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Development of a quantification model for the cost of loss of image with customer complaints

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Despite the difficulty in measuring hidden quality costs, we must be aware not only of their existence, but also of their importance. Not surprisingly, they have been the causative factor in the closure of many companies because they are doubly dangerous. One the one hand, they represent very significant quantities of money and, on the other, they remain hidden, like the submerged portion of an iceberg [Campanella, J. (1999). *Principles of Quality Costs: Principles, Implementation and Use*. Milwaukee, WI: ASQ Quality Press]. Possibly one of the most harmful hidden quality costs, and most difficult to quantify, is the cost of loss of image (CLI) a company suffers because of faults detected by its customers. This paper develops an original tool that, with the use of fuzzy logic as an alternative to probabilistic theory, is capable of facilitating the quantification of the CLI in any company from the observation of its customer complaints. Once the theoretical model is presented, we proceed with its experimentation, making use of a case study as research methodology.

Keywords: complaints; cost of loss of image; fuzzy relations; expertise; hidden quality cost; quality cost

1. Introduction

The first written reference about the term 'quality cost' was by Juran at the beginning of the 1950s. Specifically, his book *Quality Control Handbook* (Juran, 1951) defines what he calls the 'cost of poor quality' as 'the sum of all costs that would disappear if there were no quality problems'.

Also in the 1950s, Feigenbaum pioneered a system of quality costs at the General Electric Company. The cited author developed a system that strived to bring together all the costs related with the development of a quality system and the inspection of products, as well as the costs incurred when the product failed to meet requirements.

It is precisely Feigenbaum (1956) to whom is owed what has been and currently remains being (Snieska, Daunoriene, & Zekeviciene, 2013; Raßfeld, Behmer, Dürlich, & Jochem, 2015) the model used most by companies for classifying quality costs. We are referring to the so-called P-A-F (Prevention–Appraisal–Failure) model. Taking the said model as reference, quality costs are usually classified as prevention costs if avoiding errors is sought, appraisal costs when detecting them is sought, and, finally, failure costs to refer to those committed by the very company regardless of whether the customer is aware of them, external errors, or if the customer is not, internal errors. Within the costs caused by errors, a new classification can be introduced (Dahlgaard, Kristensen, & Kanji, 1992; AECA, 1995). This classification goes according to whether they can be obtained based on

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objective criteria, therefore making their quantification relatively simple, visible quality costs, or if it is necessary to resort to essentially subjective criteria that are not at all conventional for their estimation, which considerably complicates such task, hidden quality costs. The relevance of these hidden quality costs is such that various authors, including Carr (1992), Sandoval-Chavez and Beruvides (1998), Malchi and McGurk (2001), Giakatis, Enkawa, and Washitani (2001), Chiadamrong (2003), and Yang (2008) suggest modifying the classic P-A-F model in order to enable an exclusive category for them.

All companies should observe the existence of hidden quality costs when adopting any decision affecting the quality function (Morse & Poston, 1989), because, as Feigenbaum (1991) establishes, their consideration, even with simple approximations, influences the determination of the necessary preventive approach in quality programmes.

Brown and Kane (1987) warn that hidden quality costs can account for three to four times the cost of recorded failures. Nevertheless, despite authors of the stature of Juran and Gryna (1988) and Campanella (1999) insisting on the need to measure them, in practice very few companies properly manage them (Sansalvador & Cavero, 2005). In the best cases, the hidden quality costs that are estimated are usually those elements that fall within the company's sphere of influence, such as excessive debt or excessive stock (Camison, Fores, & Puig, 2010). Less frequent is the quantification of what some authors call hidden external failure quality costs (Snieska et al., 2013). Among these, one stands out as much due to its importance as to the extreme difficulty of measuring it, the loss of revenue resulting from deterioration of the company's image resulting from a defective product or service detected by the customer (Modarress & Ansari, 1987; Amat, 1992; AECA, 1995; Tsai, 1998; Summers, 2000; Kaynama & Black, 2000; Srivastava, 2008). The importance of the cost of loss of image (CLI) is such that prestigious authors like Deming (1986) suggest its use as a priority measure of quality, while others, such as Moyer and Gilmore (1979), Bueno (1991), and Larran and Ruiz (1994), recommend its analysis separately from the remaining elements that make up the quality cost.

It seems evident that customer satisfaction is fundamental in order to achieve long-term success in any business (Kristensen, Dahlgaard, & Kanji, 1992; Zeithaml, Berry, & Parasuraman, 1996; McColl-Kennedy & Schneider, 2000; Grønholdt, Martensen, & Kristensen, 2000). On the contrary, its dissatisfaction will produce some costs, which, despite their complex classification (Moyer & Gilmore, 1979), no organisation should ignore. This is precisely the objective proposed in this paper, of developing a methodology that facilitates the quantification of what is probably the most important hidden quality cost, the CLI, by using information available at any organisation, the complaints it receives from its customers.

A great part of the literature written about the measurement of hidden quality costs stems from the study by Kotler (1991), and, in particular, that by Albright and Roth (1992), where different methods for calculating such costs are outlined. Since then, several authors have dealt with the quantification of hidden quality costs from different perspectives (see, for example, Carr, 1992; Robison, 1997; Chiadamrong, 2003; Freiesleben, 2004; Snieska et al., 2013). In our opinion, we should highlight the contribution by those who have proposed methods based on the use of the 'Function of the Loss of Quality' by Taguchi, such as Kim and Liao (1994), Vera and Sanchez (2002), Sedatole (2003), Chan, Ibrahim, and Lochert (2005), or Abdul-Kader, Ganjavi, and Solaiman (2010). However, most authors addressing the issue do not include uncertainty and subjectivity in their formal approaches, which, by definition, are present in the quantification of any hidden quality cost. In our opinion, the inclusion of such elements is obtained by the application of fuzzy logic.

The application of fuzzy set theory is a suitable approach in cases where uncertainty is due to incompleteness or imprecision (Walker et al., 2003). Several authors have dealt with uncertainty using fuzzy sets (e.g. Klir & Yuan, 1995; Zimmermann, 2000; Zadeh, 2005; Brotons & Terceño, 2010). On the other hand, applying fuzzy logic in management accounting is not new. Zebda (1984) and de Korvin, Strawer, and Siegel (1995) applied fuzzy logic in cost–benefit analysis researching deviations; Kaufmann (1984) did so in zero-based budgeting; Tanaka, Okuda, and Asai (1976) employed this instrument to resolve capital budgeting problems; Brewer, Gatain, and Reeve (1993) used it to improve programme analysis; Georgescu (1998) developed a model for the flexible estimation of cost functions; Chan and Yuan (1990) applied this methodology in their cost–volume–profit analysis to assist the accountant facing uncertainty and risk; Mansur (1995) used this to assess opportunity costs. There are even application precedents of fuzzy logic towards quality costs (Gutierrez & Carmona, 1995; Sansalvador & Brotons, 2013), but without considering the determination of the CLI, and, of course, making use of methodologies very different from that proposed in this paper.

2. Development of the proposed methodology

2.1. *Facilitate complaints and improve their analysis*

There is an element in all organisations that when duly strengthened permits establishing important measures of quality. We are referring to complaints or claims presented by customers, and companies need to value their importance as a source for solutions instead of as a source of problems.

A lack of complaints is not necessarily a symptom of good performance; occasionally, it means just the opposite. Although evidently it depends upon the product, often times, users consider presenting any type of claim a waste of time, and this makes them desist from doing so. By not lodging a complaint, the company can do nothing to ingratiate itself with the aggravated customer. If there is an alternative, such customer ultimately abandons the firm, all while spreading detrimental publicity about it. Therefore, all customer loyalty processes should begin with the development of a system that encourages the dissatisfied customer to make the cause of their dissatisfaction known. This will permit the adoption of precise measures to prevent their desertion, at the same time as providing information of great interest. Analysis of the complaints that regularly reach the company will make their classification into distinct categories possible, which is essential for the proposed model, to facilitate the transformation of external data, customer complaints, into valuable internal information, the cost to the company from the loss of image due to failures detected by its customers.

2.2. *Relate complaints to dissatisfied customers*

For relating the complaints that the organisation usually receives to the degree of satisfaction, or, said better, of customer dissatisfaction, we propose applying tools that relate symptoms to diseases. Other works that have previously been interested in these relationships are Sánchez (1979) in the medicine field, or Vigier and Terceño (2008) and Scherger, Vigier, and Barberà-Mariné (2014) in the business world. Nevertheless, this paper presents a new approach: the development of the proposed tools as a part of a model that facilitates the quantification of the CLI.

Once the company becomes aware of the importance of observing complaints as a source for improvement, and has acquired a thorough understanding about the reasons customers regularly complain, we suggest the following stages:

2.2.1. *Delimitation of complaints: definition of matrix* C

This stage begins with the determination of a set of years, T_t, during which the identification and analysis of both complaints and lost customers are possible, with $T_1,\ T_2,\ \ldots,\ T_t$, that is, $T = T_k$ where $k = 1,\ 2,\ \ldots,\ t$. For such a period, C is defined as the set of complaints (classic set) consistent in various types of complaints, $C_1,\ C_2,\ \ldots,\ C_n$, that is, $C = C_i$, where $i = 1,\ 2,\ \ldots,\ n$. Each complaint, C_i, is measured in accordance with the following scale of six elements: (1) Very mild; (2) Mild; (3) Neutral; (4) Somewhat serious; (5) Serious; and (6) Very serious. Each year, there are N_i complaints of type S_i, of which $n_i^{(1)}$ are very mild, $n_i^{(2)}$ are mild, ..., and $n_i^{(6)}$ are very serious.

By assigning the corresponding values from Table 1 to the number of customers who have complained, the p_{ki} values that measure the importance of each type of complaint i during year k are obtained.

$$p_{ki} = 0.0 \cdot n_{ki}^{(1)} + 0.2 \cdot n_{ki}^{(2)} + \cdots + 1.0 \cdot n_{ki}^{(6)}, \quad k = 1,\ \ldots,\ t, \quad i = 1,\ \ldots n. \tag{1}$$

This process is repeated for each type of complaint in each year t analysed. In this manner, it is possible to configure a matrix $P = [p_{ki}]$ that shows the importance of each complaint (i) in each year (k). This matrix is of the order $t \times n$.

The next step is to obtain the membership function of each type of complaint for each year. To do this, the importance of each complaint i from year k is divided by the maximum value of column i (maximum for such complaint from all years). In this manner, the membership function of the type of complaint i for year k is obtained.

$$q_{ki} = \mu(C_{ki}) = \frac{p_{ki}}{\max\limits_{k}(p_{ki})},\ k = 1,\ \ldots,\ t,\ i = 1,\ \ldots n. \tag{2}$$

By repeating the process for all elements from matrix P, matrix $C = [q_{ki}]$ can be obtained, which demonstrates the intensity of each type of complaint (i) in each year (k). This matrix is of the order $t \times n$.

2.2.2. *Delimitation of dissatisfied customers: definition of matrix* L

The company proceeds by estimating the number of dissatisfied customers throughout the analysis period. Since not all dissatisfied customers complain, it would be interesting for the company to conduct, during a reference period, customer surveys wherein customers are asked about the degree of satisfaction about products, and to group them according to linguistic labels such as type 1: Completely dissatisfied, type 2: Very dissatisfied, and type 3: Somewhat dissatisfied.

Table 1. Values assigned to the linguistic labels.

Linguistic label	Value
(1) Very mild	0.0
(2) Mild	0.2
(3) Neutral	0.4
(4) Somewhat serious	0.6
(5) Serious	0.8
(6) Very serious	1.0

The membership function of each type of dissatisfied customer is obtained by dividing the number of dissatisfied customers of each type h and year $k(n_{l_{kh}})$ by the maximum number of dissatisfied customers of this type for all years, $\max_k(n_{l_{kh}})$.

$$l_{kh} = \mu_L(L_{kh}) = \frac{n_{l_{kh}}}{\max_k(n_{l_{kh}})}, \quad k = 1, \ldots, t, \quad h = 1, \ldots, l. \tag{3}$$

We define matrix L as the matrix that shows the nominal level of each type of dissatisfied customer for each year. The matrix order is $t \times l$ (t years and 1 type of dissatisfied customers). We denote $L = [l_{kh}]$.

2.2.3. *Delimitation of the relation between complaints and dissatisfied customers: definition of matrix* R

Once matrixes L and C have been built, measuring the dissatisfied customers and the complaints received for each one of the T years analysed, respectively, the next step is to find the matrix R, of order $n \times p$, which represents the fuzzy relationship between the type of dissatisfied customer, L_i, and the type of complaint, C_j, and that can be defined as

$$R \in F(C \times L).$$

Each element from matrix R indicates the degree to which each dissatisfied customer, L_h, entails a complaint, C_i, and is represented by means of a value, r_{ih}, where $r_{ih} \in [0,\ 1]$ with $i = 1, \ldots, n$ and $h = 1, \ldots, l$. These matrixes can be derived by means of a fuzzy relationship between the number of dissatisfied customers and the complaints towards a particular company over T years.

To determine matrix R, we begin with the expression

$$L = C^{\bigcirc} R, \tag{4}$$

where L and C are known, and matrix R is unknown and may be obtained in accordance with Sánchez (1979). The largest relation, which is a solution to this equation, is

$$R = C^{-1} \alpha L = [c_{ik}] \alpha [l_{kh}], \tag{5}$$

with

$$C = [c_{ki}]^{-1} = [c_{ik}],$$

$$[r_{ih}] = \underset{k}{\Lambda} [q_{ik} \alpha \mathrm{l}_{\mathrm{kh}}].$$

Here,

$$q_{ik} \alpha l_{kh} = \left\{ 1\, q_{ik} \text{if } q_{ik} > l_{kh}. \right. \tag{6}$$

Thus, matrix R permits obtaining the distinct types of dissatisfied customers by knowing the complaints and their degree of incidence, so we can use it for predicting the number and degree of dissatisfaction in our customers in future periods through the knowledge of the complaints that reach the company.

2.3. *Quantify the cost that dissatisfied customer means to the company from complaints received*

2.3.1. *Prediction of the number of dissatisfied customer for year* k + *1*

First, matrix row $L^* = l^*_{t+1,h},\ h = 1,\ \ldots l$ is estimated, for which expression (4) is applied wherein matrix R (order $n \times l$) was previously obtained, and matrix C^* (order $1 \times n$) is obtained from the complaints received during year $t + 1$ from each type of dissatisfied customers (i).

$$L^* = C^* \bigcirc R. \tag{7}$$

Since the values of this matrix are between 0 and 1, the next step is to estimate each type of dissatisfied customers. To accomplish this, the matrix row number of dissatisfied customers is estimated, $CL^* = cl^*_{t+1,h},\ h = 1,\ \ldots l$. Matrix L^* indicates the degree of membership of dissatisfied customers to each of the aforementioned groups (see Completely dissatisfied, Very dissatisfied, etc.). If we multiply such degree of membership by the maximum number of dissatisfied customers in the group, $\max_k(p_{ki})$, the number of dissatisfied customers from the $t + 1$ period is obtained for each type of dissatisfaction. Each element from matrix CL^* is obtained as follows:

$$cl^*_{t+1,h} = l^*_{t+1,h} \cdot \max_k(p_{kh}),\ h = 1,\ \ldots,\ l \tag{8}$$

2.3.2. *Establish the number of non-customers that each dissatisfied customer causes*

A model that relates customer satisfaction with future sales is necessary. One option to approximate the number of non-customers that each dissatisfied customer causes is to resort to market studies, but if each company has to perform studies itself, access to them by organisations with fewer economic resources would be severely limited.

Another interesting option is to establish multiplier coefficients for each of the distinct types of the aforementioned dissatisfied customers (Completely dissatisfied, Very dissatisfied, Somewhat dissatisfied, etc.). The necessary information will be provided by various experts. These coefficients, once estimated, will be considered constant over time, and the very organisation, according to its needs and possibilities, determines when to revise and update them. In order to improve the treatment of the subjectivity and uncertainty existing in information supplied by experts, we advise using the Expertise Method, which originated in the work by Kaufmann (1987). This way, in order to establish the multiplier coefficients, a group of experts will be asked to make an initial quantification of the non-customers that each type of dissatisfied customer generates using an interval, $m_h = (\underline{m}_h,\ \bar{m}_h),\ h = 1,\ \ldots,\ l$.

With the aim of improving the information, we will proceed to treat the results obtained by calculating their generalised average.

$$M^1_h = (\underline{M}^1_h,\ \overline{M}^1_h) = \left(\left(\sum_{i=1}^{m} \lambda_i \underline{m}^{1\ p}_{hi} \right)^{1/p},\ \left(\sum_{i=1}^{m} \lambda_i \overline{m}^{1\ p}_{hi} \right)^{1/p} \right), \quad i = 1,\ \ldots m, \quad \lambda_i \in [0,\ 1],$$

$$\sum_i \lambda_i = 1.$$

The result will be a fuzzy interval, whereby the number of non-customers that a

determined type of dissatisfied customers generates will range, assuming maximum uncertainty, between the values of $\underline{M}_h^1$ and $\overline{M}_h^1$, with its central value being the average of both values (m_h^1).

Subsequently, if we still want to provide greater consistency to the results obtained, we could resort to the so-called counter-expertise. This is to say, we could ask new experts to comment on the opinions of the first experts, obtaining in this case the value m_h^2. While there are various methods of counter-expertise (Kauffmann & Gil Aluja, 1987), the following can be highlighted: request experts different from those who conducted the initial expertise to make assessments in order to establish a comparison. Then, if,

(a) If both expertise assessments provide similar results, the results are reliable, and the average of both would be taken (m_h).
(b) If the expertise assessments provide different results, then the results are not reliable, and additional measures would have to be taken, such as expanding the sample.

2.3.3. *Estimate the number of potential lost customers for year* k + *1*

Then, in order to estimate the number of potential customers lost during period $k + 1$, simply multiply the number of type i dissatisfied customers, calculated in the previous section, by the multiplier established to approximate the quantity of non-customers that each dissatisfied customer generates.

Let m_h be the multiplier corresponding to the type of dissatisfied customer, h. The number of lost customers is matrix row LL^*, which is obtained by multiplying matrix CL^* by the said multiplier.

$$LL^* = CL^* \cdot m' \tag{9}$$

where m is the matrix row of multipliers, with $m = m_h,\ h = 1,\ \ldots l$, and $LL^* = cl_{1h}^* \cdot m_h$.

2.3.4. *Quantification of the CLI*

Using accounting records, the annual benefit generated by an average customer (BAC) is estimated. This benefit is multiplied by the number of potential lost customers that was calculated in the preceding section. Finally, its actual value is determined, keeping in mind that the loss of the potential customer affects the benefit not only during the $k + 1$ period, but also for future periods. For this, an average period of time the customer remains doing business with the company is defined first (an estimation of the number of years on average a customer maintains a business relationship, x) along with the type of annual interest that is called r (if the company has excess liquidity, the type of interest it applies in its investment projects must be considered; if the company has a deficit, the average cost of its liabilities is determined). Consequently, expression (10) allows the organisation to estimate the CLI for year $k + 1$.

$$\text{CLI} = \left(\text{BAC} \cdot \sum_{h=1}^{l} cl_{1h}^* \cdot m_h \right) \cdot a_{x|r}. \tag{10}$$

3. Case study

Completing the research process begun with an actual application of the proposed methodology at a company is advisable. For this purpose, we collaborated with a small and medium-sized enterprise (SME), specifically an insurance brokerage that, with an insurance portfolio for 2014 valued at 1.2 million euros, can be considered representative of the industry average in Spain. As the developed model can be applied by companies from any sector, we decided to apply it to a service company given that the intrinsic characteristics of providing services, especially the subjectivity in the perception of their quality by the customer, explain that the estimation of the external failure quality costs in them are more relevant (Camison et al., 2010). Furthermore, the decision to opt for an SME was made to demonstrate that it is not necessary to be a large organisation in order to benefit from the developed tool. To us, this seems especially interesting given that Raßfeld et al. (2015) demonstrated that SMEs quantify quality costs less frequently than do large companies. The proposed objective is, using as reference the analysis of customer complaints and satisfaction during 2009–2013, to generate a model that, by knowing the complaints, permits approximating the CLI for subsequent years. Specifically, with the complaints received during 2014, we will be able to quantify the CLI for the company for that year.

According to the proposed methodology, the steps to be followed are given below.

(a) Matrix C: delimitation of complaints.

The analysis of the complaints that normally reach the brokerage permitted grouping them into five different types:

C1: Delays in submitting tenders.
C2: Errors in filling in the policy that were detected by customers.
C3: Poor advice on coverage.
C4: Poor advice on prices.
C5: Inadequate claims management.

Tables 2–6 show during the five years in which the study was carried out (2009–2013) the number and degree, following the scale of elements proposed in Table 1, of each of the complaints registered. The importance of each type of complaint i during year k, p_{ki} has been obtained according to expression (1).

Using the information contained in the preceding tables (Tables 2–6) referring to the 2009–2013 period, producing matrix C was made possible (expression (2)). Table 7 shows the matrix C.

Table 2. Number of complaints registered from 2009 through 2013 of type C1: Delays in submitting tenders.

Year	$p_{k\ 1}$	Very mild	Mild	Neutral	Somewhat serious	Serious	Very serious
2009	4.6	0	6	4	3	0	0
2010	8.2	0	5	7	6	1	0
2011	3.4	0	5	3	2	0	0
2012	2.6	0	4	3	1	0	0
2013	2.4	0	3	3	1	0	0

Table 3. Number of complaints registered from 2009 through 2013 of type C2: errors in filling in the policy that were detected by customers.

Year	$p_{k\ 2}$	Very mild	Mild	Neutral	Somewhat serious	Serious	Very serious
2009	1.4	0	5	1	0	0	0
2010	2.0	0	6	2	0	0	0
2011	1.4	0	5	1	0	0	0
2012	0.8	0	4	0	0	0	0
2013	1.0	0	3	1	0	0	0

Table 4. Number of complaints registered from 2009 through 2013 of type C3: poor advice on coverage.

Year	$p_{k\ 3}$	Very mild	Mild	Neutral	Somewhat serious	Serious	Very serious
2009	8.8	0	0	6	5	3	1
2010	13.0	0	0	7	7	5	2
2011	6.2	0	0	5	3	3	0
2012	6.4	0	0	4	4	3	0
2013	4.8	0	0	5	2	2	0

Table 5. Number of complaints registered from 2009 through 2013 of type C4: poor advice on prices.

Year	$p_{k\ 4}$	Very mild	Mild	Neutral	Somewhat serious	Serious	Very serious
2009	10.4	0	0	11	7	1	1
2010	15.2	0	0	15	8	3	2
2011	8.0	0	0	5	7	1	1
2012	6.8	0	0	6	6	1	0
2013	5.8	0	0	7	5	0	0

Table 6. Number of complaints registered from 2009 through 2013 of type C5: inadequate claims management.

Year	$p_{k\ 5}$	Very mild	Mild	Neutral	Somewhat serious	Serious	Very serious
2009	7.0	0	0	0	3	4	2
2010	9.2	0	0	0	4	6	2
2011	4.2	0	0	0	3	3	0
2012	3.4	0	0	0	3	2	0
2013	4.0	0	0	0	4	2	0

(b) Matrix *L*: delimitation of dissatisfied customers.

Likewise, the company conducted telephone surveys with its customers during the study period with the aim of establishing the number of dissatisfied customers and their degree of dissatisfaction. From the total number of the company's existing customers, 165 customers were randomly selected each year. On a scale of 0–10, totally dissatisfied customers were those who reported their degree of satisfaction with the services provided

Table 7. Matrix *C*.

	S1	S2	S3	S4	S5
2009	0.56	0.70	0.68	0.68	0.76
2010	1.00	1.00	1.00	1.00	1.00
2011	0.41	0.70	0.48	0.53	0.46
2012	0.32	0.40	0.49	0.45	0.37
2013	0.29	0.50	0.37	0.38	0.43

Table 8. Percentage of dissatisfied customers among those surveyed (2009–2013).

Year	Completely dissatisfied	Very dissatisfied	Somewhat dissatisfied
2009	0.61	3.03	9.09
2010	1.21	4.85	10.91
2011	0.61	2.42	6.67
2012	0.00	1.82	5.45
2013	0.00	1.21	6.06

Table 9. Matrix *L*.

	C1	C2	C3
2009	0.50	0.62	0.83
2010	1.00	1.00	1.00
2011	0.50	0.50	0.61
2012	0.00	0.37	0.49
2013	0.00	0.25	0.55

by the brokerage to be between 0 and 2; very dissatisfied customers reported a 3 or 4; and somewhat dissatisfied reported a 5 or 6. Customers who reported levels between 7 and 10 were considered satisfied, or, what is equivalent, not at all dissatisfied with the services provided. Table 8 shows the annual percentage of each kind of customers.

Table 9 shows the nominal level of each type of dissatisfied customers (Matrix *L*). It has been obtained according to expression (3).

(c) Matrix *R*: relation between complaints and dissatisfied customers.

Following the proposed methodology, we proceeded to the definition of matrix *R* (Table 10), from expressions (4)–(6), capable of relating complaints and dissatisfied customers.

(d) Prediction of dissatisfied customers for year 2014.

Following the proposed methodology, we proceeded to the definition of matrix *R* (Table 10), from expressions (4)–(6), capable of relating complaints and dissatisfied customers.

Table 10. Matrix *R*.

	C1	C2	C3
S1	0.00	0.25	1.00
S2	0.00	0.25	0.61
S3	0.00	0.25	1.00
S4	0.00	0.25	1.00
S5	0.00	0.25	1.00

Table 11. Complaints registered in 2014.

	$p_{k\ 5}$	Very mild	Mild	Neutral	Somewhat serious	Serious	Very serious
A	1.0	0	3	1	0	0	0
B	0.8	0	2	1	0	0	0
C	4.2	0	0	4	3	1	0
D	5.4	0	0	6	5	0	0
E	2.6	0	0	0	3	1	0

Table 12. Estimation of the total number of dissatisfied customers with the company in 2014 by categories.

Completely dissatisfied	Very dissatisfied	Somewhat dissatisfied
0	24	87

On the basis of matrix *R* and knowing the complaints registered for 2014 (Table 11), proceeding with the prediction of the total number and type of dissatisfied customers for that year was possible (expressions (7) and (8)). Table 12 shows the estimation of dissatisfied customers with the company in 2014.

(e) Number of non-customers caused by each dissatisfied customer.

In order to establish the number of non-customers that dissatisfied customers cause, we selected two groups of experts comprising marketing specialists, qualified insurance intermediaries, and commercial managers of insurance companies. According to Robbins (1994), the number of participants required for decision-making problems varies between 5 and 7. It was for this reason that six experts were chosen for each phase of the expertise, and all of them were provided with extensive information about the study being conducted, the characteristics of the company, the business it carries out, and the composition and importance of the customer base. Aggregation of the expert opinions was made by taking $\lambda = 1/6$ in both cases and $p = 1$ to obtain the arithmetic average. Table 13 shows the results for the three m_h multipliers of the two groups of selected experts. Because the distance between both groups is not excessive (less than 15% in the three cases), the values obtained are considered valid, concluding that for the company analysed, each completely dissatisfied customer generates 5.63 non-customers, each very dissatisfied customer generates 2.04, and each somewhat dissatisfied customer generates 0.18 non-customers.

Table 13. Expertise results.

H	$\underline{M}_h^1$	$\overline{M}_h^1$	m_h^1	$\underline{M}_h^2$	$\bar{M}_h^2$	m_h^2	Distance (%)[a]	m_h
1	4.00	7.50	5.75	4.00	7.00	5.50	4.44	5.63
2	1.17	3.17	2.17	1.00	2.83	1.92	12.24	2.04
3	0.13	0.23	0.18	0.20	0.15	0.18	4.65	0.18

[a]$\text{Distance}_h = [(\underline{M}_h^1 - \overline{M}_h^1) + (\underline{M}_h^2 - \overline{M}_h^2)]/(m_h^1 + m_h^1)$.

Multiplying the preceding m_h coefficients by the different types of estimated dissatisfied customers for 2014 (Table 12) will make obtaining the number of potential lost customers for 2014 possible, which is 111.

(f) CLI

As an average customer is estimated to generate an annual profit of 100 euros, the annual loss of image is valued at 6458.75 €. This amount, and by considering that on average customers remain with the company for 5 years and an interest rate of 4%, represents a total cost to the company from loss of image of 29,903.34 € for 2014 (expression (10)).

4. Conclusions

As Heagy (1991) points out, in order for a quality cost model to be fully useful, hidden quality costs should be considered. Nonetheless, although companies are becoming increasingly aware of the importance of such costs, especially the CLI, they usually consider them too difficult to quantify (Moyer & Gilmore, 1979), and ultimately often exclude them from their calculations (Schiffauerova & Thomson, 2006). Therefore, the objective sought in this paper is to facilitate for all organisations, regardless of their size, organisational structure, or the sector they belong to, a model capable of facilitating the quantification of the CLI.

Following these premises, the proposed methodology is based on a sequential process whose operation requires essential information for any organisation, the complaints registered by customers each year. Consequently, the first step is to develop a system that encourages dissatisfied customers to complain. As the company receives complaints from its customers, they are analysed and duly classified according to their severity. According to this information, matrix C can be obtained, which demonstrates the intensity of each type of complaint in each year. Following the proposed methodology, we define matrix L that shows the nominal level of each type of dissatisfied customer for each year. The next step is relating complaints to dissatisfied customers. The proposed methodology will facilitate the acquisition of a matrix capable of predicting the number and degree of customer dissatisfaction in a period through the knowledge of the complaints registered during it (matrix R). From this matrix and the complaints registered in a particular year, it is possible to obtain the total number of dissatisfied customer for that year. However, in order to be able to estimate potential lost customers, knowing the number of non-customers that results from each type of dissatisfied customer is necessary. For this, and as an alternative to conducting market studies, we propose resorting to the opinion of experts through the application of the Expertise Method. The proposed methodology concludes with the determination of the actual value of income, which is given by the estimated benefit from potential lost customers.

After presenting the theoretical model, we proceeded with its experimentation with a case study. In this manner, quantifying the CLI that an insurance brokerage suffered in 2014 was made possible with the knowledge of the complaints the company received during that year.

Despite the interest in the developed model, we are aware that its practical application with a case study may be controversial. Although the use of this methodology in the business world has increased considerably in recent years, the use of case studies as a research methodology has been criticised by some authors who observe certain weaknesses that limit its scientific potential. The most important one refers to the problems associated with the generalisation of the results obtained from the reduced number of cases studied, since, as occurs in our work, case studies frequently do not represent a significant sample. Gummesson (1991) and Hamel, Dufour, and Fortin (1993) stress this criticism using three arguments: the lack of statistical validity; the usefulness of the results for generating hypotheses, but not for testing them; and the lack of representativeness of the phenomenon that the study object constitutes, which prevents generalising with case studies. In this sense, perhaps the most appropriate counter is that by Yin (1989), who places emphasis on the research objective, because depending on it, it can be thought that the method correctly adjusts when, like is our case, it fundamentally pursues the representation of a theoretical model.

Disclosure statement

No potential conflict of interest was reported by the authors.

References

Abdul-Kader, W., Ganjavi, O., & Solaiman, A. (2010). An integrated model for optimisation of production and quality costs. *International Journal of Production Research*, *48*(24), 7357–7370.

Albright, T., & Roth, H. (1992). The measurement of quality costs: An alternative paradigm. *Accounting Horizons*, *6*(2), 15–27.

Amat, O. (1992). *Costes de calidad y de No calidad*. Barcelona: Gestión 2.000.

Asociación Española de Administración y Dirección de Empresas (AECA). (1995). *Principios de contabilidad de gestión: costes de calidad. documento n° 11*. Madrid: Asociación Española de Contabilidad y Administración de Empresas.

Brewer, P., Gatain, A., & Reeve, J. (1993). Managering uncertainty. *Management Accounting*, *6*, 9–42.

Brotons, J. M., & Terceño, A. (2010). A risk premium in the Spanish market: An empirical study. *Economic Computation And Economic Cybernetics Studies And Research*, *1*(44), 81–99.

Brown, F., & Kane, R. (1987). Quality cost and profit performance. In A. Grimm (Ed.), (ASQC Quality Costs Committee), *Quality costs: ideas & applications* (vol. 1, pp. 131–152). Milwaukee, WI: ASQC Quality Press.

Bueno, F. (1991). La gestión basada en el factor tiempo. *Boletín de Estudios Económicos*, *46*(143), 267–275.

Camison, C., Fores, B., & Puig, A. (2010). Impacto de la calidad de conformidad sobre los resultados a través de un análisis de los costes de no calidad: Un estudio empírico en la industria hotelera. *Spanish Journal of Finance and Accounting*, *39*(148), 711–734.

Campanella, J. (1999). *Principles of quality costs: principles, implementation and Use*. Milwaukee, WI: ASQ Quality Press.

Carr, L. P. (1992). Applying cost of quality to a service business. *Sloan Management Reviews*, *33*(4), 72–77.

Chan, W. M., Ibrahim, R. N., & Lochert, P. B. (2005). Economic production quantity and process quality: A multivariate approach. *International Journal of Quality & Reliability Management*, *22*(6), 591–606.
Chan, Y., & Yuan, Y. (1990). Dearling *with fuzziness in Cost-Volume-Profit analysis*, *Accounting & Business Research*, *78*, 83–95.
Chiadamrong, N. (2003). *The development of an economic quality cost model*. *Total Quality Management & Business Excellence*, *14*(9), 999–1014.
Dahlgaard, J. J., Kristensen, K., & Kanji, G. K. (1992). Quality costs and total quality management. *Total Quality Management*, *3*(3), 211–222.
de Korvin, A., Strawer, J., & Siegel, P. (1995). An application of control system to cost variance analysis. *Managerial Finance*, *21*, 17–35.
Deming, W. E. (1986). *Out of crisis.*Cambridge, MA: MIT, Centre of Advanced Engineering Study.
Feigenbaum, A. V. (1956). Total quality control. *Harvard Business Review*, *34*(6), 93–101.
Feigenbaum, A. (1991). *Total quality control*. New York, NY: McGraw-Hill.
Freiesleben, J. (2004). On the limited value of cost of quality models. *Total Quality Management & Business Excellence*, *15*(7), 959–969.
Georgescu, V. (1998). Flexible extimation of cost functions based on fuzzy logic modeling approach. *Fuzzy Economic Review*, *3*(2), 49–68.
Giakatis, G., Enkawa, T., & Washitani, K. (2001). Hidden quality costs and the distinction between quality cost and quality loss. *Total Quality Management*, *12*(2), 179–190.
Grønholdt, L., Martensen, A., & Kristensen, K. (2000). The relationship between customer satisfaction and loyalty: Cross-industry differences. *Total Quality Management*, *11*(4), 509–514.
Gummesson, E. (1991). *Qualitative methods in management research*. Newbury Park, CA: Sage.
Gutierrez, I., & Carmona, S. (1995). Ambiguity in multicriteria quality decisions. *International Journal of Production Economics*, *9*, 25–38.
Hamel, J., Dufour, S., & Fortin, D. (1993). *Case study methods*. Newbury Park, CA: Sage.
Heagy, C. D. (1991). Determining optional quality costs by considering costs of lost sales. *Journal of Cost Management*, *5*(3), 67–75.
Juran, J. (1951). *Quality control handbook*. New York, NY: McGraw-Hill.
Juran, J. M., & Gryna, F. M. (1988). *Quality control handbook* (4 ed.). New York, NY: McGraw-Hill.
Kauffmann, A., & Gil Aluja, J. (1987). *Técnicas operativas para el tratamiento de la incertidumbre*. Barcelona: Editorial Hispano Europea.
Kaufmann, A. (1984). Fuzzy set zero-based budgenting. *TIMS/Studies in Management Sciences*, *20*, 489–494.
Kaufmann, A. (1987). *Les expertons*. París: Ed. Hermès.
Kaynama, S. A., & Black, C. I. (2000). A proposal to assess the service quality of online travel agencies: An exploratory study. *Journal of Professional Services Marketing*, *21*(1), 63–88.
Kim, M. W., & Liao, W. (1994). Estimating hidden quality costs with quality loss functions. *Accounting Horizons*, *8*(1), 8–18.
Klir, B., & Yuan, B. (1995). *Fuzzy sets and fuzzy logic*. New Jersey: Prentice Hall.
Kotler, P. (1991). Strategies for Marketing Service Excellence. *The First Global Conference, Management Centre Europe* (London, March).
Kristensen, K., Dahlgaard, J. J., & Kanji, G. K. (1992). On measurement of customer satisfaction. *Total Quality Management*, *3*(2), 123–128.
Larran, J., & Ruiz, E. (1994). Nuevos escenarios económicos y contabilidad. *Esic Market*, *83*, 63–79.
Malchi, G., & McGurk, H. (2001). Increasing value through the measurement of the cost of quality (CoQ) – A practical approach. *Pharmaceutical Engineering*, *21*(3), 92–96.
Mansur, Y. (1995). *Fuzzy sets and economics: applications of fuzzy mathematics to non-cooperative oligopoly*. London: Ed. Edward Elgar.
McColl-Kennedy, J., & Schneider, U. (2000). Measuring customer satisfaction: Why, what, and how. *Total Quality Management*, *11*(7), 883–889.
Modarress, B., & Ansari, A. (1987). Two new dimensions in the cost of quality. *International Journal of Quality & Reliability Management*, *4*(4), 9–20.
Morse, W., & Poston, K. (1989). Accounting for quality costs – a critical component of CIM. In J. Campanella (Ed.), (ASQC Quality Costs Committee), *Quality costs: ideas & applications* (vol. 2, pp.53–60). Milwaukee, WI: ASQC Quality Press.

Moyer, D. R., & Gilmore, H. L. (1979). Product conformance in the steel foundry jobbing shop. *Quality Progress*, *12*(5), 17–19.
Raßfeld, C., Behmer, F., Dürlich, M., & Jochem, R. (2015). Do quality costs still matter?*Total Quality Management & Business Excellence*, *26*(10), 1071–1082.
Robbins, S. P. (1994). *Organizational behavior*. (9th ed.) New Jersey, NJ: Prentice-Hall.
Robison, J. (1997). Integrate quality costs concepts into teams problem-solving efforts. *Quality Progress*, March *30*(3), 25–30.
Sandoval-Chavez, D. A., & Beruvides, M. G. (1998). Using opportunity costs to determine the cost of quality: A case study in a continuous-process industry. *The Engineering Economist*, *43*(2), 107–124.
Sansalvador, M., & Brotons, J. (2013). Quality cost analysis: A case study of a Spanish organisation. *Total Quality Management & Business Excellence*, *24*(4), 378–396.
Sansalvador, M. E., & Cavero, J. A. (2005). El coste total de la calidad en organizaciones ISO 9000: Un estudio empírico. *Spanish Journal of Finance and Accounting*, *34*(127), 899–924.
Scherger, V., Vigier, H., & Barberà-Mariné, M. G. (2014). Finding business failure reasons through a fuzzy model of diagnosis. *Fuzzy Economic Review*, *29*(1), 45–62.
Schiffauerova, A., & Thomson, V. (2006). A review of research on cost of quality models and best practices. *International Journal of Quality and Reliability Management*, *23*(4), 647–669.
Sedatole, K. L. (2003). The effect of measurement alternatives on a nonfinancial quality measure's forward-looking properties. *The Accounting Review*, *78*(2), 555–580.
Snieska, V., Daunoriene, A., & Zekeviciene, A. (2013). Hidden costs in the evaluation of quality failure costs. *Inzinerine Ekonomika-Engineering Economics*, *24*(3), 176–186.
Srivastava, S. K. (2008). Towards estimating cost of quality in supply chains. *Total Quality Management & Business Excellence*, *19*(3), 193–208.
Summers, D. (2000). *Quality*. Columbus: Prentice Hall.
Sánchez, E. (1979). Medical diagnosis and composite fuzzy relations. In M. M. Gupta, R. K. Ragade, & R. R. Yager (Eds.), *Advances in fuzzy Set theory and applications* (pp. 420–433). North-Holland: Amsterdam.
Tanaka, H., Okuda, T., & Asai, K. (1976). A foundation of fuzzy decision problems and its aplication to an investment problems. *Kybernetes*, *5*, 25–30.
Tsai, W. H. (1998). Quality cost measurement under activity-based costing. *International Journal of Quality & Reliability Management*, *15*(7), 719–752.
Vera, S., & Sanchez, J. (2002). La estimación de los costes intangibles de la caliad en base a la variabilidad del proceso. *Esic Market*, *102*, 175–190.
Vigier, H. P., & Terceño, A. (2008). Model for the prediction of 'diseases' of firms by means of fuzzy relations. *Fuzzy Sets and Systems*, *159*(17), 2299–2316.
Walker, W. E., Harremoës, P., Rotmans, J., van der Sluijs, J. P., & van Asselt, M. B. A. (2003). Defining uncertainty: a conceptual basis for uncertainty management in model-based decision support. *Integrated Assessment*, 4(1), 517.
Yang, C.C. (2008). Improving the definition and quantification of quality costs. *Total Quality Management Business Excellence*, *19*(3), 175191.
Yin, R. K. (1989). *Case study research. design and methods, applied social research methods series*. London: Sage.
Zadeh, L. A. (2005). Towards a generalized theory of uncertainty (GTU) – an outline. *Information Sciences*, *172*, 1–40.
Zebda, A. (1984). The investigation of cost variances: A fuzzy sets theory approach. *Decision Sciences*, *15*, 359–388.
Zeithaml, V. A., Berry, L. L., & Parasuraman, A. (1996). The behavioural consequences of service quality. *Journal of Marketing*, *60*, 31–46.
Zimmermann, H.-J. (2000). An application-oriented view of modeling uncertainty. *European Journal of Operational Research*, *122*, 190–198.