Relation between the colour of a hotel room and its emotional effect

Mónica Buenaño-Allauca[1] and **Lledó Museros**[2] and **Ismael Sanz**[3] and **Zoe Falomir**[4] and **Luis Gonzalez-Abril**[5]

Abstract. Research suggests that colour plays an important role in creating wellness emotions in a hotel customer. This document shows the results achieved in two preliminary investigations. The first studies hotel room colour palettes associated with an emotion, using the Qualitative Harmony theory (*Qcharm*). From the conclusions of the first experiment a second one has been carried out, where the importance of the *blue* colour for inspiring a calm mood in a room of a hotel has been studied.

1 INTRODUCTION

Wellness tourism is now recognized as a significant and rapidly growing tourism segment [1–3]. According to the Global Wellness Institute 2018) worldwide wellness tourism has expanded from $563.2 billion in 2015 to $639.4 billion in 2017, with annual growth projections of 7.5% until 2022, higher than the 6.4% estimated for general tourism. The regions that lead wellness tourism spending are Europe, North America and Asia.

Luxury hotels with spa facilities are recognized as the leading providers of wellness services [2], [4]–[6]. These physical facilities demand a high financial investment. While luxury hotels are among the top providers of wellness services, there is a concern of modest accommodation service providers that they may not be able to compete with the wellness offerings of larger companies [4]; therefore, entrepreneurs must find strategies to meet the needs of wellness travelers.

As more consumers incorporate wellness into their lifestyles, there are many opportunities for all companies to offer wellness in their products. For example, Dimitrovski & Todorović [7] propose that wellness tourism should be oriented towards the emotional motivation of the guest instead of using luxurious spas, taking into account that emotion is a key point in the evaluation of personal well-being [8]. According to this reasoning, it is left aside to think that the wellness offers are exclusive and sophisticated.

In environmental psychology, the Stimulus-Organism-Response (SOR) model affirms that the physical environment acts as stimuli (S) that lead to people's emotions (O), which in turn, drive behavioral responses (R) [9]. That is, favorable environmental factors, such as music, lighting, space and colour, can stimulate positive emotions [10]–[12]. This document considers that through the manipulation of colour in the interior of a hotel room, there is an opportunity to create emotions of well-being for the client.

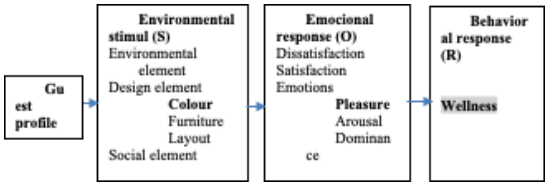


Figure 1. SOR model, relationship between colour stimuli, PAD emotions and behavioral responses

Colour is considered an indispensable element in interior design [13], which allows to alter the characteristics of the environment in an easy and economical way [13]–[15]. Furthermore, it is a subtle stimulant with a significant impact on people's emotions and behavior [14]–[18], and it can increase motivation and well-being [19, p. 1].

Based on the previous SOR model, several investigations suggest using colour to strategically manipulate emotions and achieve a positive behavioral response [14], [20]–[24]. However, it is a complex task to standardize the emotion evoked by a colour [25], due to factors that can influence its perception, e.g. by demographic factors such as age [19], gender and level of education [26], culture [27], and also by the inherent attributes of colour: as saturation, brightness and chroma [27], [28].

This context supports the great interest of businesspeople in knowing the elements of the environment that affect the emotions of their consumers. Therefore, the work presented in this paper represents the firsts steps for developing a recommender system that helps hotel interior designers to make more precise decisions about the changes to be made in decoration of physical environments, such as: recommend the colour of the interior of the room based on the demographic characteristics of the guest, or, generate decorations based on the premise of the desired emotion. In this way, hotels within the wellness industry may be able to create a pleasant atmosphere in the hotel room using colours that can meet the expectations of their future clients without the need for a large investment.

For this, two works have been developed. The first work tries to automatically generate different decorations in the same room and

[1] Facultad de Ciencias Administrativas y Económicas, Universidad Técnica del Norte, Ecuador, email: mpbuenano@utn.edu.ec
[2] Departamento de Ingeniería y Ciencias de los Computodres, Escuela Superior de Tecnología y Ciencias Experimentales, Universitat JaumeI, España, email: museros@icc.uji.es, isanz@uji.es
[3] Departamento de Ingeniería y Ciencias de los Computodres, Escuela Superior de Tecnología y Ciencias Experimentales, Universitat JaumeI, España, email: isanz@uji.es
[4] Bremen Spatial Cognition Center, University of Bremen, Germany, email: zfalomir@gmail.com
[5] Dpto. Economía Aplicada I, Universidad de Sevilla, España, email: luisgon@us.es

associate it with an emotion, through the application of the Qualitative Colour Harmony theory (QCharm) [29], which is able to define harmonic palettes based on a colour label (QCD)[30] by applying a set of operations. One of the conclusions of this test is studied deeply through a cognitive study in the second work, by studying the guests' preference for green and blue rooms when looking for calm emotions.

The rest of the article is organized as follows. Section 2 summarizes the theory of the qualitative colour harmony (QCharm). Section 3 presents the results of the work that has been carried out; colour palettes associated with an emotion and the colour preference associated with demographic factors. Finally, the conclusions and future work are presented.

2 THE QUALITATIVE HARMONY COLOUR NAMING THEORY (*QCharm*)

QCharm [29] is defined for the Qualitative Colour Naming theory presented in [30], which is a Qualitative Colour Description (QCD) model. This QCD model defines a reference system in the HSL colour space for qualitative colour description, which is built according to Figure 1 and 2, and defined as:

$$QC_{RS} = \{uH, uS, uL, QCNAME1..5, QCINT1..5\} \quad (1)$$

where uH is the unit of Hue; uS is the unit of Saturation; uL is the unit of Lightness; QCNAME1..5 refers to the colour names; and QCINT1..5 refers to the intervals of HSL coordinates associated with each colour. The chosen QCNAME and QCINT are:

$$QCNAME1 = \{black, dark\ grey, grey, light\ grey, white\} \quad (2)$$

$$QCINT1 = \{[0, 20), [20, 30), [30, 50), [50, 75), [75, 100) \in uL \mid \forall uH \wedge uS \in [0, 20]\} \quad (3)$$

$$QCNAME2 = \{red, orange, yellow, green, turquoise, blue, purple, pink\} \quad (4)$$

$$QCINT2 = \{(335, 360] \wedge [0, 20], (20,50], (50, 80], (80, 160], (160, 200], (200, 260], (260, 300], (300, 335] \in uH \mid uS \in (50, 100] \wedge uL \in (40, 55]\} \quad (5)$$

$$QCNAME3 = \{pale\text{-}red, pale\text{-}orange, pale\text{-}yellow, \ldots, pale\text{-}blue, pale\text{-}purple, pale\text{-}pink\} \quad (6)$$

$$QCINT3 = \{\forall QCINT2 \mid uS \in (20, 50] \wedge uL \in (40, 55]\} \quad (7)$$

$$QCNAME4 = \{light\text{-}red, light\text{-}orange, light\ yellow, \ldots, light\ blue, light\ purple, light\text{-}pink\} \quad (8)$$

$$QCINT4 = \{\forall QCINT2 \mid uS \in (50, 100] \wedge uL \in (55, 100]\} \quad (9)$$

$$QCNAME5 = \{dark\ red, dark\ orange, dark\ yellow, \ldots, dark\ blue, dark\ purple, dark\ pink\} \quad (10)$$

$$QCINT5 = \{\forall QCINT2 \mid uS \in (50, 100] \wedge uL \in (20, 40]\}$$

As a baseline, the QC_{RS} was calibrated according to the vision system used.

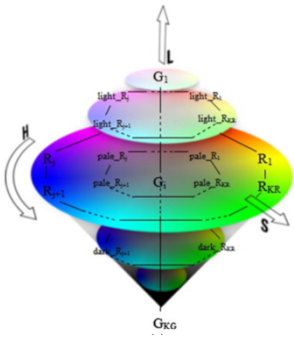


Figure 1. Describing the QCD: discretization of HSL

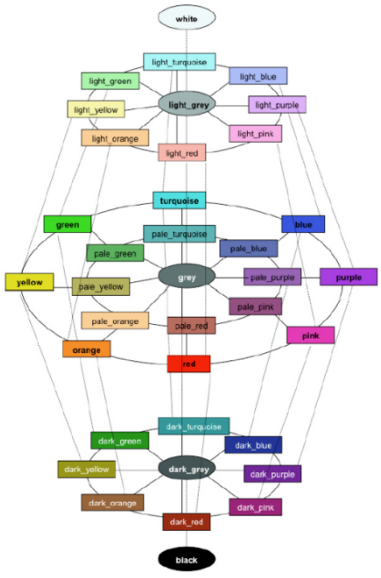


Figure 2. Labels of the QCD

The QCHarm theory is defined for QCNAME2 to QCNAME5. The gray-scale colours defined in QCNAME1 are not included, because previous research shows they can harmoniously combine with all the rest of colours.

The basic, and most common, colour combination operators are the *monochromatic*, *analogous*, *triad* and *split-complementary* operators (see Figure 3 for examples). These four basic operations return palettes of three elements. Except for the case of the monochromatic operation, the other three operators are defined for each QCNAME *independently*. Thus, it was necessary to define a fifth operation, the *combining operation*, which allows the creation of palettes of three colours belonging to different sets (QCNAME), and using colours that are not in the same hue (see Figure 4 for an example).

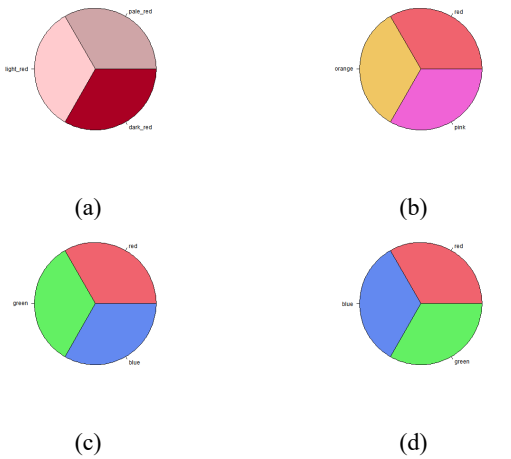


Figure 3. Examples of *QCharm* colour combinations based on the *red* colour: (a) monochromatic; (b) analogous; (c) triadic and (d) split-complementary.

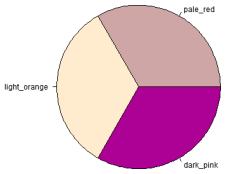


Figure 4. An example of a palette variation in *QCharm*, based on the analogous palette for the red colour shown in Figure 3.

2.1 Associating an emotion to a QCharm palette

To assign cognitive emotions, or moods semantic to a colour combination obtained by $QCharm$, the well-known Kobayashi's model [31] was used. This model was derived following a set of psychological investigations, in which 103 basic colours and 1152 three-colour combinations were matched to 202 keywords belonging to cognitive concepts related to feelings and moods (see Figure 5)

The process for calculating the correspondences between $QCharm$ and Kobayashi's model was done in two steps:

i. For each colour in a QCD palette, denoted by C, the coordinates in the 2-dimensional space defined by Kobayashi was obtained by using an SVM-based regression model. Figure 5 represents the results obtained graphically.

ii. Next, for each 3-harmonic-colour palette, and its corresponding Kobayashi colour coordinates, a semantic keyword regarding mood/lifestyle was obtained applying the k-NN technique. See Figure 6 and Table 1 for examples of palettes and the emotion associated to them

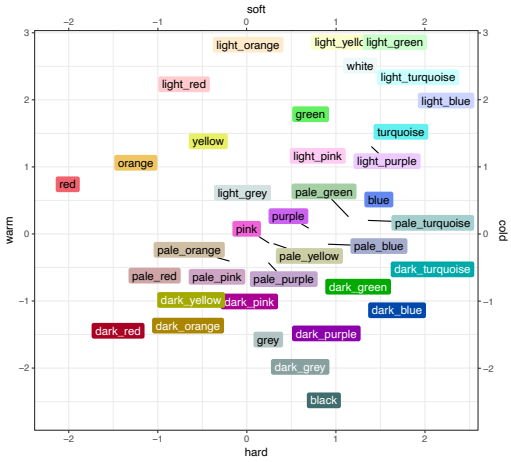


Figure 5. Graphical representation of the QCD palette in Kobayashi's space.

In order to find the correspondence between each colour in QCD (37) and a point ($kobax$,$kobay$) in Kobayashi's palettes a SVM-based regression model has been used. This model was built as follows: Kobayashi's 130 colours set is considered as the training set, where the QCD colour representation in the HSL space and the ($kobax$,$kobay$) colour coordinates are provided. Then, two SVMs are implemented, one for each component; that is, a SVM for obtaining $kobax$ and another SVM for calculating $kobay$. Finally, by applying the resulting SVM model, a vector of predicted coordinates in Kobayashi's scale is obtained for each color in QCD. So, for each colour name, apart from having their corresponding HSL coordinates, its corresponding coordinates in Kobayashi's model are also obtained.

Once each colour in QCD has its corresponding coordinates in the Kobayashi's space, then the semantic adjectives defined by Kobayashi can be related to the colours in QCD. The number of combinations of three colours provided by Kobayashi [26] is 1152, and 202 different keywords have been used for their semantic labelling. In order to take into account the label of the QCD palette, the nearest neighbour approach has been used since it is a non-parametric technique that does not make any assumptions on the underlying data distribution. After applying $QCharm$, a total of 1024 combinations have been obtained using the operators defined in the previous section. The $k-$NN learning technique requires defining a distance to evaluate which is the closest neighbour. Thus, in order to obtain a distance between combinations of three colours, it is necessary to consider all possible permutations between them, that is 3!=6. Let us clarify this point with an example: if the combinations given by the three colours A = (green, light-purple, pale-red) and B=(pale-red, green, light-purple) are considered, then the distance between them, $d(A,B)$, must be zero since A and B are the same colours, just differently ordered. Therefore, for the calculus of a distance between two combinations of three colours, the order does not matter.

Hence, if A and B are two combinations of colours, that is, if A=($C1A$,$C2A$,$C3A$) and B = (C1B, C2B, C3B) where $C\cdot\cdot$=($kobax$,$kobay$) then the distance measure between them, denoted by $d\Sigma(A,B)$, is defined as follows:

$$d^2_{\Sigma}(A,B) = min\{d^2(C_{1A}, C_{\sigma(1)B}) + d^2(C_{2A}, C_{\sigma(2)B}) + d^2(C_{3A}, C_{\sigma(3)B})\}$$

for all $\sigma \in \Sigma$ where $d(\cdot,\cdot)$ is the Euclidean distance in Ռhspace {-1.7pt}R^2 and Σ is the set of all permutations of the $\{1, 2, 3\}$ elements. For example, if $\sigma = (2, 3, 1)$ then $d^2(C_{1A}, C_{\sigma(1)B}) + d^2(C_{2A}, C_{\sigma(2)B}) + d^2(C_{3A}, C_{\sigma(3)B}) = d^2(C_{1A}, C_{2B}) + d^2(C_{2A}, C_{3B}) + d^2(C_{3A}, C_{1B})$

Then, after applying the $k-$NN and the $d2\Sigma$ distance to $QCharm$ combinations, the number of different semantic adjectives obtained is 106.

3 EXPERIMENTAL RESULTS

3.1 Associating an emotion to a QCharm palette

The *QCharm* application consisted of extracting colour palettes from real digital images of hotel rooms (extracted from the IMAGEnet database[2]) in order to associate it with a feeling or a mood.

Digital Image	QCharm-based semantic adjectives	QCharm Palette rating
R1	mature, nostalgic, alluring, aromatic	3.07
R2	decorative, extravagant, alluring, mature	3.23
R3	Aromatic, provocative, pastoral, nostalgic	3.12
R4	tranquil, formal, mysterious, quiet	2.62
R5	nostalgic, mature, stylish, Western	2.99
R6	aromatic, alluring, gorgeous, nostalgic	3.09

Table 1. Moods and rating of colour palettes obtained by QCharm in hotel images.

To be able to apply the proposed method to images, the following steps are necessary: first, colours in each image are discretised and the corresponding colour names (QCLAB) are obtained. Then, all palettes based on the 5 most frequent chromatic colours in the image are considered, but only if the combined frequency of all colours is at least 30% of the total of colours (including also grey scale colours). This prevents assigning mood keywords to palettes that are not representative enough. It also prevents the assignation of irrelevant keywords to images where grey scale colours predominate. Table 1 shows the results of the experiment for some of the images of the initial set (these images are shown in Figure 6). The table shows (i) the digital images used for extracting the colour palettes (first column), (ii) the keywords (semantic adjective representing a mood following Kobayashi' model) assigned using $QCharm$ (second column) and (iii) a palette score (between 1-5) representing how much a user can like the generated palette (third column). The four most relevant semantic adjectives for each image are shown, in order of relevance (not all are equally relevant).

In the full results we note that palettes containing *green* colours tend to have higher scores, and the palettes containing *blue* colours tend to get semantic adjectives related with calm moods. These results are consistent with the results presented in [8].

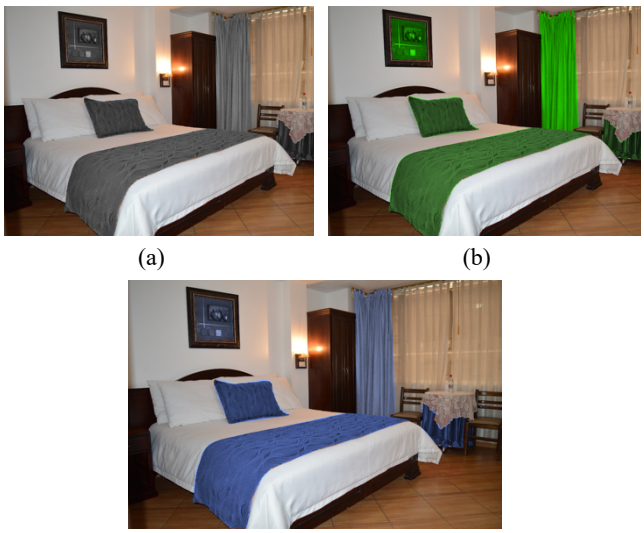
Figure 6. Images of hotel rooms extracted from ImageNET.

3.2 Colour preference associated with demographic factors

To continue evaluating the results of the previous experiment related to the *blue* colour, a new experiment was designed to determine which demographic factors influence the colour preference associated with wellbeing within a hotel room. To carry out the experiment, a survey was designed using the LimeSurvey software, aimed at people from Spanish-speaking countries: Spain, Portugal, Ecuador, Brazil, Colombia, Mexico. The first part of the survey covers demographic elements of gender, age, nationality, level of education. The second part of the survey was aimed at determining the colour preference of the standard hotel room. A photograph of rooms at the Hotel Plaza Victoria in Ibarra, Ecuador was selected. The room is made up of decorative elements, such as a decorative cushion, footboard, headboard, curtain and tablecloth, as we can see in Figure 7. These were the elements which changed during colour the experiment.

The QCHarm model was used to obtain the monochromatic combinations of the blue, green colour and combined among them in adjectives; normal, pale and dark; four combinations in red and yellow tones were included to test the *blue* user preference, and one question with an image in gray as control question was used. A total of 40 combinations, and for each test 8 room images were presented individually in a random sequence.

[2] IMAGEnet: http://image-net.org/



(a) (b)

(c)

Figure 7. Images from the survey: Study of Emotions and Colour in Hotels.

The total number of participants was 239. In order to test the hypothesis of whether there is a relationship between the favorite colour with gender of the participants, *a* chi-squared test has been carried out. The results of this test, shown in Table2, provide a *p-value* less than 0.002, and therefore the hypothesis is confirmed. A similar test has been carried out to study the relation between the favorite colour and age, and *a p-value* less than 0.01 is obtained (Table 3), again confirming the hypothesis. Once more, a chi-squared test has been carried out, in this case to study the favorite colour and level of education, and the results present a *p-value* less than 0.02 is obtained from Table 4, and therefore the hypothesis is again confirmed.

Thus, according to the results of a chi-squared test, it can be determined that there is statistically significant evidence of a relation between the favorite colour with gender, age and level of education since the *p-values* are less than the significance level of 5% (α = 0.05).

Table 2: Colour preferences associated with gender

Favorite colour	Female	Male	N/A	Total
Yellow	0.03	0.06	0.04	0.04
Blue	0.28	0.51	0.39	0.38
Orange	0.02	0.02	0.07	0.03
Red	0.17	0.08	0.25	0.15
Pink	0.08	0.02	0.07	0.06
Turquoise	0.17	0.09	0.07	0.13
Green	0.10	0.20	0.07	0.13
Purple	0.14	0.02	0.04	0.08

Table 3: Colour preferences associated with age

Favorite colour	18-30	31-40	41-50	51-60	>=61	Total
Yellow	0.07	0.03	0.04	0.00	0.00	0.04
Blue	0.25	0.34	0.60	0.44	0.50	0.38
Orange	0.00	0.06	0.02	0.07	0.00	0.03
Red	0.20	0.13	0.10	0.11	0.00	0.15
Pink	0.09	0.04	0.00	0.11	0.00	0.06
Turquoise	0.18	0.18	0.04	0.00	0.17	0.13
Green	0.13	0.16	0.08	0.19	0.00	0.13
Purple	0.09	0.04	0.10	0.07	0.33	0.08
Total	1.00	1.00	1.00	1.00	1.00	1.00

Table 4: Colour preferences associated with education level

Favorite colour	PhD	BSc	MSc	Total
Yellow	0.00	0.03	0.05	0.04
Blue	0.71	0.27	0.38	0.38
Orange	0.00	0.03	0.04	0.03
Red	0.10	0.20	0.12	0.15
Pink	0.00	0.09	0.03	0.06
Turquoise	0.03	0.13	0.14	0.13
Green	0.13	0.10	0.19	0.13
Purple	0.03	0.15	0.04	0.08
Total	1.00	1.00	1.00	1.00

These findings offer hospitality managers a significant insight into colour perception in room interior design and how consumers interpret colour design. Therefore, hotel administrators could opt for *blue* rooms as a strategy to provoke emotions such as relaxation, peace, calm, tranquility [8], [22], [27], [32]–[35], which are emotions that are compatible with well-being and sleeping well.

4 CONCLUSIONS AND FUTURE WORK

In this paper we have applied a Qualitative Harmony theory (QCharm) [29], which is able to define harmonic palettes based on a colour label (QCD) by applying a set of operations. We have shown its applicability by describing the mood associated to hotel images from the ImageNet dataset. Preliminary results of this application seem to be consistent with psychological studies about the preference of the colour blue for hotel rooms made in [8]. Therefore, this method could be used by hotels that cater to the wellness industry to adapt their rooms to the expectations and needs of their future clients.

In addition, the results of the survey carried out show us that the preference for the colour blue is related to factors such as age, gender and academic level of the client. This result strengthens the findings of the first investigation, on the importance of *blue* in room design and its relationship with calm moods.

To expand and improve research in this area, we intend to carry out future work on (i) applying surveys where rooms with different colour ranges are presented and analyzing the possible emotions of guests, (ii) analyzing whether colour influences the intention of the guest's behavior in terms of the possibility of staying or willingness to pay more for a room of a certain colour, iii) analyzing color preference between genders and other variables.

Also, as future work, we want to be able to create a system to recommend the set of colour palettes to be used in order to inspire a

feeling, or mood. This system will be useful for creating hotel marketing materials, and also for attracting and satisfying wellness travellers' needs and expectations.

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