Received: 21 December 2020 | Revised: 2 December 2022 | Accepted: 7 December 2022

DOI: 10.1002/pts.2710

RESEARCH ARTICLE

Packaging Technology and Science
An International Journal

WILEY

Interactions of fast-moving consumer goods in cooking: Insights from a quantitative ethnographic study

Gustavo Berumen[1,2] | Joel Fischer[1] | Martin Baumers[3]

[1]Mixed Reality Lab, School of Computer Science, University of Nottingham, Nottingham, UK

[2]Horizon CDT, School of Computer Science, University of Nottingham, Nottingham, UK

[3]Additive Manufacturing, Faculty of Engineering, University of Nottingham, Nottingham, UK

Correspondence
Gustavo Berumen, Mixed Reality Lab, School of Computer Science, University of Nottingham, Jubilee Campus, Wollaton Road, Nottingham NG8 1BB, UK.
Email: gustavo.berumen@nottingham.ac.uk

Funding information
UK Research and Innovation, Grant/Award Number: EP/L015463/1; Unilever UK LtD

Fast-moving consumer goods (FMCGs) are increasingly equipped with enhanced packaging that incorporates novel functionalities. Providing FMCGs with this technology is challenging due to their unique characteristics, such as their low cost and short lifespan. Knowledge derived from a comprehension of their interactions in practice can help develop FMCGs that better cater to consumer needs and are well-integrated into real-world contexts. To help develop a method for the formation of such practical insights, 20 households were visited where participants were then observed as they cooked a meal. The sessions were captured on video, and a detailed record of the interactions between individuals, FMCGs and other items was made. A quantitative ethnographic approach was applied to analyse and build an understanding of different aspects of these interactions including their frequential, sequential and correlational features. The findings are discussed through the lens of how an appreciation of the interactions of FMCGs can serve as a valuable guidance for the design and development of their enhanced counterparts. The discovery that FMCGs are linked to the use of other items, for instance, is proposed as an opportunity to make use of the unique properties of the other items that a given FMCG commonly interacts with as a resource to create functionalities. As an exploratory reflection of how FMCGs are utilised in practice, the methods and knowledge presented in this study can be valuable in creating enhanced FMCGs by advocating for a product development process in which decisions are firmly grounded in empirical insights.

KEYWORDS
consumer packaged goods, data-driven design, enhanced packaging, packaging design, practice perspective

1 | INTRODUCTION

Fast-moving consumer goods (FMCG) are relatively low-cost, non-durable goods that are partially or entirely consumed upon each use.[1] FMCGs have a pervasive presence in people's lives, as they are an essential component of many of our daily activities. FMCGs not only constitute one of the largest areas of consumer spending[2] but they are also associated with some of the greatest concerns of society including healthy eating,[3] well-being,[4] and sustainability.[5] There is a growing effort within the industry to make innovations in FMCGs by incorporating technology into packaging, which imbue them with additional functionalities.[6] To this end, some FMCG packaging is being equipped with sensor technologies and is being integrated into communication protocols to transform them into enhanced products,

which both improve the efficiency of their primary functions and incorporate novel functionalities that improve the consumer experience.[7] However, the quest for useful innovations for enhanced FMCGs has been challenging, and commercially-available implementations have thus far struggled to sway the market.

This research is based on the premise that, in order to develop enhanced versions of FMCGs, it is fundamental to first understand *what is accomplished* in these items and then to envision *what might be accomplished* with their enhanced versions. A deeper understanding of such context has proven useful in designing innovative packaging[8] and developing guidelines for assessing package performance.[9] Nevertheless, despite significant progress in the study of user-packaging interaction (for a review, see Mumani and Stone[10]), there is a lack of understanding concerning how FMCGs are utilised by consumers beyond merely investigating pragmatic and primary functions of the packaging.[11] There is information about the production of FMCGs in factories, as well as their management and sale in the retail sector,[12] but little is known about how consumers utilise these products inside households. Building upon an understanding of the use of FMCGs in practice, this study seeks to apply that information to provide insights that can lead to creating designs providing features that benefit consumers and society,[13] developing novel digital dimensions for interaction and user experience[14] and making products which are more likely to be smoothly integrated into their practical context of use.[15]

The purpose of this research is therefore to obtain a detailed understanding of interactions with and the actual usage of FMCGs in practice and to reflect on how such understanding might serve to later guide the design of enhanced FMCGs. A practice is a specific way of conducting a routine and is treated as the smallest unit of analysis and intervention by the *practice perspective*.[16] This perspective is adopted here to study the interactions of FMCGs, and other items involved in the practice of cooking. Among the different practices FMCGs are involved in, this study focuses on domestic cooking because of the unique characteristics it possesses, which make it an ideal candidate to reveal the common and familiar but often-overlooked patterns of use of FMCGs. Some relevant characteristics of cooking include the considerable amount of time most people spend on this practice daily,[17,18] its occurrence within the confines of a kitchen, and that people frequently express enjoyment, confidence and desire to improve their cooking skills,[3,19,20] and food-related FMCGs compose the largest group by sales of all FMCGs.[21] A quantitative ethnographic approach,[22] which integrates both quantitative and qualitative methods, is employed to analyse and give meaning to the vast amounts of data gathered about the interactions of FMCGs. The approach was applied in analysing four different features of the items' usages and provided insights concerning their interactions. Each of the findings can help guide the development of their enhanced versions by providing insights from a unique standpoint. This study seeks to provide contributions in three different areas: (a) methods to investigate the interactions of FMCGs in practice, (b) an understanding of the interactions of FMCGs in practice and (c) insight for designing enhanced versions of FMCGs based upon empirical observations.

This paper is organised as follows. First, Section 2 discusses work related to enhanced FMCGs and ethnographic studies of cooking, highlighting the gap in the literature about the study of the use of FMCGs in practice. Section 3 presents an argument for a quantitative ethnographic approach, a description of the field study on cooking and an explanation of the analysis methods developed in this study. Section 4 then describes the quantitative and qualitative results for each analysis method. Section 5 reflects on the contributions of this study, provides examples of how derivations from the findings can serve as implications for designing enhanced FMCGs and reflects on the limitations and opportunities of the proposed approach. Finally, Section 6 closes the paper with final remarks and suggestions for future directions.

2 | BACKGROUND

The literature review has two objectives. The first is to provide both an account regarding the latest innovations in enhanced FMCGs and the study of the practice of cooking, as well as an explanation of how those findings are translated into implications for design. The second objective is to show the gap regarding the lack of studies focused on researching the interactions of FMCGs based on detailed empirical observations.

2.1 | Enhanced FMCGs

Currently, one of the most important areas of innovation for FMCG industries is focused on equipping packaging with technology. FMCGs come in packaging, which conventionally serves the functions of containment, protection, communication and convenience.[23] Unlike durable goods, an FMCG's packaging is often part of the product itself, as it serves a functional purpose and therefore acts as a component of the product utilisation.[24,25] Improvement in the packaging helps FMCGs to better serve their primary purposes and to enhance consumers' experiences through added functionalities.[26] The FMCG sector is expected to reach more than 17 trillion USD by 2025,[21] and there is a growing competitive pressure from within industries for them to find replacements for their conventional packaging.[27] This pressure is driven primarily by two factors. One is the potential of enhanced FMCGs to meet the constantly shifting needs and demands of consumers, generally motivated by issues such as environmental concerns, the rise of digital consumers and changes in peoples' lifestyles.[28,29] The second is the increasing availability of technology necessary for the viability of enhanced FMCGs[30] such as the proliferation of smart devices and digital services, the standardisation of communication protocols[31] and declining prices of the required technologies.

Research into enhanced FMCGs has focused primarily on applications of active packaging and intelligent packaging.[26] Active packaging uses biomaterials to directly interact with its contents and improve their quality, safety and shelf life.[32,33] An example of active packaging

is antimicrobial packaging, which reduces contamination and growth of microbial populations in meat products, thereby extending the shelf life and safety of the product.[34] Intelligent packaging contains a component, which monitors and provides reliable information about the condition of the product, packaging and the surrounding environment.[35] An example of intelligent packaging is the inclusion of freshness indicators that monitor the quality of perishables by reacting to the metabolites in the content, then relaying that information to consumers.[36] A third type of enhanced packaging is interactive packaging, which is experiencing a sharp growth in interest surrounding the development of new implementations. Interactive packaging refers to that which is based on reciprocal interactions between people and the product, thereby creating a two-way communication channel and provide a dynamic response from technology-based systems.[37] Interactive features include providing functionalities such as entertainment, helping with the collection of feedback and facilitating management.[38]

Interactive FMCGs find their place on the Internet of things (IoT), a paradigm envisioned as a network of interconnected machines and devices capable of interacting with each other.[39] The core of the IoT is the collection of information by objects about their surroundings and the use of such information to make sense of their interactions and respond accordingly.[40] However, the research connecting FMCGs to the IoT is still in its early stages. This is in spite of the recent emergence of fields such as human–food interaction,[41] which are specifically aimed at enhancing one's experience with products and their packaging.[42] The limited interactive FMCG implementations have commonly focused on a specific aspect of a product's use. Some examples include (a) marketing—providing product information and functionalities to facilitate and encourage brand selection and decision-making at the point of purchase,[43] (b) product experience—incorporating entertainment such as playing music that makes interactions with and consumption of a product more enjoyable[44] and (c) security—assisting in and facilitating the authentication of products, as well as preventing counterfeiting.[45]

However, interactive FMCG implementations and associated devices have still yet to be successfully extended to a large segment of products. The implementations, which have been put on the market, have experienced only a short-lasting interest from consumers and are almost always plagued by unforeseen issues, which only became apparent when finally deployed in real-life situations. The Amazon Dash Button, aimed at helping consumers to reorder FMCGs, was discontinued because, among other issues, its main function was found to be redundant given the availability of smart assistants.[46] TagItSmart, a platform to help with the lifecycle management of FMCGs,[45] has not been able to achieve widespread acceptance as the industry has still chosen to rely upon currently-existing and long-standing solutions such as barcodes. A smart bottle, which offered entertainment such as music to complement the drinking experience,[47] was discontinued after a brief period on the market. One reason for the discontinuation of that and similar enhanced FMCGs may be that consumers simply never gained more than a passing interest and treated these products as little more than a novelty.[48]

FMCGs, like any other object, lend themselves to a particular set of actions and interactions, which need to be observed from the dyadic human-object level to the practical and contextual level. However, while a considerable effort has been made towards understanding these isolated user-product interactions, there is a lack of more than a superficial understanding of interactions involving FMCGs in a more practical, contextual use. In a review of more than 100 studies on user-packaging interactions, of which approximately two thirds were related to FMCGs, it was found that the existing research was predominantly focused on the 'point of purchase' and 'checkout' stages of interaction.[10] Only four studies were found on 'handling', and even those focused solely on the ergonomic and mechanical properties of interactions rather than on their more practical use. The research on packaging has been conventionally dominated by engineering[49,50] and ergonomic aspects of packaging,[51] and even the more recent innovative methods[42] have not considered the practical use of FMCGs. A deeper understanding of the context of packaging use has proven effective in developing guidelines for assessing the packaging performance[9] and in providing a framework for design.[52]

Practical knowledge about the use of objects can lead to broadening the set of elements considered in the design process and create products more likely to be adopted by consumers.[15] Furthermore, enhanced FMCGs and the emerging infrastructure of technological systems would demand new interactions, which both respond to the use of FMCGs in the household environment and look beyond their pragmatic aspects, as well as address the complex relationships between people and enhanced FMCGs.[53] See Figure 1 for a visual representation of an enhanced FMCG.

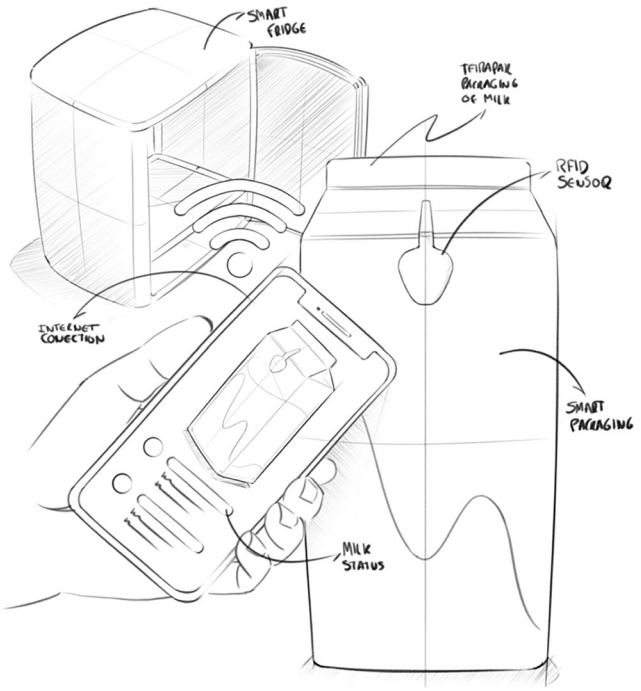

FIGURE 1 Conceptual representation of an enhanced fast-moving consumer good (FMCG)

2.2 | Domestic cooking

There is a vast body of literature on cooking including large academic compendiums such as historical accounts and diverse non-academic sources such as cookbooks. This section makes no pretence to serve as an exhaustive review; rather, it aims to provide an account of some of the studies, which have more closely focused on interactions with FMCGs.

Conducting fieldwork studies, researchers attempt to get first-hand experience by observing people's practices as they occur in their natural settings and by immersing themselves as much as possible in the activity. A fieldwork study of cooking was used to estimate its environmental impact by measuring the energy consumption associated with the cooking process. These estimates were then employed to help people reflect on their environmental footprint and design ways to reduce such undesirable effects.[5] Based on videos of food consumption, researchers proposed a consumption life-cycle as a framework for identifying how and in which situations digital interventions could be useful in promoting changes in related behaviours.[54] Conducting a digital ethnographic study of people cooking together, researchers identified eight different formations in which people arranged themselves such as face-to-face, L-shaped and semi-circular.[55] Through visits to and interviews in people's cooking spaces, it was found that the kitchen is a highly complex environment with a mix of fixed elements and flexibility. An example of a fixed element would be something like the physical structures of counters, while an example of flexibility might be the reorganisation of a spice shelf according to what people perceive as a useful classification scheme.[56]

A number of studies exploring practices related to cooking provide valuable insights into FMCG interactions, though they do not focus specifically on the use of FMCGs themselves. After identifying the activities and places inside the households of two families in which FMCGs were used over a 24-hour period, researchers used the insights gathered to cite potential opportunities and challenges in the development of ubiquitous technologies.[57] Observing the various practices with food at home such as preserving, fermenting and pickling, researchers detailed the motivations, challenges and workarounds behind sustainability and associated practices.[58] Studying the routine of shopping for ingredients, researchers were able to identify the hidden methodologies employed by shoppers and consider how such methodologies may pose challenges for the design of proactive systems aimed at supporting the practice of grocery shopping.[59] Insights from observations were used to identify the requirements in developing kitchen utensils equipped with sensors and an infrastructure to monitor their use with the overall goal of measuring people's cooking competence.[60] Through an online survey on the frequency of use for 23 utensils, researchers measured their degree of usage and ascribed them a rank ranging from high to low. They did not find a strong relationship between the use of utensils and social and economic demographics.[61]

Technological implementations in different stages of development, from prototypical to fully functional, allow researchers to explore their impact in a practical context. While a large number of technologies for the smart home have been designed to aid people in different aspects of cooking–social components,[62] counting calories[63] and cooking skills[64]–few have specifically focused on FMCGs. One implementation encourages people to scan their FMCGs upon their disposal and utilises computations to make predictions about their consumption.[65] Researchers demonstrated the challenges of making simple predictions and identified the contingencies that influenced them. An unpredictable vegetable box scheme, which delivered a randomised assortment of fruits and vegetables through a subscription service, was used by researchers to explore the consequences of delegating shopping to automated systems and how people accommodate their cooking habits to make use of food that was not purposely purchased.[66]

Although prior work provides accounts of the cooking practice, it does not go on to quantify the observed phenomena. Studies on cooking have provided insights into the social, cultural and organisational features of the practice. FMCGs have been studied as a component of practices; nevertheless, there has not been a focus on their specific interaction. Such insights might allow for a proper account of how FMCGs are utilised, a facet that has not been studied through rigorous methods in spite of people's instinctive understanding of how they are used and which may well guide the design of their enhanced counterparts.

3 | METHODOLOGY

To obtain a detailed understanding of interactions of FMCGs usage in practice, this study conducts a quantitative ethnographic investigation into the use of FMCGs in the practice of cooking, focusing on identifying the specific ways people interact with items during meal preparation. The data analysis of this study employs statistical analyses to guide the exploration and initial understanding of the interactions of all the items involved in cooking and then incorporate findings derived from ethnographic observations to obtain a more contextual understanding of different aspects of the interactions of FMCGs. The proposed method complies with the premises of traditional data analysis. As stated by Glesne,[67] 'Data analysis is the process of organising data in light of your increasing sophisticated judgements'. The uses of both quantitative and qualitative methods are ideas to accomplish the purpose of this study, which seeks to obtain an understanding of the use of FMCGs in cooking. Quantitative methods allow one to manage and initially make sense of data, as well as identify patterns through their statistical significance. An ethnographic approach lends itself well to capturing and revealing the complexities of the practice of cooking because of its contextual nature.

The proposed quantitative ethnographic approach allows for overcoming the challenges of analysing and giving a meaningful interpretation to vast quantities of data. Quantitative ethnography is a methodology that blends 'thin' descriptions–surface-level observations derived from numerical methods–and 'thick' descriptions–interpretations that add contextual knowledge–to analyse data from fieldwork studies.[22] Quantitative ethnography seeks to bridge the gap

between quantitative and qualitative methods. The context from ethnographic findings guides and provides a comprehensive interpretation of the statistical analysis, while the statistical analysis provides summaries and helps strengthen the relevance of ethnographic findings. The incorporation of quantitative methods allows one to manage and initially make sense of data and identify significant statistical patterns, such as distributions, outliers and correlations that emerge from data aggregates. This may not be identifiable from a purely qualitative analysis, which focuses on giving meaning to specific segments of the observed interactions. The resulting summary then grants us the opportunity to focus on specific details and incorporate knowledge gathered from the observed practice to achieve a qualitative and detailed description of the process.[68]

The findings obtained from a combination of the ethnographic work are to be analysed using an analytical approach that is a method of breaking down a complex process into its parts. This approach allows one to attain an understanding of people's practices both through first-hand and immersive experiences, as well as through the application of an analytic perspective. The 'implications for design',[69] which can include concrete suggestions of features, design solutions and guidelines, can be incorporated into a wide range of design practices including product requirement specifications, use case modelling and the construction of mock-ups and prototypes. The proposed approach might seem to be unconventional from both an ethnographic and packaging design research standpoint. However, two considerations must be given. First, in the ethnographic approach, there is no set of rigid steps to follow; rather, the researcher has to formulate their approach to uncover what is *seen but unnoticed*[70] in everyday life. Second, methods for researching packaging design are often adaptations of others that have traditionally been used in a wider field.[71]

3.1 | Study design

The study required participants to cook a meal from scratch in their household and permitted the researcher to record the participants' interactions. Recruitment was conducted through mailing lists, social media and referral. Participants were allowed to cook with a partner. In these cases, the participant who contacted the researcher was considered as the primary participant, while any additional participants were considered as assistants. Participants were free to choose any meal so long as they had prior experience preparing it themselves. There were no other restrictions placed on what time of day each session was to take place nor on its duration. The same researcher was designated to conduct all visits to the households.

Informed consent was obtained from all the participants in the study. First, the researcher surveyed demographic information, household characteristics and cooking practices of only the primary participant. Next, with the help of the participant, the researcher first recorded a video of the stock of all the FMCGs available in their kitchen, then positioned three video cameras and oriented them towards the participant's usual cooking area (see Figure 2).

FIGURE 2 Example of a recording of a cooking session from one of the three cameras

Participants gave verbal reassurance that the cameras were not disturbing them, as an example, P15 said 'No, you forget about them' in reference to the cameras. The recording started when participants began to retrieve ingredients and ended when they finished or served the meal. The researcher was present during the session, taking notes and engaging in conversation with the participants, so long as this was not considered a distraction for them. Lastly, a semi-structured interview was conducted to discuss the participants' cooking experience, after which they each received a £20 gift card as compensation.

3.2 | Data sample

The inclusion criteria for participation in the study were adult consumers of FMCGs between the ages of 18 and 80 and capable of preparing a meal by themselves. Twenty-three participants prepared meals in the study across 20 cooking sessions. Seventeen meals were prepared by a single participant, while only three sessions involved an assistant (p05, p09 and p18). The following demographic data correspond to the 20 primary participants as shown in Table 1. Twelve of these participants self-identified as female, seven as male and one as non-binary. The participants had a mean age of 35 years (SD = 11.6) and represented 14 nationalities. Families and couples comprised the majority of household inhabitants ($n = 14$), and the mean number of inhabitants per household was 3.2 (SD = 1.3). Seventeen participants considered their cooking skills to be intermediate, two basic and one advanced.

Participants prepared 15 different dishes categorised under the labels to which the participants had ascribed them. Four dishes were cooked in multiple sessions by different participants: *oven-roasted chicken*, *scrambled eggs*, *shepherd's pie* and *spaghetti bolognese*. The dishes were each catalogued as belonging to one of eight groupings according to common divisions found in cookbooks. The group *pasta* was the most frequently chosen ($n = 6$). The mean duration for the preparation of a meal was 57.7 min (SD = 22.6). Regarding the time

TABLE 1 Basic information about participants, households and meals

P	Gender	Age	Coo	Inhabitants	Noi	Skills	Meal	Meal type	Duration
01	Male	25	Indonesia	Professionals	2	Intermediate	Chicken coconut curry	Curry	36
02	Non-binary	28	Germany	Students	4	Intermediate	Chickpeas curry with rice	Curry	76
03	Male	19	Hong Kong	Students	6	Intermediate	Spaghetti bolognese	Pasta	21
04	Female	50	USA	Family	4	Intermediate	Green vegetable soup	Soup	45
05	Male	30	UK	Couple	2	Intermediate	Spaghetti bolognese	Pasta	41
06	Female	32	Hong Kong	Professionals	4	Advanced	Noodles with vegetables	Pasta	45
07	Male	32	Iraq	Family	3	Intermediate	Oven roasted chicken	Roast	88
08	Female	33	Russia	Couple	2	Basic	Scrambled eggs and avocado toast	Omelette	28
09	Female	29	Mexico	Couple	2	Intermediate	Chicken fajitas with rice and beans	Meat-based	68
10	Male	29	Greece	Couple	2	Advanced	Scrambled eggs	Omelette	39
11	Female	29	B&H	Couple	2	Intermediate	Spaghetti bolognese	Pasta	56
12	Male	46	Mexico	Family	5	Intermediate	Tacos of beef mince and vegetables	Meat-based	80
13	Female	29	UK	Couple	2	Intermediate	Creamy risotto with vegs and prawns	Rice	43
14	Female	35	Mexico	Family	4	Intermediate	Vegetable-based stew	Soup	73
15	Female	72	Puerto Rico	Couple	2	Intermediate	Rice with chickpeas	Rice	50
16	Female	40	Mexico	Family	3	Intermediate	Oven roasted chicken	Roast	70
17	Female	32	Ireland	Professionals	6	Intermediate	Shepherd's pie	Pie	113
18	Female	26	UK	Professionals	3	Intermediate	Pasta carbonara and napolitana	Pasta	44
19	Female	37	China	Family	3	Intermediate	Shepherd's pie	Pie	71
20	Male	46	UK	Family	3	Intermediate	Creamy chicken pasta	Pasta	68

Abbreviations: B&H, Bosnia and Herzegovina; Coo, country of origin; Duration, meal duration in minutes; Noi, number of inhabitants; P, participant.

of the day in which the sessions occurred, seven took place in the morning (p01, p03, p04, p07, p10, p12 and p14), two in the afternoon (p06 and p15) and 11 in the evening.

3.3 | Classification of data

The items were classified using a nested hierarchy consisting of three levels: type, category and item.

Type

Items were assigned to one of three types: FMCGs, *utensils* or *environment items*. The FMCG type consisted of all the products that meet the abovementioned characteristics for these goods (see Figure S1 for pictorial representations of FMCGs). *Utensils* were tools and devices that people were able to manipulate, and which were easily portable. *Environment items* were building structures, appliances and devices, which required an external energy source to function.

Category

Items of each type with similar characteristics and usage were grouped together. The categories of FMCGs were further informed by classifications of ingredients[72] and groceries. As an example, the category *spices* consisted of solid substances commonly packaged in a bottle and added to food to enhance its flavour.

Item

The objects were assigned a label under the name by which they are commonly known. For example, bottles of both fine and rock salt were labelled simply as '*salt*'. Other characteristics such as properties of the product and its observed use were employed to differentiate items, which, albeit similar, are handled differently and cannot be easily considered as a replacement for one another. For example, a bottle of garlic granules and a bulb of garlic received distinct labels, *dried garlic* and *garlic*, respectively. If more than one item with the same label was used within the same session, each item received a second label to uniquely identify it. Either a numeric label or a descriptive one based on properties of the item was used for this second label.

The items each fell into categories, which could be defined by one of the 197 distinct labels. Out of those categories of items, 115 of them were FMCGs, 71 were *utensils* and 13 were *environment items*. The FMCGs were subdivided into 15 categories: *baked goods*, *beverages*, *cleaning products*, *condiments*, *dairy products and eggs*, *dried goods*, *disposables and food storage*, *fruits*, *legumes*, *meats*, *oils and fats*,

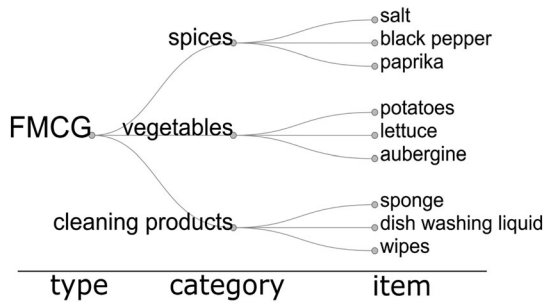

FIGURE 3 Hierarchical classification of selected fast-moving consumer goods (FMCGs)

rice and pasta, *spices*, *stationery* and *vegetables*. See Data S1 for a full list of items and Figure 3 for a visual representation of the hierarchy.

A note about the combination of FMCGs, when a given FMCG was mixed with another FMCG or group of FMCGs, the combination of FMCGs was labelled as *food* for practical reasons of data handling. In this study, *food* is defined as the combination of two or more FMCGs such that the resulting amalgamation can no longer be said to exist as a group of distinct ingredients but rather as a combination of FMCGs as its components may no longer be separable.

3.4 | Data analysis

The basis of the analysis of this study consisted of manually capturing the interactions that the participants had with any item that they had contact with in their efforts to prepare a meal. An 'interaction' was considered as any instance in which an item was used either through direct physical contact (e.g., getting a pinch of *salt* from a bag) or through the use of another item (e.g., retrieving a portion of *salt* by using a *spoon*). In the previous examples, the former would be counted as a singular interaction with *salt*, while the latter would be counted as two: one for *salt* and another for the *spoon*. Each item interaction was given a unique identification tag and included its start and end times. The durations of the interactions were recorded in 2-s intervals; thus, interactions with durations below this 2-s threshold were still recorded as lasting 2 s. The end time of an interaction was considered to be the point when the participant ceased contact with the item.

The analysis methods analyse the data at different levels, from the entire data set to a selection of items, and they range from exclusively mostly quantitative to incorporating qualitative data. The development of the analysis methods incorporated insights from fieldwork records, exploratory data analysis, knowledge of cooking and references to the literature. The quantitative data were analysed through statistical methods (including descriptive and inferential methods) using the programming language R. The qualitative data were analysed using contextual interpretations for the video recorded data and thematic analysis for the conversational data. The analysis methods focused on four different features of the interactions of FMCGs:

- Involvement: estimating the number of FMCGs utilised per session and ascertaining what fraction of the total available stock of FMCGs that represented. An item was considered to be involved in a session if it had at least one interaction in that session.
- Interactions: counting the number of interactions participants had with FMCGs and other items while cooking. An item was considered to have an interaction each time that it was involved in an instance that met the aforementioned criteria for *interaction*.
- Phases: identifying the distinct periods within the cooking sessions in which interactions took place. Each session was divided into 10 periods of equal length, and interactions were assigned to their corresponding phases according to their start times.
- Conditionality: obtaining the conditional probabilities of one item being involved in a session given that another was involved. The probability of item A being used in a session given that item B was used in that same session is known as the 'conditional probability of A given B', denoted by P(A|B).

4 | FINDINGS

The main findings of each analysis method as applied to the three levels of the nested hierarchy–*type*, *category* and *item*–are described. The analyses were not only focused on FMCGs but also integrated *utensils* and *environment items* to draw comparisons. The findings are divided into two sections. First, a quantitative section provides a summary of the statistical analyses. Second, a qualitative section provides an interpretation of the quantitative findings informed by the insights derived from the fieldwork and an analytical approach. Although the results presented in this section are already implicitly related to packaging, this relevance will be made explicit in Section 5.

4.1 | Involvement

Results showed that participants utilised a relatively small fraction of the FMCGs they had at their disposal when cooking a meal. Participants utilised a median of 18 FMCGs to prepare a meal (Interqartile range [IQR] = 16–21) from a median of 203 available FMCGs (IQR = 160–229). The FMCGs involved ranged from a minimum of 6 (p07) to a maximum of 36 (p17). The available FMCGs ranged from 38 (p03) to 429 (p17). The FMCGs involved represented a median of 9% (IQR = 8–12) of the available FMCGs. The number of FMCGs involved per session correlated positively with the number of FMCGs available $r(18) = 0.64$, $p = 0.01$.

Apart from a small set of FMCGs, most FMCGs were involved in relatively few sessions. FMCGs were involved in a median of 2 sessions (IQR = 1–3), which represented 10% of all total sessions. Only 20 FMCGs (18% of 115) were involved in 25% or more of the sessions. Among those items, the 10 with the largest involvement were salt, oil, sponge, black pepper, onion, dishwashing liquid, bouillon, cheese, garlic and kitchen roll (see Figure 4).

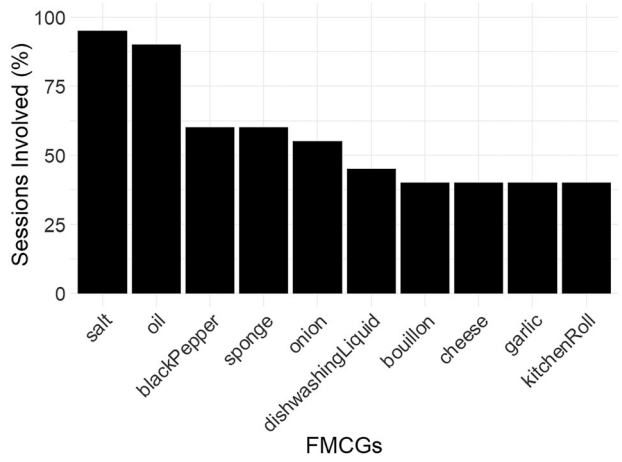

FIGURE 4 Fast-moving consumer goods (FMCGs) with the highest involvement

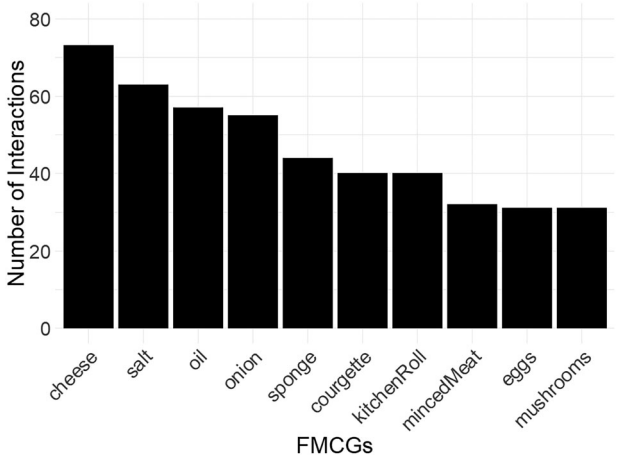

FIGURE 5 Fast-moving consumer goods (FMCGs) with the largest number of interactions

The FMCGs that were most commonly involved were not necessarily those which were most available. The category with the greatest involvement was *vegetables* (30%), while the most commonly-available category found was *spices* (15%). Categories of FMCGs with a short life span had a greater rate of involvement in proportion to their availability; this was found in the categories *vegetables* (22% availability to 32% involvement), *meats* (4% availability to 7% involvement) and *dairy products and eggs* (6% availability to 9% involvement). The proportion of categories of FMCGs available in the kitchens did not correlate with the proportion of categories of FMCGs utilised in preparing a meal $r(18) = 0.55$, $p = 0.05$.

The findings indicate that, when preparing a meal, the number of FMCGs utilised is usually a small fraction of the total number available. A given FMCG may be chosen for inclusion in a recipe for a variety of reasons, such as it being an essential component of the meal, the cook being experienced with its use or its positioning being such that it is frequently within line of sight. When planning for a recipe, people are likely to consider the need to make use of certain ingredients as soon as possible due to them nearing their expiration date. This was expressed by a number of participants when describing their cooking processes, such as P16, who stated that she uses leftover vegetables such as sweet potato and butternut squash from the soup she made the day before '… so they don't go to waste'. Evidence of this was also found in the discovery that FMCGs belonging to the *vegetables*, *meats* and *dairy products and eggs* categories had greater rates of involvement compared to their availability. Such FMCGs with short life-spans must be constantly replenished, as opposed to other FMCGs, which have longer life spans and are thus more prone to accumulating over time, such as those pertaining to the *spices* category. The findings also suggest that variety is a key component of the role of FMCGs in cooking, as only a small subset is shared across many sessions while the majority have a much narrower application and are only used in certain recipes. Apart from the most basic, versatile and commonly-used ingredients such as *salt*, *oil* and *black pepper*, people seem to employ a distinct and unique set of additional FMCGs for each meal.

4.2 | Interactions

The results showed that FMCG interactions accounted for a small portion of all the interactions. There were 1303 interactions with FMCGs across all cooking sessions, which comprised 18% of all the interactions and represents a decline from the 32% of FMCGs involved in the cooking sessions. There were 3976 interactions with *utensils* (55%) and 888 interactions with *environment items* (12%).

Just a few subsets of FMCGs accounted for the majority of interactions. Only 17 out of the 115 total FMCGs (15%) accounted for 50% of all FMCG interactions. The 10 FMCGs with the greatest number of interactions were *cheese*, *salt*, *oil*, *onions*, *sponge*, *courgette*, *kitchen roll*, *minced meat*, *eggs* and *mushrooms* (see Figure 5). Three categories of FMCGs accounted for more than half of all the FMCG interactions, those being *vegetables* (32%), *spices* (14%) and *cleaning products* (12%).

Each FMCG had only a few interactions per session. The individual FMCGs had a median of 3 interactions per session (IQR = 1.7–5) across all sessions in which they were used. The FMCGs with the greatest number of interactions were also the FMCGs which were commonly involved in most sessions $r(111) = 0.83$, $p = 0.01$. The categories *vegetables* and *meats* had the largest median number of interactions (median = 5) across the sessions in which they were involved. A one-way, between-group ANOVA showed a significant difference between the number of interactions of *vegetables* and *meats* and those of other categories such as *condiments*, *spices* and *cleaning products* at the $p = 0.01$ level (F (13, 3.27) = 48.56).

The findings show that FMCGs are interacted with a relatively small number of times. This is reflected in the fact that, among other findings, their average number of interactions represented only one fifth of the total number of interactions per session. This suggests that

FMCGs had a limited use before they were combined with other FMCGs and transformed into *food*, after which point their interactions were no longer counted individually. The nature of interactions that people have with FMCGs may be constrained by virtue of the properties of the products themselves. It was observed across the sessions that, for a bottle of *salt*, most interactions it was involved in were for the purpose of *retrieval*, *seasoning* or *storing*. Additionally, utensils and environment items are essential for the use of FMCGs. Participants had thrice the number of interactions with *utensils* as they did with FMCGs. Most FMCGs require the use of at least one *utensil*. For example, to chop *onions*, people generally use a *chopping board* and a *knife*. FMCGs that required manipulation before being incorporated into *food* had more interactions than other FMCGs; *vegetables* and *meats* had more interactions than *condiments* and *spices*. The FMCGs with the largest number of interactions were also those which had interactions independent of their packaging, such as *vegetables* as opposed to *spices*. Moreover, it was found that people used packaging in unique was as P06 reused bottles of *ketchup* to contain and dispense *oil*, which, at least subjectively, made them feel they had better control of the product.

4.3 | Phases

The distribution of interactions along the temporal phases of the cooking sessions varies according to the type of item. FMCG (median = 38.6; IQR = 16–66) and *environment items* interactions (median = 46.7; IQR = 20–73) occurred mostly during the first phases of the sessions, while utensil interactions occurred mostly in the middle phases of the session (median = 51.5; IQR = 28–73).

The results also showed that the majority of participant interactions occurred in the first temporal phases. Half of the interactions occurred in the first four phases (51%), and the first phase saw the largest number of FMCGs retrieved (17%). The most common categories of the interactions in the first four phases were *vegetables* (44%), *spices* (12%) and *meats* (11%). The results showed that participants retrieved most of the items at the beginning. Half of the items were retrieved during the first three phases (55%), and the first interval was the phase in which the largest number of FMCGs was interacted with for the first time (36%).

The distribution showed that the number of interactions across phases varies according to the category of FMCG (see Figure 6). The category *vegetables* was most commonly interacted with at the beginning with a peak of interactions before the second phase, *spices* was distributed along the session with the peak of interactions around the fifth phase and *cleaning products* had most of its interactions at the end with a peak of interaction around the eight phase.

The findings indicate that, in cooking, people had their first interactions with most of the FMCGs, which were needed for the meal at the beginning, then interacted with those products throughout the rest of the session. People kept retrieving FMCGs throughout the session, but at a diminished rate, and usually stopped retrieving FMCGs entirely by the last quarter. It might be that often more FMCGs were

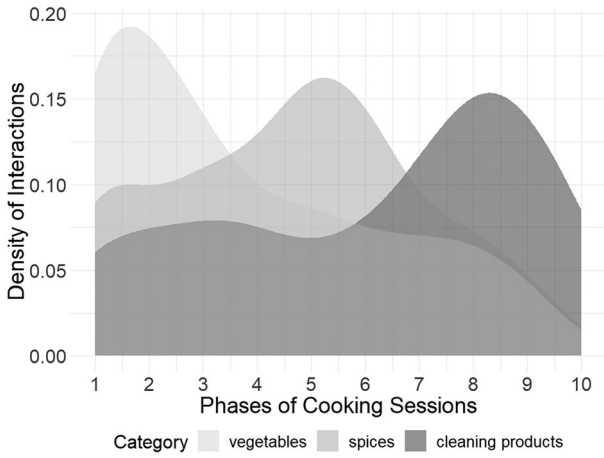

FIGURE 6 Distribution of interactions for selected categories across phases

retrieved after serving the meal, but these were not recorded. For instance, people may have retrieved items from the *condiments* category such as *balsamic vinegar* and *hot sauce* when they sat down to eat. However, the methods in this study did not allow us to capture such items as they only recorded the interactions until the moment people served their meals. The findings also suggest that different categories of items interact at different phases in the cooking sessions. For instance, items from the *vegetables* category were generally used at the beginning and required somewhat longer preparation times, as they often first had to be peeled and chopped for their eventual use in the recipe. This is in contrast to the categories of items, which were more commonly interacted with at the end of the sessions such as *cleaning products*, as they are commonly used to clean the mess produced by the previous categories of items.

4.4 | Conditionality

The concurrent analysis of FMCGs showed that FMCGs were utilised in recurring pairs with other FMCGs, utensils and environment items. The most frequent pairs of FMCGs were composed of those with the largest involvement across sessions. The most prevalent pair was {*salt*, *oil*} with an involvement frequency of 95% of the sessions. Other frequently reoccurring pairs included {*salt*, *black pepper*} (55%), {*oil*, *onions*} (55%) and {*sponge*, *dishwashing liquid*} (45%).

The three highest conditional probabilities relating pairs of FMCGs were P(*salt*|*oil*) = 0.95, P(*onions*|*black pepper*) = 0.75 and P(*dishwashing liquid*|*sponge*) = 0.75 (Figure 7). The conditional probabilities of *salt* and *oil* were nearly one regardless of which ingredient's interaction was treated as the conditioning event. In other words, given that any ingredient besides *salt* or *oil* was used, the probability that *salt* and *oil* were also used was almost one. Averaging across all conditioning items, the conditional probabilities associated with *salt* and *oil* given the use of any FMCG were P(*salt*|[FMCG]) = 0.97 and P(*oil*|[FMCG]) = 0.96.

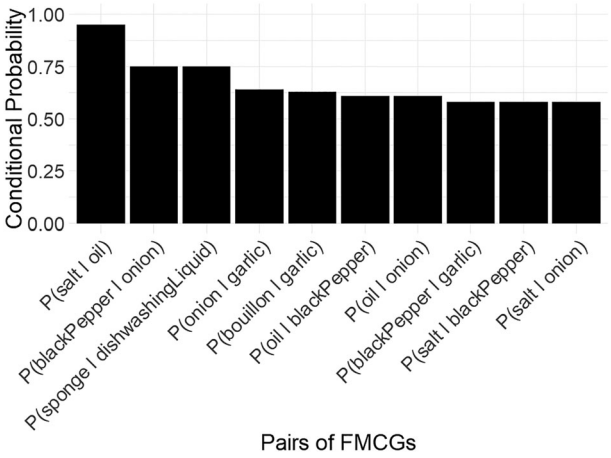

FIGURE 7 Pairs of fast-moving consumer goods (FMCGs) with the highest conditional probabilities

The pairing of individual FMCGs revealed items which are similar to each other, and which are often used in combination. For example, for pairs in which *onions* were an element, the conditional probability of there being other FMCGs from the category *vegetables* was higher than that of finding items from other categories. For instance, P(*ginger*|*onions*) = 0.64, P(*tomatoes*|*onions*) = 0.45 and P(*mushrooms*|*onions*) = 0.36. When pairing utensils and FMCGs, the *utensils* complementing the FMCG in each pair were those one would customarily associate with activities involving that FMCG. In the pairing of *onions* with *utensils*, for example, the most prevalent items were those associated with preparation, disposal and storage: P(*knife*|*onions*) = 1, P(*chopping board*|*onions*) = 1, P(*trash bin*|*onions*) = 1 and P(*fridge*|*onions*) = 1.

Items which are strongly associated with specific activities are commonly found to be paired. Pairs of items containing *salt* and *black pepper* were likely to be associated with basic seasoning of ingredients, pairs containing the item *oil* were likely to be associated with heating and flavouring and pairs containing the items *sponge* or *dishwashing liquid* were strongly associated with washing dishes. Pairs containing an FMCG are often complemented with utensils, which are necessary for its use. For instance, the utensils most commonly associated with *onions* were *chopping board*, *knife* and *trash bin*, which are conventionally linked to chopping *onions* and the disposal of its waste and was corroborated during the fieldwork observations. Additionally, FMCGs having similar features and properties repeatedly formed pairs. For instance, other FMCGs frequently appearing in the pairs containing *onions* include *garlic* and *tomatoes*. These three FMCGs have a similar use; they all belong to the category *vegetables* and are usually peeled and chopped before being blended together incorporated into *food*.

5 | DISCUSSION

The data presented here confirm that FMCGs have complex interactions, the nature of which are revealed only after rigorous observations in the field and a carefully-chosen analytical approach. The study revealed the following discoveries: (a) The number of available FMCGs for a meal is generally significantly greater than that of the FMCGs actually used, (b) most FMCGs are interacted with only a relatively small number of times per session, (c) FMCGs are utilised at different stages of the cooking process and (d) the use of FMCGs is intrinsically linked to the use of other items. This study showed that the observation and detailed analysis of FMCG interactions revealed patterns of use, which may well seem intuitive but have until now remained undocumented.

5.1 | Implications for design

Ethnographic research makes two contributions for the design of technological systems. First, it explains what happened. Second, it provides ideas for thinking about social life, which can be translated into constraints and opportunities for design.[73] Once the analytic approach has been completed from the fieldwork, researchers have to process their findings and convey their insights to other individuals involved in the design and development of technology. The challenge is to make those insights accessible for all parties involved and provide explanatory accounts and useful design recommendations, which can be presented in terms of directions, inputs, implications and options.[74]

Of particular interest to this study is the use of ethnographic findings in the derivation of implications for design.[75] As stated by Crabtree et al.,[76] 'You might reflect upon the significance that ethnographic findings have for design to elaborate what is important about the work of a setting, particularly what aspects of it cannot be dispensed with and are critical to maintaining and factor into the design'. Indeed, the implications of the findings can be applied extensively across various elements of design and the design process such as use case modelling, scenario-based design, mock-ups and prototypes.[77] Moreover, they can also be implemented to evaluate the effectiveness of design through assumptions testing. Examples of how some of the findings of this study can be translated into implications for design are provided in the form of guidelines, ideas and suggestions to develop enhanced versions of FMCGs below:

Finding: The number of available FMCGs in most cooking sessions is quite significantly greater than the number of FMCGs actually used in preparing the meal.

Implication: There should be an effort to design enhanced FMCGs, which provide support for people in managing large numbers of such items in their kitchen; for instance, by keeping an inventory of the FMCGs employed in each meal and making informed recommendations about utilising and purchasing them. Enhanced versions of FMCGs can promote interactions with less-utilised products when necessary. Some such forms of support include recommending FMCGs, which are about to expire, thus reducing product waste and suggesting the use of certain FMCGs in a given meal to enhance its flavour, as well as helping to keep an inventory to help automate shopping. Each category of FMCG will demand unique design features to improve its functions through the use of enhanced packaging. The

core implication is concerned with assisting people in managing the large number of FMCGs at their disposal. And, given that people have hundreds of FMCGs in their kitchen, they are likely not fully aware of all of the products at their disposal. Thus, enhanced versions of FMCGs could serve as a memory aid for consumers, assisting them in keeping track of the ingredients they have on hand. FMCG inventory could also facilitate shopping by making reordering items easier. The incorporation of sensors such as radio frequency identification (RFID) sensors into packaging, as well as in parts of the kitchen, such as smart cabinets,[78] could assist in identifying FMCGs. Other alternatives include a smart trash bin, which detects the FMCGs at when it is being disposed of and predicts the life cycle of a product. Furthermore, the packaging design can be altered to facilitate product identification via computer vision; this could serve as another method for detecting FMCGs, but without requiring the incorporation of technologies into the products themselves or their packaging.

Finding: FMCGs are more commonly used during some phases of meal preparation than others.

Implication: There should be an effort to design enhanced FMCGs, which make customised recommendations in a timely fashion and which reflect the details of use of that particular FMCG. Some recommendations include retrieving and having ready any ingredients, which are central to the chosen recipe, especially those which require a long preparation process at the beginning of the session, and suggestions for improving the flavour of a meal by adding ingredients, such as condiments, which are often overlooked, should usually come midway through the cooking process as more subtle adjustments to the flavour need to be made and the identity of the dish has become sufficiently clear. Those timely recommendations could employ the packaging to inform the consumer to make use of them at the appropriate time. To attract the consumer's attention, the packaging could vibrate, emit a sound and/or display a flashing light. This would require equipping the packaging with machinery and technologies, which would likely be considered expensive for current disposable packaging. This would suggest promoting the use of more durable packaging, which can retain its structural integrity for much longer periods such that the technology would remain functional throughout. Also, the technology can be made flexible in a way such that it is capable of being reprogrammed and reallocated to different packaging. FMCG packaging could use services such as Loop[79]—a subscription-based service, which uses refillable packaging.

Finding: The use of FMCGs is intrinsically linked to that of specific utensils and other FMCGs.

Implication: There should be an effort to design enhancements for FMCGs as elements of a set rather than as items in isolation.

An enhanced packaging design to record the consumption of *salt* could benefit from a consideration of which items it most commonly pairs with. The most prominent such items could be enhanced as well to help identify distinct activities related to the use of *salt* and establish communication with its packaging to better monitor its use. To illustrate, cupboards could sense when *salt* is retrieved and stored, frying pans could sense when salt is added to food and measuring spoons can identify the blend of spices it comes into contact with and recommend other seasonings to flavour a dish. Alternatively, individuals may be interested in dissociating items, which frequently appear in sets to decrease their consumption of a specific ingredient, or if they have the desire to explore ingredients which are new to them. People trying to decrease the consumption of salt may benefit from receiving a suggestion about using a wider variety of *spices* as an alternative. For instance, people who usually season *eggs* with *salt* can receive suggestions about using *black pepper* and *dried garlic* instead when preparing an omelette. Furthermore, the packaging could be designed in such a way as to complement the set of items with which it is typically used in conjunction. Although not a smart application, FMCG packaging could be ergonomically designed to better withstand the conditions in which the ingredients are commonly used. Packaging, which is typically used on wet surfaces, for example, could be designed to withstand higher levels of humidity. Furthermore, tracking FMCGs and other items may reveal insights about the variety of their uses, particularly the most uncommon ones, which then may be used by companies to inform the design of their products and packaging, particularly when such use is found to be common.

Ethnography for design offers relevant insights for the creation of technological innovations. Its findings are best implemented when they are complemented by other approaches[80] relying upon collaboration and dialogue.[81] It is proposed that the findings obtained in this study be made well-known to designers who can then collaborate in creating enhanced versions of FMCGs. The data of this study and the analysis script files have been made publicly available* for use by other researchers and any interested public so it might be further explored and analysed, for instance by exploring other features of the interactions. Collaborative design approaches[82] are to be adopted in a follow-up study. This could include design workshops to attract a wide range of people with interests in FMCGs including designers, industry experts, engineers, professional cooks and consumers. A great deal of work has to be put into translating the findings into insights, which are useful and meaningful to participants of the proposed workshops. As with the efforts put into researching information visualisation,[83,84] the findings of this study must be specially prepared for application towards any given purpose and must be presented to the target demographic such that they are both meaningful and useful as a tool for empowering one's ability to think about how FMCGs are currently utilised, as well as their potential for enhancement.[85]

5.2 | Reflections on the methodological approach

The following considerations would enrich the knowledge of FMCG interactions and address the limitations of this study: a larger sample size, repeated visits to households and other types of cooking. The sample in this study, although diverse, is relatively small considering that cooking occurs in almost every household, how frequently the activity is performed by most individuals, and that the cooking

*Access data repository: https://doi.org/10.17639/nott.7195.

methods are very diverse. However, this in no way implies that the sample in this study is not representative of the larger population, as the size of a sample does not limit or prevent identification of the methods by which people accomplish their work in such tasks as cooking[86] given their relative homogeneity and ubiquity across various cultures. As stated by Shaffer,[22] 'Knowledge is local but not too local'. Some specific findings of this study, such as the fact that *minced meat* was one of the most commonly-used items, may apply only to this sample and reflect the culture and demographic in which it was conducted. However, more general patterns of the items' interactions are likely to apply to a larger and more diverse population, such as that only a single, rather select group of items is used across many different meals while the components, which form the basis and identity of a meal, will vary greatly from dish to dish.

This study provides a quantitative ethnographic approach and methods to understand interactions involving FMCGs from a practice perspective. The methods are not limited to the study of cooking and our sample. Rather, they can be employed to evaluate the cooking practices of people in other settings and cultures, as well as to better understand the interactions involving FMCGs in other practices such as cleaning, grooming and doing laundry. The approach allowed for incorporating knowledge from both quantitative and qualitative methods. Statistical analyses provided findings, which only emerge from data aggregates such as dispersion, correlation and outliers. Ethnographic methods provide meaning and contextual knowledge to summaries of results, such as the finding that a surge of interactions involving *cleaning products* towards the beginning phases of the session (i.e., an outlier from the norm) was the result of a spill and subsequent need to clean it. The approach provided detailed descriptions and interpretations of the interactions of FMCGs, which are lacking or barely mentioned in previous studies. While ethnographic work usually focuses on thick descriptions and insightful situations,[55] it has not given detailed information about FMCG interactions and those of other items involved in cooking. Similarly, while quantitative methods provide a summary of the general findings, they do not provide information about the practical context of use beyond the numerical data.[60,61] The incorporation of quantitative methods to ethnography can allow for obtaining a measure of the relevance of the findings and help to reduce bias[87] in ethnographic interpretations. Moreover, it can strengthen the relevance of findings by providing an 'evidence base', which is firmly-rooted in empirical observation and from which one can then proceed when making decisions.[88]

The methods of this study are very time-consuming and labour-intensive; the manual recording of interactions of a video took days of work. This can be made more efficient once the methods are automated, which seems plausible in the near future with the large-scale introduction of RFID to FMCG packaging. For example, see the declaration of plan to introduce 100 billion electronic tags for products in convenience stores in Japan.[89] It should also be considered that although it is a the standard practice involves the use of video cameras to capture people's daily activities, and despite the fact most participants expressed that they were not disturbed by the presence of the cameras, still, it is a possibility that they could have been negatively influenced by their presence but did not express this to the researcher. Thus, the possibility that the participants modified their cooking process cannot be discarded. In future work, the use of less invasive methods should be explored. Furthermore, it should be considered that although the focus in this study was on drawing implications for designing products, which are either themselves or through their packaging embedded with technology, there are situations where the most appropriate solution is not to design any technological intervention at all.[90] The *practice* perspective argues that the introduction of new technologies is only one of many alternatives, which can be employed to bring change within a practice.[16] There is also need to reflect on the ways in which people already accomplish their goals as we already continually reconfigure spaces and technologies within them to meet particular demands.[91,92]

6 | CONCLUSION

The rapidly-changing landscape of FMCGs is causing manufacturers to increasingly incorporate technologies into their packaging to enhance their products. The necessity to create products, which fit in to the practices, requires finding innovations for creating products based on empirical insights. To overcome this challenge, an in-depth understanding of the interactions with FMCGs is essential. The findings of this research have provided insights, which can be used as a resource to inform the design of enhanced versions of FMCGs. This research responds to growing industry interest and the need to create enhanced FMCGs for which the design proposals are firmly grounded in a contextual setting, thereby providing better support to customers at the moment the product is used.

Conventionally, the focus on developing enhanced products has been evaluated only in terms of the relationships and the interactions between people and isolated objects. However, given the fact that all objects are used in some context, any attempt to create innovations in an object should also be seen as an attempt to create innovations for the ways the products are actually used. This study attempts to circumvent the challenges of designing for low-cost and disposable FMCGs by focusing completely on the interactions involving FMCGs and other relevant items in the practice of cooking rather than only focusing on their individual interactions. It seeks to gain a detailed understanding of FMCG interactions in cooking in order to inform the design of enhanced FMCGs. The study represents the first detailed exploration into how FMCGs are utilised within people's households in the practice of cooking, and an attempt at exploring how best to employ those insights to guide the design of enhanced versions of FMCGs for which packaging will play an essential role in the incorporation of technologies into FMCG. This research can contribute by helping others find new lines of inquiry about creating FMCGs based on their use in a practical context. It is understandable that the proposed approach should face many challenges in the long process of transitioning insights from fieldwork to the deployment of a product

into the market. To illustrate, the proposal to design for collections of FMCGs instead of for individual items would require companies to make their innovations compatible with those of their competitors; a degree of cooperation not usually found.

The main contribution of this study is that it provides an understanding of the interactions of FMCGs in the practice of cooking. There are three specific contributions. First, it presents analysis methods to study the use of FMCGs in practice, which can be applied to a broader set of practices; for instance, by studying the use of FMCGs in cleaning, the phases' analysis method can help uncover the sequence of use of FMCGs and other household items. Second, it consolidates the insights acquired from findings using the different methods of analysis; the combination of both quantitative and qualitative methods allows for providing meaning to the results, thus expanding the understanding of the findings. Third, it derives implications for designing enhanced FMCGs taking into consideration the incorporation of technologies into their packaging, which can be utilised to design smart products which fit their practical use; the suggested designs of products, such as those which work in combination with other items, are only an example of the potential implications of this study.

Further research is needed to support the claim that a better understanding of interactions involving FMCGs can prove fruitful for the development of enhanced FMCGs. Undoubtedly, collaboration is essential for those personally invested and interested in FMCGs including designers, cooks and consumers. One future avenue discussed in this paper is the creation of design workshops in which actionable versions of the findings are provided to people so they can use them as a resource for design. A further step will be the creation of guidelines and prototyping tools for designing enhanced FMCGs. The methods can also be applied to evaluate the potentiality and feasibility of proposed designs. The final step would be to develop enhanced FMCGs and deploy them in the field so that we might test their effectiveness and prepare them to be released onto the market. Overall, given the crucial roles that FMCGs play in our everyday lives, it is necessary to create versions of them that best serve people's needs, and the proposed methods of this study and its findings can lead to such innovations.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in Nottingham Research Data Management Repository at https://doi.org/10.17639/nott.7195.

ORCID

Gustavo Berumen https://orcid.org/0000-0002-8680-5445

REFERENCES

1. Law J. *A Dictionary of Business and Management*. Oxford University Press; 2009.
2. U.S. Bureau of Labor Statistics. Consumer expenditure in 2018. U.S. Bureau of Labor Statistics; 2020:1–41. Accessed September 18, 2020. https://www.bls.gov/opub/reports/consumer-expenditures/2018/pdf/home.pdf
3. Farmer N, Touchton-Leonard K, Ross A. Psychosocial benefits of cooking interventions: a systematic review. *Health Educ Behav*. 2018;45(2):167-180. doi:10.1177/1090198117736352
4. Steptoe A, Gibson EL, Vounonvirta R, et al. The effects of tea on psychophysiological stress responsivity and post-stress recovery: a randomised double-blind trial. *Psychopharmacology (Berl)*. 2007;190(1):81-89. doi:10.1007/s00213-006-0620-z
5. Clear AK, Hazas M, Morley J, Friday A, Bates O. Domestic food and sustainable design: a study of university student cooking and its impacts. In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. Association for Computing Machinery; 2013:2447-2456. doi:10.1145/2470654.2481339
6. Loucanova E, Kalamarova M, Parobek J. The innovative approaches to packaging – comparison analysis of intelligent and active packaging perceptions in Slovakia. *Studia Universitatis Vasile Goldis Arad – Economics Series*. 2017;27(2):33-44. doi:10.1515/sues-2017-0007
7. Brockgreitens J, Abbas A. Responsive food packaging: recent progress and technological prospects. *Compr Rev Food Sci Food Saf*. 2016;15(1):3-15. doi:10.1111/1541-4337.12174
8. Ward J, Buckle P, Clarkson PJ. Designing packaging to support the safe use of medicines at home. *Appl Ergon*. 2010;41(5):682-694. doi:10.1016/j.apergo.2009.12.005
9. Yiangkamolsing C, Bohez ELJ, Bueren I. Universal design (UD) principles for flexible packaging and corresponding minimal customer requirement set. *Packag Technol Sci*. 2010;23(23):283-300. doi:10.1002/pts.900
10. Mumani A, Stone R. State of the art of user packaging interaction (UPI). *Packag Technol Sci*. 2018;31(6):401-419. doi:10.1002/pts.2363
11. Petrelli D. Industry 4.0: is it time for interaction design craftsmanship? *Des J*. 2017;20(sup1):S2735-S2745. doi:10.1080/14606925.2017.1352785
12. Sonneveld K. What drives (food) packaging innovation? *Packag Technol Sci*. 2000;13(1):7-35. doi:10.1002/(sici)1099-1522(200001/02)13:13.0.co;2-r
13. Shahmohammadi S, Steinmann ZJ, Tambjerg L, van Loon P, King JH, Huijbregts MA. Comparative greenhouse gas footprinting of online versus traditional shopping for fast-moving consumer goods: a stochastic approach. *Environ Sci Technol*. 2020;54(6):3499-3509. doi:10.1021/acs.est.9b06252.s001
14. Lydekaityte J. Smart interactive packaging as a cyber-physical agent in the interaction design theory: a novel user interface. In: *IFIP Conference on Human-Computer Interaction*. Springer; 2019:687-695. doi:10.1007/978-3-030-29381-9_41
15. Balka E, Wagner I. Making things work: dimensions of configurability as appropriation work. In: *Proceedings of the 2006 20th Anniversary Conference on Computer Supported Cooperative Work*. Association for Computing Machinery; 2006:229-238. doi:10.1145/1180875.1180912
16. Kuutti K, Bannon LJ. The turn to practice in HCI: towards a research agenda. In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. Association for Computing Machinery; 2014:3543-3552. doi:10.1145/2556288.2557111
17. Smith LP, Ng SW, Popkin BM. Trends in US home food preparation and consumption: analysis of national nutrition surveys and time use studies from 1965–1966 to 2007–2008. *Nutr J*. 2013;12(1):45. doi:10.1186/1475-2891-12-45
18. Sullivan O, Gershuny J. Speed-up society? Evidence from the UK 2000 and 2015 time use diary surveys. *Sociology*. 2018;52(1):20-38. doi:10.1177/0038038517712914
19. Lavelle F, McGowan L, Hollywood L, et al. The development and validation of measures to assess cooking skills and food skills. *Int J Behav Nutr Phys Act*. 2017;14(1):118. doi:10.1186/s12966-017-0575-y
20. Majlesi AR, Ekström A. Baking together—the coordination of actions in activities involving people with dementia. *J Aging Stud*. 2016;38:37-46. doi:10.1016/j.jaging.2016.04.004

21. Allied Market Research. *FMCG Market by Type (Food & Beverage, Personal Care, Health Care, and Home Care) and Distribution Channel (Supermarkets & Hypermarkets, Grocery Stores, Specialty Stores, E-Commerce, and Others): Global Opportunity Analysis and Industry Forecast, 2018–2025*. Allied Market Research; 2018.
22. Shaffer DW. *Quantitative Ethnography*. 1st ed. Cathcart Press; 2017.
23. Robertson GL. *Food Packaging: Principles and Practice*. CRC Press; 2005. doi:10.1201/9781420056150
24. Oki Y, Sasaki H. Social and environmental impacts of packaging (LCA and assessment of packaging functions). *Packag Technol Sci*. 2000; 2(13):9-53. doi:10.1002/1099-1522(200003/04)13:23.0.co;2-#
25. Underwood RL. The communicative power of product packaging: creating brand identity via lived and mediated experience. *J MarkTheory Pract*. 2003;11(1):62-76. doi:10.1080/10696679.2003.11501933
26. Lydekaityte J, Tambo T. Smart packaging: definitions, models and packaging as an intermediator between digital and physical product management. *Int Rev Retail Distrib Consum Res*. 2020;30(4):377-410. doi:10.1080/09593969.2020.1724555
27. Kontominas M. *Bioactive Food Packaging: Strategies, Quality, Safety*. DEStech Publications, Incorporated; 2015.
28. Bradley EL, Castle L, Chaudhry Q. Applications of nanomaterials in food packaging with a consideration of opportunities for developing countries. *Trends Food Sci Technol*. 2011;22(11):604-610. doi:10.1016/j.tifs.2011.01.002
29. Lange J, Wyser Y. Recent innovations in barrier technologies for plastic packaging—a review. *Packag Technol Sci*. 2003;16(4):149-158. doi:10.1002/pts.621
30. Biji KB, Ravishankar CN, Mohan CO, Srinivasa Gopal TK. Smart packaging systems for food applications: a review. *J Food Sci Technol*. 2015;52(10):6125-6135. doi:10.1007/s13197-015-1766-7
31. Nilsson HE, Unander T, Siden J, et al. System integration of electronic functions in smart packaging applications. *IEEE Trans Compon, Packag Manufact Technol*. 2012;2(10):1723-1734. doi:10.1109/TCPMT.2012.2204056
32. Farmer N. *Trends in Packaging of Food, Beverages and Other Fast-Moving Consumer Goods (FMCG)*. Woodhead Publishing Limited; 2013. doi:10.1533/9780857098979
33. Meroni A. Active packaging as an opportunity to create package design that reflects the communicational, functional and logistical requirements of food products. *Packag Technol Sci*. 2000;13(6):243-248. doi:10.1002/pts.524
34. Quintavalla S, Vicini L. Antimicrobial food packaging in meat industry. *Meat Sci*. 2002;62(3):373-380. doi:10.1016/S0309-1740(02)00121-3
35. Vanderroost M, Ragaert P, Devlieghere F, De Meulenaer B. Intelligent food packaging: the next generation. *Trends Food Sci Technol*. 2014; 39(1):47-62. doi:10.1016/j.tifs.2014.06.009
36. Poyatos-Racionero E, Ros-Lis JV, Vivancos JL, Martínez-Máñez R. Recent advances on intelligent packaging as tools to reduce food waste. *J Clean Prod*. 2018;172:3398-3409. doi:10.1016/j.jclepro.2017.11.075
37. Wyser Y, Adams M, Avella M, et al. Outlook and challenges of nanotechnologies for food packaging: outlook and challenges of nanotechnologies for food packaging. *Packag Technol Sci*. 2016;29(12):615-648. doi:10.1002/pts.2221
38. Foroudi P, Gupta S, Sivarajah U, Broderick A. Investigating the effects of smart technology on customer dynamics and customer experience. *Comput Hum Behav*. 2018;80:271-282. doi:10.1016/j.chb.2017.11.014
39. Lee I, Lee K. The Internet of Things (IoT): applications, investments, and challenges for enterprises. *Bus Horiz*. 2015;58(4):431-440. doi:10.1016/j.bushor.2015.03.008
40. Bertin E, Crespi N, Magedanz T. *Evolution of Telecommunication Services: The Convergence of Telecom and Internet: Technologies and Ecosystems*. Vol. 7768. Springer; 2013. doi:10.1007/978-3-642-41569-2
41. Comber R, Choi JH, Hoonhout J, O'Hara K. Designing for human–food interaction: an introduction to the special issue on 'food and interaction design'. *Int J Hum Comput Stud*. 2014;72(2):181-184. doi:10.1016/j.ijhcs.2013.09.001
42. Velasco C, Spence C (Eds). *Multisensory Packaging: Designing New Product Experiences*. Springer International Publishing; 2019. doi:10.1007/978-3-319-94977-2
43. Petit O, Velasco C, Spence C. Multisensory consumer-packaging interaction (CPI): the role of new technologies. In: *Multisensory Packaging*. Springer; 2019:349-374. doi:10.1007/978-3-319-94977-2_13
44. Petit O, Cheok AD, Spence C, Velasco C, Karunanayaka KT. Sensory marketing in light of new technologies. In: *Proceedings of the 12th International Conference on Advances in Computer Entertainment Technology – ACE'15*. Association for Computing Machinery; 2015:1-4. doi:10.1145/2832932.2837006
45. Vehmas K, Georgoulas S, Krco S, Hakola L, Larizgoitia Abad I, Gligoric N. *A Smart Tags Driven Service Platform for Enabling Ecosystems of Connected Objects. Cognitive Hyperconnected Digital Transformation Internet of Things Intelligence Evolution*. River Publishers; 2018.
46. BBC News. Amazon stops selling Dash buttons. BBC News. March 1, 2019. Accessed September 18, 2020. https://www.bbc.co.uk/news/technology-47416440
47. Gosh S. How Absolut Vodka will use the Internet of Things to sell more than static pieces of glass. Campaignlive. 2015. Accessed December 18, 2022. https://www.campaignlive.co.uk/article/absolut-vodka-will-use-internet-things-sell-static-pieces-glass/1359043
48. Newgarden M. *Cheap Laffs: The Art of the Novelty Item*. Harry N Abrams Incorporated; 2004.
49. Hanlon JF, Kelsey RJ. *Handbook of Package Engineering*. CRC Press; 1998. doi:10.1201/b18045
50. Pecht M. *Handbook of Electronic Package Design*. CRC Press; 2018. doi:10.1201/9781315214085
51. Stern W. *Handbook of Package Design Research*. John Wiley & Sons; 1981.
52. Carli Lorenzini G, Olsson A. Towards patient-centered packaging design: an industry perspective on processes, functions, and constraints. *Packag Technol Sci*. 2019;32(2):59-73. doi:10.1002/pts.2419
53. Candy L, Costello B. Interaction design and creative practice. *Des Stud*. 2008;6(29):521-524. doi:10.1016/j.destud.2008.07.002
54. Ng KH, Shipp V, Mortier R, Benford S, Flintham M, Rodden T. Understanding food consumption lifecycles using wearable cameras. *Pers Ubiquit Comput*. 2015;19(7):1183-1195. doi:10.1007/s00779-015-0871-y
55. Paay J, Kjeldskov J, Skov MB. Connecting in the kitchen: an empirical study of physical interactions while cooking together at home. In: *Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing – CSCW'15*. ACM Press; 2015:276-287. doi:10.1145/2675133.2675194
56. De Léon D. Actions, artefacts and cognition: an ethnography of cooking. Lund University Cognitive Studies. 2003;104.
57. Crabtree A, Tolmie P. A day in the life of things in the home. In: *Proceedings of the 19th ACM Conference on Computer-Supported Cooperative Work & Social Computing – CSCW'16*. ACM Press; 2016:1736-1748. doi:10.1145/2818048.2819954
58. Kuznetsov S, Santana CJ, Long E. Everyday food science as a design space for community literacy and habitual sustainable practice. In: *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*. ACM; 2016:1786-1797. doi:10.1145/2858036.2858363
59. Hyland L, Crabtree A, Fischer J, Colley J, Fuentes C. "What do you want for dinner?" – need anticipation and the design of proactive technologies for the home. *Comput Supported Coop Work*. 2018; 27(3–6):917-946. doi:10.1007/s10606-018-9314-4
60. Wagner J, Ploetz T, van Halteren A, et al. Towards a pervasive kitchen infrastructure for measuring cooking competence. In: *Proceedings of the 5th International ICST Conference on Pervasive Computing*

Technologies for Healthcare. IEEE; 2011. doi:10.4108/icst.pervasivehealth.2011.246101
61. Wang WC, Worsley A. How often do we use cooking utensils? An exploratory study. *J Culin Sci Technol*. 2014;12(4):326-338. doi:10.1080/15428052.2014.904834
62. Terrenghi L, Hilliges O, Butz A. Kitchen stories: sharing recipes with the Living Cookbook. *Pers Ubiquitous Comput*. 2007;11(5):409-414. doi:10.1007/s00779-006-0079-2
63. Chi P-Y, Chen J-H, Chu H-H, Chen B-Y (Eds). Enabling nutrition-aware cooking in a smart kitchen. In: *CHI'07 Extended Abstracts on Human Factors in Computing Systems*; 2007:2333-2338. doi:10.1145/1240866.1241003
64. Sato A, Watanabe K, Rekimoto J. MimiCook: a cooking assistant system with situated guidance. In: *Proceedings of the 8th International Conference on Tangible, Embedded and Embodied Interaction*. Association for Computing Machinery; 2014:121-124. doi:10.1145/2540930.2540952
65. Fuentes C, Porcheron M, Fischer JE, Costanza E, Malilk O, Ramchurn SD. Tracking the consumption of home essentials. In: *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems – CHI'19*. ACM Press; 2019:1-13. doi:10.1145/3290605.3300869
66. Verame JKM, Costanza E, Fischer J, et al. Learning from the Veg Box: designing unpredictability in agency delegation. In: *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems – CHI'18*. ACM Press; 2018:1-13. doi:10.1145/3173574.3174021
67. Glesne C. *Becoming Qualititave Researchers: An Introduction (5 b.)*. Pearson Education; 2015.
68. Geertz C. Thick description: toward an interpretive theory of culture. In: *Turning Points in Qualitative Research: Tying Knots in a Handkerchief*. Routledge; Vol.3; 1973:143-168.
69. Crabtree A, Rouncefield M, Tolmie P. *Doing Design Ethnography*. Springer London; 2012. doi:10.1007/978-1-4471-2726-0
70. Garfinkel H. Studies of the routine grounds of everyday activities. *Soc Probl*. 1964;11(3):225-250. doi:10.2307/798722
71. Wever R. Touching tubs and grabbing gable-tops: an editorial to the special issue on human-packaging interaction. *Packag Technol Sci*. 2016;29(12):603-606. doi:10.1002/pts.2192
72. Carlsson-Kanyama A, Ekström MP, Shanahan H. Food and life cycle energy inputs: consequences of diet and ways to increase efficiency. *Ecol Econ*. 2003;44(2–3):293-307. doi:10.1016/s0921-8009(02)00261-6
73. Dourish P. Implications for design. In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. Association for Computing Machinery; 2006:541-550. doi:10.1145/1124772.1124855
74. Baskerville RL, Myers MD. Design ethnography in information systems. *Inf Syst J*. 2015;25(1):23-46. doi:10.1111/isj.12055
75. Stolterman E. The nature of design practice and implications for interaction design research. *Int J des*. 2008;2(1):55-65.
76. Crabtree A, Rodden T, Hemmings T, Benford S. Finding a place for UbiComp in the home. In: *International Conference on Ubiquitous Computing*. Springer; 2003:208-226. doi:10.1007/978-3-540-39653-6_17
77. Rapp A. In search for design elements: a new perspective for employing ethnography in human-computer interaction design research. *Int J Hum-Comput Int*. 2020;1-20. doi:10.1080/10447318.2020.1843296
78. Khan MA, Shahid MHB, Mansoor H, et al. IoT based grocery management system: smart refrigerator and smart cabinet. In: *2019 International Conference on Systems of Collaboration Big Data, Internet of Things & Security (SysCoBIoTS)*. IEEE; 2019:1-5. doi:10.1109/SysCoBIoTS48768.2019.9028031
79. Loop. Loop. Loop, Design for reuse. Accessed June 18, 2022. https://exploreloop.com/
80. Kotonya G, Sommerville I. *Requirements Engineering: Processes and Techniques*. John Wiley & Sons, Inc.; 1998.
81. Jones R. Experience models: where ethnography and design meet. *EPIC Proceedings*. 2006;2006(1):82-93. doi:10.1111/j.1559-8918.2006.tb00038.x
82. Blomberg DJ, Karasti H. Ethnography: positioning ethnography within participatory design. In: *Routledge International Handbook of Participatory Design*. Routledge; 2012:106-136. doi:10.4324/9780203108543.ch5
83. Carpendale S. Evaluating information visualizations. In: *Information Visualization*. Springer; 2008:19-45. doi:10.1007/978-3-540-70956-5_2
84. Huang D, Tory M, Aseniero BA, et al. Personal visualization and personal visual analytics. *IEEE Trans vis Comput Graph*. 2014;21(3):420-433. doi:10.1109/mcg.2015.88
85. Sanders EBN, Brandt E, Binder T. A framework for organizing the tools and techniques of participatory design. In: *Proceedings of the 11th Biennial Participatory Design Conference*. Association for Computing Machinery; 2010:195-198. doi:10.1145/1900441.1900476
86. Twidale M, Randall D, Bentley R. Situated evaluation for cooperative systems. In: *Proceedings of the 1994 ACM Conference on Computer Supported Cooperative Work – CSCW'94*. ACM Press; 1994:441-452. doi:10.1145/192844.193066
87. Neyland D. An ethnography of numbers. In: *A Companion to Organizational Anthropology*. 1st ed. Blackwell Publishing; 2013:219-235.
88. Rousseau DM. Is there such a thing as "evidence-based management"? *Acad Manage Rev*. 2006;31(2):256-269. doi:10.5465/amr.2006.20208679
89. Ministry of Economy Trade and Industry. Declaration of plan to introduce 100 billion electronic tags for products in convenience stores formulated. 2017. METI. Accessed September 22, 2020. https://www.meti.go.jp/english/press/2017/0418_003.html
90. EPS B, Silberman MS. When the implication is not to design (technology). In: *Proceedings of the 2011 Annual Conference on Human Factors in Computing Systems – CHI'11*. Vol.2011. ACM Press:2271. doi:10.1145/1978942.1979275
91. Taylor AS, Swan L. Artful systems in the home. In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems – CHI'05*. ACM Press; 2005:641. doi:10.1145/1054972.1055060
92. Wakkary R, Maestri L. Aspects of everyday design: resourcefulness, adaptation, and emergence. *Int J Hum-Comput Int*. 2008;24(5):478-491. doi:10.1080/10447310802142276

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Berumen G, Fischer J, Baumers M. Interactions of fast-moving consumer goods in cooking: Insights from a quantitative ethnographic study. *Packag Technol Sci*. 2022;1-15. doi:10.1002/pts.2710