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# Article Title A Conceptual Framework Integrating Innovation Adoption and Resistance for Intelligent Packaging

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**Abstract**

Consumer perceptions about the use of intelligent packaging (IP) technology in the food sector are explored. The technology adds epistemic value to the consumer through the provision of additional information about the product. The empirical study adopts a case study approach with a survey and more significantly, 20 in-depth qualitative interviews. Duplication across theoretical constructs in adoption and resistance theories exists, therefore the findings led to the development of an integrated conceptual framework combining these perspectives. This contextual case study provided a much-needed product driven context for IP, four specific technologies (QR Codes, AR, sensors and smart indicators) were investigated. In summary, the conceptual framework highlights the complementarities that exist between two theoretical perspectives, as well as presenting six new overarching integrated constructs. This holistic explanation of adoption and resistance factors to IP can be utilised to support effective implementation and application across the food supply chain.

# 1 Introduction

As predicted almost a decade ago by The Economist (2015) *"such mundane things as fizzy drinks and washing powder are set to become smart, as their makers attach sensors to their packaging that can detect when the product is being used, and that can communicate with smartphones when scanned"*. Changes in the food and drink packaging industry have been driven by market changes in response to consumer lifestyles, increased focus on food safety, biosecurity and environmental concerns (Yam and Lee, 2012). As a result, packaging is shifting from a passive state to an active state, to meet these needs (Young *et al.*, 2020). Smart packaging describes a group of packaging technologies that consist of two groups. Firstly, intelligent packaging (IP) which includes a subset of interactive packaging and secondly active packaging (Lydekaityte and Tambo, 2020, Loucanova *et al.*, 2016). The paper is focused on IP which improves epistemic value through providing additional information about the product (Robertson, 2012).

Applications of IP have the capability to contribute improvements to the core functions of packaging. Examples include monitoring internal and external changes to the product, provision of further product information and traceability features. Previous research has indicated that IP can create and present numerous improvements to the overall product, creating advantages for multiple stakeholders (e.g., retailers, manufacturers, distributors) in the food industry (Vanderroost *et al.*, 2014). Surprisingly, much less has been said about the impact of IP on consumers. Smart packaging technologies have to an extent already been integrated into packaging systems to meet requirements of the food supply chain – but the real opportunity for smart packaging is to offer consumer benefits and convenience (Biji *et al.*, 2015). Whilst there is a growing body of research on smart packaging, there is little empirical research exploring consumers' understanding, perceptions and acceptance of IP (Young *et al.*, 2020).

To fill this gap in the pertinent literature, in the present study we use two seminal theories, i.e. innovation adoption theory and innovation resistance theory, aiming to combine these theoretical perspectives and develop a conceptual framework specifically for IP. To do so, we synthesize arguments from innovation adoption including Theory of Reasoned Action (TRA) (Ajzen and Fishbein, 1975), Theory of Planned Behaviour (TPB) (Ajzen, 1985), Diffusion of Innovation Theory (DOI) (Rogers, 1962) the Technology Acceptance Model (TAM) (Davis *et al.*, 1989) and the lesser established literature about resistance including Innovation Resistance Theory (IRT) (Ram and Sheth, 1989).

In our study, we argue that our research problem requires a holistic approach and the synthesis of these two theoretical streams, particularly because consumers purchase food products as opposed to buying packaging. Food products are often alike, and the product innovation is mostly based on the packaging (Saner, 2014). Therefore, the empirical research concentrated on how packaging changes the value proposition for the food products itself because the functional benefits of packaging impact on consumer food choice (Young *et al.*, 2020).

The remainder of this article is organised as follows. It reviews and critiques the literature concerning the phenomenon through the identification of relevant adoption and resistance theories, as well as presenting the contextual factors affecting the adoption and resistance of IP. Then, it discusses the case study methodology. Empirical observations and interview data are analysed and presented, followed by the implications, limitations and conclusions.

# 2 Theoretical Background (Literature)

## *2.1 Review of Innovation Adoption and Resistance Theories*

Irrespective of extensive scholarly research about the adoption of new innovations, industry has not been able to use the apply this knowledge and successfully commercialise new products (Millemann *et al.*, 2022). The success of food related innovations is highly dependent on the understanding of how consumer characteristics and perceptions affect the acceptance or resistance to an innovation (Cardello, 2007), thus, this section reviews existing theories in this field.

The commonalities are striking amongst the adoption theories explored. TPB (Ajzen, 1985), TRA (Ajzen and Fishbein, 1975), TAM (Davis, 1989) and DOI (Rogers, 2003) are rooted in the cognitive processes of users, discounting the affective aspect of attitude formation. The results of adoption theory are measured in terms of behavioural change of users, according to Straub (2009) the predictors of that behavioural change are understood through contextual, cognitive, and affective factors and whilst existing theories deal independently with these factors, no theory accounts for all three. Additionally, quantitative studies have been most dominant in TPB, TRA, TAM and DOI research, and as a result qualitative research is underrepresented (Hoppe *et al.*, 2013) and the antecedents of attitudes in specific contexts remains unknown.

The extent to which the theoretical constructs from the aforementioned theories can be generalised to assess IP adoption is unknown, and there is very little empirical research about consumer's use of IP to support adapting theories to suit the context. Similarly, variations in these theoretical constructs and the number of variables included are usually limited in existing theories and are not specific about the item of diffusion (Lyytinen and Damsgaard, 2001). Additionally, a consumers level of innovativeness and natural predisposition towards purchasing new products (Steenkamp *et al.*, 1999) is not considered in any of the theories.

When drawing comparisons across the adoption theories explored, it is notable that TPB has been utilised for numerous innovation adoption studies across technology (Teo *et al.*, 2013) and food consumption (Quevedo-Silva *et al.*, 2016), demonstrating versatility as a model because it uses beliefs specific to each situation and does not assume one context. Similarly, TRA is a context independent framework (Mamonov and Benbunan-Fich, 2021). The users intention and behaviour are explored in TPB through perceptions whereas DOI explores perceptions of the predefined innovation characteristics, relative advantage, compatibility, complexity, trialability and observability (Rogers, 2003), highlighting the complementarity of the two (Weigel *et al.*, 2014). DOI theory is applied to various technology adoption studies (Mohd Suki, 2010, Hasin and Smith, 2016); and like TPB is utilised for food adoption studies (Vindigni *et al.*, 2002, Verhoef and Langerak, 2001). All studies relied on former research in their field to enable logical identification of relevant constructs to incorporate into quantitative research.

Little empirical research exists about IP and only marginally more about packaging, thus it is assuming to align this research with DOI resulting in non-meaningful constructs unspecific to IP. Some of the DOI innovation characteristics are found to have a lesser or greater influence on adoption. For example, Hameed *et al.* (2014) found that relative advantage is one of the strongest indicators of technology adoption and complexity is insignificant. Similarly, DOI innovation characteristics pose problematic because it is unclear whether the list covers all features affecting the adopter's behaviour. DOI also stipulates that an innovation has 'distinct' and 'measurable' features (Rogers, 2003), hence an innovation should be treated individually to understand its features. Whilst Hubert *et al.* (2018) argue that DOI theory is more thorough than TAM because it covers the antecedents of attitudes through the innovation characteristics (Rogers, 2003), this paper rejects such notions because product specific characteristics should be captured first.

In comparison to the adoption literature, there is a lack of empirical evidence about consumer resistance and its antecedents (Kleijnen *et al.*, 2009). Research about resistance factors is predominantly structured by five Active Innovation Resistance (AIR) barriers in IRT: usage, value, risk, traditional and image (Ram and Sheth, 1989). Heidenreich and Talke (2014) developed and tested a set of 17 comprehensive barriers, but a more manageable set of product specific barriers are advocated (Joachim *et al.*, 2018). The resistance literature overwhelmingly calls for a better understanding of product driven reasons against adoption that can be operationalised through product-specific adoption barriers driving AIR (Ram and Sheth, 1989, Kaur *et al.*, 2020).

## *2.2 Adopter Innovativeness*

Adopters are categorised on the basis of innovativeness by Rogers (2003). The terms personal innovativeness (PI) and innate innovativeness (II) are used to describe those perceived to have a general tendency towards purchasing new products. Steenkamp et al (1999, p. 56) describes it as a *"predisposition to buy new and different products and brands rather than remain with previous choices and consumer patterns".* In contrast, 'domain specific innovativeness' (DSI) is *"the tendency to learn about and adopt innovations within a specific domain of interest"* (Goldsmith and Hofacker, 1991, p. 211). A consumer's level of innovativeness matters because it impacts upon their rate of adoption for new products. Various frameworks exist about how consumer innovativeness can be measured, which vary hugely in terms of validity and reliability depending on the category (Roehrich, 2001). Ward (2013) highlights that models such as TAM exclude factors influencing technology adoption, including the level of innovativeness, the innovation characteristics and/or social processes.

## *2.3 Factors Affecting Adoption and Resistance to IP*

There is an emerging body of literature highlighting benefits of smart packaging and the factors affecting adoption and barriers to usage. However, the remit of the majority of studies reviewed is wider than IP and includes other technologies (e.g., active packaging, nanotechnology etc), nonetheless they are indicative of the adoption and resistance factors to IP and shouldn't be ignored. There are many types of IP (e.g. QR Codes, NFC, AR etc) commercially available, however little attention is given to individual applications. This is particularly relevant because consumer acceptance depends on the specific technology and its direct application (O'Callaghan and Kerry, 2016). An individual's comprehension and awareness of a technology also impacts the reaction to the non-adoption of a technology (Behera *et al.*, 2023). Young *et al.* (2020) goes some way to summarise dependent, control and moderating variables in the systematic review conducted about perceptions of smart technology, however this is based on secondary research with varying quality and not focused on consumer perceptions of IP. This highlights the shortcomings in relation to the research problem because former studies do not specifically address adoption and resistance to IP.

Similar to the adoption and resistance literature, the majority of studies undertaken about perceptions and acceptance to smart packaging are of a quantitative nature. Where qualitative techniques have been adopted, the research is frequently focused on a wider group of technologies (Greehy *et al.*, 2013), is not solely about consumer insights (Lindqvist *et al.*, 2012) or concentrates on peripheral issues rather than IP adoption (Daoud and Trigui, 2019). For example, Lindqvist *et al.* (2012) used qualitative techniques to gather information from consumers about automatic identification including some types of IP (e.g., RFID, 2D bar codes etc), however the study has a narrow perspective and is weighted towards benefits to the supply chain rather than the consumer. The thorough review of the factors affecting adoption of IP and implications for the primary research are summarised in Table I below.

Table I: Summary of Adoption Factors

| References | Key findings relating to <u>adoption</u> | Implications for primary research |
|---|---|---|
| (Kumari and Gaikwad, 2025, Daoud and Trigui, 2019) | Tamperproof benefits | Do consumers recognise the features of IP and its applications?<br><br>Are the adoption factors presented in column 2 applicable to IP applications?<br><br>Are there any additional adoption factors? |
| (Kumar *et al.*, 2025, Dirpan *et al.*, 2023) | Increase in food safety through additional information | |
| (Pennanen *et al.*, 2015, Aday and Yener, 2015, Daoud and Trigui, 2019, Lindqvist *et al.*, 2012) | Additional information is available either at point of purchase or for use in the home | |
| (Lindqvist *et al.*, 2012, Pennanen *et al.*, 2015, Loučanová *et al.*, 2018) | Added convenience for consumers to choose products to eat in order of perishability | |
| (Pennanen *et al.*, 2015, Spence *et al.*, 2018) | Increase in perceived quality of product | |
| (Kamboj *et al.*, 2025, Kumar *et al.*, 2025, Rahman *et al.*, 2026) | Reducing food waste | |

| | | |
|---|---|---|
| (Pennanen *et al.*, 2015, Spence *et al.*, 2018, O'Callaghan and Kerry, 2016) | Increasing consumer confidence | |
| (Aday and Yener, 2015) | Enthusiasm for novel packaging | |

The review also considered the issues affecting resistance to IP and the implications for the primary research are summarised in Table II below.

Table II: Summary of Resistance Factors

| References | Key findings relating to <u>resistance</u> | Implications for primary research |
|---|---|---|
| (Lindqvist *et al.*, 2012) | Downloading multiple apps - time taken, data availability and storage | Do consumers recognise the features of IP and its applications?<br><br>Are the resistance factors presented in column 2 applicable to IP applications?<br><br>Are there any additional resistance factors? |
| (Pennanen *et al.*, 2015) | Contradicting information (e.g., TTI and printed end date) leading to misunderstandings | |
| (Spence *et al.*, 2018, Chrysochou and Tiganis, 2025) | Increased cost of product | |
| (O'Callaghan and Kerry, 2016, Gupta and Arora, 2017) | Unknown risks and harm to health and environment | |
| (Aday and Yener, 2015, Pennanen *et al.*, 2015) | Increase food waste | |
| (Young *et al.*, 2020, Li *et al.*, 2020) | Trust in technology / technology failure | |
| (Lindqvist *et al.*, 2012) | Additional time taken to access information through scanning | |
| (Pennanen *et al.*, 2015, Greehy *et al.*, 2013, Loučanová *et al.*, 2018, Loucanova *et al.*, 2016, Gupta and Arora, 2017) | Product is the primary concern not the packaging | |
| (Young *et al.*, 2020) | Lack of knowledge about IP and negative perceptions about volume of packaging can lead to misunderstandings and resistance | |
| (Stoma and Dudziak, 2022) | Low awareness | |

## *2.4 Interactions Framework*

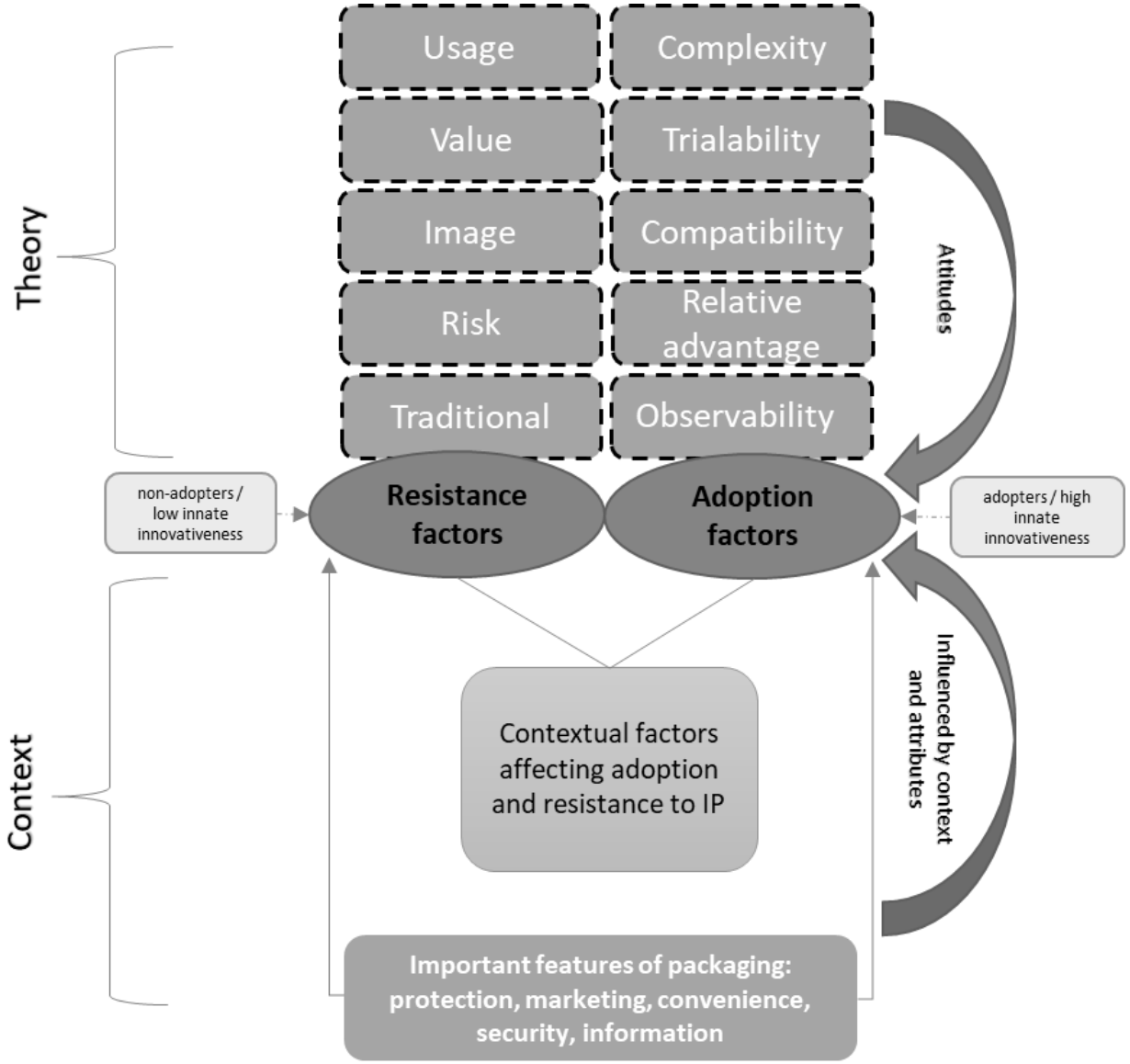
The literature demonstrates that consumer decision making is complex, both the reasons for adopting or resisting. Consumer acceptance is essential for any food product innovation to succeed (Siegrist *et al.*, 2007), conversely negative perceptions towards food technologies only prevent the adoption and failure of the innovation in question (Kleijnen *et al.*, 2009). Similarly, Krasner (2000) advocates that only through eliminating resistance factors that prevent consumers from adopting IP, will the technology ever diffuse. Researchers have commonly narrowed their attention to very specific parts of the adoption and resistance dilemma, and valuable findings have emerged. Invariably, difficulties emerge when isolating and focusing on only one perspective. Mutually exclusive elements do not exist, adoption constructs condition and flow into resistance constructs. Based on this compelling evidence it is rational to propose that these two areas of literature are connected. Adoption and resistance are two opposites of a continuum of reactions to an innovation, therefore combining them leads to a new paradigm and perspective to explain consumer engagement with IP.

Two well established theories provide a conceptual lens for this research. Firstly, IRT because of its comprehensive nature, its recent successful application in food research (Kushwah *et al.*, 2019), the growing interest towards understanding barriers to resistance (Kaur *et al.*, 2020) and the need for innovative consumer solutions like IP to better understand factors contributing to resistance (Heidenreich and Kraemer, 2016). Secondly, DOI is utilised to support understanding this complex social reality (Rogers, 2003), rather than a means to determine a causal relationship between individual knowledge, attitudes or behaviours (Woodward *et al.*, 2014). It is the most expansive adoption theory in its coverage of issues relating to the acceptance of innovation and grounded in sociology (Rogers, 2003), which is key to

understanding the IP adoption. Theories intending to predict individual behaviour or acceptance to a specific technology (e.g. TAM, TRA, TPB) are less suitable for this research.

Figure 1 represents a theoretical framework developed for researching the possible interactions of adoption and resistance factors towards IP, incorporating consumer packaging needs (DuPuis and Silvia, 2008) and levels of consumer innovativeness (Steenkamp *et al.*, 1999) to guide the primary research.

Figure 1: Interactions Framework




The research problem is conceptualised in Figure 1 and provides a platform to guide this study. The literature review supported identification of research gaps, leading to the following research questions which this study is aiming to answer: a) How aware and informed are consumers about IP?, b) What are the motivators for consumers to adopt IP on food products?, c) What are the barriers when consumers resist IP on food products? and d) Which adoption and resistance factors can be integrated to form a conceptual framework?

# 3 Research Methodology

## *3.1 Research Approach*

In order to fulfil our study's research aims, an inductive and exploratory approach was followed. A case study approach was adopted, to investigate consumer perceptions of IP through semi-structured qualitative interviews. This allowed for in-depth examination of an entire entity, with scrupulous detail to identify key themes, relationships and patterns of observations (Babin *et al.*, 2012).

## *3.2 Sampling and Data Collection*

Our main study was based on in-depth semi-structured interviews incorporating open ended questions with a range of sorting exercises. Prior to the interviews a brief survey collected information on choices and knowledge about IP which enabled us to customise the questions in the semi-structured interview discussion guide. The open sorting technique was employed and participants categorisation led to open conversations about similarities and dissimilarities in products (Faye et al., 2004) as well as contextual information about purchasing and usage, their packaging needs and adoption and resistance factors to IP. All interviews were 1 hour and conducted online.

To recruit participants, purposive sampling was employed to support achieving in-depth insights from information rich cases (Patton, 2014), enabling identification and selection of the most informative participants (Saunders *et al.*, 2019). A recruitment survey was conducted, asking participants about their awareness of the four main types of IP that are commercially available to ascertain their level of understanding about the technologies, 100 responses were secured and respondents with some experiences of IP were selected for qualitative interviews.

The survey asked participants whether they had purchased or recognised the four main types of IP that are commercially available, including augmented reality (AR), QR Codes, sensors and smart indicators (The Association of Packaging and Processing Technologies, 2018). Images and descriptions of the four IP technologies were provided in the survey to avoid any misunderstandings. Our participants were most aware of QR Codes (16 out of 20) in comparison to smart indicators (5 out of 20), augmented reality (5 out of 20) and sensors (7 out of 20). All respondents had either previously purchased products featuring IP or recognised a minimum of at least one IP technology, whereas other participants had experience of other IP technologies too. The survey results highlighted that whilst QR Codes were most recognised in comparison to other types of IP, awareness was low overall and that the interviews would require some form of education about the capabilities of the four types of IP under investigation. Therefore, all IP technologies were demonstrated to respondents at the start of the in-depth interviews for clarity.

The final interview sample was drawn from across the United Kingdom and included 20 participants. No exclusion criterion based on demographic characteristics was employed. As a result, the participants represent both genders (seven male and 13 female) and encompassed a broad representation from across the age categories (two 18-24 year olds, two 24-34 year olds, four 35-44 year olds, eight 45-54 year olds and four 55-64 year olds).

## *3.3 Data Analysis*

To analyse our data, we employed reflexive thematic analysis because of its flexibility yet systematic approach to analyse qualitative data (Braun and Clarke, 2021). Consistent with the data collection method and interview discussion guide questions employed in this study, this research is qualitative and inductive, following an interpretivist philosophy encompassing key principles of phenomenology.

The analysis was conducted using the Nvivo software package in order for the data to be managed, coded and organised relatively quickly (Morris, 2015). The coding process is integral to the development of themes, because the identification of themes are the direct results of coding (Braun and Clarke, 2021). In line with Gioia (2020), the thematic analysis reported first-order (participant focused) and second-order (theory focused) data and findings. Data driven codes ('in vivo' codes) and labels and themes developed by the research team are coded simultaneously to represent the voices of participants in the reporting of this research. Additionally, theory driven codes are generated and guided by the literature about innovation adoption and resistance. The results from the first-order and second-order coding are consolidated to generate a final coding structure leading to the themes presented in Section 4.

# 4 Results

Through taking an inductive approach, themes and patterns observed are located in the literature to refine, extend and generate theory (Ridder *et al.*, 2014). Adoption and resistance factors formed two core themes, both with a set of supporting sub-themes.

## *4.1 Core Theme: IP Adoption Factors*

This core theme is focused on factors that influence participants adoption of IP positively, including advantages, motivating aspects and positive perceptions. Some of the adoption factors resonate with well-established constructs in existing theories, which are discussed in section 5. Eight adoption factors are based on the primary research findings, as defined below.

Adoption Factor 1: Information

The provision of information was the most complex adoption factor, because all participants were specific about the type of information desired. Food safety and freshness was discussed most frequently, followed by recipe information, meal ideas, serving suggestions and ingredients. All participants were enthusiastic about the possibility of receiving real-time information about the condition of the product to improve food safety, through smart indicators because use-by dates often prove unreliable. Participant 15 said *"I think it's good, it would probably make me want to buy it more".* Smart indicators would also help participants prioritise order of food consumption.

IP labels providing direct access to detailed information about recipes, meal ideas, serving suggestions and ingredients were perceived as positive. Participants want inspiration to adopt new cooking methods, stating *"the more information, the better"* (Participant 13), which was implicitly related to reducing food waste through using leftovers more effectively. Information about authenticity, providence, compliance with dietary needs, how to recycle and food miles are useful pre-purchase. Access to recipes and serving suggestions are beneficial post-purchase. Participants welcomed nutritional information about dietary compliance (e.g., FODMAP, Keto diets), functionality to compare multiple products and flexible information retrieval with IP.

Adoption Factor 2: Entertainment

Seventeen participants associated IP with entertainment, although this did not necessarily mean they personally would enjoy it. IP was recognised as having potential to bring enjoyment to various situations including seasonality, gifting, dinner parties and group events, mostly but not exclusively with AR. The sensors were identified as suitably entertaining, Participant 9 said *"the sensors are better for alcohol and that kind of more fun exciting stuff".* Fifteen participants specifically attributed the entertainment generated by IP as being more suited to younger people because of its interactivity and gamification capabilities, specifically AR was recognised from products that are targeted at children. Linking IP on products to seasonality and events was favoured.

Adoption Factor 3: Ease of engaging

The ease of engaging and using IP was believed to be consistent with experiences of all services being increasingly accessible through smart technology, for seventeen participants. Participant 10 accepted this as the norm saying, *"now everything's on everybody's phone".* The smart indicator was viewed as the simplest to use because no device is needed to engage. Participants related experiences of scanning a QR Code, sensors and AR to a quick, easy and seamless process using smartphones. All four types of IP were well understood by participants and easy to engage with if there was a desire to do so. Downloading further apps to engage with IP was considered as simple enough if participants wanted to engage. Conversely, others were not interested in downloading multiple apps, raising concerns about storage on smartphones and download times that would prevent engagement.

Adoption Factor 4: Aesthetically appealing

IP labels have the capability of simplifying and making packaging more attractive as opposed to having too much information on labelling detracting from the branding and logo, according to participants. IP labels placed on pack in more appealing positions e.g. on the front of the pack, gives the impression that there is more to find out about the product. Thirteen participants preferred IP labels embedded into the design and branding, drawing attention to the product, giving visual appeal and enhancing attractiveness - instead of

on the reverse of a product. The smart indicator was identified as providing additional stand out appeal, participant 20 said *"this stands out that's pretty good, I like that".*

Adoption Factor 5: Promotional activities (e.g., competitions, incentives etc)

Promotional activities linked to incentives and competitions were not necessarily the reason for purchasing, but those who engage in these activities were not averse to doing so through IP. It generated interest for 13 participants, where some were influenced to purchase because of the possibility of an incentive. The way in which the promotion is accessed was much less relevant to actual participation, and IP labels did not act as a barrier to engaging.

Adoption Factor 6: Increased brand and product engagement

The use of IP and the potential for increased brand and product engagement was recognised as advantageous by nine participants. Whether it was about the provision of more information, entering competitions, obtaining free products or samples – it all strongly linked to developing a relationship with the brand. A few participants were impressed with brand owners that are implementing this technology to provide a more interactive experience with their products and increasing brand loyalty. The application of IP on packaging portrays a cutting-edge brand, thus strengthening brand connections with consumers.

Adoption Factor 7: Food waste reduction

Nearly half (9) of the participants discussed how IP can support reducing food waste. Smart indicators providing real time information was perceived as a positive step to help participants change their behaviours and make better decisions about food consumption, consequently reducing food waste. It was recognised as informing decision making about the order of product consumption, rather than reliance on sometimes inaccurate best before dates. Smart indicators also provide an alert to freeze products if their quality began to decline.

Adoption Factor 8: Packaging waste reduction

Removing some packaging and print from products and instead using IP as a vehicle to provide it was recognised by five participants. This was favoured because it was consistent with participants views about reducing packaging overall. Participant 5 said *"it might obviate the need for wasteful packaging if you just had a sticker with a QR code on it".* This was preferable for participants who were happy to engage with the technology as it could reduce packaging resources, but it must be clear what could be accessed through the IP label.

## *4.2 Core Theme: IP Resistance Factors*

This core theme is focused on factors that influence participants to resist IP, including any disadvantages and negative perceptions. Seven resistance factors based on the primary research are defined below. The similarities and differences with well-established constructs in existing theories are discussed in section 5.

Resistance Factor 1: Value

The value of IP was discussed by 18 participants, which translated into three broad areas. Firstly, 16 participants stated that some types of IP are not useful to them, and none of them are essential but more of an additional feature. Smart indicators are consistently classed as useful because they support food safety, and AR was the opposite where participants could not identify any personal benefit from engaging. This was also because AR is identified as marketing and advertising. The lack of usefulness was not exclusive to AR, as the information directed to by QR Codes often repeats what is on the physical pack. Opinions about QR Codes and sensors were more divided, based on participants own experiences. Sensors were recognised as having greater capability and interactivity than QR Codes and offering more useful information. However, some participants were simply not interested in the type of information that can be offered through the sensors, whether it was factual or promotional and described as *"gimmicky"* (Participant 6) and not essential.

Secondly, the IP labels are not always clear about benefits or value from engaging. QR Codes frequently seen on products have no call to action according to 13 participants, similarly sensors and AR do not always explicitly ask consumers to scan them. Without instructions and benefits, participants were clear they would not engage. The lack of consistency relating to what information is provided via a QR Code was not helpful, because it led to negative preconceived ideas about what to expect next time faced with the opportunity. There was also a lack of clarity about when to engage with IP, pre or post purchase. Smart indicators were perceived as the easiest IP technology to understand because they work independently.

Thirdly, nine participants questioned if IP would add cost to the product and mostly expressed an unwillingness to pay more for it. IP was perceived as a non-essential product feature, and not one that warrants a cost increase for the consumer. A marginal cost increase for IP was only acceptable for gifting, rather than daily purchases.

Resistance Factor 2: Difficulties with engaging

Eighteen participants reported a range of issues that made it difficult, challenging or even a nuisance to engage with IP. The following issues are problematic for AR, sensors and QR Codes:

- downloading further apps;
- lack of awareness that all smartphones are NFC enabled and have an integral QR Code reader;
- not everyone has a smartphone or the capability to download additional apps;
- increased screen time; and
- limited storage/memory on smartphone for downloads.

Such issues make it difficult to engage with IP and relate to the lack of knowledge and awareness about the various types of IP. AR requires downloading an additional app from the relevant brand, which is the most challenging for usage as there is no consistency or generic app.

Resistance Factor 3: IP not recognised, unnoticeable or misunderstood

Recognising, noticing and understanding IP labels was an issue for 15 participants. Familiarity and understanding of one type of IP was common, but it was not consistent across the four technologies. This is mainly because the label is not examined on everyday products, as highlighted by Participant 12, *"I just pick something up and throw it in the trolley".* IP labels are not always noticed, sometimes they are small or have less presence on the pack. Without a clear call to action or instruction to engage, IP was also misunderstood as a barcode for retailers and manufacturers.

Resistance Factor 4: Lack of time to engage with IP

A lack of time to engage with IP was discussed by 12 participants because they are time poor and claim to already have enough information. Participant 18 said *"I don't spend a lot of time looking at the information, it is what it is!"* Another said there is no time for AR and *"gadgetry things*" (Participant 13) whilst another participant resisted QR Codes because there is not enough time to explore multiple products. The distraction of using a phone to engage with IP whilst shopping was not favourable because it added time to the visit. However, participants did not always understand that engagement is not limited to pre-purchase.

Resistance Factor 5: Trust

Trust in the quality of the technology and the possible repercussions of engaging with IP was discussed by 12 participants. Firstly, data security when companies actively collect personal data and then the potential for data leaks through using smartphones for IP. Engaging with IP was also speculated as a ploy by companies to collect user data for marketing purposes. Secondly, there was a fear of the technology failing, exacerbated by existing purchases not meeting consumer expectations.

Resistance Factor 6: Changing habits

Participants considered changing habits and usage in relation to their own age and also discussed how the younger generation may interact with IP. Eleven participants did not discuss age exclusively but referred to generational issues or described themselves as *"old-fashioned"* (Participant 19). Age was not a barrier to engagement but raised as a peripheral issue to justify a lack of desire to change existing habits. Of the four types of IP, AR was perceived to be more suitable for young people. This group was also perceived as more technologically advanced and accepting of using their smartphones to acquire information. Equally, many participants were concerned about excluding the older generation.

Resistance Factor 7: Aesthetically unappealing

Six participants found the design of an IP label and the overall look that it added to a product as aesthetically unappealing. Comments about the look of the IP label were closely linked to wider branding of the product, but the size, placement and integration on the pack were all important.

# 5 Discussion

This section explores the key similarities and differences between the literature reviewed and the primary research, both from an adoption and resistance perspective. It then presents an integrated conceptual framework for adoption and resistance to IP, bringing together two theoretical perspectives. The core constructs in the integrated conceptual framework are subsequently related to the adoption and resistance factors discovered from the primary research.

## *5.1 Theory and IP Adoption Factors*

From a theoretical perspective, the majority of adoption factors derived from the primary research share similarity with the relative advantage construct from DOI (see Figure 1). Information, entertainment, promotional activities, increased brand and product engagement, reduce food waste and reduce packaging waste adoption factors all have a likeness to some degree with relative advantage which is the degree to which an innovation is perceived better than its predecessor (Rogers, 2003). It is also possible to position most of the IP adoption factors as an extension of the relative advantage construct. However relative advantage is about the benefit to the consumer, and the distinction must be made about consumer benefits and wider beneficiaries. The ease of engaging adoption factor also shares similarities with the complexity and compatibility from DOI (Rogers, 2003) as highlighted in Figure 1. Essentially the ease of engaging adoption factor incorporates issues relating to complexity and compatibility because they are inseparable and intertwined for many participants.

Whilst there are similarities with the theories explored in the literature and Figure 1, there are also key differences where the primary research provides in-depth detail about adoption factors to IP. For example, the information adoption factor unearthed all the different types of information which participants value and therefore has a significant use for practical application. The ease of engaging adoption factor for IP is different to the theory because IP is not a standalone product and is available for optional use. Reducing food waste and packaging waste differed from the theory because participants explicitly discussed the wider societal benefits rather than directly to themselves. Finally, the aesthetically appealing adoption factor resultant from this primary research has no alignment with the theories reviewed.

## *5.2 Theory and IP Resistance Factors*

In summary, five of the seven resistance factors to IP derived from the primary research share some similarities with IRT (Ram and Sheth, 1989) featured in the interactions framework (Figure 1). The value resistance factor has some likeness with the value construct from IRT (Ram and Sheth, 1989), difficulties with engaging resistance factor to some extent resembles the usage construct (Ram and Sheth, 1989) and the trust resistance factor is aligned to the risk construct (Ram and Sheth, 1989). To a lesser extent the changing habits resistance factor shares some similarities with the tradition construct (Ram and Sheth, 1989) and aesthetically unappealing resistance factor has some semblance to the image construct from IRT (Ram and Sheth, 1989).

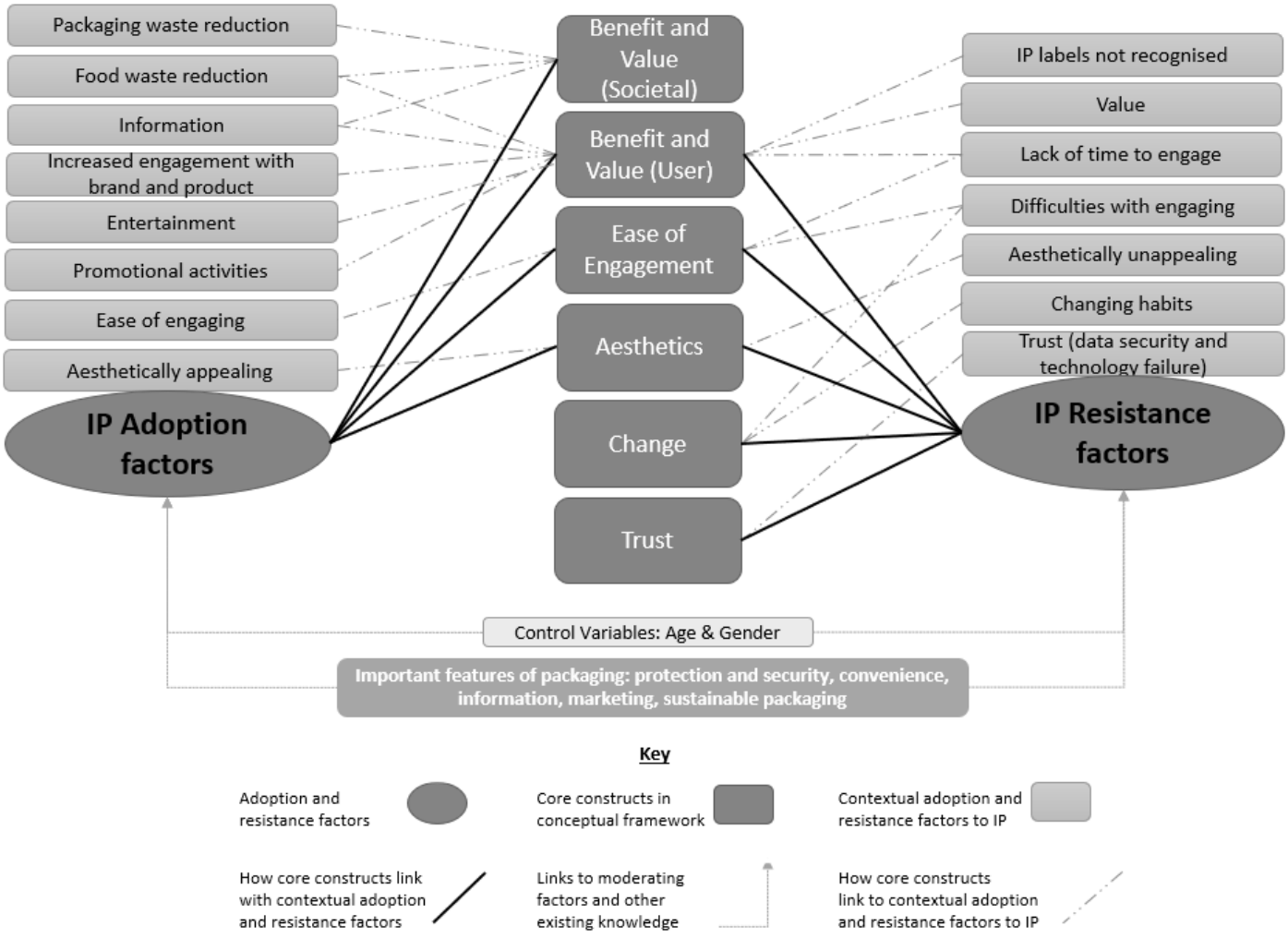
Whilst from a theoretical perspective there are similarities with the literature and interactions framework (Figure 1), there are also key differences where the primary research provides significantly more detail about resistance factors to IP. For example, the value resistance factor states how participants define value and therefore has use for practical application. Existing theory differs from the difficulties with engaging resistance factor because it incorporates wider issues around access and compatibility of IP. Similarly, the tradition construct differs from the changing habits resistance factor because the deviation from entrenched traditions is linked to additional causes rather than merely the importance of opinions from others. The aesthetically unappealing resistance factor is purely about the visual appeal of the product and how the IP label is embedded into the design of the package, rather than a low perceived image leading to resistance as per the image construct from IRT. Additionally, two resistance factors that have no alignment with previous theories reviewed are lack of time to engage with IP and IP not recognised, noticeable or misunderstood.

## *5.3 Conceptual Framework for Adoption and Resistance to IP*

The conceptual framework presented in Figure 2 is derived from the primary research and presents the adoption and resistance factors to IP, as well as the moderators and issues of greatest important in relation to packaging for participants when purchasing groceries. Figure 2 displays the associations between the six

core constructs and the contextual adoption and resistance factors to IP. It can be utilised by policymakers and practitioners as a framework to guide any future implementation or application of IP.

Figure 2: Conceptual framework for adoption and resistance to IP




To summarise, the conceptual framework (Figure 2) combining adoption and resistance to IP presents integrated theoretical core constructs which are extended with contextual factors to IP. An explanation of the meanings of the core constructs presented in Figure 2 are discussed below, highlighting the similarities and differences with theories utilised in the study.

The benefit and value (societal) core construct is underpinned by environmental sustainability and the direct benefits to society. It is increasingly a factor that is given consideration by participants when making purchases. **Packaging waste reduction, food waste reduction** and **information** are IP specific adoption factors relating to how to be more sustainable. It is not a reason to reject IP and is not associated with resistance. Previous theories have not made the distinction between the 'user' and 'societal' benefit and value. However, there are some synergies between the construct and DOI because **relative advantage** is about the advantages presented to the user (Rogers, 2003).

As a core construct, benefit and value (user) is specifically about the direct benefits to the user. It is associated with five adoption factors to IP as defined by participants, including **food waste reduction, information, increased engagement with brand and product, promotional activities and entertainment**. This construct is also associated with three resistance factors to IP including **IP labels not recognised, value and lack of time to engage**. Previous theories have not made the distinction between the 'user' and 'societal' benefit and value. There are some synergies between the construct and DOI because **relative advantage** is about the advantages presented to the user (Rogers, 2003) and IRT as users consider **value** in terms of increased performance overall (Ram and Sheth, 1989).

The ease of engagement core construct is primarily about how easy it is to engage, and that it is an optional element of the overall product. The specific adoption factor for IP mirrors this - **ease of engaging;**

similarly, so does the resistance factor **difficulties with engaging**. From a resistance perspective, **lack of time to engage** is also associated with this core construct, because of the perception that engaging with IP on multiple products is time consuming. There is some parity between this construct and DOI. The **complexity** construct which is entirely about how difficult it is to learn to use an innovation and **compatibility** because it refers to how harmoniously an innovation can be assimilated into the user's lifestyle (Rogers, 2003). The key difference to note is this construct takes into account that IP is an optional element of the overall product offering.

Aesthetics as a core construct is associated with the visual appeal of a product which is of great importance to participants. As a construct it is straightforward, and the adoption and resistance factors are mere opposites. If a product is **aesthetically appealing**, it is more likely to be accepted and if it is **aesthetically unappealing**, it will be rejected. The importance of aesthetics elevates this factor to a standalone construct in the conceptual framework presented. It differs from existing theory because the aesthetics construct is purely about the visual appeal of the product, and thus there is no similarity with adoption theory. From a resistance perspective, the aesthetics construct has marginal alignment with the **image** construct in IRT as it states that a low perceived image can lead to unfavourable media coverage resulting in resistance (Ram and Sheth, 1989).

The change core construct is characterised by participants questioning their own ability to modify behaviours and adapt to the technology particularly if it is perceived as difficult. This construct is associated with two resistance factors, namely **changing habits** and **difficulties with engaging**. The change construct has no similarity with adoption theory. It is comparable to the **traditional** construct from IRT (Ram and Sheth, 1989) because the consumer is discussing deviating from entrenched traditions (Kulviwat *et al.*, 2009).

Trust as a core construct is underpinned by the risks of adopting IP. Participants discussed technology failure, loss of data, privacy of data and also a suspicion about how personal data may be utilised for marketing purposes. It is associated with specific **trust (data security and technology failure)** resistance factor. The trust construct has no similarity with adoption theory and is presented only as a resistance factor in the conceptual framework. It does share some alignment with the **risk** construct from IRT which is defined as the unknown side effects of an innovation (Ram and Sheth, 1989). The key difference between the constructs is that participants believe they are aware of the risks with IP.

# 6 Study Implications

This study has already acknowledged the importance of IP and its potential to transform the consumer experience and deliver multiple societal benefits through its application. The conceptual framework (Figure 2) produced as an output from this research provides implications for anyone considering implementing IP. In addition, there are many new contributions to knowledge about the consumer perspective to packaging and IP which are valuable and advantageous to industry and policy makers alike. It is critical to understand the consumer perspective to IP because it directly relates to how the technology is accepted and implemented into the market (Young *et al.*, 2020) and commercialisation will not succeed without it.

## *6.1 Industry*

As recent studies show, 90 percent of all innovation projects fail (Penzal and Simon, 2021); therefore there is a need to take a different approach to understanding consumer needs. Resistance factors are distinct antecedents that differ from influences that lead to adoption (Bardhi *et al.*, 2007), both perspectives overlap (Day and Herbig, 1992) and adoption and rejection are of equal importance (Nabih *et al.*, 1997) from a practical viewpoint. The integrated conceptual framework for adoption and resistance to IP (Figure 2) combines the two perspectives to innovation and therefore would save time and resources rather than looking at these aspects in isolation. This study can be utilised by various businesses from across the food supply chain including manufacturers, brand owners and retailers to support the implementation and application of IP. Figure 2 provides a framework which can be used to guide consumer testing about the suitability of the various types of IP on grocery products. The integrated conceptual framework which is underpinned by robust research is necessary for exploring the application of IP, this will support more effective implementation and usage in the food industry.

### *6.2 Policymakers*

In a 25-year Environment Plan the UK Government outlined its ambition to *"leave our environment in a better state than we found it"* (HM Government, 2018; p. 6) through a commitment to achieving zero avoidable waste by 2050 and a target of eliminating avoidable plastic waste by the end of 2042 (HM Government, 2018). The UK Government also made a global commitment to the United Nations sustainable development goals to reduce food waste by half by 2030 (Dray, 2021). Additionally, there are a plethora of targets relating to the improvement of recycling rates across the UK nations (Department for Environment Food & Rural Affairs, 2022).

In order to meet ambitious targets policy makers could develop and support initiatives to implement IP across food supply chains that will achieve better outcomes for consumers and society. These include the reduction of food and packaging waste and more effective food safety and security (Verghese *et al.*, 2015) because it is clear that IP presents the capability to help to fulfil such needs through providing consumers with more information (Ghaani *et al.*, 2016). The primary research highlights both the importance of environmental sustainability and food safety to consumers. It also provides much needed detail about what type of information would be most useful to consumers and suggests that the consistent presentation of information across products is essential for engagement. Policy makers and regulatory bodies can also utilise the findings of this study to guide the production of educational information to raise the profile of IP and counteract low familiarity that results in rejection or a lack of engagement with the technology (Young *et al.*, 2020). Moreover, they should develop policies and initiatives to support and incentivise companies to trial IP on a wider range of food products to improve awareness. They should also support research trials to test whether the provision of more information through IP does translate into an improvement in consumers sustainability behaviours and practices. Finally, policy makers are encouraged to improve and strengthen links with innovation and packaging teams in the food industry through the provision of all the above.

## 7 Limitations

There are limitations in terms of the scope of this study. Firstly, it focused on IP, as a subset of smart packaging. A disproportionately higher number of studies about active packaging exist which is also a subset of smart packaging, therefore it was excluded despite being a worthy area of research. Another possible limitation of the qualitative approach and method selected to undertake this study is researcher bias (Mack, 2010). However, guidance about adopting reflexivity from Creswell (2003) was followed to avoid influencing the study which included being clear about the philosophical position, beliefs and assumptions prior to conducting the primary research, as well as separating theory from practice. This deep reflexive approach supported the researchers to maintain a balanced judgement through the data collection process (Lonergan, 1992) and helped mitigate against any significant risks relating to the validity of the research study (Kvale, 2002). A selection and recruitment survey was undertaken to ensure participants were appropriate for the study, and a non-forcing interview method was employed to achieve validity (Stenbacka, 2001). Finally, the study relied on self-reported data from in-depth interviews, which presents the potential for participant bias, exaggeration and dishonesty (Northrup, 1997). To mitigate against this, a good rapport was developed with participants and a clear introduction to the research was provided.

## 8 Conclusions

This paper makes a significant contribution, the conceptual framework presented addresses the imbalance between the two theoretical perspectives adoption and resistance, where adoption has dominated resulting in a need to give both equal importance (Nabih *et al.*, 1997). Constructs from well-established adoption theories have often had a negative influence (Straub, 2009) and some theories overlap (Day and Herbig, 1992) which also supports the need for this integrated framework. As an output from the primary research Figure 2 corroborates that in the most part there is overlap of adoption and resistance factors and fewer that are one-sided, with the understanding that resistance factors are distinct antecedents that differ from influences which lead to adoption (Bardhi *et al.*, 2007). The conceptual framework highlights the complementarities that exist between both theoretical perspectives, which are mapped to six new overarching integrated constructs to provide a more holistic explanation of adoption and resistance factors to IP.

Figure 2 provides a much needed product driven context (Joachim *et al.*, 2018) and addresses the limited empirical research with a theoretical foundation about IP. The emerging body of literature about the

potential benefits and barriers to the technology is mostly focused on a wider group of technologies, namely smart packaging. This study is much more focused and considers four specific types of IP, which is particularly useful from a practical and implementation perspective because it provides an evidence base to support modifications and changes needed to encourage usage of IP.

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