

## **Good acoustics as an extra source of income in restaurants – A case study**

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### **ABSTRACT**

Bars and restaurants are deeply rooted in the Spanish culture. They are places identified with socialising, friendship, relaxation and places for opportunities and inspiration. Spain is the absolute world leader in number of bars and restaurants with one for each 175 inhabitants (i.e. almost 280,000 establishments). Unfortunately, noise levels in restaurants are often so loud that having a conversation with fellow diners becomes nearly impossible without having straining the voice, which hinders acoustic comfort and results in complaints by the clientele. A case-study of a restaurant in Madrid is reported in this paper. Even though the restaurant initially complied with the Spanish acoustic regulations, customers voiced their discontent with the acoustic environment numerous times. Therefore, the restaurant owner took action and commissioned an acoustic refurbishment. To evaluate its effect, three types of assessment were taken: (i) a subjective evaluation of the customers employing questionnaires (both pre- and post-intervention), (ii) measurements of different acoustic parameters before and after the refurbishment and (iii) a financial data analysis. By comparing the post- with pre-intervention results, it was shown that not only the acoustic-related responses and the clientele satisfaction were improved, but also the yearly revenue increased by 10%, with a 1.5 months' payback.

**Keywords:** Restaurants, Annoyance, Revenue  
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## 1. INTRODUCTION

Bars and restaurants are deeply rooted in the Spanish culture. They are places identified with socialising, friendship, happy moments and relaxation as well as facilitating inspiration work and businesses relationships. As a matter of fact, the restaurant business (restaurants, cafeterias and bars) is a big part of the economic engine in which many people venture (amounting close to 6.5% of Spain's GDP) [1]. Spain is the absolute leader in number of bars and restaurants in the world with one for each 175 inhabitants (i.e. a total of almost 280,000 gastronomical establishments [2]), where Spaniards spend in average 1900 € a year in the 159 visits per capita they pay to such establishments [1,2].

However, despite the sector's popularity and the amount of time people spend inside those places, it is unfortunately not unusual to enter a bar or a restaurant where the noise levels are far from optimal. Often noise levels are of such an extent that having a conversation with fellow diners becomes nearly impossible without straining the voice. As a matter of fact, it was shown in [3] that noise bested poor service as the most irksome complaint for restaurants users. Not only that, but it has also been shown that sound levels inside such places can surpass values which could be harmful to our health and result in hearing damage [4,5]. The latter explains the existence of *apps* (e.g. *SoundPrint*) devoted to assess acoustic environment in restaurants, and thus acoustics is inevitably becoming a parameter to take into account by the owners, when venturing into those businesses, since the reputation of the place is at stake.

Apart from a poor (or inexistent) acoustic planning during the design phase, there are other causes that can contribute to the acoustic environment in restaurants being considered as unpleasant; e.g. new design trends which often prioritise clean open spaces with very reflecting surfaces, exposed ceilings and open kitchens, live music being played, densely packed tables, and owners even seeking lively/noisy atmospheres as a sign of popularity of their business. Moreover, it was shown that increased noise levels can sometimes increase the consumption of drinks, as the "arousal" produced stimulates to drink faster and order more [6,7], and that noise (and its type) can disrupt taste and smell [8,9,10]. The latter are factors that can often go counter good acoustic design and comfort in certain types of establishments due to increased revenue by the owners.

Efforts in making public buildings accessible to everybody are growing in many countries, not only focused in the physical access but also in other concepts such as acoustic comfort [11]. For example, elderly people and those with impaired hearing rate restaurants high on the list of public spaces with serious acoustical problems [3]. Therefore, there are many acoustic challenges that should be planned for when designing such types of spaces, firstly due to health and well-being of all occupants but also from the economical point of view, as good acoustics can yield an increase in turnover of the business, as it will be later shown.

## 2. ACOUSTIC GUIDELINES IN RESTAURANTS

### 2.1 Optimal acoustic design?

So the question which often arises is: "*What are the optimal acoustic design features for a restaurant?*" The short answer is that there is no good acoustic solution that fits all establishments. Acoustic design is a cross disciplinary field (physics, architecture, psychology, hygiene, etc.) where many factors (economical, scientific, individual differences etc.) and participants (owners, clients, institutions etc.) come into play. Besides, speech is an individual, dynamic and fairly unpredictable sound source which is not easy to handle, as different people are affected in different ways. On top of that, there are many different types of restaurants (e.g. fast-food, more "traditional") with

different features and needs (furniture, size, shape and finishing) that makes it difficult to generalise.

Introducing absorption in the room by means of an acoustic ceiling as well as wall panels has been shown to be very important [4] and is the immediate and first measure to consider. One possible solution is to reduce the density of people and tables, although from an economical point of view this is not as profitable from the owner's perspective. The acoustical conditions in restaurants and similar environments was characterised in [4] by the so-called quality of verbal communication (related to the Signal-to-Noise ratio –SNR) in addition to the ambient noise level. A simple theoretical model for the ambient noise level was derived taking the Lombard effect into account, the main parameters being the volume per person, reverberation time and a parameter called group size. Based on this model, a sound classification of restaurants (from A to D) was proposed, where all the different establishments (fine dining, banquet halls, bistros, food courts, cafeterias, canteens, pubs etc.) could be included.

In general, to control the noise levels inside such places, it is of crucial importance to look at the following:

- Reverberation time and sound pressure levels, so that sound levels in the space do not escalate.
- The speech clarity, so that conversations inside groups can be held without straining the voice.
- Privacy aspects so nobody feels uncomfortable due to their conversation being heard in the table next to them.

## 2.2 Spanish acoustic regulations for restaurants

The only parameter that is regulated for restaurants and canteens in the Spanish building regulations (CTE DB-HR), is the reverberation time, being limited (for unoccupied conditions) to a value of less than or equal to 0.9 seconds (averaged in the mid-frequencies, i.e. 400 Hz-1250 Hz).

## 3. THE CRE-COTTÊ STUDY

The Cre-Cottê restaurant is located in Madrid on Brasil Avenue. The owner reported complaints related to noise, not only by the employees but also by numerous customers; some had even left the restaurant due to noise-related issues. Therefore, the restaurant management decided to take action and commission an acoustic refurbishment in order to improve the indoor acoustic comfort as well as the clientele's experience.



Figure 1: Dining volume before intervention (left) and after the absorbing materials were placed (right).

The restaurant has a main open plan volume devoted to dining space, which has a floor surface of 81 m<sup>2</sup> and a volume of 245 m<sup>3</sup>. The surfaces on walls and the soffit are all covered in gypsum, whereas the floor has a cladding made of tiles. The façade facing the street has 4 windows amounting a total of 15.5 m<sup>2</sup>. The furnishing of the restaurant comprises upholstered chairs, wooden tables and shelves (cf. Figure 1).

Absorbing material in form of free hanging units (*Ecophon Solo*<sup>®</sup>) were hung from the ceiling and also directly glued onto the soffit (*Ecophon Master SQ*<sup>®</sup>), with the layout as indicated in Figure 2. In order to evaluate the effect of the acoustic intervention, two main assessments were made:

- A subjective evaluation of the customers made by means of questionnaires (both pre- and post- acoustic intervention).
- Measurements of different acoustic parameters were performed also both before and after the refurbishment.

By statistically analysing all the previous results, different conclusions were drawn.

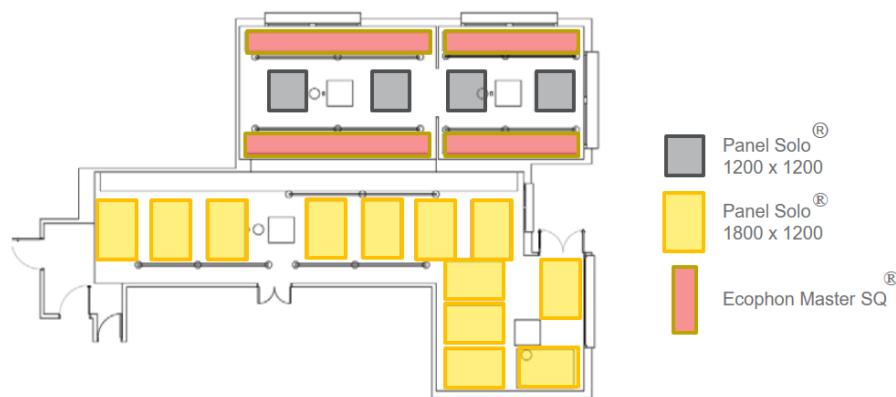


Figure 2: Layout of the absorbing materials placed on the restaurant's ceiling.

### 3.1 Surveys

The restaurant was acoustically refurbished at the end of March 2018. The work was performed without influencing the normal restaurant activities (i.e. during two evenings after closing and two bank holidays). Surveys were carried out both pre-project (during February 2018, where 194 people participated) and post-project (in the month of April 2018, with 182 subjects taking part). The short “post-card” style questionnaire, which was handed-out to the clients together with their bill (with the incentive of getting into a prize draw of a free meal for two), focused on different aspects. More particularly, the following questions were asked:

1. Ease of conversation with your colleagues
2. Distraction from other customers talking
3. Overall noise levels in the restaurant
4. The quality of the food
5. The quality of the service
6. Overall ambience/comfort in the restaurant
7. Value for money

The answers were given on a 5-point scale: “very dissatisfied”, “dissatisfied”, “okay”, “satisfied”, and “very satisfied”; see Figure 3. An additional question about whether or not they would recommend the restaurant to family, friends or colleagues was also asked, together with an explanation of why. Finally, a free-text answer was also given to the clients in case they wanted to further add any other comment. The questionnaire was written in Spanish language.

Date: \_\_\_\_\_ Time: \_\_\_\_\_ N° in party: \_\_\_\_\_ Email: \_\_\_\_\_ Phone: \_\_\_\_\_

Thank you for participating in our short survey on the *ambience* in our restaurant.  
As a thank you, we will enter you into a prize draw for a *free meal for two*.

Please rate how satisfied you are with the following factors (tick box):

	Very Dissatisfied	Dissatisfied	Okay	Satisfied	Very Satisfied
1. Ease of conversation with your colleagues	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Distraction from other customers talking	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Overall noise levels in the restaurant	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. The quality of the food	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. The quality of the service	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Overall ambience/comfort in the restaurant	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Value for money	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Would you recommend this restaurant to family, friends or colleagues?

No	Maybe	Yes
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Briefly explain your above answer: \_\_\_\_\_

Please feel free to leave any general comments on the back of this card. Thank you.

Figure 3: Questionnaire handed out to clients with their bill both before and after the refurbishment.

### 3.2 Measurements

In-situ measurements were carried out in the restaurant following the standards UNE EN ISO 3382:2010 (parts 1 and 2) in order to evaluate the effect of the acoustic intervention. More specifically, reverberation time, speech clarity, definition and sound strength measurements were performed both before and after the refurbishment. Likewise, the equivalent A-weighted sound pressure level during normal activity in the times of maximum occupancy (i.e. between 13:00-16:00) was evaluated several days before and after the refurbishment in order to see if the overall noise level was reduced which, in turn, would improve the experiencing of both workers and customers.

## 4. RESULTS

In the following sections, all the results (pre- and post- intervention) together with the statistical analyses of those with the customers' responses to the questionnaires, are presented.

### 4.1 Acoustic measurements

#### 4.1.1. Reverberation time

As previously mentioned, the reverberation time is the only parameter that is regulated for restaurants and canteens in the Spanish building regulations (CTE DB-HR), where the average reverberation time is limited (for unoccupied conditions) to a value of less than or equal to 0.9 seconds (averaged in the mid-frequencies, i.e. 400 Hz-1250 Hz). In Figure 4, the measurement results before and after the acoustic intervention are shown. It is depicted that due to the amount of acoustic absorption introduced in the restaurant, the average reverberation time in the mid frequencies sank from 0.66 seconds to 0.43 seconds.

It is interesting to see that, even though the restaurant initially complied with the aforementioned Spanish regulation, complaints due to noise often arose between the clients, thus acoustic comfort in the establishment not being optimal (a thing which was also shown in [12]). The latter not only evidences the fact that the regulation may be too lenient, but also the fact that the human hearing is multidimensional (i.e. several different components of the sound influencing how it is perceived) and should thus optimally be addressed and analysed by means of more parameters.

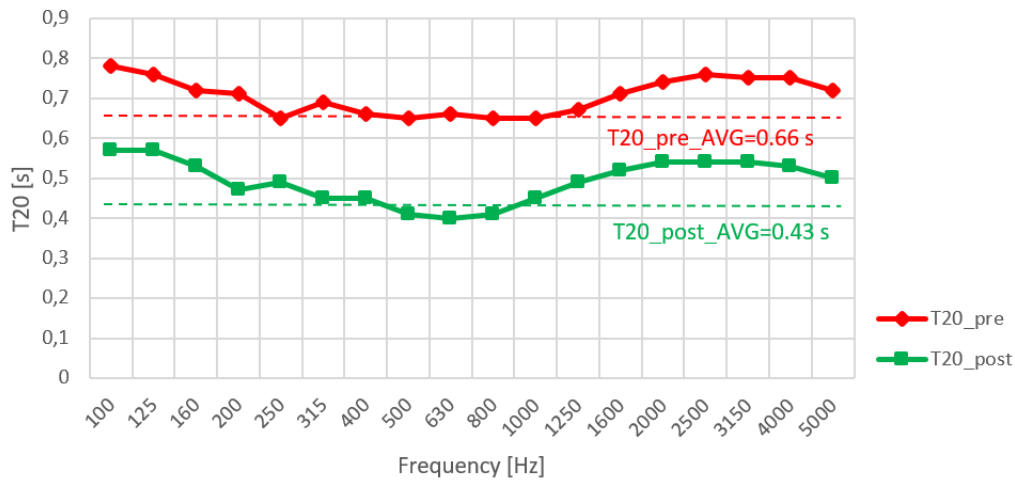


Figure 4: Reverberation time measurements both before and after the refurbishment.

#### 4.1.2. Speech clarity

In order to have a good speech clarity, we need not many late reflections (arriving to the listener later than 50 milliseconds after the direct sound does) and a good density of the first reflections and the direct sound. The higher the value (in dB), the better it is. One can easily see in Figure 5 that after the acoustic treatment, the average speech clarity (average in the mid-frequencies, i.e. 500-1000 Hz) improved more than 4 dB, indicating a betterment in intelligibility of speech.

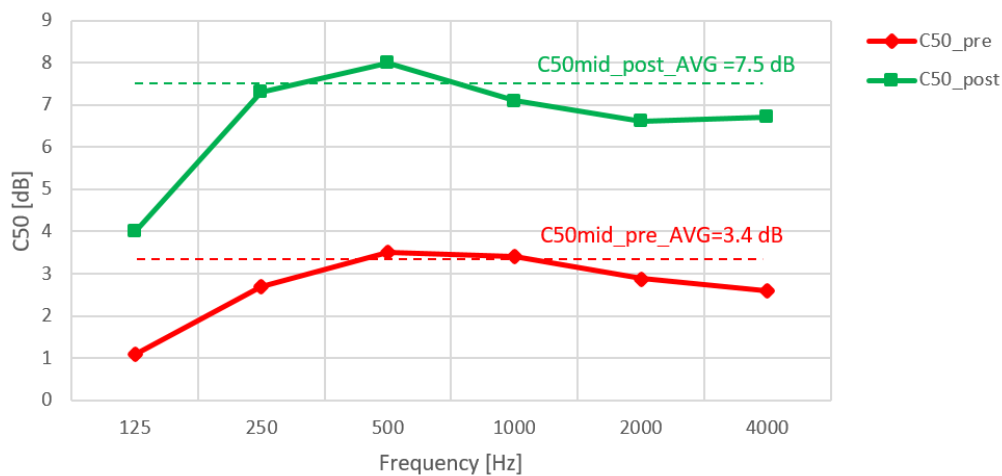


Figure 5: Speech clarity measurement results both before and after the refurbishment.

#### 4.1.3. Sound strength (G)

Strength (measured in dB) states the sound level in a real room in relation to the sound level in an anechoic room using the same sound source. Strength demonstrates the room reflections effect on the level. After the intervention (cf. Figure 6), the average room gain (in the mid-frequencies, i.e. 500-1000 Hz) diminished, which is beneficial, since in multi-talker environments such a restaurant, one wants to lower the sound strength as much as possible to avoid the Lombard effect, so that the sound levels do not escalate and consequently also worsen the speech clarity. If the speech clarity is good and sound levels are kept at a reasonable level (through low reverberation and sound reduction), this phenomenon can be reduced, helping to achieve acoustic comfort inside restaurants.



Figure 6 – Sound strength measurement results both before and after the refurbishment.

#### 4.1.4. Equivalent A-weighted sound pressure level ( $L_{A,eq,3h}$ )

The equivalent sound pressure level was measured, during the 3 hours of maximum activity in the restaurant (between 13:00 and 16:00), and thus where the highest noise levels occur, both before the refurbishment (from Thursday 15<sup>th</sup> March 2018 to Monday 19<sup>th</sup> March 2018) and after the acoustic renovation (between Thursday 12<sup>th</sup> April 2018 and Monday 16<sup>th</sup> 2018). It is depicted in Figure 7 that the sound levels markedly reduced after the acoustic intervention. As a matter of fact, the measured sound pressure levels averaged through all the days reduced 8.1 dB (from 75.3 dB -pre-project- to 67.2 dB -post-project-). This is a significant figure if it is taken into account that human hearing perceives a difference of 10 dB as double the “volume”.

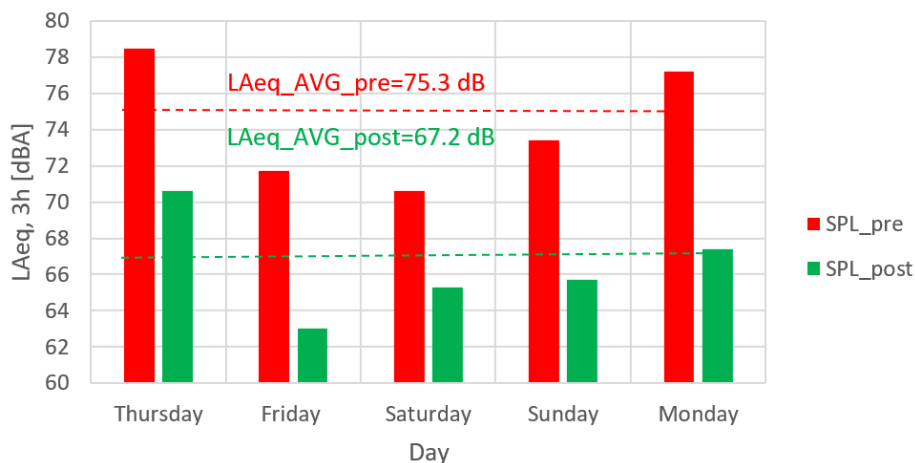


Figure 7 – Equivalent A-weighted sound pressure level measurements before and after the refurbishment.

## 4.2 Revenue, online ratings and surveys

### 4.2.1. Revenue

An analysis of the invoicing of the restaurant was carried out (cf. Figure 8). Note that in the following results, the monetary figures (in Euros) of the invoicing were omitted in order to respect the restaurant’s privacy. It was observed that the acoustic refurbishment brought alongside an increase in income (without the prices being modified). More specifically, an increase in invoicing of 11% in the 6 months following the refurbishment (compared to the same months of the previous year) was achieved. Extrapolating to one year the latter figure, it corresponds to a potential yearly revenue of

10%, i.e. slightly more than one extra one-month income in one year – compared to the average monthly income from 2017. The only months after the intervention where an increase in the invoicing was not observed was March 2018 and August 2018. Although it is difficult to find an explanation for the month of March 2018 (when the refurbishment took place – it may be it takes some time for the clientele to realise about the change of acoustic environment), August is the typical holiday month in Madrid, and thus maybe not representative of the normal activity since the restaurant is located in the CBD of the city, and also from the point of view that most of the clients would sit in the terrace and not indoors.

All in all, it was seen that an increase in the invoicing could occur due to improved acoustics. This was achieved with a simple acoustic solution (in terms of cost and installation time), which in this case had a payback period of circa 1 and a half months.

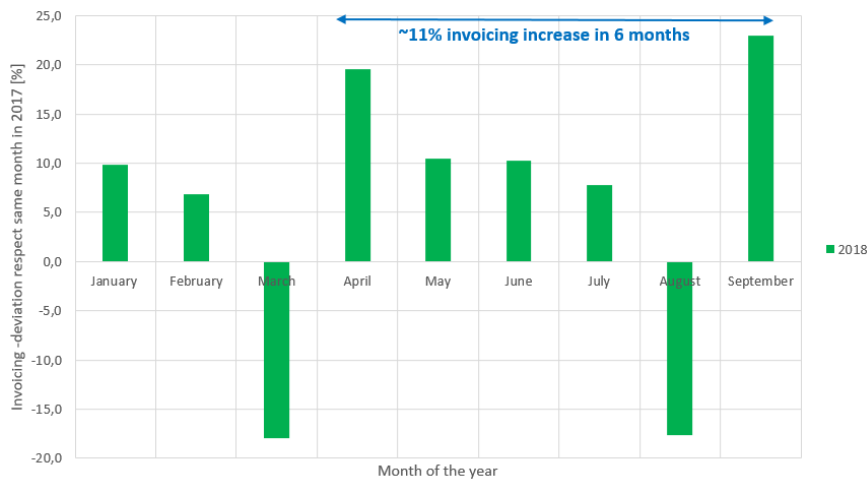


Figure 8 – Invoicing deviation in 2018 (in percentage) respect to the same month the year before (i.e. comparison before and after renovation).

#### 4.2.2. Online ratings:

An examination of online ratings was performed to see whether or not the acoustic intervention would also have an effect on them. More specifically, the platforms of *TripAdvisor*, *Google* and *El Tenedor* (Spanish version of *The Fork*) were checked. Whereas *TripAdvisor* and *Google* ratings did not show any noticeable change (due to the fact that there were not that many new reviews after the intervention), *El Tenedor* increased by 0.4 points (on a 10 scale) for April ratings pre- and post-project (cf. Table 1 and Figure 9). Moreover, in the period of time September-October 2018 (i.e. after the intervention) there are in there two specific mentions to what it could be understood as acoustic environment. The users refer to the “ambience” as “calm/peaceful/tranquil” (*tranquilo* in Spanish) and “agreeable/pleasant” (*agradable* in Spanish). Interesting enough is to see that there is no specific acoustic-related comment along those lines before the intervention.

Table 1 – Comparison of *El Tenedor* ratings both before and after intervention.

		Monthwise comparison	
		April-June	September-October
El Tenedor	2017	7,29 (17 reviews)	7,35 (10 reviews)
	2018	8,19 (18 reviews)	8,73 (15 reviews)



An increase in ratings is a very important issue from the owner's perspective. Although ratings are still nowadays focused more on food and service, and not acoustics (yet!), US economists found that when a restaurant rating improved by just half a star (in a 5-point scale) it was very much more likely to be full at peak dining times [13]. The fact is that 90% of consumers read online reviews before visiting a business, and 88% of consumers trust online reviews as much as personal recommendations. Customers are likely to spend 31% more on a business with "excellent" reviews [14].

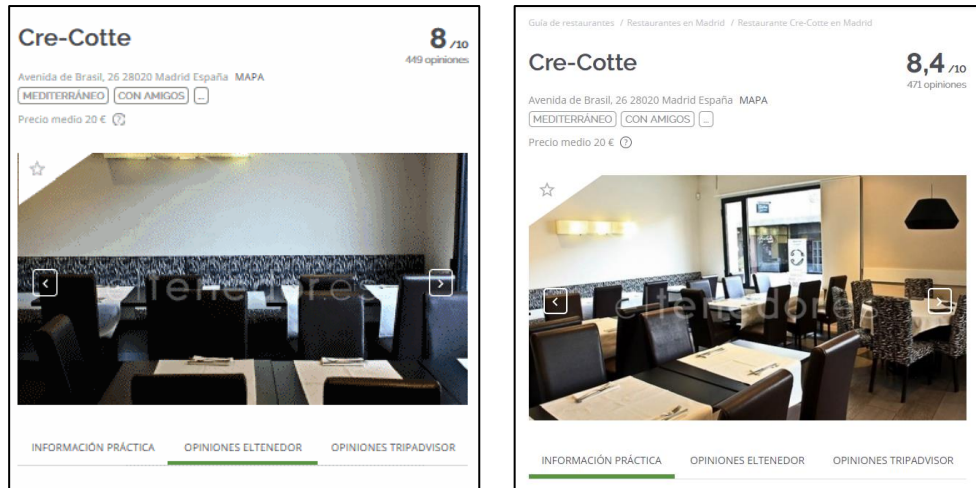


Figure 9: El Tenedor screenshots online ratings before (left – 5<sup>th</sup> April 2018) and after (right – 23<sup>rd</sup> October 2018) the refurbishment.

#### 4.2.3. Surveys

A total number of 194 persons participated in the survey pre-refurbishment (February 2018), whereas 182 subjects answered the same survey after the acoustic intervention (April 2018). The responses of the questionnaires were then statistically analysed. The right chart in Figure 10 shows the mean rating before and after the refurbishment. All differences, analysed using a Mann-Whitney U Test, are statistically significant ( $p < 0.05$ ) with a small size effect unless marked NS. The right chart shows the percentage of satisfied people (i.e. rating 4&5). All differences, analysed using a Chi-Square, are statistically significant ( $p < 0.05$ ) with small size effect, unless marked NS).

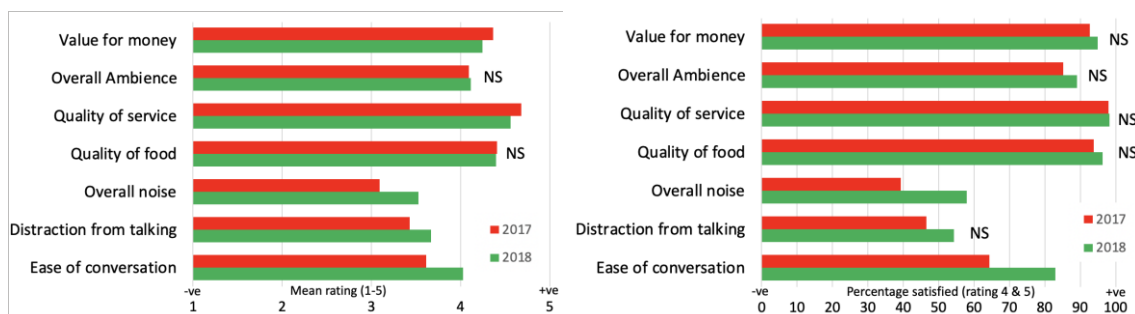


Figure 10 – Survey results. (Left): Mean rating before and after the refurbishment. (Right): Further analyses with the satisfied people.

The satisfaction with overall noise increased by 18.7% from 39.2% to 57.9%, and the satisfaction with distraction from talking and ease of conversation increased by 18.5% from 64.4% to an incredible 82.9%. A small effect for distraction from talking (7.8%) was also observed. It is clear that the acoustic-related ratings improved significantly, whereas the other ratings were maintained. The fact that the quality of the food and

service were maintained is not that surprising, as the ratings were already really high before the interventions and no changes were made to the menu or service.

## 5. CONCLUSIONS

An acoustic intervention was made in a restaurant where complains by customers and employees occurred before a refurbishment. More specifically, absorbing materials were installed in the form of free hanging units (*Ecophon Solo*<sup>®</sup>) and also ceiling panels glued onto the soffit (*Ecophon Master SQ*<sup>®</sup>). Even though the restaurant initially complied with the Spanish building regulations (average reverberation time of the empty space less than or equal to 0.9 seconds), the investigations performed by analysing the acoustic measurements and the customer opinions (surveys) both before and after the intervention showed the following conclusions:

- Acoustic measurements showed improvement (after the acoustic intervention) in terms of reverberation time, speech clarity, definition, sound strength and equivalent sound pressure levels.
- Dissatisfaction with overall noise and conversation with other guests improved amid the clientele after the refurbishments.
- No marked change in quality of food, service, ambience or value for money. However, it should be pointed out that the satisfaction was already very high pre and post-refurbishment.
- The on-line ratings showed a marginal improvement in the platform *El Tenedor*. This is a crucial aspect nowadays, as 90% of consumers read online reviews before visiting a business.
- Over the 6 months following the refurbishment, the income increased by circa 11% compared to the same months the year before, i.e. across the year there is a potential, in this case, for increasing the yearly income with slightly more than one extra month. Note that the prices in the menu were not varied between the both years analysed (2017 and 2018).
- The total cost of refurbishment for this particular case had a payback period of around 1 and a half months. From then on, the invoicing is likely to improve just but improving the acoustic atmosphere.

All in all, the simple acoustic solutions undertaken (in terms of installation time, cost and influence in the activity of the business) showed to significantly improve both customer satisfaction and revenue, with a payback period of less than a couple of months. The latter refurbishment could eventually be improved by adding other type of products (wall panels in the dining room, acoustic solutions for the kitchen), improving even more the acoustic comfort for both workers and customers.

## 6. FINAL REMARKS

One last important point that can be drawn from this investigation is that the fact that even if an establishment initially complies with the regulations in force, it does not necessarily mean that the acoustic atmosphere is optimal (as a matter of fact, this restaurant initially fulfilled the Spanish regulations in terms of reverberation time but the owner reported frequent complaints due to noise by the clients). This highlights that hearing is multidimensional and thus other parameters like speech clarity and sound strength may be necessary to take into account when acoustically designing a space.

## 7. ACKNOWLEDGEMENTS

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