Prioritization of interventions in product development using the House of Quality and multicriteria evaluation

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Abstract

The house of quality is one of the tools used in Quality Function Deployment that allows the analysis of the customer needs and relate them with product technical characteristics. In its traditional form the house of quality is subdivided into six "rooms": customer needs (whats), planning matrix, technical characteristics (hows), whats/hows relations, technical correlations and technical matrix. In each of these "rooms" are assigned importances for costumer needs, scores for the performance of the company and its competition in each customer need and are defined the intensity of the relationships between whats/hows and hows/hows. However, in the literature analysed about the house of quality it was been identified methodological errors in the multicriteria analysis perspective: direct weight assignment to the customer needs and the usage of ordinal scales as cardinal scales.

This study focus on the application of multicriteria decision analysis methods (MACBETH concretely) jointly with the house of quality with the main objective of surpass the methodological errors related with the direct weighting/score and the use of ordinal scales as cardinal. This approach converts the house of quality into a decision analysis tool that reflect the real customer values and allows a more correct prioritization of the interventions that are need to take to meet his needs.

Keywords: multicriteria analysis; house of quality; product development; interventions prioritization; quality function deployment; MACBETH.

1. Introduction

The application of the Quality Function Deployment (QFD) assures that the voice of the costumer flows through all the processes of the product development resulting in benefits such as lower start-up costs and less design changes during the product life cycle. The principle behind the QFD is that all process and components of a product have an impact in its quality. In QFD the customer needs are systematically deployed through all product processes in order to consider the voice of customer in each one of them (Akao, 1988; Hauser e Clausing, 1988; Chan e Wu, 2002). In the QFD process a conceptual map known as House of Quality (HOQ) is used to related the customer needs (whats) with the technical characteristics (hows). The HOQ is filled with the assigned importances to the whats by the customers, the performance scores of each product and its competitors both in customer and technical perspective and with de relations between whats/hows and hows/hows. With this information, the company can establish priorities for the hows to fulfil the customer needs. The QFD team can then analyse the technical characteristics in a new HOQ. This is done in a systematic way, where the input of the next HOQ is the output of the previous one assuring that the voice of the customer flows in every process (Figure 1).

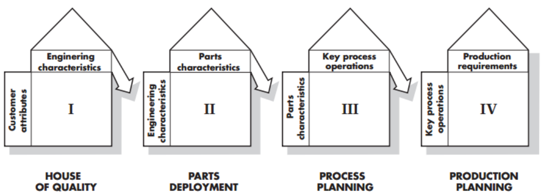

Figure 1 – QFD process example (source: (Hauser e Clausing, 1988)

In the traditional application of the HOQ are assigned weights directly and are used ordinal scales as cardinal. These procedures are wrong in the multicriteria analysis perspective and can result in incorrect prioritizations, and consequently can take the companies to make incorrect decisions.

In this study is proposed a consistent multicriteria analysis approach, using MACBETH, to surpass these drawbacks in the HOQ building. Thus, the weights assigned and the scales used will represent the real customer value system and the companies will be able to make better decisions in the prioritizations of interventions in products development.

The proposed approach is illustrated with a real case study, focusing in the first HOQ and analysing the quality of t-shirt plastic bags, and it has been done in partnership with a plastic film manufacturer.

2. The HOQ

2.1. Building the house

The traditional structure of a HOQ is formed by six "rooms" (Figure 2) and its build following the steps:

A. Identification of the customer needs and assignment of importances by the customer.

B. Customer benchmarking analysis of the product and its competitors, evaluating the performance in each one of the whats. In this section, the team also assigns sales points, define strategic objectives and calculates the strategic importance of each what.

C. Identification of the technical characteristics that are related to the customer needs and can be used to improve the product quality.

D. Definition of the intensity of the relationship between each what and how.

E. Definition of the intensity and type of correlation between each how.

F. In this last section, the product and competitor is evaluated by the QFD team in each technical characteristic. Are also defined technical objectives and are calculated technical importances for each how.

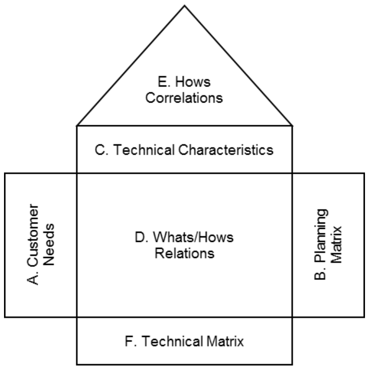

Figure 2 - Traditional structure of a HOQ

2.2. Applications

The literature about the application of the HOQ is vast. It started been applied in the industrial sector, however due to its benefits it started being applied in the services sector.

In the industrial sector it has been applied to the design of a car door (Hauser e Clausing, 1988), a wheelchair (Usma-Alvarez *et al.*, 2010), clothing (Golshan, Javanshir e Rashidi, 2012), and packaging (Marjudi *et al.*, 2013). It also has been applied in the development of food products (Park, Ham e Lee, 2012), , software (Sun e Liu, 2010), and business models (Walden, 2003).

In the services sector the HOQ has been applied in the planning of higher education courses (Gupta, Gupta e Nagi, 2012), improving of libraries (Garibay, Gutiérrez e Figueroa, 2010; Chen e Chou, 2011), and healthcare (Jeong e Oh, 1998; Moores, 2006; Azadi e Farzipoor, 2013).

2.3. Methodological errors

In the analysed literature has been found methodological errors in the building of several components of the HOQ. The errors found are relate with direct assignment of weights and the usage of ordinal scales as cardinal.

2.3.1. *Ordinal scales as cardinal*

The usage of ordinal scales it's a very usual procedure in the application of the HOQ. Due to its nature, this type of scales only can be used to determine if an object is better or preferable than other in an attribute when they aren't equivalent, resulting in a ranking.

Thus, it is not possible to determine how much an object is better than other, because the interval between categories isn't known. With this type of scales are admissible the following operations: median, non-parametric statistics and transformations that don't change de order the ranking categories of the scale (Stevens, 1946; Nunnally e Bernstein, 1994).

To gather information about how important the customer needs are and how the customer perceives the product quality, questionnaires with ordinal scales has been used to calculate means. The calculation of means is as incorrect operation with ordinal scales. It has been done to determine the customer needs importance (Usma-Alvarez *et al.*, 2010; Park, Ham e Lee, 2012; Marjudi *et al.*, 2013), the score of a product and its competitor in each customer need (Usma-Alvarez *et al.*, 2010; Golshan, Javanshir e Rashidi, 2012; Park, Ham e Lee, 2012).

Another error found in the literature is the calculation of strategic and technical importances. These calculations are done with the customer importances, the scores in the customer benchmarking and with relations between whats and hows, with are defined using ordinal scales (Walden, 2003; Peters, Kethley e Bullington, 2005; Garibay, Gutiérrez e Figueroa, 2010; Sun e Liu, 2010; Usma-Alvarez *et al.*, 2010; Vatthanakul *et al.*, 2010; Zheng *et al.*, 2011; Hashim e Dawal, 2012; Park, Ham e Lee, 2012). Due to its nature, these scales don't have any numeric value and the intervals between categories aren't known, thus, this type of calculations are an incorrect procedure.

2.3.2. *Direct weighting*

The direct weighting bearing in mind only the intuitive notion of importance is incorrect and in the multicriteria evaluation perspective is considered to be the most common critical mistake (Keeney, 1992). This practice doesn't consider the existing trade-offs between the multiple criteria based on the performances scales and result in arbitrary weights.

This practice is done at the beginning of the building of the HOQ, where the customer must assign weights directly to each one of the customer needs using an ordinal scale. This generate arbitrary weights that can lead to an incorrect prioritization of the customer needs and consequently compromise the HOQ results.

3. Multicriteria decision analysis methods

There are multicriteria decision analysis methods that have been and can be used to surpass some of the errors presented above.

3.1. Analytic Hierarchy Process

The Analytic Hierarchy Process (AHP) is multicriteria method that structures problems hierarchically and determines weights for each element doing pairwise comparisons at each level of the hierarchy (Saaty, 1980; Figueira, Greco e Ehrgott, 2005; Goodwin e Wright, 2007).

This method has been used to determine the customer needs importance (Myint, 2003; Bhattacharya, Sarkar e Mukherjee, 2005; Congcong *et al.*, 2010; Scott, Ho e Dey, 2013), in the customer benchmark analysis (Chuang, 2001; Hsiao, 2002) and to define the intensity of the relations between whats and hows (Partovi, 2007; Scott, Ho e Dey, 2013).

According to Bana e Costa e Vansnick, 2008 the rations between the weights determined using AHP should also preserve the order of preference established in the pairwise comparisons, however in some cases they not comply and break the condition of order preservation (COP). This calls into question the validity of the model.

3.2. Outranking methods

The outranking methods establish an order of preference between the alternatives according to its performance in a group of criteria and with pairwise comparisons between alternatives. These methods have been used to prioritize the technical characteristics in the house of quality.

3.2.1. ELECTRE

ELECTRE (ELimination Et Choix Traduisant la REalité) is a method that allows to choose the best alternative in a set of criteria through outranking relations (Figueira, Greco e Ehrgott, 2005).

Franceschini e Rosetto (1995 e 1997) propose the use of ELECTRE with the HOQ to rank the importance os the customer needs. However, the results using this method only represents and order of preference without any numerical value that translates how much a customer need is more important than other. Also, the remaining components of the HOQ are build using the traditional methods that are related with the errors presented above.

3.2.2. PROMETHEE

PROMETHEE (**P**reference **R**anking **O**rganization **METH**od for **E**nrichment of **E**valuations) is a multicriteria method to rank alternatives with different performances in a set of criteria. The ranking is established doing pairwise comparisons between each alternative in each one of the criteria (Figueira, Greco e Ehrgott, 2005).

In the literature PROMETHEE is used with the HOQ to rank the technical characteristics (Behzadian, Samizadeh e Nazemi, 2010a, 2010b; Behzadian *et al.*, 2013; Roghanian e Alipour, 2014; Hosseini Motlagh *et al.*, 2015).

Likewise, the ELECTRE method, PROMETHEE results in an order of preference of the alternatives without any numeric value and the remaining components of the HOQ are built equally using the traditional methods that are related with the errors presented above.

3.3. Multicriteria methods for scale construction

Below are presented methods that can be used with HOQ to construct scales that translate the alternatives performance into scores.

3.3.1. *Direct rating*

Direct rating is a method to construct interval scales where the performances of the alternatives are difficult to quantify. The first step is to rank the alternatives from the most preferable to the less in an attribute and scores to the best and worst alternative (usually 100 to the best and 0 to the worst). In the next step the decision maker assigns scores to the remaining alternatives in a way that the intervals between alternatives represent the intensity of preference. Finally, the scales must be validated by the decision maker comparing the intervals between each alternative (Goodwin e Wright, 2007).

3.3.2. *Bisection method*

The bisection method is used to create scales where the performance of the alternatives is represented by a quantitative continuous scale. The first step of this method is to assign scores to the best and worst performances in an attribute (usually 100 to the best and 0 to the worst. Then is asked to the decision maker what is the performance that is equidistant to the best and worst performance (score equals to 50). This procedure can be done in each interval considering its extremes until the intend level of detail is achieved (Goodwin e Wright, 2007).

3.4. Multicriteria methods for criteria weighting

Below are presented methods that can be used with the HOQ for criteria weighting avoiding the most common critical mistake.

3.4.1. *Swing weighting*

The first step of the swing weighting technique is to rank the criteria from the most preferable to the less considering the swing between the worst level of performance to the best. The next step takes one criteria as reference and assigns a score (usually the upmost in the ranking with a score of 100) and are assigned scores to the remaining criteria comparing the swings from the worst to the best performance in both criteria. The last step is to divide each score by the sum of each criteria score (Edwards e Barron, 1994; Figueira, Greco e Ehrgott, 2005; Goodwin e Wright, 2007).

3.4.2. *Trade-off procedure*

The trade-off procedure consists in the comparisons between two fictitious alternatives where their performance is equal except in two criteria. The first step, like in the swing weighting method, is to order the criteria based on the swing between two reference levels. Then, a criterion is selected as reference, usually the upmost in the ranking. The next step is to make an adjustment in a fictitious alternative in the reference criterion in a way that both alternatives are indifferent, then the weights are determined solving a system of linear equations. This must be done n-1 times, where n in the number of criteria and the performance of criteria must be known (Keeney, 1992; Figueira, Greco e Ehrgott, 2005; Goodwin e Wright, 2007).

3.5. MACBETH

MACBETH (***M**easuring **A**ttractiveness by a **C**ategorical **B**ased **E**valuation **T**echnique*) is a multicriteria approach that uses qualitative judgments to evaluate the difference in attractiveness to construct scales that translate the alternatives performance into scores and to define weights for a set of criteria. The judgements are done using the MACBETH semantic with the following levels: “extreme”, “very strong”, “strong”, “moderate”, “weak”, “very weak” and “null”. When there is no consensus between the decision makers, this approach allows the selection of two or more adjacent levels in the semantic scale (Bana e Costa, De Corte e Vansnick, 2005; Figueira, Greco e Ehrgott, 2005).

4. Proposed methodology

In this study is proposed the application of the MACBETH with the HOQ to surpass the methodological errors identified in the literature. Is suggested the use of MACBETH due to the following facts:

1. Contrary to other multicriteria analysis models, MACBETH uses qualitative judgements that are preferable than the quantitative ones, especially for decision makers with less numerical skills.
2. The usage of the software M-MACBETH is an advantage, because during the process of evaluating the difference in attractiveness, each judgement is tested with the previous ones, and in case of inconsistency the software suggests one or more solutions to solve the inconsistency.

The application of MACBETH with the HOQ is explained in the case study in the several phases.

5. Case study

To exemplify the application of the HOQ jointly with MACBETH, a case study has been developed in partnership with a manufacturer of plastic bags.

Contextualizing the problem, in 2015 the Portuguese Environment Agency (APA) introduced a law that states that each t-shirt plastic bag with a thickness superior to 50µm is subject to a fee of 0,08€+VAT.

In this situation, the producers and the supermarket chain stores decided to create a solution out of the bounds of the legislation to take advantage of new market.

In this study are analysed one of t-shirt bags produces by the company to one of the chain stores (Bag A) and two bags produced by other manufacturers, one for the same chain store (Bag B) and other for a different one (Bag C).

5.1. Customer needs

The first step into building the HOQ was to identify what are the customer needs related to the t-shirt bags. A preliminary poll has been done near the customer and cashiers in the supermarkets asking what characterizes a bag with good quality. Then the answers were analysed by a group of five customers, one sales manager and two engineers from the quality department. After analysing all the answers, eight customer needs were identified and filled into the leftmost side of the HOQ (Figure 5)

In the next phase, MACBETH was used to calculate importances for the customer needs. The first step was to define two reference levels for each one of the customer needs (a neutral and a good level of performance). For the customer needs with quantitative descriptors has been asked to the decision group (DG, formed by the five customers) what is considered a good (represented in green) and a neutral level of performance represented in blue) (Figure 3). For the qualitative descriptors, were create plausible levels of performance for each customer need and has been asked to the DG which levels represent a good and a neutral performance (Table 1).

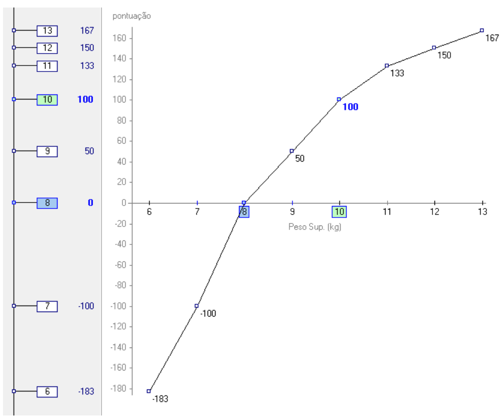

Figure 3 – Scale and reference levels for the customer need "deve suportar o peso do conteúdo”

Table 1 - Reference levels for the customer need "não deve ser possível ver o conteúdo"

Não deve ser possível ver o conteúdo
Não se consegue ver para dentro do saco, diferenciar formas e cores
É possível diferenciar formas e não cores
É possível diferenciar formas e cores
É possível diferenciar formas e cores, os rótulos do conteúdo são perceptíveis, mas não se conseguem ler
É possível ver todo o conteúdo do saco nitidamente

After the definition of reference levels was asked to the DG what was the difference in attractiveness in a bag that has a neutral performance in all the customer needs if it swings from neutral to good in a certain customer need. This procedure must be done to each customer need and results in ranking. After that comparison of the swings from neutral to good must be done in each pair of customer needs, filling the MACBETH matrix. The weights calculated for the customer needs are represented in Figure 4.

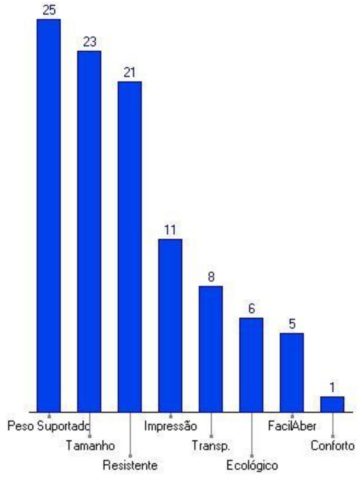

Figure 4 - Importances of customer needs

5.2. Planning Matrix

5.2.1. *Customer benchmarking*

To convert the bags performance in each customer need, were constructed scales using MACBETH. This has been done doing judgements of difference in attractiveness between each pair of the levels of scale defined previously.

In the customer need "deve ser amigo do ambiente" none of the qualitative performance levels defined represent the performance of the bags. After build the scale, three additional performance levels were added to the scale and were adjusted in the scale using the software M-MACBETH, a similar approach has been used by (Bana e Costa *et al.*, 2008).

After building the scales for each customer need, the scores for each bag were calculated (Figure 5).

5.2.2. *Sales Points*

The sales points were calculated using the following equation:

$$u_j = [w_j] \times \left[v_j(A) - max[v_j(B), v_j(C)] \right] \qquad (1)$$

Where, w_j is the importance assigned to the customer need j and $v_j(x)$ is the score of the bag x in the customer need j. If $u_j<0$, the customer need A doesn't work as a sale argument and the bag A has a bad position in the market compared with the best alternative. $u_j=0$, the customer need j doesn't work as a sale argument or isn't important to the customer. If $u_j>0$, the customer need can be used as a sale argument.

5.2.3. *Observed deviations*

In these section of the HOQ the deviations between the scores obtained by the bag A and the strategic objectives defined by the company for each customer need were calculated. If the value of the deviation is negative, mean that the bag must be improved in that attribute to achieve the strategic objective. This deviation has been also multiplied by the importance assigned to the customer need to consider the importance that each attribute has to the customer (Figure 5).

5.3. Technical characteristics and technical benchmarking

The technical characteristics related with the customer needs were identified by a DG formed by two engineers of the quality department.

To translate the performance of each bag into scores in a technical perspective the same approach as in the benchmarking of the customer has been taken. In this phase of the HOQ also has been defined technical objectives and calculated the deviation between the score of bag A and the technical objective for each technical characteristic (Figure 5).

5.4. Relations whats/hows

MACBETH has been used to define the relations between each customer need and technical characteristic. The following procedure has been taken:

1. Identify in each what where exists a relation with a how.
2. Establish the superior reference level equal to 1 (extreme relation) and the inferior level to 0 (null relation)
3. In each customer need, has been asked to the DG what is the relation of each technical characteristic with the customer need using the MACBETH semantic scales. This results in a ranking of the hows.
4. Fill the principal diagonal of the matrix comparing the difference of intensity of each adjacent relation. A similar procedure has been done by (Bana e Costa *et al.*, 2014).

This procedure results in a scoring of each relation.

5.5. Correlations hows

The same procedure has been taken to determine the correlation between hows. However, the correlations where divided into positive and negative, and in the negative ones the reference levels were defined as: inferior level equals -1 (extreme negative) and the superior level equal 0 (null correlation).

For each set of positive and negative correlations, each one were compared to the superior level correlation to define the ranking, after the principal diagonal of the matrixes were filled comparing each adjacent correlation.

The positive correlations are represented in green and the negatives in red in the HOQ (Figure 5)

5.6. Technical importances

This is the last step of building a HOQ, and it consists of calculating the importance of each technical characteristic. The technical importance has been calculated using the following equation:

$$IT_j = \sum_{i=1}^{n} R_{i,j} \times \triangle E^*{}_i \qquad (2)$$

Where $R_{i,j}$ is the relation between the customer need i and the technical characteristic j and $\triangle E^*_I$ is the weighted deviation of the customer need i (Figure 5).

5.7. HOQ Analysis

The HOQ represented in Figure 5 has been analysed using a procedure proposed by Yang e El-haik, 2003.

1. Doesn´t exist empty rows and columns, meaning that each customer need is assigned to a technical characteristic.
2. Some conflict points have been found, where the customer attributes a lower score to bag A compared with the competitors, however in the technical perspective the bag A has the highest score.

   For example, the bag A is the worst alternative in the customer need “não deve rasgar com facilidade”, however in the technical characteristic “resistência ao rasgamento transversal” has been considered the best. These situations need further development to determine who is right, the customer or the company.
3. In the analysis have been found two critical points, where both the company and its competitors had a poor score in the customer needs. The company may take advantage of these situation and improve the bag performance in the customer needs “não deve rasgar com facilidade” e “deve ser confortável the utilizar”.
4. In a general way, the most important technical characteristics are related with the resistance and dimensions of the bags, which are in concordance with the importances assigned to the customer needs.

   The hows that are related with the dimension could be improved directly, once they aren’t correlated with any other hows, improving the quality of the bags A.

   The characteristics that are related with the bags resistance should be analysed in more detail, continuing the QFD process in a new HOQ to find new solutions to improve the bags in these customer needs.

6. Conclusions

The usage of MACBETH together with the HOQ is a good solution to surpass the methodological errors found in the literature about the application of the HOQ. Using MACBETH, the scales used to score the alternatives and weighting process of the customer needs reflect the customers real value system and the companies that uses this approach will be able to make better decisions.

This article shows how MACBETH can be used in the several phases of the building of a HOQ, illustrating with a real case study applied to the quality of plastic t-shirt bags.

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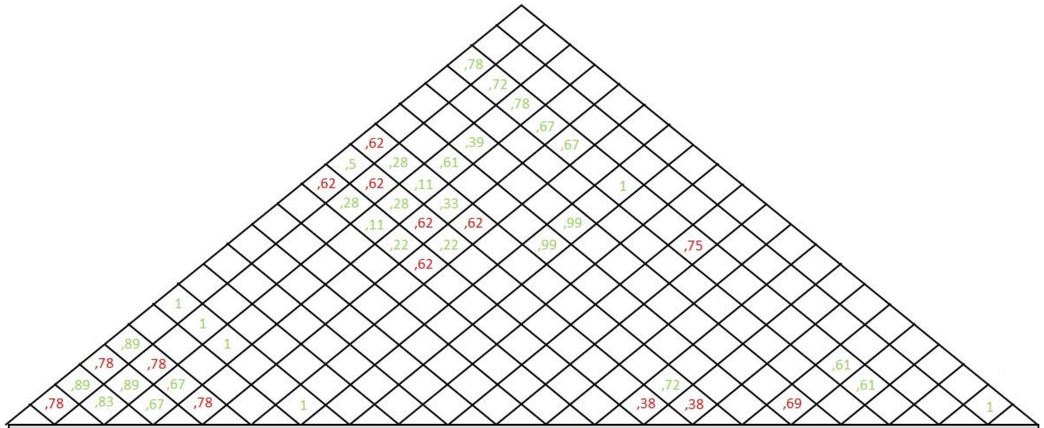

Características Técnicas (*Hows*)

Requisitos do cliente (*whats*)	Importância do cliente	Resistência ao rasgamento longitudinal	Resistência ao rasgamento transversal	Resistência ao impacto (dart drop)	Tensão na ruptura longitudinal	Tensão na ruptura transversal	Opacidade	Espessura	Largura do saco	Comprimento do saco	Largura dos foles	Comprimento das alças	Largura das alças	Tensão na ruptura na soldadura das alças	Tensão na ruptura na soldadura lateral	Tensão na ruptura na soldadura de fundo	Alongamento à ruptura transversal	Alongamento na ruptura longitudinal	Teste de atrito	Resistência à queda	Tensão Superficial	Adesão da tinta
		mN	mN	g	Mpa	Mpa	%	µm	mm	mm	mm	mm	mm	Mpa	Mpa	Mpa	%	%	%	Kg	dyn/cm	%
		⇧	ñ	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	-	-	⇧	⇧	⇧	⇧
Deve suportar o peso do conteúdo	0,25	0,40	0,55	0,49	0,86	0,29		0,79	0,55		0,07		0,64	1,00	0,71	1,00	0,24	0,57		0,49		
Não deve ser possível ver o conteúdo	0,08						1,00	0,71														
A impressão não deve sair	0,11																				0,83	1,00
Deve ser fácil de abrir	0,05							0,38					0,22						0,78			
Deve ter um tamanho adequado	0,23								1,00	0,88	0,62	0,12	0,38									
Deve ser "amigo" do ambiente	0,06	0,50	0,50	0,50	0,40	0,40								0,40	0,40	0,40	0,33	0,33		0,50		
Não deve rasgar com facilidade	0,21	0,71	0,65	0,95	0,41	0,24		1,00	0,29		0,12				0,52	0,91	0,18	0,24		0,95		
Deve ser confortável de utilizar	0,01							0,25	0,25	0,42	0,25	0,83	0,75					0,08				
Benchmarking Técnico: Saco A		70,21	105,94	-29,86	20,50	-121,00	30,00	-19,50	17,10	-24,00	-11,25	-150,00	34,40	97,10	96,75	98,75	122,67	106,01	40,00	0,00	67,00	25,00
Saco B		-91,95	100,16	37,82	93,25	230,54	-20,00	-3,00	26,22	-62,40	32,50	75,00	71,50	45,20	-89,75	74,00	101,36	-35,09	40,00	25,00	67,00	75,00
Saco C		74,65	45,02	72,53	-32,75	-255,00	0,00	-31,50	215,00	-38,40	93,75	0,00	120,30	4,70	-23,00	3,50	-38,68	21,74	180,00	166,00	100,00	100,00
Δ Avaliação competitiva		-4,44	5,78	-102,39	-72,75	-351,54	30,00	-16,50	-197,90	14,40	-105,00	-225,00	-85,90	51,90	119,75	24,75	21,31	84,27	-140,00	-166,00	-33,00	-75,00
Objectivo técnico		100,00	119,81	100,00	100,00	265,12	100,00	100,00	247,25	100,00	100,00	100,00	138,35	100,00	100,00	100,00	122,67	106,01	207,00	190,90	115,00	115,00
Importância Técnica		22,14	23,47	28,73	23,74	10,30	0,00	35,84	30,81	13,58	13,25	2,62	18,04	17,55	23,45	36,66	8,13	15,19	1,87	28,73	4,87	5,87
Importância Relativa		6,07%	6,43%	7,88%	6,51%	2,82%	0,00%	9,82%	8,45%	3,72%	3,63%	0,72%	4,94%	4,81%	6,43%	10,05%	2,23%	4,16%	0,51%	7,88%	1,33%	1,61%
Perfis de Pontuação Técnica																						

***Benchmarking* Cliente**

Requisitos do cliente (*whats*)	Saco A	Saco B	Saco C	Objectivo estratégico	Argumentos de venda	Δ s/ ponderação	Δ c/ ponderação	**Perfis de Pontuação do Cliente**
Deve suportar o peso do conteúdo	201,00	184,00	235,00	270,25	-8,50	-69,25	-17,31	
Não deve ser possível ver o conteúdo	100,00	20,00	20,00	100,00	6,40	0,00	0,00	
A impressão não deve sair	100,00	133,33	133,33	153,33	-3,67	-53,33	-5,87	
Deve ser fácil de abrir	67,00	67,00	100,00	115,00	-1,65	-48,00	-2,40	
Deve ter um tamanho adequado	50,00	50,00	100,00	115,00	-11,50	-65,00	-14,95	
Deve ser "amigo" do ambiente	90,00	62,00	38,00	100,00	1,68	-10,00	-0,60	
Não deve rasgar com facilidade	0,00	56,00	56,00	100,00	-11,76	-100,00	-21,00	
Deve ser confortável de utilizar	0,00	0,00	40,00	100,00	-0,40	-100,00	-1,00	

Figure 5 - House of quality of the t-shirt plastic bags