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Analysis of Roofing Materials for Rural Buildings Projects: Costs and Visual Integration

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Abstract: Technical development has allowed rural buildings to achieve an increasing number of functional capabilities but it has led to a higher incidence on their associated visual impact. This way, not only the prevailing economic and functional standards must be analyzed in the design of a rural building as well as in the selection of suitable construction materials, but visual aesthetic criteria should also be accounted for. Roofs play an important role in the aesthetic appearance of a building and are therefore a key factor to visual impact on the environment. Computer graphics based on the standard construction criteria in rural building. The preferences of population regarding visual integration were assessed by a set of public surveys, and were further linked to the associated costs. Many frequent building solutions were found to be more expensive than some others with equivalent functionality standards and even best rated as related to landscape integration. An average increase of 0.39% in roofing installation costs was found to achieve a 23.65% average improvement in the rating of visual integration. The present study provides a catalogue of design solutions for roofing, and includes economical valuation and quantitative comparison with regard to their impact on the rural scene.

Key words: public survey, building envelope, rural development, visual integration, projects

1. Introduction

Rural buildings have proliferated and, in many cases, in a manner discordant with the environment [1]. Subscribing to the definition of environmental impact as “any change to an environmental variable” [2], discordant rural constructions should be regarded as source of visual impact, one of the most significant types of environmental impact [3].

Landscape transformation, either by means of including a new building or by the rehabilitation or expansion of an existing one, is aimed at improving quality of life in the rural territory, which is determined by the profitability of the investment or by the achievement of welfare improvement [4]. In this type of action, the maximum return on investment usually prevails. The functional approach has thereby been imposed on other design criteria, and is strongly conditioned by the emergence of new cheaper —although in most cases less aesthetic- materials [5].

In terms of design, every building is governed by a set of concrete rules, and rural construction is no exception. In Extremadura, which is the geographical scope of this study, state, regional and local regulations rule the norms, which explicitly or implicitly determine the integration of the building into its surroundings. However, these regulations are rarely based on scientific analysis that considers strengths and needs of a particular landscape [6]. Numerous advances associated to shape, use, scale and materials have been achieved as a result of technical development, thus increasing the functional capabilities of the buildings but also their ability to distort the surrounding landscape.

Such precedents show that the aesthetic experience of landscape plays an undervalued role as a means for understanding environmental awareness [7]. In the long term a more aesthetic, or more friendly to

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environment, construction brings improvements in the sensations produced by its use, and might therefore be regarded as more profitable [8]. Popular architecture has traditionally been featured by the use of materials readily available from the surrounding area, to lead to full landscape integration. Despite the complexity and the human intervention, buildings used to integrate a harmonious landscape [9]. This evidence should be accounted for by anyone facing the design of a project in rural areas, provided not all human activities in the environment pose a negative impact [10].

Building materials for roofing are often selected by functional criteria. In most cases, thermal insulation is a key factor. However, other criteria such as mechanical resistance or sound insulation are also taken into account. Both these features and the fact that roofs are usually a very visible part of the covering which limit the main body of the building, regard the analysis of visual integration of roofing materials in the rural landscape as an issue of special interest.

This study aims to provide developers, architects, engineers and other professionals conscious about the environmental impact of rural building with a set of design criteria based on sound scientific analysis through public surveys, which might optimise the selection of appropriate building components according to their cost and their potential to enhance environmental integration into the surrounding landscape.

2. Method

Two problems emerge when considering the budgets of an entire building. The first one refers to the analysis itself, which is intricate due to the high complexity of valuation, which entails the disaggregation of the costs of a whole building. The second deals with the fact that, depending on the particular type of building, the percentages of the costs of the covering and the development may strongly vary with respect to the interior of the building, always taking into account its usage and quality of the finishing. This ample variability would prevent from setting a percentage on the increase of costs of various alternatives offered regarding the total cost of the building. For these reasons a more dynamic and less rigorous method of economic valuation was defined. All this process entailed assessing the visible covering economically, readily identifiable in the original photographs and in the computer graphics of each of the proposed design alternatives.

2.1 Methodology

2.1.1 Study of Visual Resources in A Rural Scene

A strictly rural environment always includes some visual compatible resources [11, 12]. Six elements can be drawn in a given rural scene with constructions: colour, texture, lines, shapes, spatial location and scale [13, 14]. The features listed in Table 1 can be described for the discretization of the visual resources of an anthropized rural scene.

The colours involved in a scene have a decisive influence on the assessment of this and, consequently, on the assessment of the landscape that reflects the scene. The colours of the natural environment are given by the location of the building, so the only thing that can be worked on is essentially the choice of the colours of the action to be developed. Almost any construction material in almost any colour can be currently chosen. Furthermore, most materials can be painted with tailor-made paintings. Ideally these colours are studied in the technical office, in draft form, so that the construction element contributes to mitigate negative visual impact or contribute to its improvement.

The texture analysis is also conditioned by the natural environment, with predominance of the optohaptic type, which might include different levels of regularity, density and grain size. Designers may face the challenge of trying to reconcile the flat textures of most traditional finishes with natural textures, which may also offer different contrasts among each other.

Table 1 Visual and aesthetic elements.

Elements	Features
Surface properties	
Colour	Spectrum
	Saturation
	Lightness
Texture	Regularity
	Grain size
	Internal contrast
	Formation elements
Line	Sharpness
	Complexity
	Direction
Form	Geometry
	Complexity
	Direction
Composition elements	
Space	Scenic composition
	Scenic background
	Siting of units
Scale	Scenic occupation
	Contrast of scales

The building and its surroundings make up what is called the scenic composition [15], which can be classified as:

- Open environments: no natural barriers limiting the display of the building are appreciated. A straight skyline and horizontal lines strongly dominate the scene. In these cases, it is advisable that the building should not break the skyline.
- Closed environment: a perfectly outlined definition of space prevails and the building is located within that space.
- Dominant composition: the building itself marks the scene, dominating its environment. In these cases, the integration of the building is extremely difficult because of the prominence it takes.
- Focused environment: the prevailing lines of the environment converge to a point, which is located near the building. In this case, the combination of lines, colours, shapes and textures offer a challenge as how to minimize the visual impact or how to improve the landscape.
- Filtered environment: the building is displayed by a screening vegetable cover that softens the integration, dissolving lines and shapes. Exceptional results of the integration of the building in these landscapes can be achieved with proper calculation of the colours and textures.

2.1.2 Study of Construction Resources Costs

A series of methodologies have been developed to assess economic valuation of environment. These can be classified [16, 17] into the two following categories:

(1) Direct Techniques: based on the individual demand curve and on direct surveying on population preferences. The Contingent Valuation Method belongs to this group of techniques.

(2) Indirect Techniques: the values of environmental assets are deduced through other related parameters. In this group of techniques are, among others, the Travel Cost Method and Hedonic Price Method.

Other authors [18] have reported these valuation techniques as based on the particular type of preference:

- Revealed preferences: individuals are manifested in markets where the price of environmental good or service has been constructed from proxy related data. This type includes the Travel Cost Method and Hedonic Price Method.
- Hypothetical preferences: the market behaviour of individuals is simulated through surveys such as the Contingent Valuation Method.

In the light of such type of studies, it has been shown that the environment has certain functions [19] and provides services that should be assessed and classified [20]. In this sense, Munasinghe (1992) proposed the concept of *total economic value* [21]. However, despite the developed methodologies and recognition of visual comfort and environmental services [22], there is no evidence of its exclusive application to the visual integration of rural buildings.

2.1.3 Design Criteria Regarding Visual Impact

In general, when a building is discordant with its environment it is advisable to blur the view of the building. An efficient action for that purpose is to place vegetation between the building and the main route of communication from which it will be seen. In addition to this, some changes in the building envelope can also be made in response to the substitution of some other construction materials, so that a more successful integration of the building in its surroundings is achieved. The change of construction elements of the envelope might cause significant changes in colours and textures, and therefore in the building as a whole.

Some studies on the subject are due to García *et al*. (2003) [23], who had stated the following concluding criteria:

- In order to dissociate the visual impact from the influence of the season, it is important to account for visual continuity of the roof of the building in colours that do not change with seasons, i.e. in land colours. Such continuity is guaranteed by colours and textures in the range of tones predominating in the land, which are usually well accepted by the observer. Fig. 1 [24] illustrates which colours are regarded to cause hardly compatible contrast, compatible contrast, diversity in absence of contrast or visual continuity.
- If the building has a very dominant location or if it simply breaks the skyline, fairly bright colours often provide good results.

As a general rule, both colours and textures should aim to match landscape existing harmonies. These harmonies are colour ranges as regards to colour, and density and regularity, in the case of texture.

In short, there are some early indications that may serve as a guide f or roof integration in the surroundings. However, these should be developed to state objective design criteria aimed at achieving positive response by the observer.

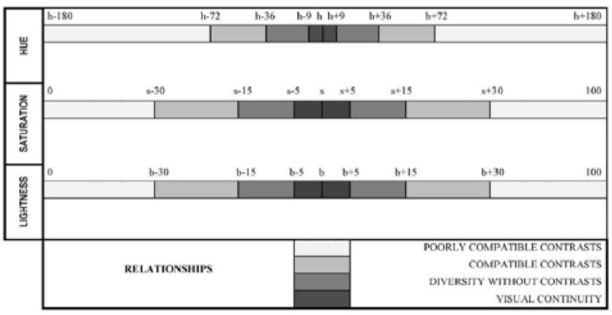

Fig. 1 Relation among hue, saturation and brightness.

2.2 Study of the Building Roofing

The envelope of a building encloses the living space and includes all components in walls, roofs and floors, except previous finishes (*Technical Building Code* CTE, 2006). This study defines the concept of visible covering, which differs from the concept of envelope as defined by the current specific regulations. In the visible covering only the last layer of the construction elements are evaluated, ignoring air chambers, insulation and second cladding layers, i.e., only those materials visible to the naked eye are accounted for.

Roofs are building elements with a visible presence in the covering of a building, which regards them to be a key element as compared to other building elements in terms of style and aesthetic appearance.

Even though there are many factors involved in the designing of a covering that influence the aesthetics, roofing materials and the type of roofing (regarding number and slope of roofs) are reported to be the most crucial parameters.

To cover a rural building the designer has two basic materials: plates (either metal or fibre-cement) and tiles. Tiles have been a very much-used constructive resource in both traditional and modern roofs because of the benefits they provide, such as easy installation, maintenance and price. Although the use of panels is preferred nowadays (fibre cement or metal sheets), tiles are widely used in rural buildings. Fibre cement currently achieves fairly competitive prices and is available in virtually any colour. As for texture, there are a couple of types of sine waves differing in the scale of the wave. The metal sheets are in single or sandwich format either made of aluminium or of galvanized steel. Such metallic materials are very bright and thus very difficult to integrate within the surrounding landscape. As a solution, these plates can be lacquered in any colour, getting good levels of landscape integration. In this sense, the *Catalogue for Construction Elements* from the Building Technical Code (2009) (a frequently updated database) were taken as a reference in the present study. This catalogue contains information on the characteristics of materials, hydrothermal and acoustic benefits of generic building blocks and construction specifics concerning basic requirements of the current legislation.

There are several construction techniques and types of roofs that have been undergoing changes over time, resulting in a virtually unlimited supply [25]. Only the most common in rural buildings have been considered in the present work, which can be grouped as follows:

(1) Flat roofs, which can be classified as trafficable or non-trafficable. The former usually have a final layering made of ceramic pavement. The latter can contain gravel, can be landscaped or can include insulation or waterproofing. In all cases, despite horizontal disposition, there is a slight slope to channel rainwater.

(2) Pitched roofs, subdivided as:

- Single pitch roofs, usually poorly lit industrial warehouses because otherwise it would require a disproportionate structure. All waters are collected in a single line of gutter, but they require a top on their sides to waterproof the whole.
- Gable roofs, the most commonly available in rural buildings. They represent an efficient way of covering due to simplicity of implementation and structural profitability. At the top, there is a ridge and on each side, a gutter is required to collect rainwater. If the plant is not rectangular, more gutter lines will be required.
- Multiple pitched roofs. In these constructions the supporting structure can be quite complex and because of this, the use of this type of roofing is only justified by very specific needs. They show a significant complexity in construction as well as higher prices than other alternatives.

(3) Other provisions. This section entails three types of roofing:

- Curved roofs, used in open warehouses without walls, such as barns or stores for little value items. They have the advantage that they are normally manufactured with self-supporting plates, ie, plates that require no roofing structure, but only a number of supporting columns.
- Sawtooth (two pitches) roofs. They have the advantage of providing very good lighting — whenever the teeth are facing north. For this reason they have been widely used in warehouses for manufacturing products such as factories and workshops. The associated drawbacks are its complex structure as well as the higher costs they involve as compared to other roofing alternatives provided the need for many gutters, finals, ridges, etc.
- Irregular roofs, to account for all those not included in the aforementioned categories, even though they might usually be set as a combination of some of the previous configurations.

2.3 Generating of Design Alternatives

Colours and textures can be acted upon with an appropriate choice of building materials. Lines and shapes are altered with a proper choice of construction solutions, flat or inclined. Therefore, a correct choice between different types of roofs, according to materials and construction solutions, will help the building appear rooted and integrated in the environment. Design alternatives were generated with the support of previous studies [24] on relations among types of visuals (VC [Visual Continuity], DWC [Diversity Without Contrasts], CC [Compatible Contrasts], PCC [Poor Compatible Contrasts]), which state that visual continuity (VC) provides a higher probability for integration to be assessed as “good” or “very good” (Fig. 2), and that the colour [23] is the most determining factor for the visual integration of a building (Fig. 3).

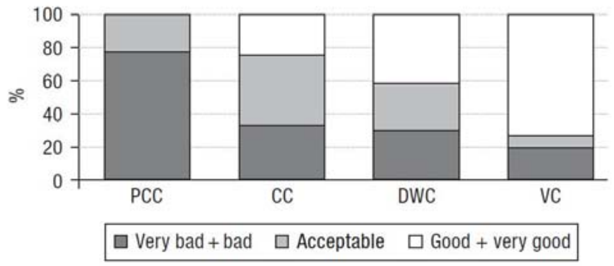

Fig. 2 Relation among integration values and among elements.

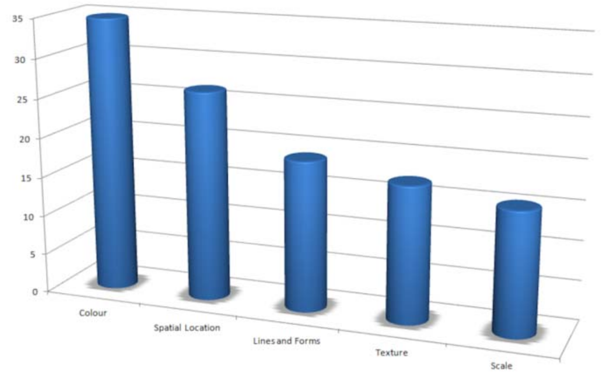

Fig. 3 Average percentage of instances in which the visual element was shown to be modified.

The study reported in the present manuscript was restricted to those parameters that could be changed in the original design, and only affected to the visible covering and its urbanization. This way, changes regarding scale of the building, location, lines and shapes and orientation were discarded. In other words, only colours and building materials were affected by the design interventions.

Colour gamut was managed to achieve visual continuity. Such criteria allowed the setting of an analytical method to objectively assess the design alternatives which would be included in a surveying questionnaire.

Data collection was performed in the Autonomous Community of Extremadura (Fig. 4), Spain, and the collected graphic material showed pictures of typical landscape views of Mediterranean climate countries locations. In order to ensure validity [26-28], the number of buildings under study should be large enough so as to guarantee repeated testing on their original aspect. Sixteen projects were therefore chosen in this work.

Fig. 4 Location of landscape integration assessment projects.

This choice was intended to account for a territory as large as possible with a diversity of landscapes, constructive solutions, locations and uses, and was assumed according to the following specific requirements regarding both the building itself and the environment:

(1) The building must be located on rural land.

(2) It must be seen in sufficient detail from nearby roads or main pathways, assuming to cover between 25% and 30% of the photograph's surface. The rest should correspond to landscape surroundings.

(3) The building surroundings must show a certain degree of variety.

(4) The building's construction project must be available.

Pictures were taken with a fixed 50 mm focal length lens in order to best approach human vision, from nearby routes of communication and always trying to catch an optimal perspective of the building.

The azimuth angle was simply set according to the height of the photographer, 1.69 m. To minimize contrasts, shots were taken avoiding sunrise, sunset and zenith times. Alternative scenarios were further designed by means of digital editing (Fig. 5) using Adobe Photoshop ©.

Five possible roofing solutions were assessed for the buildings under study (Table 2). The unregistered photographs are the original ones. Image processing of the 16 selected buildings generated 26 digital simulations which, together with the original pictures, yielded a total of 42 images.

Each digitally-edited picture accounted for a single improvement over the original scene, and all the proposed alternatives were aimed at improving landscape integration.

2.4 Population Preferences

Studies on visual integration are strongly linked to population involvement. With regard to this, surveys are the preferred methodology to involve a sufficiently large segment of the population. They allowed work on the proposed methodology and a series of issues based on the quantification of certain qualitative attributes [29]. Computer graphics were presented together with the original pictures in order to assess whether the proposed alternatives successfully met the expected improvement over the original, without disclosing to participants which pictures were original or modified. The degree of improvement achieved was quantified by comparing the individual scores for each group of images (for each of the 16 projects under study). The survey was conducted by 120 people categorised by age, occupation and location, and was always carried out personally, ruling out other massive participation procedures such as video or internet based surveying [30, 31]. The presentation of computer graphics was made in a notebook ISO A3 landscape format where each page consisted of four images identified with a number-letter code. The respondent was asked to proceed as follows:

Assess from 1 to 10 the visual integration of each construction into the landscape

1 (very poor) 2 3 4 5 6 7 8 9 10 (very good)

Design criteria were observed from the results of a couple of pictures (original and amended), and 240 estimations were therefore surveyed for those two photographs. A total of 5040 responses were recorded, which ensured statistical significance [15, 32]. Although the distribution of responses is discrete, bearing in mind that only values from 1 to 10 can be scored, the survey generated a normal distribution for the scores of each image. Extreme values of the distribution were filtered.

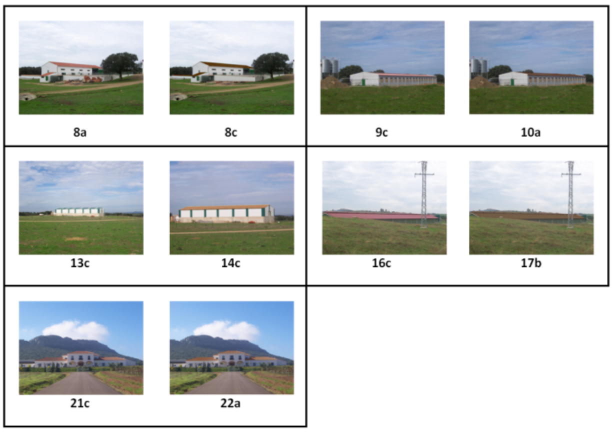

Fig. 5 Proposed design alternatives. Original pictures and digitally designed alternatives in left and right columns, respectively. Note original and digital alternatives were not disclosed in surveying questionnaires.

Table 2 Changes performed on the original photographs and identification of the photographs that include such changes.

Changes in roofs	In photograph
Change in colour of tile	1d, 3b, 4c, 4d, 12a, 12d, 13a, 13b, 21a, 21b, 22a, 22c, 22d, 23d, 24d
Replacement of the tile overhang for fibre cement	8c, 8d
Change in the colour of covering sheet	17b, 17c
Change in metal sheet for tile overhang	14c, 18b
Change in fibre cement colour	10a, 10d, 11a, 11c, 15d

2.5 Cost Analysis of Construction Solutions

The present subsection deals with the estimate of the construction cost of the collected scenes previously evaluated in the surveys, particularly from the point of view of visual integration into landscape. Such information should be a key point to state suitable assessment criteria. Budgets were made according to a standardised model, regardless the type of building, its use, dimensions and even building materials. This is a simple and very effective solution because it allows the classification of alternatives according to the particular item of the budget that may lead to a change in the final cost. Budget evaluation was performed by analyzing individual items, defined as the specific interventions needed to undertake the project. For this purpose, Archimedes SA CYPE© was used as budgeting software. However, database EXTR05 corresponding to the Junta de Extremadura was used instead of the default data records available within the aforementioned software package. The choice of this database is better suited to the geographical area under study. Moreover, a large number of new items had to be created to address the wide range of construction solutions implemented in the selected buildings. Manpower, operating equipment and required materials had to be identified, quantified and assessed in order to create a new item.

Once all the budgets were processed, those of the original photographs were compared to those of the alternatives proposed for each project. Additional costs associated to each implementing proposal (positive or negative) were then computed. It should be noted that costs associated to each picture are themselves fully measurable objective quantities. Potential deviations in cost estimates might rather be masked by the percentage formatting of quantities.

3. Results

In the light of the survey results, Table 3 illustrates the relationship between the landscape integration improvement percentage and its corresponding cost for each of the proposed solutions.

The rows correspond to the original state of the building under study and the columns to the proposed design alternatives. The results are presented using double-input cells, where higher and lower values represent the variation on the original cost and the variation in the assessment of landscape integration of the building, respectively.

Regarding cost analysis, negative values stand for less expensive solutions than the original. Likewise, positive values indicate more expensive solutions. Agreement between original and improved budgets was represented by the value 0. With regard to visual

Table 3 Matrix effects of different solutions used for walls intended to improve the integration.

Variation in cost (%) / Variation integration (%)	Appropriate design alternatives intended for visual integration into landscape: Adequate colour of tile	Substitution for glazed fibre cement	Adequate colour of sheets	Adequate colour of fibre cement
Design alternatives: Inadequate colour of tiles	+1.21 +20.79	-2.47 +21.87		
Inadequate colour of sheets	+1.11 +21.42		0.00 +37.18	
Inadequate colour of fibre cement				+2.08 +17.01

integration into landscape, negative/positive values indicate worse/better rated than the original. Again, agreement between original and improved ratings was represented by 0.

Specific valuation ranges were established in order to assess the construction solutions. Regarding costs, increases below 5% were considered “negligible”, close to 10% “cheap”, at around 20% “significant” and from 30% “expensive”. As for assessment of integration, values close to 10% were assumed as “acceptable” integrations; those approaching 20% were considered “good” integration improvements and those close to 30% were regarded as “very good” actions. Information on the results for each of the proposed construction alternatives was achieved as follows:

(1) Changing colour of tile. Ceramic and slate tiles have traditionally been used in rural buildings. At present there is a wide range of possible tiling styles: French, Portuguese, Moorish, Norman, etc. The result of replacing an inadequate tile color (PCC) for a suitable one (VC) led to “negligible” cost increase and to an improvement rated as “good” in terms of visual integration into landscape.

(2) Replacement of tile overhang by fibre cement. In agricultural and livestock industrial premises fibre cement is an alternative to consider, in particular if it is enameled in any colour. This change represented

savings in costs and a “good” improvement in terms of landscape integration.

(3) Changing the colour of the metal covering sheet (Fig. 6). If covering the building with exterior lacquered metal sheet is the option, enamel colour can be chosen freely. Non-catalogued lacquered colours might indeed slow delivery, but this alternative was associated to zero extra cost and achieved “very good” rating as related to environmental integration.

(4) Changing the metal covering sheet for tile overhangs. This change affects the buildings’ structure, provided it is positively linked to an increase in weight. However, if cost increase regarding structural reinforcement (and perhaps structural foundation) was ignored, results indicate that economic difference between lacquered metal sheeting and tile overhangs is “negligible”, and that such alternative leads to “good” improvement in terms of building integration.

(5) Change in fibre cement color. “Negligible” cost increase and “good” achievement as relating visual integration into landscape.

In general terms, an average increase of 0.39% (“negligible”) in costs associated to roofing operations was observed to achieve an average improvement of 23.65% (“good”) in terms of visual integration into the surrounding landscape.

4. Discussion

To date performance criteria show a significant influence on the selection of building materials for roofing operations, with a growing interest for thermal comfort [33, 34]. However, it should be stressed that roofing elements should also be accounted for as best promoting visual integration into the surrounding landscape, with no negative influence on functional capabilities.

16c 17b

Fig. 6 Relevance of appropriate roofing as related to visual integration into landscape.

There are several design factors that strongly affect the aesthetics of a building, the colour of the covering material reported as the main one, which is regarded as a key element to the visual integration of the whole building into the surrounding landscape. All the aforementioned results support well-known landscape integration criteria [13, 35-38], and meet the aesthetic standards for external buildings stated by Nasar (1994) [39]. Thus, all the alternatives proposed in the digital pictures, within the range of visual continuity (VC), have been proved to achieve better ratings than the original projects, within the range of poorly compatible contrasts (PCC).

The economic evaluation method followed in this study can resemble the Contingent Valuation Method proposed by Robert K. Davis (1963) [40] and popularized by Cummings, Brookshire and Schulze (1986) [41], and by Carson and Mitchell (1995) [42], but differs from it in the fact that is based on the presentation of single alternatives, rather than on the presentation of those alternatives together with the associated costs (which are instead analytically followed). This method could therefore be considered an indirect valuation method based on hypothetical preferences.

The results achieved were observed to be coherent as analyzed in couples (i.e., cost increase linked to improvement in landscape integration). Cost increases below 2% were sufficient to ensure significant improvements in visual integration into the surrounding landscape. In particular, the cheapest solution for roofing material was that of lacquered slate.

Natural finish fibre cement is slightly more expensive. The fibre cement coating implies a significant variation in cost if compared to natural finish. Finally, two options were regarded as being similar in cost: sandwich sheet and tiles, but it should be noted that only the board was estimated, and not the remaining construction elements required for each case. These data turn even more significant if it is brought to mind that the cost of the covers of these buildings is lower than that of the total project budget and usually a very small part of it.

In the light of the results achieved by the present study, the buildings under study should not be featured as *well integrated* into the surrounding landscape, provided that far-reaching parameters like lines, shape, scale and spatial location have been ignored. In this sense, it is obvious that the estimated costs would also depend on the selected case, to become steadier as the case study approaches the analyzed cases. However, it has been shown that landscape integration of rural buildings as compared to their original configuration might be achieved while respecting their form, volumes and location.

After a detailed study of building covers based on the analysis of associated costs as well as on visual integration into the surrounding landscape indicates that rural buildings can be designed to best promote landscape integration with quite low cost increase (often negligible and, sometimes, even lower than investment costs).

If these rules were brought to mind, designers or developers could undertake the integration of the projected rural buildings in the environment with *a priori* knowledge of additional costs (either positive or negative), which would favour visual continuity for the buildings in rural settings.

5. Conclusions

With the addition of aesthetic criteria to the rural building design process, the achieved conclusions might be incorporated into the catalogue of building materials. The actions described along the preceding sections do not only meet the expected functional requirements, but were proved to show higher economic and environmental profitability.

Main research conclusions are the following:

- Roofing materials that worse integrate in rural areas are often metal ones, provided their smooth finish and shine. Materials with texture and colour similar to those of the surrounding terrain are preferred, such as tiles and fibre cement.
- The green finish in rural building roofings, imposed by current legislation in some administrations, does not usually improve visual integration of the building into the surrounding landscape. Earthy or neutral tones such as grey and brown were seen to improve integration. In any case, if green shall be used, it should match natural tones of the environment and stay away from shiny and saturated tones.
- Construction materials for rural building roofing are mostly selected according to functional criteria, but specific colours could be chosen for a given material with no extra cost, which considerably would promote landscape integration.
- Costs of roofing solutions are not directly correlated to visual integration into landscape. Higher odds of suitable landscape integration could be ensured with quite low cost increase (often negligible), and frequently even at lower cost than that of the original investment.

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