A PROPOSAL TO IMPROVE THE THERMAL COMFORT IN TIRANAS' URBAN SPACES: SKANDERBEG SQUARE

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Approval sheet of the Thesis

This is to certify that we have read this thesis entitled **"A proposal to improve the thermal comfort in Tiranas' urban spaces: Skanderbeg Square"** and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science.

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ABSTRACT

A PROPOSAL TO IMPROVE THE THERMAL COMFORT IN TIRANAS' URBAN SPACES: SKANDERBEG SQUARE

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Due to the rapid and ever-growing urbanization of the city of Tirana, the Urban Heat Island effect, that is the city's unavoidable curse, has been affecting the inhabitants lives by preventing them to frequent outdoor activities due to the unbearable temperatures and discomfort. To address this issue many cities have already put in place implementations that have helped mitigate the issue even if by just a little bit. After analysing and studying various case studies and related literature from different countries around the world, we can see that every country cools down their public spaces by different methods and designs according to its respective climate and culture. After having studied some good practices, this research aims to select an effective combination of materials, shapes and cooling methods, in order to design an urban installation to be potentially implemented in the central square of Tirana, the Skanderbeg Square. After a deep analysis of the outcomes of case studies, the factors contributing to their success were identified and similarly, the eventual limitations in performing at their best. This thesis acknowledges the current discomfort that pedestrians experience while walking through Skanderbeg Square or even while doing each activity during the summer season and aims to lower the Urban Heat Island effect to make it more comfortable for the users.

Keywords: *urban heat island, excess in lighting, comfortable urban living, outdoor cooling methods, outdoor shading methods,*

ABSTRAKT

NJË PROPOZIM PËR TË PËRMIRËSUAR KOMFORTIN TERMIK NË ZONAT URBANE TE TIRANËS: SHESHI SKËNDERBEJ

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Për shkak të urbanizimit të shpejtë dhe gjithnjë në rritje të qytetit të Tiranës, efekti i Ishullit të nxehtësisë Urbane, që është mallkimi i pashmangshëm i qytetit, ka ndikuar në jetën e banorëve duke i penguar ata të frekuentojnë aktivitetet e tyre për shkak të temperaturave të padurueshme. Për të adresuar këtë çështje, shumë qytete kanë vënë në zbatim implementime që kanë ndihmuar në zbutjen e problemit, sado pak qoftë ajo. Pas analizimit dhe studimit të rasteve të ndryshme dhe literaturës përkatëse nga vende të ndryshme të botës, mund të shohim se çdo vend ftoh hapësirat e tij publike me metoda dhe dizajne të ndryshme sipas klimës përkatëse. Pas studimit të disa praktikave, ky kërkim synon të zgjedhë një kombinim efektiv të materialeve, formave dhe metodave të ftohjes, për të projektuar një instalim urban që do të zbatohet potencialisht në sheshin qendror të Tiranës, sheshin Skënderbej. Pas një analize të thellë të rezultateve të rasteve studimore, u identifikuan faktorët që kontribuan në suksesin e tyre dhe në mënyrë të ngjashme, kufizimet e tyre. Kjo tezë pranon shqetësimin aktual që përjetojnë këmbësorët gjatë ecjes nëpër sheshin Skënderbej apo edhe gjatë kryerjes së çdo aktiviteti gjatë stinës së verës dhe synon të ulë efektin e ishullit të nxehtësisë urbane për ta bërë atë më të rehatshëm për përdoruesit.

Fjalë kyçe: *Ishulli I Nxehtësisë Urbane, tepricë në ndriçim, jetesë e rehatshme urbane, metoda të ftohjes, metoda të hijezimit,*

Dedicating this thesis to my family.

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INTRODUCTION

1.1 Current situation in Skanderbeg Square

The memory of Tirana's Skanderbeg Square particularly in the summer months is etched in the minds of both locals and tourists. The intense heat and sunlight that always accompany the square in the summer not only feels hot but often becomes unbearable. As people walk through the lively heart of the city, the high temperatures intensify the thermal discomfort making each step a struggle. Instead of being a vibrant and welcoming public space, the Skanderbeg Square can be overwhelming during the summer discouraging outdoor activities and reducing the overall satisfaction this urban space can give to its users. The extreme heat experienced in Skanderbeg Square calls for immediate attention to addressing the urban heat island effect and giving a solution to it. This thesis focuses precisely in analysing the severity of the UHI (urban heat island) effect of the Skanderbeg Square and suggesting some hypothetical scenarios on how to make the Square more thermally comfortable and pleasant to use during the summer. I am motivated to give a solution to this phenomenon by proposing an installation for the Skanderbeg Square that combines different cooling methods and materials in order to provide an effective solution in mitigating the urban heat island effect.

One way to fight the extreme heat in Skanderbeg Square, is shading. Sunlight is an unavoidable daily factor, and while we have learned to use it efficiently when scarce, this thesis focuses on mitigating its negative impact when excessive. Shading, both artificial and natural, is a key solution to urban heat islands and heat-related health risks. (Lin, 2010) highlights the crucial role of shading, measured by Sky View Factor (SVF), in determining thermal comfort, finding that urban areas with minimal shading are uncomfortable in summer. (Heckel, 2023) supports this, noting that street trees not only provide cooling shade but also enhance liveability and attractiveness.

Alongside shading, water features are another highly effective cooling method in urban environments. (Brown, 1995) emphasizes the importance of creating thermally comfortable and energy-efficient environments through green and blue features, focusing on the latter. Case studies demonstrate that ponds, fountains, and water streaks cool the environment through evaporative cooling, enhancing aesthetics and recreational value. (Hathway, 2012) found that rivers and water bodies effectively create cooler microclimates, reducing air temperatures by several degrees Celsius. (Zhang, 2019) showed that water features in urban parks in a subtropical megacity in China reduce temperatures by up to 3-4°C, significantly improving thermal comfort. (Völker, 2011)highlighted the health benefits of blue spaces, including stress reduction, enhanced mental health, and improved thermal comfort. All these studies advocate for incorporating blue spaces in urban planning to mitigate the Urban Heat Island effect, improve thermal comfort, and promote public mental health and well-being.

The materials used in urban environments significantly impact their microclimate. (Akbari, 2001) found that natural soil and green spaces dramatically lower air and surface temperatures, improving air quality and reducing energy use. Cool surfaces and shade trees further aid cooling by reflecting sunlight. (Fahmy, 2009) demonstrated that natural materials, through evapotranspiration and shading, result in significantly cooler temperatures compared to artificial materials like asphalt and concrete. (Jim, 1998) confirmed that natural soil paired with appropriate vegetation can reduce urban temperatures, though soil compactness and contamination can limit effectiveness. These researchers advocate for the improved use of urban soils and vegetation in city planning to enhance microclimates, thermal comfort, and mitigate the urban heat island effect.

1.1.1 Microclimate, comfort and discomfort

As described by Gash (Gash), microclimate is the climate near the ground influenced by the immediate surroundings such as vegetation, built structures, materials and climacteric factors. Gash's book also focuses on the atmospheric boundary layer, which is crucial for understanding microclimates. While climate is generalized over a wider and larger area, microclimate is focused on smaller areas such as neighbourhoods. Similarly, in his book Geiger (2003) defines microclimate as a phenomenon that is influenced by factors such as solar radiation, ar temperature, humidity, wind patterns and precipitation at a local scale.

Although studies have shown that most people frequent outdoor activities in urban spaces when the thermal index is high in both winter and summer (Lin, 2010), Nikolopoulou & Steemers (2003) explore the connection between thermal comfort and the psychological adaptation of humans in urban spaces. They emphasize the need and importance of designing urban environments that promote thermal comfort through building design and green spaces while taking into consideration people's psychological responses to different thermal situations in different urban environments.

Nikolopoulou and Steemers (2003) explored the relationship between microclimatic conditions and how they affect comfort levels in humans. The researchers acknowledged that thermal comfort isn't only based on physical comfort but also closely tied to the psychological state of the users. The researchers acknowledged that thermal comfort isn't only based on physical comfort but also closely tied to the psychological state of the users. After conducting many surveys and researches they reached the same conclusion as many researchers before them, shading and vegetation are the best solutions to unbearably hot temperatures. The researchers also encourage urban planners to prioritise designing and creating different areas where comfort microclimates are offered, thus enabling people to enjoy and spend more time in outdoor activities. are the best solutions to unbearably hot temperatures. The researchers also encourage urban planners to prioritise designing and creating different areas where comfort microclimates are offered, thus enabling people to enjoy and spend more time in outdoor activities.

1.1.2 Urban Heat Island

One of the most ground-breaking studies relating to the urban heat island effect (UHI) is that of Oke's. T. R. In his seminal paper, Oke (1982) defines the UHI effect as the difference between the temperatures of urban areas and their rural surroundings. Typically, urban areas are characterized by a hotter temperature due to cities being bombarded with dense infrastructure and minimal vegetation. Oke also states that this phenomenon is influenced by factors such as reduced vegetation, increased impervious surfaces with materials such as asphalt and concrete, anthropogenic heat due to human activities such as transportation and industrial processes, and reduced SVF and air pollution. These factors are bound to worsen the temperatures to a point where human thermal comfort levels are so low, that users refrain from frequenting outdoor activities.

The city of Tirana is a perfect example to showcase the UHI effect given that its centre is heavily bombarded with infrastructures and buildings using impermeable materials, while the suburbs are characterized by greater surfaces of vegetation. Picari & Dervishi (2019) did extensive research on the UHI effect in the city of Tirana and they reached the conclusion that Tirana is a rapidly growing city and as such it is characterised by a drastic increase of temperature compared to other cities, thermal discomfort and high energy consumption. The researchers discovered that the air temperature reached its lowest values in the shaded areas with natural soil, while the opposite, highest values can be observed in the city centre where we find an immense use of infrastructure and impermeable materials while also being fully exposed to the direct sunrays.

The results of Picari’s and Dervishi’s research show that an unaltered airflow and a high density of vegetation can significantly and effectively improve the hot summer temperatures in order to reach human thermal comfort.

1.1.3 Thesis objective and aims

The first main objective of this thesis is to conduct research and propose a solution to an issue that is very common among humans who wander through Skanderbeg Square in Tirana during the hot summer months. The oppressive heat of the day makes the site ever so uncomfortable and impractical, causing noticeable distress on the people who choose to use the Skanderbeg Square to tend to their daily activities.

Given that I myself frequently visit Skanderbeg Square, I have noticed that the usability of the square significantly drops during the summer. If you pay enough attention, you can even notice that people choose longer routes and detours to get to the other side of Skanderbeg Square just so that they don’t have to walk through it. This avoidance and “forced” detour around the square inflict increased travelling time, effort and general fatigue to the pedestrians, which driven by these factors, start to have negative opinions both on the Skanderbeg Square and on the city of Tirana. However, both Skanderbeg Square as the centre of Tirana and Tirana itself as the capital of Albania should be portrayed as lively, appealing, comfortable and accessible as possible.

Keeping this in mind, this thesis will be focusing in analysing the situation and proposing solutions which help minimize the negative effect of high temperatures. The end result will be a proposal which is to be theoretically implemented into the Skanderbeg Square. This implementation is to be strategically placed and planned in Skanderbeg Square in order to meet the needs of its users.

In order to come up with the best solution, this thesis is going to make use of various relevant case studies and literature. These studies are going to take place in various geographical settings and climates, thus offering us insight into how the same cooling method can work on different scenarios further reinforcing the final decision on which cooling method works best for our case.

The final proposal of this thesis will not only help make the square more attractive to the human eye but also, most importantly, it will help in making the square more sustainable, comfortable and cooler for visitors.

In so doing, the objectives of this study are to provide insights on how the general vibrancy of Skanderbeg Square can be improved and enhanced as a pedestrian environment. More specifically, by creating a more conducive atmosphere and making the space more usable, the project aims to assist in turning the square into a place of active and vibrant activity even during the summer months. It shall not only help foster an immediate shade from the scorching sun, but also become a constant representation of integrated modern architectural concept and innovation, overruling the scarcity of green land.

1.1.4 Scope of works

Skanderbeg Square is one of the most important reference points and tourist attractions in the whole of Tirana, meaning that special attention should be given to it and its inhabitants. The goals of this study consist of finding out just how severe the problem or thermal discomfort is in the Skanderbeg Square of Tirana and suggesting a way to lessen it. This thesis takes place in the central square of the capital of Albania, Tirana. The research zone won't only be limited to Skanderbeg Square but to what the locals call the "small ring of Tirana" which is essentially the vehicle road boundaries around the square. The methodology of this thesis consists of a survey, vast personal research, and a computer-aided analysis. The accurate modelling of the site and simulation of the UHI effect is dependent on the availability and precision of the input data. Nonetheless, I expect that the analyses show that Tirana and its Skanderbeg Square are facing unbearable temperatures due to the UHI effect, and I plan to come up with a proposal that helps make the square more comfortable.

1.1.5 Organization of the Thesis

This thesis is divided into 5 chapters. The organization is done as follows:

In Chapter 1, the introduction, current situation in Skanderbeg Square, Thesis objective and aims, scope of works, and organization of the thesis. Chapter 2, includes the literature review which is divided into cooling by shading, cooling by water, the comparison of different cooling methods, site analysis, and the Square's history. Chapter 3, consists of the methodology. In Chapter 4 you can find the survey results, weather data analysis, and 3d model Stimulation results. In Chapter 5 the proposal, conclusions, and recommendations for further research are stated.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

We now know the common cooling methods that can be applied to urban areas and compelled by this knowledge I am to introduce various case studies which will each introduce us to an urban installation which employs one or more of these cooling methods. These case studies will illustrate examples of using methods like green roofs, shading, water features, reflective materials, and incorporating architecture and designs into cities.

Every case is devoted to a particular city or region, wherein some modern methods and technologies for the regulation of temperatures are discussed and compared. The case studies discussed in this paper are located in different geographic zones, and climate – all of which makes the picture of possible local variations of cooling techniques in urban environments detailed and quite informative. Notably, all of these installations had great impacts in minimizing the UHI effect while also improving thermal comfort within their countries.

From these successful cases, I intend to deduce the best cooling techniques as well as find out the circumstances under which those techniques create the best results. Altogether, the results of this analysis will help to shape the proposal for Skanderbeg Square, thus making sure that all the strategies applied to the design of the square must be the most efficient in terms of creating a more comfortable temperature of the public space in the context of the already worsened climate situation. Based on such case studies, it will be possible to outline some strategic interventions aimed at reducing the UHI effect in Tirana and transforming Skanderbeg Square into an ideal example of an urban area free from excessive heat.

2.2 Cooling by shading

Given that sunlight is an unavoidable factor in our daily life, we have learned on how to use it efficiently when its scarce and how to avoid and deal with it when it is excessive. This thesis focuses on the excessive occasions of sunlight and the way it can negatively impact our daily activities.

One way to avoid the extreme heat and take shelter from the direct sun rays is through shading. Shading is a very effective solution that helps mitigate urban heat islands and reduce heat-related health risks (Santamouris M. , 2014). A study conducted by Lin (Lin, 2010) analyses the relationship between levels of shading and thermal comfort in outdoor urban areas. Their study revealed that the amount of shading as measured by the Sky View Factor (SVF) plays a very crucial role in determining thermal comfort levels throughout the whole year. Lin (Lin, 2010) concluded that urban spaces with minimal shading, and therefore high SVF, were categorized as uncomfortable during summer months, thus emphasizing and pointing a finger at the importance of shading in outdoor environments.

Together with artificial shading, natural shading provided by street trees in green urban spaces is also proven to be very effective against hot temperatures and low thermal comfort (Heckel, 2023). These natural shading elements not only provide shaded areas and reduce the surrounding temperatures thus providing thermal comfort in the hot summer months, but they also enhance the liveability of the environment by beautifying the area and introducing the factor of attraction and allure, thus making an environment more frequented.

In a similar study, Klemm and his colleagues (Klemm, 2015) explore the impact of street greenery and the outdoor thermal comfort it provides in the Netherlands. The findings of his comprehensive research, he also reached the conclusion that street greenery not only improves human thermal comfort levels by providing shade but they also enhance the charm and allure effects of the environment. Klemm’s study further proves and accentuates the fact that green infrastructure such as trees, green areas and green walls, can significantly help in mitigating the urban heat and thus improving the overall well-being of the inhabitants.

2.2.1. Semiramis

The Tech Cluster Zug in Switzerland has a striking vertical garden called the Semiramis installation which was created using robots and artificial intelligence (Parametric Architecture, 2023). This installation has achieved to combine nature and technology showcasing the collaboration of computational design machine learning and digital fabrication. It consists of five wooden pods suspended by steel pillars reaching an impressive height of 22.5 meters.

The unique design of Semiramis was achieved through a machine learning design method developed by ETH Zurich. This method allowed for the creation of efficient design variations taking into account factors such as sunshade rain protection and plant-able surfaces. Müller Illien Landscape Architects Gmbh collaborated on the vertical landscaping concept providing a sanctuary for nature to thrive (Parametric Architecture, 2023).

The pods are off-limits to humans serving as a retreat and communal space for the workers and residents of Tech Cluster Zug. A centralized irrigation system ensures green densification and creates a comfortable microclimate in the summer.

When observing the Semiramis Installation I noticed some elements that I could incorporate into my own installation. Firstly, the materials used are easily accessible and affordable making mass production more manageable. Secondly, they incorporated lots that provide both cooling and aesthetic value. Lastly the vertical design of Semiramis would complement my own site.

Figure 1. *Semiramis installation* ***(Pintos, 2023)***

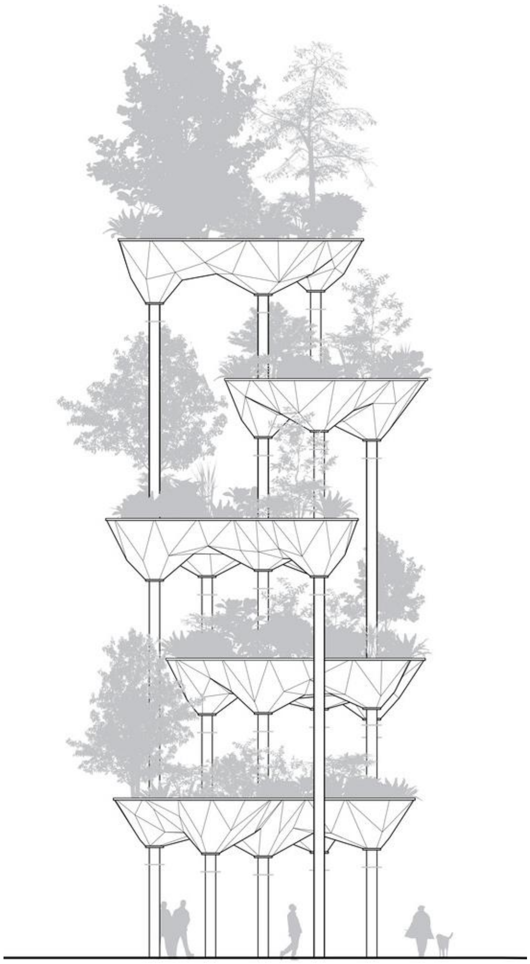


Figure 2. *Semiramis installation (elevation view)* (Pintos, 2023)

2.2.2 Metropol Parasol

The Metropol Parasol an impressive wooden structure located in Seville is both a prominent landmark and an impressive engineering feat. Designed by architect Jürgen Mayer H it features six mushroom-shaped timber parasols that offer shade to the Plaza de la Encarnación and safeguard an archaeological site (One of the Largest Timber Structures Ever Built, n.d.).

The structure comprises of four levels including a platform for archaeological viewing a marketplace a restaurant and a public balcony that provides stunning views of Seville's historic quarter. To construct this one-of-a-kind structure a special type of wood called Kerto which consists of thin veneers bonded together was utilized. This type of wood not only provides greater strength than solid wood but is also protected with a waterproof coating.

The structure heavily relies on 3000 connection nodes at the intersections of the timber elements. Engineers from Arup and FFM developed a connection detail using steel bars that were glued in place allowing for swift assembly on-site (One of the Largest Timber Structures Ever Built, n.d.). Additionally, a new bonding process had to be developed to withstand the harsh conditions of the hot southern Spanish climate. The connection elements were pre-assembled and adjusted in Germany before being transported to Spain.

What captures my interest in this particular case study is the distinctive design that offers a canopy and the deliberate selection of materials.

Figure 3. *Metropol parasol* ***(Moore, 2011)***

2.2.3 Shadow Play

The structure known as Shadow Play is composed of thin yet sturdy geometric modules created from powder-coated steel (McKnight & McKnight, 2022). These clusters are supported by vertical pillars and serve to block the intense sunlight during the daytime casting ever-changing shadows on the concrete pavers below. The initial studies conducted by the company involved using folded origami paper followed by optimization studies to find a cost-effective method of spanning between supports and creating the desired porous canopy.

Additionally, according to McKnight & McKnight (2022), the canopy is equipped with photovoltaic panels that capture sunlight storing the generated power in batteries to illuminate the structure at night. Furthermore, the firm has also designed metal benches with the same geometric pattern as the parasols. The park which was publicly funded and opened in July also boasts trees and landscaping.

Figure 4. *Shadow play* ***(Castro, n.d.)***

2.2.4 System+Oasys

The 'Oasys' is a space that looks like an oasis with palm tree-like modules as its main feature. It serves multiple purposes such as spraying mist collecting solar energy and acting as a barrier against regional and environmental issues (Oasys + System by Mask Architects, n.d.). These functions aim to create a comfortable and relaxing atmosphere. Surrounding the palm structures are planted trees that reduce sound pollution wind and add to the eco-friendly ambiance of a green oasis in the city.

The future plan for 'The Oasys' is to establish interconnected rest areas throughout cities rather than just one. The modular system allows for different scales and adjustability making it easily replicable in various spaces. The structure's foundations are already in place in designated plots of land serving as a cooling and social space with water storage and essential equipment. The cooling system can be temporary or permanent depending on the space's purpose and government approval 9989

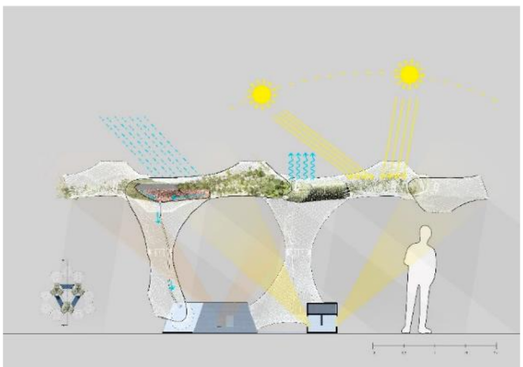
Figure 5. *System+Oasys* ***(Architects, n.d.)***

2.2.5 Urban Microclimate Canopy: Design, Manufacture, Installation, and Growth Simulation of a Living Architecture Prototype

Urban Microclimate Canopy is a digitally fabricated fiberglass structure supporting climbing plants in order to explore new ways of integrating vegetation in densely built urban environments (Shu et al., 2020b). The research describes the process of fabricating it both digitally and physically and its temporary installation in Frankfurt, Germany (Shu et al., 2020). Its microclimatic results weren't really meaningful due to the location's climate.

The integrated design approach developed for this project required the creation of a new simulation framework for the growth of climbing plants. The chosen plant was a Hardy Kiwi but unfortunately the plant failed to grow as expected (Shu et al., 2020b). There are several reasons why the Hardy Kiwi struggled to establish itself in the structure in the first year. Firstly, it is likely that the plants needed time to acclimate to the new location after being transplanted. The simulation allows for the influence of environmental stimuli on the growth behaviour of twining plants. The long-term setup was installed in a green open area where the plant could be planted in the ground (Shu et al., 2020).

This location was chosen to allow for uninterrupted development and continuous observation to gather further knowledge. To measure the microclimatic impact of such a structure a second prototype needs to be installed in an urban heat island.



(a) (b)

Figure 6. *Urban Microclimate Canopy* ***(Irwin, 2022)***

2.2.6 Parametric Design and Comfort Optimization of Dynamic Shading Structures

In this study a workflow is proposed that combines parametric 3D modelling evolutionary algorithms and environmental tools to design dynamic shadings in open urban spaces (Doris et al., 2021).

The researches aim was to find optimal shading positions that enhance outdoor thermal comfort based on specific environmental factors. The multi-objective optimization algorithm Wallacei X enables the selection of optimal solutions. The research integrates many environmental calculations and specific indexes such as the UTCI and shaded areas which aid in achieving a result as optimal as possible for the selected location (Doris et al., 2021).

The results show that the optimal phenotypes reduce thermal stress by generating shaded areas that respond to sun trajectories. Acceptable temperatures are achieved for most of the year with slightly hotter conditions during the summer. The proposed workflow can be proposed for various different locations as it is a very flexible installation, according to each locations need, sun path and user interaction. The dynamic structures will be prototyped and transferred to different areas for simulations and optimizations.

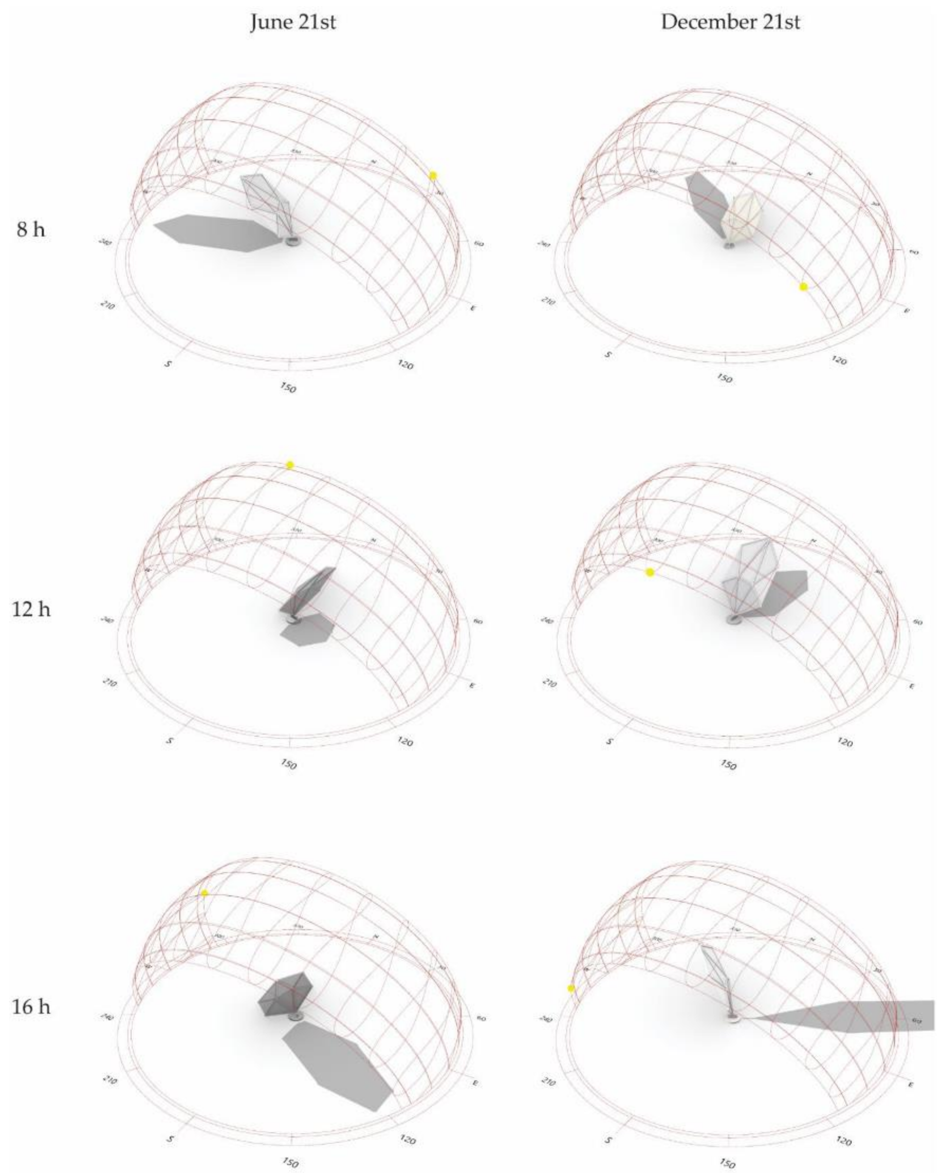


Figure 7. *Dynamic shading structure* ***(Loonen, 2013)***

2.3 Cooling by water

Alongside shading, another extremely effective cooling method are water features. In the book *Microclimatic landscape design: Creating thermal comfort and energy efficiency* (Brown, 1995) stresses on the need to create thermally comfortable and energy-efficient environments. While they explore both green and blue features, I want to focus on the latter. The authors have provided various case studies and detailed analyses of them which prove just how effective water features such as ponds, fountains and water streaks can be in cooling the environment through evaporative cooling. Similar to green features, water bodies and/or features not only help mitigate the urban heat effect but they also enhance the aesthetics and recreational values of urban spaces, thus making them visually appealing and thermally comfortable for visitors (Brown, 1995).

On another study Hathway, E. A., & Sharples, S. (2012) examine the role of rivers and various other water bodies in urban environments. In order to assess the cooling impact of water features, the authors used a combination of both computer aided simulation models and field measurements. Their findings concluded with the fact that water bodies can very effectively create cooler microclimates and thus also reducing surrounding air temperatures by several degrees Celsius.

An empirical study done by Zhang, H., He, J., & Yan, Y. (2019) assesses the cooling effects that water landscapes have in urban parks of a subtropical megacity in China. Although the megacity is never specified by the researchers, it is specified that their field measurements helped determine that water features such as ponds and streams have helped reduce the temperatures by up to 3-4°C thus significantly improving thermal comfort for visitors.

Differently from the previous studies, the researchers Völker, S., & Kistemann, T. (2011) focused in analysing the health and well-being benefits in being surrounded by blue spaces such as lakes, rivers and urban water features. The authors examine the alutogenic effect of blue spaces and emphasizing their role in reducing stress, enhancing mental health and of course improving thermal comfort.

All of the above-mentioned authors have advocated for the incorporation of blue spaces in urban planning in order to not only help mitigating the Urban Heat Island effect and improve thermal comfort, but also promote public mental health and well-being.

2.3.1. Adiabatic Urban Cooling

The winner of the SBAU2021 the adiabatic urban cooling prototype can be likened to a body of water in a park during the summer providing a refreshing sensation when approached (O.D., 2021). AREP's team achieved this by incorporating traditional Vietnamese craftsmanship which is still prevalent in rural areas where each village specializes in a particular trade such as bamboo silk and pottery. This allowed them to create a low-tech cooling device that combines the adiabatic principle with the expertise of a local craftsman.

The cooling tower designed in the shape of a hyperboloid for structural stability features a natural flow of water between the main poles due to gravity. At the center a blower captures hot air from above and directs it downwards. As the air passes over the water twice it undergoes natural cooling through the adiabatic principle. To demonstrate the effectiveness of their design AREP decided to test and build a prototype in Hanoi. Utilizing their own BIM parametric digital model, they studied various shapes and cooling effects.

With the help of a local bamboo craftsman, they successfully constructed a fully operational prototype. The test showed a temperature decrease of 6°C (from 30°C to 24°C) proving the feasibility of the design and significantly enhancing outdoor comfort (O.D., 2021). AREP's objective now is to implement this sustainable low-tech and cost-effective solution in arid climates like the Mediterranean basin or the Gulf where adiabatic cooling could be even more efficient.

This concept could be particularly suitable for cooling outdoor spaces such as public squares sunny pedestrian streets and large structures like train stations during dry and hot summers.

Figure 8. *Adiabatic cooling* ***(AREP, 2021)***

2.3.2. Monish Siripurapu’s cooling system

Siripurapu conducted an experiment using materials found on Earth and the natural process of evaporative cooling. As a result, he successfully built a cooler for the DEKI Electronics factory in NOIDA inspired by terracotta beehives (Sharma, 2019). This low-tech and energy-efficient solution harnesses the power of evaporative cooling. The beehive-shaped pots which can be utilized on both sides and have spaces in between facilitate the cooling process.

Terracotta pots are durable porous and easy to maintain (Monish Siripurapu, n.d.). The cooler's design combines art nature and technology incorporating Computational fluid dynamics analysis for aerodynamics. It operates with minimal electricity and water as the water is recirculated from a collection tank. By using locally sourced eco-friendly materials recycled water and reusable steel it becomes cost-efficient and reduces the carbon footprint. In contrast a typical air conditioner consumes 2-3 units per hour whereas the beehive installation with a cooling radius of 15 feet only uses 0.63 units per hour (Monish Siripurapu, n.d.). Under Siripurapu's leadership Ant Studio draws inspiration from nature for both form development and systems that employ bio mimicry.

The beehive cooling system with its honeycomb-like structure made of conical clay tubes naturally cools the temperature around the building through evaporative cooling. The water that circulates on top of the stacked pots is collected from a tank below.

This concept is derived from the ancient practice of using pots to cool drinking water. However, in this case air is passed through the wet hollow pots resulting in cooler air than the surrounding atmosphere by approximately 10-15 degrees Celsius (Sharma, 2019).

Figure 9. *Monish's cooling system* ***(2019)***

2.3.3. Aqua cooler

The temperature during the summer months has been increasing over the years making it dangerous to be directly exposed to the intense sun. To address this social inequality, it would be beneficial to establish more public cooling areas. Aqua Cooler is an innovative cooling system that utilizes evaporative cooling techniques to lower temperatures (Aqua Cooler, 2019). This passive cooling system consists of two walls, a metal structure and a rain collecting roof. The outer wall provides shade enhancing the effectiveness of evaporative cooling while the inner wall stores water to cool down the temperature. Additionally, the slanted design of the roof helps collect rainwater.

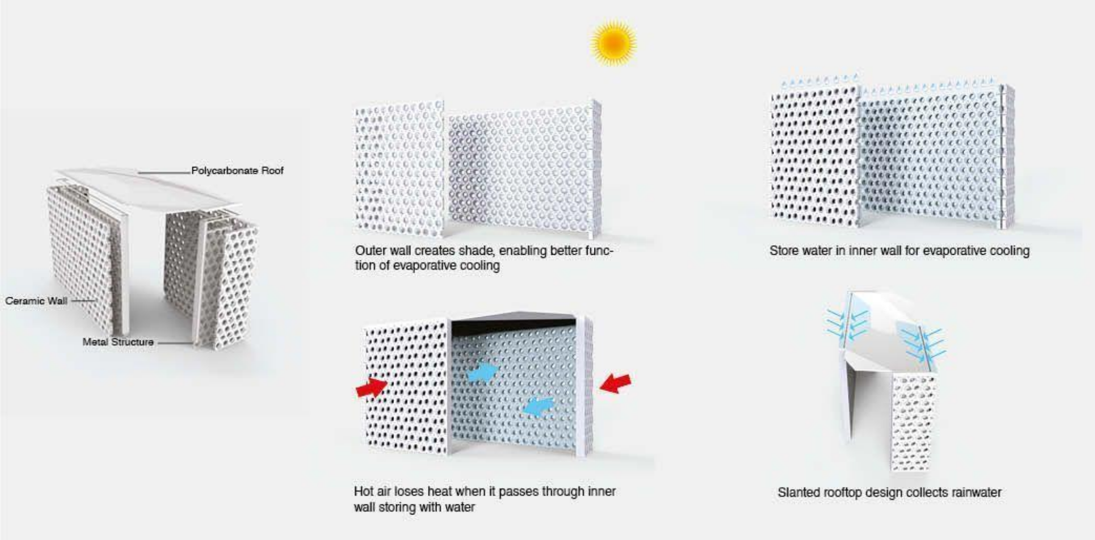


Figure 10. *Aqua cooler* ***(Aqua Cooler, 2019)***

2.4 Cooling by type of used material

Another factor that also has a significant impact on an urban environment's microclimate is the materials used in it. In order to support this claim Akbari, H., Pomerantz, M., & Taha, H. (2001) conducted a study that explored the impact of different surface materials such as natural soil, vegetation, concrete and asphalt on urban temperatures. After conducting their research, the researchers found out that areas with natural soil and green spaces experience a drastic drop in air and surface temperatures thus contributing to a better air quality and to a lower energy use that would otherwise be required to help inhabitants keep cool. Cool surfaces and shade trees provide another cooling effect by the reflectiveness of their materials which helps reflect sunlight and further reducing heat absorption.

Fahmy, M., & Sharples, S. (2009) also contributed in analysing the effect natural materials have compared to artificial ones in regards to them decreasing air quality and increasing thermal discomfort. The researchers found that areas with more natural soil showed significantly cooler temperatures when compared to areas dominates by materials such as asphalt and concrete. The cooling method that natural materials used to reduce heat are evapotranspiration and shading (Fahmy, 2009).

On a similar research Jim, C. Y. (1998) investigates the characteristics of urban soils in Hong Kong and their suitability for urban designing. His study also compares natural materials to man-made ones. Similarly to Fahmy (2009) he also reached the conclusion that when paired with appropriate vegetation, natural soil can significantly reduce urban temperatures through shading and evapotranspiration. Jim also found out the limitations of urban soils while conducting his research and found out that factors such as compactness and contamination may hinder plant growth and thus also reduce their cooling effectiveness. All of the above-mentioned researchers stress over the fact that urban soils should be improved and used in urban projects more often. By addressing the limitations of urban soils and promoting the use of vegetation, cities can improve their microclimates, improve thermal comfort and mitigate the urban heat island effect.

Another factor that contributes to microclimate and is just as important and effective as shading, water and materials, is wind. On his extensive research Oke (1982) highlights how street orientation, width, and the height of surrounding buildings can influence wind patterns and ventilation within urban areas. Oke’s study also points out that well-designed streets can enhance air circulation and thus also helping dispute hear and improving thermal comfort. Following this fact, streets that are specifically aligned with prevailing winds allow for better airflow and thus helping with reducing thermal comfort.

On a similar study, Santamouris and his colleagues (2001) investigated how urban climate, while focusing on wind and air currents, can affect energy consumption in buildings. The researchers conducted both on site measurements and computer aided calculations, and after examining various urban forms and their impact on local wind patterns, they came to the conclusion that areas with enhanced natural ventilation experience reduced energy consumption which would otherwise been used to help against the heat. Conversely, dense urban areas with poor ventilation suffer from higher temperatures and increased energy demands for cooling.

Another study done by Moonen and his colleagues (2012) focuses on wind and air currents and how they impact comfort, health, and energy demand in urban areas. The authors also discuss factors that affect wind and air currents such as wind speed, direction and turbulence, and how these factors interact with urban forms. Moonen and his colleagues, similarly to the predeceasing researchers, reached the conclusion that wind and air currents help improve natural ventilation and reduce the need for mechanical cooling and heating. All of the authors have advocated for better urban planning and designing in order to promote wind currents within the city, so that factors such as thermal comfort are increased and energy consumption are decreased.

2.5 Comparison of different cooling methods

While each literature and case study suggest very effective cooling methods, not all are suitable and/or applicable for my site. Therefore, I will be analysing all above mentioned methods to determine their applicability according to my sites' needs. The Skanderbeg square requires a cooling installation which is easily removable when needed while also being effective. The installation should be easily removable due to the fact that the Municipality of Tirana oftentimes organises different events in the

Skanderbeg Square that require a space as open as possible. The materials used in order to design this installation should also be environmentally friendly. The researcher should also be careful so that the materials and design of the cooling installation don’t damage the actual site and inflict little to preferably no changes onto it.

2.5.1 Shading

Knowing that the square barely provides any shading to its users, except for the shading provided by very few trees, this method of cooling would be easily suitable for my site. The concept of shadings and the spectrum of designs that it can provide, are so versatile, that can easily be adapted to our sites needs. A structure that provides shade can easily be designed so that it is effective, easily removable and self-supporting, thus also not damaging the site itself.

2.5.2 Water mist cooling

While water mists are effective in cooling, this method has already been implemented by the Municipality of Tirana in different areas of it. What I have personally noticed is that people tend to avoid going under the water mist installations due to the fear that not only water is being misted but some other substance as well. So while it is a good cooling method which could be implemented, it isn’t really easily accepted by the people.

2.5.3 Adiabatic cooling

In comparison to the other above-mentioned method, this one could be greatly accepted. This installation uses only a structure made out of either bamboo stems or ceramic units and small amounts of water running through them, which makes it not only easily removable when needed, but also ecologically friendly. The square also already has existing water sources that “spill” water onto it, which can be used in favour of our installation.

2.5.4 Wind cooling

While wind has been proven over and over to be an effective cooling method, unfortunately it cannot be used in our side. As the Skanderbeg Square is very wide and only surrounded by low height buildings, little to no wind currents are created, which makes wind hard to utilise.

2.6 The Square of the City

2.6.1 Short history of the Skanderbeg Square designs

To present Tirana's Skanderbeg Square's history I will be taking reference from Fagu, E., & Qorri, A. (2019) extensive and detailed research regarding this topic. The history of the Skanderbeg Square began way back, during WW1 during the Austrio-Hungarian occupation of Albania, initially as a modest open urban space at the heart of Tirana. Only after Albanians declaration of independence in 1912 did Skanderbeg Square start developing in a central urban space. During this period Tirana had both Ottoman and modern influences as Albania aimed to modernize while also preserving its vast heritage.

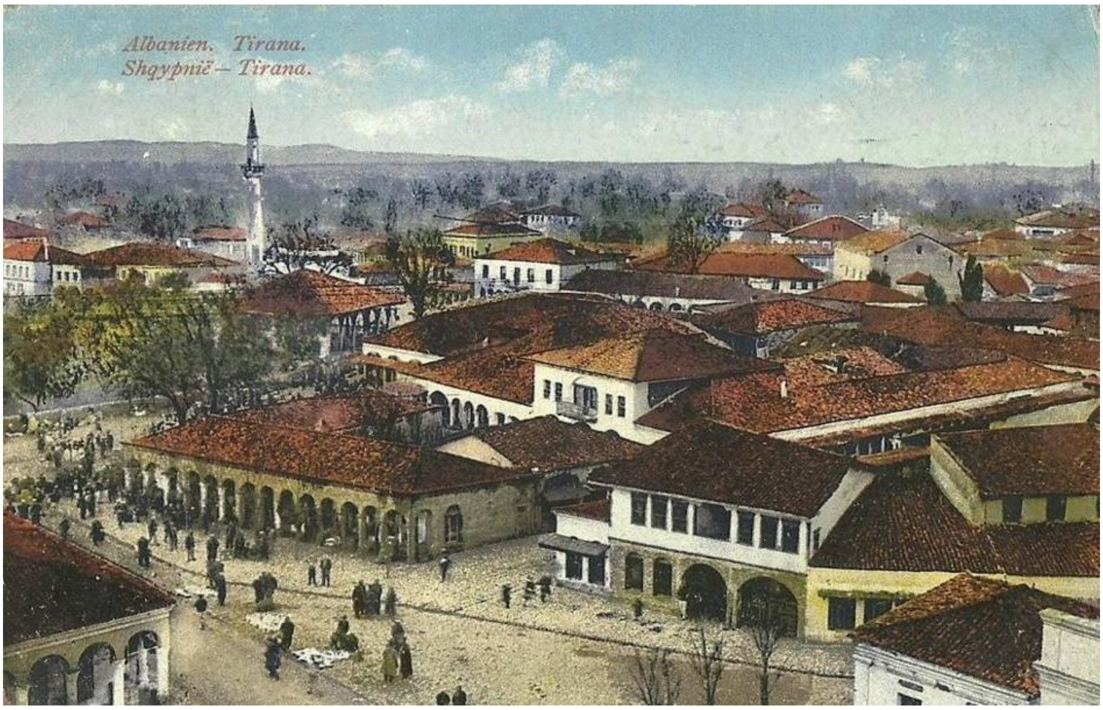


Figure 11. *Skanderbeg Square 1914* ***(Shkreli, 2017)***

Figure 12. *Skanderbeg Square 1917* ***(Ikonomi, 2015)***

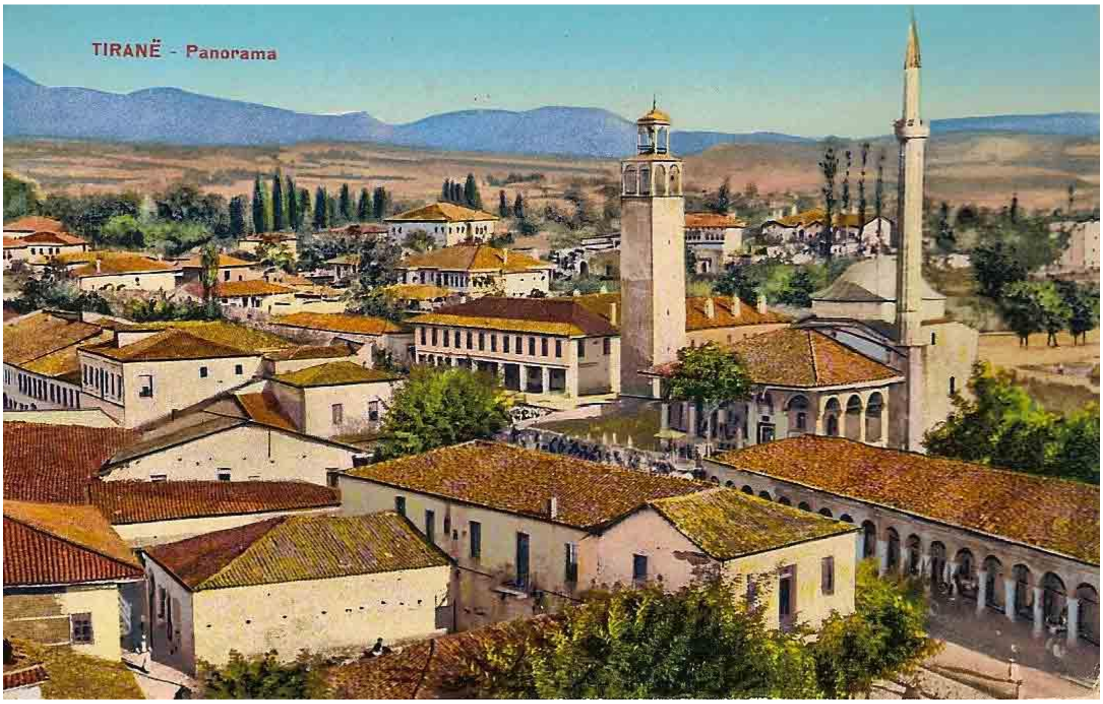


Figure 13. *Skanderbeg Square 1925* ***(Pädagoge, 2024)***

Figure 14. *Skanderbeg Square 1920-1935* ***(ABWera, 2017)***

Between 1928 and 1939 the square had a roundabout with a fountain in the centre. The old Bazaar was located where the palace of culture stands today and the former City Hall stood where the National Museum of History stands now.

Figure 15. *Skanderbeg Square 1930* ***(Dorado., 2021)***

Later on, during the Italian occupation of Albania (1939-1944) the Italians made significant architectural interventions, inspired by St. Peter Piazza in Rome, by expanding the square, adding neoclassical elements and constructing key administrative buildings that aligned with the fascist architectural style, some of which are still standing and functional to this day. The architect Armando Brasini had envisioned six 20storey buildings that were going to be used as ministries around a central oval piazza with a sunken garden in the middle. Although Brasini had originally designed the square in an oval shape, the concept was later changed into a hexagonal one. During this period a statue of Joseph Stalin was erected in the square.

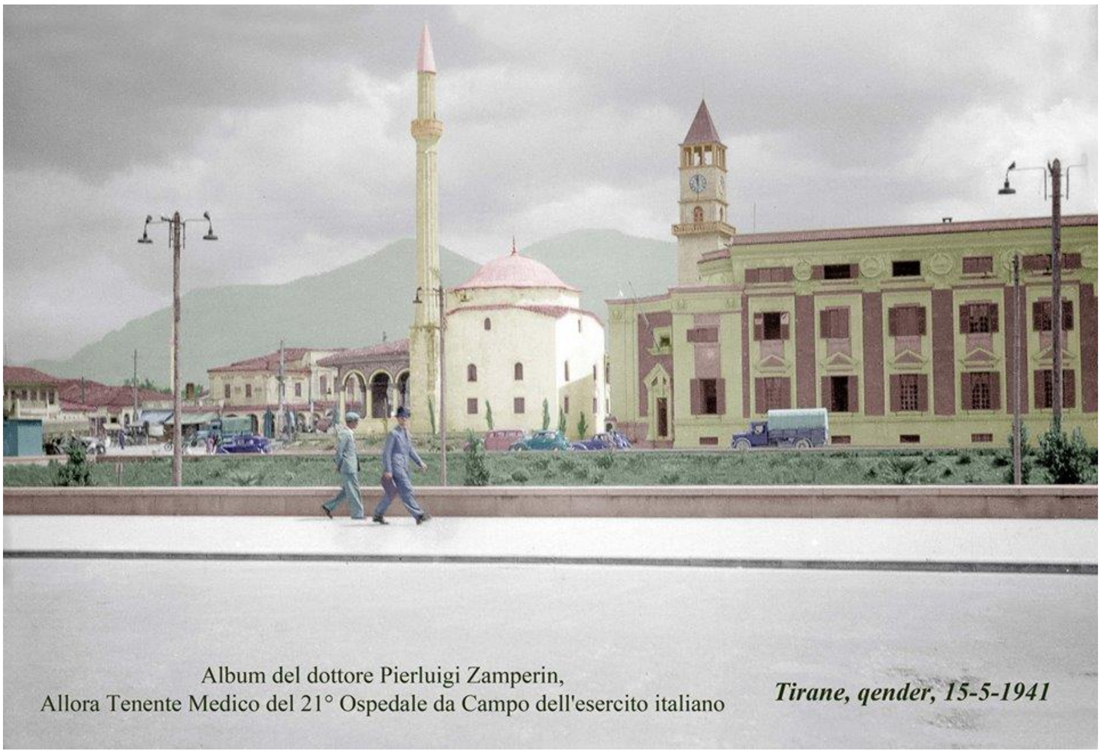


Figure 16. *Skanderbeg Square 1941* ***(KonicaF, 2021)***

With the establishment of the communist rule in Albania in 1944, the Skanderbeg Square was repurposed to fit the regimes socialist ideologies. The space within the Skanderbeg Square was used to serve as a venue for political rallies, parades and public gathering solely for the purpose of propaganda and the promotion of communist ideals. During this period, the Joseph Stalin statue that had previously been erected was replaced by a statue of Enver Hoxha. Many other reconstruction efforts were undertaken during his leadership. The time period between the 1950s to 1970s presented the square with the reconstruction of the Palace of Culture and the National historical Museum showcasing socialist realism. The structures were specifically designed to embody and portray the power and permanence of the communist regime.

Figure 17. *Skanderbeg Square 1957* ***(2017)***

Figure 18. *Skanderbeg Square 1976* ***(Dorado., 2021)***

The following years, during the 1980s, the square was introduced to further development which included the construction of additional buildings such as the National Bank and the Opera House. The square was further designed to show off as large and imposing with its wide-open spaces in order to accommodate large public events, gatherings and military parades, therefore reflecting the totalitarian control of the regime.

Figure 19. *Skanderbeg Square 1982* ***(gashi, 2018)***

The fall of the communist regime in 1991 brought a period of transition for the entirety of the state of Albania. A massive student protest, and one of the biggest protests in the history of Albania to this day, removed the statue of Enver Hoxha, thus poetically also symbolizing the fall of the communist regime, and a new one, that of Skanderbeg, was erected in its place. Except for the replacement of the statue, until the 2000s the square faced neglect and this particular state of the square reflected the political and economic turmoil that the state was experiencing.

Figure 20. *Skanderbeg Square 1988* ***(gjergjkastrioti, 2013)***

Figure 21. *Skanderbeg Square during the communist period (1)* ***(T, 2018)***

Figure 22. *Skanderbeg Square during the communist period (2)* ***(T, 2018)***

After the 2000s urban planners and architects sought to modernize and rejuvenate the square while focusing on keeping a balance between its historical elements out of respect and the need for contemporary changes. It was during this period that the square was experiencing beautifying and functional improvements, quite appealing to the human eye, due to the introduction of new infrastructure and aesthetic elements.

Figure 23. *Skanderbeg Square during the 2000s* ***(T, Foto të vjetra të Tiranës | Retro Tirana, 2019)***

Figure 24. *Skanderbeg Square 2005* ***(Dorado., 2021)***

The square faced even more changes during the 2010s when it was redesigned again into an open multifunctional public space. This redesign introduced new landscaping more pedestrian zones and for the first time it introduced water features. The goal was to create a vibrant accessible space that would serve as a cultural and social hub while enhancing its aesthetic appeal.

Figure 25. *Skanderbeg Square 2012* ***(2024)***

The most recent redesign of the square was conducted in 2017 and it hasn't changed to this day. The continuous efforts that different architects and urban planners have put into the square have reacted this perfect balance between the modern and the historical in its architectural language. The square nowadays is the perfect place for gatherings and it hosts various cultural events, festivals and concerts thus making the square a dynamic and central part of Tirana's life.

Figure 26. *Skanderbeg Square today (1)* ***(Pintos, Skanderbeg Square / 51N4E, n.d.)***

Figure 27. *Skanderbeg Square today (2)* ***(Pintos, Skanderbeg Square / 51N4E, n.d.)***

2.6.2 The evolution of the Skanderbeg Square

The following illustrations, although drawn by the author, have been referenced by Skender Luarasi's book "*The life and death of Skanderbeg Square: The chronicle of an undoing foretold, in a hundred years"* (2021).

Figure 28. *Skanderbeg Square 1921-1937*

Figure 29. *Skanderbeg Square 1937-1958*

Figure 30. *Skanderbeg Square 1958-1975*

Figure 31. *Skanderbeg Square 1975-1980*

Figure 32. *Skanderbeg Square 1980-1990*

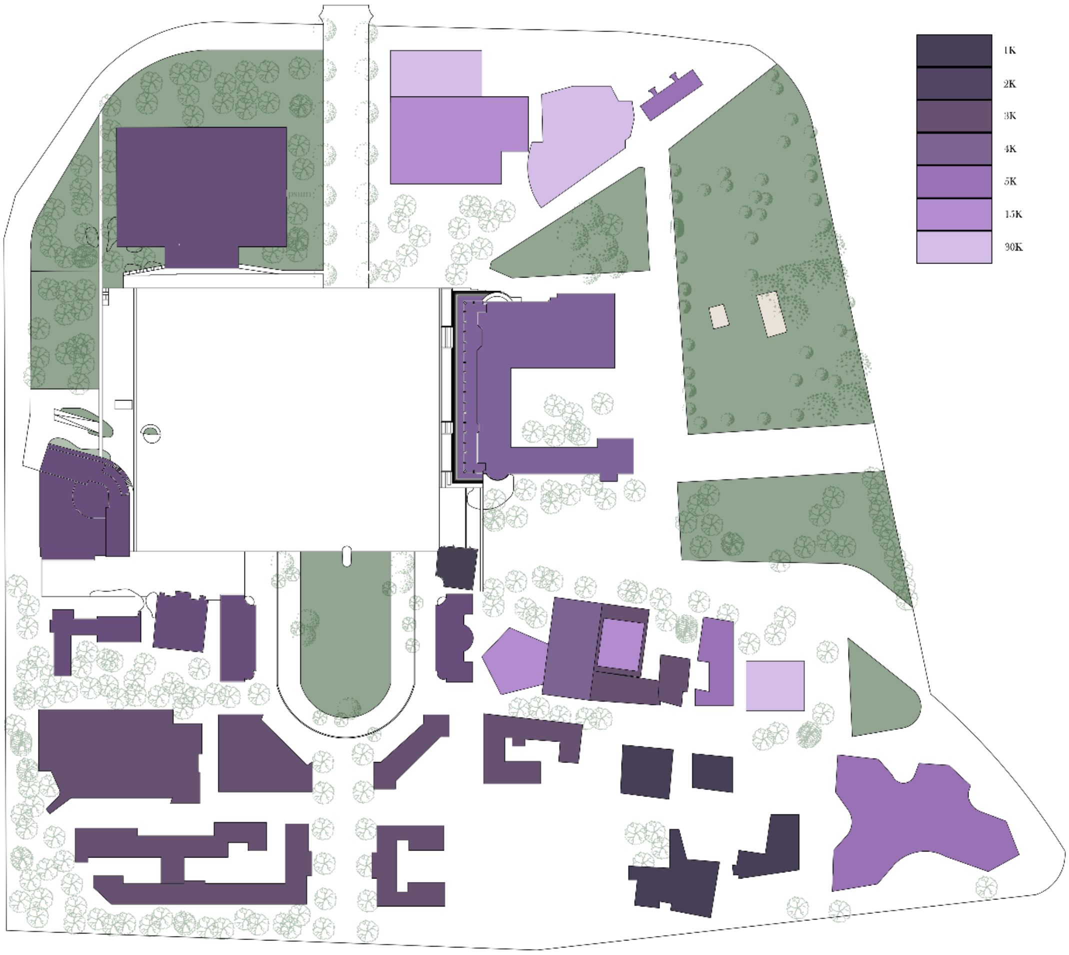
Figure 33. *Skanderbeg Square 1990-2021*

Figure 34. *Graphical overlap*

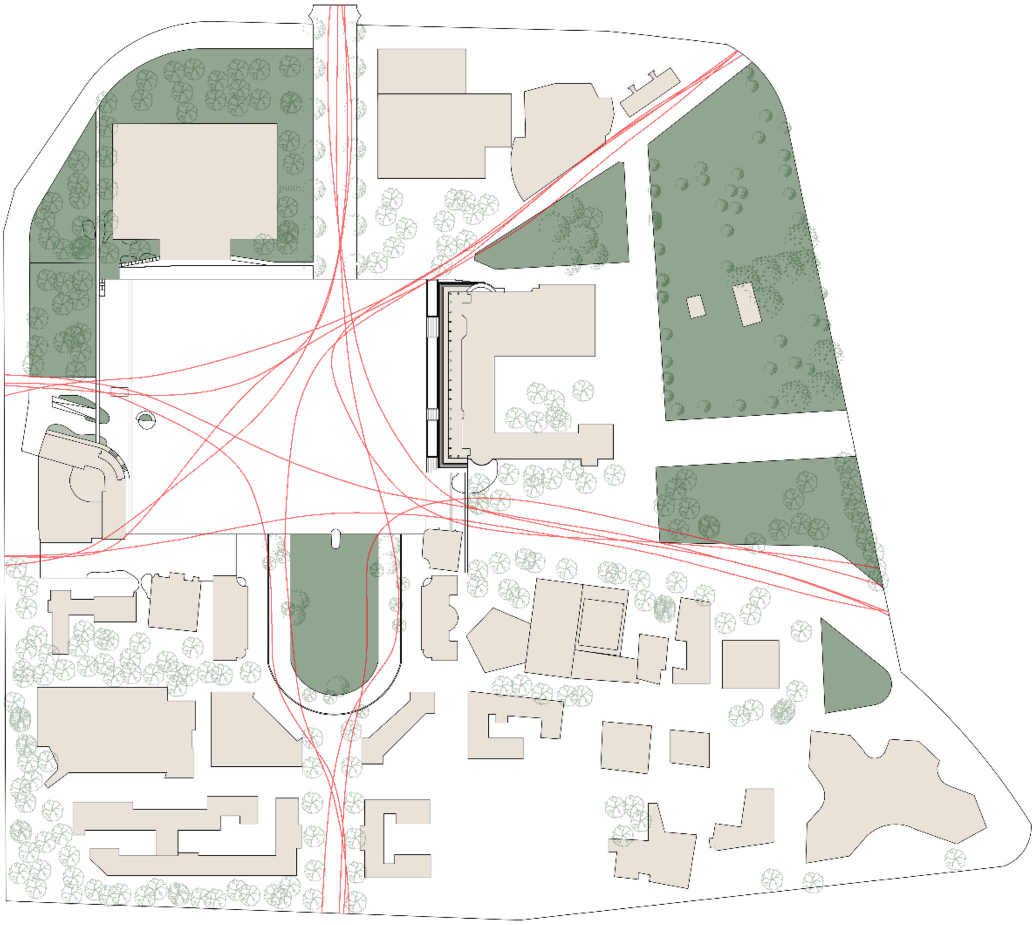
2.7 Site analysis

2.7.1. Functional analysis

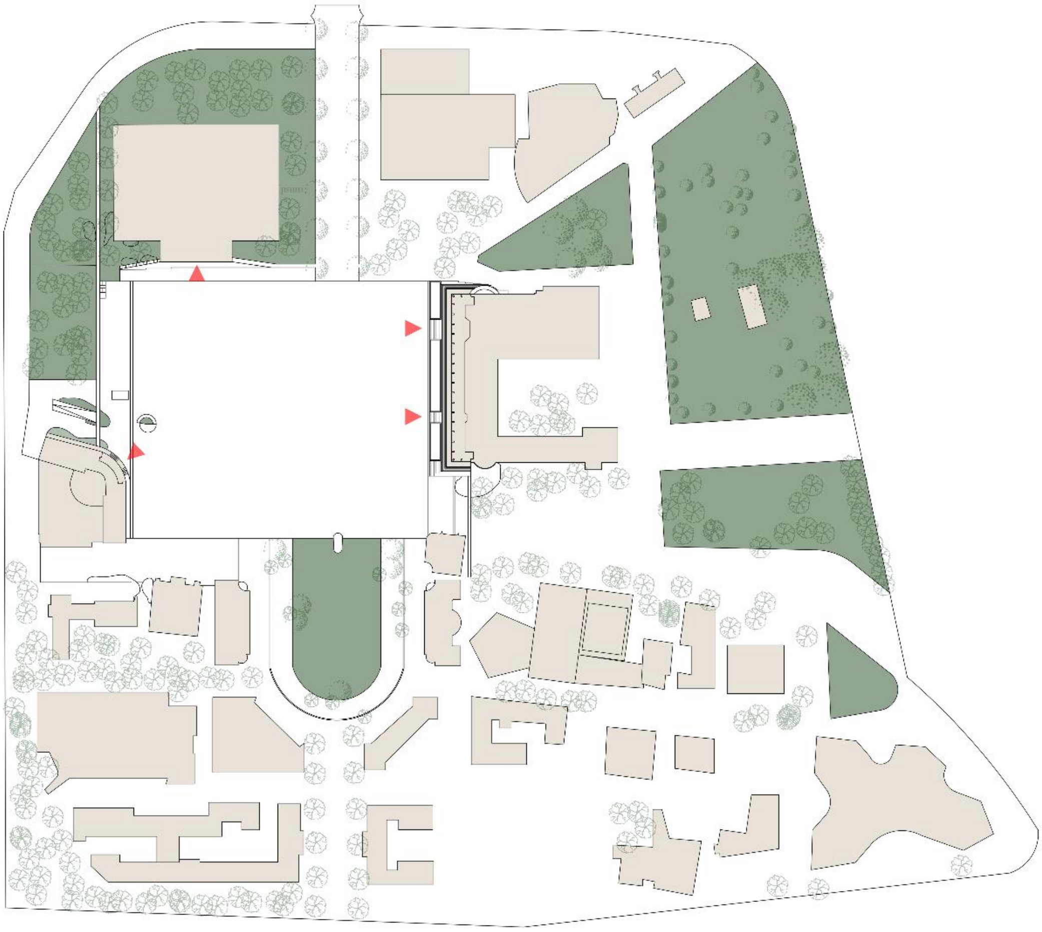
2.7.2. Building height analysis



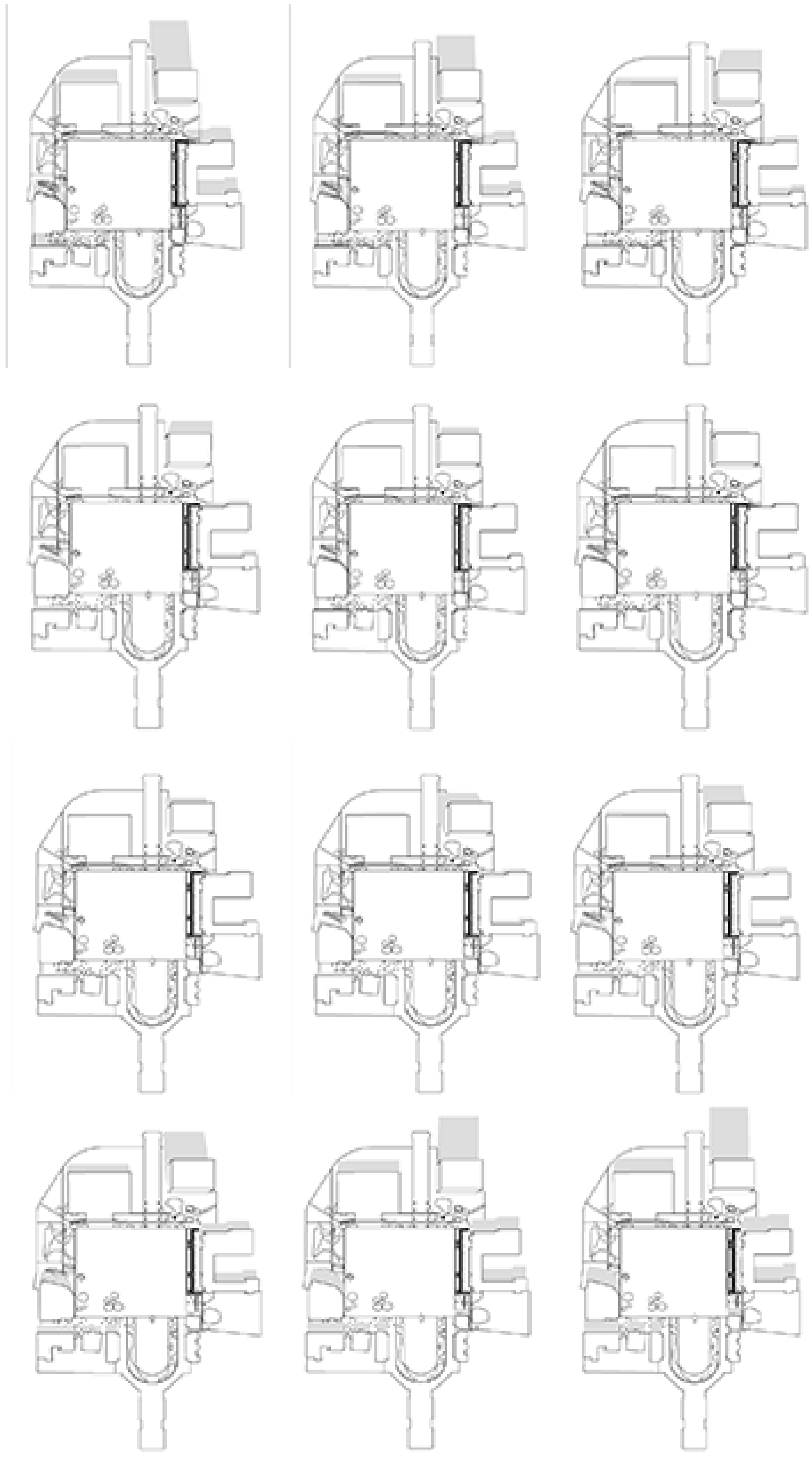
2.7.3. Circulation Analysis



2.7.4. Entrances and accessibility



2.7.4. Shadow analysis



CHAPTER 3

METHODOLOGY

3.1 Introduction

The goal of this chapter is to define the methodological approach of this study, its scope being the estimation of the severity of the UHI effect in the Skanderbeg Square in Tirana, as well as imaginary scenarios on how the situation might be improved to enhance the application of numerous theoretical and empirical findings from the respective field.

This research selects both the quantitative and qualitative research methods in an attempt to understand the UHI phenomenon and the possibility of UHI countermeasures. The quantitative method consists in obtaining quantitative data on temperature and environment for instance through instrumental reading and satellite imagery whereas the qualitative one consists on conducting a survey that aims in capturing how the people who use the Skanderbeg Square during the summer feel.

Implications and possible limitations arising from the research will also be highlighted further into this chapter in order to have a clear understanding on the concerns of ethical practices in the research study. In these elements, this chapter is to illustrate the systematic proper nature of the selected research approaches to achieve the objectives and research questions of the study.

3.2 Research approach

The research approach adopted in this study is a mixed-methods design, integrating both quantitative and qualitative approaches to provide a comprehensive understanding of the Urban Heat Island (UHI) effect in Skanderbeg Square and to develop effective mitigation strategies. This approach is structured to leverage the strengths of both methodologies, ensuring robust data collection and insightful analysis.

3.2.1 Quantitative Approach

The quantitative aspect of the study focuses on measuring and analysing the UHI effect within Skanderbeg Square. This involves collecting historical weather data from meteorological stations to analyse long-term temperature trends and abnormalities during the summer and then using the statistical tools to analyse the collected temperature data, identifying patterns, correlations, and anomalies related to the UHI effect.

Another approach is to use different software such as Sketchup, Revit and its plugins to 3D-model and visualize temperature distributions and identify hotspots within the Skanderbeg Square.

3.2.2 Qualitative Approach:

The qualitative component aims to capture the experiential and perceptual dimensions of thermal comfort among users of Skanderbeg Square. This involves collecting data through surveys. Essentially distributing structured questionnaires to a diverse sample of square users, including residents, workers, and tourists. The surveys will focus on their experiences of thermal comfort, perceptions of heat, and opinions on potential mitigation strategies.

Analysing qualitative data from the surveys would help identify recurring themes and insights regarding thermal comfort and mitigation preferences. Interpreting the stories and experiences shared by participants to understand the subjective impact of heat and the socio-cultural context of the square.

The qualitative approach enriches the study by providing a deeper understanding of how the UHI effect is experienced by individuals and how proposed solutions might be received by the community.

3.2.2 Justification for Mixed-Methods Approach

The mixed-methods approach is justified by the complex nature of the research problem, which involves both objective measurements and subjective experiences. By combining quantitative and qualitative methods we can achieve a more holistic understanding of the UHI effect, encompassing both physical and human dimensions.

The mixed-methods research approach integrates rigorous quantitative analysis with rich qualitative insights, ensuring a thorough and nuanced investigation of the UHI effect and its impact on Skanderbeg Square. This approach not only provides vast data but also ensures that the proposed interventions are informed by the lived experiences and preferences of the square's users.

3.3 Data analysis methods

The data analysis methods in this study are designed to systematically and comprehensively interpret both quantitative and qualitative data collected from Skanderbeg Square. By using a range of analytical techniques, the study aims to provide a detailed understanding of the Urban Heat Island (UHI) effect and develop effective mitigation strategies.

3.3.1 Quantitative data analysis

Quantitative data analysis focuses on interpreting numerical data to identify patterns, relationships, and trends related to the UHI effect. The following methods are employed:

Summary Statistics: Calculating means, medians, standard deviations, and ranges for temperature measurements and other environmental variables. These statistics provide a clear overview of the data distribution and central tendencies.

Frequency Distributions: Analysing the frequency of temperature readings within different ranges to identify common and extreme conditions in Skanderbeg Square.

Correlation Analysis: Assessing the relationships between different variables, such as surface temperature, air temperature, humidity, and vegetation cover.

Regression Analysis: Performing multiple regression analysis to identify the key predictors of temperature variations and the UHI effect. This helps in understanding how different factors (e.g., surface materials, green cover) contribute to temperature differences.

3.3.2 Spatial Analysis

Geographic Information Systems (GIS): Using GIS software to create detailed maps of temperature distribution across Skanderbeg Square. Spatial analysis techniques, such as hotspot analysis and spatial autocorrelation, are applied to identify areas with significant heat intensity.

3.3.3 Qualitative Data Analysis

Qualitative data analysis aims to interpret non-numerical data to understand the experiences, perceptions, and preferences of Skanderbeg Square users regarding thermal comfort and the UHI effect. The following methods are employed:

3.3.4 Thematic Analysis:

Transcribing survey responses and observation notes and organizing them into broader themes and sub-themes that capture the main insights from the qualitative data. This process helps in identifying common issues and potential solutions as perceived by the participants.

3.3.7 Integration of Quantitative and Qualitative Data

The integration of quantitative and qualitative data is a critical component of the analysis process. Having to cross-validate findings from different data sources and methods to ensure the reliability and validity of the results. For example, correlating quantitative temperature data with qualitative insights from surveys to confirm patterns and identify discrepancies.

3.3.8 Ethical Considerations

Ethical considerations are carefully observed throughout the data analysis process. This includes ensuring the confidentiality and anonymity of participants, obtaining informed consent for data use, and presenting the findings truthfully and accurately. Ethical rigor in data analysis ensures that the study respects the rights and dignity of all participants while producing credible and trustworthy results.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Survey results

This survey aims to determine how residents feel about the thermal discomfort found in Skanderbeg Square during the summer, and how they think it can be counteracted. The survey is made out of 9 questions of the multiple-choice type and answered by 143 individuals.

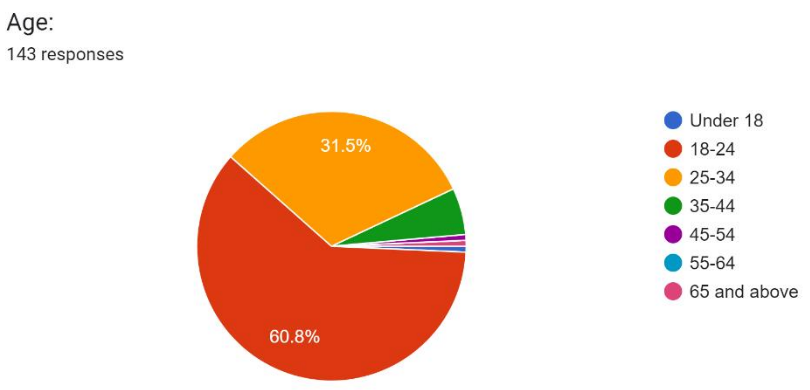


Figure 35. *Age*

The majority of the respondents (60.8%) belonged to the age group of 18-24 years old, followed by the age group of 25-34 years old consisting of 31.5% of all 143 individuals.

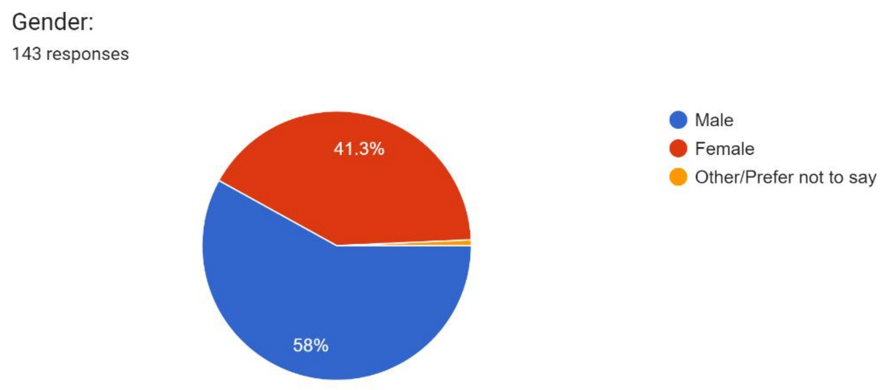


Figure 36. *Gender*

In regards to gender, the respondents were roughly divided into 60% males and 40% females.

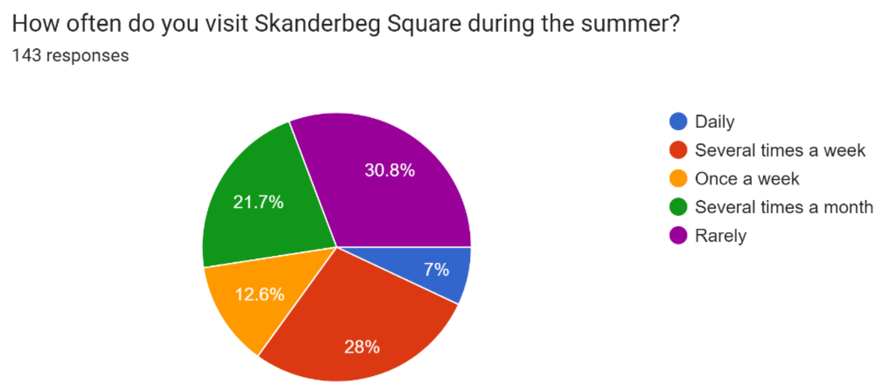


Figure 37. *How often did the respondents visit Skanderbeg Square during the summer?*

When asked about how often they visit Skanderbeg Square during the summer, the respondents seem to be almost equally divided between all alternatives. Out of all the alternatives, it looks like people either rarely visit the square (30.8%) or visit it several times a week (28%). Only a very small percentage of the respondents (7%) visit the Square daily.

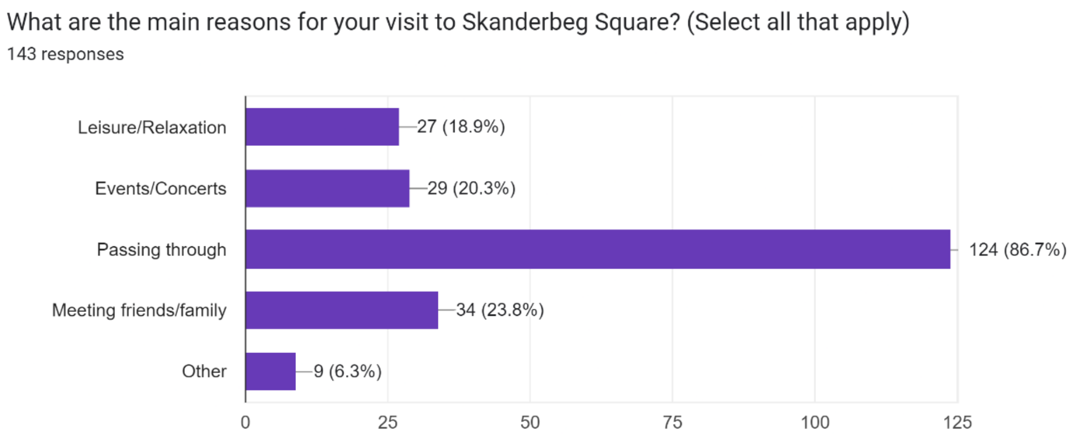


Figure 38. *Reasons for using the Skanderbeg Square*

The graph of Figure 31 tells us why the respondents use the Skanderbeg Square, and it looks like the very majority of them, namely 86.7%, only use the Square as a route that takes them fastest from one point of the city centre to the other. This fact only stresses further the need to make the square as thermally comfortable as possible so that the inhabitants choose to use it for other reasons rather than just passing through it as well.

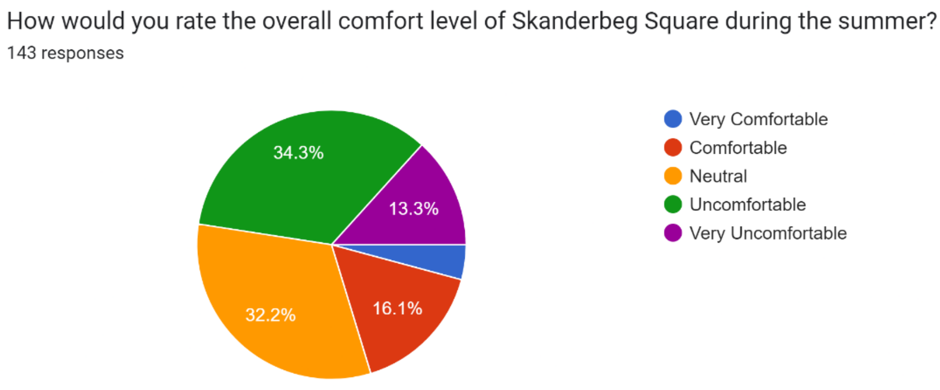


Figure 39. *The overall comfort level of Skanderbeg Square during the summer*

When the respondents were asked how comfortable they felt in Skanderbeg Square during the summer, the majority of them seemed to be torn between uncomfortable (34.3%) and neutral (32.2%) followed by 16.1% of them who felt very uncomfortable.

On the contrary, only 4.2% of the respondents feel very comfortable while being in Skanderbeg Square.

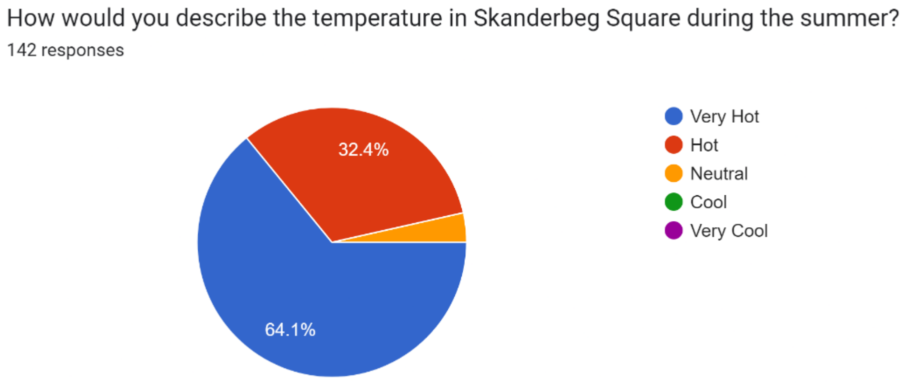


Figure 40. *Temperature in Skanderbeg Square*

The majority of the respondents seem to have found the Square as “very hot” (64.1%) during the summer, followed by 32.4% of them who find it “hot”. Only about 3.5% of the respondents find its temperatures as normal during the summer.

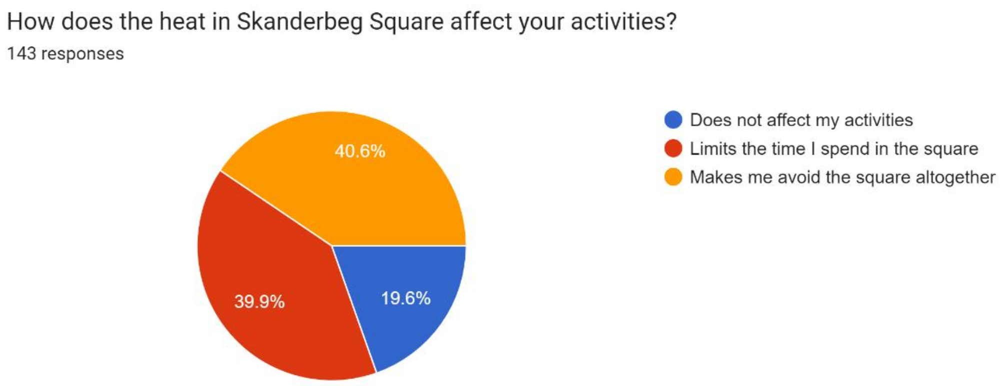


Figure 41. *How the square affects the inhabitants' activities*

When asked how Skanderbeg Square affects everyone’s daily activities, the majority of them were torn between “avoiding the square altogether” (40.6% of them) or “limiting the time they spend in the Square” (39.9%).

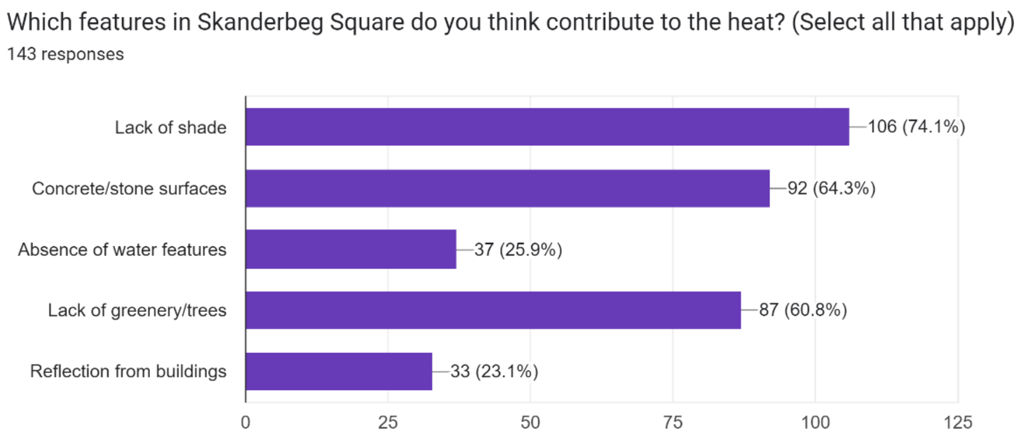


Figure 42. *Which features contribute to the heat*

When asked about their opinion regarding which feature contributes most to the heat, most of the respondents answered with "lack of shade" (74.1%) followed by 64.3% of them who think concrete/stone surfaces also have a big role in contributing to the heat, and 60.8% of them who think that lack of greenery and/or trees also has contributed to an increase of heat up to these measures.

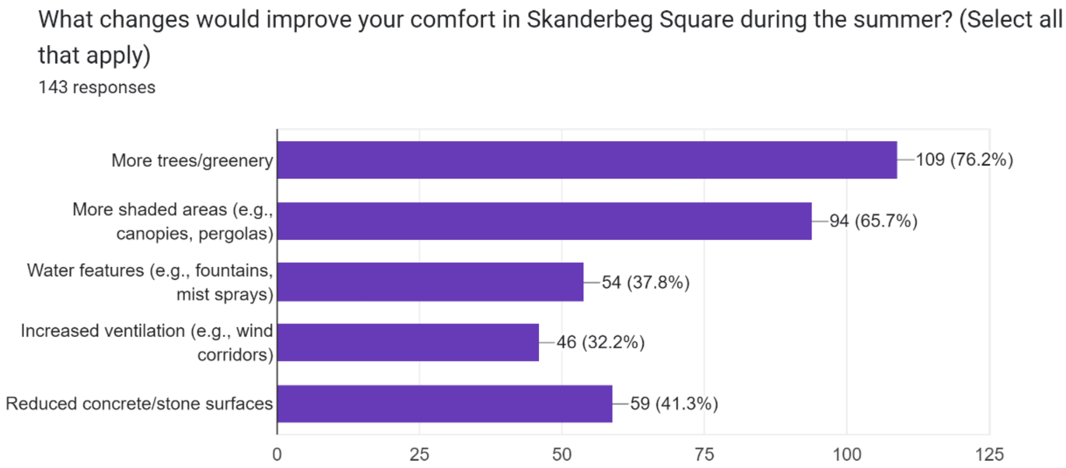


Figure 43. *What would improve the Skanderbeg Square comfortability*

When asked about their opinion regarding what would help improve their thermal comfort in Skanderbeg Square during the summer, the majority of them (76.2%)

answered with more trees/greenery followed by 65.7% of them who think that more shaded areas would also help in its improvement. Worth mentioning are also 41.3% of the respondents who think that reduced concrete/stone surfaces would help make Skanderbeg Square more comfortable.

4.2 Weather data results

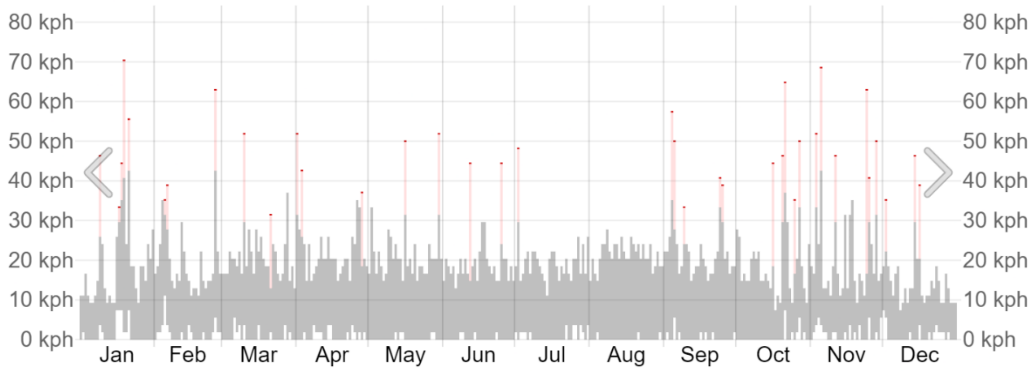


Figure 44. *Wind Speed in 2023 in Tirana* ***(2023 Weather History in Tirana, Albania, n.d.)***

Tirana is characterized by a Mediterranean climate (Climate - Tirana (Albania)) having mild, rainy winters and hot, sunny summers. While the winters are mildly cold, temperatures in the summer can get unbearably hot, especially when the sirocco currents from Africa, which have caused some of the hottest temperatures ever recorded in the city, such as last year (2023) was 43 °C.

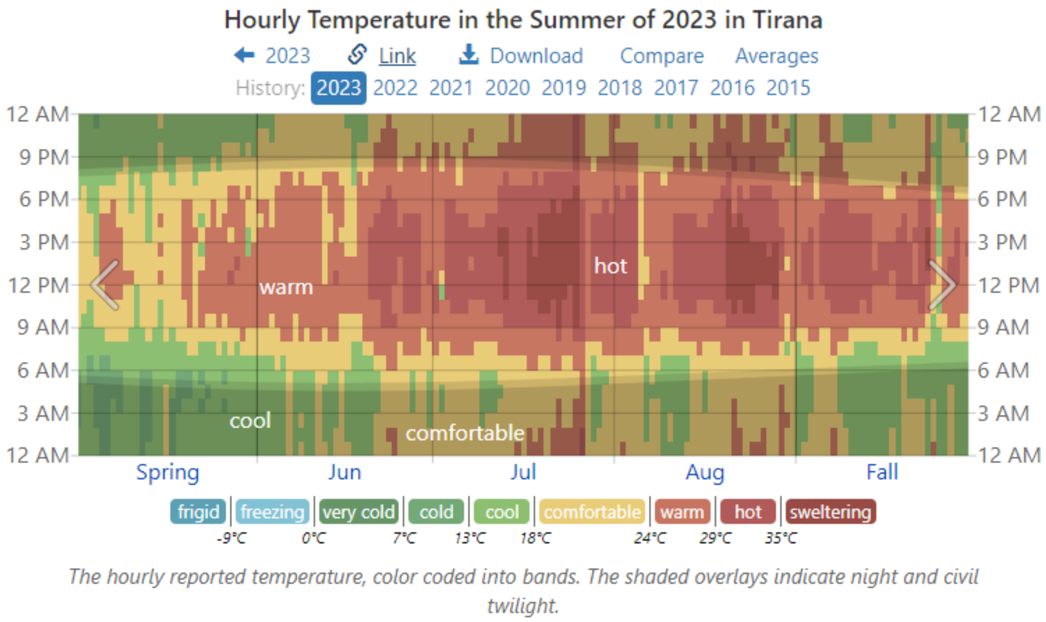


Figure 45. *Hourly Temperature in Summer 2023 in Tirana* ***(2023 Weather History in Tirana, Albania, n.d.)***

The figure above (Fig. 29) tells us about the hourly temperatures of summer 2023 in Tirana. What we can notice from the figure is that the hottest temperatures of the year were recorded at the end of July and at the end of August. During these time frames the highest hourly temperatures have reached above 35°C. It is also worth mentioning that the highest temperatures in Tirana are recorded between 9 AM and 6 PM. During the summer months, temperatures rarely go under 24°C making the city of Tirana feel hot almost all of the time.

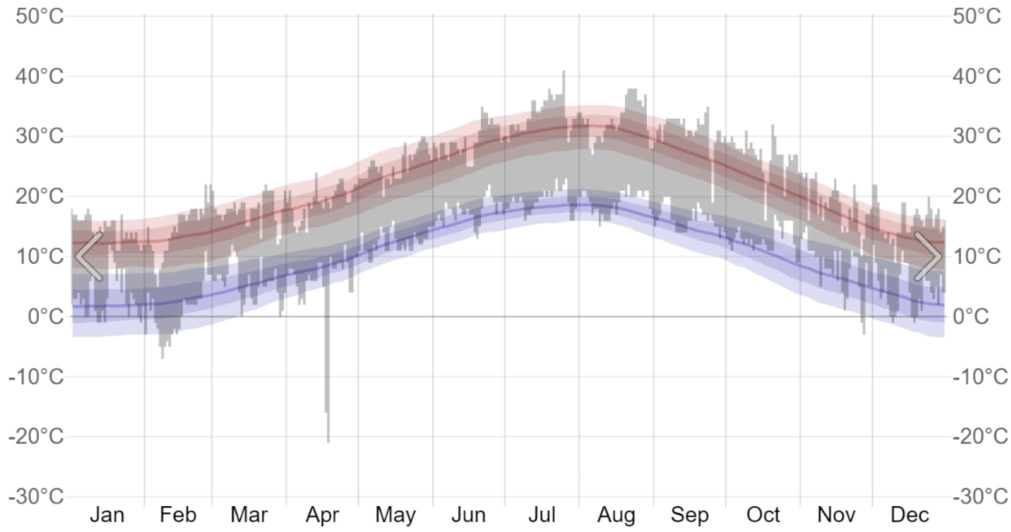


Figure 46. *Tirana Temperature History 2023* ***(2023 Weather History in Tirana, Albania, n.d.)***

The figure above (Fig. 30) helps us better visualize the differences and changes between the temperatures of the winter season and the temperatures of the summer season. Once again, we can note that the temperatures have reached their highest during mid-end July and end August. The faint red and blue curve at the back of the chart shows us the trend of temperatures calculated from past years, and thanks to it we can understand that temperatures are always highest during these months, July and August.

	chance of (very) hot weather	chance of (very) cool weather	chance of long-term precipitation	chance of hurricanes (cyclones)	chance of sunny days	UV-index
January	◌	●●	○○	◌	○	UV 0-3
February	◌	●	○○	◌	○	UV 0-3
March	◌	●	○○	◌	○	UV 3-6
April	●	◌	○○	◌	○○	UV 3-6
May	●●	◌	○	◌	○○○	UV 6-8
June	●●●	◌	○	◌	○○○	UV 8-10
July	●●●●	◌	○	◌	○○○○	UV 8-10
August	●●●●	◌	○	◌	○○○○	UV 6-8
September	●●●	◌	○	◌	○○○	UV 3-6
October	●●	◌	○○	◌	○○	UV 3-6
November	◌	●	○○	◌	○	UV 0-3
December	◌	●	○○	◌	○	UV 0-3

click here for the explanation of the symbols

Figure 47. *Chances of hot weather, cold weather, long-term precipitation, hurricanes, sunny days and the UV-index of Tirana* ***(The climate of Tirana (Albania), n.d.)***

The figure above (Fig 32.) introduces us to the chances of hot weather, cold weather, long-term precipitation, hurricanes, sunny days, and the UV index of Tirana. While the graph shows us, once again, a clear trend of the chances of hot weather in Tirana, it also shows us that the same months, May to July, record the days with the most sunlight and, therefore, high UV factor. Not only do these months cause mental strain on the inhabitants by inflicting fatigue and discomfort but they also affect their physical health due to the UV factor in sunrays.

4.3 3D-Model simulations results

This analysis first started with the massing of the "small ring" of Tirana in SketchUp.

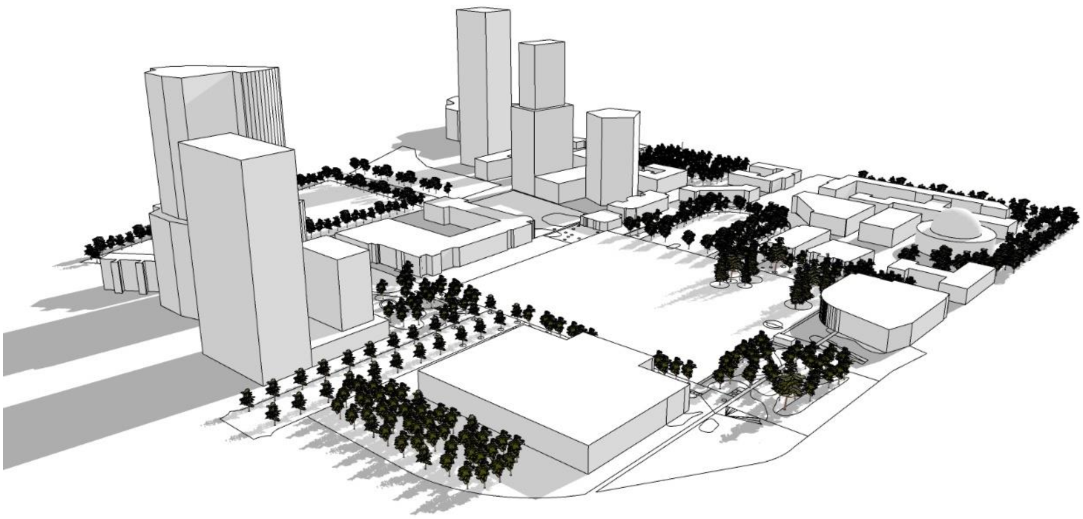


Figure 48. *3D model (1)*

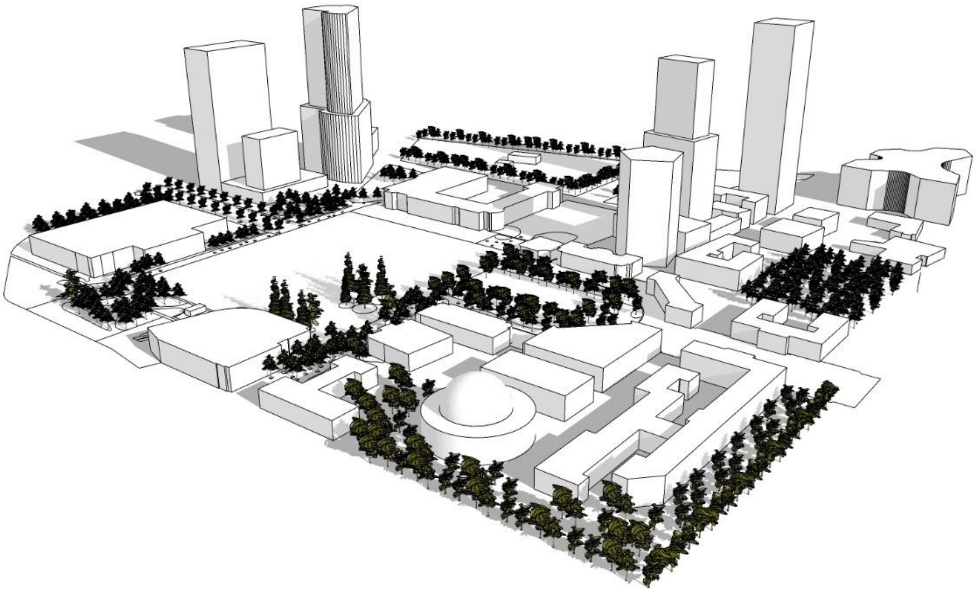


Figure 49. *3D model (2)*

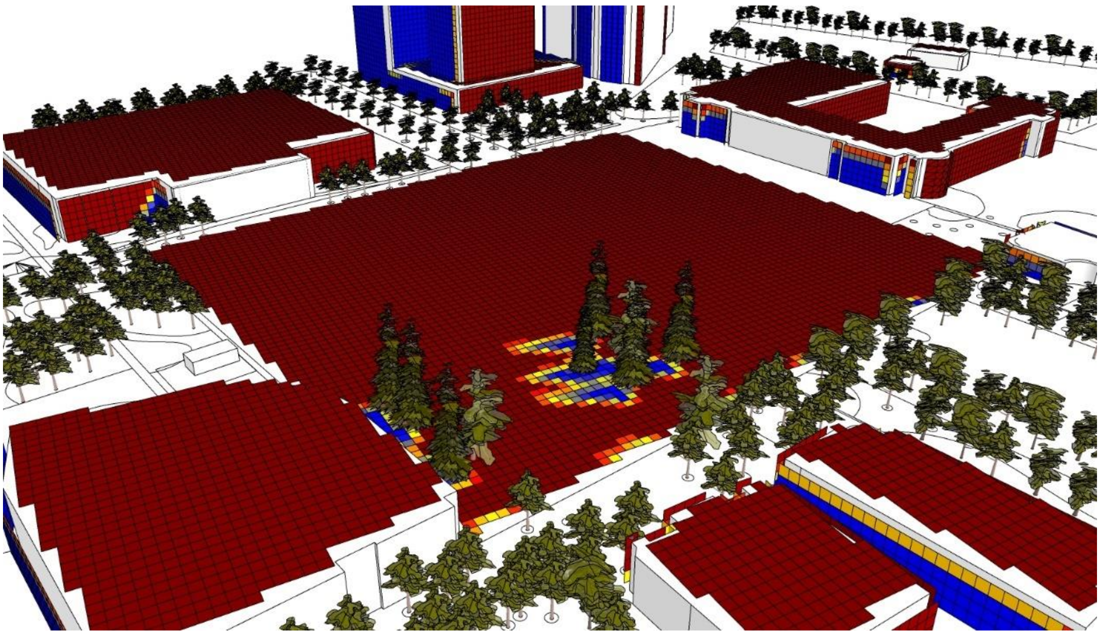


Figure 50. *3D model simulation (1)*

To calculate just exactly how much sunlight Skanderbeg Square gets, I ran the 3D model under the "SunHours" extension in SketchUp. The picture under this paragraph helps us understand just how much excessive direct sunlight the square gets in the month of August only. What we can notice in the Square is the one patch characterized by the colours blue, yellow, and orange that symbolize a cool and more comfortable area. This area in the square is the only one with trees around it, which proves, that for the whole square to be cooler and more comfortable we should be increasing green spaces and adding more trees that provide shade.

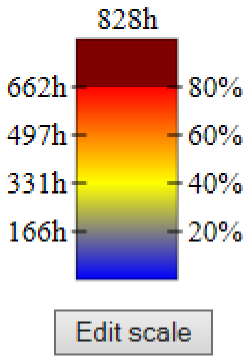


Figure 51. *Legend*

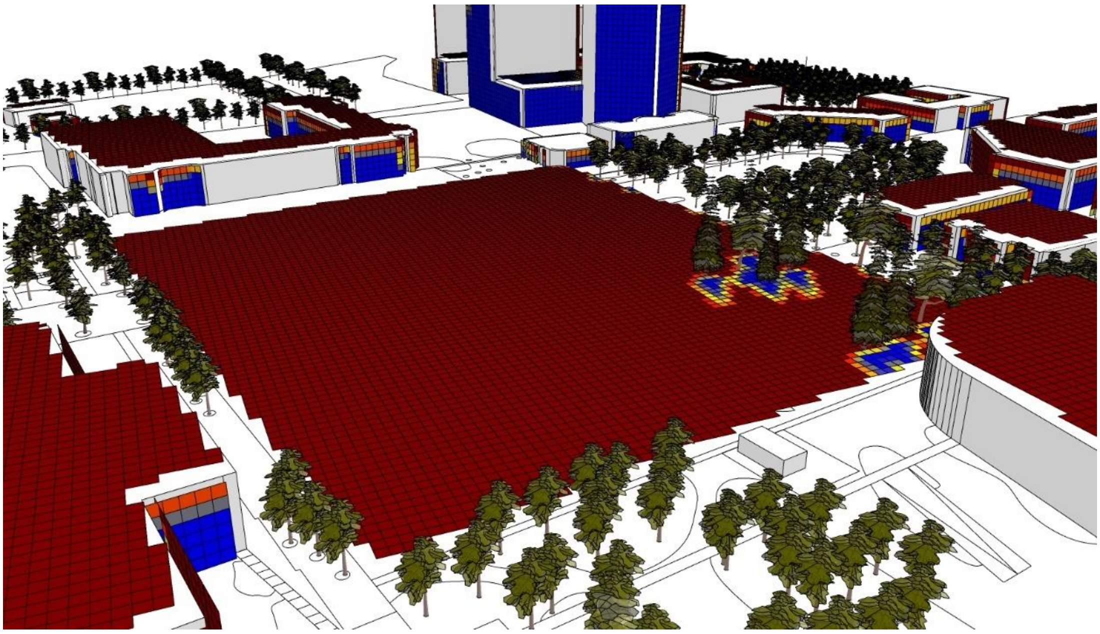


Figure 52. *3D model simulation (2)*

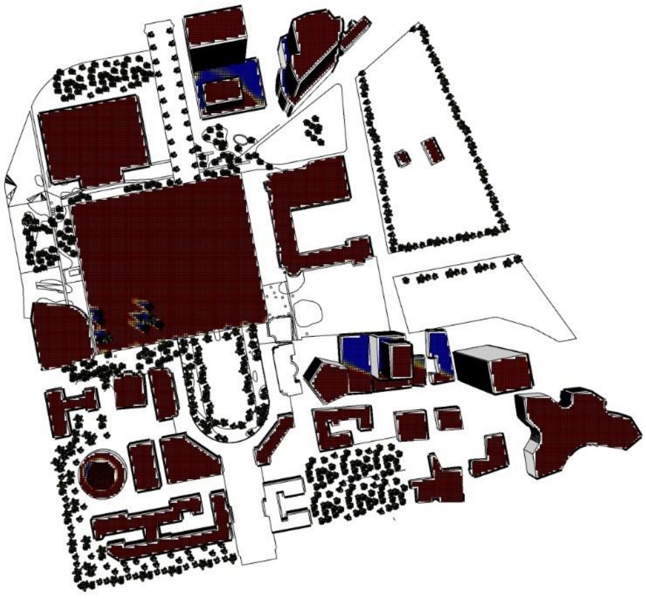


Figure 53. *3D model simulation (3)*

CHAPTER 5

PROPOSAL

5.1 Proposal

After taking into consideration all of the analysis done so far, I have decided that the best cooling methods that one can use in this situation are greenery and shading. The same two cooling methods have also been voted as most preferable in the survey which makes designing a cooling unit for the Skanderbeg Square using greenery and shading that much more preferable.

Knowing that the Skanderbeg Square is often used to hold public gatherings and events and/or concerts, I made sure to keep in mind not to use the whole square. Knowing that the square also has underground parking, I made sure to think of a solution which doesn't involve digging of great measures.

I didn't want to change the Skanderbeg Square drastically so that it felt alien to its users but just added to it enough so that it felt more pleasing to the eye and thermal comfort. Therefore, after looking at the site, I decided to pick two already existing greenery-patch shapes.

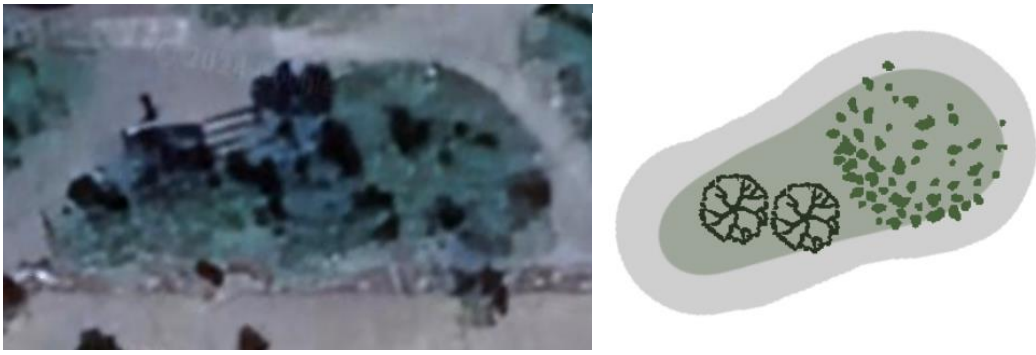


Figure 54. *Green unit 1*

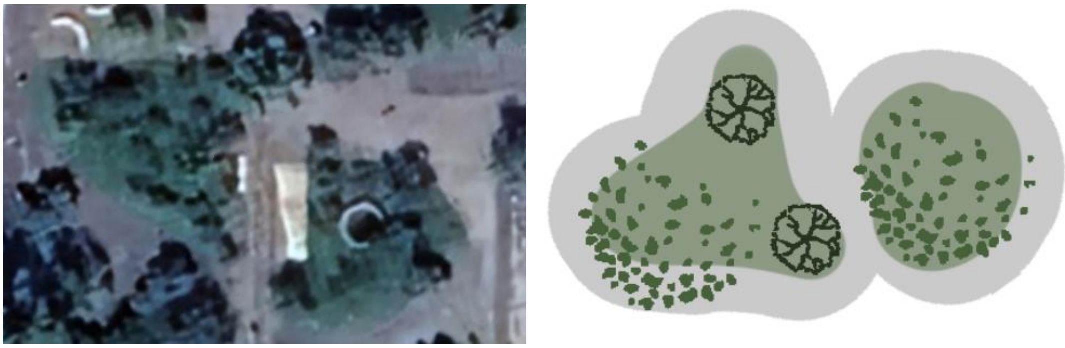


Figure 55. *Green unit 2 and 3*

The green units are simply vases that create the possibility for trees to grow and create shade. The grey offset around each of the green units represents seating intended to be used to promote Skanderbeg Square as a hangout area.

Figure 56. *Green unit 1 side view*

After having the units ready, it’s time to place them around the square. The units have to be placed far away enough from each other so that they can cool the place as much as they can.

Figure 57. *Positioning of the proposed units (1)*

What should also be kept in mind is the fact that most people use Skanderbeg Square to walk through and tend to their daily business, so we have to absolutely not interrupt their pathway.

Figure 58. *Positioning of the proposed units (2)*

This way it is made sure that the underground parking isn't touched, the circulation paths of the inhabitants and users of the Square aren't interrupted, the units are small enough so that public gatherings and events such as the Christmas Market can still hold place and the units are far enough apart so that they cover and cool down as much area as possible.

Knowing that the Square is often used for different purposes, we also need to come up with different proposal according to each case. The proposal showcased above is fit for a leisure-type square. If the walkability factor would be prioritized for the square, a proposed scenario would be to provide shading over the main circulation axes of the Square, taking reference from the circulation analysis. The shading installations are meant to be temporary and easily removable so that during the winter, or just generally during colder seasons, they can be removed in order to let more sunlight into the square.

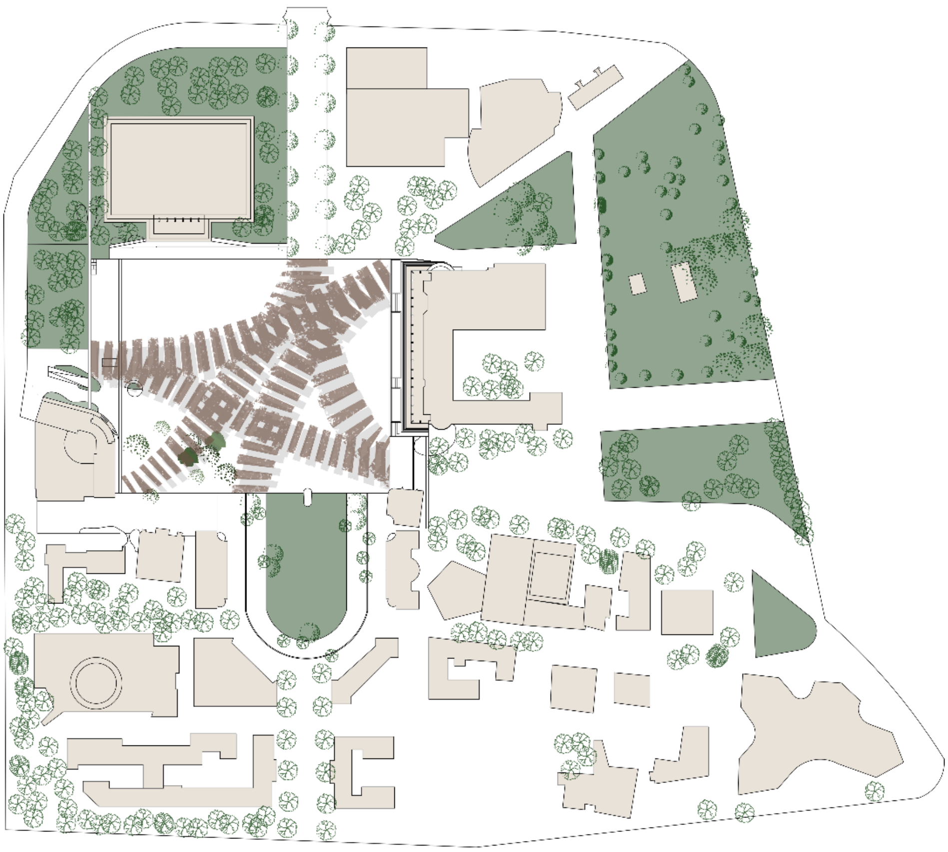


Figure 59. *Proposal for a circulation-focused Skanderbeg Square*

Another proposal would be for the events of the Christmas and other markets held in the Square. During the Christmas market there is usually a Christmas tree in the middle of the square and then different commercial shops around it. During other market events, the small shops are organized the same way with the only difference being the Christmas tree missing. Taking this into consideration the initial units are rearranged so that the centre of the Square is mostly empty, except for one smaller unit which during Christmas would be providing a pedestal for the Christmas tree, and for the rest of the markets a removable shading unit can be implemented in order to turn the centre into a small rest area.

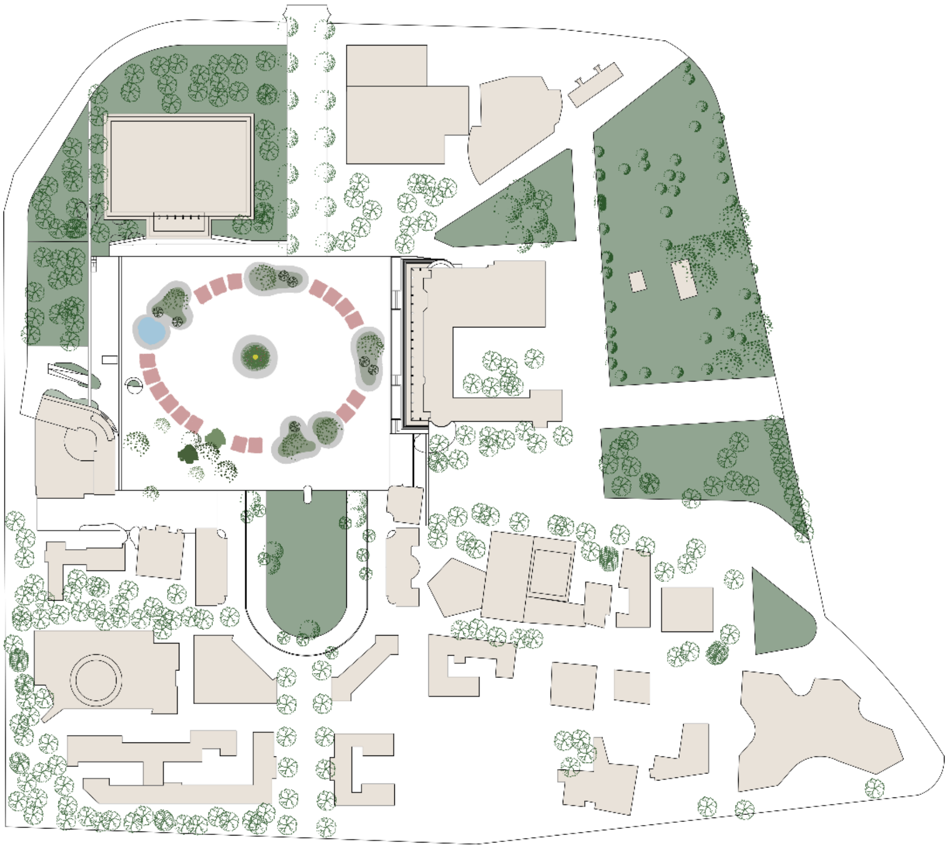


Figure 60. *Cooling units arrangement in the case of a Christmas (or other) market event*

And last but not least, the square is also often used as a location to host different concerts all throughout the year. In the case of a Concert, most of the square should be free of obstacles and open spaced so that people can freely gather in front of the stage and enjoy said concert. In this case, an arrangement of the units such as showed below would be ideal. This configuration while it provides an open area for the majority of the square, it also introduces a couple of units away from the centre in order to provide a small cooling oasis for the squares users.

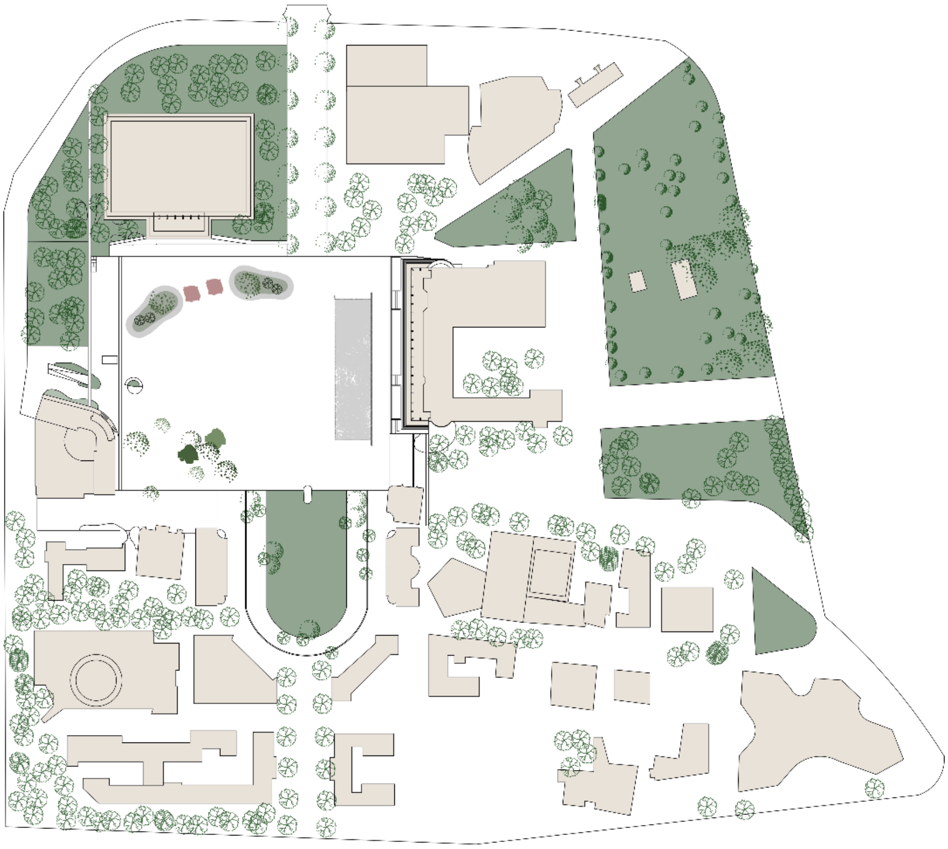


Figure 61. *Arrangement of units in the case of a concert.*

Figure 62. *Skanderbeg Square after interventions render 1*

Figure 63. *Skanderbeg Square after interventions render 2*

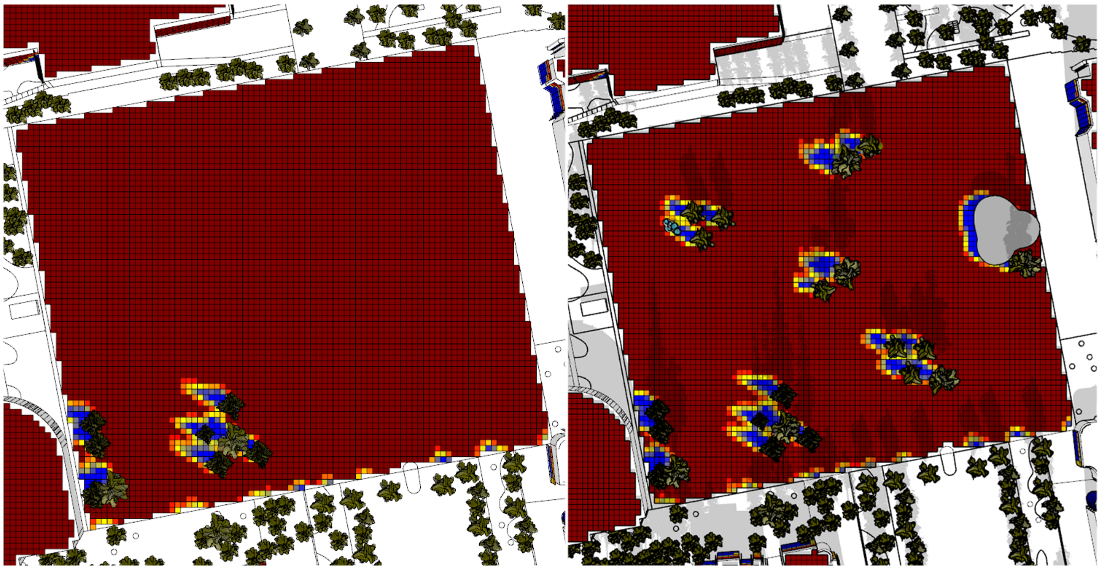


Figure 64. *Skanderbeg Square after interventions render 3*

CHAPTER 6

CONCLUSIONS

6.1 Comparison

Skanderbeg Square faces the unavoidable problem induced by heat that causes discomfort to people passing by. The large open space that characterizes it, promotes heat and the stone that the square is made out of has the ability to store heat, hence causing the whole square to act as a heat island. Little if anything is provided to protect the square from the sun, a task that a few trees, structures or anything else to block the direct sunlight would be sufficient to bring the temperature down. This largely influences comfort and as well as health by causing health like heat problems such as exhaustion and dehydration to people who choose to stay or are forced to walk through the square in order to tend to their errands.

Counteracting this situation, the proposed scheme implies the improvement of the architectural and social environment of Skanderbeg Square by applying cooling units, shading objects, and green areas. Specifically, by the installation of sun-blocking elements such as canopies at certain points, the necessary change of the square can be provided. Having founds such as fountains, or misting, will enhance the evaporative cooling effect on the air, which would make the square even cooler.

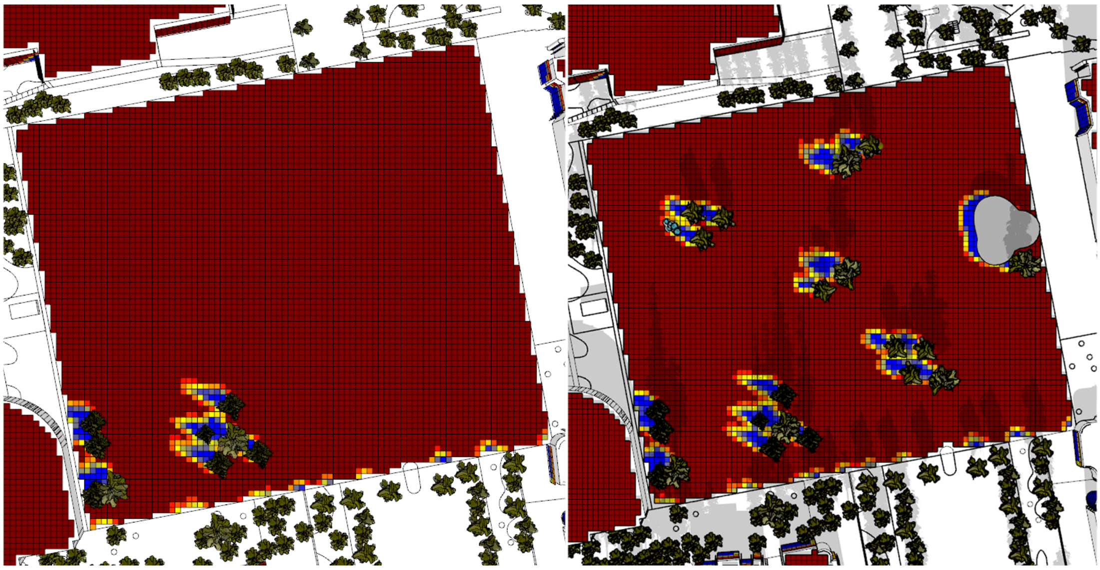


Figure 65. *Comparison between the sunlight absorption before and after intervention*

The integration of the green areas in the project would give a positive change on the microclimatic situation of Skanderbeg Square. Placing trees, shrubs and other covers will not only give shades but will reduce the temperatures through evapotranspiration. All of the changes outlined will impact the square to become more comfortable and beautiful as well as help to develop such values as environmental friendliness and the welfare of users.

6.2 Conclusions

In conclusion, the proposed intervention of adorning these areas with greenery and shading in the Skanderbeg Square indeed would solve a major concern such as the UHI effect, and improve thermal comfort. These methods are chosen based on the evidence from the prior literature and opinions of the inhabitants and users of the Square.

The proposed concept is very flexible, meaning that you can combine lots of placements of the green units in order to reach a satisfactory combination. The proposal also fully respects the Square given its' multifunctional character of the square while outlining its new qualitative functions as a place for common people meetings and different events with improved landscape design and increased ecological comfort. Because the proposal does not aim for a reconstruction of the Square, it is effective and implementable, meaning that it will not compromise existing structures like underground car parking.

The strategic installation of green units allows the large surface of Skanderbeg Square to provide a cooling effect, while the paths remain unrestricted. In a way, this careful concept shows how architects can tune streets with an eye toward muggy comfort without disrespecting the ambiance of the concrete jungles.

At the same time, the cooling strategy applied to the design of Skanderbeg Square not only reduces the intensity of the UHI effect but also positively affects the quality of life and the appeal of an important public space for people, which can be considered an important criterion for improving the welfare of users.

6.3 Discussions

The strong decision to utilize greenery and shading comes first and foremost by my own experience with the square which pushed me into wanting to find a solution which would help make the square more thermally comfortable.

The introduction of more greenery to the Square through the use of strategically placed vases serves as a pleasing way to mitigate the urban heat. 143 inhabitants and users of the Skanderbeg Square have expressed their concerns due to hot weather and therefore the survey is also clear proof that the people want greenery and shading. Trees provide shade and through their leaves not only do they provide shade but also protect the enjoyers from the heavy UV light.

The design process took into account the multifunctional purpose that the Skanderbeg Square has. This approach is respectful to its present setting because no building gets demolished from the proposal. It also respects the inhabitants from taking elements that are already existent in the site and re-using them thus not introducing anything alien to them but keeping the square as familiar as possible. The proposal also doesn't affect anyone's path while walking from one side of the Square to the other.

The placement of the green units also takes into consideration future events that might happen in the square such as public gatherings or concerts. I have tried to place the green units in such a way so that public gatherings can continue to happen in Skanderbeg Square without much trouble.

After re-running the 3D model under the extension, I noticed that the increased tree coverage provides essential shading and cooling via evapotranspiration, resulting in lower ambient temperatures. Oasis pockets, with their strategic placement and inclusion of water features, offer localized cooling and improve overall thermal comfort making Skanderbeg Square cooler but also more inviting and comfortable for residents and visitors, demonstrating the crucial role of urban greenery in mitigating the urban heat island effect and enhancing liveability.

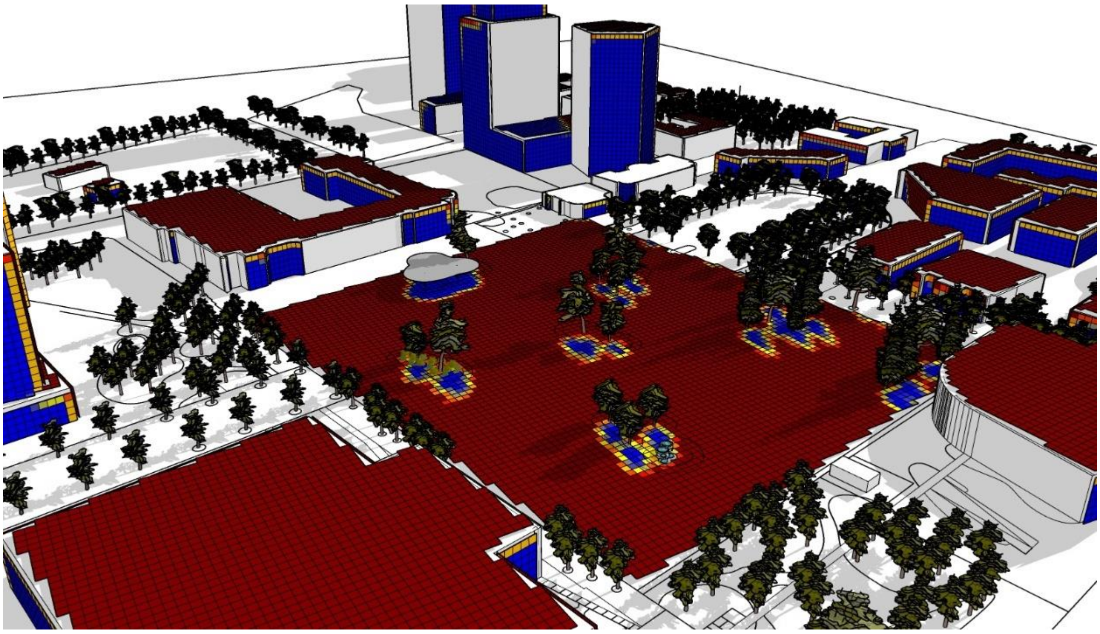


Figure 66. *Amount of sunlight that the square gets after intervention (1).*

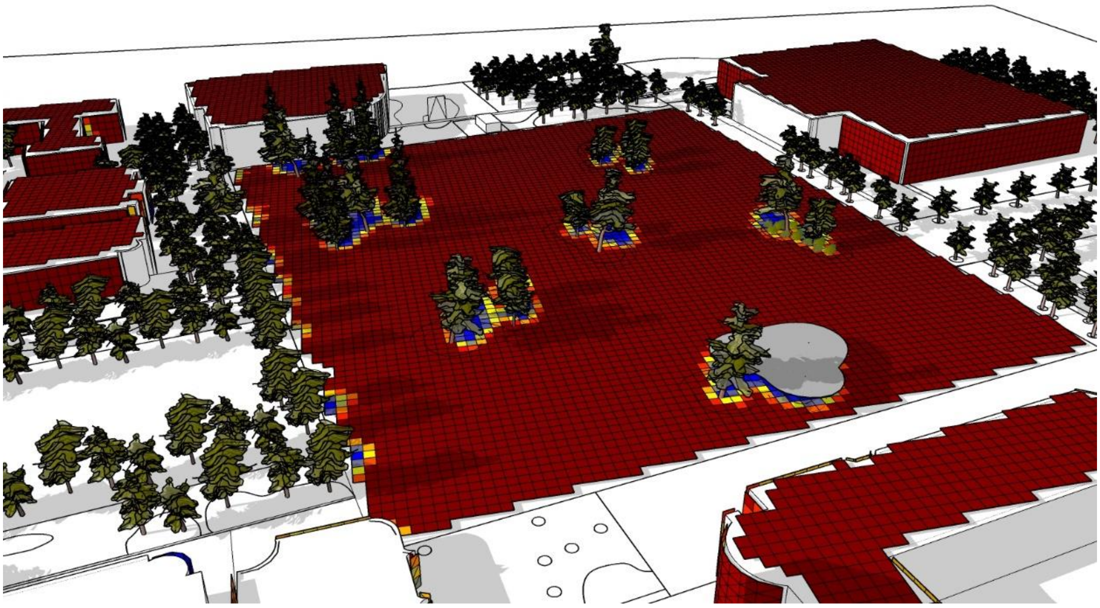


Figure 67. *Amount of sunlight that the square gets after intervention (2).*

6.4 Recommendations

From the analysis of the current situation, it became clear that when researching for a cooling method for Skanderbeg Square, it is important not only to combat the UHI effect but to also consider the square as a space intended for various events and with historical and cultural value. Future architects and urban designers who are involved in the development of such installations and similar projects should ensure that green, sustainable solutions are incorporated into their projects.

The specific approach practiced in the re-conceptualization of the Skanderbeg Square should be people-oriented. Just as in this case, every architect and urban planner or landscape architect should aim at enhancing thermal comfort for the people moving or interacting with the square and the surrounding structures. It should be noted that the proposed design must be introduced in such a way that the population of different ages, including people with disabilities and seniors, can be able to enjoy thermal comfort.

It may be critical to perform smart and flexible design solutions appropriately. Such interventional approaches must be made in such a way that they should be capable of allowing for change in the future as well as representing the new technologies that are ever emerging.

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APPENDIX

The questions asked in the survey of this thesis are listed below:

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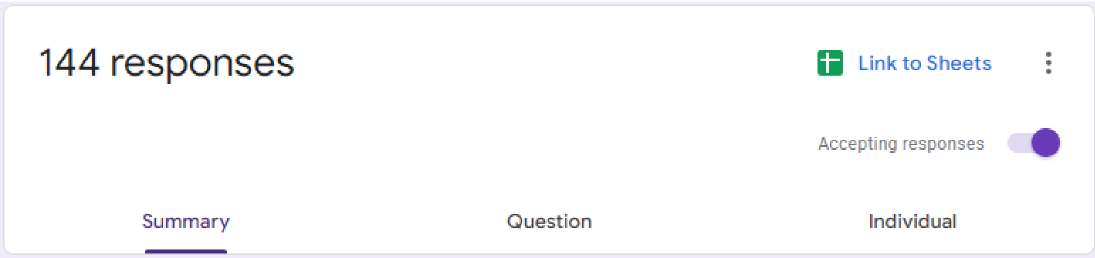

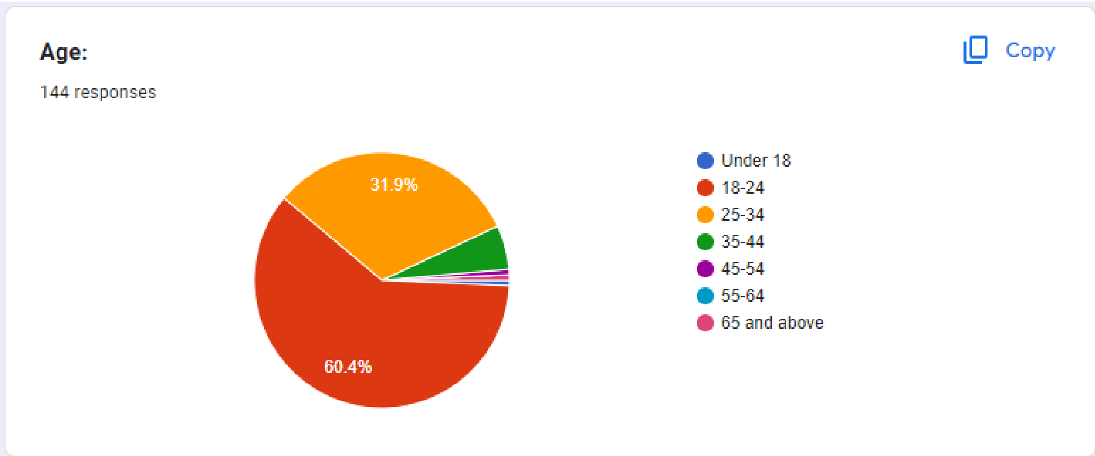

Gender:

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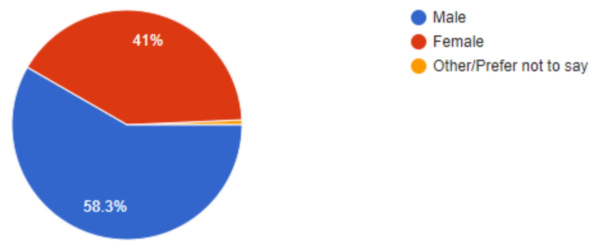
144 responses



How often do you visit Skanderbeg Square during the summer?

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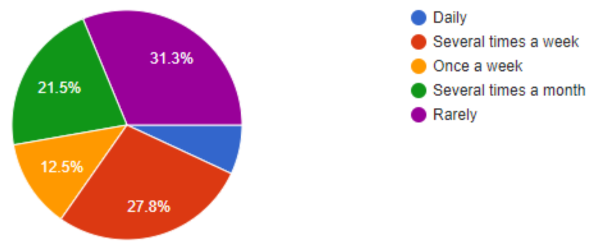
144 responses



What are the main reasons for your visit to Skanderbeg Square? (Select all that apply)

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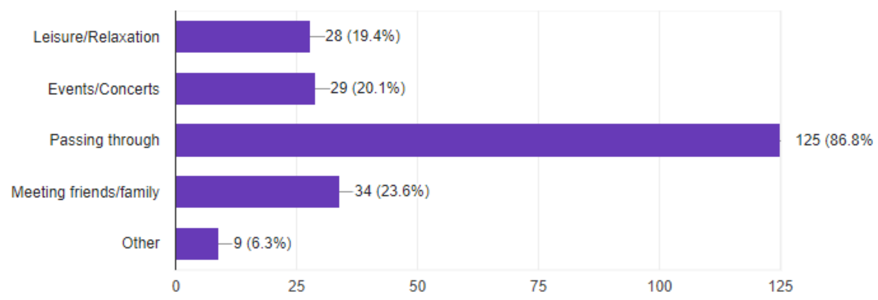
144 responses



How would you rate the overall comfort level of Skanderbeg Square during the summer?

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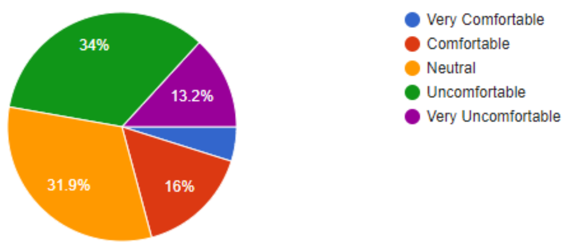
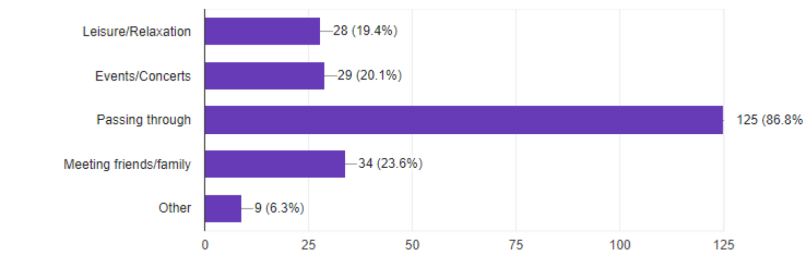
144 responses



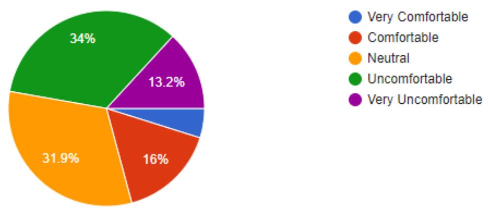
What are the main reasons for your visit to Skanderbeg Square? (Select all that apply)

144 responses



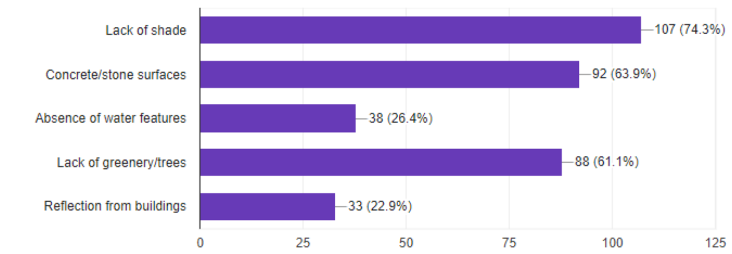
How would you rate the overall comfort level of Skanderbeg Square during the summer?

144 responses



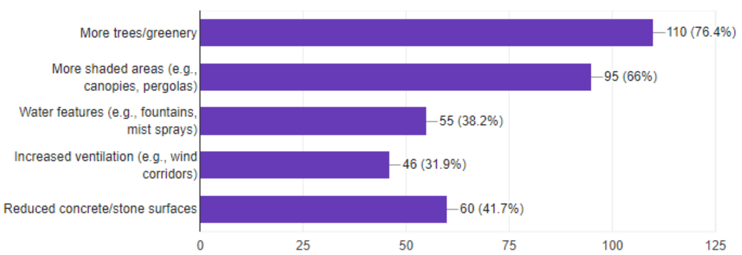
Which features in Skanderbeg Square do you think contribute to the heat? (Select all that apply)

144 responses



What changes would improve your comfort in Skanderbeg Square during the summer? (Select all that apply)

144 responses



Mema, A A proposal to improve the thermal comfort in Tirana's urban spaces: Skanderbeg Square 2024

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