Kansei Engineering methodology to support the development of a packaging-free area

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Abstract: Facing an informed, conscious and increasingly demanding society and also a market saturated with identical products, companies feel the need to offer innovative and attractive solutions, capable to impact the consumers on their first contact with the product. The technological progress along with a competitive market have resulted in a consumer-oriented philosophy adopted by many companies. Kansei Engineering emerged in Japan as an attempt to understand the affective needs of the consumer and relate them with specific properties of the product. Since this methodology has been little explored in western countries, this study intends to provide an overview of what Kansei and Kansei Engineering are and apply this methodology for the development of a 'packaging-free area', namely a self-service dispenser system, to be available in supermarkets chains for the Cerealis Group. Statistical methods such as Binary Logistic Regression and Multiple Regression Analysis were used to quantify the relationship between the consumers' perceptions and the 'packaging-free area' properties and thus obtain design guidelines. Other techniques such as Factor Analysis, perceptual maps and Conjoint Analysis were used to complement the results obtained before, in order to provide more consistent design recommendations. Kansei Engineering demonstrated to be a powerful technique and the outcome of this study can be useful for industries interested in developing or improving similar products.

Keywords: Kansei Engineering, Emotional design, Product Development, Multivariate Methods, Packaging-free area

1. Introduction

Due to the fast technological changes, companies have been dealing with much more informed and increasingly sophisticated consumers. The production centered in making cheap products in great quantities is not anymore enough to be successful in the market, and product development began to take another direction, aiming not so much the product itself, but mainly the consumer (Marco-Almagro, 2011; Schütte, 2002). Furthermore, as there is in the market a vast offer of equivalent products capable of satisfying the functional needs, consumers are more interested in the aesthetics and the emotional appeal (Chen & Luh, 2020; Schütte et al., 2004). Designers, producers, engineers need to find a way to conciliate what is tangible (product properties) with what is intangible (feelings and emotions) in order to create successful attractive products (Lee et al., 2002).

Kansei Engineering (KE), in the area of ergonomics and emotional design, seems to be a very promising solution (Axelsson et al., 2001), as it integrates techniques from different fields such as psychology, statistics and marketing, to understand the consumer's emotional perceptions and preferences and to study the relationship between the emotions and the different properties of the product, in order to obtain innovative and engaging solutions (Lanzotti & Tarantino, 2007; Schütte, 2002).

2. Literature Review

2.1 What is Kansei and Kansei Engineering

Kansei is a Japanese term, with no direct translation to other languages, which has been used in diverse areas such as psychology, philosophy, art and design. Regarding Kansei Engineering, it may be defined as a psychological feeling and image evoked by the properties of a product (Lee et al., 2002; Lévy & Yamanaka, 2006; Nagamachi, 1995, 1999). As Kansei involves emotion, intuition, perception, image and behavior, its communication is made through any artefact connected with the five senses, for example words, facial expressions or drawings (Nagamachi & Lokman, 2011; Nagasawa, 2002). Kansei Engineering was developed at Hiroshima University in Japan in the early 1970s by Mitsuo Nagamachi and has slowly been implemented all over the world. Its methodology begins with the study the of consumer's feelings and emotions and then incorporates them into existing products or into new product design specifications (Lévy, 2013; Nagamachi & Lokman, 2011; Nagasawa, 2002; Schütte, 2002). In the 1980s, the first major success of a KE application was in the automobile industry with the development of the MX-5 Miata sports car by the Japanese manufacturer Mazda (Nagamachi, 1999; Nagamachi et al., 2006; Schütte et al., 2004). Thereafter, Nagamachi was involved in more successful applications of KE, such as a shampoo for Milbon, a video camera for Sharp, a brassiere for Wacoal, an aircraft for Boeing, a kitchen design for Panasonic (Nagamachi, 2002b, 2018). KE methodology was also applied in companies from different industries such as Nissan, Hyundai and Ford, in the automobile industry, Samsung and Panasonic, in the electronic and domestic industry (Lévy, 2013; Nagamachi, 2002a). In the 2000s, KE methodology was extended beyond product development having been applied in services and digital areas too.

Schütte (2006) states that there are three main steps considered crucial for the success of KE products in the market (Lokman, 2010), as follows: Semantic Structure Identification (SSI) where semantic descriptors, known as Kansei words, are associated to customers' feelings and emotions regarding a specific product; Physical Structure Identification (PSI), where the product's properties that may influence the customers' preferences are identified; and Relationship Identification (RI), where the semantic and physical domains are associated. Nevertheless, more steps are necessary to clarify and perform this methodology (Schütte, 2006). Figure 1 shows the general model, proposed by Schütte (2005).

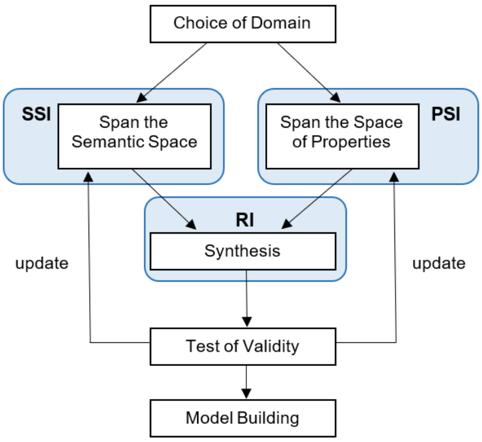

Figure 1: Proposed model for Kansei Engineering (Adapted from: Schütte, 2005, 2006)

Each product requires a specific KE study. Therefore, in this initial phase, it is important to define clearly the product domain, taking into consideration the product involved in the study and its corresponding target group (Schütte et al., 2004). After gathering this information, a sample of existing products or their pictures that meet the domain should be collected (Schütte, 2005; Schütte et al., 2004). Then the product is analysed both in terms of Semantic and Properties Spaces. To span the Semantic Space it is necessary to collect as many words as possible that emotionally describe the product under study, called low-level Kansei words (Marco-Almagro & Tort-Martorell, 2012; Schütte, 2005). Most of the Kansei words are adjectives, but other grammatical categories, such as verbs or nouns, are also possible (Schütte, 2005). Afterwards, a reduction of the low-level Kansei words will be done, i.e. they will be grouped together forming the high-level Kansei words. Qualitative methods such as experts, affinity diagram and focus group (Ayas et al., 2008; Marco-Almagro, 2011) and quantitative methods such as Principal Component Analysis (PCA), Factor Analysis (FA) and Cluster Analysis can be used to reduce the Semantic Space. (Schütte, 2005; Marco-Almagro, 2011). This phase ends with compiling the data in which the Semantic Space is finally defined and a list of the final Kansei words is obtained. Similarly, to perform the 'Span the Space of Properties' phase it is firstly necessary to collect and list, from a wide range of sources, the different properties of the chosen product. An item/category list should be also done, i.e. for each product property a certain number of categories should be established (Nagamachi et al., 2008). Subsequently, the selected product properties are reduced based, for example, on questionnaires made to potential users, focus groups, designers or experts. The final items and corresponding categories should be organised in a table, called the design matrix, which will be the support during the next step (Marco-Almagro, 2011; Schütte et al., 2004). Finally, the data is compiled, i.e. a sample of products, prototypes or existing products is obtained according to the selected properties and after the design matrix is defined (Schütte, 2005).

In the Synthesis phase the two spaces are merged together, i.e. for each high-level Kansei word one or several properties are associated. This can be done through qualitative methods such as Category Quantification (KE Type I) or quantitative methods such as Quantification Theory Type I, Multiple Regression Analysis (MRA), Ordinal Logistic Regression (OLR) and Partial Least Squares (Marco-Almagro, 2011; Schütte, 2005; Schütte et al., 2004). Afterwards, a Test of Validity is then performed and if the results obtained are satisfactory the final model is ready to be presented (Ishihara et al., 2008; Schütte, 2005).

Marco-Almagro (2011) and later Alves (2018) make some suggestions to the initial model proposed by Schütte (2005): the 'compiling the data' step, existing in both Semantic and Properties Spaces, should be put together in a single phase, called 'Data Collection', and should take place before the Synthesis; the last phase 'Model Building' should be called 'Presentation of Results' as it will give new design guidelines and suggestions in a simple and clear way.

2.2 Recent Reviewed Studies

In this subsection, reviewed studies (38) are presented to illustrate the various phases of the KE methodology proposed by Schütte (2005) and also the new phase 'Data Collection' suggested by Marco-Almagro (2011). Generally, the studies deal with tangible products (Hartono, 2012, 2016; Hsiao et al., 2017; Xiao et al., 2015). Recently, however, there has been a bigger interest in applying KE methodology to intangible products, i.e. services. In the literature reviewed, studies on 'bulk concept' and 'packaging-free area' were not found. From the 38 articles selected 66% focus on products, while 34% focus on services, most of them following the general model proposed by Schütte (2005). In order to reduce the Semantic Space approximately 74%, i.e. 28 of the reviewed studies, used qualitative methods, 29% used quantitative methods and 21% used both methods. In approximately 21% of the studies, the first reduction consisted in removing the words that were repeated and/or had identical meaning (Xiao et al., 2015; Hsu et al., 2017; Yeh & Chen, 2018; Lin et al., 2020). Afterwards, as suggested by Schütte (2005) and Marco-Almagro and Tort-Martorell (2012), approximately 26% of the studies used affinity diagrams to continue removing words. Only a few number of the reviewed studies used quantitative methods such as FA and/or PCA and Cluster Analysis (e.g. Chang & Chen, 2016; Habyba et al., 2018; Hsu et al., 2017; Karomati et al., 2019; Guo et al., 2020). Once the list of words is reduced, the Semantic Space is finally obtained. In the reviewed articles approximately 45% used up to 10 Kansei words. To span the Properties Space the different product properties were mainly obtained through websites, surveys, books, magazines, previous related studies, relevant literature, existing product samples and experts' opinion. Subsequently, to reduce the list of properties, approximately 55% of the studies used qualitative methods such as focus group, experts' opinion and affinity diagram, while only approximately 8%, i.e. three studies, used quantitative methods. As suggested by Marco-Almagro (2011), the 'compiling the data' step should be considered independent from the Spanning phases, though it may contribute to a second reduction of both Semantic and Properties Spaces. However, in most of the reviewed studies, the methodology used was the one proposed by Schütte (2005), i.e. the reduction of the Kansei words and product properties was mainly done in both Spanning phases. Most of the articles reviewed used between 10 and

19 samples (existing images or prototypes) to build questionnaires for data collection. In order to assess participants' impressions and feelings, their Kansei, all the 38 reviewed studies used rating methods, such as the Visual Analogue Scale, the Semantic Differential (SD) scale or the Likert Scale. In the reviewed studies approximately 21%, i.e. eight studies, implemented the QT1 tool, 8%, i.e. three studies, used MRA and 8% used OLR. Although it is not referred as the most common tool, in the reviewed studies approximately 24%, i.e. nine studies, opted for the Partial Least Squares.

Studies in Portugal: In Portugal there are only a few studies. For example, the one done by Vieira et al. (2017) where the KE methodology was applied to the study of in-vehicle keypads and provide guidelines to improve their design according to consumers' perceptions. Santos(2012), in the clothing area, carried out a study for the development of a new ergonomic uniform for an airline cabin crew. In the beverage industry, Balduino (2012) and Alves (2018) applied the KE methodology in the analysis of tea types consumption and in the development of a water bottle design, respectively. Carreira (2012) applied the KE methodology to study a new bus design and transportation service elements. Neto (2014), in his theoretical master thesis, investigated concepts related to the development of a product in terms of quality and design using KE methodology.

2.3 The concept of bulk sale

At the beginning of the 19th century the sale of food products in bulk was quite common (Johnson, 1984). As a response to the development and subsequent globalisation of supply chains and a more convenient way of selling/buying products, the preference for single-use packaging rapidly increased (Coelho et al., 2020; Johnson et al., 1985). Packaging contributes to a safer products' circulation from supply chains to consumers. However, lately it has been criticised due to the large amounts of plastic used in its production (Coelho et al., 2020; Geyer et al., 2017; Hawkins, 2018). Today, consumers are more aware of the serious environmental problems they face (Lindh et al., 2016) and replacing single-use packaging by reusable packaging has been seen as a sustainable solution to reduce environmental impacts (Rapp et al., 2017). Selling food through dispenser systems does not only helps to reduce the amount of packaging used in the retail sector, but also allows consumers to choose only the desired quantities, reducing food waste. In Portugal, there are already some shops selling in bulk. In order to make it easier for the consumers to find this type of shops the website "a granel" was created. At the moment, according to this website, there are 204 shops selling in bulk.

3. Case Study

Amorim Lage, currently known as Cerealis, is a Portuguese group, founded in 1919 with activity in the industrial and commercial agro-food industry. Cerealis Group is, at a national level, a reference in the agro-food sector with 46% market share in value (10% owned by Nacional brand and 36% by Milaneza brand). Internationally, it exports to more than 40 countries all over the 5 continents. With the emerging concern on the environmental impact and the reduction of the ecological footprint, taking also into account the carbon neutrality goals that the company has to achieve, they intend to make some adaptations to the product packaging design. Among different possibilities and in agreement with them, KE methodology is going to be applied in the development of a 'packaging-free area'. Presently, Milaneza has at the end of the aisles of some supermarkets a so-called 'Topo' as shown on the left side of figure 2. The goal of the study is to apply the KE methodology to develop a 'packaging-free area', including a self-serve dispenser system similar to the one on the right side of figure 2.

Figure 2:Milaneza 'Topo' model and self-dispenser system

4. Methodology

As shown in figure 3, the KE methodology adopted is based on the model proposed by Schütte (2005, 2006) and the suggestions done by Marco-Almagro (2011) and Alves (2018). As suggested by Alves (2018), the 'Data Collection' phase, used in Marco-Almagro (2011) model, is renamed 'Collecting and Compiling the Data' and the 'Model Building' phase in Schütte (2005) model is renamed 'Final Model', since the results obtained are presented as design guidelines to the company, as suggested by Marco-Almagro (2011) and Alves (2018).

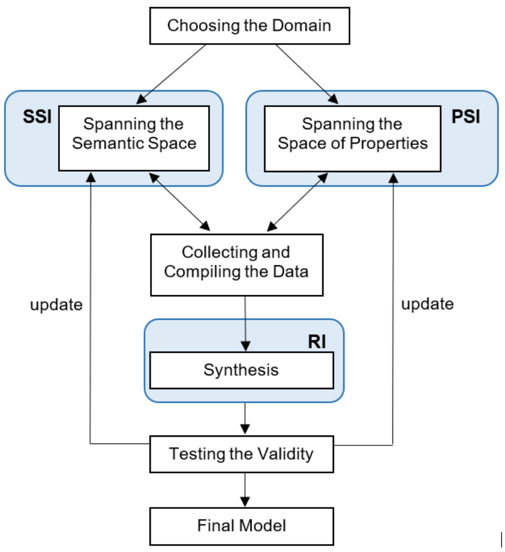

Figure 3:Proposed KE Methodology (Adapted from: Schütte, 2005, 2006; Marco-Almagro, 2011; and Alves, 2018)

Choosing the Domain: In the first step, the product under study is presented as well as the target group defined by Cerealis company. A sample of existing pictures of the product is mainly obtained from websites, online news and social networks.

Spanning the Semantic Space: This phase starts by **(1)** collecting the low-level Kansei words (KWs) and afterwards by **(2)** reducing the number of KWs. In step **(1)**, since studies on this specific product domain were not found, most of the KWs collected came from different online source such as: Cerealis Group and Milaneza websites, Cerealis Facebook page and Instagram profile, bulk dispensers websites, blogs, news and articles from magazines and journals. Some KE studies on packaging design, two Portuguese master thesis regarding bulk sale were also selected (Costa, 2018; Ribeiro, 2018).

Marco-Almagro (2011), who thinks that it is important to include in this step the final consumers, suggests the use of focus groups. Usually they consist of 6 to 8 consumers who are invited to discuss a particular topic under the orientation of a moderator (Krueger & Casey, 2002). Following this idea and in order to cover the whole target group already defined, two sessions were organized to complete the low-level KWs collection. Subsequently, in step **(2)**, the reduction followed the most used techniques in the 38 reviewed studies. Firstly, a preliminary analysis was done where duplicates, similar and non-applicable words were eliminated. Then, an affinity diagram was used in order to reduce the number of KWs by grouping them according to their similarity (Marco-Almagro, 2011; Schütte, 2005). Finally, a discussion with the company allowed to define the high-level KWs.

Spanning the Properties Space: Similarly**,** this phase includes **(1)** collecting the product properties, **(2)** reducing the collected properties and **(3)** collecting a sample of products according to the design matrix. In step **(1)** some KE studies on packaging design such as confectionery packaging (Longstaff et al., 2007), organic cereal packaging (Zhang, 2013), chocolate bar packaging (Ghiffari et al., 2018; Maleki et al., 2019) were considered as well as the feasibility study of self-dispensing systems (WRAP, 2007). It was also used the dry food dispenser catalogue from the IDM manufacturer and the research paper "Consumer perceptions of product packaging" (Ampuero & Vila, 2006). From the Milaneza 'topo' figure it was possible to collect some properties and also from the product samples collected in the Choosing the Domain. Finally, as in some of the reviewed studies, a morphological analysis was used to decompose the product and organize its properties into an item-category list (e.g. Hou et al., 2019; Ren et al., 2019; Guo et al., 2020). In step **(2)** the focus group carried out in the Spanning the Semantic Space phase was analysed and it was possible to identify some of the items that the participants considered important for the 'packaging-free area'. After this analysis, the item-category was presented to two graduates, one with a degree in Marketing and the other in Design, and they were asked to choose some items that would have the biggest impact on the consumer. As the 'packaging-free area' will be implemented by Cerealis Group in some supermarket chains, there might be some restrictions. In this sense, the commercial director of the company was contacted to critically analyse the main items selected before by the focus group and the two specialists as well as to give their opinion and suggestions in order to take the final decision. In step **(3)** a final sample of products (existing in the market or prototypes) which covers the item-category list was selected.

Collecting and Compiling the Data: In a first step, is necessary to define how to present the online questionnaire where participants will have to evaluate the product on the basis of the different high-level KWs. In this case the questionnaire was divided in five sections: i) demographic information; ii) to understand if the participants are familiar with the bulk concept; iii) to rate the different 'packaging-free area' layouts for the different KWs; iv) to evaluate the importance of each KW; v) to understand if participants are willing to buy pasta in 'bulk' in a hypermarket/supermarket. As the quality of the data collected in the 1st questionnaire was considered not suitable to proceed with the analysis in the next phase, a 2nd questionnaire was needed; a question was added in section iii) where participants had to rank the different layouts according to their preference.

Synthesis: Connection between the product properties and the high-level KWs through statistical methods as MRA and BLR and the subsequent interpretation of the relationships obtained.

Testing the Validity: Most of the studies reviewed do not carry out this phase. In order to confirm the results, a prototype of the product under study and a new questionnaire to final consumers should be created. Due to time constraints this phase was not done in the present study.

Final Model: Finally, design guidelines/strategies are presented to the company in order to develop a 'packaging-free area' to better accomplish the consumers' feelings and emotions.

In addition, to improve the traditional KE analysis, perceptual maps were used to visualize how respondents had perceived the prototypes. Those maps were based on the average factor scores of all respondents on each of the dimensions obtained in the FA. Then a Conjoint Analysis was performed, using the preference scores of each respondent regarding each product prototype, which allowed a better understanding of their preferences as well as what items had the greatest weight.

5. Analysis and Results

<u>Choosing the Domain</u>

In order to minimise the environmental impact of the use of packaging, Cerealis Group has proposed the development of a 'packaging-free area' to be available in the Portuguese supermarket chains. Among the different brands of the company, Milaneza seemed to be the most suitable for this project due to its popularity, being also considered the number one in the pasta market in Portugal. Cerealis defined that the target group for the 'packaging-free area' would essentially be middle and upper middle class shoppers living in big cities, such as Lisbon and Porto, aged from 18 up to 54. Afterwards, a sample of existing 'packaging-free area' pictures was obtained.

<u>Spanning the Semantic Space</u>

A total of 433 low-level KWs were selected, most of them from different online sources and also from the reviewed KE studies and the two focus group sessions. After the low-level KWs collection, it was necessary to reduce the list. Firstly, a preliminary analysis was done where duplicates, similar and non-applicable words were eliminated. This way, the number of KWs was reduced to 157. Secondly, an affinity diagram was applied to a focus group of 8 consumers (4 men and 4 women), all matching the target group, and the researcher acting as the moderator. At the end of the session, 8 groups of words and their headers, i.e. the high-level KWs, were obtained. Finally, a meeting with the company was scheduled to validate the results. The final KWs were thus reduced to six, namely 'Appealing', 'User-Friendly', 'Hygienic', 'Relaxing', 'Creative' and 'Elegant'.

<u>Spanning the Properties Space</u>

As for the Semantic Space, it was necessary to collect all possible items of a 'packaging-free area' from many different sources. From the sources mentioned in the

Methodology section, an item-category list was organized which resulted in 34 product items. From the focus group carried out in the Spanning the Semantic Space phase, it was possible to identify some of the items that the participants considered important for the ‘packaging-free area’. In short, the items with the greatest impact on the participants were: the material of the structure where the dispensers are attached to, the type, the colour and transparency level of the dispensers, the number of dispenser levels, the weighing scale, the instructions panel and the bulk bag to collect the food. After this, a list of the 34 product properties was presented to two specialists and they were asked to choose about ten items which would have the biggest impact on the consumer. The following properties were selected: the weighing scale, the number of dispenser levels, the type of dispensers, the transparency level of the dispensers, the location of the brand label, the material of the structure, the aiding shelf, the material of the recipient and the instructions panel. As referred before, the company was asked to analyse the main items selected by the focus group and the two specialists. This way, five final properties with two categories associated to each were selected: ‘Weighing scale and instructions panel location’ (middle; left); ‘Number of dispenser levels’ (1; 2); ‘Aiding shelf’ (yes; no); ‘QR code’ (yes; no); ‘Dispensers shape’ (rectangular; cylindrical).

At this point, it is necessary to select a sample of products (existing images or prototypes) that will be rated in the SD questionnaire (Schütte, 2005). This sample should be determined according to a design matrix, which indicates the number of products to be presented in the questionnaire and how they vary within each property. Having selected five key product items and the respective two categories, 32 possible design combinations, according to a 2^5 full factorial design, were obtained. However, due to cost and time constraints it was impossible to work with that number of combinations. To overcome this problem and still maintaining the orthogonality between designs, the Taguchi’s Orthogonal Arrays (OA) method was applied (Guo et al., 2016; Chen et al., 2017; Alves, 2018) . This method helps to reduce the number of products by identifying the minimum optimal combinations of properties (Chen & Chuang, 2008; et al., 2005; Marco-Almagro, 2011). Having defined the design matrix, prototypes representing the eight generated designs were created using the Computer-Aided Design software AutoCAD.

Analysis of the 1st Questionnaire

An online questionnaire was built to collect consumers’ emotions and feelings about the ‘packaging-free area’ using a 7- point SD scale for the evaluation of each KW. For this research, a non-probabilistic convenience sampling was used, in which respondents are willing to spend time to complete the survey (Creswell, 2014). As suggested by Almagro (2011) a pre-test was done, where the questionnaire was presented to 15 persons. The aim is to highlight potential doubts, test the order of the questions, and their level of clearness. Subsequently, as no comments were received, the questionnaire was launched. It was active between 23th October and 4th November and a total of 221 replies were received. After a first data screening, it was found that about 30% of the participants used, for each KW, only one point of the scale to rate the 8 prototypes or used a zig-zag pattern by varying between 2 points in a row, for example “3,4,3,4”. In addition, about 20% used always the same two points on the 7-point SD scale. Therefore, it was decided not to proceed with only about half of the data. In order to understand why the quality of the data was not as expected, some of the participants (who had not participated in the pre-test) were contacted to evaluate the questionnaire and a second questionnaire was prepared. As some of the participants had completed the 1st questionnaire via mobile phone, they found it difficult, due the screen size, to see the differences between the images and to classify the six KWs. Others used the computer, where the images were more visible but even so, they mentioned that the differences between images were not clear, namely the differences on the dispensers shape, between rectangular and circular shapes. As respondents also found it difficult to classify the KW ‘Relaxing’ this was eliminated. Nevertheless, a preliminary analysis of the responses of the remaining participants was made to get additional insights on what could be improved. The six KW models were estimated by applying stepwise multiple regression to the data from the 1st questionnaire. It was found that the location of the weighing scale and instructions panel, and the dispensers shape did not have an impact on any of the KWs.

Elaboration of the 2nd Questionnaire

It was decided to maintain the three items that had some statistical impact on the KWs, i.e. the number of dispenser levels, the aiding shelf and the QR code from the 1st questionnaire. Regarding the dispensers shape, it was decided to substitute this category by the type of bulk bags which were classified in non-reusable (paper bags) and reusable (paper and cotton bags) categories, the latter at a symbolic cost. Regarding the weighing scale and instructions panel, it was decided to understand whether the weighing scale and instructions panel is really an important item in the ‘packaging-free are’ by testing the option of “Yes” or “No”. Having selected the final product items and the respective two categories, the Orthogonal Array method was applied and a design matrix with a total of eight entries was produced. Subsequently, these eight prototypes were created with labels to highlight the differences between them to be shown to participants in the 2nd questionnaire. The online questionnaire was open for ten days starting on 21st November and was shared via Facebook, WhatsApp and email. Participants were advised not to use their mobile phones to fill the questionnaire. A total of 119 out of 130 valid responses were obtained in which 65.5% of respondents were women and 34.5% were men. The majority of them, 91.6%, belonged to the target group aged between 18 and 54 years and 67.2% had a bachelor’s degree. Regarding the occupation, 47% were employees and 10.9% were self-employed. The remaining, 32.8% were students and 9.2% did not work. Most of the participants, 61.3%, had a monthly net income of more than 3,001€. It could also be said that 52.9% of the respondents had households consisting of 4 or more persons, 29.4% only of 3 persons and 17.6% of 1 or 2 persons. According to the target group, the majority of respondents lived in large cities, 57.1% in Porto and 32.8% in Lisbon. In addition, some questions were asked about the sale of bulk products where it can be concluded that 61.3% of respondents have already bought bulk products, 79% have already seen products being sold in bulk and 79.8% usually buy pasta in supermarkets. At the company's request, consumers were asked if they do their shopping through the hypermarket app or website and the majority (74.8%) do not shop online. In the last question respondents were asked if they would be willing to take their own bag from home and 80.7% answered yes. According to the ranking made by participants prototype H was the preferred with an average score of 6.04, followed by prototype G (5.39), E (5.05), F (5.02), A (4.58 points), C (4.27 points), D (3.17 points) and finally the least preferred was prototype B with an average score of 2.45.

The last two sections of the questionnaire assessed the importance of each KW regarding the product under study and also the consumers' perceptions when buying pasta in 'bulk' and packaged. It was concluded that the most important KWs were 'Hygienic' and 'User-Friendly' with average scores of 6.52 and 6.43 respectively followed by the KWs 'Appealing' (5.94 points), 'Creative' (5.01 points) and 'Elegant' (4.71 points). Furthermore, the majority of respondents (60.5%) totally agreed with the statement "The sale of pasta in 'bulk' is more ecological than the sale of packaged pasta". Regarding the statement "It is cheaper to buy 'bulk' pasta than packaged pasta" the answers were not so evident as only 26.9% of the respondents totally agree. About the last statement, 49.6% of the respondents totally agreed with it.

Synthesis

Some authors applied the QT1 method to link the KWs with product characteristics (eg.g Chen & Chuang, 2008; Hsiao et al., 2010; Smith & Fu, 2011). However, since this method only works with the average of all participants for each KW and prototype, Marco-Almagro (2011) suggested the use of the ordinal logistic regression (OLR) which enables to work with each participant's rating. In order to perform the Synthesis, the five items were recoded into different dummy variables as following: 'WS_IP' (1, if it has weighing scale and instructions panel; 0, if does it not have weighing scale and instructions panel); 'Disp_levels' (1, if it has 1 level; 0, if it has 2 levels); 'AidingShelf' (1, if it has aiding shelf; 0, if it does not have aiding shelf); 'Qrcode' (1, if it has QR code; 0, if it does not have QR code); 'Bag_type' (1, if it has paper bags; 0, if it has paper and cotton bags). A first attempt of applying OLR to the dataset from the questionnaire was done. However, the 'User-Friendly', 'Hygienic', 'Elegant' and 'Creative' models violated the parallel line test. To overcome this inadequacy and as suggested by Marco-Almagro (2011) the binary logistic regression (BLR) was applied. When BLR is applied, the different points of the SD scale are merged into two categories and, in this case, the classifications on the 7-point scale were aggregated into two categories: points 1, 2 and 3 were converted into category 1 and points 4, 5, 6 and 7 into category 2. Accordingly, BLR with stepwise selection method was applied and results are expressed in equations (1)-(5), where only the statistically significant independent variables are presented. It can be seen that all the KW models are able to correctly predict more than 70% of the observations (overall percentage according to its classification table). This demonstrates the utility of the BLR for each KW model, as according to rule proposed by Simonoff (2012), this percentages are above the lower bound calculated for each classification table. For example, the 'Hygienic' model is able to correctly predict 73.8% of the observations, which is slightly above the lower bound (65%) by random estimation. It can also be observed that the variance of the 'Hygienic' model was the best explained (pseudo R^2=30.4%).

$$g(\textbf{User}-\textbf{Friendly}) = 0.181 - 0.626W\_IP + 1.281Disp\_levels + 0.690AidingShelf \quad (1)$$

Overall percentage correctly classified = 70.5%
Pseudo R^2 = 0.156

$$g(\textbf{Appealing}) = -0.717 + 2.042W\_IP + 0.991AidingShlef + 0.890Qrcode \quad (2)$$

Overall percentage correctly classified = 78%
Pseudo R^2=0.285

$$g(\textbf{Hygienic}) = -0.383 + 0.837Disp\_levels + 2.176AidingShlef - 0.554Qrcode \quad (3)$$

Overall percentage correctly classified = 73.8%
Pseudo R^2=0.304

$$g(\textbf{Elegant}) = 1.190 - 1.614W\_IP + 1.047Disp\_levels + 0.469AidingShlef - 0.312Qrcode - 0.343Bag\_type \quad (4)$$

Overall percentage correctly classified = 70.7%
Pseudo R^2=0.221

$$g(\textbf{Creative}) = 0.814 + 1.030W\_IP - 0.703Disp\_levels + 1.284Qrcode - 0.482Bag\_type \quad (5)$$

Overall percentage correctly classified = 76.3%
Pseudo R^2=0.163

In a second stage, as performed in some of the reviewed studies and suggested by Alves (2018), stepwise multiple regression was applied to understand which product items significantly influence each high-level KW and to compare the results to those obtained in the BLR. The result, where only the statistically significant independent variables are displayed, is expressed using equations (6) – (10).

$$Y(\textbf{User}-\textbf{Friendly}) = 3.649 + 1.315Disp\_levels + 0.563AindingShelf - 0.328WS\_IP \quad (6)$$

(R^2_{adj} = 0.158)

$$Y(\textbf{Appealing}) = 3.122 + 1.777WS\_IP + 0.668Qrcode + 0.584AidingShelf - 0.361Bag\_type + 0.231Disp\_levels \quad (7)$$

(R^2_{adj} = 0.321)

$$Y(\textbf{Hygienic}) = 3.013 + 1.895AidingShelf + 0.929Disp\_levels - 0.378Qrcode \quad (8)$$

(R^2_{adj} = 0.358)

$$Y(\textbf{Elegant}) = 4.296 + 1.07Disp\_levels - 1.000WS\_IP + 0.534AidingShelf - 0.286Bag\_type - 0.239Qrcode \quad (9)$$

(R^2_{adj} = 0.202)

$$Y(\textbf{Creative}) = 4.011 + 1.256Qrcode + 0.933WS\_IP - 0.588Disp\_levels - 0.420Bag\_type + 0.290AidingShelf$$

(R^2_{adj} = 0.273) (10)

Results reveal that the explained variance of the KWs remain relatively similar in each KW model for both MRA and BLR methods. The 'Appealing' (R^2=0.321;pseudo R^2=0.285) and 'Hygienic' (R^2=0.358;pseudo R^2=0.304) models were the best predicted. Moreover, the direction of the items for each KW remained constant, for example, one can see that the weighing scale and instructions panel should be included in the design to increase the 'Appealing' and 'Creative' perception, whereas it should be not included to increase the 'User-Friendly' and 'Elegant' perceptions. Notwithstanding, in the BLR method no statistical significance was found for the aiding shelf on the 'Creative' model and for the dispenser levels on the 'Appealing' model. Observing equations (1)-(5), one can see that the QR code should be included in the design to maximize the 'Appealing' and 'Creative' perception, whereas it should be not included to maximize the 'Hygienic' and 'Elegant' perceptions. In the 'User-Friendly' model, as the 'dispenser levels' coefficient assumes a positive value, it indicates that having one level of dispensers still has a 'User-Friendly' perception, which is about 1.315 higher than when it has two levels of dispensers. The 'dispenser levels' is the most important variable on the perception of the KW 'User-Friendly' (B=1.315). Therefore, the perception of a 'User-Friendly' 'packaging-free area' is obtained when it has one level of dispensers, an aiding shelf and does not have a weighing scale and instructions panel. The same reasoning can be done for the remaining equations.

Final Model

The Final Model is the last phase of the KE methodology in which final design guidelines of the 'packaging-free area' are presented. As previously verified, the results of the BLR technique were in the same direction of the MRA results, therefore the guidelines are based on this last technique as it is simpler to interpret. Table 1 shows which items 'packaging-free area' should have in order to increase each KW perception. For each category of the different items a "+" or "-" is associated, where the "+" indicates that certain category must be adopted to increase the perception of given KW and the "-" indicates a negative relationship between a particular category and KW and that category must therefore be avoided. It should be noted that the grey cells indicate that a certain item of the 'packaging-free area' is not statistically significant, so they do not influence the model. The 'Appealing' and 'Hygienic' KW models are the best predicted by the given items since they have the higher values of R^2_{adj} coefficient, 32.1% and 35.8% respectively.

		Weighing scale and instructions panel		Aiding Shelf		Nº of Dispenser Levels		QR Code		Bag Type	
MRA	R^2_{adj}	Yes	No	Yes	No	1	2	Yes	No	Paper	Paper and cotton
User-Friendly	0.158	-	+	+	-	+	-				
Appealing	0.321	+	-	+	-	+	-	+	-	-	+
Hygienic	0.358			+	-	+	-	-	+		
Elegant	0.202	-	+	+	-	+	-	-	+	-	+
Creative	0.273	+	-	+	-	-	+	+	-	-	+

Table 1:Final Kansei Model Guidelines

According to table 1, for the 'packaging-free area' to be perceived as 'Appealing', it should include a weighing scale and instructions panel, an aiding shelf, one level of dispensers, a QR code on each dispenser through which consumers can obtain additional information about each pasta and it should also include two types of bags to put the pasta (paper and cotton). Analysing table 1 some suggestions for the design of the 'packaging-free area' can be given. The "Aiding Shelf" and "Bag Type" columns definitely suggest that the 'packaging-free area' should have an aiding shelf and two types of bags (paper and cotton). In relation to the "Nº of Dispenser Levels" column, it shows that the scores for most of the KWs are higher when there is only one level of dispensers. Regarding the weighing scale and instructions panel and the QR code the situation will depend on which KW is given privilege. In order to highlight the KWs 'User-Friendly' and 'Elegant', the design should not include the weighing scale and instructions panel or QR code, while for the KWs 'Appealing' and 'Creative' it should include a weighing scale and instructions panel and QR code. Prototype C matches the 'User-Friendly', 'Hygienic' and 'Elegant' models. Although there is no prototype that has a full correspondence with the 'Appealing' and 'Creative' models, prototype H is the closest to their requirements being only necessary to add two types of bags.

<u>Investigating the consumers' perceptions and preferences</u>

In order to visualize the relative position of the prototypes the option was not to use the original five KWs, but to try to find a smaller set of perceptual dimensions. To do so, FA with PCA extraction was carried out to determine the main factors contributing to the explanation of a big percentage of the variance of the KWs and those factors were then graphically represented, by means of perceptual maps. Being aware that these five KWs are weakly correlated one should expect that FA will not result in a much smaller set of perceptual dimensions. The sample size (952 observations) exceeded the minimum ratio of five observations per variable (Hair et al., 2013). Afterwards, it was checked whether the FA was suitable for the data. From the correlation matrix was seen that all variables have at least one coefficient higher than 0.3, and therefore had the minimum required to be proceed with FA. It was also seen that, except two, all correlations are significant at the 0.01 level. The KMO was 0.577, which was slightly above the minimum acceptable for performing FA and the Bartlett's Test of Sphericity was significant with an approximated value of 642.424, meaning that the hypothesis was reject and the data was adequate for FA. PCA with varimax rotation was done and based on the eigenvalue, scree test and total variance explained criteria, solutions extracting two and three factors were considered and the one whose interpretation was most pertinent to the data was chosen. This was verified for the solution that included 3 components. Moreover, there was a significant increase in the percentage of explained variance when three components were extracted, from 64.47% to 78.62% which contributed towards choosing the three component solution. Having a three-factor solution, it was verified that all the variables presented loadings greater than 0.5 and communalities between 0.621 and 0.924, meaning that the variance of each variable is well explained. The first factor, which explained 35.96% of the variance, covered the variables 'User-Friendly', 'Hygienic' and 'Elegant'. The 'Elegant' variable was present in two factors, so it was excluded as a possible name and, having not found another word, the name 'User-Friendly/Hygienic' was given to the first factor. The second factor, with high loadings on the 'Appealing' variable, was called 'Appealing' and explained 21.97% of the variance. The third factor, as it only relied on the variable 'Creative' it was thus called 'Creative' and explained 20.97% of the variance. Subsequently, perceptual maps were elaborated to investigate how the eight 'packaging-free areas' (A-H) are positioned along the three factors dimensions obtained from PCA. Figure 4 represents factor 1 - 'User-Friendly/Hygienic' and factor 2 - 'Appealing'. It can be seen that the prototype C is perceived as the most 'User-Friendly/ Hygienic' by participants whereas G is perceived as the less 'User-Friendly/Hygienic', followed closely by B. Analysing the 'Appealing' dimension, H is the most 'Appealing'; on the opposite side, prototype B is clearly the least.

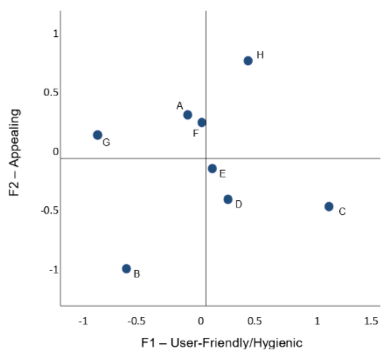

Figure 4: Perceptual map 'User-Friendly/Hygienic' against 'Appealing'

Figure 5 represents the 'User-Friendly/Hygienic' dimension versus the 'Creative' dimension. Regarding the creativeness of the different 'packaging-free areas', G is the most 'Creative' one, followed by E and H. On the opposite side, prototypes B is seen as the less 'Creative, followed closely by C.

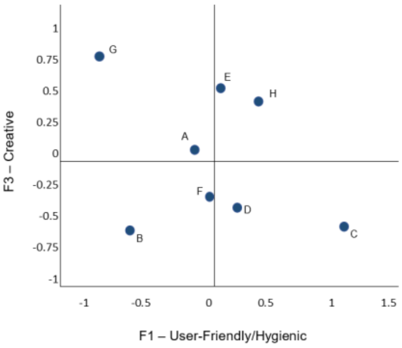

Figure 5: Perceptual map 'User-Friendly/Hygienic' against 'Creative'

Results show that in both perceptual maps prototype H the only one that located in the 1st quadrant being, therefore, the most preferred prototype by participants. Prototype H includes a weighing scale and instructions panel, one level of dispensers, an aiding shelf, QR code and only paper bags. On the other hand, prototype B is the only one that is always in the third quadrant, suggesting that it is the least preferred prototype. This prototype does not include a weighing scale and instructions panel, has two level of dispensers, does not have an aiding shelf and a QR code on the dispensers and have one type of bags (paper). In the first dimension, prototype C is considered to be the most 'User-Friendly/Hygienic' and G the most 'Creative'.

The perceptual maps complement the information obtained in the guidelines of table 1, helping in the choice of the optimal prototype. According to table 1, prototypes H and C stand out as possible design solutions and in the perceptual maps it is possible to see that prototype H is always in the 1st quadrant, what gives support the choice of prototype H.

Afterwards, Conjoint Analysis was done to link consumers' preference for prototypes (A-H) with the different items of the 'packaging-free area'. To enable the use of Conjoint Analysis, respondents were asked to rank the 'packaging-free areas' (A-H) in order of preference. Results showed that the weighing scale and instructions panel have the highest influence on the overall consumers' preference (29.08%), contrasting with the number of dispenser levels that has the lowest influence (13.53%). The maximum overall score (Y=6.664) represents a 'packaging-free area' with a weighing scale and instructions panel, one level of dispensers, an aiding shelf, QR code and two types of bags (cotton and paper). Although none of the prototypes match this set of characteristics the H prototype is, again, the most similar, by simply changing the type of bags and prototype B is the least similar. This goes along with the estimated utility score of each prototype, where prototype H had the highest utility score (6.627) and prototype B presented the lowest utility score (3.03). This way, Conjoint Analysis not only reinforces the idea that prototype B is the least preferred by the participants and prototype H the most preferred, but also provides a suggestion to improve prototype H by defining the type of bags as paper and cotton.

Finally, MRA was applied for different datasets to investigate possible differences in the KWs model for different datasets. The procedure was thus repeated, but this time for the target group defined by the company. As results were very similar those which includes all participants, the Kansei model is the same for both the target group and all participants, leading this way to equal design recommendations. MRA was also applied to participants living in the metropolitan area of Porto against those living in Lisbon and to male against female participants. Having obtained similar results, the design to be adopted by the company should mainly be the same for the different datasets, i.e. participants living in Porto or in Lisbon and male or female participants.

Main results

Although different strategies can now be adopted, during the decision making process one should take into consideration that: **(i)** the most important KWs were the 'Hygienic' and User-Friendly', followed by the KWs 'Appealing', Creative and 'Elegant'; **(ii)** the 'Hygienic' and 'Appealing' models were the better explained regression models; **(iv)** prototype H was the most preferred by participants as it was always located in the 1st quadrant; prototype C came out as the most 'User-Friendly' and G as the most 'Creative'; **(v)** from the Conjoint Analysis, the most preferred prototype was H.

If the company wants to focus on the perception of a specific KW then it should follow the recommendations given in table 1. Finally, taking into account the information obtained from the FA, perceptual maps and Conjoint Analysis, it is possible to obtain a final design recommendation. As prototype H seems to be the most preferred by participants, its design should be taken as a reference in the necessary adjustments that may be needed. Prototype H includes an aiding shelf and one level of dispensers as required by the most important KWs for respondents, i.e. the 'Hygienic', 'User-Friendly' and 'Appealing'. Regarding the weighing scale and instructions panel and QR code items, prototype H helps to decide that both should be included in the 'packaging-free area'. The only modification that it is suggested is the inclusion of two type of bags, as required by the KW models. Therefore, the recommended 'packaging-free area' should include an weighing scale and instructions panel, an aiding shelf, one level of dispensers, QR code and two types of bags (paper and cotton).

6. Final conclusions, limitations and future work

This work, based on several KE studies and on the methodology used on the research done by Schütte (2005) and by Marco-Almagro (2011), allows the reader to understand KE as an important technology to develop the design of a new product or to improve an existing one. This study describes how each phase of the KE methodology was applied to achieve a successful design for a 'packaging-free area'. To improve the traditional KE analysis and investigate consumer' perceptions and preferences, perceptual maps based on FA were developed and a Conjoint Analysis was performed. In addition, it is a simple way to show the results obtained, which allows an easier communication between engineers, designers and all people involved in the development a product.

The results obtained by applying the traditional KE methodology lead to the choice of prototypes H or C. However, the addition of perceptual maps and Conjoint Analysis revealed that prototype H is closer to the optimal design and it is only suggested the change to include the two type of bags. According to the literature reviewed, this product domain has never been studied. Thus, this study contributes to the expansion of the KE application domain and also contributes to a greater presence of the KE methodology in Portugal, encouraging to incorporate the consumer in the product development process and opening space for innovative design solutions.

The main limitations of this study are due to cost and time constraints that, for example, limited the data collection phase in which it was only possible to use an online questionnaire for the evaluation of the prototypes for each KW. Also, a non-probabilistic convenience sample was used. Therefore, it is proposed for future works with similar objectives as the present study, the use of presential sessions to present the prototypes under study which allows more sensory stimuli in consumers' minds, leading to more accurate responses in the evaluation of the KWs. It is also proposed a greater involvement with product design experts, so that new properties can be tested. In the Synthesis stage, it is suggested to include, besides the methods used in this project work, the Partial Least Squares method which has been increasingly more used and to compare the results with those obtained in this work. A Cluster Analysis to identify potential additional consumer segments and, if necessary, propose different design guidelines for each group is also suggested. As a way to improve the results obtained and to help in their interpretation, it is suggested, as done in this study, the use of perceptual maps and Conjoint Analysis. Finally, for future applications of the KE methodology, it is recommended the Validity phase to ensure the results obtained are consistent and therefore contributing to a better-founded design guidelines.

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