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Title:
Light as a Medium to Rejuvenate Urban Spaces

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Abstract:
This Master's Thesis discusses the importance of acknowledging that lighting design can rejuvenate public spaces at nighttime by enhancing the pedestrian experience. Hence, the aim is to explore possibilities of creating a liveable atmosphere in urban spaces, which could encourage their spatial usability in the dark hours. To achieve that, the impact of conventional lighting has been investigated through spatial, social and lighting analyses in two distinct areas: Israel Square, in Denmark and Dona Lindu Park, in Brazil. Those investigations provided an insight concerning the issues faced in urban scenarios at nighttime caused by the weak connection between lighting and the built environment. In fact, it has been identified that the use of direct light was implemented to promote navigability and to ensure security throughout urban spaces, and the indirect light was used only to emphasise some details with no clear intention of supporting human needs. Consequently, that is resulting in depriving the relationship between human beings and the built environment, as lighting is not reinforcing the spatial qualities nor providing a pleasant atmosphere. Moreover, studies of multidisciplinary topics have provided acknowledgment that a combination of the spatial, social and lighting aspects within the urban environment is crucial for ensuring the efficacy of urban spaces. Yet, people seek protection, comfort and delight when inhabiting urban spaces and lighting design has the power of transforming the nighttime experience through creating atmosphere. Those findings have led to the research question of this project: "How could the use of direct light together with indirect light generate a liveable atmosphere in urban spaces at nighttime to ensure that the feelings of protection, comfort and delight are satisfied among pedestrians?" Ultimately, a lighting design scheme has been elaborated emphasising on the use of direct and indirect light to create distinct light layers by generating different visual effects. That lighting concept would provide a more liveable nocturnal atmosphere in urban spaces, succeeding with the design criteria of ensuring feelings of protection, comfort and delight among pedestrians.

LIGHT AS A MEDIUM TO REJUVENATE URBAN SPACES

an illustrative concept through visual effects of the light

AALBORG UNIVERSITY
COPENHAGEN

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Alperen Ekici
Priscila Galamba

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This chapter of my life would have never been completed without those who provided me support during my studies. First, I wish to show my sincere gratitude to our thesis supervisors, Ellen Kathrine Hansen and Mette Hvass, who guided and encouraged us to be more pragmatic and to achieve our best even when the road got delicate. Then, I would like to pay my special regards to my thesis partner Priscila Galamba, who was on board with me during this special work and with whom we became close friends for life. Another thanks for the direction of Aalborg University, which managed the administrative parts of our studies, and for the academic crew of this Master's Programme to have provided us with a cross-disciplinary education. A heartfelt thanks for my family in Turkey for their moral and material support. A warm thanks to ZKLD Studio, which provided me a significant experience during my internship the previous semester. Thanks to all my friends all over the world who helped me to collect unforgettable memories and support me in this process. A kind thanks to my classmates for creating a pleasant learning environment. Thank you very much!

Alperen Ekici

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Priscila Galamba

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01 INTRODUCTION

The introduction chapter displays diverse sources of inspiration leading to awarenesses on various aspects touching upon the traditional ways of lighting up spaces, connecting to the new needs and finally stating the core targets of this thesis.

When the authors started writing this thesis, they had in common the eagerness to understand how people would naturally behave in the built environment in regards to the lighting conditions of that space. Both have lived in agglomerated urban cities, located in Brazil, France and Turkey, and decided to move to Denmark to pursue a Master's in Lighting Design where they had the chance to meet. Growing up in metropolitan areas gave them the perspective of what it is to live in over populated areas where the presence of urban spaces is a prerequisite to support the wellbeing of the population. Due to that, they acknowledge that most urban spaces lack a meaningful connection with the human scale, architecture and light because not all of them have good spatial qualities, nor the most appropriate lighting configuration. Also, working hours in urban cities are characterised for people taking long shifts or night shifts, which infers that urban spaces will be used more often after dusk. Thus, urban spaces need to be redesigned to be more liveable and inviting for different kinds of activities, also during nighttime.

During the thesis work, the world was facing an unusual situation caused by the outbreak of COVID-19 virus and as a result, population in many countries throughout the globe were demanded to be home to prevent the spreading of the virus. Also, people were allowed to leave their houses only to buy essential products for their basic needs and to perform outdoor exercises to preserve their mental health and physical conditions. There has never been more evidence of the need for the human being to connect with nature to protect their wellbeing and yet, the importance of public urban spaces for people living in metropolitan areas.

In recent years, there has been an awareness of the need for better structured urban spaces for supporting city life. Following the guidelines of the Sustainable Development Goals established by the United Nations which aim to set up peace and prosperity for people and the planet, it is believed that it is necessary to revitalise existing public urban areas in the city, as the need for quality-oriented public urban spaces arises (Budisteanu & Skovbro, 2002). It should be recommended to design such spaces to merge lighting and architecture so that people could enjoy these areas at their convenience, supporting their diverse routines. In addition, by reinvigorating these areas, people would be encouraged to spend more time outside home, engaging into social interaction or performing outdoor activities. As a result, the quality of life would be boosted and the city life would become more liveable and vibrant, also during night hours. Yet, once the world is able to control the current pandemic situation, that need will be even more accentuated because the population will have to reevaluate their social interactions.

However, it is acknowledged that implemented lighting in most urban spaces is inefficient for supporting diverse activities during dark hours. Traditionally, the streetlight with directional light is the only typology used for illuminating urban areas with an aim of allowing legibility of the space for security reasons and light level requirements. Nowadays, different lighting typologies together with technology are being used to achieve the same purpose and additionally provide a valuable experience of the

space, as the focus is changing to a more humanistic approach. In fact, not every city is capable of using lighting technologies to support the use of these areas nor there is a need for all urban spaces to adopt these methods. There is a need to learn more about how the use of different lighting typologies, combining direct and indirect illumination, can create liveable atmospheres in public urban spaces. Perhaps, that would stimulate people to be more active and increase the usability of these areas at night, while also fulfilling the primary needs. Also, which qualities of the light are attractive and which of them are repelling for people while using urban spaces at night? It should be noted that it is more important to understand these aspects in relation to users' behaviour within the space so that professionals can propose better lighting solutions in the future, than simply installing, waiting and observing the consequences of those undertaken beforehand. Therefore, the investigation of this matter should be done the other way around.

Lighting designers can collaborate in this matter by striving to acquire the necessary knowledge to be able to design more efficient lighting solutions for people using urban spaces in the dark hours to ensure a better qualitative experience of the space. Moreover, that could help to rejuvenate public urban spaces through lighting by stimulating pedestrians to embrace the use of these areas in their daily routines.

Based on all aforementioned reasons, this thesis work aims to investigate how to improve human relations with the built environment via the phenomenon of light in order to ensure feelings of protection, comfort and delight among pedestrians. Thus, the outcome will be to provide an illustrative concept of how to satisfy those feelings with a more efficient lighting scheme to generate liveable environments at nighttime. In order to formulate that concept, an evaluation of the lighting conditions of urban spaces located in two different cities will be held; Recife in Brazil, and Copenhagen in Denmark. This could bring quantitative and qualitative findings that could guide professionals like architects, urbanists, city developers and lighting designers to reckon with their future design works.

02 VISION

This chapter highlights the role of urban spaces in city life through Jan Gehl's approach and the power that lighting design has on encouraging people to use urban spaces more often at nighttime.

The global population living in metropolitan areas is estimated to increase to 68% by 2050 according to the United Nations. Therefore, strategies to bear with the urban development of these cities need to be regulated and the improvement of urban infrastructures is one of the policies on demand in order to meet the goal of sustainability and promote quality of life for the population (United Nations, 2018). In that matter, public urban spaces are physical elements of cityscapes that have always played the role of connecting people, enabling recreation and staging social activities such as protests, festivals, etc... Thus, a more effective structure of these spaces promotes liveability of the city and improves wellbeing of the population in agglomerated areas (Budisteanu & Skovbro, 2002).

In the book *Cities for People*, Jan Gehl (2010) stresses out the importance of architecture to focus their attention on the human scale, conversely to what has been prevailing over the past 50 years because of the use of cars. He states that modern architecture has been denying the human presence and spaces are now monumental and impersonal, which converted many urban spaces into empty rooms. Following that premise, the design of public urban spaces should be more centered on human beings. There is a need to encourage social interaction, physical activity, and also, to promote connection with nature and stars at night, once lifestyle and technology era are making people less active and sociable. Therefore, rethinking the lighting scheme on urban spaces at nighttime could drive people to use them more often for a more active life.

Generally, dark hours are perceived as a mystery to some and intriguing or stimulating to others which results in lack of usability of these spaces as some people might feel unsafe or because dark hours are seen as times for relaxation and introspection to others, perhaps light could be the key point to change this behaviour. Thus, lighting should ensure a valuable experience of the space to users whilst supporting a feeling of protection, comfort and delight, with an aim of stimulating the use of these spaces regularly. For those reasons, lighting needs to be used as a tool to benefit humans' behaviours and experiences in urban spaces at nighttime, bringing along the question:

What if creating a liveable atmosphere through lighting in public urban spaces could encourage the use of those areas in the dark hours?

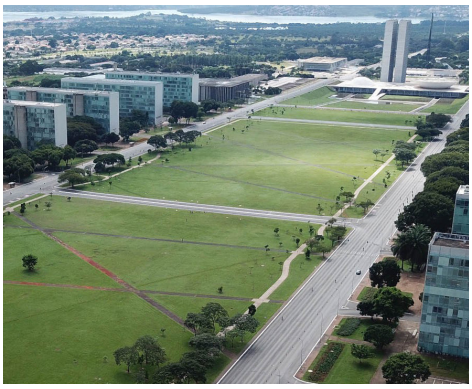

Fig. 1: Federal District of Brasilia, Brazil.

Fig. 2: Superkilen, Denmark

Fig. 3: Esplanade de La Défense, France.

03 METHODOLOGY

This chapter will introduce the methodology used in this thesis work to investigate the effect of conventional light settings on the behaviour of people using public urban spaces. The means to support the changes in the lighting approach in these environments aim to improve people's performance and ensure a qualitative experience of these spaces during nighttime. Some suggestive solutions have been taken into consideration in lighting projects of similar characteristics.

The different types of methods to analyse and understand the various aspects of this research will be mentioned and explained in this chapter, then will be respectively discussed in the following chapters: Site Analysis, Background, Context, Reference Projects, Design Concept, Discussion and Conclusion.

To begin with, an investigation conducted in two sites will be introduced in the Site Analysis chapter. This investigation will be clustered into three distinct aspects to help clarify the findings: **spatial analysis**, to describe the structure of these spaces under investigation and to evaluate whether human dimensions are respected in these spaces to fulfil the principles stated by Jan Gehl, described in the book Cities for People; **social analysis**, to understand the use of those spaces by human beings; and, **lighting analysis** to describe the light settings implemented on these sites and to help comprehend the link between the light and the space, which will be done through technical analysis based on the theories supported by two notable authors, Richard Kelly and Hervé Descottes, and through phenomenological analysis based on our own perspectivation. This Site Analysis chapter will then generate the problem statement described in the Background chapter leading to the topics that need to be studied. Following that, a Context chapter consisting of a **literature review** will be elucidated to build up the thesis structure through a collection of multidisciplinary studies depicting every single component the main topic incorporates. Both aforementioned chapters will help generate the **research question** described in the Findings chapter, which will set the basis of the design development. Continuously, **case analysis** will be presented in the Reference Projects chapter by aiming to understand the different approaches adopted towards real project scenarios, defined as being "inspiring" and "insightful" by the authors. That will help to support the **lighting solutions** illustrated in the Design Concept chapter, as a result of all the aforementioned analyses. The Discussion and Conclusion chapters will then be where the achievements of the proposals and the expected goals are reflected and reviewed, with the aim of supporting different professionals in the design process of lighting projects for urban spaces.

Disclosure: Due to the extraordinary situation caused by the COVID-19 Pandemic, some expected methods to be used in this Analysis chapter have been cancelled. Aforementioned methods were consisting of on-site interviews, on-site experiments and on-site measurements. Also, no evaluation of the lighting solutions suggested in the Design Concept chapter could be performed as the authors were restricted with having access to relevant equipment and with having physical contact with others because the population was being strongly recommended to stay home. For that reason, a theoretical evaluation of the design proposal will be indicated in the Design Experiment section with an aim of explaining how to access relevant data that can only be retrieved from real experiments.

04 SITE ANALYSES

This chapter will introduce in depth the analysis conducted in two different sites with an aim of investigating the current lighting conditions encountered in those environments and how that is reflecting on the spatial features and influencing people's behaviour.

Two distinct areas have been selected from Northern and Southern Hemispheres to find out if cultural backgrounds can influence the way people behave within those spaces. The two authors were located in different countries, which made that cross-analysis possible. One of the cases is located in the city of Copenhagen, Denmark and the other in the city of Recife, Brazil.

Moreover, Recife is the hometown of one of the authors and Copenhagen is the city where both authors were pursuing their higher education in the field of Lighting Design. Both aforementioned cities are close in demographic aspects but diverge in regards to the geographical location and the cultural aspect which could provide substantial data for the research of this thesis, as the goal is to investigate human behaviour in different contexts.

In this chapter, both cases will be presented in an analytical approach touching upon the **city context** and the **general facts on the selected areas** before concentrating on diverse analyses carried out in these spaces, clustered as **spatial**, **social** and **lighting** analyses.

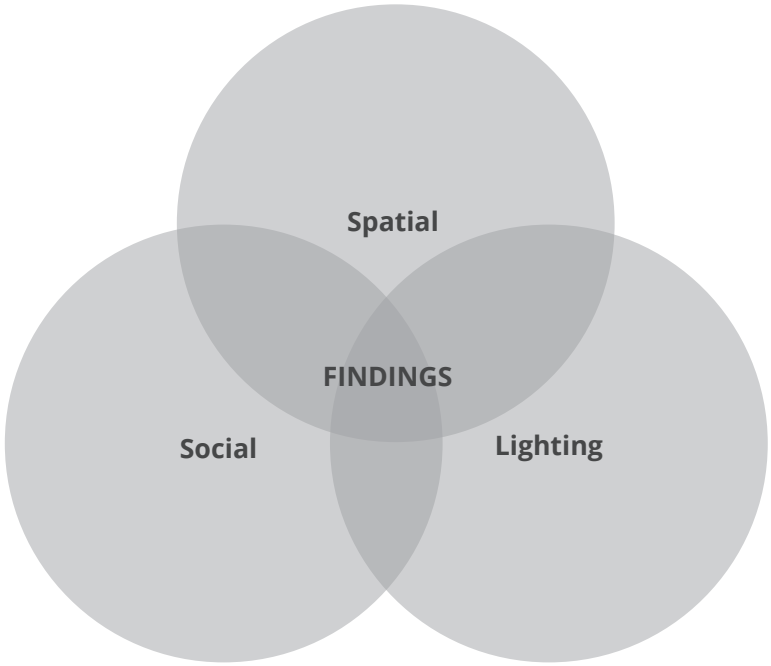

Fig. 4: Analysis Diagram

4.1 Focus Area 1 - Denmark

City Context

Copenhagen is the capital of Denmark, a country located in Northern Europe, and the first urban agglomeration of the country. The population in the city area is around 800.000 inhabitants (Larsen, 2020). The country is located in the temperate zone with most rainfall around the end of June. The average annual temperature is 8.4°C. The daylight during the shortest day, December 21st, lasts for 7 hours and 1 minute whereas on the longest day, June 20th, it lasts for 17 hours and 32 minutes. (WeatherSpark, n.d.b).

General Facts on the Focus Area

Israel Plads is an urban space project completed in 2014, located in the district of Nørreport in Copenhagen, Denmark. The project is a result of a design competition won by COBE with external collaborators for the refurbishment of the southern portion of the square. The winning proposal introduces a wide program including overlapping functions throughout the day: it serves as a schoolyard during the day, a basketball court in the afternoon and a dining area in the evening. Moreover, the square is also used as a skate park during the week and as a flea market during the weekend (COBE, n.d.).

The history of Israel Plads is a reflection of the city's transformation, where it was formerly a protective fortification area. As the city expanded its boundaries, the plaza became a vibrant market square until the 1950s, when it has turned into a lifeless car park in the following years. In 2008, the City Council of Copenhagen recognised that a major renovation of the square needed to be established. The idea of that transformation project is to celebrate the significance of the square by revitalising it into a vibrant plaza for leisure and sports used by all kinds of people. In fact, Israel Plads is a part of the local danish strategy promoting the creation of further spaces within the city to increase the urban dynamics and decrease the car traffic. Hence, the major goal of the project was to create an open space in the city that invites every citizen to explore urban life. Therefore, unique facilities have been designed for the square to inspire and encourage movement and communication, formal or informal. Underneath, the plaza hovers over the many cars that were once dominating Israel Plads by including an underground parking lot (COBE, n.d.). As for the lighting project, it includes light along the edges of the square giving an illusion of a "flying carpet" and general light throughout the square providing flexibility in terms of light intensity depending on the occurring events (Landezine, 2015).

Fig. 5 Israel Plads in the 60's
Fig. 6 Israel Plads Nowadays

Spatial Analysis

Regarding the physical structure of the square, the design intention was to allow diverse activities to take place in order to make this part of the city vibrant, dynamic and attractive. The square itself is constricted between two rows of residential buildings on the long perimeters. On the short perimeters, the square is open to the historical landscape of Ørstedsparken on one side and to the food halls of Torvehallerne on the other side. The square is composed of different natural and architectural elements providing different potential activities for its users. The most significant element throughout the space is the circular shaped basketball court standing almost in the middle of the square, but also giving opportunities for people to navigate around in a more natural way. Then, an organic shaped skateboard area is present not far from that court, with which is also visually connected. Next to it, the circular shaped parking entrance has small playground elements dispersed around the spiral car access. Moreover, a portion of the square is elevated in the two opposite corners of the space to provide people with sitting areas for observation. Next to one of them, there is a very subtle slit, filled with circular stones, highlighting the connection with the park. Finally, a few trees are dispersed along the square, with some of them providing pedestrians with an opportunity to observe the dynamism of the space by laying over on its surrounded circular benches.

As for its context in the city, the square stands out for its significant volume within the urban fabric creating a "visual break". Hence, it allows an urban visibility for both residents and pedestrians walking around the district.

Furthermore, Jan Gehl (2010) elaborates a framework defining the twelve different criteria that need to be fulfilled in order for a space to be identified as "good functioning". Therefore, this can be achieved by demonstrating a careful overall treatment of all the quality factors, clustered in three topics as "Protection", "Comfort" and "Delight". Based on that, an on-site observation has been carried out with the aim of defining the quality of the square by understanding its diverse patterns. First, the square can be defined as a protected area by providing a feeling of safety with no access for cars and by ensuring a feeling of security with overlapping functions throughout the day. However, no measures have been taken to protect pedestrians from unpleasant sensory experiences like wind, rain or glare. Second, the square receives a good grade for its comfortable aspect by providing opportunities for walking, staying, sitting, seeing, communicating and exercising. Finally, the square can also be classified as a delightful space by respecting the human scale, by giving opportunities to enjoy the climate and by providing a positive sensory experience with a pleasant spatial design.

All the aforementioned observations helped us to paint an overall picture of the spatial qualities of the project, which are obviously affecting the ways users will feel and behave once entering the square.

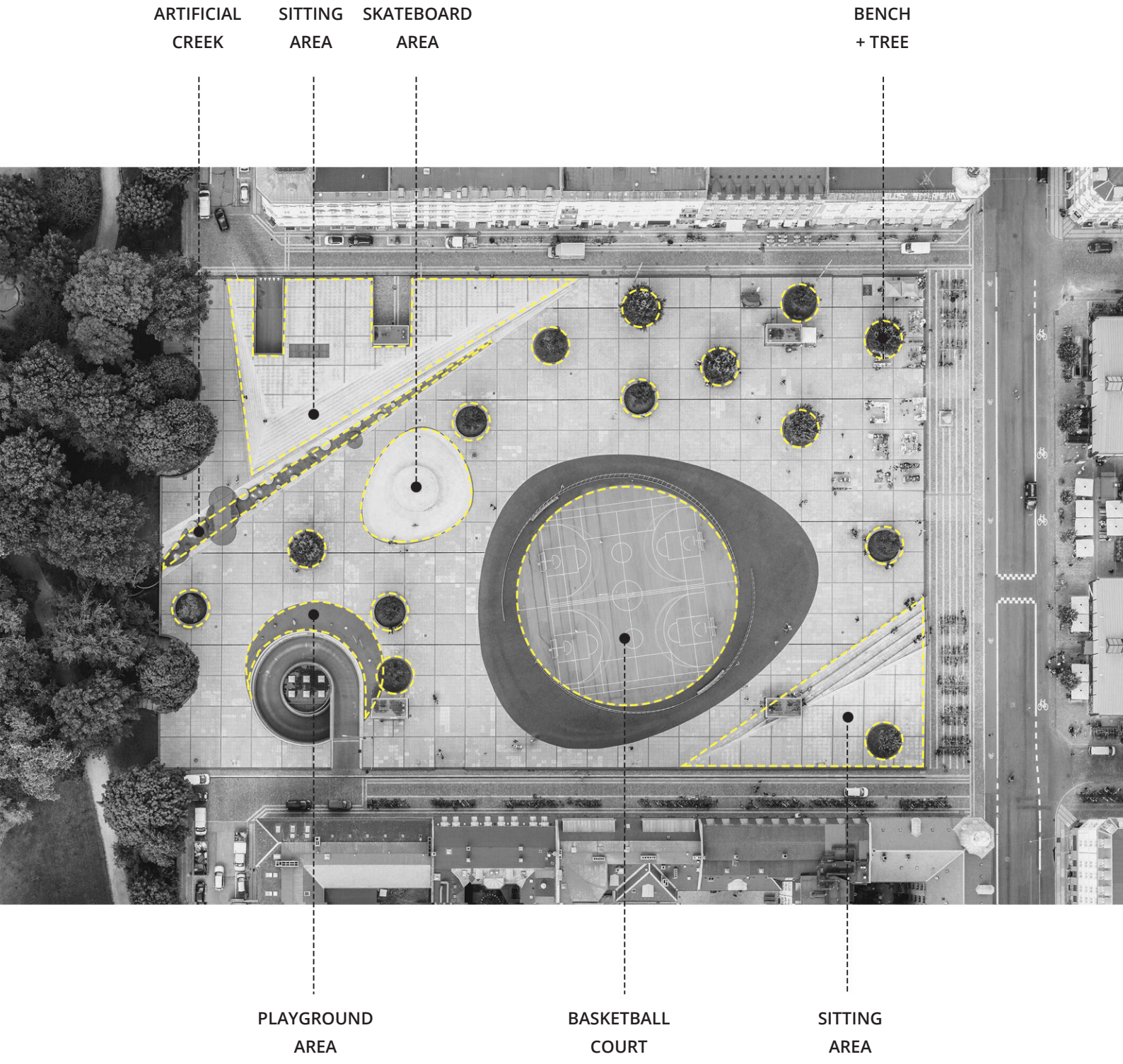

Fig. 7: Spatial Analysis for Israel Plads

Social Analysis

The first fieldwork was performed on March 4th 2020, from 7.00 PM to 8.00 PM, and it was conducted through a walk along the square. On that day, no special event was occurring on the square, the sky was already dark and the weather was cold with a temperature of around 4°C. At the beginning, the square seemed quite empty in general with no specific ongoing activities. Then, some people crossing the square have been detected. Based on their walking pace, it seemed like they were trying to avoid being in the square and to quickly reach the adjacent streets. In fact, the square seemed to be not welcoming at all. Moving further, the basketball area was not occupied either, despite possessing a good spatial quality. Same picture has been drawn for the skateboard and playground areas where no people were detected. As for the sitting areas, they seemed to be repelling for pedestrians to sit and spend time. Approaching the opposite edge of the square, two persons have been detected exiting the square towards the street leading to the main boulevard.

A second fieldwork was performed on March 7th 2020, from 22.00 PM to 23.00 PM, and it was once again conducted through a walk along the square. That observation has been especially achieved later in the evening to understand if there would be any difference with the previous fieldwork. Again, the square seemed quite empty with no specific ongoing activities. Walking towards the sitting areas, a couple was detected standing next to the tree and having a conversation. Then, two people appeared walking out their dogs, who were following the edge of the square. They were just passing by and did not seem to stay and spend time in the square. Approaching the sport facilities, no human presence has been detected in and around those spaces neither.

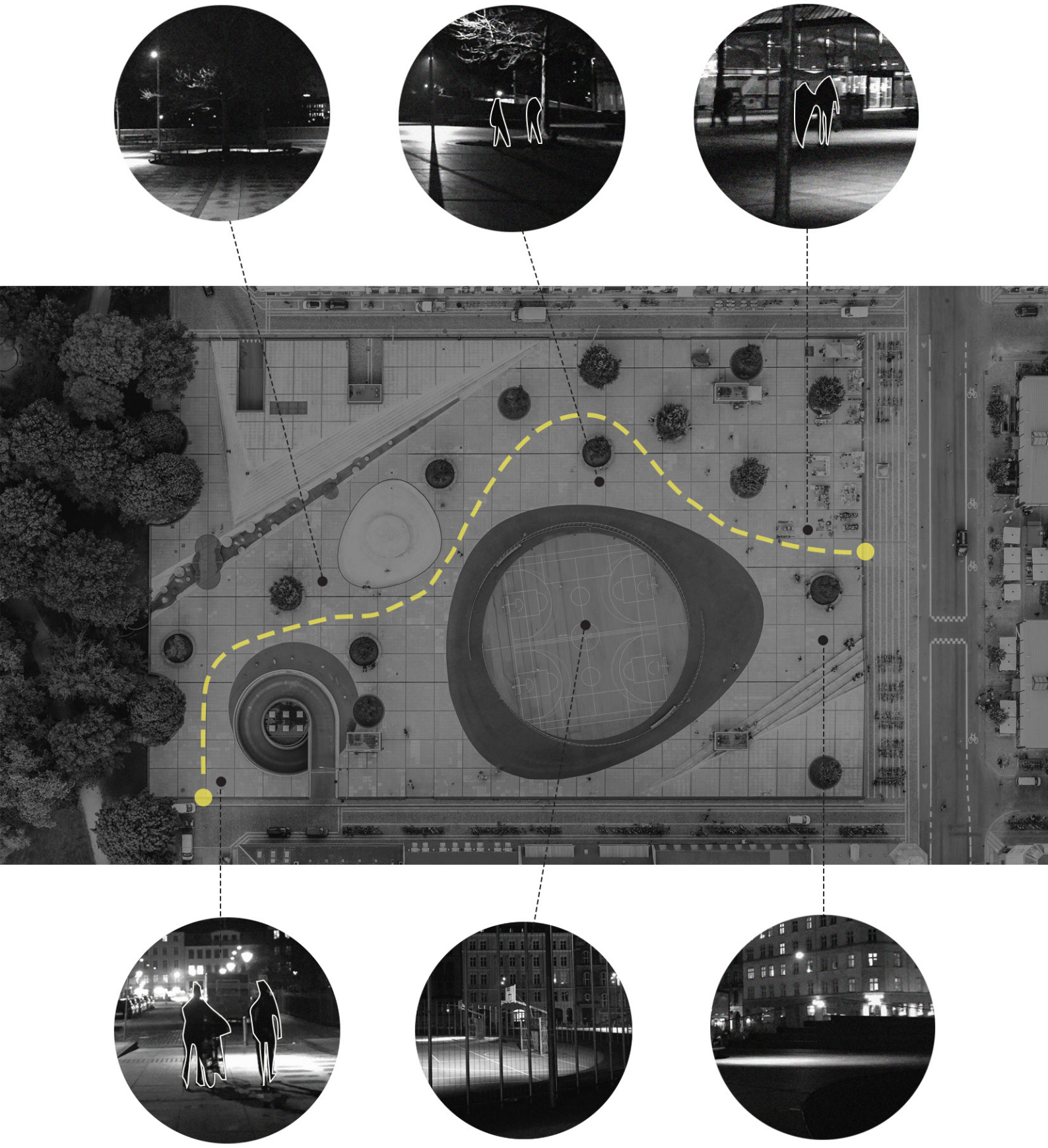

Fig. 8: Social Analysis for Israel Plads

Lighting Analysis

First of all, the electrical lighting scheme in the square has only two distinctions: the light installed throughout the square and the light outlining the perimeters. The **first typology** corresponds to the light pole located throughout the square, which consists of three lamps rotated in different directions, measuring approximately 6 meters in height, with a narrow and concentrated direct light, with correlated color temperature (CCT) at around 4.000K, high lux level. The **second typology** regards the light implemented along the perimeters, which consists of concealed linears softly indicating the edges, providing indirect illumination, with a CCT around 4.000K, high lux level.

Those lighting typologies can be clustered into two categories: Focal Light and Accent Light. The **Focal Light**, which is the light implemented throughout the square, illuminates its diverse parts with direct light beams. This light is non-uniformly distributed and provides a high illuminance on the floor and on different facilities, thus generating overexposed spots and high contrast, obstructing visibility and causing glare issues. Also, the light on the sport areas is part of this category. Due to the natural white CCT, the atmosphere does not evoke playfulness nor excitement, and the high illuminance level provokes glare issues and generates a dramatic environment. As for the **Accent Light**, it is the indirect light along the edges of the square, which emphasises its spatial boundaries. This light provides a strong illuminance on the side surfaces, which implies a visual barrier conveying the feeling of detachment between two spaces.

A **phenomenological** comprehension in regards to the perceived nocturnal atmosphere at the square with the current electrical light conditions has been allowed through the on-site analysis. In general, the lighting is perceived in fragments throughout the space which generates a very dramatic atmosphere. There is almost no differentiation of the lighting outcome, no special feature of the square is highlighted, no visual excitement is generated. The human presence was very low. As for the few people using the square, there was a feeling of being under high-exposure when crossing the strongly lit areas and a feeling of merging in the darkness when crossing the pitch dark areas. Lighting did not support the individual activities, and seemed to be implemented with no respect to the facilities that the space offers to its users. It could be noticed that once light was completely absent in the built environment, as in the corners of the square or the sitting areas, spaces look intimidating and not welcoming, resulting in a lack of social presence throughout the square.

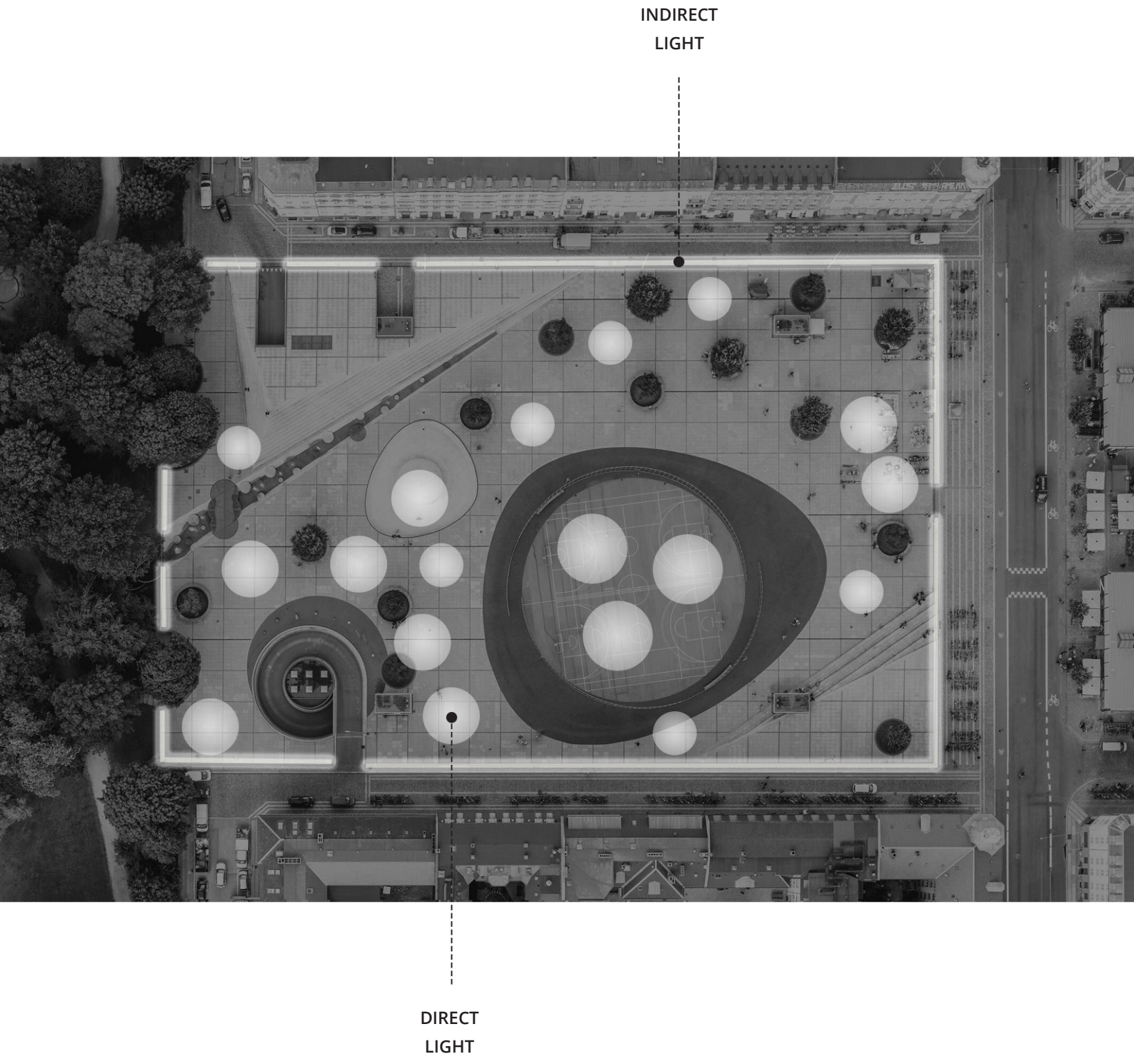

Fig. 9: Lighting Analysis for Israel Plads

Fig. 10, 11: Lighting Conditions at Israel Plads

Conclusion

Based on spatial analysis conducted in Israel Plads, it can be concluded that diverse spaces within the square are designed for providing opportunities for people to perform different activities. However, the lighting scheme implemented in the square is not supporting its architectural qualities, and does not emphasise the potentialities of the space to encourage its use during night hours. Hence, it is far from fulfilling the needs of protection, comfort and delight of the pedestrians, resulting in a very low human presence at nighttime. In fact, there are almost no variations in lighting scenarios with the same implementation of fixture typology throughout the square, with the same correlated color temperature (CCT), light distribution and light direction. Moreover, the effect of the light does not change either, with narrow and direct light beams on horizontal surfaces. All those parameters result in creating overexposed spots generating high contrasts between bright and dark areas, leading to glare issues and perception disabilities. Consequently, it has been concluded that the nocturnal atmosphere at Israel Plads is very dramatic and does not promote feelings of safety, cosiness, nor enjoyment for pedestrians.

The following matrix has been elaborated to help classify the characteristics of each space in relation to the spatial, social and lighting aspects:

	SPATIAL	SOCIAL	LIGHTING
PROTECTION	No cars are allowed No visual barrier between spaces Do not provide shelter Good physical conditions	No human presence No feeling of safety Feeling of being exposed under spot lights Feeling of being merging in the darkness	Do not enable face recognition Creates dark areas Do not facilitate wayfinding Do not provide visibility of surroundings
COMFORT	Allows diverse events to occur Creates opportunities for people to sit, walk, stand, stay, exercise, play, bike, run, talk, listen..	Do not feel welcomed Do not feel being active Do not feel stimulated to use facilities	Disconnection from the spatial design Glare issues Excessive light levels under spot lights
DELIGHT	Respectful to the human scale Create opportunities to contemplate nature Partialy interlace spaces with landscape	Do not feel belongingness Do not feel stimulated to contemplate nature Do not stimulate social interaction	Dramatic atmosphere No visual polution Do not improve experience Do not stimulate behaviour

Fig. 12: Quality Criteria Assessment for Israel Plads

Fig. 13: Human Presence

Fig. 14: No Human Presence

Fig. 15: Clear Visual Perception

Fig. 16: No Visual Perception

Fig. 17: Lively

Fig. 18: Lifeless

4.2 Focus Area 2 - Brazil

Local Context

Recife is a city located in the northeast region of Brazil, along the Atlantic Ocean and the fourth-largest urban agglomeration of the country. The population in the city area is around 1.6 million inhabitants (IBGE, 2011). The climate is tropical with significant rainfall most months and an average annual temperature of 27.5°C. The daylight during the shortest day, June 20th, lasts 11 hours, 39 minutes whereas on the longest day, December 21st, daylight lasts 12 hours, 36 minutes (WeatherSpark, n.d.a).

General Facts on the Selected Area

Dona Lindu park is a public urban space completed in 2011, located in the most populated borough of the city of Recife, on the beachfront in Boa Viagem Beach. It encompasses different facilities within its extension such as a playground for kids, a skate park, a multi-sports field and exercising installations, as well as it houses the Luiz Mendonça Theater and the Janete Costa Art Gallery (My Guide Recife, n.d.).

In the past, the area where the park is located was a brazilian-american military base during World War II and later became a concession of the national air force, remaining unused for many years until 2006, when it was yielded to the local government to be transformed into a public urban space. Due to the rapid urbanization of the region, the residents urged for the construction of better urban spaces in the city that should include sports and leisure facilities to support city life and improve quality of life. The park was first expected to be an urban green area, however, despite population demands, local, federal governments and architects decided to add an enterprise for leisure and culture, hence the construction of a cultural center along with a park behind it was implemented (Frankly, 2014). The project of the park is signed by the notable architect Oscar Niemeyer, who has conceived the project to be a counterpoint to the surroundings and to connect interior with the exterior as well as to gather the public. His intention was to raise new buildings conveying a message that the city is rejuvenating while harmonising the city and the beach by green areas (Oscar Niemeyer cited in Araújo, 2016). During and after completion, the project has faced several criticism for having more concrete than green spaces. Nowadays, the park occupies 27.000 m2 area and is a reference point for tourists and residents who seek to explore its multifunctional spaces for leisure or other purposes (Frankly, 2014). In fact, the park is recognized for hosting different functions and for allowing multicultural events to happen, such as free live concerts. By this means, its design has the premise of encouraging people to perform different activities and engaging them into social interaction, while also preserving and displaying the cultural heritage of the city. In regards to the lighting project, no lighting designer was involved, it was done by the local government in collaboration with the local electric company. The lighting was implemented only to provide general lighting for pedestrians to navigate easily and for security reasons. Later the lighting was reinforced to cover all the spaces within the park because residents claimed that the initial lighting was inefficient as they were feeling unsafe (Cosme, 2016).

Fig. 19: Dona Lindu Park in 2003
Fig. 20: Dona Lindu Park Nowadays

Spatial Analysis

In regards to the physical structure of the park, it was intentionally designed to allow multifunctional activities to take place, so forth, different spatial scales can be detected. Primarily, the park opens up to the seafront with a large scale outdoors' patio limited by two circular buildings that host a theater and an art gallery, and that are connected by a more human scaled canopy. On the theater's building, the stage can open towards the patio during the live performances, where the public is expected to gather, to provide visibility of the event. After crossing the canopy the real park takes place, and that is where the recreational areas are available for the public, comprehending playgrounds, a multifunctional sports field, some exercising equipment and a skate park. Again, the approach is anthropocentric with narrow pathways connecting distinct spaces, small benches along the recreational spots to allow pedestrians to sit for observation, trees to cast shadows and create a pleasant ambience, and an installation of equipment suitable for exercises to keep people active.

As for the city's context, the venue stands out for its relevance on the urban fabric creating a visual 'break' - a pause - within the cityscape. Hence, buildings in later locations are benefited by the ventilation and visibility of the ocean, because of the existing concrete wall of buildings on the beachfront surrounding the park.

Furthermore, Jan Gehl (2010) elaborates a spatial framework for urban spaces to ensure they provide protection, comfort and delight among pedestrians and invites people to stay in for participating in the diverse activities admitted by the space. Based on that, it is crucial to identify the peculiarities of each space within the site itself to understand what each specific area is expected to accomplish. In this sense, each space within the park is designed at the human eye level; all equipments and objects are in good condition and follow ergonomic codes to ensure usability by the specific ages it is targeted at; pathways and benches that runs through the venue create opportunities to walk, stand, sit or stay; no visual barriers limit visibility between distincts spots; the green areas create shadows and give opportunity for people to enjoy the weather; and the playful elements induce creativity and create opportunity for people to perform activity in the park.

All the aforementioned observations illustrate the spatial quality of the project, which affects the way users will feel and behave once permeating the park area.

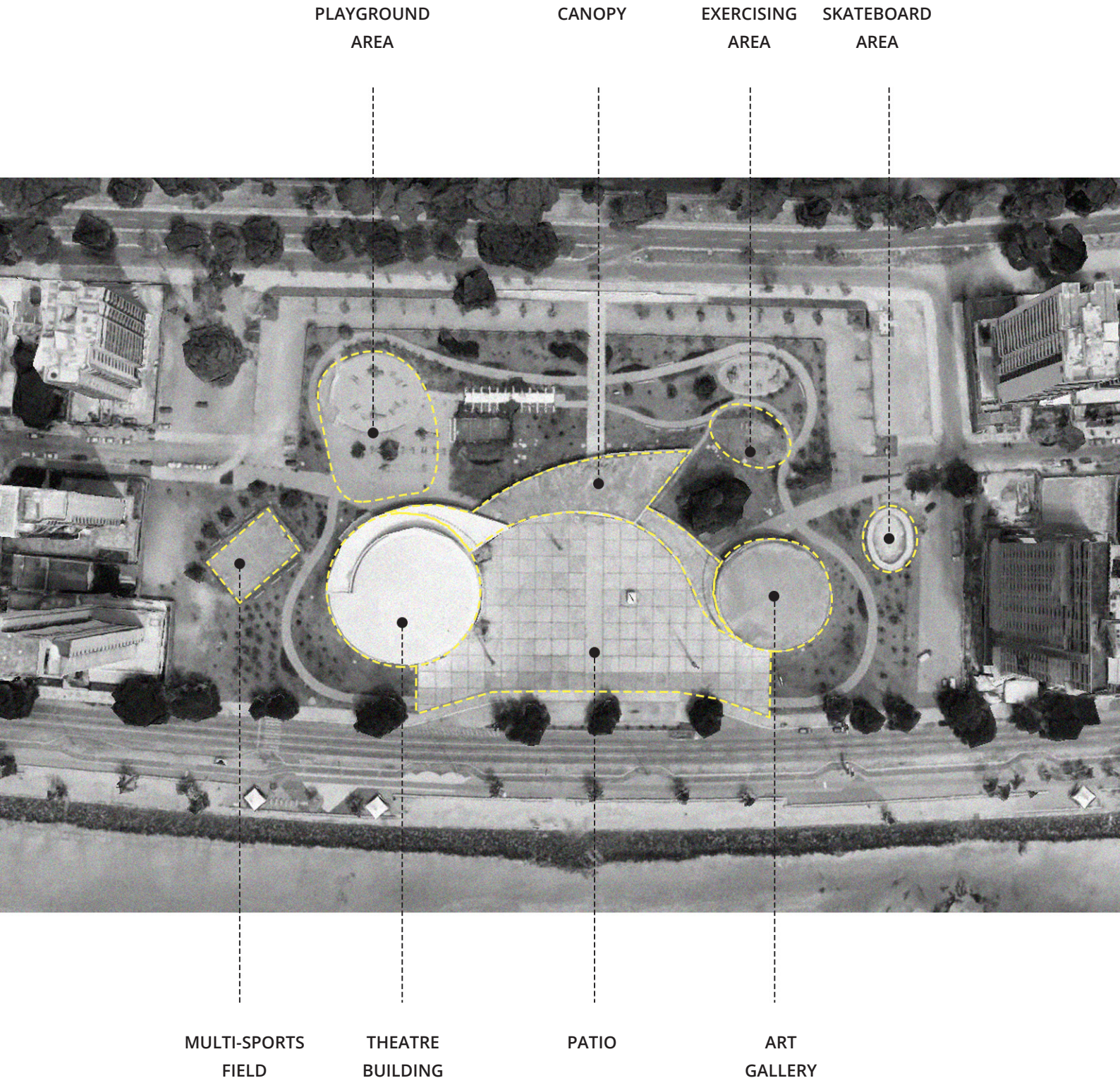

Fig. 21: Spatial Analysis for Dona Lindu Park

Social Analysis

The first fieldwork was performed on March 9th 2020, from 7.00 PM to 8.00 PM, and it was conducted through a walk along the park. On that day, no special event was occurring in the park, the sky was clear and the weather was warm with a temperature of around 31°C. At first glance, the park seemed empty with few people crossing the patio at the entrance and no activity was detected, but once staring across the space it was possible to identify people sitting on the floor under the canopy with some movement behind them. Looking towards the left side of the patio from the entrance, a group of people wearing similar outfits seemed to be meeting up to perform physical activities. The area beside the theater building where those people were standing leads to the sports field behind it and no other objects exist in this space, except trees. Once crossing the patio, entering into the recreational area, a movement of people could be detected. To the left, approaching the multisports field, children and an adult were playing soccer inside the field, while a woman sitting on the bench outside was observing their activity. At the same time, on the back of the field, a man alone was performing physical activity on an isolated exercise furniture located under a tree. Later, walking towards the center of the park through the recreational areas, some other children were playing on the playground while their mothers were sitting on the bench to observe them. Suddenly, a group of six middle aged people, the same ones noticed at the entrance, came along the pathway and sat on the benches to perform physical exercises, later on moving towards the exercise area to use the furniture available for other types of activity. What caught the attention was the fact that the benches were being used as exercising equipment, not as sitting areas. Also inside that area, three men were chatting, although they did not seem to be preparing for exercising. Then, walking along the right side of the park, the skatepark came into sight but no one was using it. Back to the entrance again, few people were sitting on the benches facing the beach and a few others were taking pictures in front of the park's signage.

A second fieldwork was performed on March 16th 2020, from 7.00 PM to 8.00 PM, and it was once again conducted through a walk along the park. However, the idea of this visit was to observe only the spaces where people were performing physical activities or sports, with an attempt to investigate more of the aspects related to people's behaviour within the physical environment that could be noticed during the previous visit. For that reason, the visit began at the multi-sports field, where it could be immediately detected two teenagers playing basketball, although for a short period of time. Not long after those people left, an adult accompanied by who seemed to be his kid entered the field to play with their dog. The observation made at this point was that once people play inside the field, they are noticed as the actors of the space, like in a play, whilst those who sit on the benches outside the field are noticed as the spectators. However, there is a feeling of being noticed also when sitting on the benches outside. Moreover, people inside the field tend to look with curiosity at those sitting on the benches, if they are not familiar with them. On the other hand, people sitting on the benches might only be looking for entertainment or they might just be waiting for an opportunity to engage in the game. Successively, on the exercising equipment standing behind the field and the area surrounding

it, a man and a coach were practicing physical activities for about 30 minutes, although no specific behaviour could be detected, they only seemed to be concentrated on the exercises and did not engage into any conversation with people passing by, afterwards they left the park. Furthermore, along the major exercising area where some furniture are installed, two men were using the equipment to perform physical activities, they were chatting and looked very relaxed while using the space. Additionally, conversely to the previous visit, at the skatepark three teenagers were riding with bikes in the space whilst two other teenagers waited outside observing the scene and wanting to play in the spot. What caused a surprise about that behaviour was the fact that people were using bikes instead of skateboards, even though no restrictions were made. In fact, it emphasises the multifunctionality admitted by the park.

The conclusion withdrawn from those two brief analyses is that people often use the urban spaces with no regards to the design intentions, that each furniture present in the space can be used for different purposes and that, depending on the action performed in the space, one can either be the actor or the spectator of the scene. Whichever way, this analysis infers that a space seems to be alive once people's presence can be detected, and also that people feel more inclined to use spaces that have close relation to the human scale as it suggests manageability and seems more inviting for staying, standing, walking and sitting. In regards to the cultural background of users and the average age of people using the spaces, nothing can be concluded once on-site interviews and other on-site measurements could be performed. There is a need to obtain more information about who the users of each spot are and what kind of activity are mostly carried out during night hours.

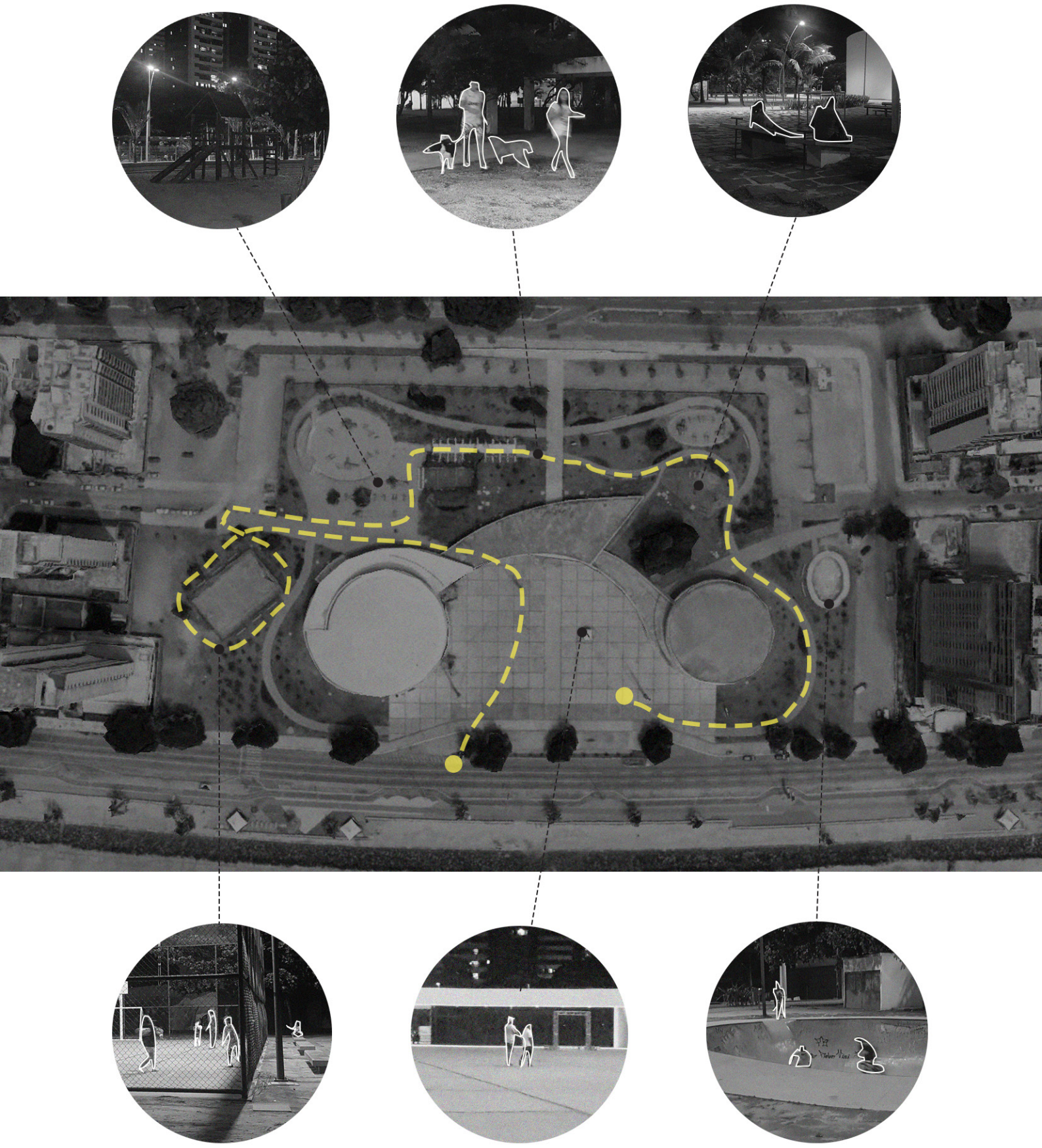

Fig. 22: Social Analysis for Dona Lindu Park

Lighting Analysis

To begin with, the electrical lighting scheme in the park has three distinctions: the light installed in the patio, the light implemented along the pathways, and the light on the two buildings. The **first typology** corresponds to the light pole located at the entrance of the park, which consists of LED projectors, measuring approximately 40 meters in height, with a wide and diffuse direct light, with correlated color temperature (CCT) at around 4.000K, low lux level and low colour rendering index (CRI). The **second typology** is an LED light pole eight to nine meters in height, located on one side of the pathway, with a wide and diffuse direct light aimed directly towards the floor, with a CCT at around 4.000K, high lux level and low CRI. The **third typology** regards the light implemented on the buildings, which consists of ground recessed uplights illuminating the facades, providing indirect illumination, with a CCT around 4.000K, excessive lux level and low CRI; and, ceiling recessed direct downlights illuminating the area covered by the canopy, with a CCT around 2.700K, high lux level and high CRI. In addition to the three lighting schemes encountered in the park, there is the light in the multi-sports field which consists of six LED light poles with direct diffuse light, excessive lux level, cool bluish CCT and high CRI resolution. Note that the CRI was measured by detecting the skin colour under those lights.

Despite the fact that those lighting typologies provide the same visual effect, it can be clustered into three categories: Ambient Light, Focal Light and Accent Light. The **Ambient Light**, which is the lighting provided by the light poles located in the patio, providing direct illumination towards the entire park and affecting its overall ambience. However, due to the height of those poles, glare issues are perceived as a source of visual pollution and people's connection with the space is lost. Yet, the cool CCT, low lux outcome and low CRI resolution, affect the colours and the spatial condition of the patio area. The **Focal Light**, that is the light on the pathways illuminating its course with direct light and scattering light onto the surroundings. This light is uniformly distributed and provides a high illuminance on the floor and on the benches located along the trajectory, thus generating overexposed spots and high contrast, obstructing visibility. The height of the poles results in glare issues and visual pollution. Also, the light on the sports field is part of this category. Due to the cool white CCT, the atmosphere evokes playfulness and excitement, and the excessive illuminance level throughout provides glare issues and generates a dull environment. Lastly, the **Accent Light**, which is the light on the buildings, emphasising its architectural qualities. This light provides indirect light with a high illuminance effect on the surfaces and creates a background effect, thus objects and people's silhouettes can be detected. Under the canopy, the warm CCT makes the space seem more cosy and inviting, as well as it is more linked to the human scale.

On-site visits allowed a **phenomenological** comprehension about the atmosphere perceived in the park at night from the electrical light conditions planned for the space. In general, the lighting is perceived as equally distributed which generates an overall dull atmosphere. There is not much differentiation of the lighting outcome, no special feature of the space is highlighted, no visual excitement is generated.

People seemed to be constantly active and happy, although there was a feeling of being noticed and under evidence whenever one was walking on the pathway or sitting on the bench. Lighting did not support the activities individually, it seemed to be implemented with no regards to the activities displayed. It could be noticed that once light creates a link with the built environment and human scale, as happens under the canopy, spaces look more inviting and cosy, thus the human presence becomes inevitable. With exception, the patio at the entrance has a very low illuminance and is evenly illuminated which results in abandonment and people feeling pushed away. Also, the light becomes a visual barrier, it does not respect nature neither it connects to it.

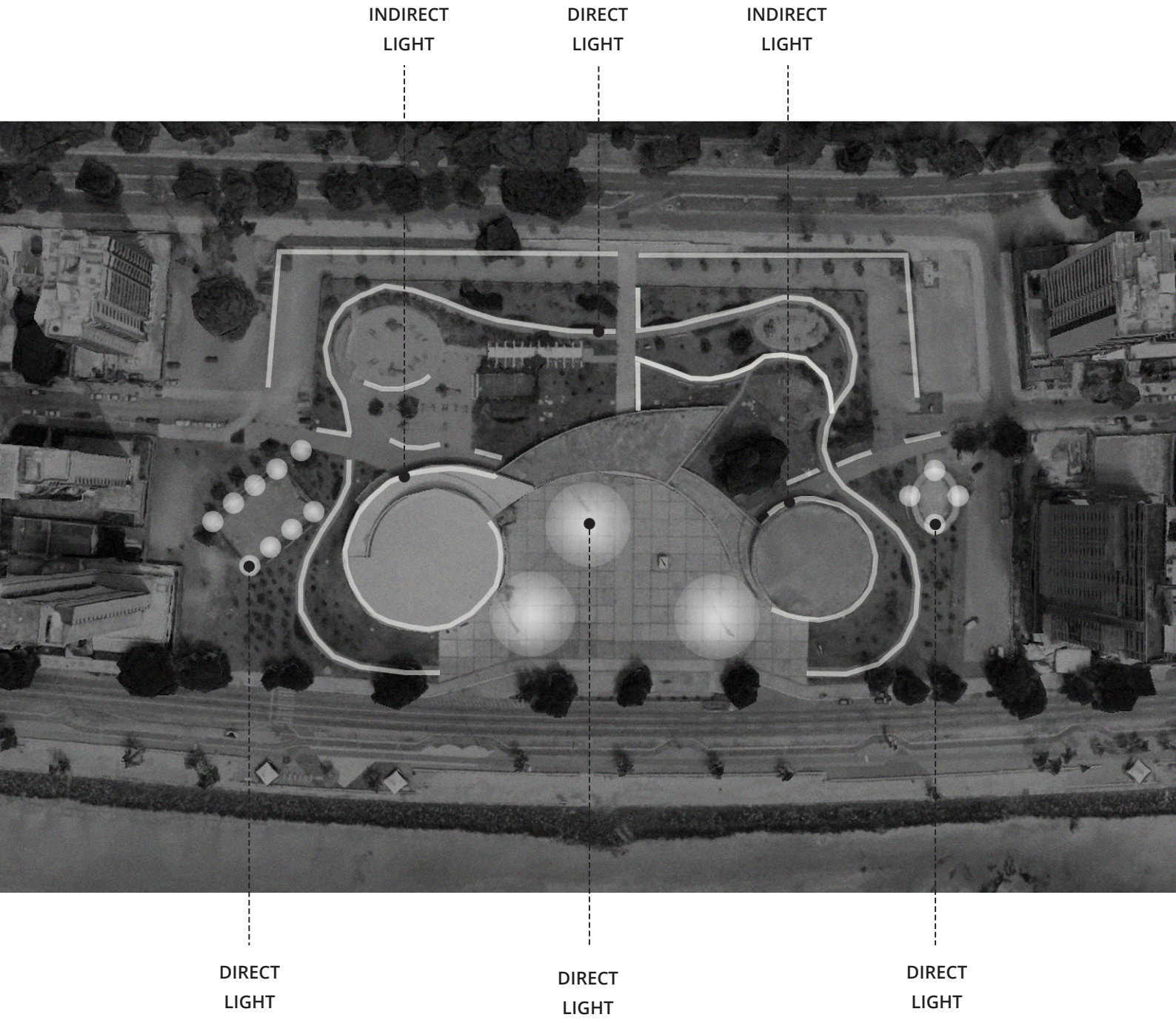

Fig. 23: Lighting Analysis for Dona Lindu Park

Fig. 24, 25, 26, 27: Lighting Conditions at Dona Lindu Park

Conclusion

From the spatial analysis conducted in Dona Lindu Park, it can be concluded that most spaces within the park are designed for the human scale, providing opportunities for people to perform different activities, although the patio at the entrance is wide and empty, and it is not being used for any specific activity. Also, the lighting scheme implemented in the park is not distinguishable throughout, it is disconnected from the architectural design and does not emphasise the potentialities of the space to encourage its use during night hours. In fact, the lighting aims only to allow visibility of the space for wayfinding and safety reasons, but the diffuse and directional light from the lighting poles generate over exposed spaces and poorly illuminated surroundings, affecting visual performance and face recognition. Moreover, the uncareful implementation of the lighting poles result in visual pollution and damage the visibility of the sky and the ocean, jeopardising human connection with nature. Finally, the atmosphere generated is dull, does not invite people to spend more time in the park, does not improve experience, neither stimulates behaviour. Despite all, people still visit the site and use its spaces during nighttime, perhaps due to the weather condition or to people's cultural background, but that would require more investigation.

The following matrix has been elaborated to help classify the characteristics of each space in relation to the spatial, social and lighting aspects:

	SPATIAL	SOCIAL	LIGHTING
PROTECTION	Cars are allowed on the patio area No visual barrier between spaces Few spaces provide shelter Good physical conditions	Human presence Feeling of safe only while walking on the pathways Feeling of being exposed	Enable face recognition Creates dark areas Do not facilitate wayfinding Do not provide visibility of surroundings
COMFORT	Allows diverse events to occur Creates opportunities for people to sit, walk, stand, stay, exercise, play, bike, run, talk, listen.. No function of the patio regularly	Do not feel welcomed Feeling of being active only in the sports area Do not feel stimulated to use facilities	Disconnection from the spatial design Glare issues Excessive light levels Low CRI
DELIGHT	Partially respectful to the human scale Create opportunities to contemplate nature Interlace spaces with landscape	Do not feel belongingness Do not feel stimulated to contemplate nature Do not stimulates social interaction	Dull atmosphere Visual polution Do not improve experience Do not stimulate behaviour

Fig. 28: Quality Criteria Assessment for Dona Lindu Park

Fig. 29: Foreground

Fig. 30: Background

Fig. 31: Camouflaged

Fig. 32: Exposed

Fig. 33: Inviting

Fig. 34: Uninviting

4.3 General Conclusion

In regards to the spatial aspect, both sites are designed by notable architects who provided multiple recreational opportunities for residents supporting the city life and improving people's wellbeing. However, those opportunities are compromised during nighttime because there is an evident disconnection between lighting and architecture, which results in spaces not functioning as intended. Both cases employ direct lighting with the aim of supporting wayfinding and safety for pedestrians and indirect lighting for emphasising some architectural / urban details with no clear intention of supporting human needs. Hence, feelings of protection, comfort and delight among pedestrians are not satisfied, as people seem not to feel welcomed to inhabit the space nor encouraged to spend more time performing any activities at night. Also, there were lots of strong visual contrasts interfering with the perception of space and the human presence.

05 BACKGROUND

This chapter emphasises on the problems that conventional lighting methods provoke in urban scenarios at nighttime, resulting in not meeting the fundamental needs of pedestrians.

The analysis conducted on-site, mentioned in the previous chapter, has provided a clear insight about the issues faced in urban scenarios at night caused by the poor application of lighting in these environments. It has been clearly identified that in both cases analysed, lighting settings follow the traditional way of implementing light to cover only the spatial trajectory in order to promote navigability and safety. In fact, both scenarios use only direct light to illuminate the space, but it has resulted in poor visibility, glare issues, disconnection with nature and lack of support for activities. Moreover, they do not promote human connection with the environment as lighting is not reinforcing the identity nor providing a pleasant atmosphere to improve human experience.

In general, liveability of urban spaces has been compromised throughout the years due to the lack of spatial, social and economic strategies, along with poor policies and regulations to support city life (Budisteanu & Skovbro, 2002). Societies living in agglomerated cities claim for physical structures of the city to be capable of perpetuating throughout the years, despite any undergone damage, and that can ensure their well-being and quality of life (Arup & The Rockefeller Foundation, 2014). Moreover, urban spaces are not usually designed to boost liveability of urban life and encourage social activity, and are not adapted to the lifestyle of people, especially after the COVID-19 pandemic that has hardly hit city life. As a matter of fact, life in urban areas have long been pleading to adapt their environment to modern lifestyles and to generate ways of improving city life, and consequently, human well-being. People are in search of new ways of using urban spaces, for better life experiences and for having a more active and social life. Thus, it is necessary to admit useability of the built environment during nighttime, as well as through the daytime hours.

Considering that, the conventional lighting implemented has proven to be ineffective in achieving people's demands as it was unable to support the use of urban spaces for exercising, entertaining and socialising at nighttime, inducing people to a healthier lifestyle. Also, from the site analysis, it was observed that lighting was not ensuring the expected feelings of protection, comfort and delight to be satisfied among pedestrians because they seemed to feel unprotected when navigating those areas, discouraged from performing all activities available, and unhappy while being in the space.

06 CONTEXT

This chapter is a result of the site analysis together with the problem background, stated in the previous chapter, which have provided insights about the multidisciplinary studies that need to be comprehended. Those topics will be explained to provide the basis for the development of a lighting design scheme to be implemented in urban spaces at nighttime, which would still assist the spatial qualities and the social demands.

6.1 Spatial Context

The spatial context regards understanding the way urban spaces are structured in the city context and the way they can influence urban life, during day and night hours. Therefore, it is important to comprehend those relationships because it would help to establish a link between light and architecture. As a result, the spatial qualities would be identified and then emphasised through lighting to make the space liveable for pedestrians.

6.1.1 Urban Spaces

This section aims to elucidate the design goals for urban spaces in contemporary urbanism as supported by Jan Gehl, as well as to introduce the terms of "Nocturnal City" and "Lighting Urbanism". Respectively, they refer to the nighttime potentials of urban spaces and the new lighting approach indicated for illuminating urban areas at night.

As expected by the United Nations (UN), 5 billion people will be living in urban areas by the year 2030. Hence, it is crucial that efficient urban planning and management practices are being considered to tackle human related challenges generated by urbanisation. Through the Goal №11 of the Sustainable Development Goals, titled as "Sustainable Cities and Communities", the UN aims to make cities inclusive, safe, resilient and sustainable (United Nations, n.d.). Following that premise, Jan Gehl (2010) explains that the organisation of urban spaces is essential to this process and that, to improve quality of life, these spaces need to ensure easy access for all, safe environments and more human centered management. In addition to that, the quality of the experience assessed by pedestrians at the eye level within these spaces should be considered a human right and a universal pre-requisite, no matter where the urban space is settled. Hence, three quality criteria should be reinforced such as Protection, Comfort and Delight, otherwise the experience in those spaces would be compromised if any of those criteria are unmet. The essential structure of those criteria is to ensure that the basic human activities are preserved, such as walking, staying, sitting, seeing, or hearing, and that many others are allowed to be performed such as socialising, exercising or biking.

Another aspect in regards to urbanisation is that it also generates a change in the way people experience the city throughout the day. Nowadays, more social and economic activities are occurring after dark, affecting the life cycle of the city. Arup (2015.b) understands it as a phenomenon that affects the way people experience urban life, calling it "the 24hs city". This new phenomenon, also known as "Nocturnal City", indicates the need for a coherent form of organisation to assist the economy and the social life aspects in cities at night (Eymeri, n.d.). Thus, urban spaces need to be planned to safeguard the criteria suggested by Jan Gehl also at night, which can reveal potentialities of the night realm in the urban

environment that has been ignored throughout the years. It should be noted that a different design approach is required as culture, economy, politics and social life are specific for each place (Arup, 2015.a). The same way, lighting should assist architecture in supporting the demands of the night realm. "Current developments towards 24h cities tend to blur our perception of day and night. As we start to understand the importance and distinctiveness of the different shades of night - from dusk till dawn - we shift away from seeing light as a purely functional element" (Arup, 2015.b). For that reason, lighting design in urban cities has changed from a technical approach, called "Nocturnal Urbanism", to a more intuitive approach, now called "Lighting Urbanism", that has changed the focus onto night hours, with an aim of encompassing the creation of nighttime atmospheres to resemble the culture and (or) other potential features of the city (Narboni, 2016). Yet, lighting should enhance the identity of urban spaces in order to enliven the area which can be assessed with a thorough analysis of the context, cultural background and useability of the space (Narboni, 2012). Thus, the future of lighting design in urban spaces is to emphasise the nighttime potentials of the city through light along with creating atmospheres that will enhance specific areas and bring darkness to where it is needed, respecting personal demands. As a consequence, the night in urban spaces would be transformed into a more vibrant and liveable experience for the inhabitants of the city.

In conclusion, architectural and lighting designs should be orchestrated concomitantly once nightlife of urban spaces are recognised, in order to ensure that the quality criteria for protection, comfort and delight are met during the day and night hours. Likewise, urban life can be improved and citizens can be granted a more qualitative experience, boosting their wellbeing.

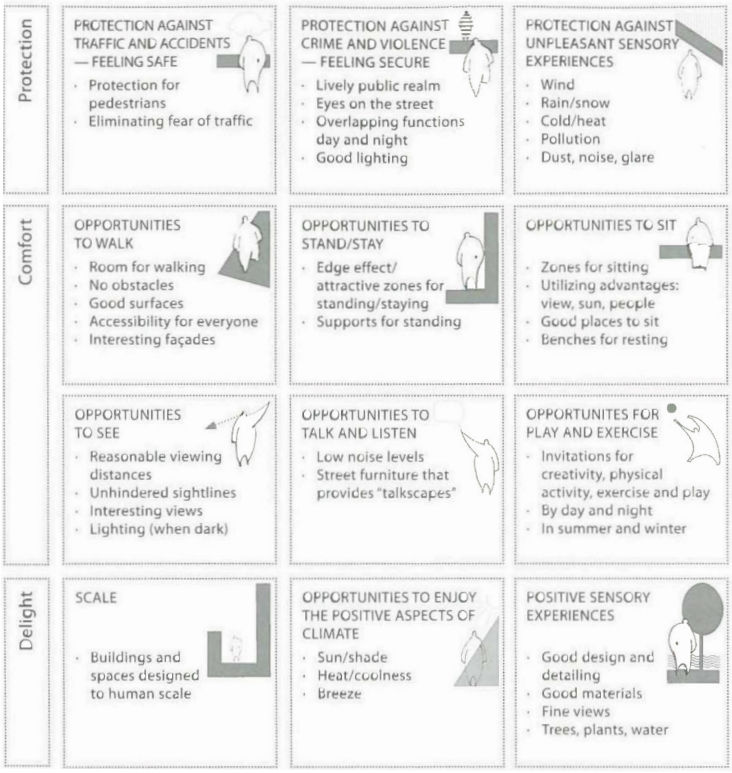

Fig. 35: Jan Gehl's 12 Quality Criteria Concerning the Pedestrian Landscape

6.1.2 Urban Rejuvenation

The goal of this chapter is to emphasise the need for revitalising urban spaces for promoting urban life as well as for strategising cities' spaces to adapt to the impacts and changes caused by natural or man-made actions in an attempt to generate more resilient cities.

According to Arup & The Rockefeller Foundation (2014), "city resilience can be defined in terms of a city's ability to fulfil and sustain its core functions so that human life and activity perpetuates". A resilient city involves articulation of the physical, social and economic aspects. Thus, evaluating whether a city system is operating or not helps identify infrastructures and urban spaces that are eligible for transformations.

In regards to the physical structure of the city, on many occasions, the remnant urban spaces need to undergo adaptation and change entirely the initial functions designated for it, in order to adapt to the new demands of society ensuring that it can be accessed by everyone and that sustainability and economic goals are met. Also, new designs implemented in these spaces need to be attractive and encourage users to participate in events or opportunities that the new space provides during the day and night, with an aim of reinvigorating urban spaces, improving the quality of city life. For that reason, strategising lighting in those spaces at night can contribute to repairing urban identity, assisting human activities, ensuring that urban spaces can be experienced by everyone and that local economies or social life can be sustained, hence improving urban life in cities. An example of a successful project implemented in a city context with an aim of restoring urban spaces is the ChonGae Canal Restoration Project implemented in the city of Seoul, South Korea. It is a transformation project of an elevated highway into an urban park that restored the water quality and minimized the risk of floods, while conveying the symbol of the unification of both Koreas. The designers made use of the light to reinforce the identity during nighttime and in addition encourage public engagement in the park. It has been known that since its completion in 2005 more than 10 million visitors and residents have visited the site, and that many important events have been hosted in the area (Mikyoung Kim Design, 2011).

In conclusion, local governments need to recognise the importance of strategising urban spaces to overcome conflicts generated by man-made or natural actions, and architecture needs to target its design on accessibility, security and human-centric aspects. Hence, citizens would be rewarded with more adaptive, vibrant and inviting urban spaces bringing along not only happier citizens, but also more resilient and attractive urban spaces, oftentimes helping to reinforce local economies and reduce environmental impacts.

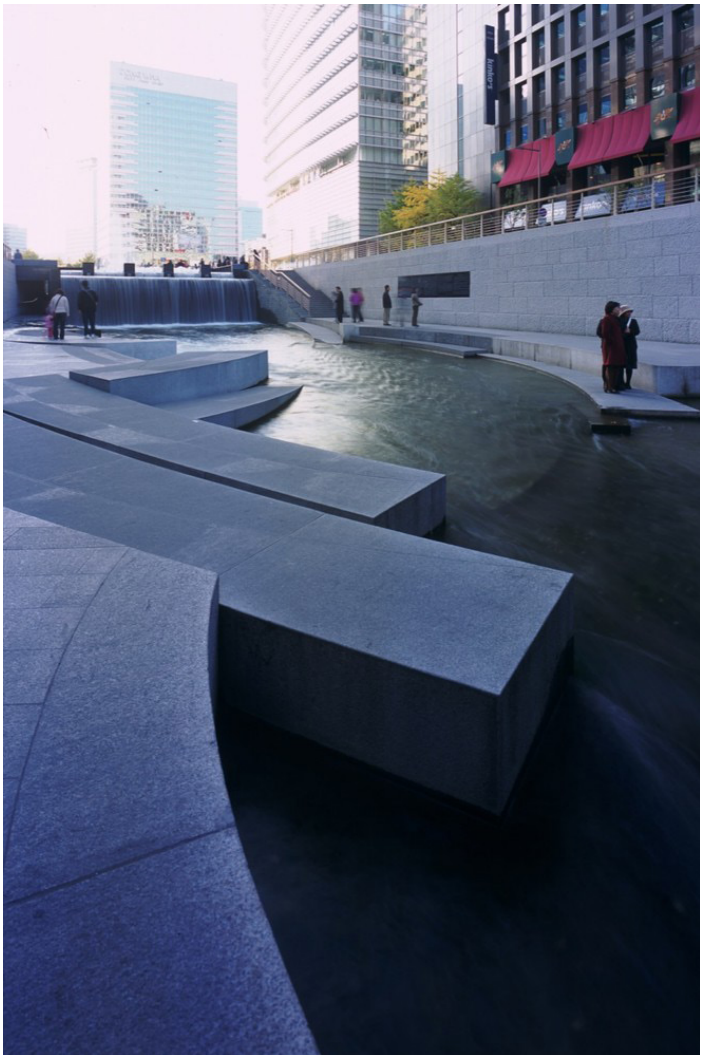

Fig. 36: ChonGae Canal Restoration Project at Day

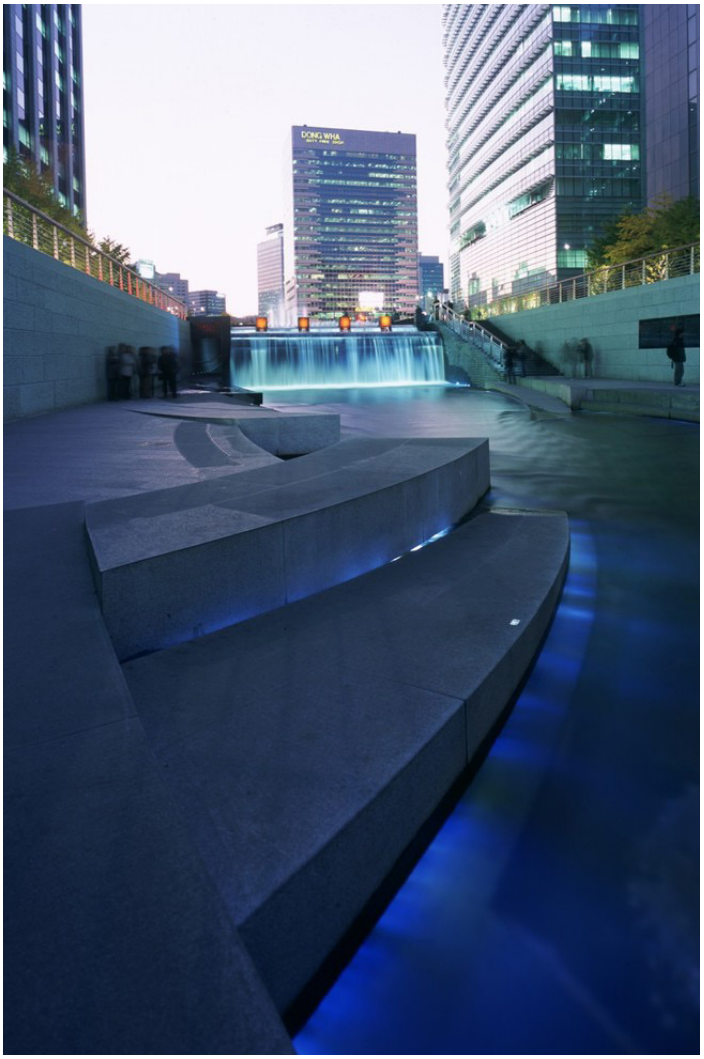

Fig. 37: ChonGae Canal Restoration Project at Night

6.2 Social Context

The social context regards understanding the way people behave within the built environment and the way they perceive it, therefore there is a need to comprehend those relationships as it would provide the means for ensuring the feelings of protection, comfort and delight are satisfied among users through lighting.

6.2.1 Anthropo-Spatial Relations

The following section aims to elucidate the term "Anthropo-Spatial" and its correlation with aspects of the human needs that are essential for inhabiting and experiencing the built environment. The term "Anthropo" comes from the Greek word "anthrōpos" that means "human being" (Merriam-Webster, n.d.a), whereas "Spatial" comes from the latin word 'spatium' and is described as of, relating to, or involved in the perception of relationships (as of objects) in space (Merriam-Webster, n.d.b). Therefore, the terminology "Anthropo-Spatial" means the relationship between space and human beings.

For anthropologists, human beings are influenced as well as they influence the built environment. Within architecture, the built environment is considered to be a nonverbal representation of an individual's or a society's culture and contributes to the maintenance of society (Lawrence & Low, 1990). In fact, the built environment is shaped according to how society behaves and thinks, thus people are affected positively or negatively by the environment they shape, which contributes to their perception of the space and the intangible assets it contains, such as the feeling of safety. Many writers have raised awareness on the impact urban planning has in minimising crime rates and that designing physical environments that appear to be safe and suitable for connecting communities can contribute to that result. Thus, the structure of the built environment, regarding buildings, lighting, mobility zones as well as private and public spaces, can influence human perception of the environment concerning feeling of safety. (Lamprecht, 2016).

As for the perception of space, when one is the actor, as being part of the context, the location is a 'place', whereas once as an observer, as being out of the context, it becomes a 'space', and vice-versa (Agnew cited in Low, 2009). Such definition helps describe the sense of place or space perceived by people within the built environment. In the same way, it is essential to have the feeling of attachment once inside the place, which might also involve other individual aspects as it will be further elucidated in the chapter Atmosphere Perception.

Essentially, humans' relation with the built environment is only feasible due to the presence of light because people seek for visual information when inhabiting a space in order to fulfill their activity

needs. As described by William James (cited in Lam, 1992) people's judgement of a built environment is intrinsically related to the way they are able to see and focus their attention on what they want to do in a particular space, which is equal to how they can perform voluntary behaviours or "activity needs", represented by walking, sitting, reading, etc. However, other involuntary actions are still required which relates to the "normal congenital impulses", named as "biological information needs", and involves orientation, physical security, relaxation of the body and mind, time orientation, visual contact with nature and other living beings, and spatial definition (Lam, 1992). Hence, the outcome for a good and pleasant perception of the environment can only be achieved once voluntary and involuntary behaviours are allowed to occur, which is directly connected with the lighting condition of the space.

In regards to the spatial dimensions of behaviour, a space can stimulate or inhibit behaviour. Sense of privacy or territory perceived by people, becomes a representation of cultural experiences which differs from one individual or society to another. Eventually, "Privacy is achieved more often through rules regulating interpersonal behavior rather than by direct manipulation of the environment" (Lawrence & Low, 1990), and levels of intimacy is regulated by 'proximity and distancing' between people (Zumthor, 2006). Tuan (2001) added that cross-cultural similarities exist as 'man' is the center of everything. He states that: 'if we look for fundamental principles of spatial organization we find them in two kinds of facts: the posture and structure of the human body, and the relations (whether close or distant) between human beings'. As a result, "sense of place" becomes an impression caused by the proportionalities between the built environment and human scale, and the human behaviour within that environment. Among other things, "The connection between distance, intensity, closeness and warmth in various contact settings has an interesting parallel in decoding and experiencing cities and city space" (Gehl, 2010). Gehl uses terms like 'distance sense': seeing, hearing and smelling, and 'close sense': feeling and tasting, to describe that human senses gradually activate once the body distance from an object changes. "In contact between people, the senses come into play at highly disparate distances" (Gehl, 2010). At great distances, humans' perception of the environment isn't as clear as short distances, therefore it influences the communication and interaction between human beings.

In conclusion, understanding about human behaviour within the built environment will help us evaluate how the built environment is influencing people and how people are perceiving those environments to fulfill their voluntary and involuntary needs and connect with others. Once that can be presumed, behavioural patterns can be found and design solutions can be developed with an aim of improving the quality of urban spaces.

6.2.2 Atmosphere Perception

This chapter aims to introduce the experience of perceiving atmospheres, by describing the natural way human beings can perceive environmental atmospheres in relation to the connection of mind, body and space.

According to *Cambridge Dictionary*, the term of "Atmosphere" can be defined as the character, feeling, or mood of a place or situation (Cambridge University Press, n.d.). However, it differs from Mood because it is considered to be an intuitive interpretation of the environment (Vogels, 2008). Moreover, Pallasmaa (2014) claims that there is an evident range of clustering atmospheres as being environmental or interpersonal like cultural, social, workplace or family. In this context, the focus will be on environmental atmospheres, because of the framework with the relation between human and environment.

Zumthor (2006) claims that human beings perceive the notion of atmosphere with emotional sensibility, which is a form of perception that works very fast, and which human beings evidently need to survive. Not every situation allows people to make up their minds on making preferential decisions. Something at the intersection of the mind with the body tells a tremendous amount straight away. Pallasmaa (2014) explains that the act of judging and interpreting our environment is a complex multi-sensory fusion of various factors which are generating an overall atmosphere, ambience, feeling or mood. The perception of atmospheres also involves judgements beyond the five conventional senses, such as sensations of orientation, gravity, balance, stability, motion, duration, continuity, scale and illumination. Therefore, we are using our entire body and existential senses to perceive atmospheres in a diffuse, peripheral and unconscious manner. On the other hand, personal background might also influence the way people perceive atmospheres. Harris (2015) claims that our backgrounds (environmental, social, economic, religious, educational, familial) influence us to focus on certain aspects of the environment and react to them in emotional and cognitive ways according to cultural norms and values. Hence, one person might act differently than others in front of a certain atmosphere.

Regarding the connection between the human mind and the environment, Harrison states: "In the fusion of place and soul, the soul is as much of a container of place as place is a container of soul, both are susceptible to the same forces of destruction" (Pallasmaa, 2014). Pallasmaa also explains that an atmosphere is an exchange between materials of space and the immaterial realm of human perception and imagination, also assimilating that the term "atmosphere" is a synthesis of an individual's previous experiences (Pallasmaa, 2014). McGilchrist, a psychiatrist, clarifies that we can never be sure if mind or body is a thing at all, by explaining that the mind has the characteristics of a process more than an entity (McGilchrist, as cited in Pallasmaa, 2014).

Furthermore, in a built environment, lighting is an essential tool for people to experience the space ina positive or negative way, and it can be manipulated to evoke human feelings. In the article published by Flynn, at el. (1973) it was stated that the lighting condition of a space can change or ease human interpretation of the environment, then an investigation was conducted to evaluate the impressions caused by the lighting where interpretations were measured under three factors called Perceptual Clarity, Spaciousness, and Pleasantness. Later, another study conducted by Vogels (2008) claimed that the atmosphere can be expressed by four underlying factors, called Cosiness, Liveliness, Tenseness and Detachment, which has shown more significant results. Thus, to assess information about atmosphere perception by means of lighting, many reports using those evaluation methods should be examined and reckon with the feelings it is intended to achieve.

To conclude this chapter, the science of atmosphere is also crucial for this research as Pallasmaa suggests becoming more interested in atmospheres by claiming that understanding this topic will teach us about the secret power that architecture has to influence entire societies and enable us to define our own existential wealth. He also adds that this capacity of comprehending environmental situations could be well named as our sixth sense allowing us to perceive better our genuine presence and emotional feelings (Pallasmaa, 2014).

6.3 Lighting Context

The lighting context is about understanding the physiological effect of the light on humans, the tools for manipulating the light to be able to generate visual variations in the space and the lighting effects that are responsible for the materialisation of the light. As a result, that would help with the creation of atmospheres through managing the visual effects of the light.

6.3.1 Science, Perception and Effects of Light

This chapter aims to understand the phenomenon of light touching upon the way it is detected by the eyes, the relation it has with the brain and the way it influences human health and well-being.

The *Collins Dictionary* defines light as the brightness coming from sources such as the sun, moon, lamps and fire making us able to see things. As stated in the book *The Design of Lighting* (Tregenza & Loe, 2014), light can be described as a flow of energy like radiant heat, radio waves and X-rays, part of the electromagnetic spectrum and identifiable in terms of wavelength and power. The light that is visible to the eye is the light that ranges from 400nm to 700nm wavelengths in the electromagnetic spectrum, in other words from the violet colour (short wavelengths) to the red colour (long wavelengths). The wavelengths below or above that range are not visible but identified as ultra-violet (UV) and infrared lights. However, it should be noted that the eye is not a camera: the optical images which are projected onto the light-sensitive surface at the back of the eye are not what we perceive. In fact, a series of transformations is performed first in the light-sensitive layer of the eye, called the retina. Then, the information is changed through the visual cortex of the brain where the balance of brightness and colour is altered and images of the present scene are replaced by earlier images retrieved from the memory. Consequently, the way one sees depends on one's individual experiences and on the physical structure of the eye and the brain.

Following that, the eye is known for its complex relation with the light, when adjusting its sensitivity to the light levels of its surroundings. The photoreceptors, light-sensitive cells of the retina, are responsible for making the adaptation. They contain pigments releasing electrical energy when exposed to light making them less sensitive in the process. Once the light is removed, they gently regenerate to gain back their sensitivity. The retina adapts itself for an optimum sensitivity in ambient lighting. Moreover, there are two types of photoreceptors in the retina: the rods and the cones. The rods are sensitive at low levels of light and do not give recognition of colours. As for the cones, they are sensitive at brighter levels with three different types responding to different wavelengths which generates the basis of the colour vision. This process of adaptation generates different phases in the eye which are described as photopic, mesopic and scotopic visions. Once there is light, the photopic phase begins to activate,

resulting in the perception of colours and the fine details. As the level of illumination drops off, our ability to see the details degenerates, therefore we do not see spectral colours but perceive everything on a blue-grey hue, when the scotopic vision begins to activate itself. The change between photopic and scotopic visions happens over a rapid variation in the light levels, known as the mesopic vision. During this process, both cones and rods are active while our perception of space and details are being formed. Additionally, the eye operates with two distinct visual fields in order to perceive the physical world: the central vision and the peripheral vision. The central vision, also called the foveal vision, has the ability to discern small details (visual acuity) happening over a small area on the retina called the fovea. The peripheral vision, especially sensitive to motion, is related to perceiving objects coming into the field of vision with no specific consciousness, a probable quality preserved from survival needs (Tregenza & Loe, 2014).

On the other hand, light is not only helping us to perceive our surroundings but also affecting our health and well-being. Primarily, the sun is a primitive source of light responsible for the human sense of time, giving the body the power to differentiate the day and night cycles, whilst regulating our circadian rhythms and synchronizing our bodies with the environment. The circadian cycle affects the rhythms of the human body and influences sleep, mood, wakefulness, digestion, temperature control and even cell renewal. In fact, part of the light that is projected onto the eye is absorbed by photosensitive cells present in the retina, called intrinsically photosensitive retinal ganglion cells (IpRGC). These photocells are responsible for activating parts of the brain that affect the human body system leading to the production or suppression of hormones like melatonin or cortisone, influencing the mind and body response (Lucas et al., 2014). Additionally, a research conducted by Talieh Ghane shows that an adequate amount of light improves our mood and energy levels, while poor lighting contributes to depression and other problems in our bodies. In order to improve the quality of sleep, the well-being and the productivity, it is recommended by experts to be exposed to brighter/cooler (short wavelengths) lights during the day and dimmer/warmer (long wavelengths) lights during the night. The reasons behind those suggestions are based on scientific grounds. High levels of illuminance and cooler color temperature tend to make the environment more stimulating resulting in people feeling more awake, focused and productive, whereas the opposite of those lighting attributes tend to make the environment more welcoming leading to people feeling more relaxed (Souza, 2019).

To conclude this chapter, it is essential to understand the phenomenon of light, its correlation with the human structure and its non-visual impacts on human health and well-being, in order to acquire the ways of determining and implementing the desired objectives and human responses within different spatial contexts.

6.3.2 Shapes of Light

In this section, the work of two important writers in the field of lighting design will be presented to further assist the design development of this thesis work, and another certified investigation will be introduced to clarify which qualities of light can contribute to create atmosphere in a built environment.

The first author, Richard Kelly, has contributed to the field by setting the design principles for any lighting design project to be successful. The design principles consist of three visual effects of light: ambient light, focal glow and play with brilliants; which together enable visibility and safety perception, provide visual comfort, and excites the senses (Kelly, 1952).

The second author, Hervé Descottes, has reinforced the topic by providing a more clarifying explanation about the lighting attributes that, when manipulated, will enable the creation of the three lighting layers described by Richard Kelly. These lighting attributes were clustered into 6 visual principles: illuminance, luminance, colour & temperature, height, density and, direction & distribution. Each one of those qualities change the perception of the built environment and, when orchestrated carefully, provide different sensory experiences for users (Descottes & Ramos, 2011).

Lastly, a study published by Erp (2008) in collaboration with Philips Research, investigated and testified that not only lighting can contribute to atmosphere perception, as some specific lighting attributes can help generate different responses from the public in relation to cosiness, liveliness, tenseness and detachment factors. This study concluded that illuminance, colour & temperature, and distribution of the light are lighting qualities that can affect perceived atmosphere within the built environment. The results showed that for illuminance levels, high intensity was preferred over low intensity. For the correlated colour temperature (CCT), warm CCT was preferred over cool CCT. As for the spatial distribution, concentrated downlight was a bit more preferred over diffuse downlight and resulted in people perceiving the space as being more cosy, less tense and more lively. Additionally, at warm CCT and high intensities, spaces seem more lively, less tense and less cosy. However the feeling of detachment was perceived on ambients with diffuse downlight, high intensity and a cool CCT. If the diffused downlight has a warmer CCT, then the space seems to be more cosy, less tense and less detached. The final conclusion of this study indicates that high illuminance and cool CCT are more applicable for functional spaces, and warm CCT for relaxing and calm activities. On the other hand, the aforementioned study lacks investigation on the effect of different applications of the light on the space, such as direct and indirect light, which could have brought controversial data for the perceived atmosphere in the built environment.

Nevertheless, the outcome of that study can be merged with the explanation supported by Descottes (Descottes & Ramos, 2011) about each of those lighting attributes. First, Illuminance is responsible for

the light intensity in a space. He suggests that, controlling it ensures visual and spatial flows, comfort and legibility of the space. Second, Colour & Temperature account for the visual appearance of the light and affect the way we perceive objects and their surroundings. The perceived coloration of the white light depends on the combination of different wavelengths and is called correlated color temperature (CCT), measured in Kelvin (K). "The careful choice and use of color in an architectural setting can shape occupants' memories and experiences of a space while provoking psychological response on situ" (Descottes & Ramos, 2011). Third, Direction and Distribution give form to the light as it concerns the aim, beam and shape of the light source. By playing with these aspects, a lighting designer can create different effects in the scene revealing or hiding forms and details, and in the same way, it can provoke a sense of drama or visual excitement. A concentrated light can accentuate an object and create illusions, whereas a diffused light can flatten an object, create atmospheres and reveal spatial limits.

In conclusion, it should be acknowledged that all the inherited qualities of light corroborate with the creation of different atmospheres in a space and that, by their manipulation, it is possible to create variations in the visual field to generate spaces that induce movement, actions and feelings of users, whilst enabling legibility of the space for functionality purposes. Therefore, the role of lighting designers is to recognise the power of light and to be able to master its visual effects on the built environment in order to achieve initial design intentions.

6.3.3 Direct Light & Indirect Light

This chapter will explain different effects of the light that are materialised from the orientation of the light beam over a certain surface or object, which are known as Direct Light and Indirect Light. Once these resultant effects are implemented in a space, different spatial outcomes occur and the perception of the space is altered.

To begin with, Direct Light is the light that falls directly from a light source over a target surface or object, in other words it is a straightforward radiation. This lighting effect inherits other attributes since it is connected to the aim, beam and shape characteristics of the light, but as it is more focused and concentrated, it creates more harsh shadows, as well as it can produce glare. On the other hand, Indirect Light is the light that reaches the focus surface or object through reflection, this light is a non straightforward radiation. In general, it generates more diffused or ambient light, non defined or smooth shadows, and it can be sensed but not seen. Yet, as it is emitted through reflection, it reduces risks of glare.

However, it is important to differentiate the directionality of the light beam, by means of placement of the lighting fixture, from the effect of the light perceived in a space deriving out of that placement. For instance, a concentrated direct light illuminating a surface, concealed in an architectural detail as a cove light, will generate an indirect light effect in the space because the light that reaches our eyes results from the reflection of the direct light over another surface.

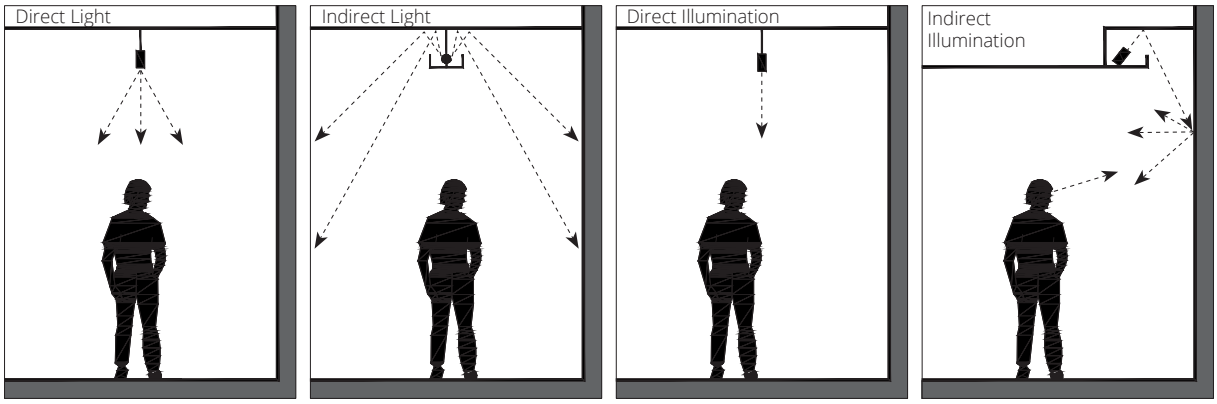

Fig. 38: Illustration of the direct light vs. indirect light effects & direct illumination vs. indirect illumination

By playing with these outcomes, a lighting designer can create different effects in the scene revealing or hiding forms and details, and in the same way, it can provoke a sense of drama or visual excitement. A concentrated direct light can accentuate an object and create illusions, reveal texture and imperfections, and it can give a false appearance of time and space. Whereas, a diffused light, direct or indirect, can flatten an object, hide details, create atmospheres, reveal spatial limits and work as a background for revealing silhouettes (Descottes & Ramos, 2011).

Fig. 39: Concentrated Direct Uplights

Fig. 40: Diffuse Indirect Downlights

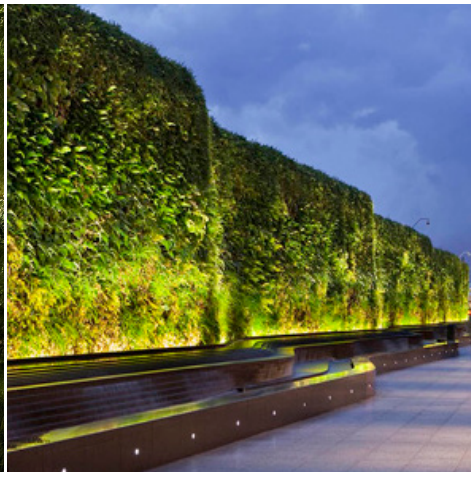

Fig.41: Diffuse Indirect Uplights.

Within architecture, daylight has always been manipulated through the form of the apertures of buildings in order to generate different lighting effects on the inside, which can only be carried out during the day. However, with the emergence of the electrical light, possibilities of playing with the light have been transforming its relation with architecture and the appearance of the spaces can be manipulated to evoke atmospheres, emotions and memories that cannot be disentangled from architecture. Lighting is a powerful tool for architecture, thus their synergy should be seamless (Descottes & Ramos, 2011).

Finally, direct and indirect lighting effects should complement each other and set the basis for any lighting design project, as their application in architecture can emanate different responses. Additionally, much evidence indicates that direct lighting is more applicable for functionalities and indirect lighting is more applicable for atmospheric experiences.

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Fig.42: Daylight Employment, Brione House, Switzerland.

Fig.43: Electrical Light Employment, The Therme Vals, Switzerland.

07 FINDINGS

This chapter sums up the findings collected within the spatial, social and lighting contexts, leading to the research question of this thesis.

The aforementioned studies help with the interpretation of the topics that are essential for the development of the Design Concept chapter, leading to answering the research question of this thesis work.

This project started by recognising the spatial aspects of urban spaces during day and night hours, and its importance for the development and the well-being of society. In this phase, it was acknowledged that there are specific qualities that an urban space needs to incorporate in its design to ensure users with the basic needs of habitability. Also that urban spaces are alive during day and night hours, thus there is a need to strategise them carefully to tackle the impacts of nature or man-made actions imposed now and in the future.

Then, the social demands and the relationship between people and the built environment, together with the way they sense it, were clarified. Along this stage, it was acknowledged that cultural background influences the way people relate with the built environment and the way people shape it in line with their beliefs. On the other hand, the way they sense a space is a matter of personal experience and varies from one individual to another. Despite all, every human being seeks for the same aspects when inhabiting a built environment, but some behaviours are voluntary, others involuntary.

Finally, the lighting qualities and its visual effects were studied in order to formulate new ideas for coping and improving humans' relationship with the built environment. In that sense, it was widely recognised the influence that light has in changing the built environment and in affecting people's perception of it, not only physiologically, but also psychologically. By manipulating the lighting attributes to generate various scenarios, people will experience and respond to it differently. However, to achieve that goal, different visual effects need to be orchestrated concomitantly to generate the atmosphere and the outcome intended for a specific project. In order to ensure the efficacy of urban spaces, all those three aspects, spatial, social and lighting, need to be working effectively and in collaboration. However, the analysis conducted on the sites mentioned in the Site Analyses chapter, have provided a clear understanding that this outcome is not completely satisfied because one of those aspects are missing or they are not complementing each other. It is acknowledged that most urban spaces lack one of those aspects, more likely because lighting is still not seen as a powerful tool to change this reality.

Therefore, the research question has been generated as the following:

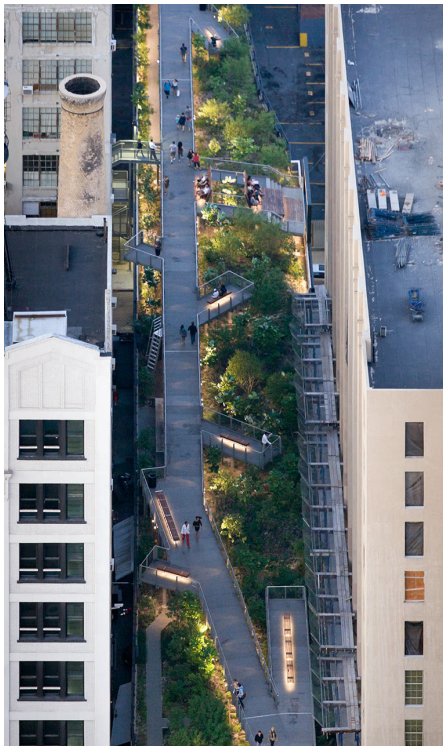
How could the use of direct light together with indirect light generate a liveable atmosphere in urban spaces at nighttime to ensure that the feelings of protection, comfort and delight are satisfied among pedestrians?

08 REFERENCE POJECTS

This chapter aims to introduce three distinct urban lighting projects from different parts of the world with the aim of reflecting on the synthesis of the current thinking in the field of urban lighting design. Each case will be analysing how lighting was used to transform the urban environment after dark hours by using a combination of direct and indirect lighting to create liveable atmospheres for pedestrians. Those design examples will help to frame a strong and clear design vision that would enable us to build the following chapter, where the design concept will be developed for public realm lighting.

8.1 High Line, New York - USA

The High Line is a public park built on a historical freight line elevated above the streets in the heart of New York City, USA. The concept behind the lighting design project, developed by L'Observatoire International, intends to drive attention towards the unique spatial relationships that the space offers with its surroundings. In fact, the method implemented through lighting was to promote an unobstructed view of the city at nighttime, by shielding the light sources and keeping luminaires below the eye level. The incontestable consideration made for this design concept was to avail the lighting of the cityscape as the ambient light of the space. Hence, the implemented lighting is focused **to create a pleasant nocturnal atmosphere through combining direct-indirect lighting** throughout the park, respecting the surroundings and allowing visibility of the space. Consequently, different lighting typologies have been considered along the way to fulfill the goals of the lighting design concept. The walkway is illuminated by soft perimeter lighting installed on the underside of the guardrail structure, by walkway lighting situated along the periphery of the pedestrian lane and by bench lighting concealed on the underside. The perimeter lighting has been achieved with the implementation of linear LEDs providing direct light towards the diverse plantings, revealing their colors and texture patterns. That is, certainly, a subtle way to highlight the limits of the lane through indirect illumination, without creating a visual barrier leading to a comfortable sight. As for the walkway lighting, that has also been achieved with the implementation of linear LEDs providing direct light towards the ground, but this time with a higher luminance level to enable visibility of the pathway, along with allowing face recognition, for a better feeling of protection. When it comes to the bench lighting, linear LEDs have been installed underneath the benches providing indirect diffuse light, which renders a delightful appearance of floating benches by creating low pockets of lights along the walkway. All of the three design implementations minimise luminance contrast and glare issues, helping pedestrians to perceive the effect of the lights and not the fixtures themselves (Descottes and Ramos, 2011).



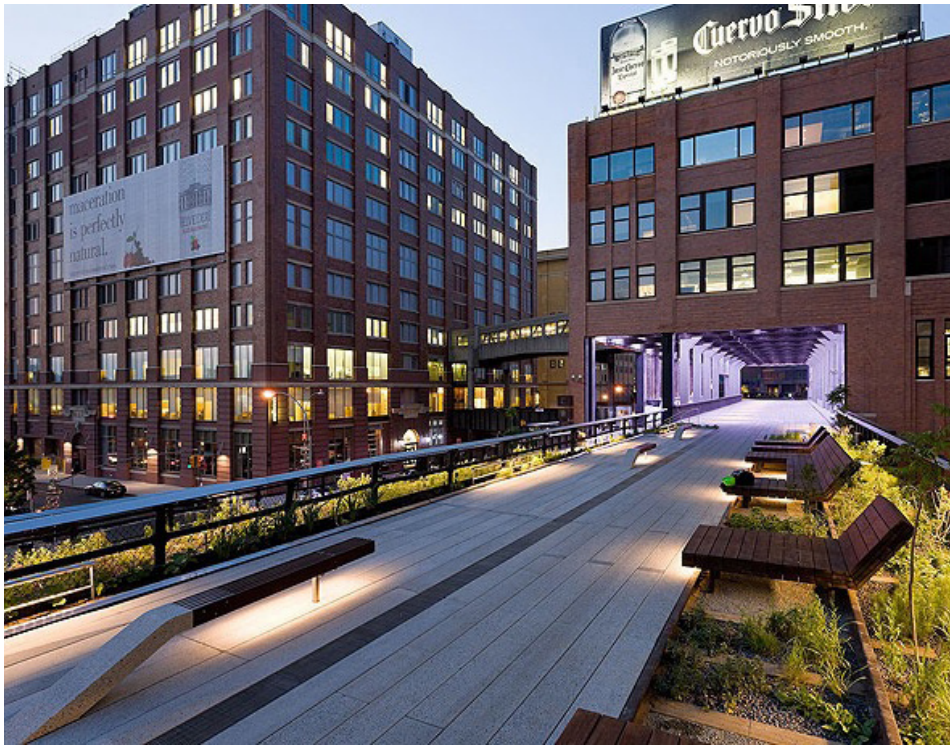


Fig. 44, 45, 46 & 47: The High Line, New York City

8.2 King's Cross Square, London - England

An urban lighting design project has been conceived for the redevelopment of King's Cross station square located in London, England. The concept behind the project, developed by Studio Fractal, intends to create a strong visual identity, to support wayfinding and to encourage commuters to linger and appreciate the space. The lighting strategy concentrates on integrating lighting into the built environment, highlighting the station's historical façade and emphasising on diverse materials and textures. The challenge, in this specific case, was to provide lighting over such a wide square in a manner not only respecting the architectural context, but also creating a pleasant lit environment (Davoudian, 2019). For that purpose, lighting was used **to support different activities occurring in the square through combining direct-indirect lighting**, along with different levels of illumination, in order to provide a visual variation in the space. The square is illuminated by general lighting implemented in front of the station entrance, by wayfinding lighting located along the main axes and by supplementary lighting integrated into various structures and forms. The general lighting has been achieved with the installation of three steel columns housing an array of individually focused direct LED spotlights, responding to the context of the square while delivering a crisp appearance. As for the wayfinding, that has been achieved with shorter columns having also several LED spotlights, with the aim of guiding commuters in a comfortable way towards the ticket office. When it comes to supplementary lighting, a variety of lighting elements have been designed to create a delightful atmosphere for pedestrians, such as concealed lighting emphasising on the sitting areas and ground-recessed uplights highlighting the presence and texture of the trees. Consequently, the combination of gently glowing historic façades, floating benches and carefully worked lighting details is being defined as a successful way of transforming the square from a neglected site into an examplary public urban square, well frequented both day and night. Boris Johnson, the former mayor of London, identifies the square as a fantastic open space which has led to the creation of a whole new vibrant district, making the space beautiful but also triggering all sorts of regeneration (Studio Fractal, n.d.).

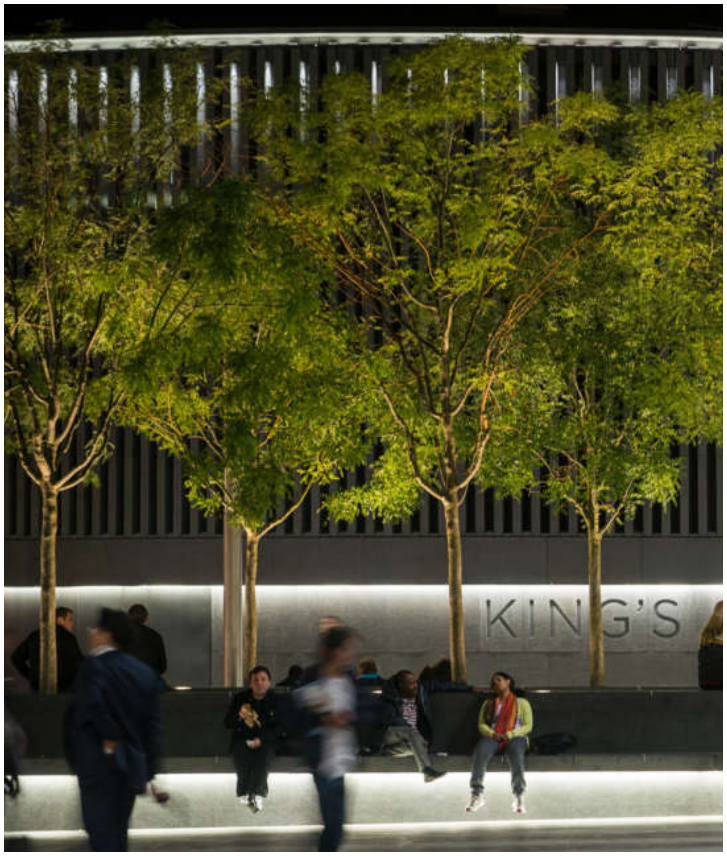


Fig. 48, 49, 50: King's Cross Square, London

8.3 Grangegorman Campus, Dublin - Ireland

The Grangegorman Campus is a part of the urban redevelopment project of Grangegorman, an inner city located in Dublin, Ireland. Formerly being a psychiatric hospital, the venue serves now as a campus for the Dublin Institute of Technology. The concept behind the lighting design project, developed by ECI Lighting, intends to reinforce the connection of the campus with its surroundings by creating a lighting hierarchy in terms of light intensity and fixtures' heights. Therefore, lighting has been implemented **to provide an identity for the student hub by combining direct-indirect lighting**. The overall campus is illuminated by general lighting implemented around the main square, by wayfinding lighting located along the pathways and by perimeter lighting recessed alongside the buildings. The general lighting has been achieved with the installation of tall lighting columns with wide beam spotlights, enabling visibility to ensure the feeling of protection among students. As for the wayfinding, that has been achieved with shorter columns providing diffused indirect lighting, with the aim of guiding students along sidewalks in a comfortable way around the campus. When it comes to the perimeter lighting, ground-recessed wall washers have been installed along the façades facing the square to create a delightful atmosphere with a balance of light and darkness, and also revealing the historical textures. All of those lighting design intentions are expected to support the initial aim of the project as to create a vibrant environment around the student hub, allowing social permeability. (Davoudian, 2019)

Fig. 51, 52, 53: Grangegorman Campus, Dublin

09 DESIGN CONCEPT

This chapter aims to introduce innovative lighting design solutions for the problems detected in both focus areas, previously explained in the Site Analysis chapter, and will be based upon the knowledge acquired through the multidisciplinary topics elucidated in the Context chapter. After deliberative thoughts over those contents, some goals have been set in order to provide the basis for a concrete design approach. Consequently, a conceptual lighting design will be proposed to demonstrate the design approach for similar contexts. That will be achieved by illustrating the concept on specific areas of each analysed site with an aim of rejuvenating urban scenarios, promoting a better spatial experience and encouraging users to utilise those areas at their leisure on a regular basis.

9.1 Success Criteria

The starting point for the design solutions suggested for such contexts is to determine what are the criteria to be accomplished through lighting in order to transform the atmosphere generated by the conventional lighting present in urban spaces around the world.

Based on the quality criteria for the design of urban spaces supported by Jan Gehl (2010) and described in the Context chapter, the solutions undertaken in this project will follow the same concept. So forth, for this particular context, along with supporting the spatial qualities, lighting should ensure that the feelings of protection, comfort and delight are fulfilled. To better illustrate how lighting could achieve that, a matrix has been elaborated and is exemplified bellow:

	SPATIAL	SOCIAL	LIGHTING
PROTECTION	No cars allowed No visual barrier between spaces Provide shelter Good physical conditions	More human presence Feeling of safe Not feeling exposed to danger	Enable face recognition Prevention of dark areas Facilitate wayfinding Provide visibility of surroundings
COMFORT	Allows diverse events to occur Creates opportunities for people to sit, walk, stand, stay, exercise, play, bike, run, talk, listen..	Feeling welcomed Feeling active Feeling stimulated to use facilities	Identification of the spatial features Prevention of glare issues Regulate light levels Good CRI
DELIGHT	Design respectful to the human scale Create opportunities to contemplate nature Interlace spaces with landscape	Feeling of belongingness Feelig stimulated to contemplate nature Feeling stimulated for social interaction	No visual polution Highlight texture of natural elements Creating atmosphere Indicating trajectories

Fig. 54: Success Criteria Assessment for Lighting in Urban Spaces, based on the quality criteria matrix of Jan Gehl

The matrix above illustrates how the spatial design and social aspects should be treated within public urban spaces to help optimise the city space and ensure that the feeling of protection, comfort and delight are fulfilled, as discussed by Jan Gehl (2010). Additionally, the lighting content has been included to this matrix to demonstrate which actions could be taken through lighting to support that those criteria are met also during the dark hours.

Therefore, the aim of this thesis work is to illustrate in a conceptual way how to accomplish those criteria via the phenomenon of light, along with suggesting technical solutions for solving this matter. By following that, lighting in urban spaces can be regulated in order to create a better link with the architectural design intentions.

9.2 Design Intentions

Based on previous analysis conducted on both sites, it has been evaluated whether current lighting implementations are operating well within the urban context. Hence, it has been recognised that the lighting typologies previously analysed on both sites are not suitable for the needs of the society. In fact, they only provide direct light, which is not enough to complement the spatial design of these urban spaces. Many issues have been identified, which could indicate the need of implementing a more efficient lighting solution for these scenarios. For that matter, an ideal solution will be to include another layer of light into the lighting schemes of these urban spaces to support its diverse functions and promote a valuable experience for its users. Hence, it has been determined that the missing layer is the indirect lighting which should be included in any urban contexts to help their rejuvenation, resulting in the development of more resilient urban spaces.

Narboni points out that lighting should reinforce the urban design so that the city functions during nighttime as well as it does during daytime. Ideally, the combination of direct-indirect lighting should work together to promote the nocturnal uses of both spaces, whilst providing users with a qualitative experience and ensuring that the fundamental needs aforementioned are satisfied. Therefore, the lighting design approach consists of combining both lighting modes to focus on relevant areas by consciously creating illuminated environments, instead of bathing the whole space with uniform lighting. Likewise, different atmospheres will be created, transforming urban spaces into more vibrant and liveable public urban areas.

Jan Gehl (2010) states that the interpretation and experience of city spaces are intrinsically related to the way humans connect with the built environment through distance, intensity, closeness and warmth impressions. In that manner, human senses are activated and the feelings of intimacy, privacy, belongingness and conviviality, among others, are distinguished. By generating different atmospheres through lighting, it is possible to emphasise that connection during nighttime. Hence, three different lighting layers have been created, following the same criteria stated in the previous section, to bear with the different demands carried on these urban scenarios. That will be elaborated with the conception of an Ambient Layer, a Focus Layer and an Accent Layer, following the visual light principles supported by Kelly (1952) in the publication “Lighting as an Integral Part of Architecture”. All strategies undertaken through those layers of light would set up spatial boundaries and enhance the importance of urban spaces for the city life.

First, the **Ambient Layer** should change the overall ambience of the space to enable visibility and invite pedestrians to enter, navigate and stay. This layer is the diffuse, indistinguishable light in a space, not directly visible but perceivable by the senses that would generate a feeling of reassurance, also inducing restfulness and tranquility among pedestrians. By illuminating the horizontal and vertical

surfaces, there would be a more balanced distribution of the light throughout the space that would help minimise the contrast between dark and bright spots, whilst ensuring the minimum lighting level requirements. The overall ambience is responsible for the human eye to adjust to the different light intensities within the space which will enable the spatial visibility along with the facial recognition. The feeling of **Protection** would then be supported with this lighting effect which can be created in any urban scenario. Therefore, the illumination generated by this layer would be responsible for supporting human biological information needs, the involuntary behaviours of orientation, safety and spatial perception, as described by Lam (1992).

Second, the **Focus Layer** should allow people to perform different activities occurring in urban spaces, therefore supporting the opportunities for sitting, walking, standing, exercising, playing and biking which are integrated in the spatial design. This particular lighting layer should induce movement, action and communication, but also invite for conviviality, contemplation and introspection. To achieve that goal, the light implemented over the playful areas should differ from the light installed on the static elements, therefore evoking different feelings on pedestrians. The feeling of **Comfort** will be supported by this lighting effect since pedestrians will be able to see their actions when performing specific activities. Therefore, the illumination generated by this layer would be responsible for supporting human activity needs, the voluntary behaviour of performing consciously an activity, as stated by Lam (1992).

Third, the **Accent Layer** should trigger human senses and raise their curiosity towards specific spots. This lighting effect excites the human optic nerves, which results in stimulating the body and spirit (Kelly, 1952). That particular setting can be identified as entertaining and abstracting, drawing the attention to where it is needed. Moreover, the manipulation of light would enable dynamism helping to reestablish the use of the space and to reinforce the identity of the site, whilst emphasising on the spatial potentialities. As stated by Narboni, that would stress out the power that lighting design has to create attractive nocturnal atmospheres through urban renovations (Narboni, 2016). The feeling of **Delight** will be supported by this lighting effect as it will be used to enhance the atmosphere, indicate trajectories, highlight the architectural features and the natural elements. Therefore, the illumination generated by this layer would be responsible for supporting emotional states, the consciousness of feeling satisfied in the heart, as stated by Zumthor (2006).

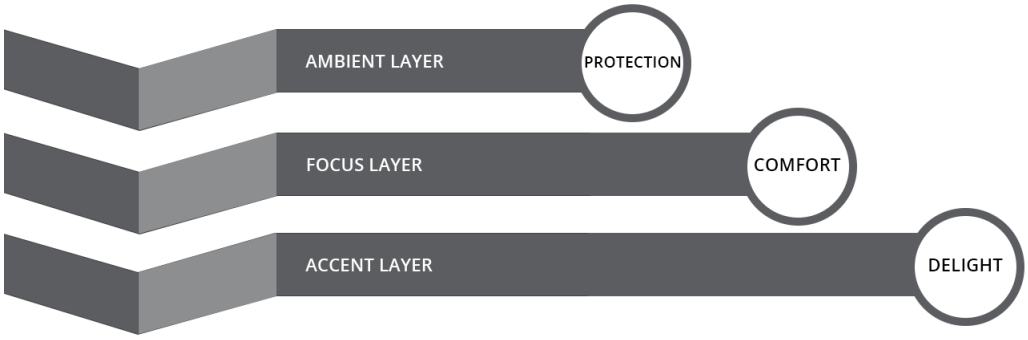


Fig. 55: Light Layers Diagram.

Generally, only one of these three distinct layers should be dominant. The manipulation of those lighting effects will be made through the subtle variations of the lighting attributes, as supported by Hervé Descottes (Descottes & Ramos, 2011), and will be individually exemplified later in the section Lighting Design Principles to better illustrate how that could be accomplished.

9.3 Design Experiment

Before any lighting solution can be implemented, it is necessary to evaluate the use of the indirect and direct lighting under laboratory conditions to determine to what extent each of those settings are more beneficial to support the feelings of protection, comfort and delight.

That could be achieved through an experiment staged in a lighting laboratory, consisting of different lighting scenarios using direct and indirect light to be evaluated by diverse participants. To access the results, participants should be exposed under those lighting conditions for a certain period of time and should answer a questionnaire about the experience and sensations perceived during the experiment. The questionnaire should be able to measure how participants, under the atmosphere created with those lighting conditions, were assessing the feelings of Cosiness, Liveliness, Tenseness and Detachment, based on the methods described by Vogels (2008).

The results concluded from this experiment could provide valuable solutions on how to best achieve the criteria of this project and what to avoid in each lighting setting. Also, it would set up a stage for further experiments. However, as mentioned before, due to the extraordinary situation, that experiment could not be carried out during the time this thesis work was being conducted. For that reason, this section is only attempting to illustrate a way of evaluating the effects of different lighting conditions on human feelings.

9.4 Design Principles

In this stage, a lighting design method for urban spaces will be elaborated through combining direct and indirect lighting. Those lighting effects will be orchestrated through the Ambient, Focus and Accent Layers, described earlier, for generating a more liveable atmosphere in urban spaces and to succeed with the design criteria of ensuring feelings of protection, comfort and delight among users. Likewise, the layers will be shaped through the different lighting attributes: illuminance, luminance, colour & temperature, height, direction & distribution, and density. In order to elucidate how to materialise those layers, both analysed sites will be used as illustrative models and exemplified individually through each layer.

Ambient Layer

The Ambient Layer should aim to provide a shadowless illumination throughout the space. The light source should not be visible but the emitted light should bounce back to the space from reflecting on the surfaces. However, determining those surfaces would contribute to generate the overall illumination of the space, so that the lighting attributes can be manipulated to change the current lighting settings in these scenarios and immediately promote a change in the atmosphere. Moreover, the effect that citylights have on the space should be considered, as it could indicate that no additional light is needed or that interventions need to be taken beforehand.

In many similar scenarios, the circulation areas and the landscape are the most dominant elements in the architecture of the space that would contribute to enable this lighting effect to be implemented. In other cases, surfaces of the surrounding buildings could have the potential to play that role, so that lighting should be designed to avail of these surfaces to create a pleasant atmosphere in the space whilst avoiding visual discomfort for people inhabiting those buildings.

On circulation areas, where pathways are clearly defined, light sources should be placed near the ground level, aiming downwards, which would bathe the floor surface with a soft and diffuse light throughout the trajectory, providing orientation and, consequently, preventing glare issues and visual discomfort. Whereas if pathways are not clearly defined, the overall illuminance should be achieved through providing a diffuse, indirect and uniform lighting on the floor surfaces. As for the colour temperature, a warm white light, from 3000 to 4000K, would create a refreshing ambience to admit different activities to take place at the same time. Also, the illuminance levels should be set to enable visibility for safety reasons whilst ensuring navigability. As suggested in the publication *Light for cities. Lighting Design for Urban Spaces. A Handbook* (Brandi and Geissmar-Brandi, 2006), it should be around 5-7lux, however more deliberative analysis about the appropriate lux level should be given in order to ensure that different activities could be performed concomitantly and facial recognition could be admitted. By regulating the light on circulation areas, the feeling of being in evidence when people are walking would disappear, instead, a neutral and relaxing atmosphere would be experienced, and wayfinding would be facilitated as trajectories would be accentuated.

As for the landscape lighting, light should reveal the texture of nature and create a soft glow on the leaves that would help illuminate the surroundings, minimise contrast and permit spatial definition to be materialised. Ideally, floodlights should bathe the leaves and glow it from below to accentuate the trees. The white light should be arranged between 2500 to 3000K CCT to create a cosy atmosphere and promote a soft colour transition from the light located on the circulation areas beside it. Those improvements would bring life to the landscape, help create an inviting atmosphere and support the feeling of protection.

The subtle variation of the illuminance level and colour temperature on both spaces would help establish spatial hierarchy and create a balance between dark and bright spots, so that the peripheral vision is constantly active. Also, the landscape would represent the background for people's silhouette to be distinguished so that pedestrians would be able to identify in advance the presence of other people in the site.

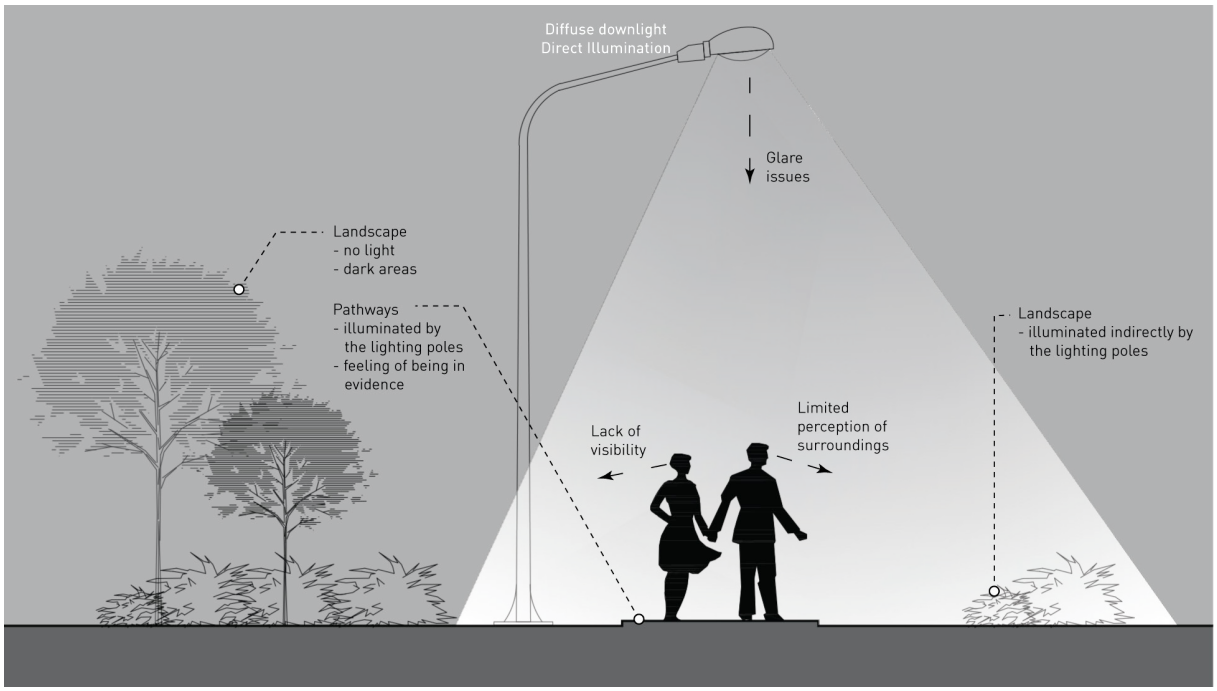


Fig. 56: Conventional lighting on defined pathways.

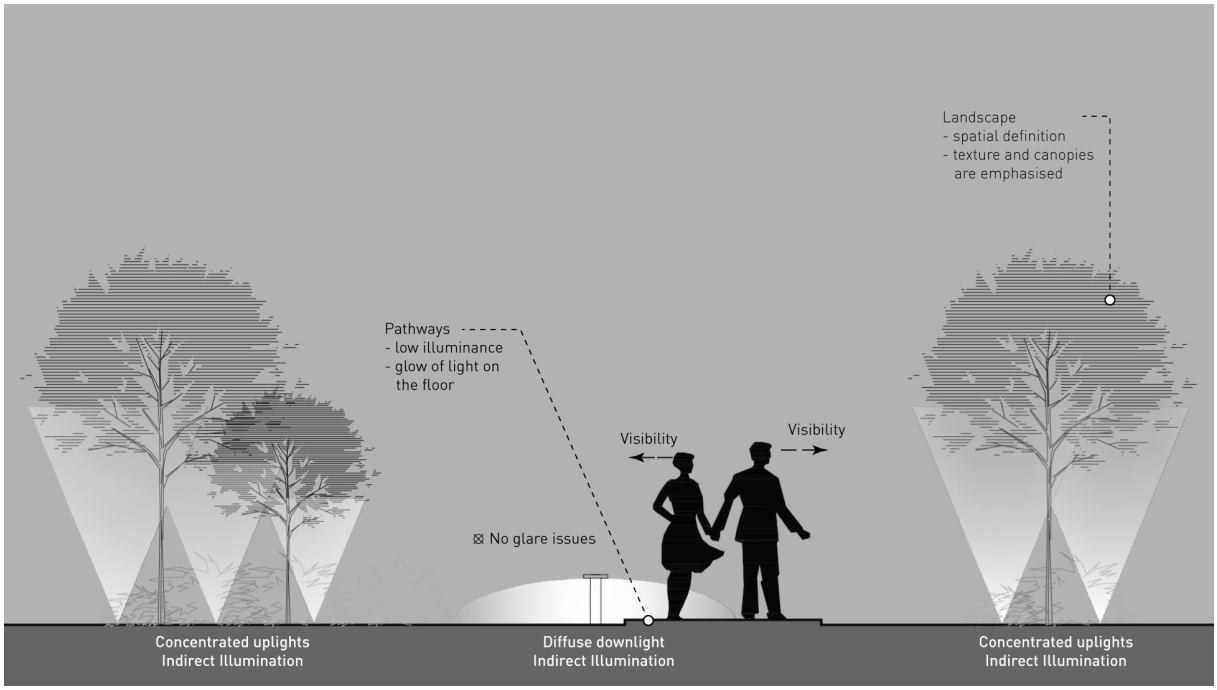


Fig. 57: Lighting proposal on defined pathways.

Conventionally, implementing diffuse direct light is the most common solution to light up defined pathways, as it has been observed in the urban park (Fig.58). However, that brings many problems together with causing glare issues and limiting the visibility perception of the pedestrians. As for the landscape, there is no specific lighting implemented, just the light emitted by the street poles trespassing the pathways which makes pedestrians unable to perceive nature. In the example of the residential garden (Fig.59), providing low illuminance on the floor helps pedestrians to perceive their surroundings better and the recessed uplights around the trees provide vertical illumination, bathing the surroundings for a clear spatial definition.

Fig. 58: Only direct diffuse light providing direct illumination. At Dona Lindu Park, Recife.

Fig. 59: Multiple typologies providing indirect illumination. At a residency, South Dakota.

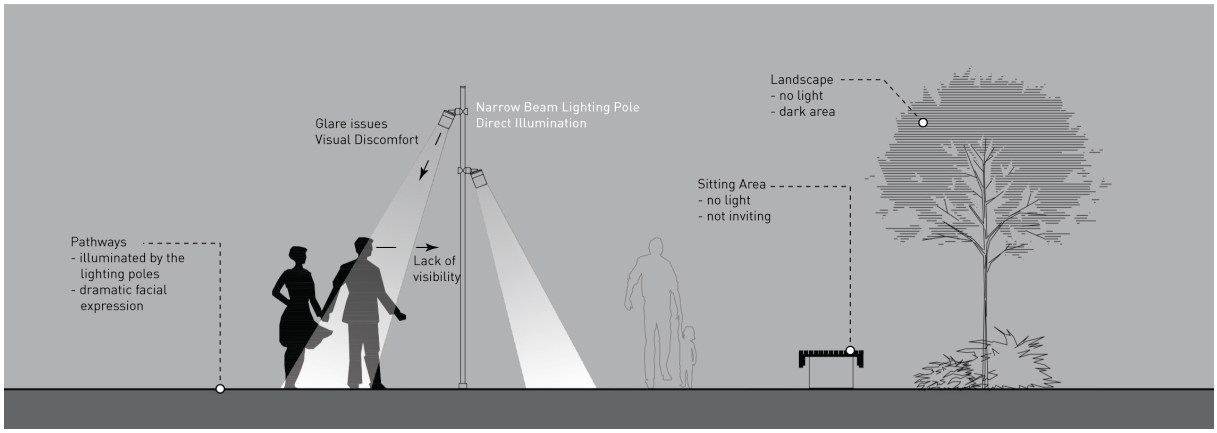


Fig. 60: Conventional lighting on non defined pathways.

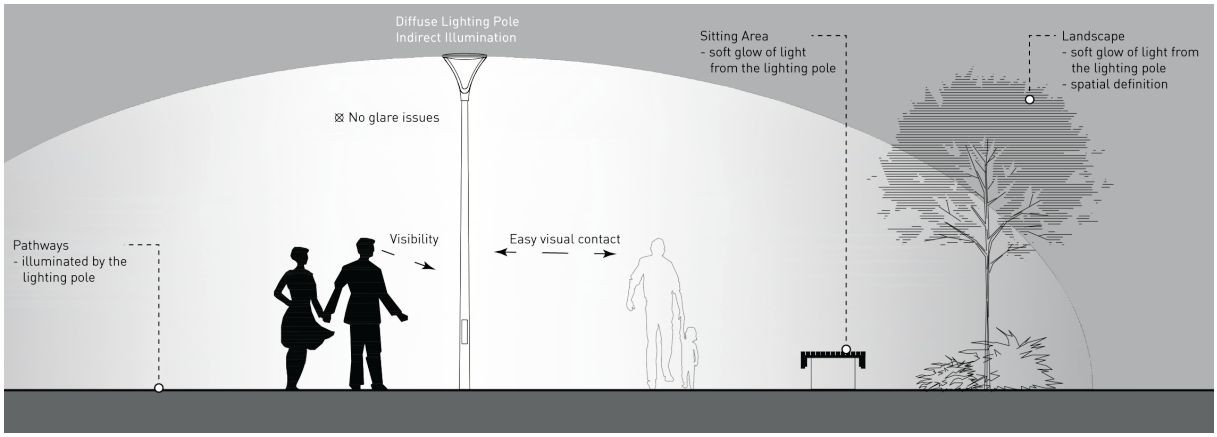


Fig. 61: Lighting proposal for non defined pathways.

Fig. 62: Direct concentrated light.
At Israel Plads, Copenhagen.

Fig. 63: Indirect diffuse light.
At Kauffman Center for the Performing Arts, Kansas City.

The lighting on the non-defined pathways is usually implemented with direct concentrated light, as it has been observed in the square (Fig.62). However, that lighting solution can easily provoke glare issues generating a visual discomfort for the pedestrians. Moreover, distinct light beams on the ground do not show the entire pathway, not supporting the wayfinding nor the feeling of safety. As for the landscape elements, they are becoming dark areas since they are not being lit up. In the example of the pathway leading to the performing arts center (Fig.63), providing diffuse indirect light along the space helps pedestrians to perceive better their surroundings, allowing facial recognition with no visual obstruction.

Focus Layer

The focus layer should support the diverse activities that stasis and transit areas provide in urban spaces. Both analysed cases encompass these elements in their spatial design, therefore lighting approach should take the same considerations but be accommodated to the specific cities where they are settled.

The light implemented in transit areas, such as playful areas, should be more technical, enable visual acuity and be placed within the space through the use of direct light, and provide a diffused distribution of the light to illuminate evenly and prevent dark spots within the space. The illuminance should follow lighting level requirements for sports activities, however if the floor coat generates a high luminance level, making it excessively bright or providing inadequate reflections, then the illuminance level should be adjusted. Or else, visual performance would be compromised which could result in physical accidents. Above all, the light in playful areas should not be excessively distinguishable from the surroundings, thus illuminance levels should be set to take that into account. Moreover, colour temperature should be set on a cool scale so that the atmosphere created would induce activity, adventure and fun, but would not drastically detach from the colour temperature applied on the surroundings. Pendant or column luminaires with non-glare homogeneous light would be best suitable for delivering this layer of light over the spaces. Strategically, the height of those fixtures together with a cool CCT, ranging from 5000 to 6500K, would emit light above the eye level and mimic the sun's position at noon, when the sun is at its highest position. Thus, subconsciously, activating circadian rhythm and boosting energy levels to induce people to be more active.

On the other hand, light on the stasis areas of the space, such as sitting areas, which requires less concentration, should be less technical but provide a more atmospheric experience. Placing indirect light below the eye level and concealing it on the spatial features of the site would best suit the needs of conviviality, contemplation and introspection. Technically, this lighting effect would mimic the sun's position at dusk, when it touches the horizon, providing an intimate atmosphere and bringing along the feeling of belongingness. Hence, the CCT levels should be set between 2000 and 2500K. Yet, Illuminance levels should be set under the level established for the ambient light of the surroundings for generating a cosy and inviting atmosphere.

Playful areas with lighting poles providing direct diffuse light placed on both sides of the space, as in the urban park (Fig.66), generates an overly lit area and highlight its presence in the park. Also, people sitting on the benches on the sides are affected by the lighting condition and experience the feeling of being in evidence. On the other hand, if the space is lit with a lower illuminance through direct diffuse light from above, more confined within the area, as in the campus quads (Fig.67), then the space seems more integrated in the context and less in evidence. Then, people sitting on the benches experience a more soft and comfortable illuminance, and they feel more welcomed to observe the space.

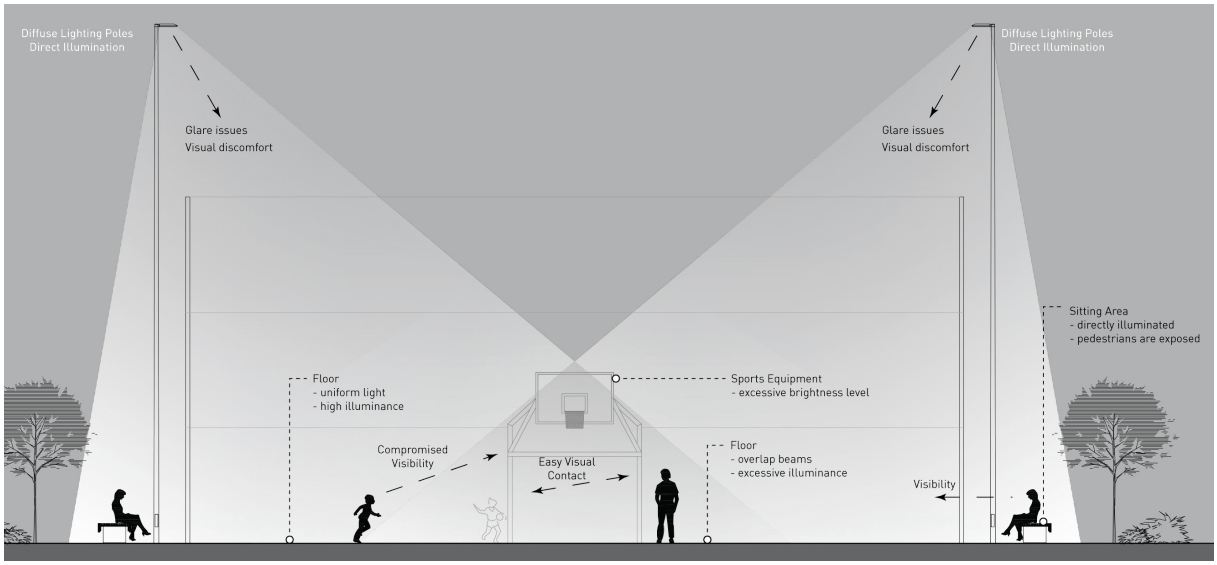


Fig. 64: Conventional lighting on recreational areas.

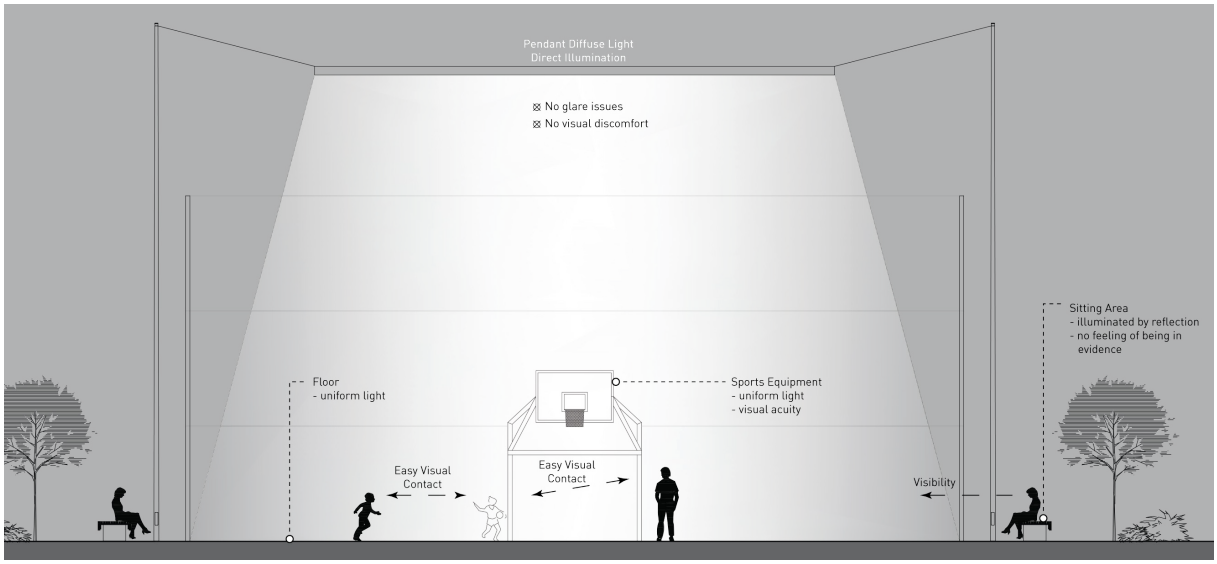


Fig. 65: Lighting proposal with direct diffused light confined within recreational areas.

Fig. 66: Direct diffuse light.
At Dona Lindu Park, Recife.

Fig. 67: Direct diffuse Light confined within the area.
At University Campus, Chicago.

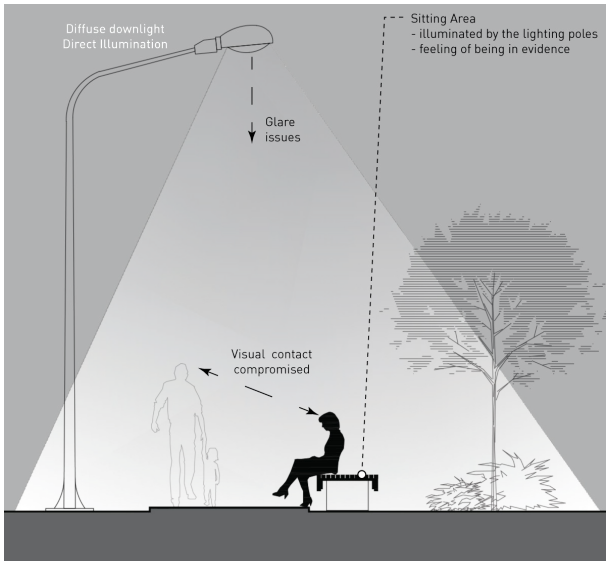


Fig. 68: Conventional direct light.

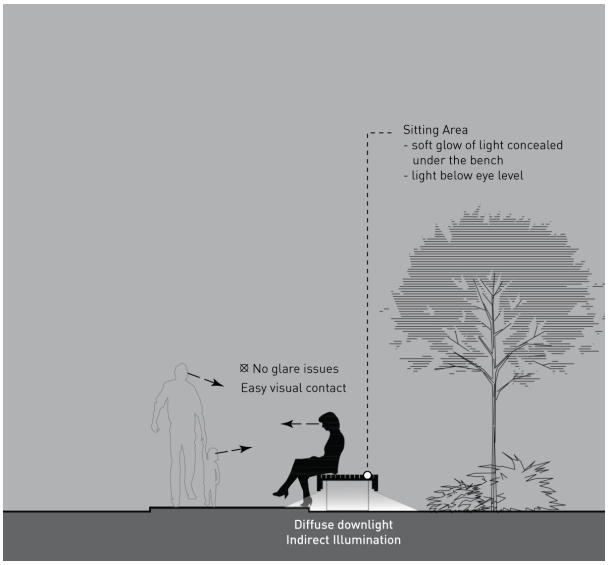


Fig. 69: Lighting proposal with indirect light.

Fig. 70: Direct diffuse cool light.
At Dona Lindu Park, Recife.

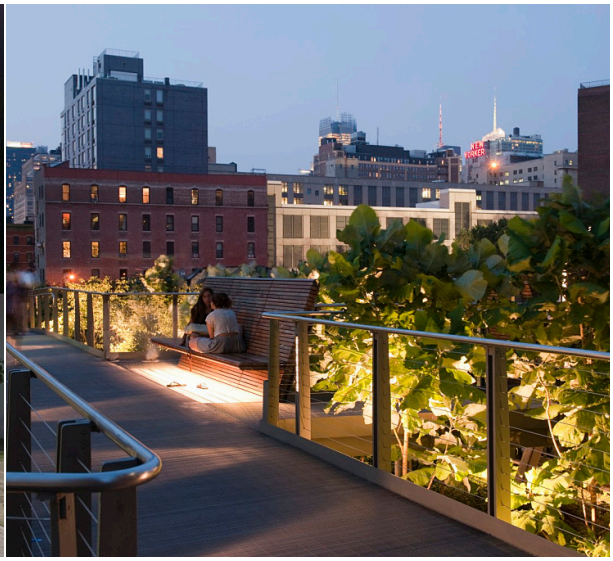


Fig. 71: Indirect diffuse warm light.
At The High Line, New York.

In the sitting areas located in the urban park (Fig.70), the spots are lit with direct diffuse light and a cool CCT bringing along the feeling of being under evidence and detachment. It is also producing glare and creating a visual barrier, thus pedestrians are unable to contemplate the sky at night. Under those lighting conditions, the different levels of intimacy are lost, thus the benches belong to anyone. In the urban park (Fig.71), the light is concealed underneath the benches with a warmer CCT which makes the focus change towards the sitting spots rather than people, and feelings of cosiness and relaxation are perceived. Yet, it allows pedestrians to gaze at the sky and connect with nature. The intimacy level is preserved as the benches are now dedicated to the ones occupying it.

Accent Layer

The Accent Layer should aim to accentuate the notable features of the space in order to reinforce the identity of the site. In essence, it grants an opportunity to invigorate the functionality and unseen potentialities during nighttime. Every urban space has its own character and lighting should be orchestrated carefully together with the designers to create a strong link with architecture.

In cases of mixed-use spaces with defined functions, the role of light is to emphasise the existing features to facilitate interpretation of the space for the users and make it visible in order to raise curiosity and trigger unexpected reactions. In the particular case of Israel Plads, the trees dispersed throughout the whole square are prevailing on the scenario, suggesting conviviality and conveying a sheltered meaning. Thus, illuminating those trees at night with an accent light from below, narrowed and concentrated, would reveal the canopies and textures of nature, and welcome pedestrians to sit beneath. Additionally, the colour temperature used to illuminate the trees should be between 2500 to 3000K in order to highlight the sheltered connotation and create a cosy atmosphere. Illuminance levels should not be excessively high but should set a bright accent light on the canopy to emphasise the colour of the leaves.

In other cases, the potentialities of the space are unseen or not clearly established, then the role of light is to welcome users, induce them to populate that space and make it suitable for their individual needs. Yet, the atmosphere generated should convey cordial and joyful messages so that people would feel invited to enter and stay. In the case of Dona Lindu Park, the patio is not being used on a regular basis, it has an unseen potentiality, then it becomes a promising territory for pedestrians to perform diverse activities. Also, it works as the entrance to the park but because of the emptiness perceived in the space and the disconnection from the human scale, people are discouraged to stay. Playing with light in this environment would help bring people back, reinvigorate the use and emphasise the entrance to the park. Due to the buildings present in the patio, light should not create a visual barrier. Therefore, it is suggested to have light installed along the extension of the patio on the floor, complementing the organic forms of the buildings with an aim of indicating trajectories and connecting the pathways located in the surrounding areas. Moreover, it should be set to indicate the pace of people within the space, thus playing with densities of the fixtures and illuminance levels would help indicate that. The CCT of the light should be set to change gradually from 2500 to 4000K towards the pathways, so that it would mimic the moment the sun touches the horizon bringing along the feeling of orientation and belongingness, and also the feeling of refreshment, conveying a playful atmosphere. Additionally, the current lighting applied on the buildings should be better employed to help enhance the ambience of the patio, thus wall washers should illuminate the surfaces with a warm white light and low illuminance level, reducing brightness, to provide a soft glow of light to the surroundings. Hence, the buildings would be accentuated helping to retain the aspect of the landmark of the venue also at nighttime, then pedestrians would easily navigate in the vicinity by perceiving them as significant reference points.

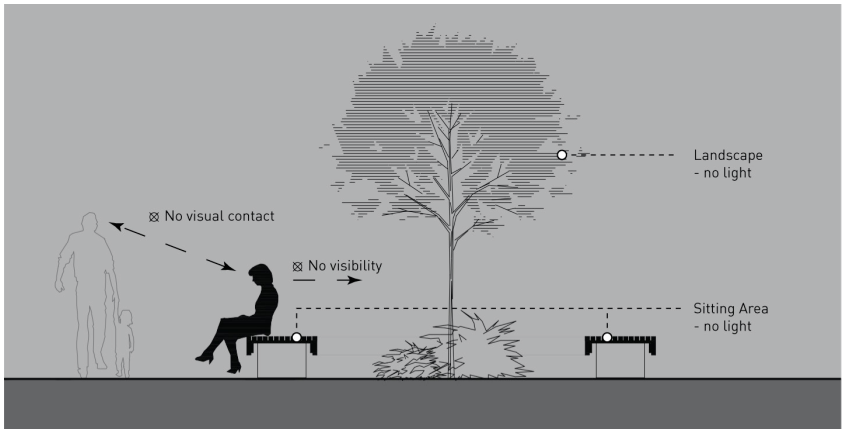


Fig. 72: No Lighting

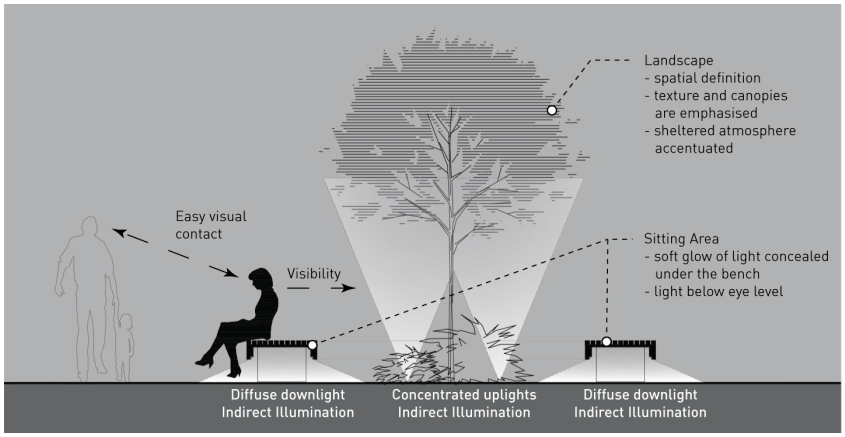


Fig. 73: Lighting Proposal with indirect light.

Fig. 74: No light.
At Israel Plads, Copenhagen.

Fig. 75: Indirect illumination underneath benches and on trees
At Northeastern University International Village, Boston

In the urban scenario (Fig.74), the lighting is dispersed throughout generating a lot of contrast and dark areas, and does not emphasise any architectural feature of the square. It becomes hard to identify the spatial qualities and the presence of other people in the space. The atmosphere perceived is more dramatic and eerie, pushing people away. In the communal area (Fig.75), the resting spot is emphasised through placing the light underneath and the sheltered atmosphere is enhanced by the lighting accentuating the presence of the trees. Together with the neutral CCT of the light, the feeling of being welcomed is perceived, and also social engagement is encouraged.

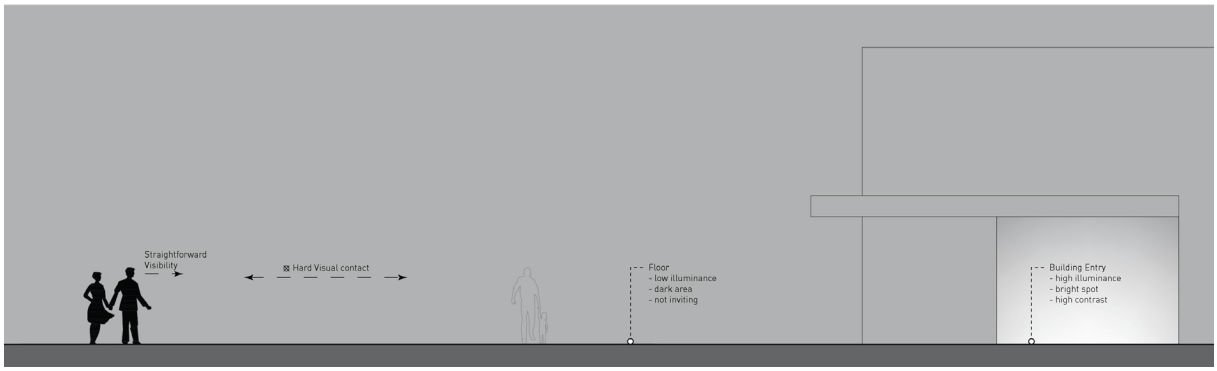


Fig. 76: Lighting on spaces with non clear functionality

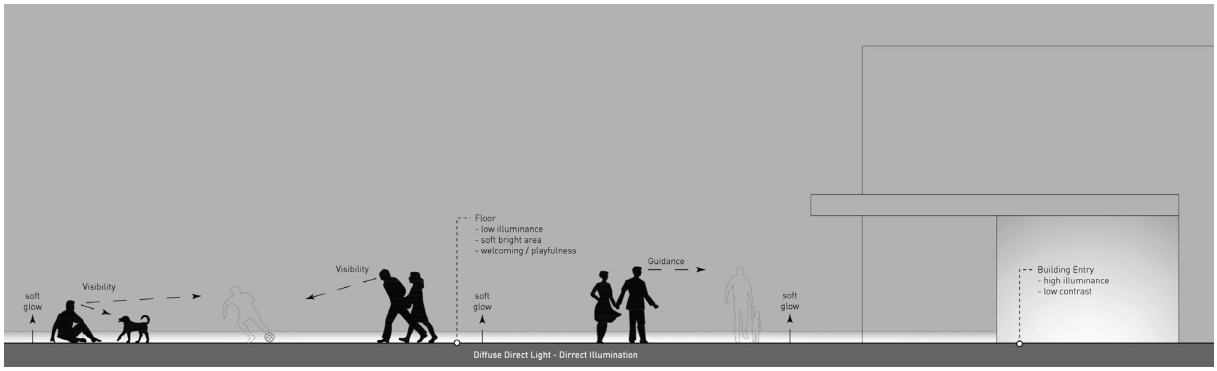


Fig. 77: Lighting Proposal for integrated lighting to enliven spaces.

Fig. 78: Diffuse and uniform light with no clear intention.
At Dona Lindu Park, Recife.

Fig. 79: Light entertaining pedestrians.
At Civic Plaza Bridgelife Neighborhood Park, Shangai.

Some public spaces encompass areas with no urban elements installed along its extension, as it has been seen in the urban park (Fig. 78), thus the light implemented is disconnected from the architectural design and provides only general lighting with poor visibility, just for a matter of orientation. In those cases, the space becomes empty because people do not feel welcomed to engage in any activity. If the light can be integrated into the architectural context, to induce people to use the space at their convenience whilst indicating direction, as seen in the civic center (Fig.79), then it could bring identity to the space and make it look more inviting and playful.

Design Concept Visuals for Israel Plads

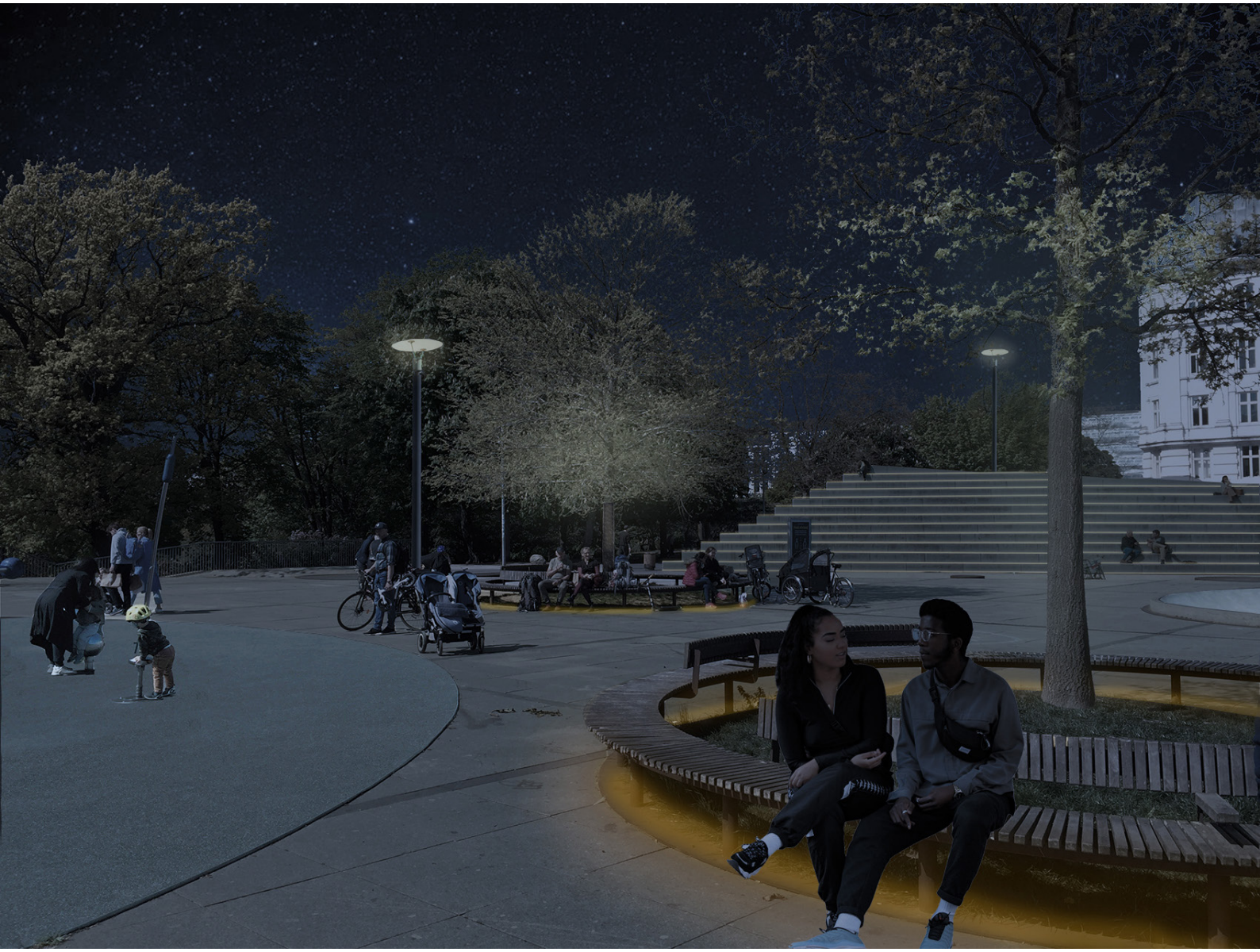


Fig. 80: Overall Ambience Illustration for Israel Plads.

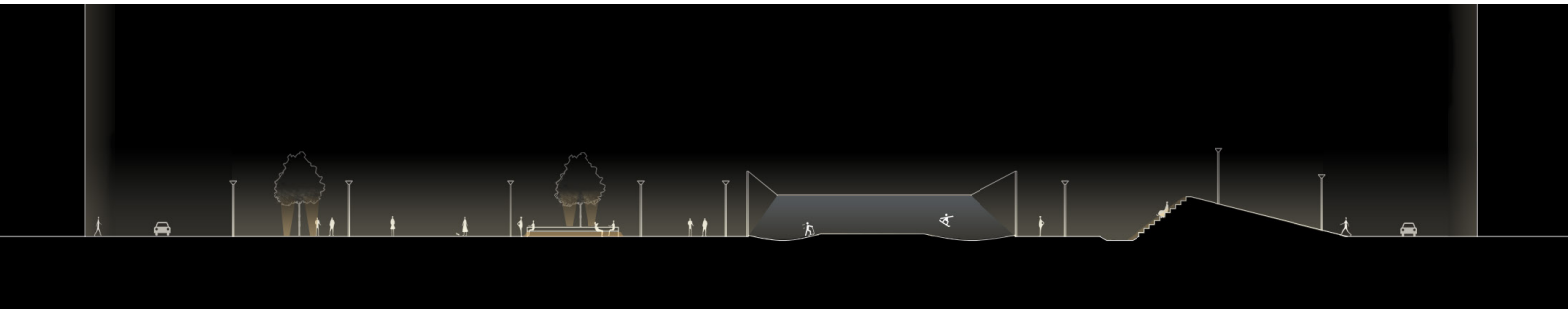


Fig. 81: Longitudinal section of Israel Plads Proposal.

Design Concept Visuals for Dona Lindu Park

Fig. 82: Overall Ambience Illustration for Dona Lindu Park.

Fig. 83: Longitudinal section of Dona Lindu Park..

10 DISCUSSION

The purpose of this chapter is to interpret and describe the significance of the findings explained in the previous chapter and to discuss any new understanding that emerged as a result of the problem framework summarised in the research question: How could the use of direct light together with indirect light generate a liveable atmosphere in urban spaces at nighttime to ensure that the feelings of protection, comfort and delight are satisfied among pedestrians? It has been found that the employment of indirect light together with direct light is essential to satisfy the feelings of protection, comfort and delight of pedestrians. Those lighting effects can contribute to support the diverse activities occurring in specific areas within the space, and can change the overall appearance to restore the spatial qualities and boost habitability. Nowadays, most implemented lighting schemes do not step beyond the aim of providing a light level to assist visibility for wayfinding and security reasons, and a distribution of the light to focus in the creation of a pleasant and inviting atmosphere. That is resulting in empty spaces in the city, which could be changed with appropriate lighting conditions. However, on-site experiments should be carried out in order to evaluate whether the design proposal is achieving the design criteria or not. Thus, people should be expected to answer if the space is fulfilling their basic needs via direct and indirect lighting. Hence, the employment of both lighting effects have the power to enable different lighting layers to be materialised and promote diverse visual effects which are responsible for determining the quality of the atmosphere perceived in the space. Despite that, they are not capable of supporting the design criteria alone because other lighting attributes should be considered for the creation of atmosphere. Therefore, as lighting designers, we are responsible for reevaluating the conventional ways of lighting up urban spaces, to encourage social engagement within the urban scene. Also, this phase has to be managed in close collaboration with diverse professionals working in relevant fields to understand the human needs better, and consequently to provide the most accurate lighting design scheme for urban spaces.

11 CONCLUSION

This master's thesis project sought to investigate more effective ways of implementing lighting with the aim of rejuvenating urban spaces at night hours through satisfying the feelings of protection, comfort and delight among pedestrians.

This investigation started with analysing the lighting implemented in public urban spaces of two different cities in order to evaluate the impacts of the lighting conditions on the built environment and consequently, on the behaviour of people within different cultural backgrounds. From that analysis, it was concluded that both sites were using the same lighting effect of direct light, but they differed in the lighting distribution, where one was diffused providing uniform light throughout and the other one was concentrated generating islands of light throughout. Both lighting outcomes were inefficient and far from fulfilling the requirements of protection, comfort and delight that are expected for those environments to make people confident to inhabit them. As well as it resulted in more people attending one space than the other, although that could not be fully comprehended because of the COVID-19 pandemic which affected the use of these spaces during the time this thesis work was being written. Despite that, it became clear that the use of direct light alone was unable to support the requirements and to help urban spaces to perform their functions effectively during night hours.

Before any deliberations are taken, this project strongly recommends that for any lighting project to be successful, urban spaces need to be recognised for their importance to the city life and residents, and for their power to affect social life. Yet, their physical structure can assist the lifestyle and needs of society living in agglomerated urban environments as people expect those spaces to provide opportunities for performing leisure activities. Additionally, humans' connection with the built environment needs to be clarified because cultural background, individual experiences and other aspects inherited by human nature can affect that relationship. Finally, it is essential to comprehend how lighting is perceived by the human eye and how light is affecting the built environment as it has the power to change the spatial appearance and consequently, the perception of the space among users.

Most important of all is to acknowledge that people seek for protection, comfort and delight when inhabiting an urban space as it has been stated by Jan Gehl in his book *Cities for People*, which should be the goal when lighting up urban spaces. Lighting is then responsible for transforming positively or negatively the experience of people in urban spaces at night through creating atmosphere. Then, working with two lighting effects, direct and indirect light, would change the outcome of the implementation of conventional lighting that is being done in similar contexts. Direct light would support activity needs as it enables visual acuity. Indirect light would support biological information needs as it enables peripheral vision to be active constantly. Their combination would touch emotional senses as their coexistence animates the scene. Those effects should then be manipulated through

multiple layers, defined as Ambient, Focus and Accent Layers, which can be conceived by adjusting lighting attributes to shape an overall atmosphere enabling diverse activities to take place, whilst supporting human needs.

In conclusion, this thesis work was an attempt to raise awareness of the need to rethink the lighting design approach in urban environments and to set effective parameters of design, using direct and indirect light. That would provide different visual effects resulting in the creation of qualitative experiences for pedestrians, whilst ensuring that feelings of protection, comfort and delight are satisfied. In the same way, lighting would enhance the identity of the urban space to resignify its role within the city context, improving city life and boosting the wellbeing of residents. Consequently, creating a link between light and architecture would help to rejuvenate urban spaces and restore their liveability.

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