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EXPLORING THE RELATIONSHIP BETWEEN CUSTOMER NEEDS AND PRODUCT TARGET SPECIFICATIONS FOR COSMETIC EMULSIONS

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ABSTRACT

Cosmetic emulsions are consumer products that must be designed based on customer needs. In this sense it is important for the designer to have tools to understand and translate these needs into product specifications. With the aim to contribute to the progress on this matter, this research explores how the expert opinion could be used to define the representativeness of product specifications in relation to customer needs to be used in QFD (Quality Function Deployment). Here, the first matrix of QFD also known as the House of Quality (HoQ), is implemented as an information structure for the translation of customer needs into product specifications. A list of customer needs frequently found in the design of a moisturizing cream and a complete list of possible product specifications to translated them were identified and connected with the aid of experts of the cosmetic sector. Information obtained from experts was organized, statistically analyzed, and integrated in the HoQ matrix to achieve the translation. The results show that using this approach, it is possible to determine the most important groups of product specifications able to translate customer needs in cases of the cosmetics industry.

Key words: Product design, Quality function deployment (QFD), Customer needs, Cosmetics

1. INTRODUCTION

A key step during the design of cosmetic products is the translation of customer needs into product specifications, which is a task normally done by experts based on their Know-how. The formalization of such a procedure can potentially allow cosmetic designers to better understand customer needs and clearly propose solutions responding to them. This study analyzes the relationship between customer needs and some of the product properties of skin moisturizers with the aid of a group of experts. This case study was selected as an example of a skin care product, which is a large market with a significant growth projection within the cosmetic sector (Rähse, 2019). The findings are therefore specific to this context but also open potential perspectives to confront the results by applying the present methodological approach in other areas. Among various tools for analyzing and translating customer needs into product specifications, QFD (Quality Deployment Function) could be

used as a guide to designers on which aspects should be considered during the product design and development process (Ginting et al., 2018).

Our method aims at using empirical investigation in real context in order to identify patterns intending to generate theory (Yin, 2013) (Eisenhardt, 1991). We start by understanding a phenomenon in its proper context and observe how it manifests and develops (Hlady-Rispal, 2016). The main objective here is then to define the representativeness of each specification in relation to each need to be able to select those that better-described needs in a case in the field of cosmetic emulsions. For this purpose, we use the input of different experts in the field of cosmetics to evaluate the relevance of the interactions between each need and each product specification.

2. MATERIALS AND METHODS

2.1 Methodological approach:

The methodological approach used in this article comprises four steps and it is based on a set of techniques and static analyses:

- 1) Preparing a list of customer needs and a list of product specifications based on a literature review.
- 2) Consulting experts about the relationship between each element in both lists, through an online questionnaire based on a QFD (Quality Function Deployment) formalism.
- 3) Analyzing the results with statistical techniques (Generalized Procrustes Analysis and Principal Component Analysis).
- 4) Selecting the most representative specifications to evaluate a product design, relying on a Clustering method.

In this procedure, once customer needs and product specifications are identified, a research framework relies on the QFD method (Quality Function Deployment) is used to connect them. The QFD is a customer-based quality tool that enables the subsequent transformation of customer needs into product, component, or process specifications and quality control parameters, using a series of matrices (Franceschini, 2002). The first matrix, also known as the House of quality (HoQ) is implemented in this study as an information structure for the translation of customer needs into product specifications. In that matrix, information obtained from expert consultation is organized and integrated to achieve the translation (Roberts, 2007).

Then, the Generalized Procrustes Analysis (GPA) (Bartoli et al., 2013) is applied to the obtained data. GPA is a method used to measure the residuals configuration of each expert. It provides a comparative study of the consensual between experts. Following, a principal component analysis (PCA) (Hammer et al., 2001) is used to analyze the correlation between the different variables.

Finally, the clustering technique of Hierarchical Ascending Classification (HAC) is used. HAC is a tool based on general linking data using the Ward criteria aggregation method (Ward, 1963). The principle is to create in every stage a partition obtained by aggregating the closest individuals (or group of individuals). The functioning of this technique is based on regrouping needs or product specifications by minimal distance on a plan, according to the expert evaluations.

2.2 Research Framework: Customer needs and product specifications

Based on the information-gathering step of our methodology, a list of customer needs and a list of product specifications to translated them are presented in Tables 1 and 2.

Needs and product specifications have been extracted from various documents:

- i. The recommendations from the program Safe+ program of the United Nations Industrial Development Organization (UNIDO) for stability tests in cosmetics (ONUUDI, 2018)
- ii. The guidelines from the European Cosmetic and Perfumery Association (Colipa) (COLIPA, 1997); (COLIPA, 2004); (CTFA & COSMETICS EUROPE, 2004)
- iii. Explanation of clinical tests, sensorial tests and instrumental tests in (Pensé-Lhéritier, 2016).
- iv. Explanation of rheological and texture test (Gilbert et al., 2013)

Then, the components of both lists are classified in groups: Four in the case of customer needs (Performance, usability, safety and sensations and appearance) and six for product specifications (safety and regulation, sensorial tests, clinical test, instrumental test, physical and microbiological stability and price).

According to the QFD formalism, the customer requirements (“Whats”) and the Product specifications (“Hows”) represent the components of the House of Quality (HoQ) matrix.

Table 1: Customer needs or (Whats)

Groups		Needs	Abbreviation
Performance	1	It provides an immediate moisturizing effect	Moist0
	2	It provides a prolonged (8h) moisturizing effect	Moisth
Usability	3	It is easy to dose and spread	Spreadability
	4	It has a pleasant appearance	Appearance
	5	It has a pleasant aroma	Fragrance
	6	It is affordable	Affordability
Safety	7	It is safe and reliable	Safety
Sensations and appearance	8	It does not leave an oily texture	Oiliness
	9	It does not feel sticky	Stickiness
	10	It has a soft/light texture	Light texture
	11	It is natural	Naturality

Table 2: Product specifications or (Hows)

Groups		Product specifications	Abbreviation
Safety and Regulation	3	Microbiological quality	SR - Mbiology
	5	Dermal tolerance and non-irritability	SR - irritation
Sensorial test	6	Sensory panel (stickiness)	ST - stickiness
	7	Sensory panel - product appearance	ST - appearance
	10	Sensory panel (oil on skin)	ST - oiliness
Clinical test	14	Clinical test - Allergenic test	CT - allergenic
	17	Clinical test - skin conductivity before and after application	CT-corneometer

Instrumental tests	19	Rheological profile	IT - Rheo
	21	Spreadability test in Texturometer	IT - spreadability
	24	pH	IT -pH
Price	25	Product price (production costs + company profit)	Price

3. RESULTS AND DISCUSSIONS

3.1 Analysis of Experts consensus

The HoQ matrix has then to be evaluated by experts. They were consulted through an online survey, that was sent to 50 experts of the cosmetic field and 20 responses within 75 days were obtained.

The group of experts were asked to assess the relationship between product specifications and customer needs with a scale between 1 to 9, where 1 means a weak relation, 3 a moderate relationship, 5 a medium relationship, 7 a strong relationship and 9 a very strong relationship. To reduce respondent fatigue, the number of questions was limited by screening out the pairs of need/product specification in which it was considered there is not a relationship.

The first step of this analysis is to carry out a comparison of expert consensus. In order to study the degree of agreement and consistency among the experts. The consensus can be measured by analyzing the residuals by configuration of each expert (Terhaag & Benassi, 2011) using the generalized Procrustes Analysis (GPA), as shown in Figure 1.

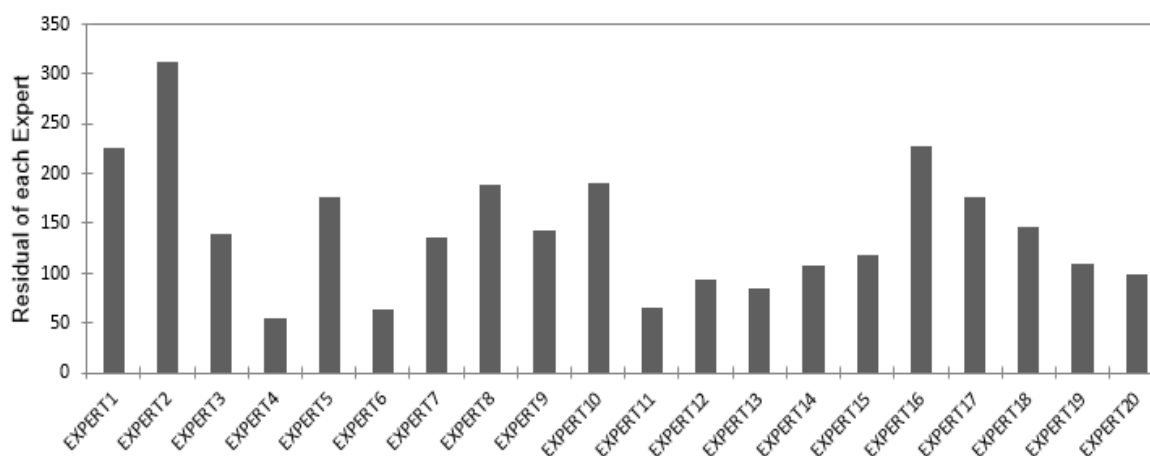


Figure 1: Residuals by expert (after the transformation by GPA)

Figure 1 shows that 3 experts provide significantly differentiated evaluations (Expert 1, Expert 2, and Expert 16). They do not seem to reach a consensus with the other experts of the panel. Looking deeper at the experts' characteristics, Experts 1 and 2 have a low level of experience (less than 2 years). Based on this observation, an assumption can be considered according to which the level of experience of the experts impacts their evaluations.

Figure 2 shows the level of experience of the respondents, from which 60% have more than 5 years of experience.

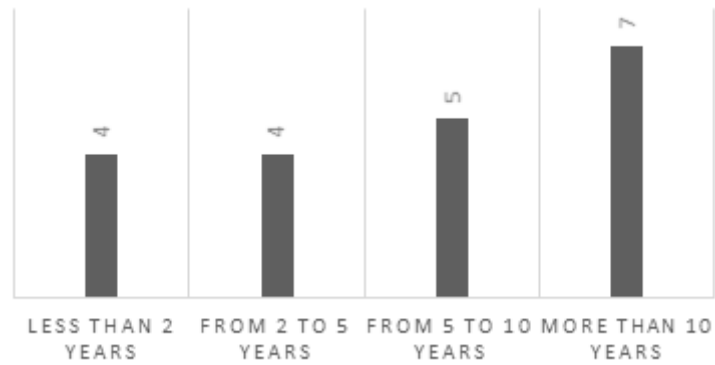


Figure 2: Level of experience of experts

To test this assumption, a PCA is performed using the software PAST (Hammer et al., 2001). The representativeness of each product specification according to each expert is computed as the average value of the representativeness of the specification in relation to assessed needs. Additionally, the representativeness of each of the six groups of specifications (in Table 2) is computed as the average of its components.

Figure 3 shows the result of the analysis. The first two principal components represent the 67% of the variance; with the third principal component, it is possible to explain the 80% of the variance. Principal component 1 is highly correlated with the level of expertise of respondents and with the price, while principal component 2 is more correlated with the other four groups of specifications. According the PCA formalism, the variable “level of experience” seems not correlated with the variables related to the evaluations (the blue ones). The variables indeed appear as orthogonal in the loading plot. While this observation may be debatable because of the poor representation of the evaluation variables on the loading plot, it seems that the level of experience of the experts do not significantly impact the values. So, the high residuals of experts 1, 2 and 16 highlighted by the GPA in Figure 1 could maybe be explained by other factors, as for example, the way these experts filled out the questionnaire.

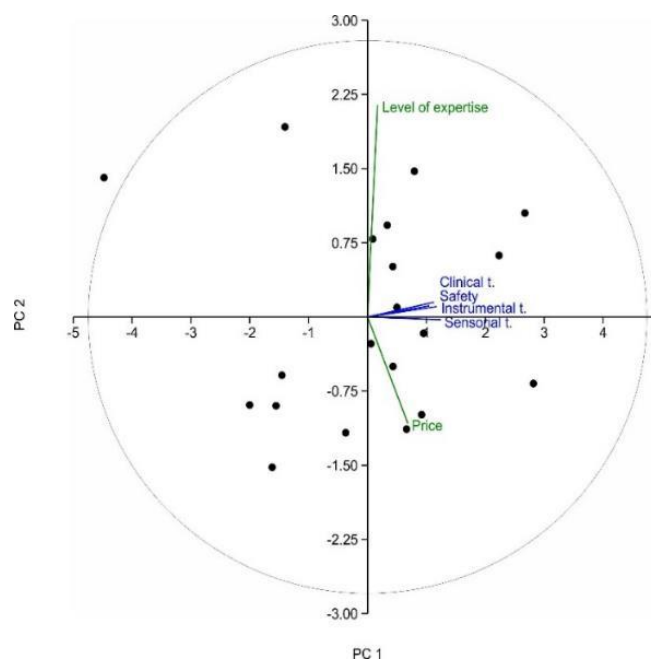


Figure 3: PCA of the six product specifications groups

3.2. Framework Validation

Based on the answers given by the 20 experts of the panel, a HoQ matrix was built to visualize the relationship between customers' needs and product specifications. These results are presented in Table 3.

Table 3: HoQ matrix – Average values from experts' survey

		Product specifications																									
		SR - PC Stability	SR - Toxicity	SR - Mbiology	SR - allowsubs	SR - irritation	SP - stickiness	SP - appearance	SP - stringiness	SP - fragrance	SP - oiliness	SP - spreadability	CT - appearance	CT - appearance8	CT - allergenic	CT - TEWL	CT - TEWL8	CT - corneometer	CT - corneometer8	IT - Rheo	IT - oiliness	IT - spreadability	IT - extrusion	IT - penetration	IT - pH	Price	
Needs	Moist0											7.4			8.2		7.2								5.7	5.5	
	Moisth												8.0				7.9		7.4							5.2	6.5
	Spreadability						7.2	5.1	6.9			8.4								8.1		7.4	7.2	5.8		5.5	
	Appearance	8.0	5.9	6.9	4.5			8.0																			7.1
	Fragrance	6.9	5.6	7.4	5.0					8.4																	7.2
	Affordability												4.1	3.9	3.9	3.8	4.0	3.3	3.4	3.5	3.1	3.6	3.6	3.1			6.8
	Safety	7.8	8.2	8.1	8.2	8.6							6.4	6.7	7.8	5.8	6.2	5.2	5.1							8.1	
	Oiliness						5.6	6.9	4.9		8.0	5.5								4.7	7.2						6.1
	Stickiness						7.6	6.2	5.9		6.5	6.8								6.2		5.3	5.0	4.1			5.9
	Light texture						6.7	7.8	7.3	3.6	7.3	7.2								6.9	5.3	6.7	5.5	6.1			5.8
	Naturality	4.6	5.2	4.1	5.4	6.2		3.6		4.8						5.3										3.3	6.9

First, an analysis of customers' needs is carried out to visualize their importance according to the experts (study of What's). To ensure the robustness of the assessments, a GPA is carried out to highlight the presence or absence of consensus among the experts (Figure 4). While the experts agree on most needs' evaluations, it is not the case for Naturality and Affordability, which show significant residues. It means that the experts' evaluations on these needs should be qualified because it lacks a real consensus enabling to provide a robust interpretation.

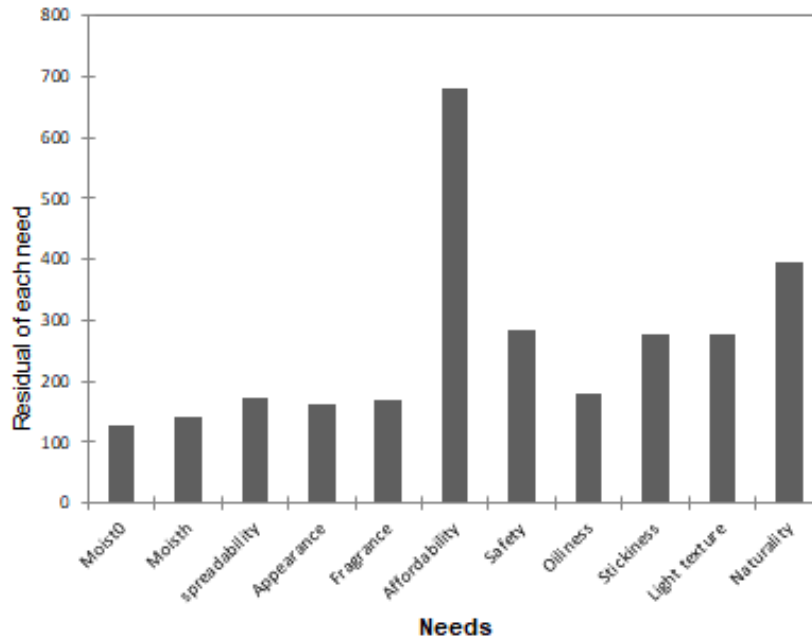


Figure 4– Residuals by need after the transformation by GPA

To avoid this interpretation issue, a corrective ratio is proposed to integrate the reliability of the evaluations to the analysis. The ratio integrates the average of the experts’ evaluation over the standard deviation for each need. The most important and most reliable needs are indeed represented by the highest ratio. Results are summarized in Figure 5: The most important needs are those related to safety and product safety, fragrance, and feeling (oiliness and spreadability). The least rated ones are the affordability and the naturality of the emulsion, mainly because of the lack of consensus among experts on their evaluations.

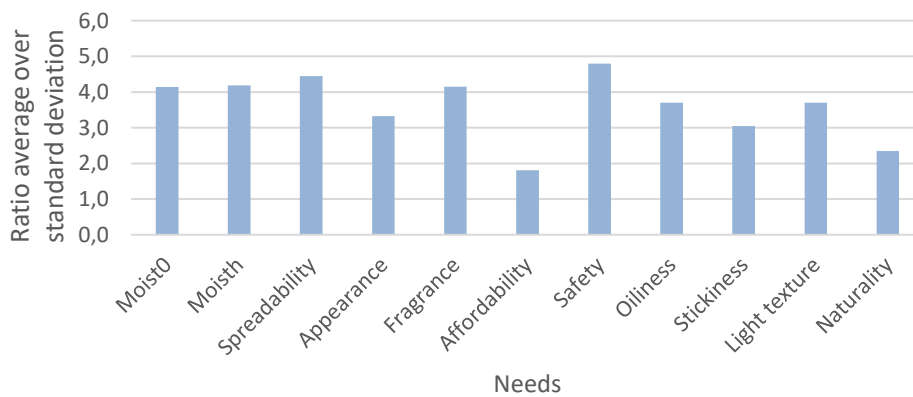


Figure 5 – Study of “whats”- needs

The same study was done to analyse experts’ consensus about the importance of product specifications (study of “Hows”). In this case the transposed matrix of the answers of experts is analysed and the average over the standard deviation was calculated for each specification. As in the study of “whats”, high ratios mean a high representativeness of the specifications. Results are summarized in Figure 6.

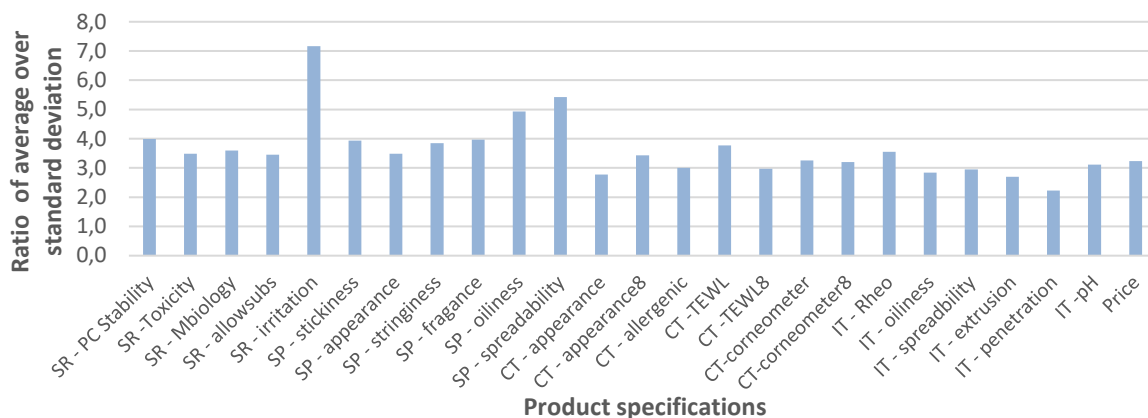


Figure 6 – Study of “hows” or product specifications

According to Figure 5 and 6, it appears that the specifications in which experts agree correspond to the groups of safety and regulation (where the specification of irritation stands out) and sensorial tests (where oiliness and spreadability stand out). The first is a must in any industry. The second shows that the feeling given by products is of high importance and that the sensorial tests represent it better than other tests with the same purpose such as rheological and textural test. Sensorial tests are more difficult and expensive to implement because they required trained panels and long protocols. However, experts agree they are more accurate to represent customer needs.

3.3. Specifications and Needs clustering:

Finally, and with the aim of find those product specifications that are similar between them, a clustering analysis based on Euclidian distance was applied to the data presented in Table 3. The results are shown in Figure 7, where groups of product specifications are organized in successive clusters with a correlation coefficient of 0.92. Product specifications that form groups at small distances are very similar, i.e., they can be used to describe similar needs. For example, the clinical test of appearance, the Corneometer test and the transepidermal water loss test (TEWL) are relatively near among them within the plot. This happens because the three of them are used to measure hydration. The same happens with the sensory panel test of stickiness, spreadability, stringiness and the instrumental test of rheology, which indicates that all of them are used to represent sensorial properties of the cream. By its part, price seems to be located very far from other product specifications.

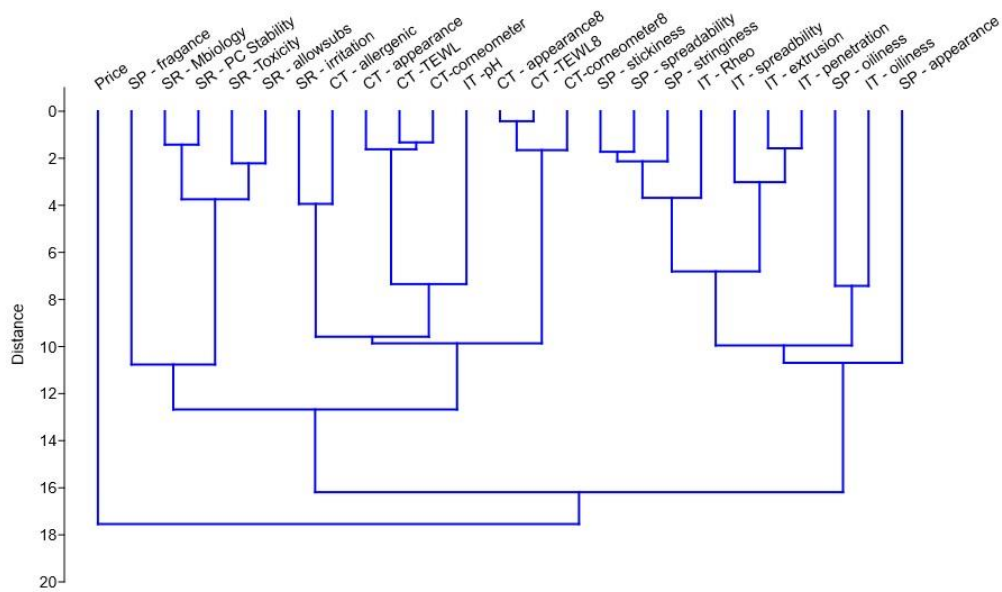


Figure 7. Clustering of product specifications

Regarding the needs, the results are shown in Figure 8, where they are organized in successive clusters with a correlation coefficient of 0.88. Here safety is a standalone need that cannot be easily related to other needs.

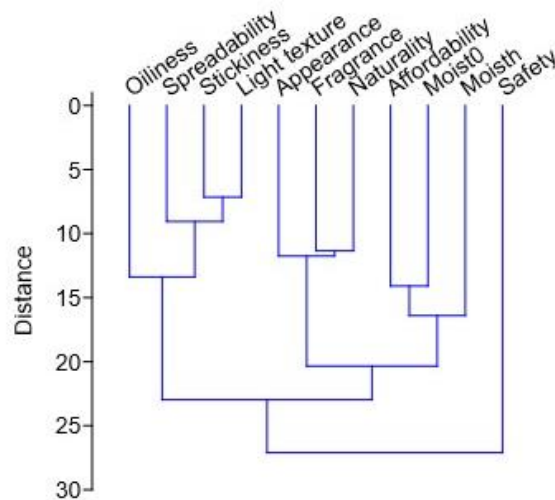


Figure 8. Clustering of needs

4. CONCLUSION

The article presents a methodology to translate customer needs into product specifications in the field of cosmetic based on expert knowledge. The methodology proposed to use different statistical tools to analyze needs importance and product specifications representativeness, based on the experts' responses to a survey. This information can be used to assist in the decision-making process during the design of cosmetic creams.

In the case analyzed, a moisturizing cream, implementing GPA it was found that product naturality and price have the lowest level of consensus for the experts. By calculating the ratio between the

average values of the scores and their standard deviation, additional information about the most relevant product properties (irritation and spreadability) was obtained. By implementing the clustering method, the product designer has information to select a representative test to measure a group of interconnected needs. In the case of consumer needs, safety represents the most important requisite to be fulfilled.

A complete multivariate analysis will be addressed in a future research work.

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