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Planning restoration of a historical landscape: a case study for integrating a sustainable street lighting system with conservation of historical values.

Abstract

Issues relating to the illumination of historical minor centers have taken on increasing significance in debates on urban rehabilitation. Interventions must ensure balance with the surrounding environment whilst implementing high-efficiency, energy-environment systems, and enhance architectural structures. The research presented in this paper aims to identify appropriate strategies and effective criteria for lighting design in historical centers. The methodology developed is based on transcalar analysis and has been applied to a village in the Abruzzo Region (Italy). The methodology involved surveys carried out in the urban context together with up-to-date and detailed analyses aimed at highlighting the criticalities and potentialities of the village in the case study. This allowed the elaboration of intervention strategies applied to two different areas: one within the historical nucleus of the village and the other in a peripheral area. This research has contributed to enriching the current debate on so-called "inland areas", including developing new ways to benefit from the special characteristics of these areas and implementing more sustainable action..

Keywords: Lighting scenarios, Energy Efficiency; Sustainability; Rehabilitation; Historical values

1 Introduction

Optimization of infrastructure systems using standard methodology is not necessarily successful in cities. In fact, an analysis of optimization processes shows interesting results for new methods and techniques of construction, tested in different sectors (construction, transport, energy), but these are not always functional or efficient within a system-oriented approach [1-5]. The objectives are often sectorial and do not produce the exponential effect of a system-oriented approach. Some cities are now struggling to provide adequate responses to the diversified demand of increasingly specialized services and to adapt their systems to new requirements such as accessibility, usability and energy efficiency [6-11].

Some authors have reported interesting results with LED street lighting in German municipalities [12], others have investigated factors that may have played a significant role in the successful adoption of light-emitting diode-based lighting in Malaysia [13].

Furthermore, urban decay and the difficulty in adapting obsolete structures and buildings to conform to today’s needs present further complications. [14-16] and the situation becomes even more complex when the design intervention concerns historical villages, where invasive or high-impact actions must be limited

and constraints exist in terms of limitations of space and height differences. As x stated “Fragmented planning renders consideration to the reciprocity which exists between the historic fabric, the townscape and the natural environment difficult” [17]. Interventions in historical villages are also hindered by the fact that,, the technical documentation is often missing, maintenance operations are only performed in the event an emergency and the actual condition of the subsoil of the village often depends on the historical memory of the few people who still live there. Many of these minor centres are now in a state of decay [18, 19]. However, the region has witnessed a renewed interest in the historical centres of the Abruzzo region as a result of their number, their historical, architectural, environmental value as well as their importance to local economies [8, 20-22].

Furthermore, the need to rebuild the buildings damaged by an earthquake in 2009 in central Italy has provided the 73 municipalities affected an opportunity to support the reconstruction and the optimization of infrastructures and networks through the introduction of innovative technologies to ensure comfort and safety to contemporary users in the open spaces [23]. Interestingly, one of the most important factors that ensures comfort and safety is lighting and this is the focus of this research paper.

2 State of the art

Generally, only the functional aspects of the liveability of outdoor spaces, defined by technical regulations are taken into consideration when addressing city illumination.. However this is a great loss, as illumination, when used knowledgably and effectively, allows us to enjoy not only what surrounds us, but also the space and elements that constitute a city:, to perceive the materials that compose it and to look and enjoy the urban area from a different perspective (Fig. 1).

The theme of street lighting design has not yet been defined fully and is often overlooked despite it being an important tool that can be used to enhance the urban night scene and promote its usability [18, 24]. Indeed lighting, if properly designed, can contribute to the historical and aesthetic development of a city and to the readjustment of urban spaces as well as urban regeneration. It is an element capable of recreating recognizable images of the urban fabric and therefore can be used to restore the shape of the city with the perception of the elements that represent it. Urban settings can be remodeled to complete daytime perceptions acquired superficially during the rush of everyday life. In fact, lighting can be used to configure a night-time reality, totally independent of the daily one, yet complementary to it.

An analysis of the lighting in Italian cities reveals that, in most cases, light is only considered a functional or technical element and its potential to allow the city to regain an identity during the night is often ignored[25, 26]..

Another element that is often overlooked is light pollution which negatively affects the image of our cities. It occurs when the light emitted by the lamps is poorly designed, generally facing upwards Fig. 2. This condition causes environmental damage (loss of orientation for animals, alteration of circadian rhythms in humans), cultural damage (disappearance of the starry sky) and economic damage (waste of electricity for areas that do not require lighting).

The ancient centre of the village is illuminated by lanterns anchored to the facades of buildings by means of 80-cm long brackets, usually placed at an average height of about 5 meters. The distribution of the lighting fixtures is fairly uniform, but the head lamp is not compliant with legal standards (UNI 10819). In fact, light is emitted above the angle 0°-180°. Furthermore, the light source is a mercury vapour type. The good color rendering of these lamps is neutralized by poor efficiency.

FIG 2 ABOUT HERE

There are no national reference regulations regarding street lighting in Italy.. Each Italian region has its own guidelines, which in most cases only refer to the importance of limiting light pollution, with no special reference to street lighting design [25]. In Abruzzo, for example, the reference legislation is Regional Law n. 12 of 2005, published in the Bura N°. 15 of 18.03.2005 which local planning must refer to. However, very few of the numerous villages scattered across the Province of L'Aquila have adopted the guidelines set down and technical documentation is often missing or not appropriate.

3 Methodology

Artificial illumination cannot be considered a mere support to vision nor a guarantee of fictitious safety. It should confer a night-time identity to urban morphology, redefining space through its immateriality. Indeed, artificial illumination allows another vision of the built environment. The weaving of the construction systems, the plastic effects of the façade elements, the special characteristics of the materials used and their appearance and colours are the product of the incidence of light on the matter. They are influenced by the variation of intensity and temperature from dawn to sunset, by the daily and seasonal weather conditions, clouds, mist and fog. All this produces an identifiable concept of landscape and place. Therefore artificial illumination should not be a undertaken with the scope of achieving a homogenous standardization as this would rob urban contexts of their differing historical heritage.

Furthermore, artificial light should be seen as an important means of transmitting knowledge of the urban context; an autonomous and articulated, architectural language and an essential feature of urban

rehabilitation. Illumination gives planners the opportunity to create a new night vision of an urban area that enhances its characteristics and promotes urban security without harming the environment. When designing street lighting, be it traditional or innovative, the first steps must involve establishing what the end result must achieve whilst at the same time communicating the sense of the urban environment and enhancing its aesthetic features. These steps must go hand in hand with addressing issues relating to security, light pollution and energy saving.. It is evident that the night environment is made up of luminous elements that signal activity, capable of communicating visual messages, architectural spaces, facades of buildings that, once illuminated, become the scenes of new settings, new architecture and new scenarios.

The main objective of our study was to look at ways of reducing the economic, energy and environmental impact of interventions, whilst integrating lighting systems that enhance the identity of the urban context.

Today there is a lack of balance in the night landscape of minor historical centers, characterized by discontinuous illumination, uneven lighting systems where pieces of architecture are totally decontested and detached from their surrounding environment. It is therefore necessary to develop a conscious methodology of design that takes into account two different approaches: technical and functional, as well as aesthetic and emotional, linked by a common denominator: the compatibility of the intervention in the historical context.

The purpose being to recognize the crucial role of lighting because of its ability to enhance architectural characteristics whilst simultaneously uniting the whole urban area, typifying places at an emotional level and recreating the original space hierarchies, uniformities or differences.

The operational method for our research consisted of the following:

- A survey of current, national, regional and municipal legislation in order to identify solutions that meet the already mentioned objectives: enhancement of the lighting scenarios, energy saving and security.
- Acquisition of in-depth knowledge of the historical center, in particular: functional, morphological and aesthetic analyses of its urban spaces, identification of significant architecture, the main spatial categories and analysis of the lighting network and lighting fixtures which characterize them. Fig. 3.

FIG 3 ABOUT HERE

- The meta-design phase: consisting in the identification of the critical aspects of the spatial categories and the lighting system examined, with the development of the homogeneous intervention areas.

- Design phase: consisting in the implementation of the compatibility process between the context of intervention and the solutions considered compliant, which led to the elaboration of the possible design scenarios and the consequent executive design.

This methodology was applied to two case studies, both located in the village of Fontecchio (Aq); the first in the village's historical centre, the second in a peripheral area.

4 Case study

4.1 Classification of the village of Fontecchio

The first traces of this village date back to the time of the Italic people, to whom the archaeological sites found in the areas of "Il Castellone" (948 meters above sea level) and of "Monte San Pio" (1005 meters above sea level) have also been attributed. Although no one knows exactly which people (Vestini, Samnites, Marsi, or Peligni,) lived in the ancient part of the Aterno valley, now part of the village of Fontecchio, the traces of masonry, the necropolis and other findings are unequivocal examples,of Italic fortified centers. This area was of great importance in ancient times, being strategically located between the Subequana and the Navelli–Capistrano valleys and.as the discovery of a carriageable road, probably a branch of the "Iter Superequum," which passed through the Castellone towards Opi Fagnano and beyond, testifies..

The village of Fontecchio also preserves remains of the Roman period, probably the original nucleus of settlement before the establishment of the village itself. This nucleus is thought to be located where Palazzo Corvi now stands. There is a cistern located under the building's internal courtyard and the corner tower, that is on the left of the main entrance of the building, is of Roman structure.

However, the real establishment of the village dates back to the period of the barbarian invasions which spread terror amongst the farmers and shepherds who until then had been living quietly in the valley. These continuous raids which lasted from the second to the fifth century AD, led the inhabitants to form small aggregates for safety, eventually giving rise to a number of villages. Around the eleventh century, the small villages (vicus) of San Giovanni, San Pietro, Sant'Arcangelo, San Felice and "Fons Tichiae" joined together to create the "Castrum Fonticulanum" (Fontecchio). Although united for safety,, these small villages initially kept their own churches, and only around 1080-1095 was the joint parish of Santa Maria della Pace built, today the village's parish church.

The territory of the village of Fontecchio is located within the Sirente-Velino Regional Park, a protected natural area including to the northeast, the Aterno valley, to the west, part of the plain of Campo Felice and

to the south, the Fucino basin. The territory is characterized by a large variety of geomorphological features: from the severe massifs of Mount Sirente, Mount Velino, and the Magnola mountains, to the amazing Gorges of Celano, passing through the charming plateaux of Altopiano delle Rocche and Piani di Pezza.

In contrast to this mountain landscape, the village of Fontecchio is located in a gentler landscape, in the Aterno valley..The village nestles in this green valley, naturally protected and remotely monitored by the majesty of Mount Sirente and surrounded by forest vegetation consisting mainly of oak, hornbeam and various types of maple tree.

The ancient origins of the village of Fontecchio are still easily recognizable today and the urban fabric that characterizes it, with the exception of some limited areas, is well conserved. The elements that represent a "value" because they arose from the knowledge of our predecessors and are the product of the so-called "material culture" are easily identifiable. Any intervention in contexts like this must preserve these historical, architectural, landscape and construction elements so that they can be passed down for posterity. As mentioned above, one possible approach in such a context could be the preservation or controlled transformation. This aim being to find a balance between the preservation of the existing values and technological updates in relation to the performance standards required by existing regulations, whilst also enhancing the perception of the village by increasing the quality of its night-time scenes..

4.2 The surveys

The surveys carried out consisted of the analyses of: the spatial categories and their intended uses: road network, types of access, building types and the characteristics of the curtain walls including their typological and dimensional features; the elements that constitute the facade system and significant pieces of architecture which allowed us to identify and define the village's historical and architectural values.

Surveys of the open spaces of the historical centre of the village revealed that the road system around the village's historical nucleus is mainly pedestrian, narrow streets and steps characterizing the living fabric whilst roads suitable for vehicles run along the margins of the village and spread out into the urban fabric of the village's most recently developed areas. The focal points of open spaces are the main square, Piazza del Popolo, and the square located in the village's oldest nucleus that comprises the ruins of the church of San Nicola.

After completing these studies, the focus shifted to the lighting network of the village and a survey was carried out of all the lighting systems which were then classified according to their type,,energy source and capacity. Electricity is transmitted through overhead lines, with the exception of the section from the entrance

to the village to the historical nucleus, overlooking Piazza del Popolo, and the square of San Nicola, where electricity is transmitted underground.

All the light sources are sodium vapor lamps, mainly 70 W lamps with the exception of the projectors installed on the church, the ruin and the village's entrance door that have power ranging from 250W-400W. Most of the fixtures installed are lanterns in style mounted on the buildings' walls at a height of approximately 3,5 m by means of support arms.

The effect of this lighting is uneven with some areas being poorly illuminated with yellow light that is not very solid and does not enhance the features of the village.

4.3 Analysis of the most important pieces of architecture and existing values

The first nucleus of houses was built in the thirteenth century in the vicinity of the Church of San Nicola and spread up to Piazza della Fontana which was the main centre of daily activities. The historical centre then developed along the ridge, with building units parallel to the contour lines, which defined the main road, initially used as a link to the sheep routes and later becoming a connecting link to adjacent villages.

Following seismic events, especially those since the eighteenth century, reconstruction and construction works were carried out on the southern side of the historical center, masking, in some cases, the typological characteristics of the original built fabric. In the nineteenth century, new groups of building units with a more complex structure were built and new housing units were erected on the north east border of the village.

The most important pieces of architecture still recognizable today are the following: Piazza della Fontana, the communal bread oven, Palazzo Corvi, Palazzo Muzi and Palazzo Ciocca. The surveys also identified special architectural features of note deriving from the vernacular construction, of this village the so called "wall-houses", housing units parallel and perpendicular to the contour lines. The main type of road section is humpbacked, although there are also other types localized in short stretches. The curtain walls are only regular in part with openings that are irregular in distribution and size; almost all buildings have eaves and balconies that must be considered during the street lighting design phase.

Further analysis of the façade elements of the curtain walls showed that the main technique used to construct the walls was masonry with stone blocks, not squared, and most of surfaces have a coating of plaster. Doors and windows have often jambs and arch or lintel stone whilst balconies are widespread and built, in most cases, with shelves and stone slabs. The most dominant type of eaves is made with decorative corbels and wooden planks. Ashlar quoins are also very common.

4.4 Analysis of the critical aspects

The analyses described above have allowed us to highlight some of the critical issues that the village of Fontecchio faces with regards to urban lighting and the usability of open spaces.

The main issue with open spaces is the difficult access to some of the pedestrian areas of the village, and in particular steep steps with uneven paving and a lack of parapets that do not aloow safe or easy access. A second issue is that concerning plumbing, electrical and gas systems, and most of the power supply lines which require modernization work to comply with current regulations. The joints of cables, conductors and wire ropes are often mounted on spans or supports, or are roughly installed on the facades of buildings. Moreover there is a dangerous coexistence of different distribution wire systems. The type of lighting equipment used for street lighting is an old model without glass covering. These models cause a decrease in duration of the life span of the light source, that is subject to continual temperature change, as well as a decrease in the efficiency of the lighting fixtures with losses up to 70%, due to lamps and reflectors becoming dirty..In fact the blackening of the lamp bulb and reflector causes a strong reduction in the efficiency of the lighting fixtures and the illumination originally planned on the road surface is not sufficient and there is a consequent decrease in lighting uniformity.

Public lighting of architectural pieces allows a minimum nocturnal perception of their quality but does not enhance their chromatic characteristics (see, Fig. 4).

FIG 4 ABOUT HERE

This type of lighting is provided by 250-400 W projectors installed on walls, that illuminate the ruins of the church of San Nicola, the fourteenth-century fountain and the village entrance door.

The village is illuminated by 70 W sodium vapor lamps, the main disadvantage of this type of lighting is the poor color rendering or rather its poor ability to reproduce the actual colors of the materials. In fact the entire village appears an indistinct colour and buildings of historical and architectural value are indistinguishable from the rest. Furthermore, only a section of the power lines are underground: power lines underground ensure greater safety and longevity, rendering powerlines above ground obsolete. The surveys carried out showed that one of the most critical issues affecting the whole village is the lack of compliance with current regulations that results in the lack of road safety and, therefore, public safety. Furthermore there appears to be little attempt to encourage an optimization of consumption and a more considered use of resources.

4.5 Choice of the sample areas to analyse

Following the analyses above,, two urban areas with similar spatial characteristics were selected as sample contexts: the first located within the historical nucleus of the village and the second on the outskirts of the village.

The first area was the Square of San Nicola and Via delle Rondini which was chosen on the basis of its architectural and morphological features; this area contains meeting spaces, elements of historical value, green public spaces and pedestrian only zones. The main issues faing this area are the use of inadequate lighting fixtures and hence inadequate levels of illumination, excessive electrical wiring, poor enhancement of historical and artistic elements, blinding illumination of openings and poor lighting in the covered walkways.

The second sample area was Via Braccio da Montone, typical of the peripheral area and featuring the typical “wall-houses” - very high houses with thick walls and small windows, from which the village was defended. This area has many visible strengths such as panoramic views, vehicular access, historical doors accessing the village as well as the above mentioned “wall-houses”.The critical issues reported in this area are very similar to those encountered in the historical centre of the village. In addition there are a number of hidden access roads.which may endanger motorists and pedestrians, considering that this area is open to vehicles.

4.6 Intervention strategies

The assessment of the most suitable intervention strategies focused on the objectives listed below:

Ob 1) Adoption of current regulations, resulting in improved road and public safety;

Ob 2) Improvement of comfort, and perception of quality of life in open spaces;

Ob 3) Improvement of the aesthetic aspects of the village;

Ob. 4) Reduction of light pollution;

Ob. 5) Reduction of energy consumption (25);

Ob. 6) Optimization of operational and maintenance costs.

The main focus for the first area was the correct illumination of architectural features and open public spaces whilst for for the second area, the main focus of intervention work was to provide a correct perception of the village even from the neighbouring villages and the surrounding areas.

5 The project

The idea of the project arose from the desire to make the lighting network more functional and efficient and to assign a specific spatial hierarchy to the two areas using light as a "tool". Each area was treated as a "context apart," and design choices were made according to the characteristics of each zone.

In the spatial area housing the "the historical pieces of architecture" accent lights with a neutral white color and temperature of approximately 4000 K, were used to enhance the characteristics of specific pieces of architecture, namely the ruins of the church of S. Nicola, Fig. 5. The type of lighting adopted was LED technology that allows a remarkable efficiency with regards to the flux emitted and electrical power absorbed. The lighting systems chosen allow two optical effects: “flood” used to perceive the overall volume of the ruin; and “spot” to enhance the architectural features preserved.

FIG 5 ABOUT HERE

The design intention for the spatial areas including the Piazza was to highlight the empty spaces,enclosed by the full volumes of the surrounding buildings.

The curtain walls enclosing the square are the elements that separate this empty space from the buildings. Linear lighting systems were placed under the eaves to create a holistic vision of the borders of the "square space”. Metal halide bollards placed along the edges of the square were used for the in-ground lighting to complete the system.

The side walls of the ruin were interpreted as a margin, an element separating the square “space” from the space of the ruin itself. Diffused linear light was used for this area, with in-ground elements and an upward-directed light beam. This choice was taken both to differentiate this architectural scenario from the surrounding curtain walls: separation of the volumes of the dense urban fabric of the inner village centre on the one part, from a specific architectural element on the other.

In the spatial area of the "internal streets" of the village, street lighting systems were mounted on walls, to obtain uniform illumination and to meet, the minimum values of illuminance required by legislation.. The illuminance values in this case were such as to allow the recognition of users’ faces at predetermined distances to ensure user safety. The average values of horizontal and semi-cylindrical illuminance were respectively equal to 18,00 lx and 6,58 lx, whilst the minimum requirement by law are 8,13 lx and 2,00 lx.

Several factors influenced the choice of lighting systems for the project; ,size ensures minimum impact whilst asymmetric longitudinal optics (Alo) allows the light to flow in the direction of travel and to drop in the area where it intercepted any building overlooking it: These properties are essential for the narrow streets of the historical village.

The colour temperature of light was also one of the parameters chosen to characterize the different spatial areas: warm and homogeneous through the streets of the inner centre of the village; warm and well-organized in the two lighting systems installed in the square; neutral light for accent lights.

The simulation and assessment of the lighting scenario during the planning phase was carried out using software, Dialux Evo version 3.3, (Fig. 6) which also helped us to calculate the amount of lux on any surface, as well as the semi-cylindrical illuminance Fig. 7.

FIG 6 ABOUT HERE

FIG 7 ABOUT HERE

The study was followed by a test of the lighting scenario, implemented using the extraction of colour scale images to compare with the graduated scale of illumination, Fig. 8.

To support the checks carried out some control points were introduced located on the street level, and a control surface located at the square level, to obtain the corresponding calculation values stored in a table, Fig. 9.

The software also provided data about the energy needed, in kWh, to supply all the appliances introduced in the project. This allowed us to quantify the energy savings achieved by the scheduled shutdown of portions of the illumination system[3] (excluding the ?? streets)[4].

FIG 8 ABOUT HERE

FIG 9 ABOUT HERE

The same design concept was then applied to the second area of the study which was divided into two spatial areas: border of the village centre and border streets, Different lighting scenarios were used according to the elements to be illuminated and enhanced.

In the first area specific wall washer lights were installed, to inspire a consistent perception of the existence of a “separating” element. In fact, the curtain walls of the margin of the old village centre mark the boundary between the inside and the outside of the village centre to the people approaching the village. The type of lighting fixture used was a light source with a warm colour temperature (3100 K), the effect of which is similar to the colour temperature of the light sources already existing in the village of Fontecchio and neighbouring villages.

In the second area, the border streets, a type of recessed luminaire was used, with flood optics pointing the ground, with a neutral colour temperature that does not interfere with the façade lighting.

LED recessed luminaires were used in both areas and and provides excellent performance combined with a lower energy consumption, meeting concerns of, both the public and private sectors.

4. Conclusions

Night illumination should not only ensure safety on the roads and open areas, but also highlight the hidden and charms of minor centers.

Lighting therefore needs to be designed with this dual function in mind providing a basic background illumination to ensure safety and visibility within the urban fabric, with modulation of light intensity level to maximum natural visibility; whilst also allowing the right visibility of the built environment through lighting solutions that are similar to the daytime conditions or totally original as for the colour temperature and orientation, to highlight and accentuate the formal and spatial content of the building on which the visual attention is to be focused.

The central assumption of our study and the methodology proposed has been to consider each historical center as a unique and indivisible body, whose components must be recognizable but at the same time linked by a global overview that can ensure functional homogeneity of the urban landscape. The basis of this approach is the identification of all the key elements present at urban level and of the cohesion logic existing between them and the surrounding context. The aim was to develop a street lighting design that, in addition to complying with existing regulations, becomes the creator of a new, non-discontinuous urban night identity, able to enhance the fundamental aspects of the built landscape, without altering the shapes perceivable during the day..

A further boost to design is given by the current need to match effective lighting, suitable for the proper performance of its function, to efficient lighting that can ensure, with the same performance levels, lower energy consumption thanks to the latest development of innovative technologies. In this area in particular not only the designers, but also the Local Authorities, are involved in the sustainable urban development process, In fact, for them the public lighting is a burdensome expense, due both to the consumption and management/maintenance of the systems.

It is essential to address the illumination of the historical villages through a coherent process of rehabilitation of the urban context. In fact, it is necessary to understand that the problem lies in the subtle relationships that bind the parts between them and each one with the whole. Through the culture of the project and the implementation of the proposed methodology, a number of compatible, non-invasive interventions, capable of enhancing the existing cultural content, may be carried out. Both the object-specific interventions and the context-related interventions must offer new emotional and suggestive contents without interfering with or altering the pre-existing values. At the same time, it is important to shape the light and make it flexible so as to adjust the luminous fluxes, overcoming the rigidity and fixity of uniform and predefined inputs with the

introduction of new elements capable of varying their contents and the specific values of intensity, colour temperature, directional flow, etc.

The topic of enhancement of the built environment throught night lighting has attracted growing interest in recent times. Local governments and authorities are particularly keen to give new dignity to the context of belonging through a more correct interpretation of their built heritage throughout the day. The task of the local governments must be to check the maintenance and management phase of the asset. The first one should be easily manageable by non-specialized personnel, and the second one, for a better overall efficiency, should have different sectors operating independently, thanks to motion detectors able to activate levels of lighting varying according to time, during the different hours of the night.

In conclusion, the developed research is part of a complex debate on city lighting that is currently animating not only the scientific community, but also municipal administrators and citizens. In particular, it is able to respond to the constant demands for greater preservation of the perception of the city landscape and its representation rooted in the collective imagination as well as environmental sustainability and energy saving. This research, has covered these themes by introducing the following innovative aspects:

- It has provided an analysis of the architectural scenes and prospective views of value of a historical village, with the aim of preserving them;
- It has defined the "scenario types" (open space, road, piece of architecture, margin context, etc.) based on which ad hoc strategies have been developed aiming at introducing new technologies or restoring traditional systems;
- it has promoted the introduction of compatible technical solutions by avoiding generalized, abstract and disadvantageous choices for the most delicate contexts.

Notes

[1] Image edited by Eng. Rossana Paoletti as part of her degree thesis, supervisor Prof. Pierluigi De Berardinis.

[2] Image edited by Sabrina Di Giorgio, Chiara Munzi, Marina Paglione, Silvano Sciandra, during the course of TPCME, University of L'Aquila, supervisor Prof. Pierluigi De Berardinis, tutor Eng. Lisa Di Bartolomeo

[3] As required by the Abruzzo Regional Law No 12 of 18 March 2005 et seq. mm. and ii. starting from midnight lighting is reduced by more than 30%.

[4] UNI 11248:2007 and UNI EN 13201-2

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The authors wish to thank Eng. Rossana Paoletti for providing some of the images developed in her Master's thesis, "Progetto di riqualificazione sostenibile nell'edilizia storica di Colonnella", supervisor Prof. Eng.

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Figure Captions

Fig. 1. Power lines of Santa Maria del Ponte (Aq).

Electricity lines are mostly overhead and often coexist in vicinity to other distribution lines. These "foreign elements" cause an incorrect perception of the façades. In addition, cable and conductor junctions and wire rope joints are often installed haphazardly along the facades of the buildings[1].

Fig. 2. The lighting system of Santa Maria del Ponte (Aq).

The ancient centre of the village is illuminated by lights anchored to the facades of buildings by means of 80-cm long brackets, placed at an average height of about five meters. The distribution of the lighting fixtures is fairly uniform, but the head lamp is not compliant with legal standards (Uni 10819). In fact, light is emitted above the angle 0 ° - 180 °. Furthermore, the light source is a mercury vapour type. The fairly good colour rendering of these lamps is neutralized by a poor efficiency[1].

Fig. 3. Spotlights in Santa Maria del Ponte (Aq).

Mapping of the spotlights in the village (single circle: wall lighting, double circle,-ground lighting)[1].

Fig. 4. The night scenario of Fontecchio (Aq).

On the left a daytime view of the village; on the right a night-time view. The pictures show that the final effect is a limited and irregular illumination, with poorly illuminated areas and a chromatic rendering which is incapable of enhancing the characteristics of the village. In particular, the general night perception of the village, both from inside and out tell us little about the identity of the historical centre.

Fig. 5. The project of Fontecchio town centre.

The design choices for the lighting of the ruins of the church of S.Nicola in context[2]. Ground lighting was designed to ensure the correct perception of the paving. In addition, the curtain walls were illuminated from the bottom up in a diffused and homogenous manner in order to define the spatial boundaries of the square. In the image, in addition to the two project renderings, the details of the new lighting system of the square and the types of lamps chosen are given. The latter include the bollards with symmetrical horizontal emission at 360° ("B1" type), the ones with asymmetrical horizontal emission at 180 ° ("B2" type), linear lighting systems placed under the eaves ("LL1" type) and under the slab ("LL2 type").

Fig. 6. Volumetric reconstruction of Fontecchio.

Volumetric reconstruction of the minor centre of Fontecchio[2]. Highlighted, the two portions of the village under study. At the top, the axonometric exploded view of the portion of the square and the ruins of the Church of San Nicola.

Fig. 7. The project.

Assessment of the lighting scenario using software[2]. The picture shows the isolux diagrams projected on the square surface, ie curves that connect the points with equal illuminance value.

Fig. 8. Analysis of solutions to reduce energy consumption. In order to reduce the power used for lighting, from midnight the linear lighting systems placed under the eaves along the fronts of the square will turn off; there will be a 50% reduction in the power of the projectors inside the ruin placed on the back and front walls, and shutdown of the lateral ones and some of the ones placed at the ruin apse. So the absorbed power drops from 3.319,8 W to 1.249,8 W, with a reduction of about 60% in line with the minimum levels of horizontal and semi-cylinder illuminance established by law. On the left: lighting ordinary service, on the right reduced service[2].

Fig. 9. Assessment of the project results.
On the left, identification of isolines; on the right, graphic representation of the illuminance values achieved[2]. In the detail, considering that the reference surface on which the calculation was made is the plane of the square, from left to right the horizontal illuminance isolines, the semi-cylindrical illuminance ones, the horizontal illuminance values and the semi-cylindrical illuminance values are represented.

Highlights

- We studied the village's featuresof interest
- We analyzed the existing lighting system and its critical aspects
- We identified technologically compatible solutions currently available on the market
- We evaluated the improvement of energy behaviour

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