

# Daylight for Sustainable Intervention in Historic Towns: The case of Edinburgh and Cairo

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**ABSTRACT:** Both the old town of Edinburgh and old Cairo are currently going through major regeneration schemes. In each case, the regeneration strategy tends to utilise new materials replacing the decayed materials that characterise the historic environment. In old Cairo, the implementation of such practice has instigated a cultural debate on whether the scheme has negatively affected the identity of the area [2,13]. The 2005 Management Plan of the old town of Edinburgh has also indicated that one of the major challenges the site meet is the erosion of Edinburgh's unique Scene of Place and outstanding townscape through the loss of local materials, inappropriate intervention, and the introduction of inappropriate materials [4]. Previous research in one of old Cairo alleyways showed that the introduction of new materials in the rehabilitation project has led to changes in daylight levels and reflections in the space and hence modify the visual perception of the place itself [15]. The results indicated an increase in the daylighting levels following the implementation of the intervention. Current investigation by the authors, in one of Edinburgh's closes, has also revealed the variability of daylight performance following the implementation of development scheme [6]. The work reviews the impact of an infill project that has been recently implemented in the historic Lady *Wynd* using new material on the performance of the reflected and total energy of daylighting. In this paper a comparative analysis is made to review the above research and measure the extent of the impact of intervention schemes on similar urban space configuration (alleys) located under different sky conditions. The paper aims to provide insight of the performance of daylight three components and the total energy of daylight in the examined built fabric in both Cairo and Edinburgh via using daylight simulation package. The paper examines the peculiarity of the daylight performance in the selective context, and hence its potential contribution to the preservation of place identity.

Keywords: place identity, daylight, solar simulation, heritage, regeneration

## 1. INTRODUCTION

Parts of old Cairo are currently going through major regeneration projects. Following the implementation of a number of these projects, there has been a significant debate on whether such intervention has negatively affected the identity of the area. In previous research [15], the controversial refurbishment strategy of one of the well-recognised alleyways in el-Darb el-Asfar medieval quarter in Cairo was reviewed (Fig.1). The investigation was primarily conducted to assess the practice of using new materials replacing the decayed materials, a main part of the intervention scheme, in relation to the context. The work showed that the introduction of new materials in rehabilitation project has led to changes in daylight levels and reflections in space and hence modify the visual perception of the place itself.

The historic core in the city of Edinburgh has recently also witnessed an increasing number of planning applications for the development in the World Heritage Site [3]. The number of applications that were given in 02/03 monitoring report reached a total of 2538 planning applications between 2001 and 2003. In terms of this trend, the 2005 management



**Figure 1:** The recently restored historic alleyway of el-Darb el-Asfar, historic Cairo

Plan of the Site clarified that one of the major challenges the site faces is the erosion of Edinburgh's unique sense of the place through: loss of local materials, inappropriate intervention, changes to historic street patterns, and the introduction of inappropriate materials [4:43-44].

In the context of Edinburgh, the traditional materials had made an important contribution to the unique identity and character of the Old Town. Like the

previous case, the regeneration strategy also tends to utilise new materials in implementing the development scheme. In current investigation conducted by the authors, one of the City's closes that lay in the heart of the Old Town, which has been undergoing an infill project is reviewed. The scheme, that includes the erection of the street frontage at the alley's lower section, represents an example of development where the height and mass of the newly erected building was implemented in response to the traditional geometry of the site but via using new materials (Fig. 2).

Previous research in Cairo case showed the critical impact of photometric qualities of the materials, which is directly affected by the clear sky conditions of the city, on the visual identity of the place [15]. In this paper, the validity of the research is challenged in similar urban configuration in different altitude, and under different sky conditions.

## 2. THE CASE STUDIES DEFINITION

Al-Maiyah and Elkadi [15] have investigated the impacts of the renovation of a historical part of Cairo historic centre on the identity of the place. The examined project includes updating the infrastructure, pedestrianisation of the alley, introduction of limestone pavement, as well as re-painting and re-plastering of the alley's external facades [7]. The cultural debate on the new *sparkling* look of the alley has surfaced as a result of adoption of various criteria of assessment. The project was "completed in 1999; enthusiasts applauded the sparkling new quality of work; purists bemoan the lost of patina of age" [2:178].

While, "Close", is the term commonly used in Edinburgh for a narrow passage between houses, "Wynd", such as the currently selected case study (the *Lady Wynd*), is usually used to describe a slight wider passage capable of admitting a small cart [11]. Previous studies (e.g. Edinburgh Old Town study, 1984; 2000 Action Plan) showed that only about one third or around 83 closes and *wynd*s remained, compared with 255 in 1851, and about 330 shown in Edinburgh's drawing in 1742.

However, over the last three decades there has been a steady programme of maintenance and repair of the closes and *wynd*s, together with their re-paving [9]. The 1995 Review of the Action Plan lists 23 sites, which offered opportunities for change that the currently selected case study was included. Located within the *Grassmarket*, an area of archaeological importance with a considerable visitors interest, the selective *wynd* provides access between two thoroughfares: the King's Stable Road and the West Port. The lower section of the *wynd* was originally occupied by housing but has been cleared and vacant for a long period. By the beginning of 1990s, planning permission for the erection of 12 dwellings and 4 commercial units was granted. The eastern and

western boundaries of the *wynd* are surrounded by residential and commercial properties including two listed blocks (Fig. 2).



**Figure 2:** The Lady Wynd, Edinburgh's Old Town, (left) the recently erected residential block at the lower section of the site

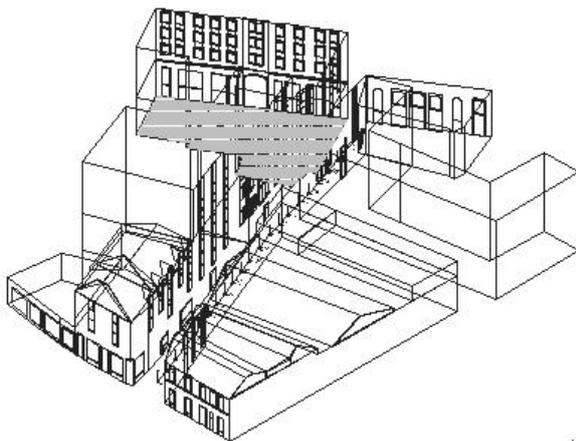
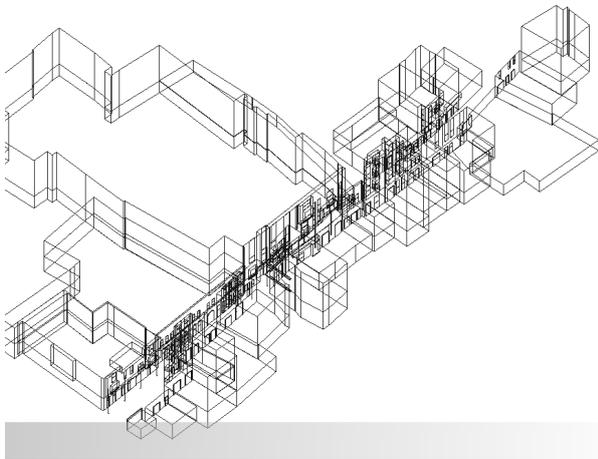
## 3. DAYLIGHT PERFORMANCE IN THE BUILT FABRIC

Daylight performance in an urban context relates to a combination of direct sunlight, diffused skylight and reflector of light from the facades and the ground. Daylight literatures identified a number of technical variables that are related to the characteristics of space configuration that impact upon the daylight performance. The physical configuration of the space, according to an explanation by Baker *et al.* [12], could be a morphological composition of vertical planes (the *frame*) and horizontal ones (the *floorscape*). The enclosure of the configuration consequently is formed by the integration of these perpendicular planes. Based on this morphological technique, previous work conducted by the authors classified the technical variables of the space configuration into three typological levels: the *frame* configuration variables, the *floorscape* configuration variables, and the space configuration variables. Al-Maiyah and Elkadi [15] have identified and described in details these variables in their work in Cairo.

## 4. THE DAYLIGHT SIMULATION MODEL OF THE HISTORIC STUDY (S)

In each case under study, the model utilised a system of reference points alongside the examined configuration. In Cairo case, a set of 22 points is used to examine the change in daylight performance in the two simulated old and recently restored scenes. Investigation scenario that based on the reference points system was also used to measure the variability of daylight performance in Edinburgh case. A 1.8m height has been selected to explore daylight performance at the eye level height and the sky opening factor at each point is also calculated.

A combination of *photogrammetric* and CAD software with lighting simulation tool are employed. In the lack of the required detailed architectural drawings of the historic buildings, the *photogrammetric* approach is mainly used to outline the geometry of the buildings. Mantzouratos *et al.* [14] utilised similar integrated approach. 3D CAD model for each case under study was created based on 2D CAD drawings and the district map (Fig. 3). Photometric properties were assigned to the model and detailed hourly climatic data for the cloud cover, diffused and direct solar energy (using the meteo-file in TownScope package), and parameters of the relative humidity and atmosphere turbidity were selected.



**Figure 3:** Axonometric view illustrates the benchmark distribution system in the alleyway (up) and the wynd (bottom)

The simulation exercise is basically conducted to assess the solar access and the sky opening factor alongside the developed models. The performance of the daylight's three components as well as the total energy of daylight of a selective urban setting in both the Cairene and the Scottish context is simulated at June and December the 15th.

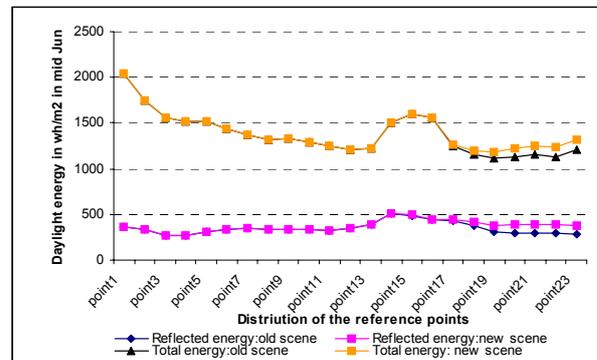
## 5. PERFORMANCE OF DAYLIGHTING IN THE TWO SELECTED SPACE CONFIGURATION

The simulation modelling investigated the variability in daylight performance pre and after the intervention scheme in the alleyway and the wynd site.

In Edinburgh case, the output of the simulation shows that the renovation of the street frontage with recent materials has led to improvement in daylighting level at the lower section of the alleyway and a sort of equilibrium in the daylighting performance alongside the space.

The results show an increase in the reflected components in June the 15th as much as (15.6 or 24.16%)<sup>1</sup> that has resulted in an average increase of (4.05 or 6.25%) in the total daylight levels. The increase in the reflected component due to the use of new materials has led to more homogeneity in the daylighting level (along the alleyway) as compared to the gained results from using the stone facing (Fig. 4).

Similar performance in the reflected energy is gained during wintertime. The analysis shows an increase of as much as 21.26% and 5.5% in the reflected and total daylighting levels, respectively.



**Figure 4.** The variability in the total daylighting and reflected component due to the implementation of the street frontage at the eastern boundary of the wynd with new materials in mid June

However, the increase in the reflected component is much more influential during summer time with an average increase of as much as 90.71% in the availability of the reflected component more than the obtained figure during mid winter. This seasonal increase in the reflected component in Edinburgh

<sup>1</sup> The figures are obtained by considering the overall increase till the mid of the alley or by considering the increase at the points that are directly located in front of the target building only (the mean divided by 7)

contradicts the results in Cairo's alley scenario. In Cairo case, the increase in the reflected component proved to be most influential in mid winter leading to 8.98% average increase in the total daylighting level (Fig.5) as compared with 1.31% during summer.

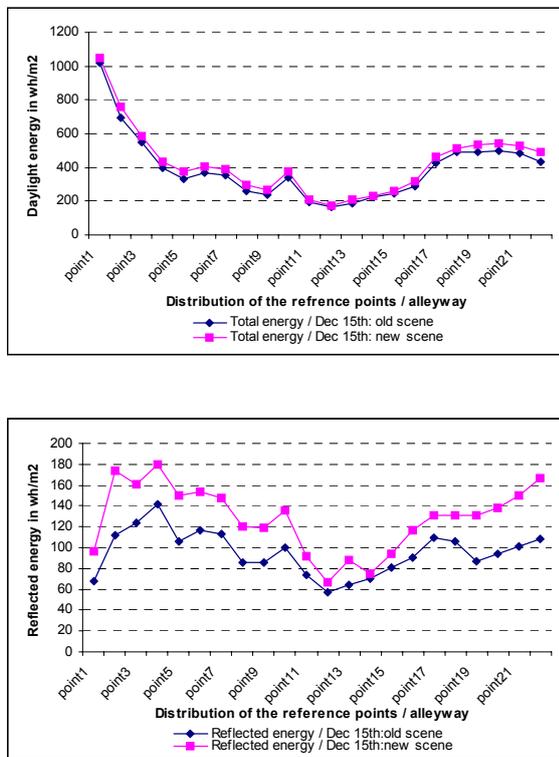
In the city of Edinburgh, the long sunshine hours during summer combined with the low solar altitude of the City, as a result of its high latitude, have influenced the amount of the reflected component. In Cairo case, the high increase in the reflected component by mid winter (33.75%) can be explained by the low solar altitude in the season that allows the reflection from the vertical planes more than the impact of the reflective ground plane during the high solar altitude in mid summer. The usefulness of the vertical surfaces (the facades) as a light source during winter months than summer supports conclusions reached by studies investigating the indoor illuminance-related researches (e.g. Tsangrassoulis *et al.*, 1999).

There is, therefore, a need to pay further attention in regards to the selection of the appropriate materials and their photometric properties as an essential element of the refurbishment scheme in Cairo context.

In contrast, the low level of daylight in the Scottish context results in much more flexibility towards a selection of materials in any intervention project.

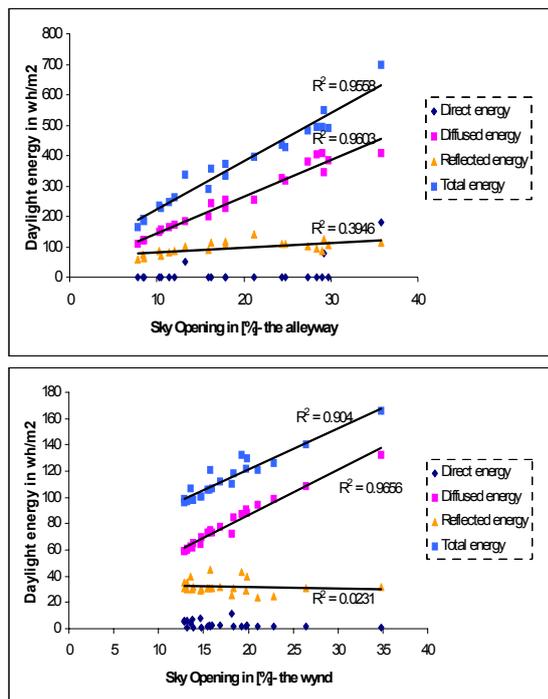
Correlation analysis is also conducted to investigate the relationship between the compactness ratio, represented in the sky opening value and the daylighting performance in similar urban components related to different context. Linear relationship between the diffused energy and the sky-opening factor, which represents *the percentage of the sky visible from a point* [10], is obtained in both seasons in the alley in Cairo and in Edinburgh (Fig. 6). The results show that comfortable visual experience in urban space is directly related to urban site layout configuration.

The obstruction of the low solar altitude in mid winter in Cairo case and in Edinburgh (all year around) influences the performance of the direct energy in both urban components (Fig. 6). The relationship between the sky opening factor and the total daylighting level in both Edinburgh and Cairo cases provides an insight of the peculiarity of the daylight phenomenon as place-specific. The predominance of the diffused component that has the highest influence of the total daylighting level in Edinburgh's case has resulted in the strong correlation with the sky opening factor in both seasons. The poor correlation of the total daylight level and the sky opening factor in Cairo's alley is related to the predominance of the direct component and the high solar altitude in mid summer. The significant correlation in the alley at December the 15<sup>th</sup>, like its counterpart in Edinburgh, is therefore ascribed to the obstruction of this (direct) component during wintertime combined with predominance of the diffused energy (Fig. 6).



**Figure 5:** The variability in the reflected and total daylight level due the rehabilitation in the alleyway in mid Dec

In Cairo's alley scenario, the impact of the variability (increase) in the daylight performance has been perceived as a contradictable issue. While increasing daylighting levels during winter time, as a result of the introduction of new materials, are generally welcomed by the residents of Cairo's alleyway, the sharp increase led to loss of what is perceived as authenticity.



**Figure 6:** Correlation analysis of the daylighting performance (wh/m<sup>2</sup>.day) with the sky-opening factor (%) in the alleyway configuration in both of Cairo (bottom) and Edinburgh (up) in mid winter

## CONCLUSION

The recent interests in conservation areas have mushroomed demand for planning applications for restoration, renovation, and re use of many parts of historical sites around the World. The impacts of many intervention projects are clearly positive in city council's regeneration efforts. The scale of expansion is however alarming and led to concern about loss of identity of these preserved areas. This paper shows that daylighting plays an indirect role in the perceived feeling of loss of identity as a result of the sparkling look of the newly developed or renovated schemes. The changes of daylighting levels seem to be a by-product of the facades renovation and/or the introduction of new materials. This was mainly related to the variations of the reflected energy components. Two case studies in Cairo and Edinburgh were compared. The results show that the sense of loss of place due to change in the applied materials are sensitive to both the altitude and the sky conditions of the site. The results show that the changes in visual perception as a result of architectural intervention are related to the influence of the reflected components of daylighting. The perception of changes is therefore reduced in a historic built environment, with narrow alleyways, with clear sky conditions and/ or high solar altitude such as Cairo in summer time. The feeling of loss of identity is however greater in winter time when reflection provides a significant component to the daylighting profile.

The results highlight the conflict between benefits obtained by the residents of the historic sites and requirements of the tourist industry. In Cairo, the improvement in the winter daylight level, as a result of improving the reflectivity of the new materials, is strongly criticised by the romantic attitude of visitors as a loss of authenticity. This conflict was less apparent in the Edinburgh case as the low sun maintains constant light before and after intervention due to the low contribution of the reflected component to the total energy (appx 15% in Edinburgh and 25% in Cairo).

Careful consideration for the performance of various daylighting components can therefore be crucial in maintaining a sense of place in historic sites. Intervention projects should carefully analyse the impacts of changing daylighting, particularly with regard to new façade materials. These results can be enhanced with further work on the impacts of changing ground materials.

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