Kansei Engineering methodology to support the development of a water bottle packaging

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**Abstract:** Kansei Engineering Methodology, introduced by Mitsuo Nagamachi in the early 1970’s, is applied to establish guidelines that attempt to improve Água das Pedras packaging, a sparkling water bottle in the Super Bock Group portfolio. The main Kansei evoked by bottle designs on the consumer minds are selected, as are the key properties with a high emotional impact. An analysis of the main groups of competing products and of its respective positioning support the final design recommendations. Statistical tools, such as QT1, logistic regression and multiple regression analysis, are used to quantify the relationship between the bottle properties and the consumer emotions. The consistency among results allows to successfully build the final Kansei model. The main conclusions and limitations of the study are outlined and future recommendations are summarized.

**Keywords:** Kansei Engineering, Product Development, Multivariate Statistical Analysis; Emotional design.

1. **Introduction**

Today’s society is more informed, sophisticated and demanding than ever before (Marco-Almagro, 2011; Schütte, 2002). A consumer-centered paradigm has emerged (Lokman, 2010; Nagamachi, 1995, 2002). Adding differentiating features to product functionality is critical to build successful experiences and to triumph in nowadays highly competitive market reality (Mouta et al., 2017; Schütte et al., 2008). Moreover, Norman (2004) emphasizes that, although the success of a product undoubtedly depends on its functionalities, the emotional side of design may be the most determining factor towards success. There are several methodologies in the area of emotional design, which focus on grasping consumer needs (Schütte, 2002, 2005). According to Schütte (2005), these methodologies include the Quality Function Deployment (QFD), Conjoint Analysis and the Semantic Description of Environments (SMB). However, none of these can translate the consumer subjective emotions into design parameters adequately (Lokman, 2010; Nagamachi, 1995). Kansei Engineering (KE), founded by Mitsuo Nagamachi, in the early 70s (Nagamachi, 2011), excels in this field due to its capability of building quantitative models that unveil the hidden relationships between product properties and the consumer emotions (Lokman, 2010; Schütte, 2005).

2. **Literature Review**

‘Kansei’ is a Japanese multifaceted expression associated with psychological feelings, wants, needs, sensations, affection, emotions (Nagamachi & Lokman, 2011; Schütte, 2005; Schütte et al., 2008) and everything that is processed in the human mind, when absorbing information from external world (Lee et al., 2002). Human Kansei are complex and difficult to assess. Hence, KE emerges as a structured scientific approach that aims at discovering and translating this subjective Kansei into concrete parameters of product design (Nagamachi & Lokman, 2015; Schütte et al., 2008).

KE applications are spread across several industries in both Japan and worldwide (Nagamachi, 2016). According to Lokman (2010) and Shauchenka (2015), successful examples include the development of Mazda Miata MX-5, a best-selling convertible sports car, Sharp video camcorder, which allowed the company to increase its market share from 3% to 24%, and the Wacoal company new bra design, allowing them to conquer 42% of the Japanese market. It has recently started to spread across European countries, having called the attention of multiple brands in the automotive industry (e.g. Volvo, Ford), aircraft industry (e.g. Boeing), food industry (e.g. Nestlé, Danone), electronics (e.g. Panasonic, Electrolux), and others (Guerin, 2004; Lévy, 2013; Masson et al., 2016).

The process of developing an emotion-based product, initially proposed by Mitsuo Nagamachi, has been evolving with major contributions from authors like Marco-Almagro (2011) and Schütte (2005). The several phases of KE general model proposed by Schütte (2005) are depicted in Figure 1.

![Diagram](image)

**Figure 1 – Proposed Model on KE (Schütte, 2005).**

The ‘Choice of Domain’ phase includes defining both the target-market and specifications of the research object (i.e. the product) to be studied (Schütte, 2005; Schütte et al., 2008). According to Guo et al. (2014) the research object is generally
chosen by the enterprise, while the target-market may be established after a market investigation. Based on this input and subsequent collection of product representations (products, prototypes, drawings, etc.) the domain is refined. Thus, the outcome includes both existing products, concepts, and yet to be conceived design solutions, in an attempt to cover as much as possible the selected domain (Schütte et al., 2004).

Then, follows the ‘Span the Semantic Space’ phase, which is subdivided in three main steps: i) collection of a preliminary large set of adjectives, nouns or expressions (between 50 and 600 words) from different sources of information (e.g. magazines, internet, experts and designers, experienced users, and/or related KE studies), known as low-level Kansei Words (KW), that semantically describe the chosen domain; ii) the selection of KW, where one must identify the Kansei structure and reduce the initial set of low-level KW, to reach a treatable and practical set of high-level KW. For this purpose, both qualitative and quantitative tools are proposed in the literature, namely affinity diagrams, expert/designer opinion, interviews, Factor Analysis (FA)/Principal Component Analysis (PCA), and others (Lokman, 2010; Schütte, 2005); and iii) the ‘Compiling Data’ step, which is next explained.

In parallel, the ‘Span the Space of Product Properties’ phase, is also subdivided in three phases as follows: i) collection of the product properties related to the chosen domain, again using different sources (e.g. design manuals, designer/expert opinion, related KE studies, and internet); ii) selection of the properties with the highest emotional impact, along with the selection of products which vary in terms of those properties and respective levels (e.g. property ‘color’ may have two levels ‘yellow’ or ‘orange’). Schütte et al. (2004) highlight that the most commonly used tools at this step are affinity diagrams, designers’ choice, ranking studies, and the Pareto diagram. Then, according to Marco-Almagro & Llabrés (2012) the stimuli/products can either be created (e.g. prototypes) or gathered (already existing market samples); and finally iii) ‘Compiling Data’ phase which consists of using both the previously selected high-level KW and the herein selected products to access the consumer perceptions and emotions towards the given stimuli. There are several tools available, according to Lokman (2010) and Schütte (2005) to grasp the consumer Kansei. These include Semantic Differential scale (SD-scale) or visual analogue Scale questionnaires, measuring the consumer brainwaves or heart rate, and eye movement tracking systems.

Marco-Almagro (2011) suggests that this iii) step should be called ‘Data Collection’ and should appear in the Schütte’s model as a single stage, after selecting both the KW and products, in order to highlight its importance and making it evident that such compilation gathers the data from the two previously spanned spaces. However, since the compiled data may also be used for newly selecting/reducing the spanned spaces, using the referred quantitative tools (e.g. FA/PCA), even if this is not clearly presented in Figure 1, it also makes sense that Schütte (2005) includes this step in the spanning phases of the methodology. Therefore, a suggestion is made in Chapter 4, in order to integrate both Schütte (2005) and Marco-Almagro (2011) suggestions and attempting to clarify these methodology steps.

After compiling the data, comes the ‘Synthesis’ phase, the KE core area (Schütte; 2005), where the relationships between the selected properties and the selected KW are established and quantified. Schütte et al. (2008) outline several tools available for this purpose, such as: Quantification Theory Type I (QT1) – a multiple linear regression which works with dummy variables and with the average of all individual responses; regression analysis; general linear models; fuzzy logic; genetic algorithm; rough-set-analysis; and others. However, Marco-Almagro (2011) criticizes QT1, the tool most widely used at this phase, as this does not consider the variability among the study participants. Thus, the author recommends using Ordinal Logistic Regression (OLR).

Finally, the established design guidelines are outlined, and after conducting the ‘Test of Validity’ phase (i.e. testing the resulting prototype within a small group of consumers), the validated guidelines constitute the final KE model (Marco-Almagro & Llabrés, 2012; Schütte, 2005).

KE applications in the Beverage Industry and in Portugal: the scrutiny of past KE applications allows to verify that its vast majority focus on the automotive industry, electronics, food consumption goods, and on home appliances. In fact, few studies are found in the beverage sector. These include the study by Okamoto et al. (2007) on a beer can the design, a rather specific work by Chihara & Yamazaki (2012), concerning the diameter of aluminum bottles, the works by Luo et al. (2012) and Tanaka et al. (2017), which aim at developing a beverage bottle and a beer cup design, respectively. Although providing scarce details in the analysis, Djatna & Kurniati (2015), also studied a new packaging design for a tea powder freshener. Finally, Marco-Almagro & Llabrés (2012) exemplify how to apply KE to an illustrative case of a fruit juice, Barnes & Lillford (2009) develop a beer bottle design, and Yáñez et al. (2018) perform but only the first three steps of the methodology, to motivate the development of a beer bottle design.

Additionally, no studies have been found to be specifically directed to the development of a water bottle packaging, and the application of KE in Portugal is still very limited. The few Portuguese studies found are the work by Mouta et al. (2017), in the automotive industry, the thesis by Balduino (2012), addressing a tea consumption analysis, the study by Santos et al. (2010), regarding the uniform
design of flight attendants, and a theoretical thesis by Neto (2014) to support and motivate future KE applications. As a result, the aim of the present study is to extend the application range of KE applications in the beverage sector, more precisely, to develop a bottle of water packaging in a Portuguese-based company. Exploring this industry through the application of a new methodology, scarcely used in Portugal, may represent a major opportunity.

3. Case Study

The Super Bock Group, founded in 1927, is the largest Portuguese controlled beverage company with a multi-brand and multi-market strategy. The company claims to incorporate a culture of continuous search for new frameworks, such as scientific and technological tools, to develop, enhance, and continuously innovate its processes and product portfolio. The group facilities are spread from north-to-south on Portuguese territory and present in more than 40 countries worldwide.

Contact was initiated with the Sales Vice President and after the idea having received his acceptance, a meeting was scheduled with both himself and the Director of Innovation, in order to introduce and present the KE methodology. Such a meeting generated both the interest and the accord to proceed with an actual KE application. At this point, the selection of a bottle of water packaging design was brought forward as probably the most suitable subject, from the company perspective, for a potential KE application. A second meeting was agreed to address the ‘Choice of Domain’ phase – first stage of the methodology – in accordance with the group best interests, where the company officials should propose which specific bottle is to be studied among the five brands currently existing in their water drink category: Vitalis, Caramulo, Melgaço, Água das Pedras, and Vidago.

4. Methodology

The KE methodology, proposed in Figure 2, is derived from the literature. As mentioned in Chapter 2, it not only integrates both Schütte (2005) and Marco-Almagro (2011) contributions, but also attempts to clarify some aspects concerning the final selection of KW and products. Looking at Figure 2, it is possible to verify that this suggestion consists of giving evidence to a previously hidden phase in KE methodology (‘Collecting and Compiling Data’) and also to the iterative relation existing between itself and the ‘Selection’ phases (within the ‘spanning spaces’ phases, in the Figure). It not only clarifies that the data is compiled using the output from both the semantic space (selected KW) and from the space of product properties (selected products), but also that only after data being collected (i.e. after products being ranked against the selected KW by the participants), may the quantitative tools that are assigned to the selection steps (e.g. FA/PCA) be used to further reduce more KW or products. The present study follows this exact procedure, where firstly qualitative tools are used to select a treatable number of both KW and products for use in the first ‘Collecting and Compiling data’ phase, and only then quantitative tools are applied to newly reduce the dimensions under study, for use in the second and final questionnaire.

Proposed tools to use at each phase of the methodology: the product specifications and target-market within the ‘Choice of Domain’ are chosen according to the company best interests (see Chapter 3). The ‘Collection of KW’ is performed by means of the internet and social networks, advertisements, related KE studies referred in Chapter 2, and a focus group discussion; and the ‘Selection of KW’ starts by using an affinity diagram, design expert opinion, and the company marketing manager opinion, and then FA/PCA technique. To ‘Span the space of Product properties’ this study uses related KE studies, the internet, design guideline manuals, and design expert opinion in the ‘Collection of Properties’ step, and then a focus group discussion, design expert opinion, and the company marketing manager opinion in the ‘Selection of properties’ step. Afterwards, the products varying in terms of the selected properties are selected from the market and the second and final selection of products uses both a cluster analysis and an Orthogonal Array (OA).

In the ‘Collecting and Compiling Data’ phase, the Kansei assessments are gathered by means of two distinct online questionnaires, each using a seven-point SD-scale. Finally, at the ‘Synthesis’ stage, both QT1 and logistic regression are applied and results are compared. QT1 is firstly applied, as being the most widely used tool in KE studies. However, agreeing with the negative critic made by Marco-Almagro (2011) to the use of this tool, and following the author suggestion, logistic regression is applied. Finally, a multiple regression analysis (MRA) is also conducted, as its results are considerably easier to analyze and interpret, and comparisons are newly made. The final Kansei model is obtained and summarized in a table, following previous KE papers.

Figure 2 – Proposed KE Methodology (Developed from: Schütte, 2005; and Marco-Almagro, 2011).
such as the study by Schütte (2013). Finally, the ‘Validation’ phase falls out of the scope of the present study, but it is reinforced that the company should internally carry out a validity test, prior to the final Kansei product development and launch.

5. Analysis and Results

Choice of Domain: the elected product is ‘Água das Pedras’, a sparkling water, and the fixed product specifications include the material of the container - glass bottle - and the bottle capacity - 25cl. The company tags the target with “Living life to the fullest”, which should include ambitious consumers who are greatly focused on family and appreciate spending time with friends or traveling. The study focuses only on the Portuguese market, as different perceptions and emotions vary with different types of cultural and environmental contexts. It should also include consumers from 35 up to 54 years of age, and be comprised by a rather homogeneous number of both males and females (approximately 50% each). The education level of the participants should be mainly high and their economic class medium-high.

Additionally, the identified main brands competing, in similar sizes (25cl), with the regular bottle of ‘Água das Pedras’ consist of: i) Luso Gás Regular; ii) Água do Castello Regular; iii) Frize Regular; iv) San Pellegrino; v) Perrier.

Finally, several pictures of products are collected, to cover the chosen domain. A visit to the local supermarkets in Lisbon, allows to gather 17 bottles with different packaging attributes, including five of the abovementioned competing products (Água das Pedras, inclusive). The San Pellegrino bottle is the only rival not available in the Portuguese supermarkets. Then, an examination of the market area in question is conducted through the internet (Google, Pinterest:https://www.pinterest.pt, and competitors webpages), and 62 additional pictures of bottles, existing in the International market, are collected (including the picture of the San Pellegrino’s bottle). As a result, a total of 79 market samples are initially collected to cover this domain.

Span the Semantic Space: a total of 385 low-level KW appropriated for the chosen domain is collected, from which: 61 KW come from the Internet and social networks (i.e. the Super Bock group and Água das Pedras Official websites, Facebook and Instagram and from the identified competitors’ websites); 292 semantic terms from previous KE studies; and additional 32 words from a focus group discussion, constituted by eight lead consumers (four males and four females) and one facilitator. The focus group is performed following the work by Yánez et al. (2018), where the collected physical products are placed at the center of a table and participants are asked to select three preferred bottles and reject the three less preferred ones. Later, a discussion is raised to find out which emotions are being evoked by each of the selected and rejected bottles, respectively.

Subsequently, in the selection step, 195 duplicates, antonyms and non-applicable words are firstly eliminated, resulting in 159 KW. Then, by means of an affinity diagram (performed by six design students, an industrial design expert, and by the researcher), those words are aggregated into 18 subgroups according to their meaning, and the best representative word, for each group, is selected. The 18 selected KW, along with its opposite (to form pairwise KW for use in the SD-scale questionnaire) are: ‘Stimulating-Monotonous’, ‘Healthy-Unhealthy’, ‘Attractive-Unattractive’, ‘Refreshing-Warm’, ‘Tasty-Insipid’, ‘Natura-Artificial’, ‘Cool-Uncool’, ‘Beautiful-Ugly’, ‘Simple-Complex’, ‘High-Quality vs Low-Quality’, ‘Strong-Fragile’, ‘Whenever-wherever vs inconvenient’, ‘Perfect-Imperfect’, ‘Distinctive-Ordinary’, ‘Harmonious-Disharmonious’, ‘Modern-Traditional’, and ‘Manual-Industrial’. Finally, following the suggestion of the company marketing manager, the ‘Whenever-Wherever’ need is eliminated, as this would only be interesting to analyze when comparing different types of materials. As such, the remaining 17 pairwise KW constitute the semantic space descriptors, at this stage.

Span the Space of Product Properties: firstly, a total of 18 properties (e.g. neck length, label shape, bottle shape) are collected from the previous KE studies on the food and beverage industry by Luo et al. (2012), Tanaka et al. (2017), Okamoto et al. (2007), Barnes & Lillford (2009), Djantra & Kumiati (2015) and Schütte (2013). Additional research through BA Group (http://www.bavidro.com) and Tintos e Tantos (http://www.tintosetantos.com) webpages, and through BA Group technical guideline manual, allows to add 10 properties to the previous list (e.g. bottle diameter, type of label, and bottle punt). Finally, all the properties varying among the initially collected samples (in the ‘Choice of Domain’ phase) are analyzed, written down, and organized, with the help of the six design students, who had already participated in a previous methodology phase. A table containing 33 different bottle properties (obtained from both this observation and the precedent research) is developed and the properties are subdivided into both Human Interface Elements and levels, following the study by Guo et al. (2014). This output is then used for the selection step, as next described.

The selection of properties is performed under three different sub-steps, as suggested by Marco-Almagro (2011). Firstly, a discussion is raised by the facilitator to understand which properties are influencing the selection and rejection of the three bottles, carried out by the focus group. This discussion reveals that the bottle body shape, surface details (embossing), and label, are the three main properties impacting on the consumer preferences. Secondly, the table containing the 33 collected properties, is shown to the design expert, whom is asked to select the five properties with the higher degree of emotional impact. The
designer selection (ordered from the most to the least important property) consists of the bottle proportions, body shape, color, label shape, and label placement. Finally, the outcomes from the two previous steps are consolidated and the final key properties are selected, following the majority of KE studies, generally selecting four properties with two variation levels each.

The resulting four bottle properties and levels consist of: Body Shape (BS) (curvy/orthogonal), Color (C) (Green/Transparent/Blue), Embossing (E) (yes/no), label format (LF) (oval/rectangular). Note that, the bottle proportions are found to be extremely correlated to its body shape, and thus only the body shape is selected (as being the one which is important for both the designer and the consumers). Also, the third level of the color property (blue) is preserved at this stage, to enable a more comprehensive benchmarking analysis. Nevertheless, the second questionnaire, will already include only four properties with two levels each, due to several reasons next explained. Finally, 14 pictures of well-known market products (including Água das Pedras competitors) which vary in terms of the selected properties, are chosen among the initial set of collected pictures, for use in the first Kansei questionnaire.

Collecting and Compiling Data from the 1st questionnaire: a seven-point SD-scale questionnaire is built in Google Forms, a free-of-charge online platform. This questionnaire is divided in three parts, as follows: i) a set of demographic questions to analyze whether the sample comprises the target group individuals; ii) the body of the questionnaire is where the 14 selected, photographed, and edited pictures of bottles are to be ranked against the 17 selected pairwise KW; iii) individuals are asked to identify, in the same SD-scale, the relative importance of each KW. The bottle pictures have been edited, in order to remove all brand names, backgrounds, and visual effects. A pre-test is then sent to 14 individuals and a few adjustments are made, including the removal of the ‘Manual-Industrial’ KW from the analysis (being not understandable by the participants). The final form link is sent by email, Facebook private messages, and WhatsApp to specific individuals, potentially within the target group, who are asked to forward the link to friends within the same age segment (snowball sampling). A few other trusted individuals (family, friends and colleagues) and design students are also included in the sample. The entire form takes approximately 10 minutes to complete and it is on-line during a 13 days period. A total of 172 responses is yielded, but only 152 are kept, after eliminating 20 with less than 82% (i.e. 14 out of 17) of suitable responses. These include, for instance, the ones persistently giving the same ratings, independently of the bottle or KW under evaluation. Thus, the 152 kept responses for the 16 KW and 14 bottles in use, result in a total of 2128 observations. The sample is comprised by 42.1% male and 57.9% female individuals, and each target requirement (i.e. 35-54 age segment, high education, medium-high economic class, and frequent traveler), always comprises the majority of respondents.

Final Selection of KW: the proposed KE methodology, in Figure 2, shows that once data is collected and compiled, a second phase of ‘Selection of KW’ may take place to further reduce the semantic space, this time using quantitative tools. Following the procedure described in Chapter 4, FA is applied, to reduce the dimensions used by participants to perceive the 14 bottles in the analysis. According to the five times rule by Hair et al. (2010), the sample size is verified to be more than suitable for FA, as the number of observations (2128) is largely above 80 (5 x 16 variables). Thus, the analysis proceeds respecting the following procedure: i) evaluate the appropriateness of the data for FA, by extracting the correlation matrix, and computing both KMO and Bartlett’s test of sphericity; ii) define the number of factors to extract; iii) evaluate the rotated factor loadings for all variables, using varimax rotation; iv) factor scores computation and interpretability. Firstly, the correlation matrix for the 16 KW shows that all variables are significant at the 0.01 level and have at least one correlation coefficient above the 0.3 limit (Monteiro et al.; 2010). The KMO value is found to be 0.940, which is classified as “marvelous” by Kaiser (1974) and the Bartlett's test of sphericity results in a test with a high value of 15636.575 and a low associated probability of 0.000 (below the 0.05 limit), meaning that the hypothesis that the correlation matrix is an identity matrix is completely denied (Leech et al., 2005). Thus, data is largely suitable for FA. Then, several criteria are analyzed to decide on the number of factors to extract (Hair et al., 2010). Based on both the ‘eigenvalues greater than 1’ and on the scree test by Cattell (1966) criteria, the solutions for three, four, and five factors are analyzed, according to the remaining criteria (% of variance and communalities). The four-factor solution, not only presents the best results across all the established criteria, with 65% (more than the 60% limit defined by Hair et al., 2010) of variance explained by the model and with all communalities varying between 0.571 and 0.821 (greater than 0.4 suggested by Costello & Osborne (2005)), but also shows the best factor structure interpretability. Table 1 shows the result of PCA extraction with varimax rotation method to the complete dataset. Note that, the exact same four-factor structure is verified for a test sample (two thirds of the respondents) and a validity sample (the remaining one third). Table 1 shows that ten variables have excellent loadings above 0.7, and the remaining six variables have significant loadings above 0.5 (Hair et al., 2010). All but two variables (‘PER’ and ‘HAR’) load high on only one factor. Nevertheless, the factor with the highest loadings on
together with the other perceptual maps in sensation is still strongly evoked by other five bottles than the average. Nevertheless, the ‘Healthy’ quadrant of the perceptual space, indicating that the bottle F, A, I, and C are perceived as ‘Unhealthy’ look ‘Healthy’ to the respondents, whereas bottle E opposite extreme of this dimension. In terms of the ‘Distinctive’ that the bottles H, J are built into the same cluster. The last one contains only curvy green bottles (bottles C, E, A, F). That note, in order to ensure the representativeness of each competing group, at least one product should be extracted from each cluster, and used in the ensuing evaluation. Looking at the figure below, it is possible to verify that the bottles H, J, and M are the ones perceived as more ‘Distinctive’, whereas bottles B and D are at the opposite extreme of this dimension. In terms of the perceived Healthiness of the bottles, bottle D and N look ‘Healthy’ to the respondents, whereas bottle E, A, I, and C are perceived as ‘Unhealthy’ products. The bottle F–Água das Pedras–is placed in the second quadrant of the perceptual space, indicating that the bottle looks slightly healthier, but less ‘Distinctive’ than the average. Nevertheless, the ‘Healthy’ sensation is still strongly evoked by other five bottles in the sample (bottles D, N, G, K, H) than by the company product. This perceptual map in Figure 3, together with the other perceptual maps for the remaining KW in study (not presented in this paper), allow to conclude that Água das Pedras is not perceived as a ‘HEA’, ‘DIS’, nor a ‘STR’ bottle, being poorly positioned in these three perceptual dimensions, when compared to the other bottles with distinct physical properties. Its favorable positioning is only observable along the ‘ERG’ dimension, where it is in fact perceived as the most ‘Ergonomic’ bottle within the sample.

**Table 1 – PCA Extraction with Varimax Rotation.**

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<td>EPO</td>
<td>183</td>
<td>183</td>
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<td>38</td>
<td>38</td>
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<td>DIS</td>
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<td>38</td>
<td>38</td>
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<td>38</td>
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<td>38</td>
</tr>
<tr>
<td>HOS</td>
<td>183</td>
<td>183</td>
<td>38</td>
<td>38</td>
<td>38</td>
<td>38</td>
<td>38</td>
<td>38</td>
<td>38</td>
<td>38</td>
<td>38</td>
<td>38</td>
</tr>
</tbody>
</table>

Thus, looking at both the variables with the highest loadings on each factor and to the real concept behind each derived dimension, the four KW selected for the ensuing evaluation are named ‘Distinctive’ (DIS), ‘Healthy’ (HEA), ‘Ergonomic’ (ERG), and ‘Strong’ (STR).

**Perceptual Maps, Dimensions Relative Importance and Cluster Analysis:** two complementary steps are added to the proposed KE methodology, as relevant for the Super Bock Group. More precisely, perceptual maps are built to benchmark the 14 bottles of water across the four derived dimensions, and the third part of the form is analyzed to assess the relative importance of those dimensions. A subsequent cluster analysis allows to identify the main groups of bottles competing in the perceptual space.

Participants assign a slightly higher importance to the ‘HEA’ and ‘DIS’ dimensions, with the average scores of 5.35 and 4.73, respectively. Figure 3 depicts the perceptual space formed by those two KW and the respective main groups of competing products, identified by means of a cluster analysis with Ward’s agglomerative method (Ward, 1963). Bottles with similar physical properties are successfully merged into the same clusters. For instance, the first cluster to merge is formed only by blue and transparent bottles, all with embossing and rectangular labels (bottles J, M, H, and N). The last one contains only curvy green bottles (bottles C, E, A, F).

Looking at the figure below, it is possible to verify that the bottles H, J, and M are the ones perceived as more ‘Distinctive’, whereas bottles B and D are at the opposite extreme of this dimension. In terms of the perceived Healthiness of the bottles, bottle D and N look ‘Healthy’ to the respondents, whereas bottle E, A, I, and C are perceived as ‘Unhealthy’ products. The bottle F–Água das Pedras–is placed in the second quadrant of the perceptual space, indicating that the bottle looks slightly healthier, but less ‘Distinctive’ than the average. Nevertheless, the ‘Healthy’ sensation is still strongly evoked by other five bottles in the sample (bottles D, N, G, K, H) than by the company product. This perceptual map in Figure 3, together with the other perceptual maps for the remaining KW in study (not presented in this paper), allow to conclude that Água das Pedras is not perceived as a ‘HEA’, ‘DIS’, nor a ‘STR’ bottle, being poorly positioned in these three perceptual dimensions, when compared to the other bottles with distinct physical properties. Its favorable positioning is only observable along the ‘ERG’ dimension, where it is in fact perceived as the most ‘Ergonomic’ bottle within the sample.

**Final Selection of Products:** at this stage, the best possible balanced combination of the properties and levels dictates the products to be selected. However, due to cost constraints, prototypes matching these combinations are not created and thus, real market products are used instead, as done in the majority (80%, according to Marco-Almagro (2011) of past KE studies. As previously mentioned, keeping three levels (i.e. green/transparent/blue) of the ‘color’ property, would cause an even increased difficulty in finding existing market samples that match all the level combinations or design requirements. Thus, and following the majority of the KE studies, the third level – blue – of the bottle ‘color’ is eliminated from the subsequent evaluation as, for instance, the green and transparent colors are the ones of Água das Pedras current main competitors, constituting thus a priority to the company. A design of experiments matrix is then built with the final selected properties and levels and its orthogonality index (OI) is computed, following Marco-Almagro (2011), in order to guarantee that the matrix is balanced enough to avoid the extraction of biased conclusions. The OI is found to be of 99.3%, meaning that the matrix is extremely close to orthogonality and thus, the four properties are kept in the study. Table 2, shows this matrix, including the eight bottles that are found to be matching the required combination of properties and levels. Note that, the resulting samples coincide with the extraction of two bottles from each of the four previously identified clusters.

**Figure 3 – Perceptual Map ‘DIS’ vs ‘HEA’.

**Table 2 – Design of Experiments.**

<table>
<thead>
<tr>
<th>Prod</th>
<th>Bt</th>
<th>Cl</th>
<th>E</th>
<th>LF</th>
<th>Bottle</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Curvy</td>
<td>Green</td>
<td>Yes</td>
<td>Oval</td>
<td>C</td>
</tr>
<tr>
<td>2</td>
<td>Curvy</td>
<td>Green</td>
<td>No</td>
<td>Oval</td>
<td>F</td>
</tr>
<tr>
<td>3</td>
<td>Curvy</td>
<td>Transp.</td>
<td>Yes</td>
<td>Rect.</td>
<td>J</td>
</tr>
<tr>
<td>4</td>
<td>Curvy</td>
<td>Transp.</td>
<td>No</td>
<td>Rect.</td>
<td>K</td>
</tr>
<tr>
<td>5</td>
<td>Orth.</td>
<td>Transp.</td>
<td>Yes</td>
<td>Rect.</td>
<td>N</td>
</tr>
<tr>
<td>6</td>
<td>Orth.</td>
<td>Green</td>
<td>No</td>
<td>Rect.</td>
<td>B</td>
</tr>
<tr>
<td>7</td>
<td>Orth.</td>
<td>Transp.</td>
<td>No</td>
<td>Oval</td>
<td>D</td>
</tr>
<tr>
<td>8</td>
<td>Orth.</td>
<td>Green</td>
<td>Yes</td>
<td>Oval</td>
<td>I</td>
</tr>
</tbody>
</table>
Collecting and Compiling Data from the 2nd Questionnaire: according to the procedure described in Chapter 4, a second questionnaire (equivalent to the first one) is elaborated in Google forms, this time only containing the bottles selected in Table 2, and the high-level KW, identified in the final KW selection. This resulted in a considerably smaller questionnaire, requiring less time to respond (five minutes maximum) and hence, a much smaller attention span. After a pre-test being sent to ten individuals, the link to the final form is send via email, Facebook, and WhatsApp to a new universe of respondents (relying again on the snowball sampling and on specific available individuals, such as university colleagues, and friends). Responses are collected during the ten subsequent days after its release. Thus, 130 responses are collected, ranking the eight bottles against the four KW, resulting in a total of 1040 observations. The demographic responses show that, again, the sample gender is almost equally distributed (53.1% males and 46.9% females), more than one quarter (26.2%) of the population is within the desired age range (35-54 years), the education level is majorly high (91.6% of the population have, at least, a bachelor’s degree). The economic level of the majority is medium-high (52.3% earn at least, a monthly net income between 1001 and 2500€, there are still 36% students in the sample, but 59.2% of individuals is currently employed). Finally, 97.6% of the population travels abroad on vacations at a minimum average of one time per year. Note that, once not all target group requirements are verified in simultaneous, the posterior analysis (Synthesis phase) will compare the results for the complete dataset with the ones including only the target respondents.

Synthesis: this is the KE core area, where the linkage between the key identified bottle properties and Kansei evoked on the consumer minds is established. Firstly, it is necessary to compute discrete dummy variables for the four properties. Following Schütte (2002), once there are two levels for each property, only one dummy variable per property is required, assuming the value one if a level is verified in a given property of a product, and zero otherwise. Thus, the four variables are coded as follows: Body Shape (curvy:1/orthog.:0); Color (green:1/transparent:0); embossing (yes:1/no:0); label format (oval:1/rectangular:0). Afterwards, QT1 is the first tool to be applied. However, as aforementioned, this tool uses only the average results across respondents. In order to overcome this concern and following Marco-Almagro (2011), logistic regression is applied. The ordinal logistic regression (OLR) results show that two out of the four KW violate the proportional odds model assumption. That is, only the ‘Healthy’ and ‘Ergonomic’ KW, successfully fail to reject the null hypothesis of the test of parallel lines, having associated chi-squared p-values greater than 0.05 (Chan, 2005). Thus, again following Marco-Almagro (2011), the response categories one, two, and three are merged against categories four, five, six, and seven, and binary logistic regression (BLR) is applied.

The model for the first KW (‘DIS’) is able to correctly classify the outcome for 76.6% of the cases, according to its classification table. Table 3 reveals that the ‘DIS’ dimension is the one greatly explained, in 40.1%, by the model predictors, with all bottle properties being statistically significant, i.e. p-values below the 0.05 limit (Marco-Almagro; 2011), and thus depicted in a darker color. The models for the three remaining KW, i.e. ‘HEA’, ‘ERG’, and ‘STR’, are correctly classifying the outcome for 69.6%, 61.9%, and 75.2% of the cases, respectively. Additionally, looking at Table 3, it is observable that these same three KW are only explained in 8.7%, 10%, and 12.5% by the model predictors, respectively. Nevertheless, it is still possible to conclude that the properties ‘color’, ‘embossing’, and ‘label format’ significantly impact on the ‘HEA’. Kaansei, two properties significantly impact the ‘ERG’ dimension (‘body shape’ and ‘label format’) and three properties (‘BS’, ‘C’, and ‘E’) significantly impact on the ‘STR’ KW. The graphics in Table 3 show the direction and extend at which each level is related to each KW. For instance, looking at the levels with the highest regression coefficients, B, on each KW, one can see that: i) a bottle with embossing has an odd about 1/0.098 =10.204 times larger of being perceived as ‘Distinctive’ than one without embossing and transparent bottles have an odd about 1/0.222 = 4.505 times larger of being perceived as ‘DIS’ than green ones; ii) transparent bottles or bottles with an oval label are about 3 times more likely to be perceived as ‘Healthy’ than green ones; iii) curvy body shapes have an odd about 2.915 times larger to be rated as ‘ERG’ than orthogonal ones, and iv) orthogonal body shapes have an odd about 2.755 times larger of being considered ‘STR’ than curvy ones.

Finally, MRA is also applied to the original dataset and results are compared with the ones from logistic regression. Summarily, it is verified that the $R^2$ values, the impact that each property has on each KW, and the relative importance that each level has on each KW, are identical across the models. Moreover, the direction of the relationships between each property and each KW is always preserved, as well as the properties declared as statistically significant. The similarity between these results strengthen the consistency among the models and suggest that future studies may consider relying on MRA at the synthesis phase, as its outputs are considerably easier to understand and interpret, when compared to the former ones. Note that, the QT1 results are also consistent with the ones from MRA and logistic regression, in terms of the relative importance that each level has on each KW and in terms of the direction of all the established relationships. However, in QT1 less properties are considered to be statistically significant and the $R^2$ values for each KW
are substantially larger than the ones obtained with all the remaining tools (OLR, BLR, and MRA).

Table 3 – BLR Results for each KW.

<table>
<thead>
<tr>
<th>Property</th>
<th>SLG</th>
<th>Property</th>
<th>SLG</th>
<th>Property</th>
<th>SLG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Shape</td>
<td>Curvy</td>
<td>Orthogonal</td>
<td>6°</td>
<td>Curvy</td>
<td>Orthogonal</td>
</tr>
<tr>
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<td>Green</td>
<td>Transparent</td>
</tr>
<tr>
<td>Embossing</td>
<td>Yes</td>
<td>No</td>
<td>6°</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Label Format</td>
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<td>Rectangular</td>
<td>6°</td>
<td>Oval</td>
<td>Rectangular</td>
</tr>
</tbody>
</table>

Table 4 – The Final Kansei Model.

<table>
<thead>
<tr>
<th>KW</th>
<th>Property</th>
<th>SLG</th>
<th>Property</th>
<th>SLG</th>
<th>Property</th>
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<tbody>
<tr>
<td>Body Shape</td>
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<td>Color</td>
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<td>6°</td>
<td>Green</td>
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<td>6°</td>
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<td>Embossing</td>
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<td>6°</td>
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<td>Label Format</td>
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</tbody>
</table>

Main Results and Discussion: the observed poor positioning of Água das Pedras bottle along three of the four derived dimensions (i.e. ‘DIS’, ‘HEA’, and ‘STR’) reveals to be quite weak, in comparison to its competitors, and support the suggested design modifications. These are explored under different scenarios, to be chosen according to the company preferences. For instance, the design modifications may simply follow the guidelines provided in Table 4 or a deeper approach may focus on the compromise between increasing one specific KW and decreasing another relevant one. In this case, one should not only look to the directions of the established relationships, but also to its relative importance to each KW, i.e. to each level associated odds, presented before the brackets below (e.g. a bottle with embossing has an odd about 10.2 times larger of being perceived as ‘Distinctive’ than one without it; a transparent color an odd about 4.5 times larger than a green color; a rectangular label an odd about 2.3 times larger than an oval one; a curvy body shape an odd about 1.7 times larger than an orthogonal one):

- Distinctive: 10.2 (with embossing); 4.5 (transparent color); 2.3 (Rectangular label format); 1.7 (curvy body shape).
- Healthy: 3.3 (oval label format); 3.1 (transparent color); 1.9 (without embossing)
- Ergonomic: 2.9 (curvy body shape); 1.5 (oval label format)
- Strong: 2.8 (orthogonal body shape); 2.4 (yes embossing); 2.0 (transparent color).

Conclusions and Future Work: the present study focus on proving a viable structured solution to the problem of designing consumer-oriented products, in the context of an increasingly competitive market environment. The literature review shows that there are very few KE studies on the Portuguese beverage sector, resulting in a promising area to explore. The primary KW, properties, and products are successfully obtained, and a large number of
responses are collected in the Kansei questionnaires. The obtained results prove consistency across all the applied tools. The product competitive positioning depicted in the perceptual maps (obtained from the first questionnaire), supports the final design guidelines, resulting from the final questionnaire. Thus, the present study has served the purpose of broadening the range of KE applications in the Portuguese beverage sector and suggests that KE might in fact improve a product positioning along the main subjective dimensions inherent to the consumer preferences, to potentiate the development of a product that meets the consumer Kansei, and to successfully unveil the hidden relationships between the physical properties of a product and the respective emotions evoked on the consumer minds.

A few limitations of the work include the cost and time constraints that prevent using a more appropriate software to build the Kansei questionnaires, as well as the development of 3-D prototypes, and the consequent limited number of properties/levels included in the analysis. Additionally, using already existing market samples (instead of developing prototypes) also prevents testing ideas, visions or completely new design solutions. Moreover, it is also believed that a presential experimentation (making use of all human senses to acquire information) would have better fitted the ‘Collecting and Compiling Date’ purpose. However, this was not possible due to the absence of all the required products in the Portuguese market and also due to the time and cost related constraints. Finally, not all sample participants were found to match the target group requirements, as responses were gathered by relying on a snowball sampling and on the dependency of individuals available. Nevertheless, the synthesis analysis has also been carefully applied to the target sample only, and the final KE model was approved.

As such, future research is encouraged to improve on the referred limitations, namely by using 3-D prototypes, including more properties/levels in the analysis, specifically testing the emotional impact of the herein removed ‘blue color’ level, and verifying whether similar results are obtained by means of presential experiments, instead of online questionnaires. Finally, QT1 alternatives are highly recommended at the ‘Synthesis’ phase, such as logistic regression analysis or even MRA, given that its results are considerably easier to interpret.

7. References
Luo, S. J., Fu, Y. T., & Korvenmaa, P. (2012). A preliminary study of perceptual matching for the


