A Study on the Design for Daylight in Old Middle Eastern Cities in the Context of Urban Planning

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Abstract

This study will look into how urban planning has considered daylight designs in the old cities of the Middle East which in general have a hot dry climate with long duration of sun exposure, and the planning process and design methods in modern western countries regarding the provision of daylight in the urban scene, and also looking into the region's (Middle East) modern cities, as how they are working toward implementing daylight designs in today's urban design compared to the past and also the modern developed countries, the aim of the study would be to find out the recent natural daylight research methods in order to achieve one of the aspects of holistic sustainability, and an exploratory research approach is taken into looking at the history and development of the region

Keywords: daylight, urban planning, Middle East

Introduction

As the world's population increases, more high-density cities will emerge, and in these cities, buildings are fighting each other for natural light and ventilation. In result, developing ways that optimizes the design for daylight and air became an important task for architects, engineers and industry stakeholders [1].

Urban planning has always been a process that considers combining society's needs with holistic sustainability, through the study and application of various passive design strategies with the master plan layout of cities in order to achieve a sustainable environment, and an important aspect has been daylight design, as many cities from ancient times have tried to optimize their layout based on the climatic characteristics, and this process has been different from climate to climate, as in colder climates, the layouts tried to maximize the penetration of daylight into the buildings and alleys, while in hot climates it was the opposite, as direct sun and daylight into the spaces would be avoided to prevent overheating if possible.

As time passed by, extensive exploitation of solar irradiation in urban zones has become an essential and practicable strategy to maintain sustainable development. And in recent times, more advanced methods for the study of solar penetration into different urban textures are needed [2].

Many cities in the Middle East were planned considering the effect of sun on the region, but with time due to expansion of these cities, they have moved on from the traditional vernacular style in to modern industrial styles, this decreased their overall performance which led to relying more on technologies to improve them, but in recent years, architects and urban planners are starting to go back and reintroduce the effective traditional architecture and modify it to today's standards.

The paper will look into the designs and principles that were devised in the old times to provide sufficient daylight levels into the urban layout but also avoid direct solar gains due to the hot nature of the region, and compare them with modern cities as to how much has changed since then.

Methodology

The research method to be employed is a qualitative exploratory research approach, as the study will be looking into the urban planning of notable Middle Eastern cities such as Erbil in Iraq, Damascus in Syria and others in northern Africa as they are known to have an organic urban layout that provided them good visual comfort and avoided unintended heating, and analysing the methods used in designing and organizing the blocks and housing units, and exploring if this procedure has managed to provide sufficient daylight for the buildings, and comparing it to recent western cities on how they have decided to design the urban grid in order to receive the needed daylight.

Literature Review

For this study, articles and journals will be looked into that have studied the relationship between urban forms/layouts and the climates of specific regions, regarding how the overall layout should be designed in order to make use of the daylight based on requirements and needs.

Recent study results performed by R. M. Dekay based on the city of Chattanooga, Tennessee, USA, show that existing buildings were not designed to consider other sites' rights to light and sun.

From this a design pattern was suggested which is a generalized solution to a recurring design problem, stated in such a way that the exact built pattern can be done in many possible ways as they offer suggestions regarding size, shape, location and organization of the urban components [3].

These considerations have clearly lead architects and designers to specialize in a more focused profession e.g. urban planners and designers.

This specialization can be seen in two different studies performed by E Ng et al, which one was for a residential complex (Hoi Lai estate) in Hong Kong [4], and the other on the dense urban centres of Hong Kong [1], and tried to

understand the problems the residents have regarding natural lighting through surveys, and through modelling and analysis establish some specific and detailed regulations for the city as he noted Hong Kong lacked in any governmental regulations and design standards to maximize passive means for the urban layout for quite some time.

Although the literatures are not based on any cities in the Middle East, it can be seen that daylight on an urban level is still a common problem throughout the world, as many concerned architects and planners are working to find the best possible solution and patterns in order to provide a healthy comfortable spaces for the cities' population, and as in lately most of the developed countries are using 3D modelling software to predict the best shape, size and orientation for the urban pattern, this process can be difficult for developing countries due to technological restrictions, but local proficient architects have started looking into past techniques in their region and also referring to the previously mentioned studies in order to find the right balance between imported modern technologies, sustainable solutions and preserving their country's unique identity.

Discussion and Results

Looking into the urban layout used in the following Middle Eastern cities (e.g. Erbil, Damascus and Istanbul), we can see notable patterns and methods used to reduce direct solar gains and provide daylight into the urban units.

Starting with Erbil, its oldest part is the Citadel of Erbil (sources indicate urban life dates back to around 6000 B.C.) [5], which is also the city's centre, housing units populate the citadel, and in (Fig. 1) it can be seen a random organic pattern taking form, there is no clear documentation stating when exactly the first unit was built, but many researchers concluded that the reason for this particular pattern has been due to the hot climate, topography and social requirements [6].

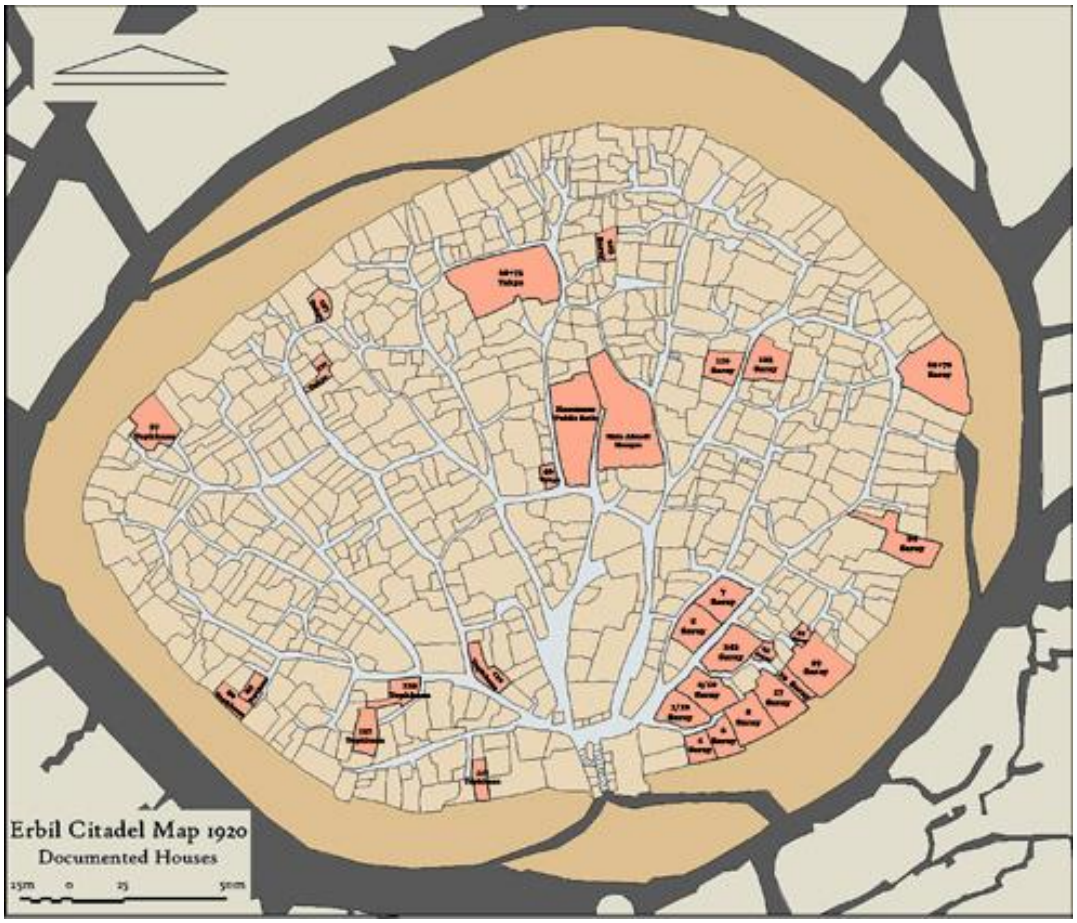


Figure 1: Map of Erbil's Citadel in 1920 [7].

Most of the streets have been designed and built as very narrow pathways (Fig. 2), this was to decrease the influence of solar radiation and create enough shade and shadow to make it comfortable for people's daily circulation, and also direct solar radiation into the buildings have been minimized by reducing the size of the openings in the facades that look onto the streets. And instead of relying on the main facades to get natural light, internal courtyards and atriums (Fig. 4) have been constructed to provide sufficient daylight, as most of the rooms would be organized around the courtyard and be separated from it using a gallery-type corridor (Fig. 3) that would further prevent direct solar radiation to penetrate the rooms, therefore only skylight and reflectance from the internal surfaces would provide the much-needed light.

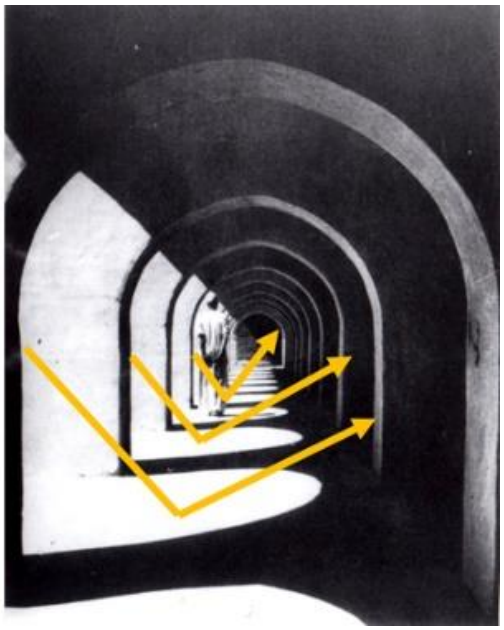
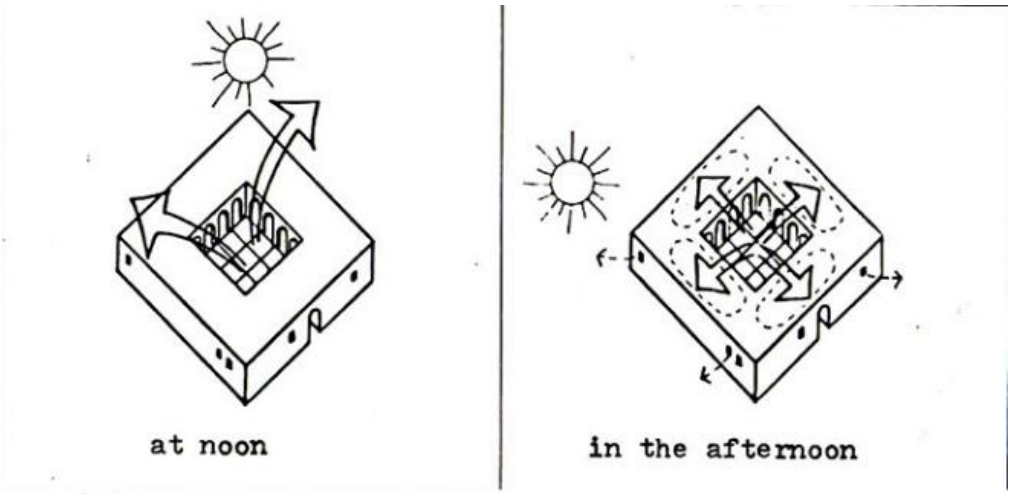


Figure 2: (Left) Example of the narrow street.
Figure 3: (Right) Gallery corridors or balconies provided in the courtyards [8].



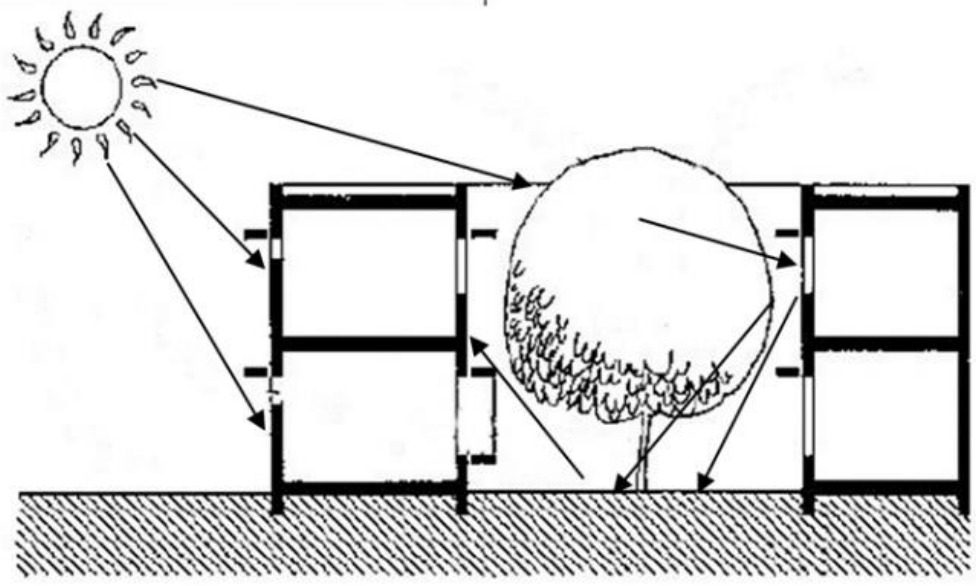


Figure 4: Use of courtyard in the residential units [8].

These patterns were not only specific to Erbil, but many neighbouring countries were developing cities in a similar manner, even in northern Africa the planning of its cities were in the same organization due to similar climate, and each country would differ by implementing local traditional materials and details that would make them standout from each other. Similar to Erbil's urban layout can be seen in Syria, Egypt, Tunisia, Iran, Turkey and many other cities as we can see in (Fig. 5 and 6).

Figure 5: Master plan of Damascus in Syria showing the use of courtyard in most of the part of the city [8].

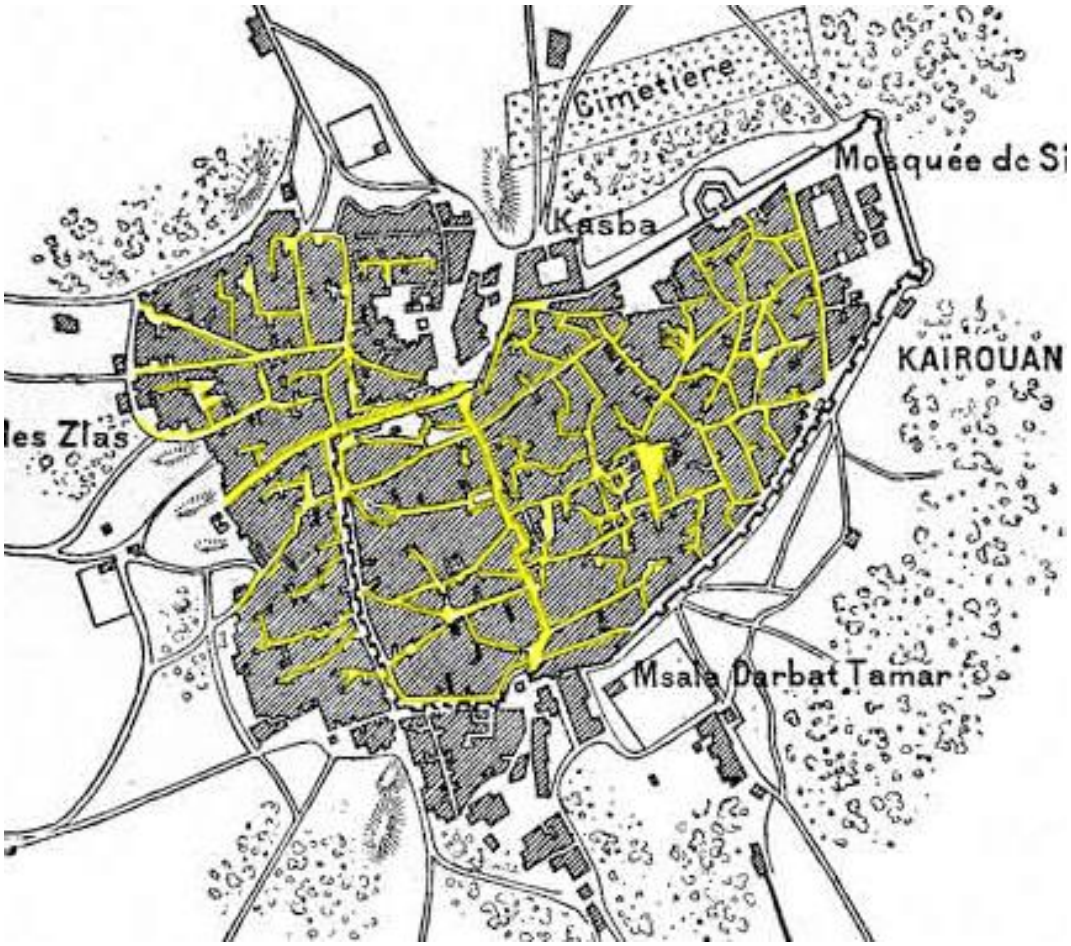


Figure 6: Master plan of Kairouan in Tunisia, the organic pattern with narrow streets are visible [8].

The shopping districts (called bazaar) have a slightly different approach in providing daylight, as it's more like a closed complex with the roof of the pathways between the shops covered entirely and have high side openings to provide daylight.

These roof covering were usually in the shape of domes and/or vaults that would have openings either at the top or the sides of the roof elements based on the width of pathway in the bazaar, in (Fig. 7 and 8) these methods of daylighting can be noticed.

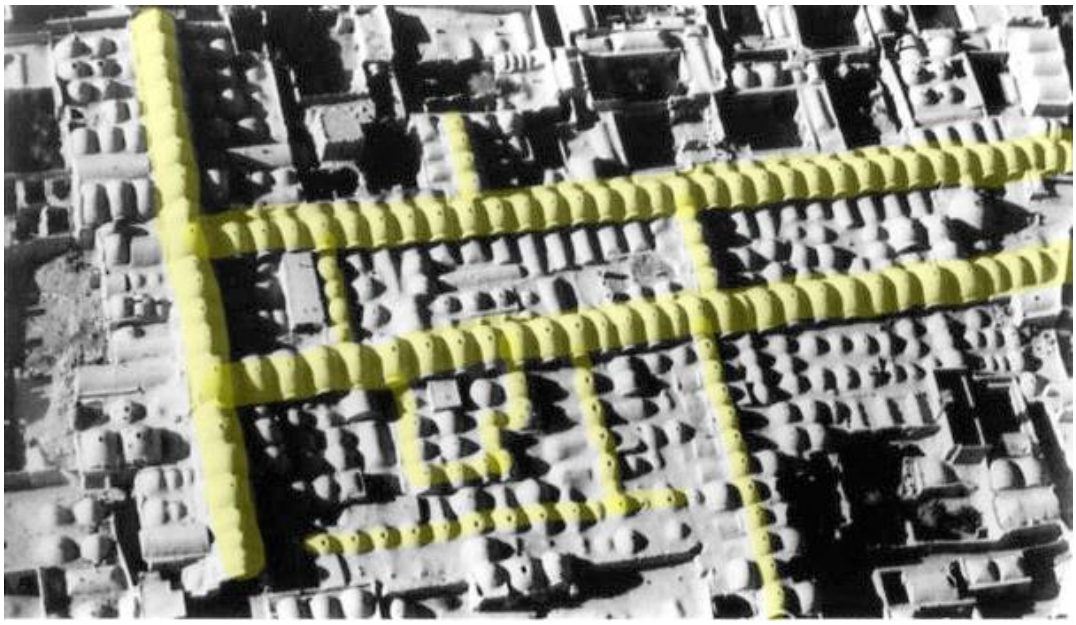


Figure 7: Aerial view of a bazaar in Seojane in Iran [8].

Figure 8: Interior view of the great bazaar in Istanbul, Turkey [8].

Other elements were devised to provide daylight without the direct sun such as the mashrabiya, which is basically acting like a balcony, this element also helped give a unique characteristic to the overall façades, and created a unique skyline for these regions. They weren't only used on the external façade, but also internally in the corridors facing the courtyards (Fig. 9), which helped the rooms to be further protected from unwanted solar radiation.

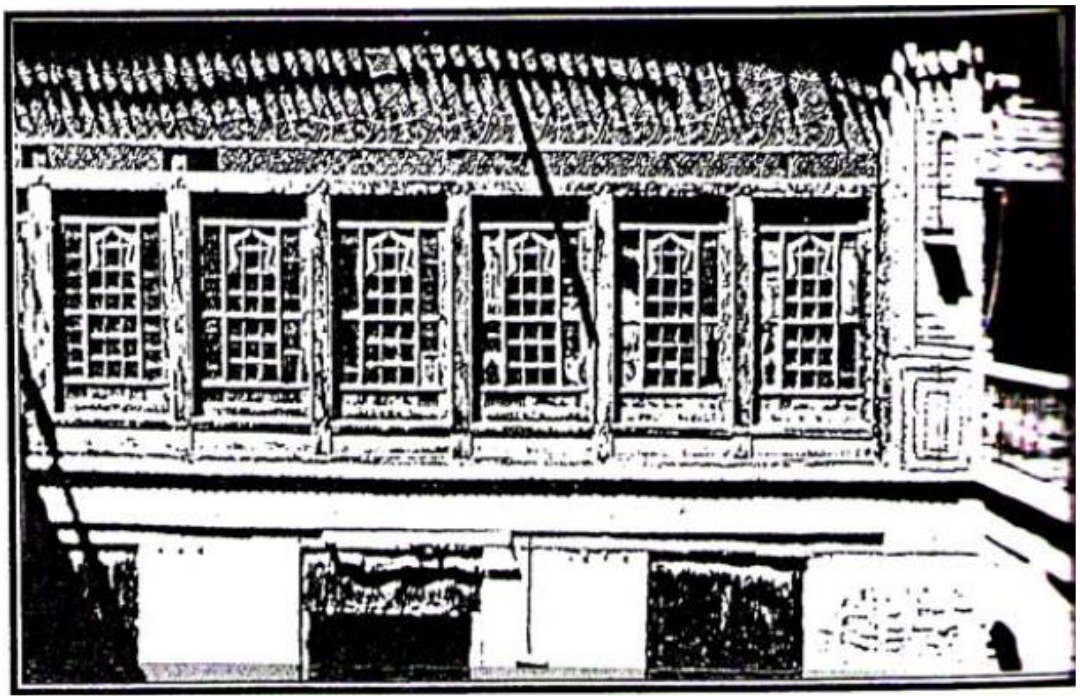


Figure 9: Mashrabiya screens used inside the courtyard [8].

These characteristics and patterns unified the Middle East region and was synonym with what is known today as the Islamic Architecture style [9]. This style would evolve and expand into many other countries, until around the beginning of the 20th century, with advances in technological capabilities and the emergence of modern industrial movement in the west, many countries in the region started to adopt this way of expansion around the 1940s and 1950s. And in result, most of the newer parts of these cities were shaped very differently and were also based on different standards compared to before.

This led to a contrast in the shape and performance of the urban layout (Fig. 10 and 11), as the older part would be providing a cooler environment, while the newer parts would lead to heating up creating urban heat islands in the process, this obsession of trying to copy the style and advancements of western developed countries in hope of the region can evolve too has led to some sort of identity crisis.

Also the procedure of implementation was very different compared to the west, for example in Iraq's cities the urban layout was created by dividing the land plots in a more geometrical pattern without considering any small details and the only regulation to be specified was how high the buildings

should be, meanwhile the western countries were developing their urban layout in a very different manner, due to different climate and geographical characteristics, many architectural firms and urban planners were dedicating themselves to mathematically and geometrically try to solve the urban problems like providing daylight and good wind speed while reducing unwanted heat gains.

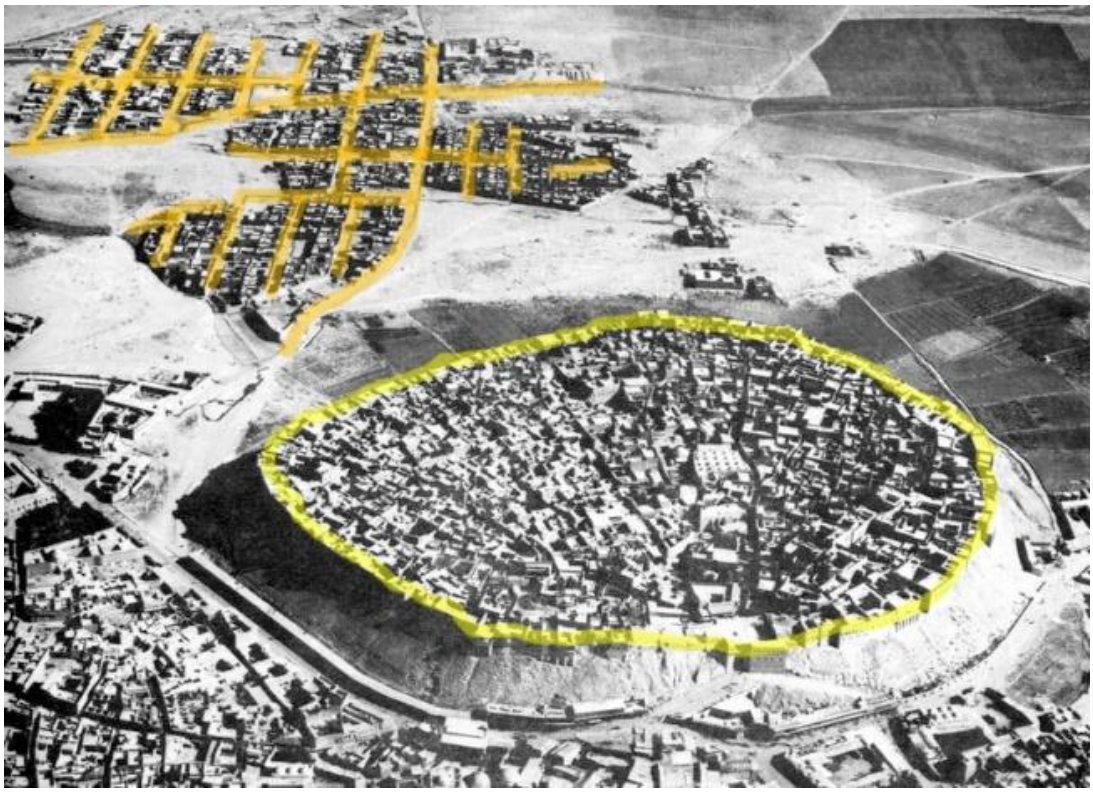


Figure 10: Aerial view of Erbil, in the distance the new grid layout expansion can be seen [7].

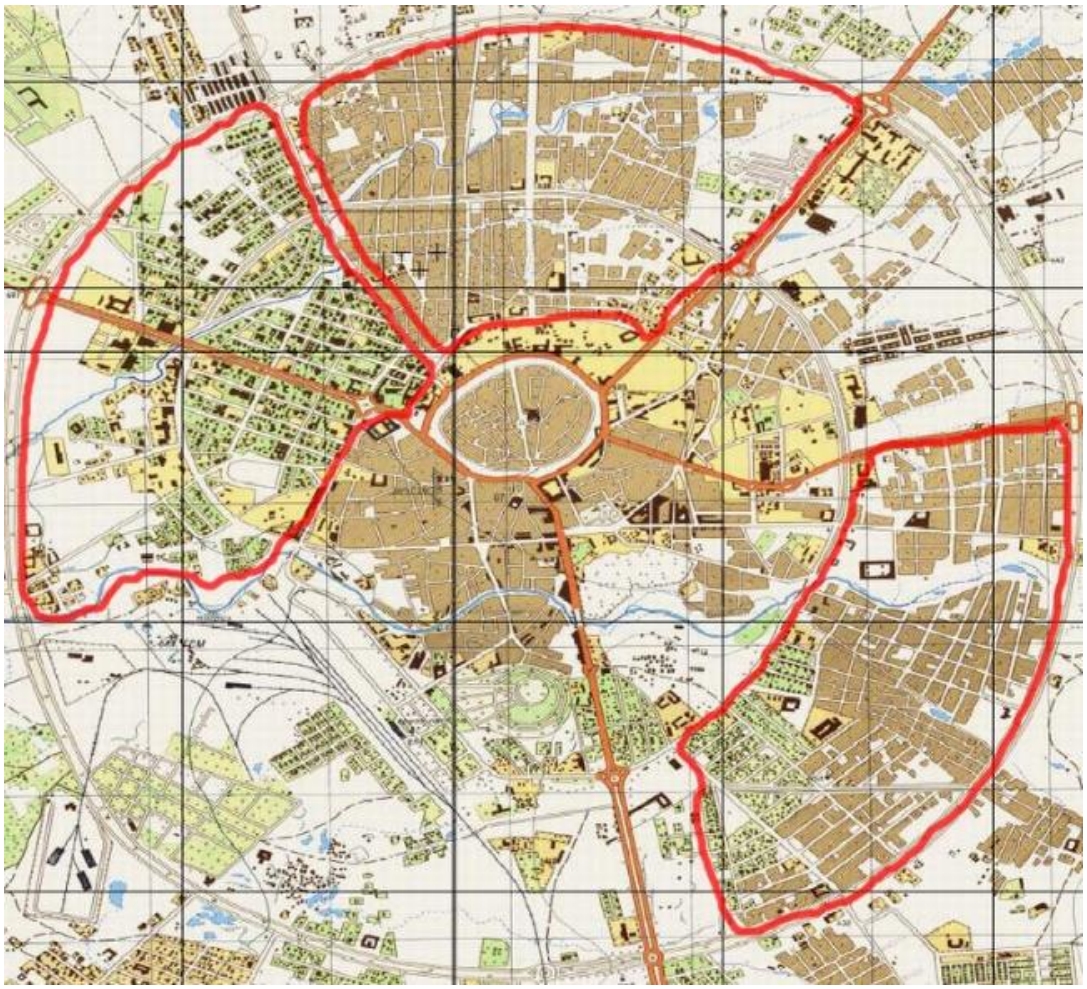


Figure 11: New master plan of Erbil, showing the contrast between the newer parts and the Citadel in the middle [7].

In the years at the end of the 20th century, some of the countries in the Middle East and northern Africa have started trying to re-implement and improve the traditional methods of daylight design in the urban context. One of the most well-known architects to rise into prominence in the Middle East was Hassan Fathy from Egypt, who worked to re-establish the traditional materials and features of the old Islamic architecture in the region and reduce the western building designs and layouts, he was also one of the first architects to reiterate the importance of sustainability especially with the continuous climate change, stating that "a solution must be found to the problem of clashing the industrial products with the demand of nature and of society" [10].

One of the modern example of working to achieve sustainability through the traditional architectural techniques in the Middle East is Masdar city in the

United Arab Emirates, the architectural firm (Foster + Partners) has applied different traditional techniques to increase the environmental performance of the building blocks alongside modern technological features and solutions (Fig. 12 and 13), for instance the distance of the streets were reduced in order to shade the streets and any nearby buildings [11].

On a building level the privacy factor of the traditional Islamic architecture was considered by using Mashrabiya screens, which were made from glass reinforced concrete instead of the usual wood and coloured with local sand to minimize required maintenance [12].

Figure 12: Aerial rendering of Masdar city, clustered units surrounding a courtyard can be seen throughout the site [11].

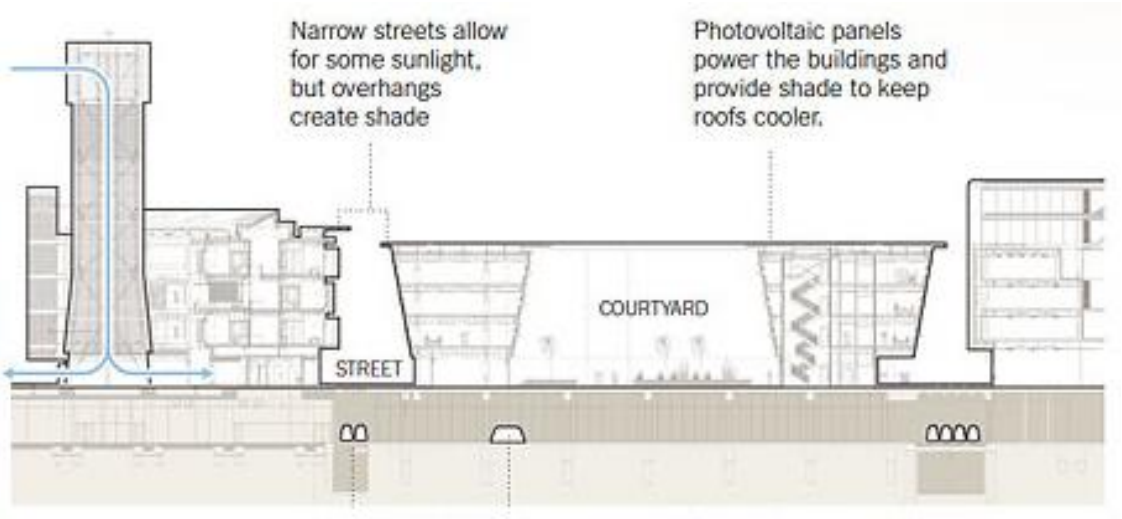


Figure 13: Use of narrow streets and courtyards in Masdar city to provide natural daylight and reduce sunlight [11].

Modern urban planners are taking the urban design process in whole different style especially when the work would be on an international level and different capable technologies are available to them, in recent years, more emphasis is made on conceptual 3D modelling on an urban level to look for the best possible solutions for the daylight problem, and in result the design pattern that was discussed earlier was born, to try and tackle this continuous problem, for instance in a research led by R. M. Dekay [3] using modelling a process called “climatic envelope” was devised, which was separated into three different steps “daylight envelope, solar envelope, formation of the climatic envelope” in order to try to shape a building block into one that would have the maximum benefit of daylight, then this newly acquired 3D model would be further analysed in an urban pattern to finalize its design (Fig. 14, 15 and 16).

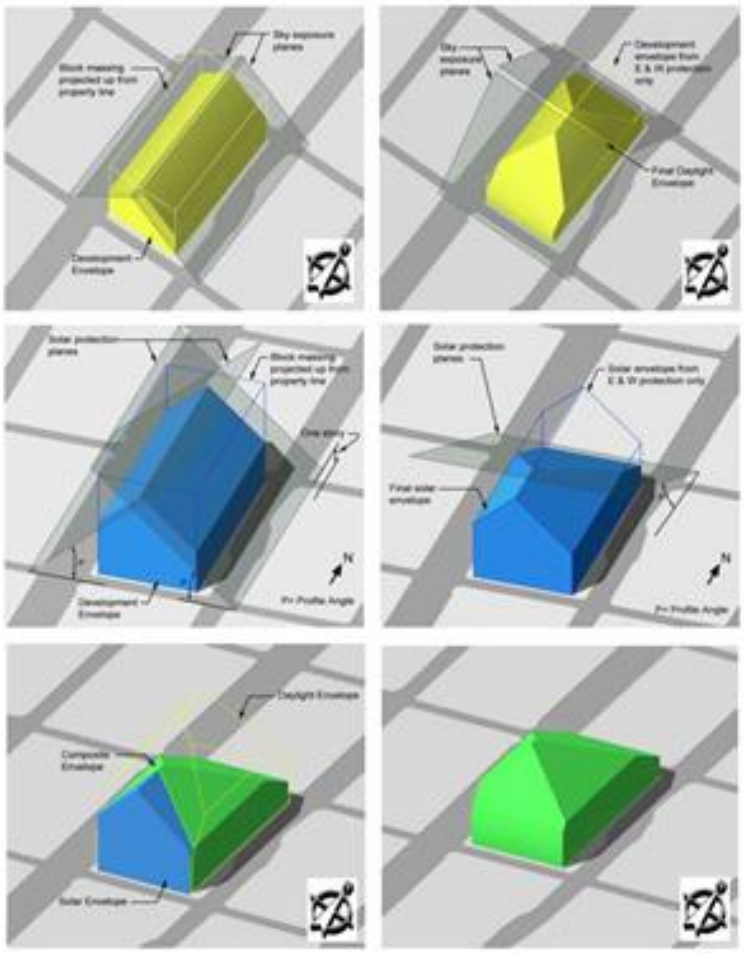


Figure 14: (Top) Construction of the daylight envelope.
Figure 15: (Middle) Construction of the solar envelope.
Figure 16: (Bottom) Formation of the climatic envelope through combining the two previous results [3].

From what has been discussed, a learning curve can be seen regarding daylight considerations in urban planning, as in ancient times it was relied more on personal knowledge of what was best for human comfort, the importance of close social relationship factor, and repeated usage of specific organic patterns, a unique urban infrastructure with specialized daylight solutions were created, and although the urban scene with its specialized daylight design was changed with the emergence of the modern movement in different countries with different social needs, urban planners have started to preserve the traditional architecture of the region and re-introducing the traditional vernacular designs with modern features in order to adapt them to today's conditions and also prepared them for the future.

Conclusion

This study attempted to look into the development and evolution of daylight designs in an urban context in the Middle East region through looking at the different ages up until now, what was found that in the past there was reasonable and an appropriate approach on how to solve the daylight issues throughout the region, but with the emergence of a modernized style in the world halted its progress.

But deeper understanding of the importance of natural daylight especially in order to achieve sustainability has made the traditional vernacular style to reappear into today's social and urban needs, many planners and designers are working harder with a newer approach like utilizing 3D modelling software to produce a network of relatively simple design patterns that can be available to easily incorporate into urban development planning and regulations, and based on recent studies led by Dekay [3] it was proposed that if these efficient daylight designs to be implemented now, it will provide the buildings most of the site-based energy resources they will require in the coming renewable energy economy, which for the Middle East would link the daylight design methods with renewable energy, for instance the unwanted solar radiation that is being blocked from the main facades can be used to produce electricity for cooling systems, and thus reliance on fuels would be reduced.

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