to be noticed by the receiver (Connelly et al., 2011; Kharouf et al., 2020). Signal *fit* refers to the level of correlation between the signal and the unobservable attribute (Connelly et al., 2011). Signal *consistency* could be explained as the degree of coherence between multiple signals sent from one signaller (Connelly et al., 2011; Kharouf et al., 2020). Signal *frequency* is defined as the number of signals sent from the signaller (Connelly et al., 2011; Kharouf et al., 2020). Signal *credibility* is the degree to which the signaller is truthful, and the signal conforms to signal quality (Connelly et al., 2011; Kharouf et al., 2020).

For the receiver, there are attention and interpretation constructs. The receiver's *attention* refers to the degree to which receivers monitor the signalling environment to look for the signal (Connelly et al., 2011). The receiver's *interpretation* is described as the process of the receiver converting signals into perceived meaning (Connelly et al., 2011). In the context of feedback, there is a *countersignal*, which could be described as the act of the receiver sending back information to the signaller in response to their signal effectiveness (Connelly et al., 2011). This response is anticipated because the signaller also desires information about how to improve the signalling process (Gulati & Higgins, 2003). Lastly, in the signalling environment, there is a *distortion*, which is a reduction of signal quality or signal effect as a result of noise that could be introduced by the signalling environment itself, by another receiver or by another signaller (Connelly et al., 2011).

5.2 | Mapping the constructs

From the text corpus, the information relating to the communication barriers and drivers is mapped accordingly to build the construct of the conceptual framework. Subsequently, the information is laid out in the following Table 6.

In the literature, the ability to accurately communicate the message is considered important for commercial entities because it has been identified that they have difficulties communicating the environmental advantages of their products (Gaffey et al., 2021). Newcomer

firms reported struggles to understand and comprehend the unfamiliar language related to regulations, standards and directives for bioplastics (Fletcher et al., 2021). We propose this signaller's ability with the term '*proficiency*', which is the capability to create effective communication with the consumer. Furthermore, within the text corpus, it is repeatedly emphasised that information to the consumer must be clear and easy to understand (Fletcher et al., 2021; Mehta et al., 2021; Ottoni et al., 2018); thus, we suggest this as the signal *clarity* construct.

5.3 | Conceptual framework

A company's business strategy is defined as the long-term plan of action that is set to accomplish its objectives (Zahra & Covin, 1993). Consequently, if a company in the bioplastic packaging industry has a long-term objective to drive consumer adoption and aims to deliver evidence of participation in the circular economy by guiding consumers to dispose of the bioplastic packaging waste through the appropriate end-of-life route, it is imperative that a framework for communication with consumers is created as part of a compelling business strategy. Thus, in an attempt to better understand the communication factors that influence the mechanism of consumer adoption and proper disposal, we would synthesise propositions and a conceptual framework to provide the answer to RQ3.

Hence, based on the constructs that have been previously described in Table 6, we develop a conceptual framework for the communication mechanism for bioplastic packaging for consumers. The term *mechanism* is employed to discern crucial constructs within the communication activity and to investigate their interrelationships in achieving specific outcomes, which are consumer adoption and proper disposal practices. This approach operates from a mechanistic perspective, seeking to identify the constructs that exert influence on others. The resulting conceptual framework visually represents the interplay between these constructs.

Studies show that honesty is a required characteristic for bioplastics producers or other commercial entities (Fletcher et al., 2021; Shahrasbi, 2019). Even though the company wants to make its product appealing to the consumer, greenwashing practices should be avoided when communicating the value proposition (Hall et al., 2010). It is also emphasised that the ability to communicate the message accurately is important to the companies (Prothero et al., 1997), because there are instances in which companies are having difficulties understanding the unfamiliar language within the regulations while conveying environmentally beneficial messages (Gaffey et al., 2021).

> **Proposition 1a.** *The signaller's integrity will have a greater impact on the signal to the consumers.*

> **Proposition 1b.** *A signaller's proficiency will have a greater impact on the signal to the consumers.*

TABLE 6 Barriers and drivers found in the literature.

Element	Construct	Barrier	Driver	Reference
Signaller	Integrity	The practice of greenwashing or misleading labels and advertisements.	Communicate the value proposition avoiding greenwashing. Consumers need an official and trustworthy label to increase awareness.	(Gaffey et al., 2021; Goel et al., 2021; Hall et al., 2010; Nazareth et al., 2019; Shahrasbi, 2019; Vaverková et al., 2014)
	Proficiency	Brands have difficulties communicating environmental benefits. Inexperienced companies struggle with unfamiliar language from the standards, regulations and directives.	-	(Fletcher et al., 2021; Gaffey et al., 2021)
Signal	Cost	Some producers or distributors use self-proclaimed labelling instead of certified labelling.	Established producers and brands with certified labels. Accessing paid applicable documents and examining lifecycle analysis is expensive and resource-burden for small bioplastics companies. Large brand owners and retailers work together with academic institutions and environmental associations to educate consumers.	(Bhagwat et al., 2020; Fletcher et al., 2021; Gaffey et al., 2021; Goel et al., 2021; Keränen et al., 2021; Nazareth et al., 2019; Philp et al., 2013; Tudu & Yadav, 2019)
	Visibility	Labels are not easily seen by consumers. Biobased plastics are hard to distinguish from fossil-based plastics. Lack of information or general disposal procedure for the public.	Communication of the advantages of ecological packaging to consumers to change their attitudes and behaviour towards sustainability. Encouragement of visibility for biobased products Consumer willingness to pay (WTP) more per package if it displayed a biobased label or is exposed to pro-environmental nudge.	(Alaerts et al., 2018; Allison et al., 2021; Cheng et al., 2021; Grebitus et al., 2020; Hall et al., 2010; Taufik et al., 2020)
	Fit	Unclear disposal message due to various waste collection systems, including areas with no systems. The packaging attribute and message do not fit.	Terms such as biodegradable evoke environmentally friendly associations. Product labels and product design demonstrate a positive and significant influence on consumer product choices. Eco-friendly product positioning and labelling to help the buying decision of the consumers. Relevant information triggers WTP. During the crisis period, consumers disfavour offensive framing, which relates to the marketing messages from retailers that only emphasise product promotion without addressing consumer's concerns about the crisis situation.	(de Waard et al., 2020; Felix et al., 2021; Fletcher et al., 2021; Karana, 2012; Purohit, 2012; Salmi Mohd & Pung Xin, 2013; Seo & Scammon, 2017; Taufik et al., 2020; Wang et al., 2021; Wensing et al., 2020; Zhu & Wang, 2020)
	Consistency	Various certification labels across jurisdictions. Various terminology is used referring to biobased and biodegradability.	Detailed and uniformity of information to ensure that consumers have a better understanding.	(Bhagwat et al., 2020; Di Bartolo et al., 2021; Fletcher et al., 2021; Philp et al., 2013; Shahrasbi, 2019)

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TABLE 6 (Continued)

Element	Construct	Barrier	Driver	Reference
	Clarity	The communication regarding material source and disposal is not sufficiently clear. The label communication is not straightforward.	Clear and simple communication helps consumers identify the material and encourage purchasing. Communication of the value proposition should be in a clear message.	(Fletcher et al., 2021; Gaffey et al., 2021; Hall et al., 2010; Mehta et al., 2021; Ottoni et al., 2018)
	Credibility	Unproven biodegradability claims exist.	Marketers should have credible scientific evidence to back up their biodegradability claims.	(Nazareth et al., 2019; Shahrasbi, 2019; Vaverková et al., 2014)
Receiver	Attention	Consumers do not pay attention to labels or information on packaging.	Attentive consumers show relatively high WTP for biobased material followed by certified labelling.	(Allison et al., 2021; Cheng et al., 2021)
	Interpretation	Emotional claims in packaging do not fit certain consumer segments. Signal configuration is not suitable for a certain segment. Consumers' knowledge gap for compostability due to regulation and familiarity with the concept of composting waste. Consumers incorrectly interpret biodegradable, thinking that the packaging could rapidly degrade in an open environment. Consumer lack of knowledge about certain terminology, materials, labels and disposal procedures. Very little prior knowledge about biobased plastics. Some consumers believe all plastics should always be recycled. Consumers believe that the environmental impact of plastics is not significant. Consumer risk perception influences switching intention to bioplastics products. Green perceived risk influences the green purchase intention. Consumers have misconceptions that they think biobased plastic is by default biodegradable. Preference to choose reusable or recyclable instead of biodegradable packaging. Some consumers are sceptical of decomposition claims.	Messages that match the consumer thinking style have the strongest effects on WTP. Awareness of the plastics waste problem influences the behaviour to use bioplastics. The green awareness factor positively impacts online purchase decisions. Consumer education about green packaging leads to green purchases. Consumers believe that bioplastics have a lower negative environmental impact. Consumer's perception of value influence the switching intention to bioplastics product. Green perceived quality and value influence the green purchase intention. The perceived effectiveness of a green product contributes to buying decision of a green product. Personal perception that most people will approve the environmentally friendly behaviour. Consumers' perception of their ability to reduce plastics consumption influences their intention to use bioplastics. Positive attitude toward eco-friendly packaging or product predicts consumer buying intention. Environmental attitudes influence green purchase intentions. Positive attitudes toward biobased plastics will improve WTP for biobased plastics. Consumer green self-identity influences purchase or switching intention to bioplastics products.	(Aagerup et al., 2019; Allison et al., 2021; Bhagwat et al., 2020; Boesen et al., 2019; Cammarelle et al., 2021; Confente et al., 2020; Dilkes-Hoffman et al., 2019; Filho et al., 2021; Grebitus et al., 2020; Gutiérrez Taño et al., 2021; Herbes et al., 2018; Purohit, 2012; Ramesh & Samudhra Rajakumar, 2019; Scarpi et al., 2021; Suhartanto et al., 2021; Taufik et al., 2020; Trivedi et al., 2018; Wensing et al., 2020; Zwicker et al., 2021).

(Continues)

TABLE 6 (Continued)

Element	Construct	Barrier	Driver	Reference
			Consumers' trust in a green product influences their green purchase intention. Some consumers expect biodegradable plastics to decompose much more quickly than traditional packaging. Consumers' ecological concerns influence green purchase intention and behaviour.	
Feedback	Countersignal	Littering due to incorrect understanding of 'biodegradable' terminology. Disposing of compostable bio-based packaging in the incorrect trash bin.	WTP. Intention to purchase. Intention to switch to bioplastics. Intention to use bioplastics. Green purchase behaviour. Routine use or consumer adoption. Consumer acceptance. Positive word-of-mouth and recovery of consumer trust. Clean & proper waste stream for the waste processor. Proper disposal method for home composting.	(Alaerts et al., 2018; Bhagwat et al., 2020; De Marchi et al., 2020; Evans et al., 2020; Filho et al., 2021; Friedrich, 2021; Grebitus et al., 2020; Gutiérrez Taño et al., 2021; Herbes et al., 2018; Kakadellis et al., 2021; Karana, 2012; Purohit, 2012; Scarpi et al., 2021; Taufik et al., 2020; Trivedi et al., 2018; Wang et al., 2021; Wensing et al., 2020; Zwicker et al., 2021)
Environment	Distortion	Online retail did not show packaging material information. The existing plastics disposal information medium generally promotes recycling.	-	(Allison et al., 2021; Taufik et al., 2020)

New and small bioplastics companies consider that accessing a paywall document for standards and conducting lifecycle analysis is costly and resource-intensive (Fletcher et al., 2021; Philp et al., 2013). These favour established producers and brands to have certified labels to convince customers (Goel et al., 2021; Tudu & Yadav, 2019). Furthermore, popular brands and retailers could afford to collaborate with universities and environmental associations to conduct consumer education, aiming at consumer adoption (Keränen et al., 2021). Ineptly, to get around this cost issue, some producers or distributors choose to use self-proclaimed labels, which are often misleading (Nazareth et al., 2019).

> **Proposition 2a.** *A more costly to imitate signal will have a greater impact on the receiver, improving the feedback and therefore improving consumer adoption.*

The visibility of the message is crucial for the consumer (receiver) to identify the bioplastics material and be motivated to purchase those materials (Mehta et al., 2021; Ottoni et al., 2018). Thus, consumers would be willing to pay more per unit for a package with a bio-based label or subject to a pro-environmental message (Cheng et al., 2021; Grebitus et al., 2020). Visually, consumers might find it challenging to discern between fossil-based and biobased plastics or biodegradable plastics, creating difficulties at the end-of-life, such as manual sorting (Alaerts et al., 2018; Taufik et al., 2020).

> **Proposition 2b.** *Better signal visibility will have a greater impact on the receiver, thus improving the feedback and therefore improving consumer adoption and the proper disposal.*

Clear and straightforward communication aids in the identification of the packaging material and might encourage purchase (Mehta et al., 2021). Indeed, the valuable benefit of the container should be conveyed in clear language (Gaffey et al., 2021). When the packaging information is not easily understood, the consumer is confused (Ottoni et al., 2018). Others also revealed unclear communication regarding the material's source and disposal procedure (Fletcher et al., 2021).

> **Proposition 2c.** *Greater signal clarity will have a greater impact on the receiver, thus improving the feedback and therefore improving consumer adoption and the proper disposal.*

In bioplastics communication, some terms are perceived as associated with eco-friendliness, such as 'biodegradable' (de Waard et al., 2020); however, to reconcile the information asymmetry between the signaller and the receiver and influence the consumer's purchasing decision of green products an appropriate product design, positioning and labelling are suggested (Purohit, 2012; Salmi Mohd &

Pung Xin, 2013). Regarding end-of-life, there are circumstances in which the disposal instruction might not fit with the consumer situation because of various waste collection systems, including areas that do not have the required infrastructure (Fletcher et al., 2021; Taufik et al., 2020). That waste might end up in a landfill, where the biodegradation of bioplastics could release hazardous methane gas (Zhu & Wang, 2020).

> **Proposition 2d.** *A better signal fit will have a greater impact on the receiver, thus improving the feedback, therefore improving consumer adoption and the proper disposal.*

Message inconsistency in various mediums is an issue that affects the consumer's decision. Different certified labels exist in different regions and countries (Bhagwat et al., 2020; Di Bartolo et al., 2021). However, the concepts of biobased and biodegradability use various terms, confusing consumers (Fletcher et al., 2021; Philp et al., 2013). Indeed, the uniformity of a plastic biodegradability testing method will enable companies to have accurate advertisements, and consumers will have a better understanding if the information is detailed and uniform (Shahrasbi, 2019).

> **Proposition 2e.** *A better signal consistency will have a greater impact on the receiver, thus improving the feedback and therefore improving consumer adoption.*

Certification can signal sustainability to consumers (Iles, 2008). However, not all compostability claims from bioplastics manufacturers are credible (Vaverková et al., 2014). Greenwashing practices are highlighted to persuade consumers to purchase under the false credible message (Nazareth et al., 2019; Torelli et al., 2020), which will influence consumer confidence (Kahraman & Kazançoğlu, 2019; Nygaard & Silkoset, 2022). Accordingly, unqualified biodegradable plastics claims from producers may lead the consumer to take the incorrect disposal route (Shahrasbi, 2019).

> **Proposition 2f.** *Greater signal credibility will have a greater impact on the receiver, thus improving the feedback and therefore improving the consumer adoption and the proper disposal.*

Prior studies have found that a larger environmental distortion will reduce signal visibility and fit. For example, products with bioplastic packaging sold through the internet that do not give sufficient information about the environmental advantage of the packaging (Allison et al., 2021) create difficulties for the consumer to understand the message from the brands, while physical product packaging can provide an adequate message about the packaging material (Allison et al., 2021). Other situations about the distortion of the signalling environment could be inferred from the end-of-life plastic waste treatment public information that generally motivates and gives guidance about recycling plastics (Bhagwat et al., 2020). This might

prompt consumers to expect that all kinds of plastics should be recycled, including biodegradable ones (Taufik et al., 2020).

> **Proposition 3a.** *A greater environment distortion will reduce signal visibility.*

> **Proposition 3b.** *A greater environment distortion will reduce the signal fit.*

As individual information searches are evidently necessary for triggering purchasing behaviour towards sustainable packaging (Testa et al., 2020), attentive consumers are more willing to pay for biobased materials and display-certified labelling (Cheng et al., 2021). Nonetheless, some consumers often ignore labels and information on the packaging for reasons such as time constraints for checking all products' packaging material information while shopping; thus, this is identified as a barrier to bioplastic packaging purchasing behaviour (Allison et al., 2021).

> **Proposition 4a.** *A higher receiver's attention will improve the feedback, therefore improving consumer adoption.*

Various factors within consumer behaviour may result in the purchase of bioplastic packaging, including green awareness, knowledge of certain terminology, knowledge of green packaging and perceived effectiveness (Allison et al., 2021; Grebitus et al., 2020; Trivedi et al., 2018), which impact the receivers' (consumers') interpretation ability. Thus, when the type of message matches the characteristics of the consumer's cognitive style, the strongest effects for WTP are generated (Wensing et al., 2020). Related to end-of-life treatments, less ability to interpret the signal by the consumers will also reduce the clarity of the countersignal, for example, some consumers misinterpret that biodegradable plastics can quickly disintegrate in the natural environment, leading them to litter (Bhagwat et al., 2020). Others believe all plastic waste can always be recycled (Taufik et al., 2020), potentially contaminating other waste streams (Alaerts et al., 2018). These inevitably affect the expected proper disposal outcome from consumers.

> **Proposition 4b.** *The better the ability to interpret will improve the feedback, therefore improving consumer adoption and proper disposal.*

Building from propositions, the proposed conceptual framework is presented in Figure 3. The solid arrows represent the general communication process as depicted by ST, while the dashed arrows represent propositions that have been suggested by the literature review and thus the refined framework of communication mechanisms for bioplastic packaging consumers. While signal frequency is proposed in the original construct by Connelly et al. (2011), nonetheless that construct is non-existent within the bioplastic packaging communication literature, so we removed it. The feedback includes consumer adoption and proper packaging waste disposal, which is aligned with our
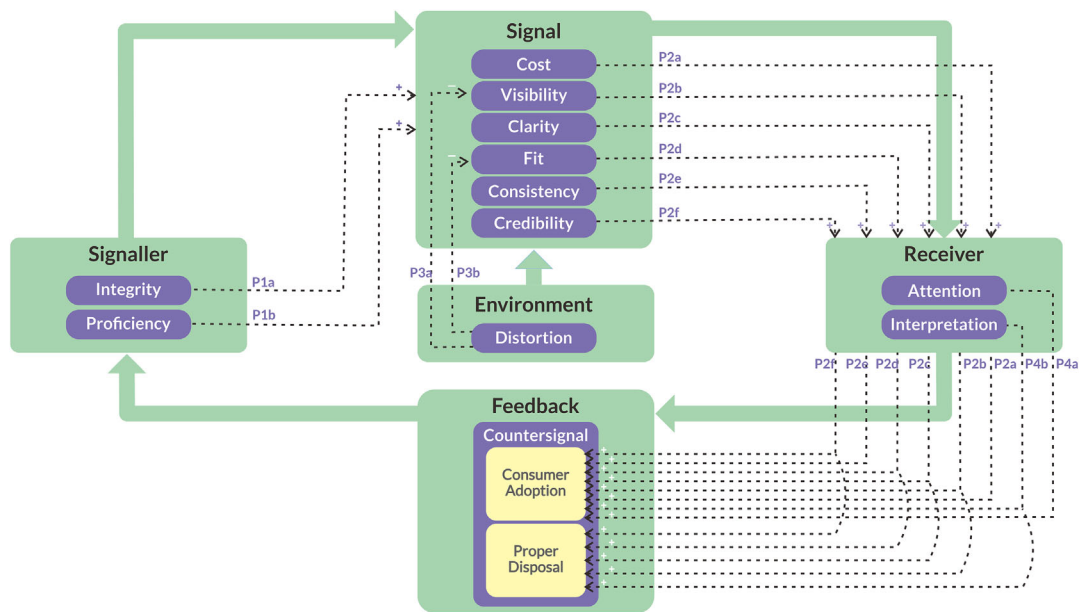
FIGURE 3 Conceptual framework of the communication mechanism to consumers of bioplastics packaging.

third RQ. We also propose the signaller's proficiency and signal clarity as those suggested in the text corpus.

6 | CONCLUSIONS

The purpose of this paper is to understand the process, the barriers and the mechanisms of communication for consumers of bioplastic packaging, particularly in the adoption and disposal practices. We have found that within bioplastic packaging, the main actors that currently communicate to the consumers are commercial entities through packaging, labels, advertising and campaigns with the primary purpose of product adoption. However, to improve the communication of sustainable innovations to consumers (receivers) to ensure proper disposal, necessary changes in the signal (e.g., messages) to overcome the communication barriers and their connections with diverse signallers at the end-of-life are needed beyond the firm-level remit.

Communication barriers embedded in the messages and the consumers are found to be hindering those changes. The difficulties in communicating positive environmental advantages, varied and unclear terminology and labels, misleading claims, messaging issues, a lack of clarity and sometimes inexistent disposal routes are substantial examples of barriers to the message, whereas limited knowledge, inattentive behaviour, certain perceptions of plastics, as well as scepticism are some examples of consumer-related issues.

By drawing from the signalling theory, the study showed that the desired packaging material adoption and disposal outcomes could be achieved by improving the signalling integrity and proficiency of the firms (brands and producers). However, the firm-level changes alone are not sufficient to improve the signal (Keränen et al., 2021); the receiver is also influenced by signals from the end-of-life, which need to be coordinated and coherent. The greater environmental distortion

also plays a key role in the quality of the signal, reducing its visibility and fit, creating difficulties for the consumer to understand the message from the brands at the end-of-life. The signal improvement has a cost for the signalling firms in terms of certifications and/or life cycle analysis (Truong et al., 2021), favouring brands and retailers that could afford those changes. Besides, greater signal visibility, clarity, fit and consistency of the signal (e.g., message) will lead to consumer adoption and disposal. The receiver (consumer) also plays a role in the communication; attentive consumers with the ability to interpret the message are more receptive to adopting and properly disposing of these products.

This study has therefore unveiled the imperative of communication signals in boosting business strategies of the bioplastic packaging industry.

6.1 | Implications

For theoretical implications, this study extends the signalling theory framework previously suggested by Connelly et al. (2011) and hence contributes to the addition of signaller proficiency and signal clarity as crucial constructs in the packaging communication context. These two constructs are evidently vital in ensuring that the company can communicate correctly and that the message is clear enough for consumers to acknowledge the benefits of bioplastic packaging. Therefore, the proposed conceptual framework in this study not only adds to the existing body of knowledge on bioplastic packaging but also offers a valuable theoretical perspective for future research in the packaging communication field.

Regarding managerial implications, this study has provided insights into how to strengthen communication signals to boost business strategies. First and foremost, it is crucial for companies to

uphold integrity, ensuring that all consumer communications are truthful (Shahrasbi, 2019). Subsequently, companies should be aware of the relevant standards and regulations so as to be able to effectively communicate the advantages of bioplastic packaging (Fletcher et al., 2021). Indeed, organisations' capability to employ knowledge and information for the purpose of profit generation and reinforcement of business strategies is a crucial determinant of success (Tan et al., 2016).

Furthermore, the main communication messages should be strategically positioned in a visible manner, employing language that is easily understood by consumers and accurately representing the biobased or biodegradable nature of the packaging (Allison et al., 2021). Ensuring message consistency across various communication media is important, and the message's credibility can be enhanced by incorporating third-party certifications from reputable bodies (Fletcher et al., 2021). Investing in 'signals' that are difficult for competitors to imitate, for instance, those that are showcasing the firm's commitment to environmental sustainability so that they can entice consumers who are willing to pay a premium (Cheng et al., 2021), can also serve as a strategic business approach. Moreover, companies should closely examine the place of distribution or marketing environment to ensure that particular contextual factors do not undermine the messaging about the advantages of bioplastic packaging (Allison et al., 2021).

Finally, it is essential to devise effective strategies aimed at improving consumers' attention and enhancing their understanding of promotional materials or labels pertaining to the benefits of bioplastic packaging (Wensing et al., 2020), as well as the correct procedures for its disposal (Taufik et al., 2020). The ultimate goal is to foster wider adoption of bioplastic packaging while ensuring proper waste management practices that align with the suggested guidelines.

Considering there is a notion that companies are pressured to be more environmentally responsible with the post-consumption waste of their products (Dües et al., 2013; Rivera, 2019), the conceptual framework could be useful. This is consistent with Mukonza and Swarts (2020), who suggest that successfully communicating environmental commitment as a part of business strategy will positively impact company image and business performance. In addition, the existing greenwashing practices should be a call to action for regulating bodies to design more effective regulations and stronger law enforcement (Li et al., 2023; Prothero et al., 1997).

6.2 | Limitations and future research

By using a systematic literature review, some potential articles or documents might not be captured due to the rigid data collection and filtering protocols. However, we have also embraced flexibility by allowing the inclusion of relevant peer-reviewed papers from high-impact journals that were not acquired from a systematic search. Besides, the study should be considered under the sustainable packaging remit and shall only be applied in other industry contexts with similar characteristics.

From the findings that have been described previously, some areas are considered to have insufficient information, thus limiting the ability to conclude. These topics are being less examined within the extant communication of bioplastic packaging literature.

6.2.1 | Communication from other actors

Apart from the commercial entities (i.e., producers, brand owners and retailers), there is a lack of information relating to different actors in the supply chain communicating with consumers. Effective communication among producers, consumers, waste management and downstream actors is crucial to prevent end-of-life issues associated with bioplastic packaging (Beltran et al., 2021; Fletcher et al., 2021). Indeed, the biobased biodegradable plastics packaging supply chain extends until the waste management process (D'Adamo et al., 2020; Di Bartolo et al., 2021).

TABLE 7 Future research agenda.

Research gap theme	Potential future research
Signaller	• Communication from waste management sector actors, such as composters, material recovery facilities and recyclers • Communication from cross-sectoral actors, such as government and civil organisations • Attributes to measure signaller proficiency
Signal	• Communication signal to help consumers distinguish material visually • Significance of communication frequency
Receiver	• The specific relationship of each construct of the signalling element with the receiver and its subsequent feedback • Other internal or external factors to the receiver along with the signal that could affect the feedback
Environment	• Strategies to reduce environmental interferences in online commerce settings, physical stores and public spaces • Environmental circumstances that can amplify signals
Feedback	• Communication for end-of-life routes, in particular, proper disposal of biodegradable plastics • Effective feedback that could improve signal quality
Context	• Empirical research to validate the propositions suggested • Research in developing countries or emerging economy countries • Research on closed-loop systems that potentially enabling material circularity

6.2.2 | Communication for end-of-life

Research is limited on how communication influences proper disposal for the end-of-life phase. Compostability is one of the advantages of biodegradable plastics over fossil-based plastics. The post-consumption packaging waste, however, needs to have a proper disposal route and treatment to be able to biodegrade.

6.2.3 | Communication to distinguish material

Improving the recognisability of biodegradable plastics from non-biodegradable could help in better end-of-life treatment of the bioplastic packaging (Alaerts et al., 2018; Kakadellis et al., 2021). Visual communication might be an aid; however, prior research in this area is still limited.

Table 7 summarises the research gaps and the potential future research in accordance with the framework. By exploring these avenues, a fine-grained communication mechanism for bioplastics to influence consumer behaviour could be revealed, and the suggested propositions could be clarified; thus, the accuracy of the framework could be enhanced to help devise a compelling business strategy.

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APPENDIX A

TABLE A1   PRISMA statement (v2009).

Section/topic	#	Checklist item	Reported on section
Title			
Title	1	Identify the report as a systematic review, meta-analysis, or both	Title
Abstract			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number	Abstract
Introduction			
Rationale	3	Describe the rationale for the review in the context of what is already known.	1
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes and study design (PICOS)	1
Methods			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number	3
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	3
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	3
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	3
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in the systematic review, and, if applicable, included in the meta-analysis).	3
Data collection process	10	Describe the method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	3
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	3
Risk of bias inindividual studies	12	Describe methods used for assessing the risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	3
Summary measures	13	State the principal summary measures (e.g., risk ratio, the difference in means).	N/A
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I2) for each meta-analysis.	N/A
Risk of bias acrossstudies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	3
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	3
Results			
Study selection	17	Give numbers of studies screened, assessed for eligibility and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	3
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Appendix

TABLE A1 (Continued)

Section/topic	#	Checklist item	Reported on section
Risk of bias withinstudies	19	Present data on the risk of bias of each study and, if available, any outcome level assessment (see item 12)	N/A
Results of individualstudies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	N/A
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency	N/A
Risk of bias acrossstudies	22	Present results of any assessment of the risk of bias across studies (see Item 15).	N/A
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression (see Item 16)	N/A
Discussion			
Summary ofevidence	24	Summarise the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users and policymakers).	5
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review level (e.g., incomplete retrieval of identified research, reporting bias).	6
Conclusions	26	Provide a general interpretation of the results in the context of other evidence and implications for future research.	6
Funding			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); the role of funders for the systematic review.	Author Statement

TABLE A2 Articles included in the study.

No	Author(s)	Year	Title	Journal	Database
1	Aagerup, U.; Frank, A. S.; Hultqvist, E.	2019	The persuasive effects of emotional green packaging claims	British Food Journal	Scopus
2	Alaerts, L.; Augustinus, M.; Van Acker, K.	2018	Impact of bio-based plastics on current recycling of plastics	Sustainability (Switzerland)	Scopus
3	Allison, A. L.; Lorencatto, F.; Michie, S.; Miodownik, M.	2021	Barriers and enablers to buying biodegradable and compostable plastic packaging	Sustainability (Switzerland)	Scopus
4	Auliandri, T. A.; Thoyib, A.; Rohman, F.; Rofiq, A.	2018	Does green packaging matter as a business strategy? Exploring young consumers' consumption in an emerging market	Problems and Perspectives in Management	Scopus
5	Bertini, M.; Buehler, S., Halbheer, D.; Lehmann, D. R.	2022	Carbon Footprinting and Pricing Under Climate Concerns	Journal of Marketing	Reference
6	Bezawada, R.; Pauwels, K.	2013	What is special about marketing organic products? How organic assortment, price, and promotions drive retailer performance	Journal of Marketing	Reference
7	Bhagwat, G.; Gray, K.; Wilson, S. P.; Muniyasamy, S.; Vincent Salom Gnana, T.; Bush, R.; Palanisami, T.	2020	Benchmarking Bioplastics: A Natural Step Towards a Sustainable Future	Journal of Polymers and the Environment	ProQuest Central

(Continues)

TABLE A2 (Continued)

No	Author(s)	Year	Title	Journal	Database
8	Boesen, S.; Bey, N.; Niero, M.	2019	Environmental sustainability of liquid food packaging: Is there a gap between Danish consumers' perception and learnings from life cycle assessment?	Journal of Cleaner Production	Scopus
9	Cammarelle, A.; Viscecchia, R.; Bimbo, F.	2021	Intention to purchase milk packaged in biodegradable packaging: Evidence from Italian consumers	Foods	Scopus
10	Cheng, H.; Lambert, D. M.; DeLong, K. L.; Jensen, K. L.	2021	Inattention, availability bias, and attribute premium estimation for a biobased product	Agricultural Economics (United Kingdom)	Scopus
11	Confente, I.; Scarpi, D.; Russo, I.	2020	Marketing a new generation of bio-plastics products for a circular economy: The role of green self-identity, self-congruity, and perceived value	Journal of Business Research	Scopus
12	D'Adamo, I.; Falcone, P. M.; Imbert, E.; Morone, P.	2020	A Socio-economic Indicator for EoL Strategies for Bio-based Products	Ecological Economics	EBSCOhost
13	De Marchi, E.; Pigliafreddo, S.; Banterle, A.; Parolini, M.; Cavaliere, A.	2020	Plastic packaging goes sustainable: An analysis of consumer preferences for plastic water bottles	Environmental Science and Policy	Scopus
14	de Waard, E. F.; Prins, G. T.; van Joolingen, W. R.	2020	Pre-university students' perceptions about the life cycle of bioplastics and fossil-based plastics	Chemistry Education Research and Practice	ProQuest Central
15	Di Bartolo, A.; Infurna, G.; Dintcheva, N. T.	2021	A Review of Bioplastics and Their Adoption in the Circular Economy	Polymers (20734360)	EBSCOhost
16	Dilkes-Hoffman, L.; Ashworth, P.; Laycock, B.; Pratt, S.; Lant, P.	2019	Public attitudes towards bioplastics – knowledge, perception and end-of-life management	Resources, Conservation and Recycling	Scopus
17	Evans, D. M.; Parsons, R.; Jackson, P.; Greenwood, S.; Ryan, A.	2020	Understanding plastic packaging: The co-evolution of materials and society	Global Environmental Change	Scopus
18	Felix, R.; González, E. M.; Castaño, R.; Carrete, L.; Gretz, R. T.	2021	When the green in green packaging backfires: Gender effects and perceived masculinity of environmentally friendly products	International Journal of Consumer Studies	Scopus
19	Filho, W. L.; Salvia, A. L.; Bonoli, A.; Saari, U. A.; Voronova, V.; Klõga, M.; Kumbhar, S. S.; Olszewski, K.; De Quevedo, D. M.; Barbir, J.	2021	An assessment of attitudes towards plastics and bioplastics in Europe	Science of the Total Environment	Scopus
20	Filiciotto, L.; Rothenberg, G.	2021	Biodegradable Plastics: Standards, Policies, and Impacts	ChemSusChem	ProQuest Central
21	Fletcher, C. A.; Niemenoja, K.; Hunt, R.; Adams, J.; Dempsey, A.; Banks, C. E.	2021	Addressing stakeholder concerns regarding the effective use of bio-based and biodegradable plastics	Resources	Scopus
22	Ford, A.; Moodie, C.; Hastings, G.	2012	The role of packaging for consumer products: Understanding the move towards 'plain' tobacco packaging	Addiction Research and Theory	Scopus
23	Friedrich, D.	2021	Market and business-related key factors supporting the use of compostable bioplastics in the apparel industry: A cross-sector analysis	Journal of Cleaner Production	EBSCOhost

TABLE A2 (Continued)

No	Author(s)	Year	Title	Journal	Database
24	Friedrich, D.	2021	What makes bioplastics innovative for fashion retailers? An in-depth analysis according to the Triple Bottom Line Principle	Journal of Cleaner Production	EBSCOhost
25	Friedrich, D.	2021	Comparative analysis of sustainability measures in the apparel industry: An empirical consumer and market study in Germany	Journal of Environmental Management	Scopus
26	Gaffey, J.; McMahon., H.; Marsh, E.; Vos, J.	2021	Switching to Biobased Products – The Brand Owner Perspective	Industrial Biotechnology	ProQuest Central
27	Goel, V.; Luthra, P.; Kapur, G. S.; Ramakumar, S. S. V.	2021	Biodegradable/Bio-plastics: Myths and Realities	Journal of Polymers and the Environment	ProQuest Central
28	Grebitus, C.; Roscoe, R. D.; Van Loo, E. J.; Kula, I.	2020	Sustainable bottled water: How nudging and Internet Search affect consumers' choices	Journal of Cleaner Production	EBSCOhost
29	Gutiérrez Taño, D.; Hernández Méndez, J.; Díaz-Armas, R.	2021	An extended theory of planned behaviour model to predict intention to use bioplastic	Journal of Social Marketing	Scopus
30	Hall, C. R.; Campbell, B. L.; Behe, B. K.; Yue, C.; Lopez, R. G.; Dennis, J. H.	2010	The appeal of biodegradable packaging to floral consumers	HortScience	Scopus
31	Herbes, C.; Beuthner, C.; Ramme, I.	2018	Consumer attitudes towards biobased packaging – A cross-cultural comparative study	Journal of Cleaner Production	Scopus
32	Kakadellis, S.; Woods, J.; Harris, Z. M.	2021	Friend or foe: Stakeholder attitudes towards biodegradable plastic packaging in food waste anaerobic digestion	Resources, Conservation and Recycling	Scopus
33	Karana, E.	2012	Characterization of 'natural' and 'high-quality' materials to improve perception of bio-plastics	Journal of Cleaner Production	EBSCOhost
34	Kardos, M.; Gabor, M. R.; Cristache, N.	2019	Green marketing's roles in sustainability and ecopreneurship. Case study: Green packaging's impact on Romanian young consumers' environmental responsibility	Sustainability (Switzerland)	Scopus
35	Keränen, O.; Komulainen, H.; Lehtimäki, T.; Ulkuniemi, P.	2021	Restructuring existing value networks to diffuse sustainable innovations in food packaging	Industrial Marketing Management	EBSCOhost
36	Lim, J. H.; Rishika, R.; Janakiraman, R.; Kannan, P. K.	2020	Competitive effects of front-of-package nutrition labeling adoption on nutritional quality: evidence from facts up front–style labels	Journal of Marketing	Reference
37	Luiz Ottoni, B.; Deus, R. M.; Gobbo Junior, J. A.; de Carvalho, Â. M. G.; Gomes Battistelle, R. A.	2018	Communication and Biodegradable Packaging Relationship: A Paradigm for Final Disposal	Journal of Applied Packaging Research	EBSCOhost
38	Mahadi, Z.; Yahya, E. A.; Amin, L.; Yaacob, M.; Sino, H.	2021	Investigating Malaysian stakeholders' perceptions of the government's aim to replace conventional plastic bags with biodegradable and compostable bioplastic bags	Journal of Material Cycles and Waste Management	Scopus
39	Mehta, N.; Cunningham, E.; Roy, D.; Cathcart, A.;	2021	Exploring perceptions of environmental professionals, plastic processors, students and consumers of bio-based	Sustainable Production and Consumption	Scopus

(Continues)

TABLE A2 (Continued)

No	Author(s)	Year	Title	Journal	Database
	Dempster, M.; Berry, E.; Smyth, B. M.		plastics: Informing the development of the sector		
40	Mookerjee, S.; Cornil, Y.; Hoegg, J.A.	2021	From Waste to Taste: How "Ugly" Labels Can Increase Purchase of Unattractive Produce	Journal of Marketing	Reference
41	Nazareth, M.; Marques, M. R. C.; Leite, M. C. A.; Castro, Í. B.	2019	Commercial plastics claiming biodegradable status: Is this also accurate for marine environments?	Journal of Hazardous Materials	Scopus
42	Orset, C.; Barret, N.; Lemaire, A.	2017	How consumers of plastic water bottles are responding to environmental policies?	Waste Management	Scopus
43	Orzan, G.; Cruceru, A. F.; Balaceanu, C. T.; Chivu, R. G.	2018	Consumers' behavior concerning sustainable packaging: An exploratory study on Romanian consumers	Sustainability (Switzerland)	Scopus
44	Pan, C.; Yu, L.; Wu, J.; Wang, Y.	2021	The influence of green packaging on consumers' green purchase intention in the context of online-to-offline commerce	Journal of Systems and Information Technology	ProQuest Central
45	Petljak, K.; Naletina, D.; Bilogrević, K.	2019	CONSIDERING ECOLOGICALLY SUSTAINABLE PACKAGING DURING DECISION-MAKING WHILE BUYING FOOD PRODUCTS	Ekonomika Poljoprivrede	ProQuest Central
46	Philp, J. C.; Bartsev, A.; Ritchie, R. J.; Baucher, M. A.; Guy, K.	2013	Bioplastics science from a policy vantage point	New Biotechnology	Scopus
47	Purohit, H. C.	2012	Product Positioning And Consumer Attitude Towards Eco-Friendly Labeling and Advertisement	Journal of Management Research (09725814)	EBSCOhost
48	Ramesh, M.; Samudhra Rajakumar, C.	2019	Determinants of online purchase decision of green products	International Journal of Engineering and Advanced Technology	Scopus
49	Rokka, J.; Uusitalo, L.	2008	Preference for green packaging in consumer product choices – Do consumers care?	International Journal of Consumer Studies	Scopus
50	Salmi Mohd, I.; Pung Xin, Y.	2013	Investigating the preference for green packaging in consumer product choices: A choice-based conjoint approach	Business Management Dynamics	ProQuest Central
51	Scarpi, D.; Russo, I.; Confente, I.; Hazen, B.	2021	Individual antecedents to consumer intention to switch to food waste bioplastic products: A configuration analysis	Industrial Marketing Management	EBSCOhost
52	Seo, J. Y.; Scammon, D. L.	2017	Do green packages lead to misperceptions? The influence of package colors on consumers' perceptions of brands with environmental claims	Marketing Letters	Scopus
53	Shahrasbi, S.	2019	Consumers, Plastic, and What It Means To Be Biodegradable	Georgetown Environmental Law Review	ProQuest Central
54	Shruti, V. C.; Pérez-Guevara, F.; Roy, P. D.; Elizalde-Martínez, I.; Kutralam-Muniasamy, G.	2020	Identification and characterization of single use oxo/biodegradable plastics from Mexico City, Mexico: Is the advertised labeling useful?	Science of the Total Environment	Scopus

TABLE A2 (Continued)

No	Author(s)	Year	Title	Journal	Database
55	Suhartanto, D.; Kartikasari, A.; Hapsari, R.; Budianto, B. S.; Najib, M.; Astor, Y.	2021	Predicting young customers' intention to repurchase green plastic products: incorporating trust model into purchase intention model	Journal of Asia Business Studies	Scopus
56	Taufik, D.; Reinders, M. J.; Molenveld, K.; Onwezen, M. C.	2020	The paradox between the environmental appeal of bio-based plastic packaging for consumers and their disposal behaviour	Science of the Total Environment	Scopus
57	Trivedi, R. H.; Patel, J. D.; Acharya, N.	2018	Causality analysis of media influence on environmental attitude, intention and behaviors leading to green purchasing	Journal of Cleaner Production	Scopus
58	Tudu, P. N.; Yadav, R.	2019	EnviGreen Biotech: An Eco-friendly Alternative to Plastic Bags	South Asian Journal of Business and Management Cases	Scopus
59	Vaverková, M.; Adamcová, D.; Zloch, J.	2014	How do degradable/biodegradable plastic materials decompose in home composting environment?	Journal of Ecological Engineering	Scopus
60	Wandosell, G.; Parra-Meroño, M. C.; Alcayde, A.; Baños, R.	2021	Green Packaging from Consumer and Business Perspectives	Sustainability	ProQuest Central
61	Wang, Y.; Zhang, M.; Li, S.; McLeay, F.; Gupta, S.	2021	Corporate Responses to the Coronavirus Crisis and their Impact on Electronic-Word-of-Mouth and Trust Recovery: Evidence from Social Media	British Journal of Management	Reference
62	Wensing, J.; Caputo, V.; Carraresi, L.; Bröring, S.	2020	The effects of green nudges on consumer valuation of bio-based plastic packaging	Ecological Economics	Scopus
63	Yang, Y. C.; Zhao, X.	2019	Exploring the relationship of green packaging design with consumers' green trust, and green brand attachment	Social Behavior and Personality	Scopus
64	Yeh, C.-H.; Lücke, F.-K.; Janssen, J.	2015	Bioplastics: Acceptable for the packaging of organic food? A policy analysis	Journal of Agriculture, Food Systems, and Community Development	ProQuest Central
65	Zhang, W.; Chintagunta, P.K.; Kalwani, M.U.	2021	Social Media, Influencers, and Adoption of an Eco-Friendly Product: Field Experiment Evidence from Rural China	Journal of Marketing	Reference
66	Zhao, X.; Pan, C.; Cai, J.; Luo, X. R.; Wu, J.	2021	DRIVING E-COMMERCE BRAND ATTACHMENT THROUGH GREEN PACKAGING: AN EMPIRICAL INVESTIGATION	Journal of Electronic Commerce Research	Scopus
67	Zhu, J.; Wang, C.	2020	Biodegradable plastics: Green hope or greenwashing?	Marine Pollution Bulletin	Scopus
68	Zwicker, M. V.; Brick, C.; Gruter, G. J. M.; van Harreveld, F.	2021	(Not) doing the right things for the wrong reasons: An investigation of consumer attitudes, perceptions, and willingness to pay for bio-based plastics	Sustainability (Switzerland)	Scopus

TABLE A3 Final template.

Coding	Subtheme	Theme
Advertising	Communication medium	Communication process
Campaign		
Labels		
Packaging		
Written communication	Packaging as a communication medium	
Non-verbal communication		
Bioplastics producer	Communication actors	
Brand owner		
Retailer		
Waste processor		
Academics		
Civil organisation		
For adoption	Communication purpose	
For disposal		
Verified claims	Communicating sustainability claims	
False claims		
Establishing standard	Regulating communication	
Giving certification & labelling		
Regulating marketing communication		
Difficulties in creating effective message	Message as barrier	Communication barrier
Insufficient information		
Various terms		
Various labels		
Label not obvious		
Irrelevant message		
Visual similarity		
Misleading information		
Limited knowledge	Consumer as barrier	
Lack of awareness		
Confusion		
Misunderstanding		
Inattentive behaviour		
Did not believe the advantage		
Believe all plastics should be recycled		
Sceptical		
Colour perception		