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The Accessibility Paradox of Packaging as a Communication Channel

ABSTRACT

Packaging is one of the most widespread communication channels in everyday consumer life, carrying the message between sender (manufacturer) and receiver (consumer) at the point of sale and use. Interactive or "smart" packaging like QR codes, NFC tags, embedded video and companion applications extends this channel from a static, printed medium to a mediated, digital one, and is widely promoted as a way to make product information more accessible, including older and visually impaired audiences. This study asks whether that channel actually reaches the audience it is meant to serve. Based on a survey of 404 Zagreb residents aged 18-75 (a probabilistic sample stratified by age and gender), it analyses awareness and use of interactive packaging elements, and the perceived importance of accessing additional product information through apps or video and tests them against age and visual status using chi-square, ANOVA, Pearson's correlation and linear regression. The findings reveal a communication failure rather than a design failure. Reach is weak: 39% of respondents had never encountered interactive packaging and only 9% had ever used it, with awareness collapsing among the oldest group (81% of those over 66 had never heard of it) and among glasses wearers (58% are unaware of it). Perceived value of the channel declines with age ($r = -0.294$, $p < .001$; respondents over 66 rating it lowest, $M = 1.65$), and the products recalled are dominated by beverage and snack brands, indicating that the packaging as a communiction channel functions more often as a marketing tool rather than an accessibility tool. Interpreted through the diffusion-of-innovations framework and the knowledge-gap hypothesis, the results describe an accessibility paradox: a channel introduced to widen access to information instead reproduces an information gap, leaving the audience most in need of accessible communication the least reached by it. The paper argues that the limiting factor is not the technology itself but channel reach, and proposes that the social environment of older consumers - family, caregivers and peers acting as interpersonal intermediaries should be treated as a complementary link in the communication chain, helping to explain the function and use of smart packaging and supporting its capacity to reach and empower the audience it was designed to serve.

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KEY WORDS
Packaging communication, channel-audience mismatch, knowledge gap

1. Introduction

Packaging is one of the first things a consumer sees and the last medium a brand controls before a choice is made. It protects the product and it also speaks. On the shelf it delivers a brand's message at the exact moment of purchase (Rundh, 2005).

Its role goes beyond persuasion. Packaging is a communication channel in a more complex sense. It carries identity, meaning and instructions, and it does so through both what the consumer reads on the surface and what the consumer learns by handling and using the product over time (Underwood, 2003). Seen this way, every package is a form of communication between

a sender (the manufacturer) and a receiver (the consumer). For most of its history this channel has been static and printed. Now, that is changed. Interactive or "smart" packaging adds a digital layer to the printed surface through QR codes, Near Field Communication (NFC) tags, embedded video and companion applications, linking the physical product to online content (Liu & Wang, 2024). A shopper can scan a code or tap a tag and reach information that would never fit on a label: fuller instructions, origin and traceability data, allergen detail, or audio and video guidance. In communication terms, the channel has been extended from a one-way printed message to a two-way, mediated exchange.

Much of the positivity around this extension is largely asigned to its potential to enhance accessibility. If a label is too small to read, the argument is, a digital layer can offer magnified text or spoken instructions; if information is too dense, an application can structure and simplify it. This promise is often aimed at older consumers and people with visual impairments. The reasoning is appealing but it also rests on an assumption that is rarely tested: that the intended audience knows the channel exists, understands it, and is willing to use it. Communication theory gives reason to test that assumption. Rogers' (2003) diffusion of innovations describes adoption as a sequence that starts before use - first knowledge of an innovation, then persuasion, then the decision to adopt. People cannot adopt what they have never heard of, and Rogers notes that interpersonal channels, more than mass ones, move people through the persuasion stage. The knowledge-gap hypothesis adds a second caution: as new information flows into a social system, better-resourced groups tend to acquire it faster, so the gap between them and others widens rather than closes (Tichenor, Donohue & Olien, 1970). A digital layer introduced to broaden access can deepen existing divides instead of bridging them. This pattern in research on ageing and technology is called the grey divide. While the digital divide has narrowed for younger cohorts, it persists across generations and is sharpest among older adults, where the use of digital tools falls steeply with advancing age and can leave the oldest groups largely excluded (Friemel, 2016). The divide is not only about access. It reflects differences in confidence, prior exposure and technical interest, and it is shaped by a person's social surroundings. Evidence from the English Longitudinal Study of Ageing suggests that this gap is driven more by generation, or birth cohort, than by age itself. Differences in internet use persist even after income, education, employment and health are taken into account (Gilleard & Higgs, 2008). For older users, technology adoption is frequently shaped by social support, previous experience, facilitating conditions and confidence, while relatives may provide both practical assistance and emotional encouragement (Friemel, 2016; Park & Robinson, 2020). It also runs deeper than access to a device. A Slovenian study of NFC tags on food packaging found low overall awareness, concentrated almost entirely in the younger generations (Žurbi & Gregor-Svetec, 2024). For a channel that depends on a smartphone and the willingness to use it, these are not minor obstacles; they decide whether the message is received at all.

Conventional food packaging frequently presents difficulties for older and visually impaired consumers because essential information is printed in small type, may have insufficient contrast, and is often difficult to locate or read (Plečko, Brozović & Kovačević, 2023; Mustić, Cigula & Kovačević 2025a, 2025b). This becomes more important as Europe's population ages and this group expands (Eurostat, 2025). The importance of accessible packaging is emphasised by Europe’s ageing population. On 1 January 2024, people aged 65 years and over accounted for 21.6% of the EU population, while the corresponding share in Croatia was 23.0%. Croatia was among the EU Member States with the highest proportions of older people. Between 2014 and 2024, the share of people aged 65 and over increased by 4.5 percentage points in Croatia, compared with an increase of 2.9 percentage points at EU level (Eurostat, 2025). In Croatia, the share of people aged 65 and over is projected to reach approximately 30% by 2050 (European Commission, 2024). Population ageing is also evident at the oldest ages: between 2004 and 2024, the share of people aged 80 and over increased in the EU from 3.8% to 6.1% (Eurostat, 2025). The demographic relevance of inclusive packaging is likely to increase further.

This study treats interactive packaging as a communication channel and asks does it reach its intended audience? Using survey data from a general adult population, it measures how far the channel has actually penetrated, how much value people place on it, and how both vary with age and visual status - the two characteristics that define the audience the accessibility argument is meant to serve.

The study has three objectives: to investigate consumer awareness and use of interactive packaging elements; to measure the perceived importance of reaching additional product information through such elements; and to test how awareness, use and perceived importance differ by age and by the use of visual aids. From these objectives, four research questions follow:

- RQ1: How aware are consumers of interactive packaging elements, and how many have used them?
- RQ2: How important do consumers consider access to additional product information through these elements?
- RQ3: How do awareness, use and perceived importance vary by age and visual status?
- RQ4: Does the observed pattern among older consumers and visual-aid users sup-

port the claim that interactive packaging serves their accessibility needs?

In line with diffusion and knowledge-gap reasoning, three hypotheses are proposed:

- H1: Awareness and use are low overall and decline with age.
- H2: The perceived importance of interactive access declines with age.
- H3: Consumers who use visual aids, the group most likely to value accessible information, are no more aware of interactive packaging.

2. Methods

2.1. Data collection method

The study draws on a telephone survey carried out with a structured questionnaire. This mode was chosen deliberately. It lowers the barrier to participation for people who struggle with written or online forms, whether because of age or a sensory limitation, since it removes the need to read or handle survey materials (Dillman, Smyth & Christian, 2014). It also lets the interviewer clarify a question in real time, which matters for scale-based items where a respondent may need an example before answering. The questionnaire combined three formats: closed questions, open questions, and scale-based questions, among them five-point scales measuring degrees of difficulty or importance. It covered socio-demographic indicators together with a broad set of attitudes toward packaging design. The survey underlies two earlier studies, which examined the readability of packaging and its adaptation for older and visually impaired users (Mustić, Cigula & Kovačević, 2025a, 2025b). The present paper analyses the items concerned with interactive packaging- whether respondents were aware of and had used interactive elements such as QR codes and NFC tags, and how important they considered access to additional product information through applications or video. Awareness and use were captured by a question: "Have you ever used products with interactive elements on the packaging, such as QR codes, NFC tags, video content or applications?" Respondents who answered affirmatively were asked to name examples, and from this item two indicators were derived- awareness (whether the respondent had heard of such products) and use (whether they had used them). Perceived importance was measured on a five-point scale (1 = not at all important, 5 = very important) with the question: "How important is it to you that packaging provides access to additional product information through mobile applications or video content?" All 404 respondents answered to both items.

2.2. Population and sample

The target population was residents aged 18 to 75. A probabilistic random sampling method, stratified by age and gender, was used to secure representation across groups. The final sample comprised 404 respondents and the sample size was broadly consistent with the conventional benchmark of a ±5 percentage-point margin of error at the 95% confidence level under simple-random-sampling assumptions. Because the study used stratification and a telephone-survey design, this benchmark should be interpreted as approximate. Respondents were informed of the purpose of the survey and gave verbal consent before participating.

Table 1 summarises the sample by gender, age and use of visual aids. Gender is evenly split, the four age bands are close in size, and just over half of respondents wear glasses or contact lenses. That last distribution matters here, because age and visual status are the two variables against which the interactive-packaging items were tested.

Table 1

Achieved sample by socio-demographic indicators (N = 404)

Indicator	Category	N	%
Gender	Male	202	50.0
	Female	202	50.0
Age	18–35	89	22.0
	36–50	107	26.5
	51–65	111	27.5
	66 and more	97	24.0
Visual aid (glasses or lenses)	Using glasses or lenses	210	52.0
	Not using glasses or lenses	191	47.3
	Without reply	3	0.7
Total		404	100.0

2.3. Data analysis methods

Analysis began with frequency distributions and proportions for each item. Group differences were then examined with appropriate tests. The chi-square (χ^2) test compared frequencies across categories, such as awareness of interactive packaging by age group. The independent-samples t-test and analysis of variance (ANOVA) compared mean scores, and Pearson's correlation coefficient measured the strength and direction of the relationship between variables, in particular between age and the perceived importance of interactive access.

Finally, simple linear regression modelled perceived importance as a function of age, giving an estimate of how much of the variation age alone accounts for.

3. Results

3.1. Awareness and use of interactive packaging

Respondents were first asked whether they had ever used products with interactive elements on the packaging- QR codes, NFC tags, video content or applications and, if so, to name examples. All 404 answered. The overall results show a shallow reach. Across the sample, 39% had never heard of interactive packaging at all. A further 43% had heard of such products but never used them, 9% had used them, and the remaining respondents were unsure. So, four in five people had either never met the channel or knew of it only in passing, and fewer than one in ten had actually engaged with one.

Awareness and use differed sharply by age ($\chi^2 = 129.856$, df = 9, $p < 0.001$). The share of those who had never even heard of interactive packaging was highest among respondents aged 66 and over, at 81%, and fell in the younger groups. Having heard of such products without using them was most common in the 36–50 group (57%), followed closely by the 18–35 (48%) and 51–65 (47%) groups. Actual use sat in the middle of the age range: highest among the 36–50 group (16%) and next among the 18–35 group (12%). The oldest respondents were the least likely to know the channel exists, and use never rose above a small minority in any group.

The divide by visual status was just as clear ($\chi^2 = 67.093$, df = 6, $p < 0.001$). Among respondents who wear glasses or contact lenses, 58% had never heard of interactive packaging, against 19% of those who do not, a gap of nearly forty percentage points. Those without visual aids were far more likely to have heard of such products without using them (59% against 28%). Actual use was low and similar in both groups. Respondents who reported using glasses or contact lenses were less aware that the channel exists.

Of the 37 respondents who had used interactive packaging, 16 named a specific product. Their answers, summarised in Table 2, cluster around a narrow set of categories. Multiple answers were allowed, so the figures sum to more than one hundred percent.

In this sample, the recalled uses of interactive packaging were concentrated in beverage category (Cedevita, Coca-Cola, beer, Pepsi, drinks in general) and snack products (cereals, Nutella, chips, chocolate), suggesting that respondents primarily encountered the technology as a marketing and engagement tool rather than as an accessibility feature. These are consumer goods aimed at a broad, largely younger users, and they are precisely the categories where brands add interactive elements for promotion and engagement.

Table 2

Named examples of interactive packaging (n = 16 respondents who cited an example; multiple answers possible)

Product / category	Count	% of 16
Cedevita	11	69
Coca-Cola	11	69
Beer	7	44
Drinks (general)	7	44
Cereals	4	25
Nutella	2	13
Chips	2	13
Organic products	2	13
Other single mentions*	1	6

* Other single mentions: hygiene products, chocolate, cosmetics, Pepsi, chicken, pasta

3.2. Perceived importance of interactive access

At the end of the section, respondents rated how important it was to them that packaging gives access to additional product information through mobile applications or video, on a five-point scale from 1 (not at all important) to 5 (very important). All 404 participants answered. The result is low and one-sided. More than half the sample, 52%, rated this unimportant- 33% not at all important and a further 19% unimportant. Another 27% were indifferent. Only 20% called it important, and of those just 5% rated it very important. The mean across the whole sample was 2.39, which sits below the midpoint of the scale and matches the skew in the distribution.

Perceived importance fell with age, and the drop was concentrated at the top of the age range. Analysis of variance confirmed a significant difference between groups ($F = 17.663$, $p < 0.001$). As Table 3 shows, the three younger groups gave similar mean ratings, all close to the scale midpoint, while respondents aged 66 and over stood clearly apart at 1.65. Post-hoc tests placed this oldest group significantly below every other. The people for whom the accessibility argument is most often made, then, valued the channel least.

Table 3

Perceived importance of interactive access by age group (1–5 scale)

Age group	Mean	SD
18–35	2.66	1.25
36–50	2.66	1.27
51–65	2.55	1.18
66 and more	1.65	0.87
Total	2.39	

Two further tests examined age as a continuous variable. Pearson's correlation between age and perceived importance was −0.294 ($p < 0.001$), a weak-to-moderate negative relationship: as age rises, the value placed on interactive access tends to fall. This matters because the direction is negative. Across most other packaging attributes in the wider survey, older respondents rated features as more important, not less; here the sign is reversed.

Simple linear regression with age as the predictor confirmed the effect and put its size in context. Age alone explained 8.7% of the variance in perceived importance ($R^2 = 0.087$), and the model was significant overall ($F = 38.162$, $p < 0.001$). Each additional year of age was associated with a drop of about 0.021 points on the five-point scale ($B = −0.021$, $t = −6.178$, $p < 0.001$), with a 95% confidence interval for the slope of −0.028 to −0.015.

Because the interval does not cross zero, age is a genuine predictor of how important a person finds interactive access- but a modest one, accounting for less than a tenth of the variation. The direction is clear and consistent, but the magnitude is small.

4. Discussion

The three hypotheses were confirmed. Awareness and use of interactive packaging were low and declined with age (H1); the perceived importance of interactive access declined with age (H2); and the group most likely to need accessible information, those who use visual aids, were not more aware of the channel but markedly less so (H3). The findings describe a communication failure rather than a design failure. The findings also suggest that the principal limitation may lie less in the technical capacity of the technology than in the reach, visibility and social mediation of the channel.

Rogers (2003) describes adoption as a sequence- knowledge, persuasion, then decision- and an innovation cannot be adopted by people who never reach the first step. Interactive packaging is stuck there. With 39% of the whole sample, and 81% of those aged 66 and over, unaware that such products exist, the channel has not cleared the knowledge stage for the very audience the accessibility argument names. The small group who had used it sat in the middle of the age range and reached mostly for drinks and snacks, which is the profile of early, engagement-driven adopters rather than of users drawn by accessibility.

Rogers also notes that interpersonal channels move people through persuasion more effectively than mass ones; the near-absence of use among older respondents suggests that this interpersonal push has simply not happened for them yet.

Tichenor, Donohue & Olien (1970) observed that when new information enters a social system, better-resourced groups absorb it faster, so the knowledge gap widens rather than closes. A digital layer added to packaging behaves the same way. It is taken up first by younger, connected consumers and passes older ones by, reproducing the very divide it was meant to bridge. This fits the wider evidence on the grey divide, where the use of digital tools falls steeply with age and is shaped by cohort and social context more than by age alone (Gilleard & Higgs, 2008; Friemel, 2016).

Across the survey, older respondents rated packaging attributes as more important than younger ones did- the clarity of information, the adaptation of packaging for older and impaired users, prominent naming on the front of the pack. For interactive access, the correlation with age turned negative ($r = −0.294$). It shows that older consumers do not place a low value on product information as such; they place a high value on it. What they do not value is receiving it through a digital channel. In communication terms, the barrier is the medium, not the message. The same person who wants a larger, clearer printed label does not want to fetch that information by scanning a code or opening an application. Claim that interactive packaging improves accessibility for this group has to reckon with the fact that the group itself does not see it that way. This gap is channel-specific rather than a general unfamiliarity with packaging innovation. Two further findings point the same way. The perceived importance of interactive access was low across the whole sample (mean 2.39), so this is not only about age; the channel is weakly valued in general.

The channel exists; it simply carries a different message, to a different audience, than the accessibility case assumes. This is the accessibility paradox. A channel introduced to widen access to product information reaches the audience that needs it least and misses the audience that needs it most. The failure lies not in the code or the tag but in the match between channel and audience. Seen this way, the problem is not that older and visually impaired consumers reject better information; it is that the route chosen to deliver it does not reach them.

4.1. Limitations

The study has limits. It draws on self-reported awareness and importance rather than observed behaviour, and its design is cross-sectional, so it captures a moment rather than a trend. It measures whether people know and value the channel, not whether they could use it well if shown. Future work should test that directly- through usability studies that pair older users with an intermediary, and through on-pack trials of the kind of clear activation cue recommended here, evaluated with older audiences rather than younger ones.

The use of glasses or contact lenses should not be interpreted as equivalent to visual impairment. It represents a broad self-reported indicator of visual-correction needs and may include respondents without clinically significant visual limitations. A further caution concerns the analysis by visual status. Because the use of glasses or contact lenses rises with age, the two independent variables overlap: older respondents are both more likely to wear visual aids and less likely to be aware of interactive packaging. The lower awareness observed among glasses wearers may therefore partly reflect the age effect rather than visual status as such, since the chi-square comparison by visual status was not controlled for age.

5. Conclusions

This study set out to ask whether interactive packaging, treated as a communication channel, reaches the audience it is meant to serve. Awareness and use are low across the board and lowest among older consumers and those who use visual aids, and the same groups place the least value on receiving product information through a digital channel. A channel promoted as a way to widen access instead reaches the audience that needs it least and misses the audience that needs it most. This is the accessibility paradox, and its cause is a mismatch between channel and audience, not a fault in the technology itself.

If the barrier is the channel, the answer is to change it, or, more precisely, to add one. The results point away from the device and toward the people around the intended user. This is the logic of the two-step flow of communication: messages from a mass channel often reach people only after passing through "opinion leaders" in their immediate circle, who take them up first and relay them onward (Katz & Lazarsfeld, 1955). For interactive packaging, the family member, carer or more confident peer is exactly that intermediary- the person who notices the tag, understands it, and shows the intended user what it does. Diffusion research holds that interpersonal channels, not mass ones, carry people through the persuasion stage of adoption (Rogers, 2003), and work on older adults and digital tools shows that encouragement from family and friends is among the strongest predictors of whether an older person takes up a new technology, with informal help inside trusted relationships working better than formal instruction (Gilleard & Higgs, 2008; Friemel, 2016). The social environment of the older consumer, for example family members, carers, peers, is the interpersonal channel that a printed-plus-digital package cannot supply on its own.

That environment is not hypothetical. The wider survey shows that older respondents and those who use visual aids already rely on exactly such a network for packaging: many older respondents reported needing help from a partner, household member, carer or friend to open packaging or read its information, against almost none of the youngest group. The support structure is already in place. The same person who today helps a parent read a small label or open a jar is well placed to show them how to reach the extra information a package offers. What is missing is not the relationship but a reason and a cue to use it.

This points to recommendations aimed at the environment rather than the device. Awareness efforts for accessible interactive packaging should address families and carers, not only end users, and can draw on intergenerational demonstration, in which a younger or more confident person introduces the feature. On the package itself, interactive elements need a clear, conventional and legible cue- a short, plain invitation to act, set apart by colour and position, so that an intermediary can find and explain it quickly. Above all, a digital layer should complement legible print, not replace it. Interactive access can add value for those who choose it, but it cannot stand in for clear information on the surface, because for much of the intended audience the digital route is still not their first choice. The question is no longer whether the technology can carry accessible information. It can. The question is how to make sure that the message arrives.

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