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Additional Information

**IMPROVEMENT OF THE INTEGRATION OF VISUALLY IMPACTING  
ARCHITECTURES IN HISTORICAL URBAN SCENE, AN APPLICATION OF  
SEMANTIC DIFFERENCIAL METHOD.**

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# **IMPROVEMENT OF THE INTEGRATION OF VISUALLY IMPACTING ARCHITECTURES IN A HISTORICAL URBAN SCENE, AN APPLICATION OF THE SEMANTIC DIFFERENTIAL METHOD.**

## **1. Introduction**

The visual impact of buildings that substantially differ from their surroundings is a matter of interest and research, both in the case of artificial elements in natural landscapes and in the case of tall buildings in urban cityscapes (Karimimoshaver, 2018). This visual impact in urban scenes is crucial for buildings in the proximity of monumental architectures in historic city centers, since they can disturb the perception of the cultural values of the urban scene and viewers' observation of the monuments.

### ***1.1. Visually impacting architectures in urban scenes***

Located in the historic centers of different cities, particularly in Europe, there are buildings listed as "Assets of Cultural Interest" for their great architectural value. Around them protected areas are defined that regulate the urban activities permitted, with the purpose of preserving cultural values and the opportunity to contemplate the monument. Often, poor quality architecture is found in these environments that lessens visual value because of its extent, size, color, composition, architectural typology, construction materials, etc., as indicated by the urban building regulations in certain regions of Spain. We want to discover if treatments can be applied to the surfaces of these visually impacting architectures to improve their integration into cityscapes until they are ultimately replaced, if necessary.

There is “an extensive literature regarding visual integration of infrastructure and industrial facilities in the natural environment: (1) agro-industrial buildings (García et al., 2003),

(2) farms, (3) wind power plants (Ladenburg, 2008; Tsoutsos et al., 2009), (4) Photovoltaic power plants (Chiabrando et al., 2011, 2009), (5) high voltage lines (Sumper et al., 2010), etc. However, there are fewer studies regarding the visual integration of architecture into landscapes (Cloquell-Ballester et al., 2006; García et al., 2006; O’Connor et al., 2008) in urban settlements (Ünver and Öztürk, 2002)” (Serra Lluch et al., 2013, p. 560) and ancient city centers.

While some authors have empathized the importance of considering other aesthetic or perceptual aspects (Tolli et al., 2016), in most of these studies and environmental impact assessment projects the visual impact decreases when the artificial element is invisible, or as similar as possible to the backdrop. Sometimes, the mere presence of buildings is perceived negatively in terms of the visual quality of natural landscapes, whereas the compatibility or “fit” with their surroundings is considered important (Kent and Elliott, 1995; Ryan, 2006). In general terms, respondents consider that scenes containing buildings are “more ugly and unpleasant” in comparison to scenes with natural features (Kuper, 2017, p. 411). Nevertheless, architectural style can influence this evaluation; thus, buildings with rural characteristics have been shown to improve the positive perception of natural landscapes (Cloquell-Ballester et al., 2012).

While respondents tend to prefer developments that blend with natural settings (Kearney et al., 2008), we need to ask if this is also true in urban scenes. “The prevailing criteria used for visual impact assessment such as distance or visibility” are considered to be insufficient in historic landscapes (Jerpåsen and Larsen, 2011, p. 214), and recent findings have demonstrated that the meaning and the aesthetic of an architecture is sometimes more important than its visibility (Karimimoshaver and Winkemann, 2018). There might be architectural interventions that, although contrasting with their surroundings, increase the visual value of a cityscape. As pointed out by the London—based CABE (Commission for Architecture and the Built Environment), the relationship of a design to its context does not necessarily imply it has to ‘fit

in’: “At its worst, this can be little more than an excuse for mediocrity (CABE, 2003, p. 14)”.

When working in historic city centers, “townscape has to be understood as an integrated totality, where both change and conservation coexist” (Swensen, 2012, p. 381).

The previously mentioned research into the visual impact of artificial elements in natural and urban landscapes notes that visibility is an important criterion, but argues that other elements must be considered, such as aesthetics and meaning, opening the possibility of improving visual quality without reducing visibility. Therefore, we asked respondents to assess a building’s overall visual impact in a historic urban scene from three perspectives: its integration into the urban scene, the improvement of the cityscape’s visual quality and personal preference.

### ***1.2. Facade solutions to reduce the visual impact of architecture on cityscapes***

Some architects and artists have developed interesting facade solutions to establish a dialogue between architectures and their immediate surroundings (Serra, 2013). We can roughly classify these facade solutions into 3 types: *mimetic*, *harmonic* and *contrasting*. This initial classification is coherent with others used in environmental impact assessments: “visual continuity, diversity without contrast and diversity with contrast” (García et al., 2006, p. 837), camouflage, subordination, equal ordination, superordination and isolation (Spillmann, 1985).

Artistic approaches based on *mimesis* aim to render the visually impacting building invisible, by blending the architecture into the environment by using the same shape, material and/or color. This is the case with the exemplary *trompe-l’oeils* by Mehdi Ghadyanloo, and the use of mirrors to reflect surroundings, as in Roeland Otten’s work (Figure 1a).

Artistic trends based on *harmony* do not aim to make a building “disappear, but to make it congruent with the surroundings” (Serra Lluch et al., 2013, p. 561). Physical features, such as colors, materials and textures, are oriented to transform the perception of size, geometry, weight,

rhythm, and any other visual properties of the shape. Outstanding examples of this technique are works by the artist F. E. von Garnier (Garnier, 2007) (Figure 1b) and the Longyearbyen (Norway) project developed by G. Smedal (Smedal, 2009).

Artistic trends based on *contrast* use colors and materials distinct from the surroundings, considering divergence as a potential solution to increase the visual quality of the environment. Some studies have argued that, to achieve a positive aesthetic assessment in a natural landscape, a certain degree of contrast is required to “produce tension and change” (Schindler, 2005), and pointed out that “observers appreciate the lack of ambiguity in outlines that are not clearly perceived” (García et al., 2006). Recognized examples of these trends are the Beukelsblue in Rotterdam by Florentijn Hofman, the color projects in underdeveloped social communities by Boa Mistura, and the Louvre pyramid by Ming Pei (Figure 1c).



**Figure 1.** (a) Otten, Roenland. Electrical substation, Rotterdam. (b) Von Garnier, F. E. Rasselstein, Andernach. (c) Pei, Ming. Louvre Pyramid, Paris.

### ***1.3. Sensory impressions that influence visual assessments of cityscapes***

The aesthetic response to an environment begins with a first sensory impression; however with the addition of post-perceptual factors, such as knowledge, the response changes (Bell, 2001).

“Kuller (1991) used bipolar antonyms in Likert-type scales to assess the perceptions of observers in environments using architectural concepts: *pleasantness*, *complexity*, *coherence*,

*openness, affection and originality*, to which various other authors have added more, such as *naturalness* and *liveliness* (Real et al., 2000), *stimulation* (Desmet, 2003) and *protection* (Torres Sibille et al., 2009). O'Connor (2011) compared judgements about the *apparent size, visual dominance* and *congruity* of buildings" (Serra Lluch et al., 2013, p. 561), as well as *sympathetic* and *harmonic*, which have often been used in similar studies (Groat, 1992; Janssens, 2001).

One of the common criticisms made of EIA studies is that they use overly-technical terminology. Kansei engineering corrects this by using terms familiar to the population under study (Nagamachi, 2006). This methodology aims to identify users' perceptions of a product (in this case a facade) in their own words, and to quantify the relationship between their responses and the design features. Consequently, the assessment variables need to be tested before any relationship can be established between the individual design variables and the overall assessment of the product (Llinares Millán et al., 2018). These evaluation variables are the semantic space or conceptual scheme of the observers, that is, the general public; it is here that differential semantics are applied.

The Kansei modeling methodology is a relatively new approach to architectural assessment. Kinoshita, Cooper, & Kamei (2007, pp. 2–3) applied Kansei to the impression of the colors in the historic urban landscape in Kyoto, Japan, using the following pairs of opposing adjectives: “*cold – warm, unrefined- refined, restless-calm, unfriendly – friendly, uncomfortable – comfortable, artificial – natural, typical – individualistic, conservative – progressive, quiet – lively, old-fashioned - modern, awkward – elegant, western-eastern*. [...] The colors in Kyoto primarily evoked calm, elegant, comfortable, natural and conservative impressions”.

#### ***1.4. Design attributes that affect the visual impact of an architecture in an urban scene***

There are numerous physical, biotope and human components that both differentiate and identify a landscape. Among the design attributes considered in research about visual integration are color, shape, and texture (Cloquell-Ballester et al., 2012; de la Fuente de Val et al., 2006), together with fractality and concurrence (Bokharaei and Nasar, 2016; Torres-Sibille et al., 2009); architectural style, color contrast, and vegetative screening (Kearney et al., 2008); height, design of the top and color (Samavatekbatan et al., 2016); and the variety and presence of plants (Kuper, 2017). In cityscapes, urban regulations usually determine the design variables related to height (size), color and construction materials, to limit the aesthetic impact of an architecture (Cañas Guerrero et al., 1995; Cañas Guerrero and García and García, 1994). The visual texture of a landscape also plays an important role when assessing both natural (Krause, n.d.) and urban scenes (García et al., 2006). In historic urban scenes, the texture of a building is related to the construction materials of the architecture and their arrangement. We selected three design attributes for the analysis, shape, color and material, because they are the most common physical features considered in urban building regulations (Cañas Guerrero, 1994).

### ***1.5. Research aims***

The main objective of this research is to identify the best facade solution to improve the overall assessment of visually impacting architectures in a historic city center.

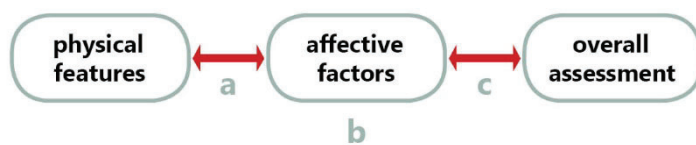
This objective is pursued based on the Kansei engineering approach (Figure 2), so we analyze the relationship between the physical features of facades and citizens' overall assessments from a perceptual point of view, on the basis that their perceptions depend on two main aspects, physical-objective parameters and subjective or affective evaluations. The subjects react to the particular characteristics of a facade, integrate these reactions into affective impressions and then transfer these affective impressions into an overall aesthetic evaluation of



the facade. Thus, the general objective can be disaggregated into the following specific objectives: (a) to identify the affective structure related to the description of the facade solutions (Figure 2b); (b) to identify the influence of the affective structure on the overall assessment of the solution (Figure 2c); and (c) to identify the influence of design parameters on observers' assessments (Figure 2a).

Following Kansei methodology, the affective factors that describe the assessment of the visual impact of an architecture in an urban scene (Figure 2b) were identified by the semantic differential method.

Regarding the physical features of the buildings (Figure 2a), we considered three design attributes, shape, color and material, and subsequently grouped the interventions based on these characteristics. Regarding overall visual assessment (Figure 2c), we considered three approaches: integration into the urban scene, the increase of the visual quality of the surroundings and personal preference.



**Figure 2.** Kansei Method Scheme

## ***2. Material and method***

### ***2.1. Case study***

We chose a visually impacting residential building in the protected area surrounding the Santa Cruz Church (1281), located in a historic neighborhood in Valencia (Spain).

## ***2.2. Stimuli: Proposed facade solutions.***

For the building used as the case study, we designed and considered ten possible facade solutions, together with the current solution. These solutions are different enough to cover the 3 potential visual relations of *mimetic*, *harmonic* and *contrasting*. To ensure variability in the stimuli, 10 highly skilled observers (3 experts in color with doctoral degrees, 3 experts in landscape with doctoral degrees and 4 architects) evaluated the images, focusing on the similarities and differences between the building and its surroundings based on the visual variables *shape*, *color* and *material*. 1- The *shape* has the same size, width and height, of the existing building in every suggested solution, but with different architectural styles, composition of windows, balconies, etc. These shapes were compared to the shapes of the traditional typologies in the historic city center of Valencia. These traditional houses have a tripartite composition: a ground floor with large windows and materials and colors different to the upper floors, then three or four upper levels with similarly-sized balconies and windows, and then a top floor, under a cornice, that may (or may not) have a formal solution with a set of small windows along the facade. 2- *Color* refers to the general color palette of the facade proposal compared to the usual color palette of the surrounding urban scene. The traditional color palette of the Valencian city center is well known from the study by García-Codoñer (2012) and mainly includes ochers and earthy colors. 3- *Material* refers to the construction materials of the suggested facade compared to the surroundings. The traditional materials of the Valencian historic urban scene are building stone for the ground floor and isolated elements, lime plasters, wood for the windows and forged iron for the balconies.

The comparison between the suggested facade treatments and the surroundings was evaluated using a scale from 1 to 5: not similar, not very similar, somewhat similar, quite similar

and very similar. In Table 1, these assessments for *shape*, *color* and *material* were transformed into a numeric value between -2 to +2. This initial evaluation served to classify the different interventions in mimetic (scores higher than +1), harmonic (scores between -1 and +1) and contrasting (scores lower than -1).

Regarding *shape*, all the facade solutions maintain the size, width and height of the existing building. This *shape* is quite similar to that of the surrounding facades. In images 2 and 3 a painted mock-up is used to match the shape of the traditional facades in the immediate surroundings. Images 0,1,4,6 and 9 have formal shape solutions that are unusual in the immediate surroundings and in the traditional city center, in general. Images 5, 7, 8 and 10 have a neutral evaluation and are considered somewhat similar in shape (Figure 3). Regarding *color*, five images are similar to the surroundings: images 2, 3, and 10 are associated with traditional architectural colors and image 9 with the green of vegetation. Two images have colors dissimilar to the surroundings, with saturated reds (image 1) and blues/violets (image 6). Images 0 and 7, with white colors, are considered neutral and somewhat similar to the surroundings, together with image 8, which reflects the colors of the surroundings on the mirrors of the cladding. Regarding *materials*, images 2,3,5,7 and 10 display local materials similar to the surroundings (lime plaster and stone), image 9 displays local vegetation as a “material”, although not traditional in the architecture, and images 0,1,4,6 and 8 use materials dissimilar to the surroundings.

Through this initial evaluation, we ensured we had a wide enough range of stimuli to analyze the relationship between the architecture and its surroundings in terms of shape, color and material: 3 mimetic, 3 harmonic and 4 contrasting.



Figure 3. Facade solutions proposed in this study

**Table 1.** Classification of the visual stimuli into three categories (mimetic, harmonic and contrasting), based on the similarity between the building and its surroundings using the variables shape, color and material.

<i>Stimuli shown</i>	<i>Same shape</i> [-2, +2]	<i>Same color</i> [-2, +2]	<i>Same material</i> [-2, +2]		<i>Initial classification*</i>
0	-1.4	-0.8	-1.2	-1.1	Contrasting
1	-1.8	-2	-2	-1.9	Contrasting
2	1	1.4	1.2	1.2	Mimetic
3	0.6	1.4	1	1	Mimetic
4	-1.6	-0.4	-1.6	-1.2	Contrasting
5	-0.2	1.4	0.8	0.7	Harmonic
6	-1.6	-2	-2	-1.9	Contrasting
7	-0.2	-0.2	0.6	0.1	Harmonic
8	-0.2	0.8	-2	-0.5	Harmonic
9	-1.6	1	0.4	-0.1	Harmonic
10	0.2	1.6	1.4	1.1	Mimetic

\* Contrasting [-2,-1], Harmonic [-1,1], Mimetic [+1,+2]

### 2.3. Visualization

Photographs are regularly used as stimuli in environmental visual assessments in both digital (Bishop, 1997) and analogical formats (Daniel and Vining, 1983) and, according to Roth (Roth, 2006, p. 179), “the overall scenic quality can be faithfully reproduced on the Internet”.

Unlike other studies, our research used spherical panoramic photographs, with a horizontal visual field of 360° and a vertical field of 180°. This allowed us to assess the building against its entire surroundings rather than just against a preset framework. The assessment of the building was carried out online through the respondents’ viewing devices (click to open online panoramas: [0](#), [1](#), [2](#), [3](#), [4](#), [5](#), [6](#), [7](#), [8](#), [9](#), [10](#)).

### 2.4. Questionnaire

The final questionnaire contained the following information:

(a) Objective information on the individual: age, gender, education, expertise in architecture (Yes/No), knowledge of the urban scene (Yes/No); if yes, the familiarity was categorized into 5 steps ranging from “I regularly go there” to “I go there from time to time”.

(b) Subjective information with 14 expressions to describe observers’ emotional responses.

Initially we collected 40 expressions used in assessments on landscape interventions in the legal and scientific literature (O’Connor et al., 2008), compiled during a preliminary stage using the focus group technique (Baxter, 1991). Later, this set of expressions was condensed using the affinity diagram technique (Terninko, 1997). The definitive set of expressions is as follows: distorts, congruent, coherent, shocking, large, contrasting, contextualized, attractive, striking, nice, complex, orderly, disturbing, pleasant. Each expression was evaluated on a 5-point Likert-type scale: totally disagree, disagree, neutral, agree, totally agree.

(c) A final overall assessment of each image with three statements: (1) “*I like the building in its surroundings*”, (2) “*The building increases the visual value of its surroundings*” and (3) “*The building is integrated into its surroundings*”. Each expression was evaluated on a 5-point Likert-type scale: totally disagree, disagree, neutral, agree, totally agree.

### ***2.5 Development of the survey***

The number of subjects was 133 (Table 2). Thus, the sample was bigger than the minimum size recommendation of Field (2005), with the criterion of a minimum of 6 observations for each variable included in the factor analysis. The selection technique was simple random sampling of citizens walking around the case study building and others belonging to a local neighborhood association.

**Table 2.** Descriptive analysis of the sample of participants in the study

<i>Gender</i>			<i>Age</i>			<i>Profession</i>			<i>Familiarity</i>		
Male	64	48.1%	<25	22	16.5%	Architect	59	44.4%	0	39	29.3%
Female	69	51.8%	25-35	31	23.3%	Non-architect	74	55.6%	1	40	30.1%
			36-45	35	26.3%				2	13	9.8%
			46-55	21	15.8%				3	18	13.5%
			>55	24	18.0%				4	7	5.3%
								5	16	12.0%	

\* The familiarity values range from 0= "I do not know the area", to 5= "I am a local resident"

The questionnaire was presented to the observers in an online survey. This included browsing at will the 360° panoramic images and an online survey to complete the Likert scales.

The statistical analysis of the findings was undertaken using SPSS 16.0 software (for more detail of the use of the software and the statistical techniques applied, see Field 2005). The data processing is described below (see summary scheme in Figure 4).

### *I. Descriptive Analysis*

First, an exploratory analysis was carried out to determine the overall assessment of the 11 images as a whole, using the 14 expressions to describe the observers' emotional responses and the 3 overall assessment questions.

### *II. Obtaining the semantic and perceptual space*

#### *II.1. Obtaining the semantic space*

We used principal component analysis to extract the semantic space. This reduction technique is mainly used to obtain conceptual schemes or semantic axes (Bastlevsky, 1994). Semantic axes are independent variables that characterize the perception of a product, in this case, an architectural intervention. Each axis is composed of a combination of concepts correlated to the respondents' answers. First, Bartlett's sphericity test was applied to verify the null hypothesis that the correlation matrix is an identity matrix. We selected only axes with eigen values greater than one, and used a varimax rotation. Each semantic axis was then assigned a label that

represented the set of variables. In assigning this label, it was taken into account that the most representative variables are those with the greatest contribution to the axis. Finally, Cronbach's *alpha* coefficient was applied to evaluate the internal consistency of the dimensions (Streiner, 2003).

## *II.2. Visualizing the subjects' perceptual space*

The factors that define the perceptual space are depicted in graphic format. This preference mapping enables visualization of the set of expressions analyzed together with the stimuli in a common space. The semantic distances, that is, the similarities and differences between concepts, can thereby be analyzed.

## *II.3. Affective evaluation of images*

With the factors that represent the affective responses, the semantic profile or assessment of each of the proposed architectural solutions can be obtained. To achieve this, the values of each of the factors were standardized with the current situation, so that the graph enables us to compare the assessments of each proposed solution with that of the current facade.

## *III. Obtaining the preference model*

We then determined the ranking of axes or perceptions which influence the overall assessment of the intervention by applying regression analysis. Three models were obtained, one for each overall assessment variable (1) "I like it", (2) "It increases the visual value", (3) "It is integrated into its surroundings". This analysis allowed us to identify the significant factors in the assessment of the proposed architectural solutions.

## *IV. Correlation between design attributes (shape, color and material) and affective factors*

We later determined how the design attributes (shape, color and material) impacted on the affective responses. To do this, we first obtained the Spearman's Rank Correlation Coefficients between the design attributes and the affective factors.



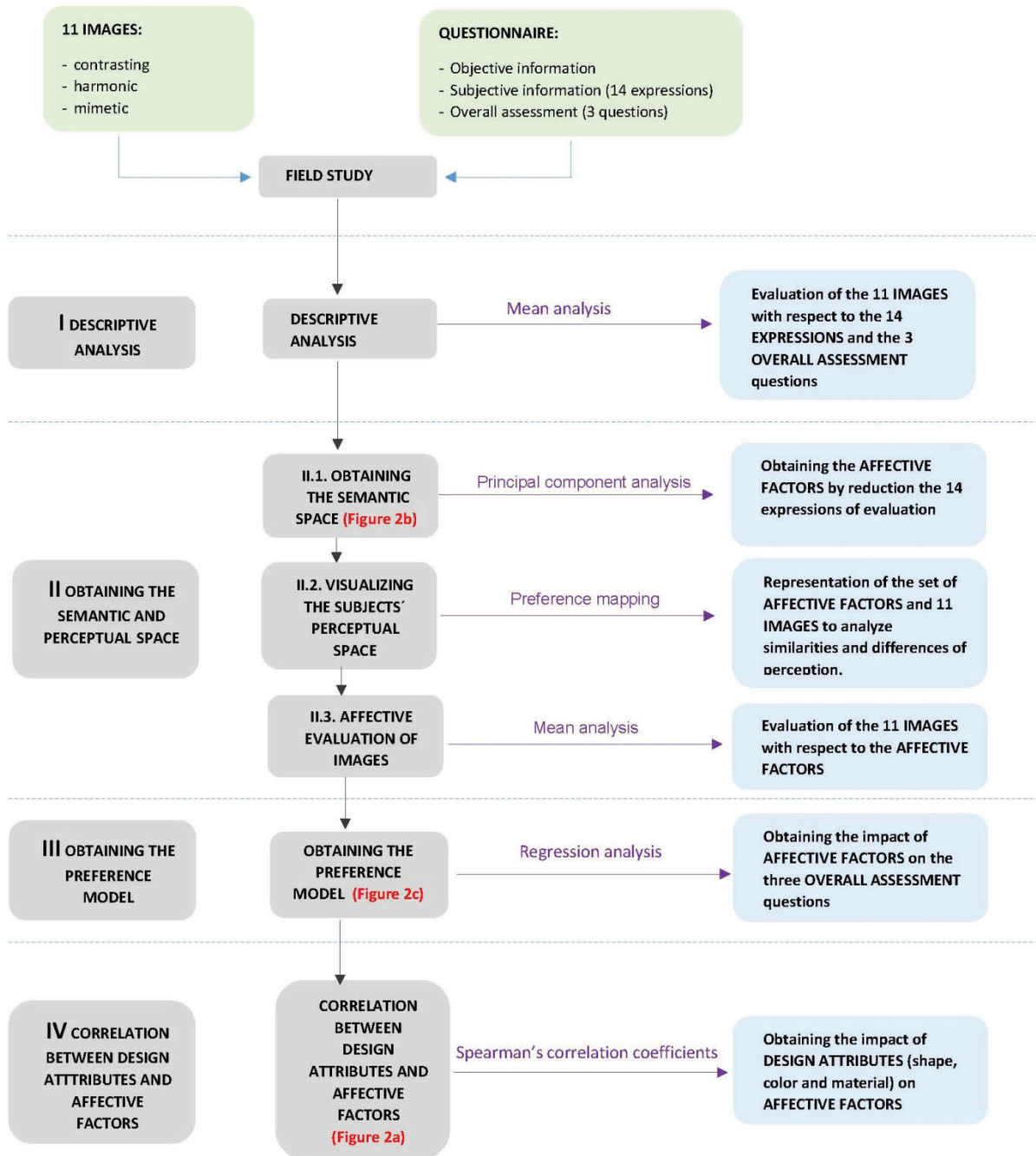


Figure 4. Methodological scheme of the study.

### 3. Results

#### 3.1. Descriptive Analysis

Figure 5 contains the average rating for each of the 14 expressions, the responses being differentiated by type of image, mimetic, harmonic or contrasting. Overall, we found more extreme evaluations in the contrasting images, both positive and negative, and more conflicting assessments of the mimetic solutions in comparison to the harmonic and contrasting assessments. The assessments of the harmonic and contrasting interventions are very closely related. They are not considered *congruent*, or *contextualized*, or *adapted to the surroundings*, contrary to the proposed mimetic solutions; furthermore, they are considered *striking* solutions, that distort and contrast. Moreover, the mimetic solutions, in contrast to the other two types of interventions, are considered *attractive*, *nice*, *orderly*, *pleasant* and *not unsettling at all*.

At Figure 6 are the evaluations of each of the architectural solutions compared to the current appearance of the building, based on the overall assessments: “I like it”, “It increases the visual value” and “It is integrated into”. Between the three groups of images, mimetic, harmonic and contrasting, we find important differences. Mimetic interventions have the best evaluations in the three assessments. Contrasting images receive the lowest scores for preference and integration, but a better assessment regarding increase in visual value. Image 6, a glass facade with bluish colors, is the only one considered worse than the current solution. Certainly, it contrasts with the surroundings in shape, color and material, glass walls being unusual solutions in historic city centers. Finally, harmonic images received mid-range evaluations in terms of overall assessments. Image 5 stands out within this group of harmonic images because it has lower rates for preference, integration and increase in visual value. Image 5 is a solution

consisting of stone slabs, a material present in the surroundings, but with a non-traditional composition of windows and balconies (shape).

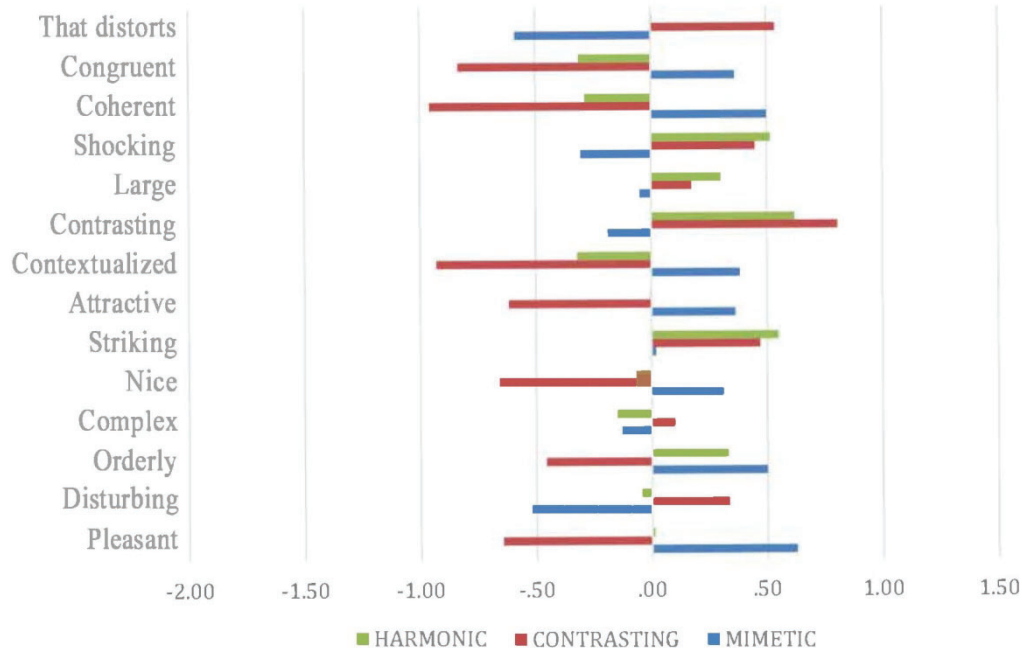


Figure 5. Descriptive analysis of the harmonic, contrasting and mimetic interventions.

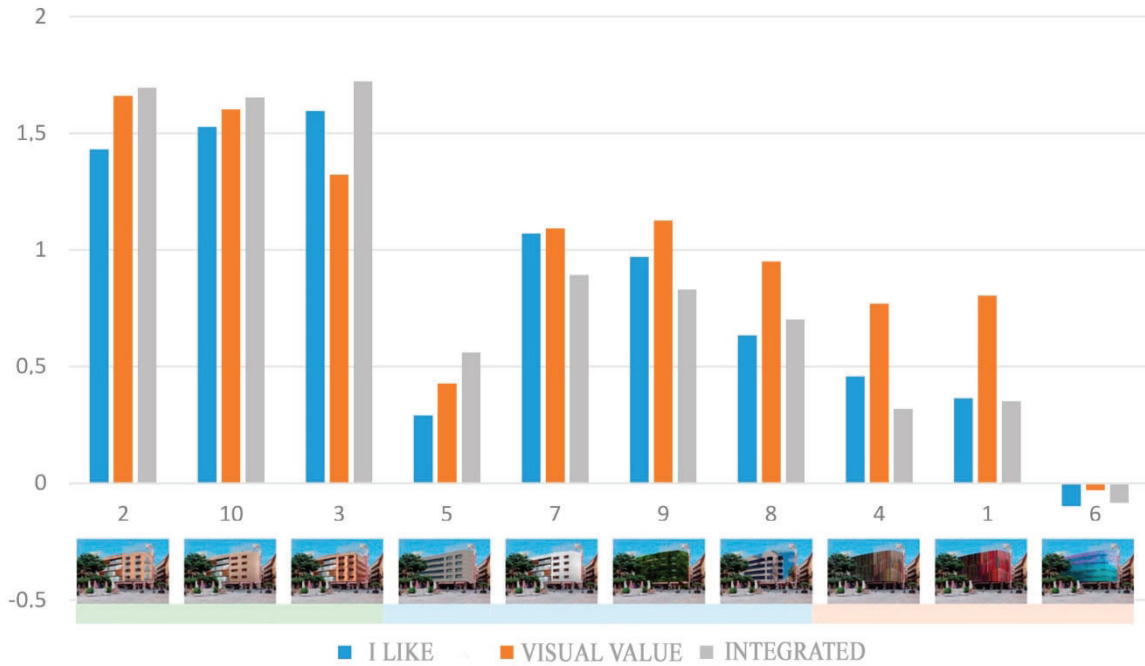


Figure 6. Mean value of each of the 10 proposed architectural solutions compared to the building's current state for the overall assessments: "I like it", "It increases the visual value" and "It is integrated into".

### 3.2. Obtaining the semantic and perceptual space

#### 3.2.1. Obtaining the semantic space

Principal component analysis was used to group the 14 expressions employed in the questionnaire into two “affective factors”, also known as “semantic axes”. These axes explain 61.57% of the variance. [Table 3]

**Table 3.** Factorial analysis of the 14 expressions used

	<b>Factor 1</b>	<b>Factor 2</b>
<i>% Variance Explained</i>	39.89	21.68
<i>Cronbach's alpha</i>	0.915	0.751
Coherent	0.895	
Contextualized	0.854	
Pleasant	0.845	
Congruent	0.839	
Nice	0.776	0.408
That distorts	-0.753	
Attractive	0.699	0.534
Orderly	0.642	
Shocking		0.740
Striking		0.635
Contrasting	-0.491	0.626
Complex		0.611
Large		0.500
Disturbing		0.350

We then carried out an analysis of the contribution of the 14 expressions to the two affective factors; this allowed us to assign to the factors appropriate descriptions. The following two axes were determined:

- Axis 1: This axis represents the *visual coherence* between an architecture and its surroundings. It shows a strong correlation with adjectives such as *coherent*, *contextualized*,

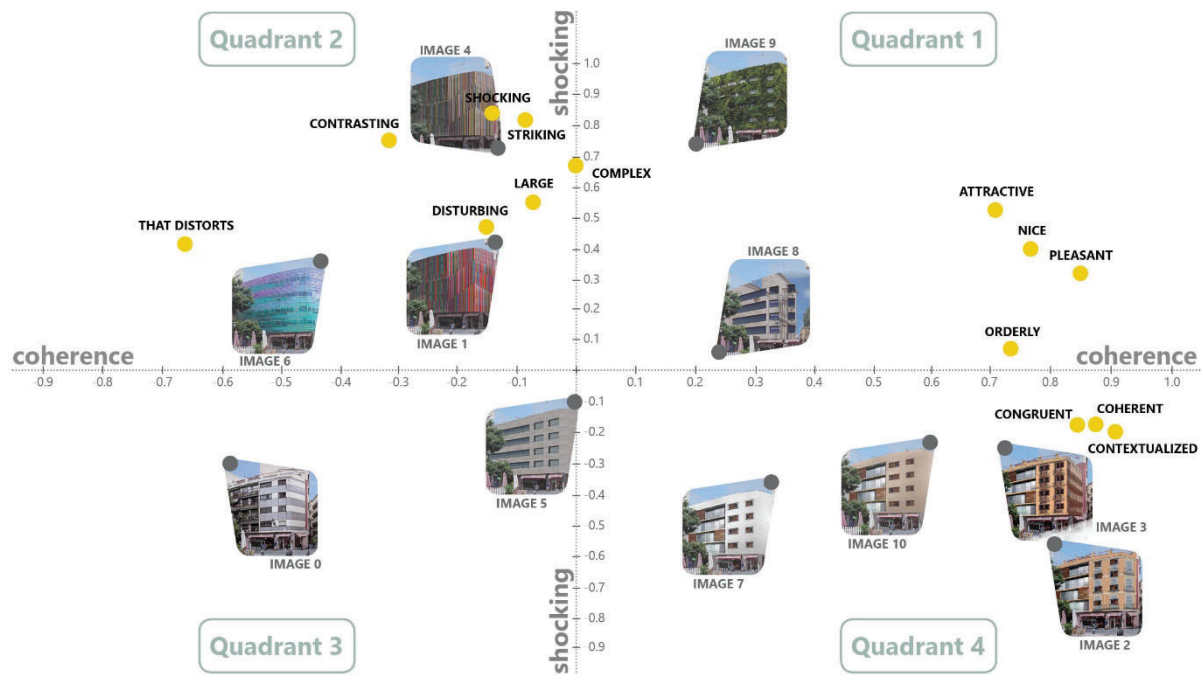
*pleasant, congruent, orderly* and *does not distort* its surroundings. It explains 39.89% of the variance.

- Axis 2: This axis represents a visual *shocking* contrast between an architecture and its surroundings. It shows a strong correlation with adjectives such as *shocking, striking, that contrasts, complex, large* and *unsettling*. It explains 21.68% of the variance.

Cronbach's *alpha* was used to verify the consistency of these factors. The values of this reliability coefficient for the two dimensions vary by 0.75, which shows that the scales are particularly reliable.

### **3.2.2. Visualizing the subjects' perceptual space**

The space defined by the semantic values obtained are presented in graphic format at Figure 7. The graphic shows the similarities and discrepancies between the expressions and the set of images being assessed. The x-axis represents the visual *coherence* factor. As previously noted, the high scores in this factor correspond to concepts such as *coherent, congruent, contextualized* and *pleasant*. This x-axis therefore separates proposals perceived as less *coherent* or poorly *contextualized* (image 0), as opposed to highly *contextualized* proposals (image 10). The y-axis represents the visual *shocking* factor, which separates the *shocking, striking* or *contrasting* images (images 4 and 9) from those that do not match these descriptions (images 2 and 7). The architectural solutions with the best overall values [Figure 7] are found in the fourth quadrant (positive value for *coherence* and negative value for *shocking*), while the images with the worse overall scores have a negative value for *coherence* and a positive value for *shocking*. The current situation can be found in the third quadrant, with negative values in the *coherence* and *shocking* factors.



**Figure 7.** Representation of the semantic space with the two affective factors, coherence and shocking. The figure shows the position of each expression from the test and facade proposal.

### 3.2.3. Affective evaluation of the images

We observed that the mimetic interventions (2, 10 and 3) significantly improved the perception of *coherence* compared to the current situation and reduced the perception of *shocking* [Figure 8]. The harmonic images (5, 7, 9 and 8) improved *coherence* but have no homogeneity regarding *shocking*, with values both above and below the current value. Last, the contrasting interventions (4, 1 and 6) generated the highest *shocking* perceptions compared to the current situation and improved the perception of *coherence*.



**Figure 8.** Improvement or worsening of the coherence and shocking factors of each proposed solution compared to the current situation.

### 3.3. Obtaining the preference model

#### 3.3.1. The “I like it” preference model variable

Regression analysis was carried out to assess the affective factors based on their relation to the overall evaluation “I like it” (Table 4). It can be seen that both are significant. The *coherence* variable has the greater weighting (1.143 compared to -0.186). The *shocking* variable is inversely correlated to the positive assessment. In other words, the greater is the perception of the *shocking* effect of an intervention, the lower is the “I like it” rating. The model fit is high (R=0.838).

**Table 4.** The preference model for the “I like it” overall assessment.

<i>I like it</i>	<i>B</i>	<i>SE</i>	<i>Beta</i>	<i>t</i>	<i>Sig.</i>
(Constant)	2.648	0.033		80.820	0.000
Coherence	1.143	0.033	0.827	34.868	0.000
Shocking	-0.186	0.033	-0.135	-5.685	0.000

### 3.3.2. The “Increases the visual value” preference model variable

The “increases the visual value” variable was similarly analyzed, and we observed that the *coherence* factor accounted for virtually the entire “increases the visual value” variable, with a model fit (R) of 0.727. The *shocking* factor completely disappeared from the model. [Table 5]

**Table 5.** Preference model for the overall assessment “increases visual value”.

<i>Increases visual value</i>	<i>B</i>	<i>SE</i>	<i>Beta</i>	<i>t</i>	<i>Sig.</i>
(Constant)	2.738	0.041		67.218	0.000
Coherence	0.994	0.041	0.727	24.384	0.000
Shocking	-0.017	0.041	-0.012	-0.408	0.683

### 3.3.3. The “It is integrated into” preference model variable

The same analysis was carried out on the “It is integrated into” variable, and we observed that both concepts are important in this factor, with a model fit (R) of 0.860. The *shocking* factor presented an inverse correlation, that is, the greater the *shocking* value, the lower is the building’s integration with its surroundings. [Table 6]

**Table 6.** The “It is integrated into” preference model variable.

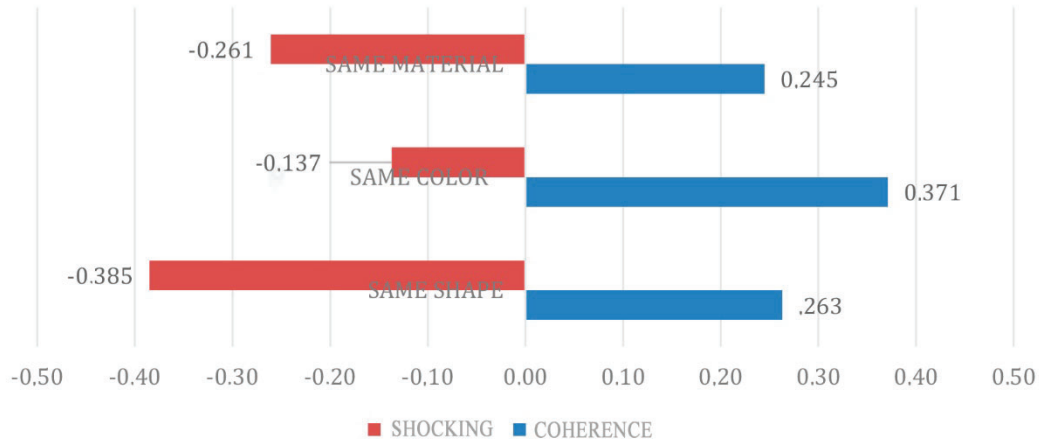
“It is integrated”	<i>B</i>	<i>SE</i>	<i>Beta</i>	<i>t</i>	<i>Sig.</i>
(Constant)	2.543	0.031		83.274	0.000
Coherence	1.106	0.031	0.802	36.179	0.000
Shocking	-0.429	0.031	-0.311	-14.043	0.000

## 3.4. Relationship between design attributes (shape, color and material) and the affective factors

Figure 9 shows the influence of the design attributes (shape, color and material) in the affective responses, using Spearman’s correlation coefficients. The images with greater degrees of similarity between the building and its surroundings, with reference to the design attributes, positively and significantly influence the perception of *coherence* and negatively and significantly influence the perception of *shocking*. Similarity in color is the design attribute with



the greatest influence on the perception of *coherence*. Lack of similarity regarding shape is the design attribute with the greatest influence on the perception of *shocking*.



**Figure 9.** Influence of the *material, color and shape* design variables on the affective factors of *shocking* and *coherence*.

#### 4. Discussion

The present study analyzes the type of facade solutions that might improve the overall responses of citizens to the visual impact of architectural interventions in a historic city. The analysis was carried out based on the Kansei engineering approach, that is, by analyzing the relationships between the physical characteristics that determine architectural interventions and the overall assessment of the citizen from a perceptual point of view.

Unlike other studies where the element to be integrated is framed within a photograph, our display system comprises spherical panoramic photographs with 360° computer-screen navigation capabilities which allow the viewer to direct his/her gaze in any direction.

Regarding the methodology, the main contribution relies in the application of differential semantics, within the scope of Kansei engineering, to identify which attributes are relevant to evaluations, based on concepts expressed by observers. Thus, differential semantics is a verbal measurement instrument that identifies the conceptual structures that observers are able to recognize in their evaluations.

Regarding the potential applications of the findings, our research demonstrates that the visual impact assessment of a building in a historic urban scene can be modelled using two independent factors: *coherence* and *shocking*, which account for 61.57% of the variance in the perception of the sample. Reducing the 14 expressions about the visual impact of architectures on cityscapes to two highly consistent factors is an advance that can be used for future projects that will address citizen engagement, as specified by current legislation.

The *coherence* factor accounts for 39.89% of the variance and represents the variables *contextualized*, *congruent*, *orderly* and *does not distort the surroundings*. Similar variables, although labelled differently, have been obtained in similar visual impact assessment studies. Thus, Kaplan and Kaplan (1982) put forward a landscape preference model highlighting the *coherence* factor. Similarly, Kuper (2017) showed a correlation between the *coherence* factor and preference in the design of gardens against an urban backdrop and Herzog and Bosley (1992) found a strong direct correlation between estimations of *coherence* and preferences with landscapes. The estimation of *coherence* was found to be directly correlated to the preference for roadless woodland environments (Herzog and Kropscott, 2004). One of the most in-depth studies into *coherence* was developed by Stamps (2004a), who found that, based on a meta-analysis of the findings of eleven earlier studies, *coherence* estimations had a high correlation with *preference ratings*. Thus, the findings of our research are consistent with those of earlier studies (Stamps, 2004b) and are new in their application to historic urban scenes.

The second factor, labelled *shocking*, accounts for 21.68% of the variance and represents the *striking*, *contrasting*, *complex*, *large* and *unsettling* variables. This factor has been used in studies on visual impact assessments to determine the impact of human activities on natural environments (Palmer, 2019). When an observer evaluates an architecture to be *shocking*, it would appear to be partially related to the term *disturbing*, which is the “lack of contextual fit” (Bell,

1996). However, some authors have considered *disturbing* to be the opposite of *coherent* and not an independent factor (Fry et al., 2009; Tveit et al., 2006), while our research demonstrates that *shocking* is a factor independent of *coherence*. In this sense, *shocking* has a different meaning to *disturbing*, and is related to the terms *striking*, *contrasting*, *complex*, *large* and *unsettling*, as mentioned previously.

Regarding the relation between overall visual assessments and the two factors, we observed that the greater the *coherence*, and the lower the *shocking* effect of a building, the better are the overall assessments of an intervention in terms of personal preference and integration into the historic urban scene. Thus, these two overall assessments can be represented by a single question in future environmental impact assessment studies. Nevertheless, regarding the overall assessment "It increases the visual value", only *coherence* is an influencing factor. In other words, the fact that a building is *shocking* or not has no influence in the increase in the visual quality of its surroundings.

When we plot the 14 expressions and the different architectural solutions based on the two factors, we observe that those solutions that score better in the overall impact assessments are located in the fourth quadrant of the graphic (a positive value for *coherence* and a negative value for *shocking*), whereas the lower overall rated solutions are found in the second quadrant (a negative value for *coherence* and a positive value for *shocking*).

An anomaly occurs in image 0, which shows the current situation, because it is assessed as *non-integrated*, but is not considered *shocking*. This can be explained by the fact that citizens get used to seeing architecture that is *non-integrated* and has no *visual quality* but which, over time, stops being perceived as *shocking*. Nevertheless, there are no significant differences in the assessment of the images based on *degree of familiarity with the area*. This might be because this type of non-integrated building is common in other Spanish urban environments.

Image 9, consisting of vegetative screening that completely covers the architecture, is assessed as both *shocking* and *coherent*, and so has a positive assessment in *preference*, *visual quality* and *integration*. Earlier studies showed the positive role that vegetation has on the preference for a landscape (Bishop, 1997), as well as its *diversity* and *complexity* (Crawford, 1994); this is understood in terms of the variety of the vegetation in the landscape. In general terms, findings have shown that “the presence of nature has a positive effect on the aesthetic quality of a particular environment” (de la Fuente de Val et al., 2006, p. 394). Nevertheless, placing plants on the facade of a building in a historic center is a somewhat unusual solution, and alien to the traditional architecture, which is why its positive impact on *preference*, *visual quality* and *integration* is a noteworthy finding.

In contrast, image 5 is a solution consisting of stone slabs, a material present in the surroundings, but it does not receive a positive assessment for *coherence*. The image is placed in a neutral position in terms of *coherence* and *shocking*, and is considered a neutral image in its overall assessment in terms of “I like it”, “It is integrated into” and “It increases the visual quality”.

Last, we analyzed how the design attributes shape, color and material influenced the two factors. We observed that the three attributes have significant weighting. The equalization of materials between the building and its surroundings reduced the *shocking effect*, the equalization of the shape reduced the *shocking effect* and increased *coherence*, while equalization of the color increased *coherence*. Along similar lines, previous studies have shown that the overall height and detail of buildings are important physical features which impact on human feelings (Karimimoshaver and Winkemann, 2018).

Considering these findings together with the overall assessment of each image, we can place the different proposed architectural solutions into three groups:

- Those that *are integrated, are liked and increase visual quality*. They have high *coherence* values and low *shocking values*. They are mimetic as far as shape, material and color are concerned.
- Those that are partially integrated, partially liked and partially increase visual value. They have low *coherence* values and varying *shocking* values. They are not mimetic as far as shape is concerned, but they use local materials.
- Those that are not integrated, are not liked and do not increase visual value. They have negative *coherence* values, and high *shocking values*, except for the current situation. They display shapes alien to the local environment.

As to the limitations of this study, it should be noted that, although the proposed model has general validity, and could therefore be applied to evaluate other proposals and other population segments, it is possible that the results would vary when analyzing other very different cultural contexts.

## ***5. Conclusions***

The best facade solutions to reduce visual impact are those perceived as being highly *coherent* and with low *shocking* effect, and which increase the overall assessment in terms of personal preference and integration into the historical urban scene. Regarding the analysis of the physical features of shape, color and material, the equalization of materials between the building and its surroundings reduces the *shocking* effect, the equalization of shape reduces the *shocking* effect and increases *coherence*, while the equalization of color increases *coherence*, color being the variable with the highest influence on the overall assessments.

The results of this study are significant for architectural practitioners, particularly in solving the problem of existing buildings with visual impact located near historic monuments.

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