


Review

# The Role of Food Packaging Design in Consumer Recycling Behavior—A Literature Review

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**Abstract:** Household waste sorting at the source is an essential part of the waste management system in many countries. Correct sorting of this waste, including food packaging waste, is cost-effective, it facilitates the recycling process and enhances the quality of the recycled product. Although there is a growing body of research that studies the effect of different attributes of food packaging on household recycling behavior, the effect of these attributes on the sorting of the food packaging waste is not well known. This contribution reviews work that studies the relationship between attributes of food packaging and consumer sorting behavior. The review highlights the potential of the visual attributes and the quality of packaging as a communication channel for encouraging consumers to sort the food packaging waste. The efficiency of the waste management system and the quality of recycled products can hence be affected by the proper design of food packaging.

**Keywords:** food packaging; packaging design; packaging waste; sorting behavior; household waste

## 1. Introduction

The ever-increasing global population and urbanization leads to growing amounts of household solid waste (HSW) [1,2]. For instance, in Sweden, the annual amount of HSW increased from 317 kg per person in 1975 to 476 kg per person in 2017, and this trend is expected to continue [2,3]. The global increase in HSW leads to increases in economic costs associated with waste management, it has a large environmental impact and, unless properly treated, raises concerns for the health and well-being of the local population. Waste management systems are therefore facing large challenges when contributing to all three aspects of sustainable development: economic, environmental, and social [4–6]. These challenges become more demanding in developed countries, where there is a strong link between economic growth, consumption, and the amount of generated waste [2,7].

A sustainable waste management system, which recovers material and energy from the waste, is therefore required to reduce environmental impacts [5,8,9] and to make advances towards a circular economy [10–12]. Although advances in technology are important to improve methods to treat waste, the waste management system requires the active participation of all stakeholders, including actors that generate the waste (such as households), funding institutions, and the actors that manage the municipal waste [3,5,6,8]. At the same time, the National Sword project in China and other Southeast Asian countries, which bans the importing of contaminated and mix-waste, increases the requirement of proper recycling in many countries around the world [13,14].

The rate of material recycling can be increased by separating the waste into different fractions and using these unmixed fractions as input to the technical system [15]. Household waste separation can take place in two ways. It can be achieved by mechanical/or manual sorting at Material Recovery Facilities (MRFs) or by citizens at their homes. The latter is called sorting at the source since the sorting is done where the waste is generated [1]. The advantages associated with citizens participating in the

waste management scheme, and in particular in sorting at the source, have been discussed in previous studies [1,6,16–21]. For example, the fractions that are obtained when sorting at the source (e.g., glass, plastic, and paper) have a higher quality compared to fractions obtained when sorting at MRFs, and the source separation process is less expensive [1,3,19]. Hence, correct sorting of waste fractions can increase material recycling and contribute to a circular economy.

Among the different fractions of HSW, food packaging is of interest due to the increasing amount of this type of waste. Also, food packaging is estimated to be more than one-third of the total global packaging market [22,23]. However, the amount of recycled food packaging waste still is not sufficient. For instance, in 2017 only 56% of the 4.4 million tons of packaging waste that was generated in Australia was recycled [24]. In the United States of America, in 2015 the recycling rate of packaging waste and containers was 53% and over 23% of packaging waste was landfilled [25]. In Sweden, approximately 60% of household mixed waste still contains recyclable packaging waste [3]. On a global scale, this amount of un-recycled food packaging waste, especially plastic packaging, can significantly harm the environment [26,27]. This impact could be reduced by proper waste sorting. Proper sorting of food packing, irrespective of whether it is plastic, paperboard, or metal, allows the material to be recycled instead of being used for energy recovery, landfilling, or dumping. Thus, food packaging waste could be a valuable resource that would have lower environmental impacts if it is sorted according to the type of the material that was used to make the packaging [1,3]. In addition, the positive correlation between increasing urbanization and packaging consumption is expected to continue [26]. This is likely to lead to a greater amount of food packaging waste in the future. It is therefore important to motivate consumers to participate in the waste sorting system [15]. Since sorting occurs at the interface between the consumers and the technical waste management system, it has stimulated research in both the social and engineering sciences [28] such as waste management [1,29], sustainable development [30], and packaging design [31,32]. Furthermore, Trudel et al. [33] stated that the consumer's decision whether or not to recycle packaging is a complex issue which is affected by a variety of factors (e.g., environmental concern and effort). This multidisciplinary topic requires studies by different disciplines involved with packaging development, such as design, marketing, sustainability, waste management, and policy development [2,34–36].

There have been numerous studies on the role of packaging both as a physical container of food and as a means to communicate with consumers. In contrast, there is little research that specifically studies the influence of food packaging attributes on the household sorting of this waste, despite its benefits [1,34,37,38]. This contribution aims to present the potential of food packaging to influence consumers decision for sorting of packaging waste, via a review that focuses on food packaging and recycling behavior.

The outcomes can shed light on the following questions:

- (1) How does the design of food packaging influence the sorting of packaging waste?
- (2) Regards to the sorting of food packaging waste, what attributes of the packaging are preferred by consumers?
- (3) How have different scientific disciplines and fields, that are linked to food packaging design, taken sorting of the packaging waste into consideration?

## 2. Materials and Methods

The steps for a literature review that have been suggested by Mayring [39] and MacInnis [40] were followed in the present review. First, the material to be reviewed was collected after stipulating the research boundaries and selecting the sources (the material databases) and search terms. The formal aspects of the collected material were subsequently assessed in a descriptive analysis using the following steps: identification classification, comparison, and illustration. The retrieved information also formed the basis for the theoretical analysis. The main research categories that were studied in the reviewed articles were then identified. These categories form the major topics of the subsequent analysis. In the final step, the results of the reviewed studies are analyzed and discussed, and conclusions are drawn.

## 2.1. Material Collection

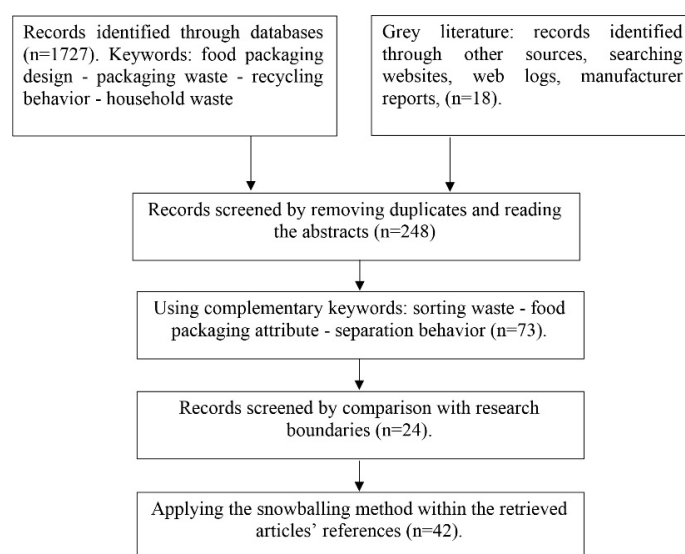
Several research boundaries were selected for the current literature review. There is no geographical limitation for the material selection. However, only literature published after 1990 is included, since global attention on environmental issues of waste began at this time. The review is limited to household food packaging waste. Hence, other types of waste and food packaging waste that is generated by other actors or in other places, such as industries, offices, or public areas, are not included in the review.

Here, food packaging is defined as the product designed to preserve the quality of food by keeping it isolated from outside influences and preventing damage to the food product along the entire supply chain to the households [41,42]. The review also focuses on the sorting of the food packaging waste carried out by the households. Sorting of food packaging waste is done in an attempt to manage this waste fraction at the proper level in the waste hierarchy, i.e., recycling [5,43]. Similar to previous studies, the act of sorting the waste for preparing the packaging for material recycling is also called ‘recycling behavior’. In this review, the term “waste sorting” is used interchangeably with the term ‘recycling behavior’ [44–47].

Studies that investigated the influence of attributes of food packaging on consumer recycling behavior were also considered. Since the focus of this review was on the packaging itself, the food products that are contained in the package have not been analyzed. Also, packaging that contained liquid or solid food is included in the scope of the review. It should be noted that some of the reviewed articles may have no contribution in sorting of packaging waste. However, they are included in this literature review as their vision, methods or results concerning the influence of attributes of packaging on consumer behavior has served as an inspiration and has been discussed by the articles that are related to recycling behavior, e.g., Silayoi and Speece [48].

Figure 1 shows the process of material collection from the initial search using the keywords to the final snowballing based on the references of the reviewed articles. This process resulted in 42 publications that were analyzed in the final review.

The literature review started by searching within the ‘Web of Science’ database, ‘Google’, and ‘Google Scholar’. As shown in Figure 1, the initial search was performed in these databases using ‘food packaging design’ (title) AND ‘packaging waste’ (topic). The large number of articles obtained was reduced using the keywords ‘recycling behavior’ (topic) AND ‘household waste’ (topic). The search also included the British spelling of these keywords. This yielded 1727 contributions. An independent search of the grey literature (company reports, weblogs, websites, etc.) was done to identify any possible additional literature that described the effect of packaging on consumer behavior. This resulted in an additional 18 contributions.



**Figure 1.** Steps in the material collection.

These 1745 articles were screened by removing duplicates and by comparing the title and contents of the abstracts with the research boundaries described above. Relevant contributions from the resulting 248 articles were subsequently identified by imposing a limitation using the keywords ‘sorting waste’ OR ‘food packaging attribute’ OR ‘separation behavior’. This resulted in 73 contributions. These contributions were screened by comparing their entire text to the research boundaries discussed above. This resulted in 24 articles that were included in the deeper analysis. The references in these articles were also used to identify other relevant articles via the snowballing method [49]. This resulted in 41 articles and a technical report that were used in the deeper analysis.

The VOSviewer software was used as part of the descriptive analysis. VOSviewer is a software tool for constructing and visualizing bibliometric networks, which can also be used to identify common topics that were discussed among a group of selected articles. The software extracts the selected articles bibliometric data from either Web of science or Scopus to visualize the relationship between the articles the most discussed topics [50].

## 2.2. Descriptive Analyses

### 2.2.1. Time Development of Publications and Research Topics

Figure 2 shows the distribution in the year of publication of the 42 publications included in the analysis. The low number of publications before 2010 shows that household sorting of food packaging waste had not gained much attention as a research topic. However, a steady increase in publications over the past seven years indicates a growing interest in the topic.

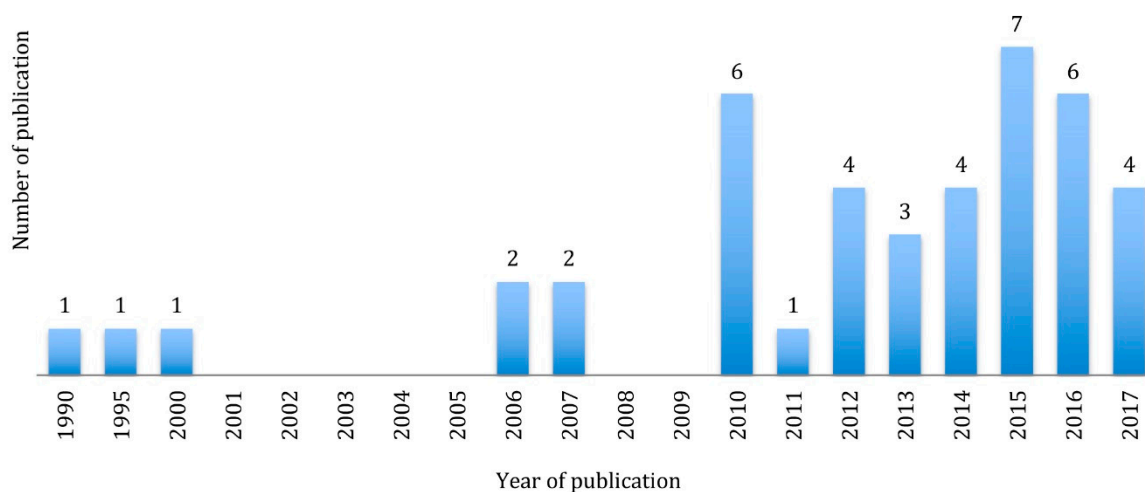
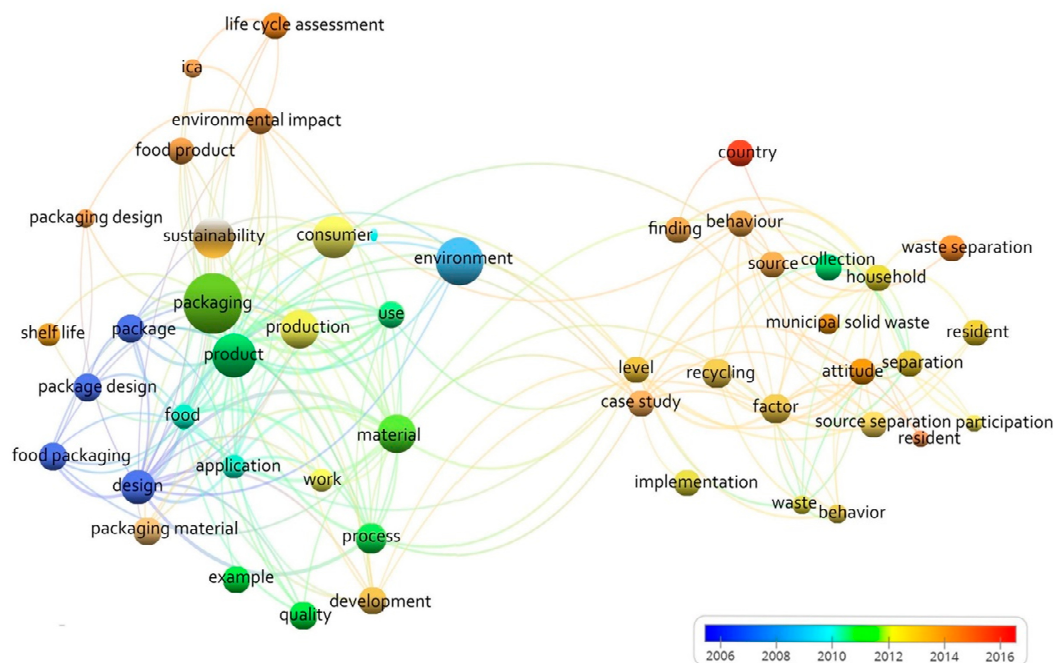


Figure 2. Distribution in year of publication for the articles included in the review.

One of the reasons for the increasing number of publications after 2010 could be a larger awareness of the environmental impact of food and food packaging waste, as well as modernizing waste management schemes to reduce its impact. For example, in 2008, the European Union requested all member states to formulate national waste prevention programs and introduced extended producer responsibility. Hence, packaging producers, who also design the packaging, were given a direct role in the management of the packaging waste [51,52]. At the same time consumer awareness of the environmental impact of products increased [53,54]. These developments probably created a demand for expanding the knowledge and research in this field, which would be reflected by an increasing number of publications that focus on waste management and its relation to packaging and recycling behavior.

Figure 3 shows the time evolution of research topics discussed in the reviewed literature. The terms shown in the figure are obtained from the title and abstract of the articles. Hence, the same or similar terms (e.g., ‘life cycle assessment’ and ‘environmental impact’) appear in the figure. A larger

circle reflects the fact that term is used by many of the articles, and the terms are linked if these terms are used in the same article. However, of most interest to the present review is the time evolution of research focus from topics related to packaging and production (including materials and design), shown by blue and green colors, to topics related to environmental and waste management shown at the top and on the right-hand side of the figure respectively, in orange and red.



**Figure 3.** Time evolution of research topics showing a change from packaging and production related topics to environmental and waste management topics.

### 2.2.2. The Journals where the Reviewed Literature was Published

Figure 4 lists the journals where the reviewed articles were published. The figures to the right of the rows show the number of articles published in each journal. As mentioned above, the total number of reviewed publications is 42. Of these, 40 are published articles (shown in Figure 4), one is a book chapter published by Springer Nature [55], and one is a technical report published by WRAP (Waste and Resources Action Program) [41].

It is evident that the literature has been published in a large number of journals and that the journals focus on a wide variety of topics, including marketing, food, logistics, and waste management. This indicates that there is a broad interest in household sorting of food packaging waste. The waste management field includes different functions of waste treatment from waste sorting (recycling behavior), collection, material recycling, converting waste to energy and compost, and landfilling. The articles selected in this field are mostly about the waste sorting or recycling behavior within the scope of this review.

Twenty-six articles had a focus on food packaging and consumer recycling behavior and five articles studied the influence of packaging attributes on purchasing. The other eleven articles had a focus on the influence of non-packaging factors on recycling behavior. Two articles [32,56] that are published in 'Packaging Technology and Science' and one article [57] that is published in 'Food control' include research on waste management. This indicates waste management, including waste prevention and recycling, are of interest to both packaging and food research fields.





**Figure 4.** Journals where the reviewed literature has been published.

### 2.2.3. Scientific Methods Used in the Reviewed Articles

A variety of scientific methods were used in the reviewed articles. As shown in Table 1, these include both qualitative and quantitative methods and can be categorized as follows:

- Interviews, which include structured and semi-structured interviews, some of which are face-to-face and in some cases the interviews were recorded.
- Questionnaires and surveys that include online, email, and postal surveys.
- Case study methods that use a combination of techniques such as observation, interviews, and surveys.
- Modeling methods that often use computer simulations and can include life-cycle assessment (LCA).
- Empirical methods that collect data, such as observations, tests, and waste composition studies.
- Documentary methods where previous studies are reviewed, such as literature reviews.

Recycling behavior and food packaging are complex issues, and include social behavior, culture, organizational aspects such as rules and standards, design, and marketing [1]. Hence, as suggested by Ajzen [58] and Creswell [59], studies of these issues need a broader knowledge and benefit by combining research approaches. In fact, 26 of the reviewed articles combine qualitative and quantitative methods to study the relationship between consumer behavior and attributes of packaging or waste management services, e.g., Wikström et al. [36].

Interviews are used in 14 articles that focus on sustainable development and waste management. They were used to identify factors that influence recycling behavior. Of these, 12 articles integrated interviews with complementary methods such as questionnaires, case studies, and empirical approaches to widen the scope of the investigation [29–31,41,56,60–66].

Questionnaires and surveys were the most common methods used for collecting large quantities of data. Twenty-four of the 42 articles used at least one of these methods. Both methods were employed

as a quantitative approach to examine the relation between the socio-demographic characteristics (e.g., age, gender, income, education) of consumers and their recycling behavior. However, the validity of these methods was questioned as in some articles nearly half of the responses were identified as not being valid. For instance, Xu et al. [67] only received 631 valid responses from 1515 questionnaires, and only 7427 of the responses from the 15,000 questionnaires distributed by Chen et al. [18] were identified as valid responses.

Case studies were used alone or in combination with questionnaires and surveys by articles that focused on sustainable development and waste management services (12 articles). The main aim of these articles was to understand the effect of packaging attributes [56] or waste management services [18,29] on recycling behavior. In addition, case studies have been used to investigate the validity of different theories [55,68].

**Table 1.** Methods used for data collection \*.

Method Used	Interview	Questionnaire & Survey	Case Study	Modeling	Empirical	Documentary
<b>Articles</b>						
Ampuero and Vila (2006)						
Azzi et al. (2012)						
Buelow et al. (2010)						
Carrillo et al. (2014)						
Chen et al. (2017)						
Czajkowski et al. (2014)						
Gofman et al. (2010)						
Grönman et al. (2013)						
Henriksson et al. (2010)						
Klaiman et al. (2017)						
Langley et al. (2011)						
Lewis (2012)						
Lindh et al. (2016)						
Lockamy (1995)						
Marsh and Bugusu (2007)						
Martin et al. (2006)						
Martinho et al. (2015)						
Meroni (2000)						
Miliute-Plepiene and Plepys (2015)						
Molina-Besch and Pålsson (2016)						
Nguyen et al. (2015)						
Nordin and Selke (2010)						
Ordoñez et al. (2015)						
Plumb et al. (2013)						
Robertson (1990)						
Rousta et al. (2016)						
Ryynänen and Rusko (2015)						
Seo et al. (2016)						
Silayoi and Speece (2007)						
Svanes et al. (2010)						
Vieira et al. (2015)						
Westerman et al. (2013)						
Wever (2010)						
Wikström et al. (2014)						
Wikström et al. (2016)						
Williams et al. (2012)						
Wilson et al. (2017)						
Xu et al. (2016)						
Xu et al. (2017)						
Zhang et al. (2012)						
Zhang et al. (2014)						
Zhang et al. (2015)						

\* The shade block indicates the main method that each article used in its study. For example, Ampuero and Vila (2006) used “interview” and “modeling” as main methods in their study.

Modeling was used in six articles. Of these, two were computer simulations [60,69] and four were LCA [36,55,62,68]. Computer simulations were used since they provide a fast and accurate way to design packaging based on consumer preferences [60,69]. The aim of LCA, on the other hand,

was to measure the environmental impact of food packaging with specific attention given to the packaging material.

Of the ten articles that used empirical methods, five used waste composition analyses together with other methods such as experimental tests, observations, interviews, and questionnaires. The main objective was to identify interventions that can influence sorting behavior and how these interventions can be altered to optimize this behavior. Household waste separation is the main focus of three articles [18,20,64], while the influence of packaging attributes (e.g., size, material, and easiness to open, clean, and seal) on recycling behavior was studied by the two other articles [56,70].

The remaining five articles [32,54,69,71,72] used different empirical methods to understand the influence of packaging attributes (e.g., label, graphic and size) on consumer behavior. Examples of these methods are laboratory experiments [54,72], eco-feedback, and a scripting approach [32].

Documentary methods, including literature reviews, were used as the major methods for data collection in ten articles [29,57,62,65–67,73–76]. As can be seen in Table 1, five of the 42 articles do not use any of the methods listed above. These are Marsh and Bugusu [77] which is a scientific status summary, and Gordon and Robertson [42], Lockamy [78], Meroni [79], and Svanes et al. [80] that can be classified as fundamental research, as they all strive to expand knowledge in a specific research area.

### 3. Results

#### 3.1. Concept Categories

A critical analysis of the 42 articles resulted in two concept categories: (1) Attributes of food packaging that influence consumer behavior including recycling behavior, consists of 31 articles that exclusively examine the attributes of food packaging that can enhance or restrain consumer behavior whether for recycling of packaging waste or purchasing, and (2) other (non-packaging) factors that influence consumer recycling behavior, consists of 11 articles that focus on factors such as attitude, income, and recycling facilities that can influence consumer recycling behavior.

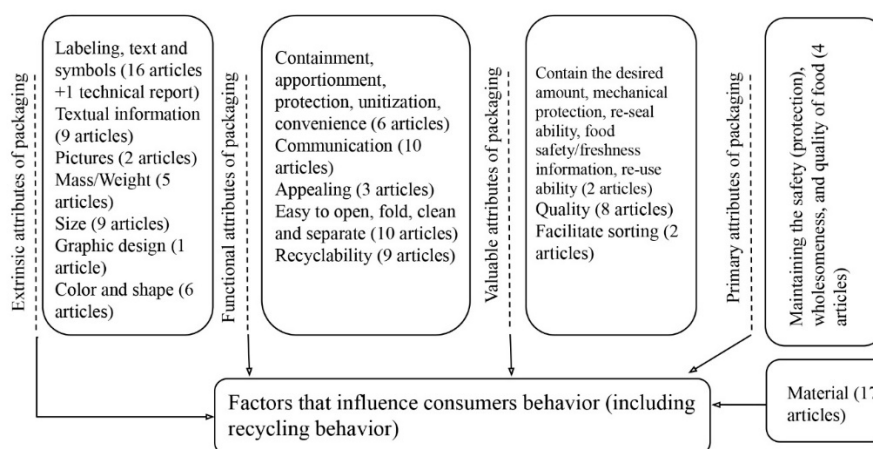
##### 3.1.1. Attributes of Food Packaging That Influence Consumer Behavior, Including Recycling Behavior

The publications that study the role of packaging attributes on consumer behavior typically choose between a holistic or analytic approach. A holistic approach considers packaging in its totality, without focusing on its different attributes. In contrast, the analytical approach considers the packaging attributes separately and independently. The analytical approach classifies the packaging attributes into (i) visual attributes that include structural features such as material, shape, size, weight, texture, and graphical/iconic features such as color combination, image and text layout, logo, and label, and (ii) verbal attributes that consist of lengthier textual explanations [48,81–84]. There are also other views on how to categorize packaging elements into different categories. For instance, Magnier and Schoormans [85] suggest that these categories can be structural, graphical, and informational. However, in the reviewed articles, the packaging attributes that could influence recycling behavior were not limited to these classifications and were selected based on the aim of the research. For instance, Langley et al. [56] divided the packaging attributes into physical (such as structure, strength, durability, re-seal ability, size, and shape) and non-physical (such as color, graphic, brand, print, and logo).

In this review, the analytical approach defined above has been used to categorize the attributes of packaging as visual or verbal. The advantage of the analytical approach is that it facilitates studies of the interaction between a specific packaging attribute and consumer behavior, including recycling behavior. Furthermore, it allows one to study how, and to what extent, manipulating each attribute might change consumer recycling behavior [32,56,68,70]. Therefore, the aim of the reviewed articles that were placed in this first concept category, was to study consumer response to various attributes of food packaging. The articles were written with perspectives based on different research disciplines, such as capturing consumer attention in the marketing field, minimizing food waste and recycling in sustainability and waste management fields, and improving the design of packaging in the packaging



design field. This diversity in research perspectives resulted in a wide range of food packaging characteristics being studied, which are classified into several categories (see Figure 5).



**Figure 5.** Attributes of food packaging that influence consumer behavior (including recycling behavior).

Further progress in packaging design requires a deeper understanding of its functions from the perspective of all stakeholders that are involved in producing, using, and handling packaging [86]. Therefore, Lindh et al. [86] suggested that the packaging should be judge based on its ability to fulfil given tasks (i.e., functional analysis), which was also used by Silayoi and Speece [48] and Wikström et al. [68].

Similarly, this review uses a functional analysis to analyze the packaging as a product and not just as a container. Accordingly, within the first concept category, food packaging is assumed to be a product. As a consequence, the attributes of the packaging are assumed to lead to functions that may influence consumer behavior in recycling or purchasing [32,56,68,70,87]. The most relevant functions for recycling that were revealed in the reviewed articles in the first concept category are communication, quality, and facilitating sorting.

### Communication

Since food products, and hence their packaging, are purchased often and regularly, they are low-involvement products [48]. Consumers do not take time to read the lengthy texts that form attributes and hence the visual attributes are more promising for communicating with consumers [48]. Visual attributes of packaging are perceived faster and unintentionally by consumers, and they therefore facilitate transfer of a particular message to the consumers [32,48,56].

The potential of packaging as a carrier of information was discussed in articles that focused on sustainable development and marketing. Knowledge for action is an important prerequisite for behaving in an appropriate manner, and lack of relevant knowledge would be a significant barrier to action. For instance, in recycling behavior, packaging can be used to enhance the environmental knowledge of the consumer [70,74]. Several studies showed that packaging could influence environmental awareness, thereby increasing recycling rates [54,56,68,70,87,88]. Since consumers have a limited knowledge about some issues, such as the environmental impact of packaging, health-related benefits or the real quality of packaging content, they primarily make decisions based on the packaging attributes [60,61,69,71,82]. Although the ways of attaining the environmental knowledge varied (e.g., via public media), packaging appears to be a particularly promising communication medium [68].

Communication can be facilitated using the visual attributes of packaging. Labels, symbols, or logotypes, such as anti-littering labels [32], informational labels [41], or recycling logotypes [88] were highlighted as factors which can enhance recycling behavior [31,32,41,57,68,72]. However, as

discussed by Buelow et al. [31], due to the confusion and complexity within current packaging labeling and recycling systems, consumer understanding of packaging material and labels is insufficient to enable proper sorting behavior. In addition, Langley et al. [56] argued that recycling behavior relies on consumer beliefs and general knowledge about specific material such as metal, glass, and cardboard rather than what is communicated via symbols on packaging. In contrast, Wever et al. [32] argued that anti-littering labels and recycling symbols offer a promising way to communicate with consumers, especially to disseminate environmental knowledge. However, the labels or symbols must be vivid and unique to capture consumer attention. The same article presented results showing that small labels or written text cannot effectively communicate with consumers. Subsequently, the environmental impact of the packaging or its recycling benefits may be neglected by consumers and, hence, the packaging is likely to be wasted instead of recycled. A larger label with a distinctive place on the packaging was therefore suggested [32]. As a conclusion, a balance between visual elements is needed to convey a clear message [71].

The visual aspects of packaging, such as graphic, color, image, and shape, were the packaging attributes that were most preferred by consumers because they increased consumer satisfaction and facilitated communication. For instance, Carrillo et al. [61] showed that advertising labels or symbols associated with specific messages (i.e., a visual attribute) were preferred by consumers more than conventional written messages (i.e., a verbal attribute).

### Quality

This section presents studies that discuss the perceived value (i.e., worth) of packaging as a factor that affects recycling behavior. It is important to note that different types of values can be associated with packaging attributes. However, the reviewed articles have not studied any possible correlation between the perceived level of value (either functional or emotional) with the sorting behavior.

Langley et al. [56] argue that the packaging materials and resealability give a perceived functional value. The article showed that visual attributes of packaging, and the way that these attributes are perceived as giving the packaging a high or low value, could enhance or hinder recycling by the consumer. Moreover, due to consumer perspectives, packaging made from glass and cardboard are more likely to be recycled than packaging made from thin plastic [56]. Functional value was also mentioned in other articles as a factor influencing recycling behavior [68,70]. In contrast, Silayoi and Speece [48] and Martinho et al. [87] stated that the visual attributes of packaging, such as graphic and color, are perceived by consumers as an emotional value.

Therefore, to prevent the packaging from being sorted as mixed waste, it is important to design the visual attributes of the packaging, as well as its functionality, in a way that is not perceived as a low value by consumers [48,56].

### Facilitating Sorting

According to the reviewed publications, inconvenience is the most important factor that hinders proper recycling in households [29,30,55,56,74,77,89]. The perception of inconvenience depends on the individual and is influenced, among other things, by their desire to participate in the sorting system. These inconvenience factors can be perceived as time, effort, and space required to participate in the system. Accordingly, the packaging attributes and its functions (e.g., easy to separate) may subsequently facilitate sorting [36,56,57].

Along with graphical features, the size of the packaging is considered as an attribute that influences recycling behavior [36,41,57,70,72,89]. Wikström et al. [68] noted that large or heavy packaging might increase the risk for incorrect sorting when there are obstacles such as lack of space for trash bins. Therefore, the ability to fold the packaging was considered as a valuable attribute to facilitate sorting [36,56,70]. In the same way, some studies identified that consumers perceived that larger packaging has lower quality, which led to wastage rather than recycling [36,57,72]. In contrast,

Langley et al. [56] found that bulky packages are usually perceived as being more valuable, which increases the rate of recycling.

Hence, there are contradictory views on how the size of packaging influences sorting behavior. In fact, apart from one article [70], there is no explicit definition of ‘small’ or ‘big’ size, and further research is needed to identify the influence of packaging size on recycling behavior.

Emptying and cleaning packaging are also perceived as difficult and time consuming, and these may be other attributes that influence sorting behavior [56,57,62,68,70,89]. Langley et al. [56] showed that consumers not only had difficulty emptying metal containers that contained bloody material such as meat, but also perceived this as disgusting work. Similarly, Williams et al. [70] showed that packaging that contains liquids with high viscosity, such as yogurt, and packaging with screw-on lids were difficult to empty and caused incorrect sorting. Packaging that is easy to separate (e.g., paper packaging with plastic lid) enhances correct sorting [36,56,70]. Langley et al. [56] also showed that packaging that is made of mixed materials is more likely to be wasted compare with packaging made from a single material, e.g., glass or cardboard. In summary, the following packaging functions have been seen to facilitate proper sorting: easy to empty, easy to clean, easy to fold, easy to separate, easy to reseal, and availability of information on how to sort.

Appendix A lists the reviewed articles within the first category and provides complementary information.

### 3.1.2. Other, Non-Packaging Factors That Influence Consumer Recycling Behavior

The concept category ‘other, non-packaging, factors that influence consumer recycling behavior’ is the smaller group and is comprised of eleven articles. Research in this category focuses on identifying factors other than packaging that influence household recycling behavior. The factors that are discussed in each of the eleven articles are listed in Appendix B.

These factors can be used to improve the waste management system and/or the willingness of households to use the system [90,91]. In fact, advances in waste management systems and improving consumer recycling behavior are considered to be the most important factors for enhancing recycling rates [92]. Five of the eleven articles in this category identified that it is the inconvenience of present waste management systems that is the main reason for ineffective household recycling [65–67,90,93].

The Theory of Planned Behavior (TPB) is used in four articles [67,90,91,93] to understand the interplay between psychological factors and waste separation behavior. The main contributing factors in the TPB are attitude (the individual’s positive or negative perception of performing a behavior), subjective norms (the individual’s perception of social pressure to engage in a behavior), and perceived behavioral control (the individual’s perception of his or her ability to perform a given behavior) [58]. However, household recycling behavior is complex, and other factors are often considered when studying this behavior [64,92]. These include socio-demographic factors such as age (elderly people are more willing to sort) [63,93], race (residents from different parts of world have different recycling behaviors) [64], income (people with high income are more involved with recycling than those with low income) [63,93], gender (female and male have different attitudes towards recycling) [57,91], external factors (e.g., economic, social, and cultural), and internal factors (e.g., motivation, environmental knowledge, awareness, attitudes, and emotions) [92]. Zhang and Wen [93] showed that among the socio-demographic factors, the inhabitant’s age is the most important influential factor that determines waste separation behavior, if supported by waste management services (i.e., source separation facilities) and government policy.

Inhabitants attitudes and willingness to sort do not have a significant impact on their waste separation behavior. In fact, the results from five articles [18,20,63,67,90] showed that the influence of internal factors such as attitudes, willingness to sort, and environmental knowledge (ability to identify symbols, concepts, and behavior patterns related to environmental protection) together with demographic factors such as income and gender are factors that influence waste separation. These factors appear to be more important than improving the waste management system, e.g., by introducing

curbside schemes, different rooms for separation of bulky and electronic waste, or increasing the availability of containers for sorting. Thus, any change in a waste management system should be adapted with the habitants' real desires and expectations from the system [18,20,63,67,90].

Rousta et al. [64] developed and used the recycling behavior transition (RBT) procedure to identify, implement and evaluate interventions that can alter household recycling behavior. Although this procedure can be used in any waste management system in any location and culture, they used it in an urban neighborhood in Sweden. Two main factors identified by the study that hamper waste sorting are lack of knowledge of how to sort waste into the different fractions and the distance between the households and the nearest recycling station. Of these two factors, the distance between the residents' homes and the nearest recycling station is reported by several studies as the more important factor that affects recycling behavior [41,57,63,87,93,94].

It should be noted that a lot of the research discussed above is based on case studies, and the local context (e.g., culture, social norm, and income) is likely to affect the results obtained in these studies. For example, the aim of Nguyen et al. [90] and Martin et al. [63] was to investigate factors that influence household waste separation. However, one of the studies revealed that households are willing to pay for waste collection [90] while the other study showed that households are reluctant to pay for this service [63].

#### 4. Reflection

In this section, the review that is presented above is revisited in order to shed light on the three research questions identified in the Introduction.

##### **How does the design of food packaging influence the sorting of packaging waste?**

According to the publications that were reviewed, packaging can contribute to reduce the main barriers for household waste sorting by influencing:

- Consumers environmental knowledge
- Consumer attitude towards recycling and sorting
- Consumer uncertainty about sorting of different materials
- Consumers perceived difficulty (inconvenience) of sorting

When discussing the concept categories (Sections 3.1.1 and 3.1.2), it was noted that environmental knowledge and attitude toward recycling significantly influence recycling behavior. The communication function of food packaging, especially through visual attributes such as labels, images and color, are particularly important to enhance consumer environmental knowledge (providing recycling information) and exhibiting the packaging as having a high value. This influences consumer attitude. The ability of packaging to communicate can also be used to eliminate consumer uncertainty about sorting different packaging materials [36].

Perceived convenience is another important factor that influences sorting behavior. In this case, packaging attributes, such labels, symbols, and size, as well as its functionality, such as ease to separate, fold, and clean, were central since these attributes and functionalities can support and simplify the process of sorting.

As Martinho et al. [87] noted, consumers are usually not aware of the impact of each of the individual packaging attributes. These attributes should be planned and designed in symbiosis to meet consumer demands and to help them fulfill tasks such as recycling [32,36,55].

##### **Regards to the sorting of food packaging waste; what attributes of the packaging are preferred by consumers?**

Packaging is the first contact that consumers have with the packaged product. The visual attributes of food packaging such as labels, images, color, graphics, and shape are the attributes that are preferred by consumers. They are preferred since they can communicate different features of the packaging, such as value or quality, and they can be appealing at the same time. As Carrillo et al. [61] showed,

even in sensitive cases related to health, consumers make decisions based on the label rather than conventional textual information. Therefore, these attributes could be used to convey clear messages to the consumers and thereby support correct sorting behavior.

**How have different scientific disciplines and fields, that are linked to food packaging design, taken sorting of the packaging waste into consideration?**

Design of packaging and its influence on consumer behavior is a multidisciplinary subject [76]. As seen from the reviewed literature, examples of disciplines that are important for development in this field are marketing, packaging design, sustainable development, and waste management. As discussed in Section 2.2.1, the extended producer responsibility should, in principle, force all producers of food packaging to consider the recyclability of the packaging as early in the design stage as possible. This should also include assisting and/or motivating households to correctly sort the packaging waste [31].

Some of the publications that were reviewed focused on marketing and were therefore limited to food packaging attributes that were appealing to consumers when purchasing products. This increases profit margins, which is an important goal for marketing [95]. Thus, they did not consider the impact of these attributes on packaging waste, and hence neither on the sorting of this waste. However, results from research done in marketing may inspire development in waste management since psychological notions are the essence of studies about consumer behavior (e.g., perception of value can be appealing for purchasing and motivating for recycling). In fact, researchers in marketing developed some of the pioneering research to understand the influence of food packaging attributes on consumer behavior, e.g., Robertson [42]. It was seen in this review that there are similarities between results in the marketing field and in other fields that have also studied the influence of packaging on consumer behavior. For example, packaging material, visual attributes, the perceived quality of the packaging, and using packaging to convey a message influence consumer behavior more than verbal attributes. This is noted by some articles within the literature that was reviewed, such as Ampuero and Vila [60] and Silayoi and Speece [48]. This is relevant to most, or all, types of consumer behavior, including recycling.

Some of the reviewed publications considered the environmental impact or recyclability of the food packaging. For example, environmental friendliness of packaging (i.e., where the packaging material is biodegradable) was considered in one article to be useful, but not necessary [42]. Also, as discussed in Section 3.1.1, two studies focused on the influence of different attributes of food packaging on recycling behavior [32,56]. The aim of one of these articles was to understand how the packaging attributes could reduce the amount of waste, rather than influence the waste sorting behavior [32]. In the other article, recycling behavior was divided into following stages: usage, post-usage, reduction, re-use, and separation. This is the only article where the relation between different attributes of packaging with recycling behavior was studied during each stage of recycling behavior [56]. In summary, these two articles emphasized how the packaging design can be utilized to influence recycling behavior. However, the relation between packaging design and consumer behavior is not simple, and some studies gave unexpected results. For instance, Wever et al. [32] designed a packaging for candy that was aimed to reduce waste. However, as explained by them, it was found that candy in the new packaging was wasted more than the candy in the original packaging [32].

The publications that focused on waste management do not typically consider food packaging as a factor that influences sorting behavior. There are only two articles that have this focus and that describe certain attributes, such as difficulty of separation, lack of desired information, or the type of material used for the packaging, that may prevent households from sorting the waste properly [20,57]. Many articles that had a focus on waste management investigated how waste collection systems could be developed so they would engage users and to ensure long term performance of the systems [18,20,29,67]. These researchers also argued that consumer attitudes towards recycling and environmental knowledge were factors that can influence sorting behavior.

The focus of the reviewed sustainable development studies was to understand the influence of food and packaging waste on society, the economy and the environment [62,80]. The potential of food



packaging attributes to improve sorting of packaging waste was studied in some articles [30,31,68,70]. Attributes such as size, material, labeling, easiness to open, clean, and recycle, as well as reseal-ability, are examined in these studies since these attributes could change consumer attitude. Therefore, they could facilitate the sorting of food and packaging waste, and prevent them from being sorted into the mixed, residual waste fraction. In this sense, waste management policy makers could utilize the potential of packaging as an instrument (i.e., service provider) to encourage consumers to actively engage with waste separation. Also, packaging developers and designers should consider attributes of food packaging as an instrument to enhance recycling in addition to other functions. It may be noted that organizations that focus on sustainable development and food also focus on the importance of food packaging. For example, the Swedish organization KRAV (Kontrollföreningen för Alternativ Odling' translated in English: 'Control Society for Alternative Growth) includes food packaging attributes, such as easiness to recycle, as a requirement for packaging to be classified as eco-packaging. Similarly, WRAP, which helps organizations to achieve greater resource efficiency, includes these attributes in sustainable packaging. This emphasizes the importance of attributes of food packaging and practicing of waste sorting from a sustainable development perspective [41,96].

It is important to note that the different research disciplines reviewed in this study highlighted the recycling of food packaging as an environmental issue and showed different solution for proper recycling. However, the lack for a common solution does not provide a single, well-defined path for development of packaging and policies. As Wright and Nyberg [97] stated, all of the involved sectors must have a common interpretation of the problem in solutions, otherwise all efforts will remain in their infancy.

## 5. Conclusions

The articles that were reviewed in this study had different focus areas regarding food packaging and factors that influence sorting behavior. The review revealed how these research disciplines can provide a broad knowledge and identify gaps in knowledge regarding sorting of packaging waste. The studies on recycling behavior considered the possibility of using attributes of food packaging as interventions to motivate consumers to participate in household waste separation. In this case, the ability of packaging to communicate a message, primarily through its visual attributes, was considered as an important factor to stimulate sorting behavior.

In addition, the material used to make the packaging and the packages' functionality influenced consumers perception of the quality of the packaging. This is due to a change in view of the function of the packaging from a dependent product, where the packaging is merely a container for its contents, to an independent one, where it can also be used to convey a message.

This means that packaging can have an inherent function that is elevated from a container to a valuable product that can communicate with consumers. The way that consumers perceive the quality and value of packaging, whether by means of attributes or functions, appears to be the most effective factors to change consumer attitudes towards sorting. In addition, the reviewed publications also highlighted the potential of the visual attributes of packaging as a communication channel for encouraging consumers to sort the food packaging waste.

The results of this review lead to the conclusions that food packaging and its attributes could hinder or motivate consumers to sort packaging waste correctly. The design of food packaging is therefore a factor that influences recycling behavior and should be taken into account by different sectors involved in food packaging. Therefore, recyclability of packaging should be considered an inherent value of the packaging, similarly to attributes such as beauty and durability.

Further research in this field should be multidisciplinary due to the complexity of recycling behavior, which is at the interface between the users of the waste management system and the technical part of the system. For this reason, terminologies used in different studies, e.g., size of packaging, should be clearly defined in order to enable comparison of results.

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## Appendix A Attributes of Food Packaging That Influence Consumer Behavior, Including Recycling Behavior.

Ref. No.	Author (s)	Research Theme	Packaging Attribute	Packaging Function	Consumer Related Issue	Results
60	Ampuero and Vila. (2006)	Consumer perception of packaging attributes	Color, typography, shapes, images	Communication, quality, appealing	Consumers willingness to buy, perceived quality	High quality of packaging usually presents bold, large, upper case letters with expanded characters. Vertical straight lines, squares, straight outlines, and symmetrical composition with one single element are preferred for graphic design.
73	Azzi et al. (2012)	Conceptual framework for packaging design	Material, shape, mass	Ergonomics, logistics, sustainability, safety and marketing	Consumers environmental knowledge, attitude	A packaging decision is a complex process involving different actors, design of packaging can enhance some activities such as recycling.
31	Buelow et al. (2014)	Packaging labels impact on recycling behavior	Material, label	Recyclability, easy to sort	Consumer sorting behavior, intention for recycling	Recycling labels are not helpful for sorting. Consumers rely on their own knowledge and external information provided in collection places for sorting. Action labels e.g. 'remove cap and recycle' are helpful. Consumers inability to judge material results in miss-sorting. Labels should be designed to convey a clear message.
61	Carrillo et al. (2014)	Consumer perception of health-related information on packaging	Visual (symbol), verbal cue (information as a text)	Communication, quality, appealing, attractiveness	Consumers willingness to buy, perceived quality	A symbol is more appealing than a phrase on a package. Furthermore, images have higher relative importance than verbal cue.
69	Gofman et al. (2010)	Consumer interaction with packaging	Graphic, image, health information as a text	Communication, appealing	Consumers willingness to buy	Consumers should co-create the package to ensure that they will eventually buy it. Utilizing computer software allows for dynamic creation and evaluation of experimentally designed packages.
62	Grönman et al. (2013)	A framework to design a sustainable package	Material, form, label, information as a text, size, weight	Recyclability, protection, useability, appealing, easy to fold, easy to empty, recloseability, easy to sort	Consumer attitude, consumer willingness to buy, perceived quality	There is an obvious need for different methods in the sustainable packaging design process. The quality attributes related to packages are valued by consumers e.g. the prevention of leakages, the packing and the best-before date, the protection and the declaration of contents.
30	Henriksson et al. (2010)	Consumer uncertainty impact on waste handling	Material, information as a text, label/symbol	Recyclability, easy to separate, communication	Recycling knowledge, perceived convenience, consumers recycling behavior	Many consumers readily and willingly discriminate between different materials but not between packaging and other items (i.e., non-packaging) made of the same material. This uncertainty results in miss sorting.
57	Klaiman et al. (2017)	Packaging attributes impact on recycling behavior	Material	Easy to recycle, easy to clean	Inconvenience, storage problems	Packaging that is difficult to clean can hinder consumers from active involvement in the recycling process. Distance from recycling stations hinders recycling behavior.

56	Langely et al. (2011)	Attributes of packaging and influences on waste	Material, size, label	Refillability, resealability, cleanability-content (wet, dry, unopened, used, dirty), informational	Consumer attitude, consumers perceived value/quality, consumers perceived inconvenience	Materials such as glass, metal and cardboard are more likely to be recycled than plastic materials due to higher perception of higher value. Higher quality means more chance to recycle or re-use. Packaging function can change consumers attitude and perception of quality. Difficulty to clean prevents consumers from proper sorting.
55	Lewis, H. (2012)	Packaging for sustainability	Material, anti-litter label, information as a text	Containment, protection, handling, delivery, presentation, promotion, use of products, recyclable, appealing, easy to open, easy to separate	Perceived convenience	Design is critical for achieving packaging sustainability goals. For this reason, life cycle thinking must be embedded in the product-packaging development.
86	Lindh et al. (2016)	Packaging contribution to sustainable development	Material, size, mass, quality, text, picture	Protection: mechanical, barrier, thermal and sealing properties, facilitate handling (Physical design, fill rate, openability, gripability, resealability), recyclability, communication	Consumer attitude, perceived inconvenience	Packaging has great potential to contribute to sustainable development by reducing product waste along the whole life cycle. Consumers have limited knowledge about the environmental effects of packaging.
78	Lockamy (1995)	Improve packaging design	Visual and verbal	Containment, apportionment, protection, convenience, communication, eco-friendly, quality	Perceived quality/value, willingness to buy	Packaging is a key strategic variable capable of providing a competitive advance in the marketplace.
77	Marsh and Bugusu. (2007)	Food packaging impact on the environment	Material	Quality, protection	Perceived convenience	The impact of packaging waste on the environment can be minimized by prudently selecting materials, following guidelines, and reviewing expectations of packaging in terms of environmental impact.
87	Martinho et al. (2015)	Sustainable packaging impact on recycling & purchasing behavior	Label, material	Useability, design, quality, communication	Gender, environmental awareness, concerns about societal opinions, attitude	The packaging price and quality can shape consumers green behavior. Theory of planned behavior is not able to explain the motivation for recycling behavior.
79	Meroni, A. (2000)	Introducing active packaging	Mechanical and chemical	Protecting, containing, communication, packaging as service provider	Consumers environmental knowledge, attitude	More effort is needed to change consumer attitude about advances in packaging technology, and advances from utilizing active packaging in terms of preservation and hygiene.
29	Miliute-Plepiene and Plepys (2015)	Influence of food waste sorting on sorting of packaging waste	Material, verbal	Quality	Attitude towards sorting, recycling information, perceived convenience, environmental awareness, socio-demographic factors, recycling infrastructure, waste tariffs	An increased sorting of packaging waste in connection with food waste sorting is an expected effect in many municipalities, because if people sort one fraction more, they are more likely to better sort other fractions. Furthermore, waste fees did not have a big effect on waste minimization and almost no effect on packaging waste sorting.
89	Molina-Besch and Pålsson (2016)	Packaging development to reduce negative environmental impact	Size, data label, information as text	Containment, protection, easy to empty, easy to reseal, informational	Perceived convenience	The green packaging approaches presented in the literature can be used to improve the design of packaging. The improvement can be coupled whether with economic benefits or without any positive economic effect.

75	Nordin and Selk (2010)	Definition of sustainable packaging	Material, environmental label	Recyclability, functionality, quality, containment, protection, preservation, communication	Environmental knowledge, attitude	Development of sustainable packaging should begin with consideration of meeting the psychological and social needs of consumers, which ultimately influence their attitude and behavior.
41	Plumb et al. (2013)	Improvement in packaging design to be recycled and sorted	Label, material, information as a text	Recyclability, communication, protection, easy to separate	Consumers environmental knowledge, attitude	There is a strong correlation between concerns about packaging materials and how easy it is to recycle them at home. Informational labels on packaging can encourage consumers to sort properly.
42	Robertson. (1990)	Eco-friendly packaging	Label	Containment, apportionment, protection, convenience, communication, eco-friendly packaging, perception of quality	Environmental knowledge	Eco-friendly labeling is not enough for packaging to be judged as a good or bad, it is also depends on the consumer.
82	Ryynänen et al. (2015)	Consumer interaction with packaging	Color, typography, graphical shapes, images, shape, size, material	Communication, quality, appealing, attractiveness, useability, tactile interplay	Symbiotic relationship, consumers willingness to buy	It is really hard for a consumer to explain why something is appealing. It is something they cannot articulate. Consumers perceive packaging and the product as one entity. For the consumer, well-designed packaging provides functional and pleasing experiences at the same time.
54	Seo et al. (2016)	Eco-friendly packaging	Size, color, shape, material	Quality, eco-friendly content, eco-friendly appearance, communication	Environmental knowledge, willingness to buy, perceived value	Consumer preference for an eco-friendly package is higher than the preference for an eco-friendly product.
48	Silayoi and Speece (2007)	Packaging as a vehicle for consumer communication	Colors, designs, shapes, symbols, messages, graphic, label, picture, size	Picture, communication, quality	Consumers attitude, consumers willingness to buy	The packaging technology, convenience, information, graphic and shape can influence consumers behavior to buy.
80	Svanes et al. (2010)	Sustainable packaging design	Label, texture, color	Protection, preservation, easy to empty, recyclable, communication, right quantity, legal requirements, quality	Consumer attitude	The methodology introduced in the article is to assist packaging designers to evaluate all requirements for packaging and product solutions throughout the packaging design process, and to be able to balance between the different requirements.
76	Vieira et al. (2013)	Packaging influence on consumer behavior	Material, label, color, shape, design, size	Communication, appealing	Willingness to buy, perceived value, environmental awareness	Packaging and its influence on consumer behavior is a multidisciplinary subject, relevant in different areas of knowledge such as purchase decisions, conscious consumption, food preservation, innovation in warehousing processes, health problems, storage and transport, contamination, etc.
71	Westerman et al. (2013)	Effect of packaging visual attributes on consumers assessment	Visual attributes	Communication, quality, appealing	Consumers willing to buy, perceived quality	Consumer response to packaging may be influenced by a range of design variations, including the type, number, size, and combination of graphical design elements. Consumers reaction to visual attributes are affected by the type of product and its brand.

32	Wever et al. (2010)	Packaging design impact on disposal behavior	Label, information as a text	Recloseability, communication	Consumers environmental knowledge, awareness, attitude, disposal behavior	Labels must be designed explicit and vivid, packaging changes consumers behavior although it could be not yet predictable. Labels need a big space and size to be visible.
68	Wikström et al. (2014)	Packaging impact on food waste	Material, mass, shape, surface, data and smart label, information as a text	Protection, convenient handling, contain the desired quantity, resealability, easy to open, grip, dose and empty, facilitate sorting	Consumer attitude	The connection between packaging design and food waste must be acknowledged and valued by all involved stakeholders such as food producers, manufacturers, brand owners, retailers and consumers.
36	Wikström et al. (2016)	Packaging attributes impact on recycling behavior	Shape, material, mass, sorting-related information, symbol, label	Easy to empty, easy to clean, easy to separate, easy to fold, informational, preservation, containing the desired quantity	Recycling information, attitude	Packaging material and weight can change the value perception and low-value package is likely to end up in mixed-waste. Difficulty to clean and separate may hinder recycling behavior.
70	Williams et al. (2012)	Packaging impact on food waste	Size	Easy to empty, easy to reseal, easy to recycle	Consumer attitude, price awareness	Packaging and its functions may play a significant role for the amount of food waste in households. About 20 to 25% of the food waste was related to the packaging design attributes.
72	Wilson et al. (2017)	Packaging impact on food waste	Data label, size	Quality, safety, communication	Perceived value, willingness to waste	Date labels impact consumer behavior and the amount of the food that they waste.

## Appendix B Other, Non-Packaging, Factors That Influence Consumer Recycling Behavior.

Ref. No.	Author (s)	Research Theme	Influential Factors	Consumer Related Issue	Results
18	Chen et al. (2017)	The effect of household's attitudes and behavior on sorting	Government facilitators, motivations, social-demographic factors	Sorting behavior, environmental knowledge, attitude	The inconsistency between people's environmental awareness and behavior may contribute to the lack of environmental knowledge. Also, environmental education is necessary to translate people's environmental awareness into actual behavior and improve source separation.
94	Czajkowski et al. (2014)	Factors that influence sorting behavior	Recycling facilities, pay as you throw, inconvenience, income, social norms, community norms	Attitude, willingness to recycle	Households believe that home sorting of wastes is more effective than collective sorting. They assumed a self-sorting as a moral duty.
63	Martin et al. (2006)	Factors that influence recycling behavior	Recycling awareness, motivation, economic incentives, publicity and promotion, cultural factors	Attitude, willingness to recycle	Households are willing to participate in recycling; however, local recycling services are too unreliable and inconvenient to allow them to do it.
90	Nguyen et al. (2015)	Factors that influence sorting behavior	Trust, personal moral norms, perceived difficulties, reciprocity	Sorting behavior, environmental knowledge	Trust of individuals is a decisive factor in their waste separation intentions. Policies and initiatives centering on building trust are crucial to an increased participation of households in waste separation.
20	Ordoñez et al. (2015)	Enhancing household sorting rates	Access to sorting facilities, information, mismatches between the technical system and the user's perspective, inconvenience	Attitude, environmental knowledge	Users do not categorize between packaging and non-packaging waste in their everyday life, they simply categorize it by material. In this case, housing companies can provide better information for sorting to tenants. It is important that any advance in recycling improvement is matched with habitants needs.
64	Rousta et al. (2016)	Factors that influence sorting behavior	Attitudes, environmental concern, convenience, easy access to recycling facilities, distance to the recycling stations, motivation	Sorting behavior	To improve source separation in the pilot area the following intervention could be relevant: 1) decrease the distance to recycling station and 2) providing adequate information.



65	Xu et al. (2016)	Enhancing household food waste sorting rates	Facilities provided, frequency of collection, attitude, beliefs, social norms, self-efficacy, motivation, education	Attitude, willingness to recycle	Volunteer involvement with sorting of food waste was key to forming good habits. In particular, the volunteers activities were perceived by some to be encouraging, at a personal level, and the characteristic of “personal encouragement” has previously been reported to increase recycling behavior.
67	Xu et al. (2017)	Factors that influence sorting behavior	Market incentives, market facilitators, informal recycling market, government incentives and facilitators, motivations, social-demographic factors	Sorting behavior	Market incentives, government incentives and government facilitators have significant effects on recycling intention thus effect on recycling behavior. Lower income groups produce less waste by means of budgetary rewards, while higher income groups are more likely to be affected by government facilitators.
66	Zhang et al. (2012)	Factors that influence sorting behavior	Negative neighbor effects, confused classification of MSW, mixed transportation and disposal method	Sorting behavior, environmental knowledge, attitude	Habitants are motivated to sort at home. However it is limited to particular materials such as paper or plastic. They seem reluctant to sort food or kitchen waste. For glass and hazardous waste, the convenience of the collection facilities is not always adequate.
93	Zhang et al. (2014)	Factors that influence sorting behavior	Attitudes, subjective norms, perceived behavioral control, intentions, situational factors	Sorting behavior, intention to separate, environmental knowledge	Attitude, subjective norms, perceived behavioral control, intention, socioeconomic, education and situational factors significantly affect household waste behavior. Lack of time and inconvenience in terms of place will likely hinder waste sorting.
91	Zhang et al. (2015)	Factors that influence sorting behavior	Age, source separation facilities, government policies, accessibility to waste management service, community type	Sorting behavior, environmental knowledge, attitude	Though the respondents have a very positive attitude about source separation, it has not transformed into separation behavior. The main factors that make them reluctant are residents’ age, source separation facilities and government policies.

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