Assessment of the quality of public garden use through their urban furniture, case study of the city of Guelma, Algeria

DOI: 10.46932/sfjdv5n12-063

Received on: Nov 19th, 2024
Accepted on: Dec 09th, 2024

Zeyneb Bouhallit
PhD Student in Sustainable Architecture and Urban Planning
Institution: University of 08 Mai 1945, Guelma, Department of Architecture, Laboratory of Civil Engineering and Hydraulics – LGCH
Address: Guelma, Algeria
E-mail: bouhallit.zeyneb@univ-guelma.dz

Fatima Zahra Djouad
Doctor in Architecture and Urban Planning
Institution: University of 08 Mai 1945, Guelma, Department of Architecture
Address: Guelma, Algeria
E-mail: djouad.fatimazahra@univ-guelma.dz

Assoule Dechaicha
Doctor in Architecture and Urban Planning
Institution: University Mouhamed Boudiaf, M'sila, Department of Architecture
Address: M'sila, Algeria
E-mail: assoule.dechaicha@univ-msila.dz

Djamel Alkama
Doctor in Architecture and Urban Planning
Institution: University of 08 mai 1945, Guelma, Department of Architecture,
Address: Guelma, Algeria
E-mail: alkama.djamel@univ-guelma.dz

ABSTRACT

Guelma, located in central northeast Algeria, is known for its semi-arid climate, which directly affects the use of its public gardens, as well as the presence of basic urban furniture. How does urban furniture contribute to the qualification of a public garden based on its users' vision? The purpose of this article is to highlight the necessity of promoting urban furniture as a sustainable social, economic, and environmental lever to improve the city's public gardens. The methodological approach used in this study focused on the following evaluation phases: spatial, climatological, energetic, and sociological, using, in order, photo-interpretation and photography, in-situ climate measurements, energetic data from the assembly of the commune of Guelma, and a sociological survey, we depended on direct observation throughout all phases of this investigation. The findings show that urban furniture faces social, environmental, and economic challenges, making it an important and essential element that affects the use of a garden. In the process of developing the quality of public gardens use, the recommendations emphasize the importance of this research, presenting proposals to improve the design of urban furniture, towards the creation of contemporary sustainable public gardens in the city of Guelma. This is an important step towards designing sustainable and smart public spaces to promote sustainable urban development.

Keywords: Urban Furniture, Assessment, Public Garden, Sustainable Design, Guelma, Algeria.

1 INTRODUCTION

A city's urban development is simply the result of its society evolving, which frequently seeks to meet its needs (Adolphe, 2023, p.4). Human-caused accelerated urbanization, global warming, and the global economic and health crisis have created serious environmental and social urban ills (Li; Stringer; Dallimer, 2022; Zheng *et al*., 2024). Uncontrolled urbanization currently poses a major challenge for urban and spatial planners, given its unprecedented scale and the harmful consequences it has generated (Dechaicha; Alkama, 2020). Given the rapid pace of development, we must reconsider the design of our cities to make them livable and sustainable. Public spaces, with their social, cultural, aesthetic, environmental, and ecological dimensions, are an essential component of the foundation and development of the sustainable and resilient city (Nguyen; Han; Ahito, 2019; Ricart *et al*., 2022). Their urban design must align with current sustainability issues by combining smart design and biophilia (Tarek; Ouf, 2021), to ensure the comfort and well-being of users, the sustainability and contemporaneity of the space, and among them is the public garden.

2 THEORETICAL FRAMEWORK

The public space is the urban cytoplasm that combines the user, the environment and the urban space; it plays an influential role in urban dynamics and vitality, this focus requires it to be designed according to the principles and objectives of sustainable urban development, the smart and resilient city.

An essential feature of well-designed public spaces, urban spatial resilience focuses on the interconnectedness of a city's natural and built environments, emphasizing how spatial activities and arrangements contribute to its overall resilience (Bechlem; Djouad; Salah-Salah, 2024). In this context, urban furniture is seen as one of the components of this resilience in urban public space.

Among the typologies of public space is the public garden, the most frequented public space in the city and the showcase of the urban landscape. The search for the sustainability and quality of use in these spaces calls for the study of the most significant design components that occupy and shape these spaces.

2.1 THE CONTEMPORARY URBAN DESIGN ASPIRATIONS FOR A PUBLIC GARDEN: BIOPHILIC, SUSTAINABLE ENERGY, AND DIGITAL DESIGN

A contemporary sustainable public garden is a smart self-sufficient garden. It depends on a sustainable urban design that integrates several aspects of urban sustainability, including biophilic design, sustainable energy design, and digital design. Biophilic design serves as a significant foundation for

sustainable landscape design. He guarantees the ecological, microclimatic, and aesthetic aspects of the garden (Djouad, 2021). Biophilic design, which incorporates nature into urban development, significantly contributes to sustainability (Djouad, 2010). This dimension supports the coherent connection between user, urban environments and nature for reasons of emotional well-being and ecological adequacy, constituting a key to urban, social, and environmental health (Alhefnawi, 2022). Biophilic design aims to provide therapeutic or healing effects in urban parks to mitigate the adverse effects of urban challenges such as pollution, heat, and elevated stress levels (Ryan; Browning, 2020; Ristianti *et al*., 2024).

The other pillar of urban sustainability in a public garden is sustainable energy design. The concept of energy design is based on the integration of sustainable renewable energy sources, such as solar, wind, hydro, biomass, and geothermal energy, into urban planning. Besides their essential role in combating climate change, these energy sources are also seen as factors of urban resilience by facilitating decarbonized and decentralized production. One of the major objectives of the energy design of public Garden is to ensure their sustainability through the use of clean and renewable energies, by integrating a substantial number of renewable equipment and furniture to capture these energies within the Garden. The goal is to transform this space into a showcase of sustainable energy for future generations (Hakimizad; Asl; Ghiai, 2015).

The third pillar of contemporary sustainable urban design is digital design. This aspect encompasses several tools, such as artificial intelligence (AI) and the Internet of Things (IoT). In a public garden, urban furniture represents a challenge in terms of digital design.. In a context where it is imperative to adopt a sustainable techno-social paradigm to prevent the harmful consequences of a resource-consuming and short-sighted lifestyle, artificial intelligence (AI) has the potential to act as a catalyst for transformation (Kaplan; Haenlein, 2019; Nikitas *et al*., 2020). Artificial intelligence promises to improve our health, wealth, and happiness by reducing the need for human labor and significantly accelerating our scientific and technological advancements (Everitt; Hutter, 2018; Nikitas *et al*., 2020). Urban artificial intelligence is defined as the integration of AI into urban infrastructure and spaces (Babu; Kumar; Kodati, 2021). These measures represent steps contributing to the enhancement of contemporary urban design, which aims to make urban spaces sustainable, including gardens where there are many urban components such as users, plant and water design, in addition to urban furniture.

2.2 URBAN FURNITURE, A CONTEMPORARY URBAN DESIGN CHALLENGE, AND A LEVER TO SUSTAINABILITY

Urban furniture encompasses all urban elements and accessories installed in public spaces such as streets, boulevards, public gardens, squares, small squares, corniches, and all other outdoor urban spaces

for public use, such as public benches, streetlights, trash bins, tree and plant planters, orientation panels, bus shelters, children's playgrounds, statues, symbolic and decorative elements, and all other landscaping elements. urban furniture has become a fundamental element of many nations' identities (Mohamed Hassanein, 2017). In the public garden, it is considered an essential element for design and equipment. They are design elements that can meet the users' requirements in terms of well-being, orientation, traffic management, safety, and entertainment (Cengiz; Karaelmas; Dağlı, 2018). Urban furniture is of paramount importance in the development of urban public spaces, as an essential component of the urban environment. He maintains a close and interactive relationship with the users as well as with their environment (Allameh; Heidari, 2020). Urban furniture plays a crucial role in improving the quality of urban spaces, as a distinctive element that shapes social assembly places within the urban environment (Ben Dhaou; Vasváry-Nádor, 2022). It is essential that all urban stakeholders, including government authorities, domain specialists, and users, recognize that urban furniture plays a crucial role in urban planning with the aim of improving the quality of the environment and life in urban areas (Prvanov, 2019). The reconciliation between contemporary sustainable design and urban furniture generates design challenges, such as biophilic urban furniture, energy-efficient urban furniture, and digital urban furniture, those who can influence the quality of use of a garden. Urban furniture elements with a biophilic design are described as smart urban planning elements that promote biodiversity. This aspect of sustainable design is manifested through the integration of benches combined with planters, for aesthetic, sanitary, or food purposes, which can contribute to the improvement of the quality of an urban public space. Another example is biophilic canopies such as the roofs of bus shelters, shade structures, and plant canopies. These elements can promote shade, thermal comfort for the user, urban agriculture, social links, and environmental preservation. These strategies also promote the quality and sustainability of public space, particularly a public garden. In addition, incorporating renewable energy sources into furniture design represents a progression towards sustainable urban development (Tereci; Atmaca, 2020). Energy urban furniture such as solar benches, bus shelters, lighting, solar canopies, and pergolas constitute the remarkable typologies of this sustainable design object (Premier, 2020). In addition to these elements, there are kinetic energy pavement, wind-powered streetlights, Kinetic children's play equipment, or kinetic energy sport furniture. All these elements of energetic urban furniture contribute to improving the quality of use of a public space, particularly a garden where people of all age groups can be found. Also Contemporary digital design of urban furniture is also a pillar for enhancing the quality and durability of a public garden. Digital design and smart technologies enable the collection of data that can be used to improve parks accessibility, enhance security, optimize programming, manage operations, and foster interactions between park officials and users (Smart Parks, Luskin Center for Innovation, 2018). In this context, urban furniture can promote and influence the quality of use of a public garden.

Guelma, located in northeastern Algeria, experiences a semi-arid climate and is known for being one of the hottest regions in the area. The city has undergone rapid and extensive urban expansion, resulting in significant changes to its urban landscape (Guechi; Gharraz; Alkama, 2022). Consequently, there has been a rise in temperature, leading to the occurrence of the urban heat island phenomenon. Which significantly affects the use of urban furniture and public space. Inadequate urban design of these spaces, which fails to take into account climatic conditions and user needs, leads to abandonment or infrequent use of these areas. The result is a range of urban, social, economic, environmental, energy and cultural problems, such as social stratification, congested and unliveable public spaces, increased energy. The public gardens in Guelma are very popular, diverse, and visually captivating. These places are designated for social gatherings and serve as social connections, with various areas distributed across the city. Barriers, plants, and urban furniture such as streetlights, benches, and fountains primarily characterize them. These elements highlight the most susceptible and ill-suited aspects of contemporary urban design, prompting us to question the following: How can we assess the quality of use of public gardens in the city of Guelma through the design of their urban furniture?.

The hypothesis focuses on the lack of sustainability vision in the design and planning of public gardens in Guelma city. We believe this is mainly due to the inadequacy of contemporary sustainable urban design of their urban furniture, which directly impacts the durability of the gardens, the comfort, and the well-being of the users. This study aims to assess the quality of public gardens in the city of Guelma through their urban furniture, and analyze its influence on the use of space. With a view to proposing some recommendations to improve the quality of urban furniture design.

3 METHODOLOGY

This article is dedicated to the scale of contemporary sustainable urban design by evaluating the quality of use of public gardens in the city of Guelma through their urban furniture, adopting a combination of several approaches: spatial, climatic, energy, and sociological, with the aim of improving the usability quality of a public garden through their urban furniture.

Spatial evaluation was used to classify public spaces (Djouad, 2021) in the city of Guelma according to specific criteria, including the degree and nature of urban furniture, as well as the presence of natural elements or their representations. We then selected three public gardens from the entity with the highest number of urban furniture elements. We justify this selection by the sociological criterion of frequentation. The final stage in this spatial assessment phase was the architectural analysis (Boulekbache-Mazouz, 2008) of the selected public gardens. This analysis covers morphology, accessibility, visibility, urban design in particular urban furniture. The main method used for data collection is direct visual

observation or in-situ observation, which constitutes a primary tool for data collection for the evaluation of the quality of a studied urban space (Angers, 1996).

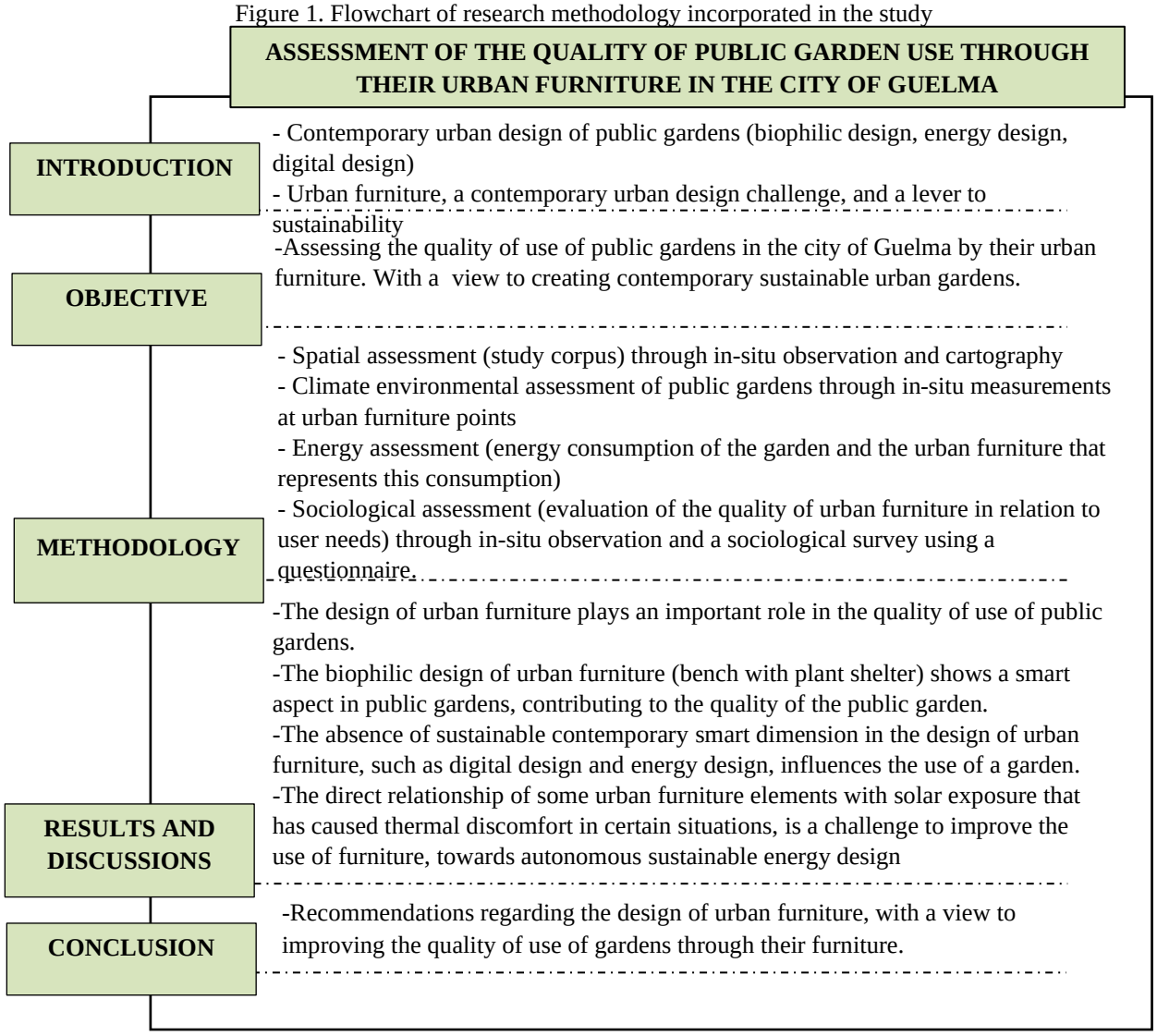
In addition, climatic evaluation enables us to assess the adaptation of urban furniture to the microclimatic environment of public gardens. In this part of the study, we relied on in-situ measurements. Air temperature T C°, relative humidity H% and wind speed V m/s were measured every three hours from 8am to 5pm in August 2024. For our measurement campaign, we used two instruments, a thermo-hygrometer and an anemometer. The measurement points were the points where the urban furniture was installed in the three gardens evaluated. The points we chose are the locations of furniture in shaded areas and the locations of furniture in sunny areas, related to the most frequently found furniture and the closest to the user. In the first garden, the chosen urban furniture elements are the benches, tables, and children's play equipment. Furthermore, the bench in gardens 2 and 3. These urban furniture elements, in addition to being more used by the users, are considered the most prominent elements in the garden.

The energy assessment of the selected public gardens was carried out by collecting municipal energy data from the energy department of the People's Assembly of the Guelma commune. Additionally, in this evaluation section, we relied on in-situ observation where we were able to classify urban furniture that has an energy aspect.

The final multi-criteria evaluation focused on the sociological aspect. Based on a survey using a directive questionnaire, which makes it possible to interview people directly, and to take a quantitative sample (Angers, 1996) with questions of a closed type according to the Likert scale.

The methodological scheme of the study is shown in (Figure 1).

Figure 1. Flowchart of research methodology incorporated in the study

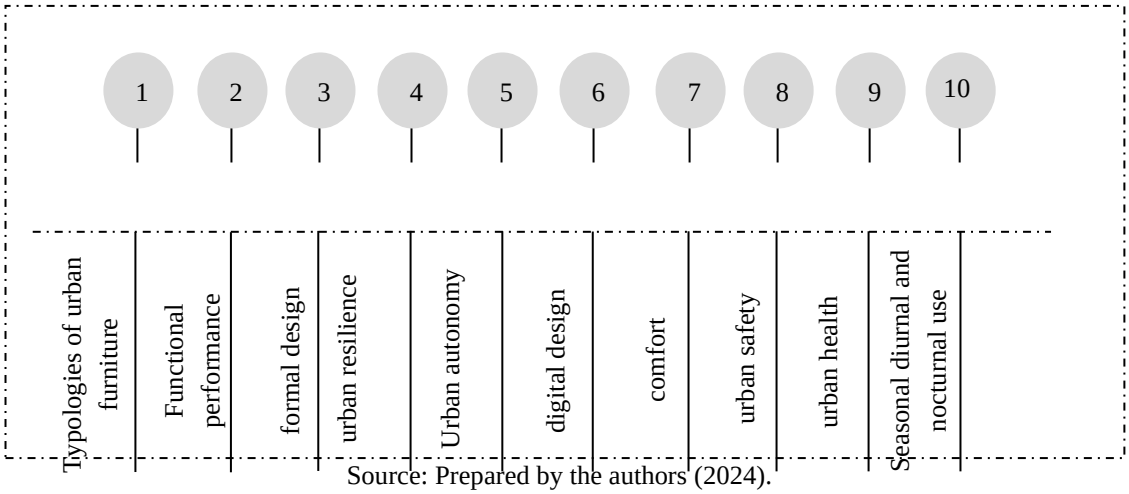


Source: Prepared by the authors 2024.

3.1 PUBLIC GARDEN ASSESSMENT CRITERION AND STUDY SAMPLE

The sample size of the study, is specified according to the (Angers, 1996) formula (Table 1). The questionnaire was conducted during the July 2024 summer period. Functional performance, use, comfort, resilience, autonomy, safety and health are the criteria we used to assess the quality of use of a public garden through the design of urban furniture (Figure.2). The management and processing of the data collected by the questionnaire were analysed using SPSS software. The numbers on the Likert scale were transformed into averages, and then we determined the weighted average of the five-point Likert scale, The degrees of agreement and disagreement for each element were specified, ranging from ‘strongly disagree’ to ‘strongly agree’ (Pimentel, 2010; Alonazi; Beloff; White, 2019) (Table 2).

Figure 2. Criteria for assessing the design quality of urban furniture.



Source: Prepared by the authors (2024).

Table1. The size of the study sample.

Sample size adopted in each case	the sample size of the study is specified according to the (Angers, 1996) formula - Population size ranging from a few hundred to a few thousand (10%) - Population size less than a hundred (50%)		
	Garden 1	Garden 2	Garden 3
	100	70	30
Total intensity of use	200		

Source: Prepared by the authors (2024).

Table2. The Weighted mean of the Likert scale.

Likert scale (five points)	1	2	3	4	5
Weighted average	[1-1.8)	[1.8-2.6)	[2.6-3.4)	[3.4-4.2)	[4.2-5]
Description	Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree

Source: Prepared by the authors (2024).

In this part of the sociological analysis, we used multiple and simple linear regression, with EViews software used for data processing. The estimated model of the multiple linear regression function for the variables studied is shown in equation (1), and the estimated model of the simple linear regression function for some of the variables studied is shown in equation (2).

$$\gamma = \beta 0 + \beta 1x1 + \beta 2x2 + \beta 3x3 + \varepsilon i \quad (1)$$

Where:

γ: Dependent variable: The dimensions of the public gardens assessment section (frequentation, function, use, urban design)

x 1: Independent variable 1: urban furniture typologies

x 2: Independent variable 2: functional performance

x 3: Independent variable 3: formal design

εi: The rest of the independent variables of the urban furniture design evaluation component (comfort, autonomy, safety, health, use, digital design)

$$\gamma = \beta 0 + \beta x \quad (2)$$

Where:

γ: Dependent variable: The dimensions of the public gardens assessment section (frequentation, function, use, urban design).

x: Independent variable: the dimensions of urban furniture design assessment (typologies, foncional performance, formal design, comfort , autonomy, safety, health, use, digital design).

3.2 MATERIALS AND EQUIPMENT

At each evaluation phase of our study, we employed a particular method. In-situ observation is the method used throughout the various evaluation approaches. In the spatial evaluation, we used it to conduct a reading on the public space of the city of Guelma, followed by the gardens. During the climate assessment phase, we used in-situ measurements with two instruments, which are a thermo-hygrometer to measure air temperature and relative humidity, and an anemometer to measure wind speed. These measurements allow us to conduct a micro-climatic assessment of the gardens through the urban furniture. During the energy assessment phase, in addition to direct observation, we used the energy consumption data provided by the Energy Department of the city of Guelma. Furthermore, during the sociological evaluation phase, we employed various tools, including in situ observation, which allowed us to assess the use of garden furniture by users. In addition, we also used a structured questionnaire.

3.3 DATA ANALYSIS

In this study, we used two analytical software programs to analyze the results of the sociological evaluation. We used SPSS to perform a descriptive and evaluative analysis of the results from the different sections of the questionnaire. To establish the correlation and impact between each garden and the furniture design, we used the EViews software.

4 RESULTS AND DISCUSSIONS

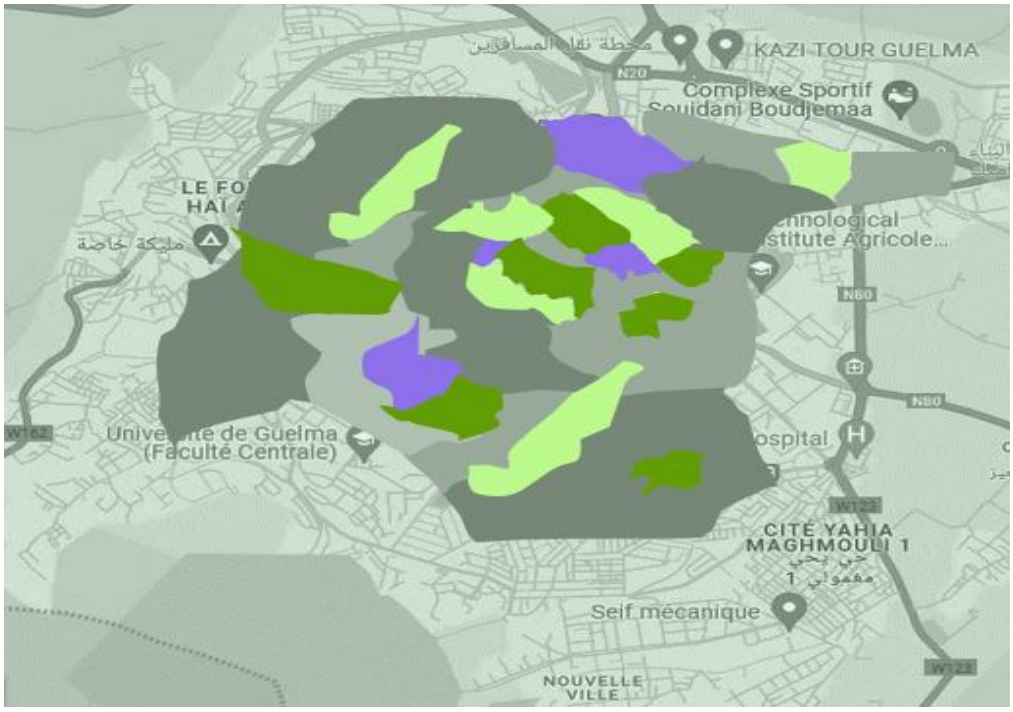
Guelma is a city located in the northeastern region of Algeria, 60 km southwest of Annaba, 110 km east of Constantine, 60 km from the Mediterranean Sea, and 150 km from the Tunisian border (PDAU Guelma Algeria). Guelma, formerly known as Malaca, is a historically significant town that boasts significant cultural and historical landmarks. The location of the area is situated at a latitude of 36.28° north and a longitude of 7.25° east. It covers a surface area of 45 square kilometers and has a population of 154,000 individuals, according to the Communal statistical data from 2023. In order to demonstrate Guelma's classification as a semi-arid climate, we utilized the aridity index (mm/c°) determined through De Martonne's formula. This calculation was based on climate data collected over the past decade (2013-2023). The data processing indicates a range of aridity between $10 < I < 20$, with an index of 18.5 mm/c°. Guelma is located in a semi-arid climatic zone characterized by seasonal climatic extremes, including high temperatures and a prolonged dry season that spans most of the year.

From the atrocity of semi-arid climatic conditions to the urban microclimate in the city, Guelma is characterized by an urban microclimate, which results in a significant alternation of thermal climatic conditions. These extreme micro-climatic conditions have led to the use of the city's outdoor spaces in situations of discomfort, leading to the abandonment of these spaces.

4.1 GUELMA'S PUBLIC GARDENS: THE MOST DESIGNED PUBLIC SPACE

Guelma, similar to other cities in Algeria, possesses a combination of contemporary public areas as well as those passed down from the Roman, Ottoman, and French periods. This article aims to categorize public spaces based on the level and type of urban furniture used to create the (Figure.3) photo interpretation provided below.

Figure 3. Typology of public spaces in Guelma city, Depending on the varieties of urban furniture



LEGEND

Urban entity where the public space possesses only public lighting poles.

Urban entity where public space has poles street lighting and public benches: the key areas of focus of the city

Urban entity or public space with a fountain with a contemporary design

Urban entity where public space has poles public lighting, benches and a fountain.

Source: Prepared by the authors (2024).

The initial urban entity consists primarily of housing estates and collective housing groups, with public lighting poles being the sole source of illumination in the public space. This entity holds the highest level of prominence. The second category comprises the city's main roads, such as Soudani Boudjemaa and 1 November, which are furnished with street lighting poles and public benches. The third urban entity is characterized by its abundance and diversity of urban furniture, including street lighting poles, public benches, litter garbage cans, and fountains that adorn the squares and public gardens. The roundabouts constitute the ultimate entity, distinguished by the contemporary design that visually sets them apart from the urban collection.

4.2 ARCHITECTURAL ANALYSIS OF PUBLIC GARDENS IN GUELMA

Guelma is home to several public gardens that have historical, residential, or recreational significance. These gardens are popular among people of all age groups. At this stage, we have chosen our study sample based on the biophilic design criterion. We have selected three types of gardens (Figure.4). The first Garden is the 19 June 1954, which bears the name of the deceased mujahid Ben Mihoub Hassan. This Garden is known as the Esanawbre Garden due to the pine trees in it, which is one of the components of the botanical heritage in this city. Which has a genuine biophilic design and preserves the natural vegetation of the site, including trees and plants, and Mustapha Séridi, which combines artificial vegetation (planted and not native to the site) on the ground with natural trees. The Guehdour city garden is a newly established space where all the design elements that mimic nature are manufactured.

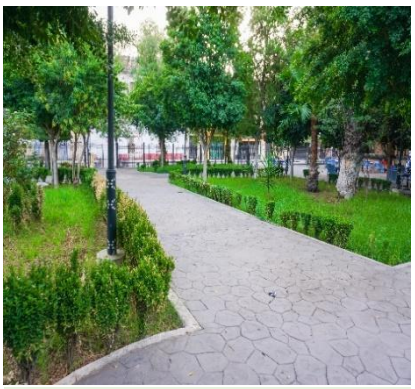
The Esanawbre public garden: a contemporary creation in time, not in urban furniture: Esanawbre, is a new public garden for rest and recreation that was renovate in 2023. with the goal of minimizing the artificial nature of pavement (a 10 cm thick, lightly reinforced, printed concrete paving) while giving it a natural character, with its old pine trees and shrubs that provide shade and natural air conditioning throughout the garden. Located in downtown Guelma, this 1500 m² trapezoidal garden is set on uneven ground and visually open to the surroundings. The garden, is enclosed by steel railings with straight solid bars œ 18 mm spaced: 120 mm maximum and a minimum useful height of 2 meters from ground level to the tip of the spear. There are three types of benches: wooden benches with cast-iron structure, red wooden slats with a seat width of 40 cm and length of 170 cm. The second type are benches with tables. the third type of bench is the rectangular bench, covered in marble with a thickness of 2 cm with the following dimensions (width = 45 cm, H = 50 cm), rounded bench corners, found only outside the garden. The placement of the public benches demonstrates a lack of research that considers shade and artificial lighting when incorporating them into the garden space. The garden features three types of lighting element, the first is a single-cross public lighting, the other is a double cross with round, conical, or telescopic from, designed with powder-coated galvanised steel, as well as 40 mini-lamps with fluorescent lamps and aluminium and stainless steel structure these mini-lamps are 1 metre high and deliver 11 watts of power. Waste collection is carried out by 45 wooden litter bins, measuring 50 x 30 x 80 cm and with a capacity of 26 litres, fixed to the ground or on a post with a threaded rod and anti-corrosion galvanised bolts. The children's play area includes a two-seater autoclave-treated Scots pine swing with polyamide hooks, a polyurethane seat and bearings, stainless steel chains, a two-seater autoclave-treated Scots pine rocker, and a polyethylene toboggan.

The Mustapha Séridi public garden: a colonial legacy rehabilitated: The Mustapha Seridi Garden is a public garden located in downtown Guelma near Place des Martyrs, will open its doors to the public in 2022, following the urban redevelopment work begun in 2020. This linear space, covering an area of 9071 m2, is planted with large trees inherited from the colonial period: the 5th-age Washington palm and the 5th-age Ficus, as well as artificial vegetation such as thorny roses branched at the base, perennials such as (fusain, myoporum, privet, planting of hardy grasses...). This biophilic design encourages natural shade and refreshment for users, especially given the flat terrain and location in the city's colonial center, which creates a visual barrier between the user and the outside environment. The garden is protected by a steel fence with œ straight 18 mm round bars. It is equipped with ARTDECO benches in ductile grey cast iron, 2 m long and 68 cm wide. H=71 cm. These are complemented by 114 mm-diameter, H=3.5 m, round, powder-coated galvanized steel cantilevers, a 15 cm-thick decorative clamp, and a single luminaire for ambient lighting fitted with a kit of 50 Watt LED modules. The litter garbage cans are made of perforated steel and rest on a perforated sheet steel support with reinforcing bars and removable perforated steel caps. The garden floor is treated with printed concrete, 10 cm thick and slightly reinforced.

The Guehdour garden: an open space exposed to sunlight: Located at the entrance to the Guehdour neighborhood, the garden spreads over an elongated area of 2050 m². This rectangular garden lacks green space in comparison to the other two gardens Esanawbre et Seridi Mustapha, which leads to its use during hot or rainy weather. The absence of water jets thus distinguishes it as both an aesthetic tool and a refreshment source. This non-enclosed garden is designed with low concrete walls that serve as a foundation, and lighting, including round, powder-coated galvanized steel candelabras, makes it accessible both day and night. The litter garbage cans in this garden, are constructed from wood, while the lack of information panels and water fountains has been observed.

Figure 4. Public gardens evaluated.

Esanawbre Garden



Seridi Mustapha Garden

Guehdour Garden

Source: The authors 2024.

4.3 URBAN FURNITURE AND THE MICROCLIMATIC AMBIANCE OF THE PUBLIC GARDEN

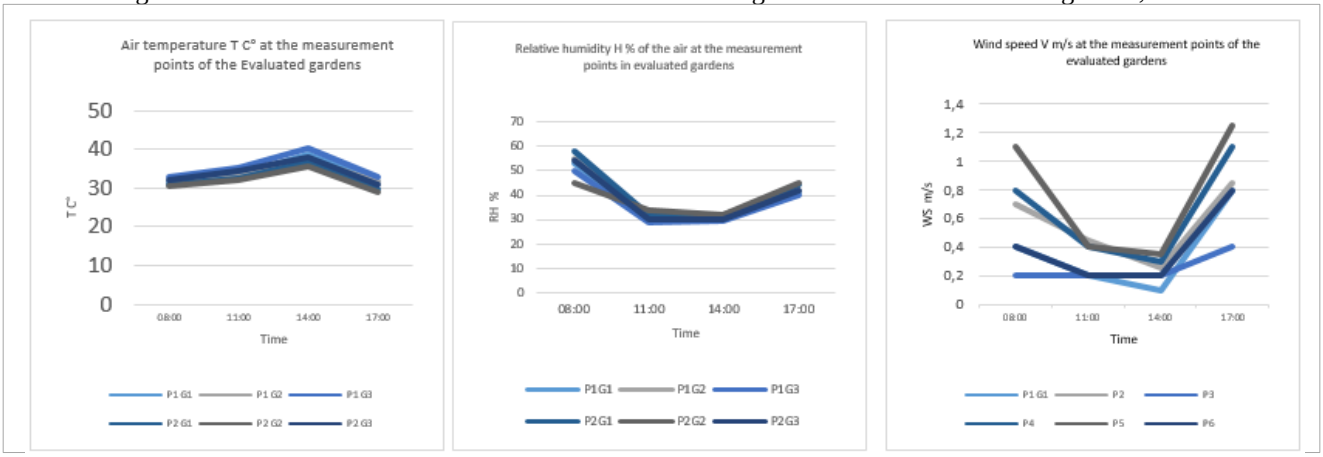
The results of the measurements In-situ indicate that the city of Guelma is characterized by an urban microclimate, where the climatic parameters differ in the evaluated gardens. The elements of urban furniture closest to and most used by users in the Esanawbre garden are the public bench, the tables, and the children's games. In the Seridi Mustapha and Guehdour garden, the public bench is the piece of furniture most used by visitors. (Figure 5) shows the results of the microclimatic evaluation of public gardens through their urban furniture at different points from 8:00 AM to 5:00 PM.

The highest T value in the three cases evaluated was recorded during the session from 11:00 to 14:00 at point P1 (sunny urban furniture) with 40°C in Guehdour Garden, 39°C in Esanawbre Garden, and 38°C in Seridi Mustapha Garden; while at 17:00, point P2 (shaded urban furniture) shows a low value with 30.1°C in Guehdour Garden, 28.5°C in Esanawbre Garden, and 28.1°C in Séridi Mustapha Garden. These results are strongly linked to the biophilic plant design of each garden (type and degree) which brings a conceptual effect to the elements of urban furniture. For the second evaluation parameter, which is relative humidity, the highest value was recorded at 8:00 AM and 5:00 PM at P2 in the Séridi garden at 55%, in the Esanawbre garden at 53%, and in the third garden Guehdour at 50%. While the lowest value of 21% was recorded in P2 during the session from 11:00 to 14:00 in the Guehdour garden. Furthermore, at 8:00 AM and 5:00 PM, the highest wind speed was recorded in P2 (shaded urban furniture) with 1.4 m/s in the Séridi and Esanawbre gardens, and 0.8 m/s in the Guehdour garden. While the lowest value is recorded at 2:00 PM in P1 with 0.1 in the Guehdour garden m/s. In each garden, the positioning of the furniture (shaded area, sunny area), the time of measurement, the degree and type of biophilic design are the parameters that determine the adaptation of urban furniture elements to the microclimatic ambiance. These results show a moderate perception of the microclimatic ambiance in urban furniture elements with a biophilic design.

The micro-climatic evaluation of the three gardens through their furniture by observation and in-situ measurements showed that there is a difference in usage between shaded furniture and sunny furniture, due to the temperature differences between shaded furniture and furniture directly exposed to the sun. The furniture elements that are shaded by the garden plants have contributed to creating thermal comfort, such as the benches that have plant cover provided by the trees in gardens 1 and 2, as well as the tables and children's games in garden 1. In contrast, the furniture exposed to the sun is generally abandoned and unused, especially during periods when temperatures are high (the benches exposed to the sun in all three gardens, as well as the children's games and tables in garden 1). We also noticed that the material design of furniture exposed to the sun affects its use. Indeed, we have observed in gardens 2 and 3, where there are steel benches, that they heat up a lot, which impacts their use and, consequently, the

quality of the garden. On the other hand, the accumulated heat spreads during the period when the bench is in the shade, that is, at night. This heat increases the sources of global warming and heat islands. This results indicate that there is a direct relationship between the architectural design of the furniture and the microclimatic conditions of the garden. In the three cases evaluated, it is observed that the elements of street furniture exposed to the sun experienced a decrease in usage during extreme weather conditions (high temperatures), which is due to the architectural design of the furniture (materials and positioning).

Figure 5: Microclimatic Evaluation of Public Gardens through Their Urban Furniture August 23, 2024.



Source: Prepared by the authors 2024.

4.4 ENERGY ASSESSMENT: LIGHTING AS A UNIQUE FORM OF CONSUMPTION

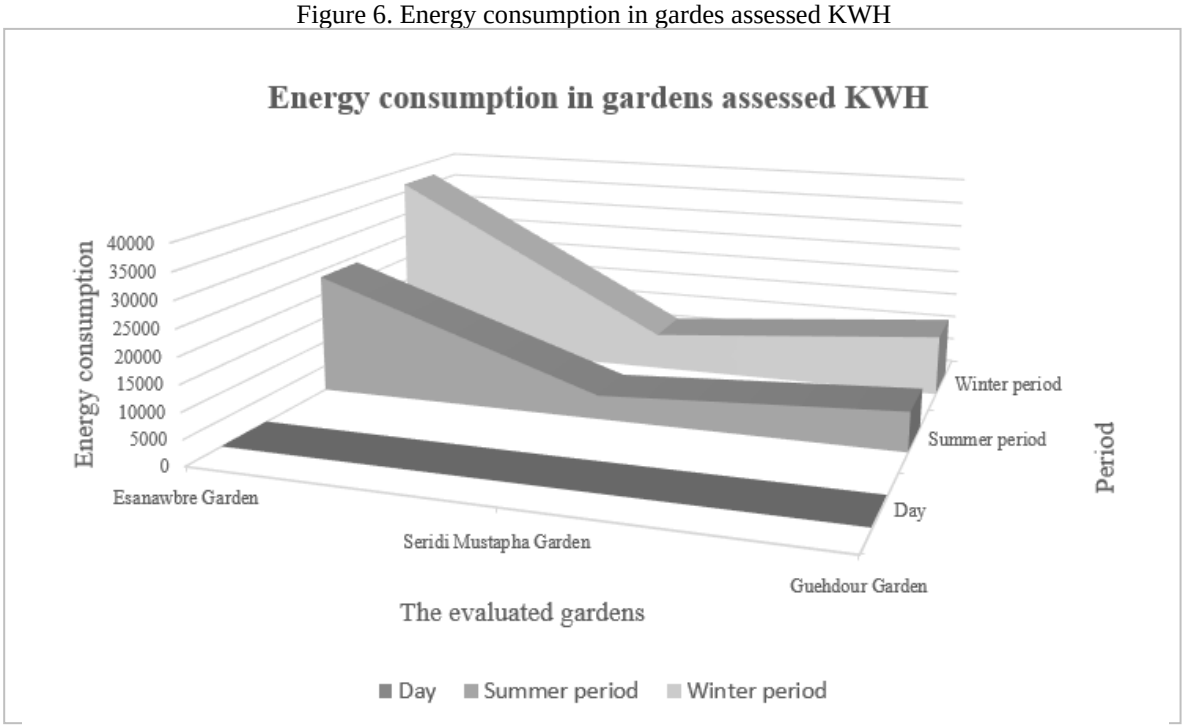
The electricity poles in the evaluated gardens are the primary urban objects responsible for the majority of energy consumption. They serve as the lighting structure during the night, ensuring accessibility, safety, legibility, and ease of use in the garden. Energy consumption during the summer was lower than during the winter in all gardens instances.

The Esanawbre garden, spanning 1500 m² and consisting of 84 lighting poles, exhibited a significant energy consumption rate of 23635.8 kWh in during the summer period and 36766.8 kWh during the winter period, in comparison to the Seridi Mustapha Garden (number of lighting columns =58, Surface=9071 m², Summer energy consumption =4698 kWh, Winter energy consumption =7308 kWh), and Guehdour Garden (number of lighting columns = 39, Surface =2050 m², Summer energy consumption= 7695 kWh, Winter energy consumption=11970 kWh). The provided energy graphs (Figure 6) depict the daily and annual energy consumption specifically for the summer and winter periods of the evaluated gardens. The energy evaluation by observation indicates that the energy urban furniture in the three gardens is the streetlight, its energy consumption is based on the use of conventional energy.

On the other hand, certain types of garden furniture that have a direct relationship with the user, such as benches, children's play equipment, and tables in garden 1, as well as the bench in gardens 2 and

3, are in some cases in direct contact with solar energy, which sometimes affects the user and their comfort, prompting them to leave the garden, especially in summer during periods of intense heat or in cases where the user prefers shaded areas. In this case, solar energy can be a challenge and an element of sustainable design instead of being a source of nuisance.

Figure 6. Energy consumption in gardes assessed KWH



Source: Prepared by the authors 2024.

4.5 SOCIOLOGICAL EVALUATION OF THE USE OF URBAN FURNITURE IN PUBLIC GARDENS

After assessing the spatial and energy aspects of the gardens under study, we decided to adopt a different sociological approach, focusing mainly on surveys and observations. The aim was to determine the level of use of these gardens by examining their urban furniture. The survey will, therefore, take place over four consecutive days in July 2024 (25, 27, 29 and 30), starting at 6:00 pm. This decision is justified by the low intensity of use from 8:00 am - 6:00 pm due to extremely high temperatures.

At present, we have recorded a minimum frequency of 200 users in the Esanawbre garden, 140 users in the Mustapha Seridi garden and 60 users in the Guehdour garden. To determine the appropriate sample size for each garden, we followed the indicated formula (Angers, 1996) in the (Table 1). The main instrument used in this analysis was the in-situ questionnaire, and the data obtained were analyzed using SPSS. The data processing procedure began with database design, questionnaire entry, variable coding based on the Likert scale, calculation of Cronbach's alpha coefficient to assess questionnaire reliability,

and use of the Kolmogorov-Smirnov and Shapiro-Wilk tests to confirm the normal distribution of the data. In this questionnaire, which contains three parts: a section for identifying the interviewee, a section for evaluating the quality of the public garden, and a section for evaluating the design of urban furniture. We used SPSS for descriptive and evaluative analysis, and EViews for multiple and simple regression between the dependent and independent variables.

The users of public gardens in Guelma: in the gardens of Mustapha Séridi, Guehdour, men are more frequent (G2. 74.28% -G3 70%), where as in the Esanawbre garden (G1), there is almost an equal number of men and women (45% and 55%), This is due to the quality of design of each garden. The predominant age group in the Esanawbre garden is those under 20 years old (30%) and those between 20 and 40 years old (37%). This is due to the presence of urban furniture for children (playground) and young people (sports furniture). In the other gardens, the dominant category is that of 20-40 years old (50% G2, 63.33% G3). In the three cases evaluated, the majority of users are city dwellers, with a percentage of over 70% city dwellers (75% G1, 71.42% G2, 70% G3).

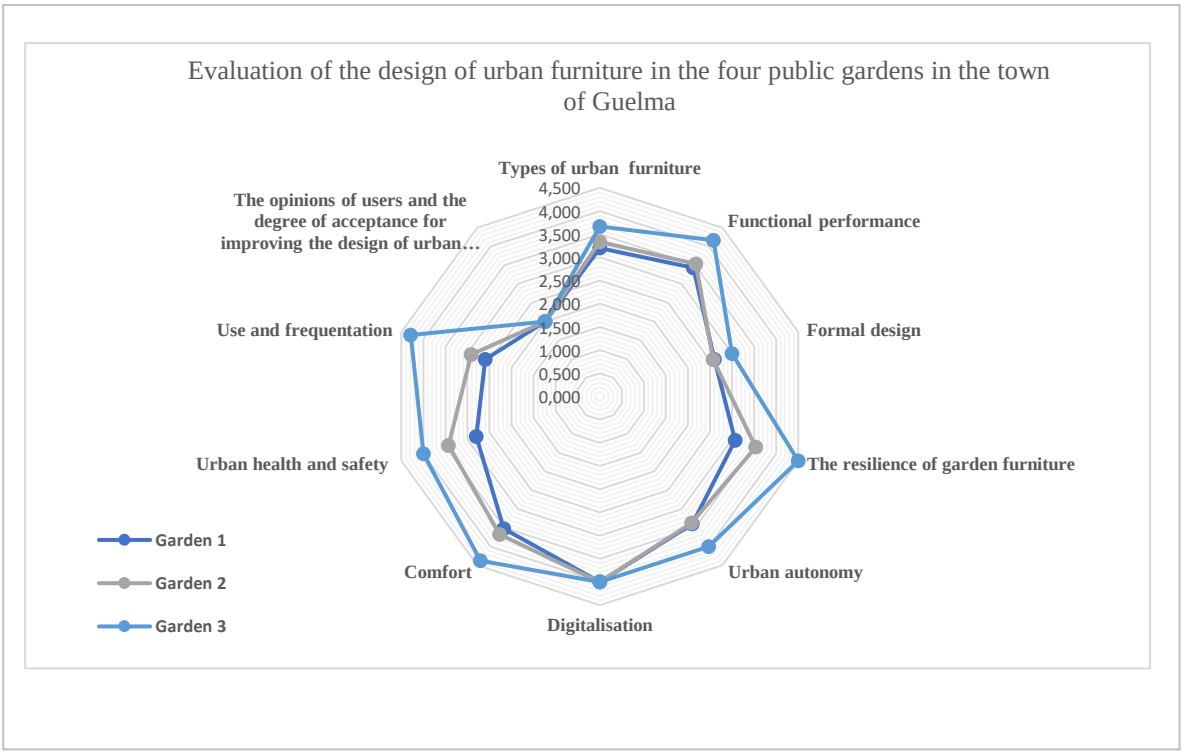
In the investigation of garden use quality, daily and weekly attendance was highest in the Esanawbre garden, average in the Séridi garden, and lowest in the Guehdour garden. In the first Esanawbre garden, 40% of users frequent the garden on weekends, 50% visit twice weekly, and 10% attend once weekly, the same case for the Séridi garden, in the third garden, more than 50% of users use the space occasionally. Moving on to the second criterion, which evaluates the duration of use in each garden, the results show that the two gardens Esanawbre and Séridi experienced a usage duration of more than 2 hours (50%). The short duration of use appears in the third garden with more than 50% of users using the garden for less than an hour. The third criterion of this evaluation concerns the choice of use, where most users chose the Esanawbre garden due to the diversity of the furniture's functions (30%), its quality (30%), and the shade it provides (40%). In the second garden, nearly 20% of users chose the garden for its location, 40% for the shade, and nearly 20% for the quality of the urban furniture. In the third garden, most users (over 50%) chose the space because of its location. Furthermore, we interviewed the users about their satisfaction with the functions of the garden. Most users of the Esanawbre and Séridi gardens are moderately satisfied with the garden's functions (50% Garden 1, 57.14% Garden 2), but in the third garden, most were not satisfied. When evaluating the factors that encourage and hinder the use of the garden, it is observed that the shade that will provide shelter for the bench has an impact on the use in garden 1 and 2. For the factors that prevent the use of the garden. 50% of the garden users 1 Esanawbre and 2 Seridi chose the absence of smart design with digital furniture, Moreover, the absence of smart and resilient technologies in urban furniture in response to the microclimatic environment (the presence of benches without shelters, and they are exposed to climatic conditions such as extreme summer weather). In the third garden, 50% chose the absence of smart digital design and 50% chose the absence of smart

furniture design (shade and cooling). The evaluation of gardens in this section, we show that the design of urban furniture influences the quality of use of public gardens, particularly those that adopt smart technologies (urban furniture with biophilic design, which provides shade and refreshment for the user, this aspect is marked in Garden 1 and 2).

In the third section, which focuses on the evaluation of urban furniture design, the analysis of the results showed that this element has a different design in the three gardens evaluated. For the first dimension of the evaluation "types of urban furniture," users in the three assessed cases agree that the urban furniture is basic and does not contain any digital aspects. Regarding the second evaluation criterion, which is functional performance, users of the Esanawbre and Séridi gardens are 50% in agreement on the presence of urban furniture that provides shade, such as the public bench shaded by the garden's biophilic design, and 45% responded with not at all in agreement. This is due to the positioning of the garden benches (bench in the shade, bench exposed to the sun). This is what affects the satisfaction rate of users through the functions that urban furniture provides. In the first garden, the Esanawbre and Séridi gardens, the users are moderately satisfied, and in the third garden, most users are not satisfied.

The evaluation of the resilience of urban furniture in each garden shows that this object is moderately resilient in gardens 1 and 2, where users moderately agree. This is due to the presence of biophilic design near the urban furniture elements (bench, table, children's games in garden 1) (and bench in garden 2). However, users of garden 3 do not agree that the furniture is resilient to various microclimatic factors, and do not agree that the urban furniture is adapted to the users' needs. Moving to digital design, the three gardens show no aspects of digital design, with no agreement at all in all three cases. The urban furniture elements with biophilic design show a state of thermal comfort in Garden 1 Esanawbre and Garden 2 Séridi, but in the third case, the urban furniture elements show no state of comfort. The following (Figure 7) shows the results of the sociological evaluation of gardens through their urban furniture design.

Figure 7. Results of the evaluation of the design of public garden furniture in Guelma city.



Source: Prepared by the authors 2024.

To show the relationship and influence of urban furniture on the quality of gardens, we performed multiple and simple linear regression between attendance, degree and choice of use, satisfaction with functions, and the design of urban furniture. The results of this regression are summarized in the following table (Table 3).

Table 3. Regression of dependent and independent variables of the evaluated gardens (G1.G2.G3).

Dependent variables		Frequentation			duration of use			choice of use			Function		
The public gardens evaluated		G1	G2	G3	G1	G2	G3	G1	G2	G3	G1	G2	G3
Dependent variables urban furniture design	Coefficient	2.131832	1.688989	18.54545	2.217317	1.246761	0.039216	1.969940	3.575115	18.54545	2.360296	1.998015	2.123955
	Adjusted R-squared	0.535306	0.804726	0.152597	0.638218	0.565750	0.717532	0.730091	0.779124	0.717532	0.584937	0.606433	0.737701
	F-statistic	115.0435	285.3490	6.222222	175.6453	90.89464	74.66667	268.7905	244.3925	74.66667	140.5182	107.3196	279.4314

In the three gardens, the F-statistic value is represented by an interval between (10-300) with a probability value of 0.000000 less than 0.05, which indicates the significance of this regression model and the significance of the effect of the independent variable (urban furniture design) on the dependent variables (attendance, duration of use, choice of use, satisfaction with the function). It appears that this aspect (urban furniture design) with all its independent variables plays a role in explaining the factors of attendance, degree and choice of use, satisfaction with the function of the garden by the user (Prob < 0.05) (see Table.3).

The value of the coefficients of the independent variables "design evaluation of urban furniture" is positive in the two gardens Esanawbre and Séridi for the two dependent variables (Attendance, duration of use, and choice of use), and negative in the third garden, indicating the existence of a direct correlation between the design of urban furniture and the quality of public gardens. And the probabilistic values are 0.0000, below the confidence threshold of 0.05, meaning that this aspect affects garden use (frequency, duration, and choice of use). The quality of the furniture in the three gardens has featured a different design. This explains the difference in the level of attendance, as well as the duration and choice of use, saturation or the absence of saturation of users of the services of each garden.In the first garden, Esanawbre, and garden 2, Séridi, half of the users are moderately satisfied with the garden functions. The values of the coefficient of the variables "functional performance, formal design, comfort (plant bench, cooling and shade), sanitary and sports furniture, variety of use" are positive, indicating the existence of a direct correlation between these and the garden function. And the probabilistic value between (0.0000 and 0.0124) is less than 0.05, meaning that the function is positively affected by these variables. Also, the values of the coefficient of the variables "digitization, online service, resilience with smart technologies" are negative, indicating the existence of a correlation between them and the 100 percent dissatisfaction of users with the functions of the gardens. And the probabilistic value less than 0.05, meaning that satisfaction with garden functions is also positively affected by these variables. In the third garden, most users are dissatisfied with the garden's functions, the values of the coefficient of the urban furniture design variables (typology, functional performance, resilience, autonomy, digitization, usage, health, and safety) are positive, indicating the existence of a direct correlation between them and the insufficiency of the functions of the Guehdour garden. And the probabilistic value between (0.0000 and 0.0124) is less than 0.05, meaning that the insufficiency in the garden function is positively affected by these variables. The lack of quality in the design of urban furniture in Garden 3 is reflected in the users' inability to utilize its functions.

The adjusted R-squared coefficient indicates that the design of urban furniture has a 50% impact on the usability quality of public gardens 1, 2, and 3. The presence of certain quality standards in the design of urban furniture has allowed the user to be moderately satisfied with the gardening services. The

lack of satisfaction is due to the absence of certain quality criteria such as digitization. Energy independence and services... Health, safety, and remote services, which is explained by the results of parks 1 and 2. Regarding Garden 3, the user was not satisfied with its performance due to the absence of the qualitative design criteria described in the section dedicated to the evaluation of urban furniture design.

Urban furniture is a fundamental object in the use of a public space, more specifically a public garden. This importance derives from its direct correlation with the user, making it a vital element of spatial urban design (Allameh; Heidari, 2020). In this study, the evaluation of urban furniture design shows the effect of this urban object on the quality of use of the public garden in the city of Guelma, where its design is influenced by several factors: sociological, environmental, and economic. Through the landscape reading of the city of Guelma, we observed that the entity primarily formed by public gardens promotes more choices in terms of urban furniture elements by incorporating other qualities of urban design such as biophilic design. On an architectural scale, we found that the first public garden Esanaoubare is a contemporary creation in terms of time, without visual limits, with a biophilic design that was very remarkable for its authentic character. The second Séridi garden is the result of the rehabilitation of a public space inherited and visually closed on its three sides, with the presence of architectural elements from the past and a biophilic design that is a hybrid between the inherited elements and those arranged in the present. The latest public garden, Guehdour, is an open space with low vegetation density. The common point between these gardens was the presence of basic urban furniture with a visible absence of the smart dimension in its design (digital and energy design).

The microclimatic environmental assessment with in-situ measurements indicates that urban furniture shaded by biophilic plant design promotes a state of comfort for the user. On the other hand, urban furniture exposed to the sun is abandoned in extreme microclimatic situations. This projection, which combines an uncomfortable urban environment with an energy aspect, leads us to rethink solar energy as a design challenge for furniture.

The energy assessment of the study gardens, both in terms of the quality of the energy furniture and the quality of the energy used, showed that the gardens still rely on conventional energies, which is reflected in the only energy furniture (the lighting). On the other hand, some furniture is directly related to renewable energies (solar energy), and is exposed to it daily. Instead of causing inconvenience to furniture users, we can rely on it to develop an energy-efficient design for furniture such as benches and lighting. This sustainable energy can improve the design of furniture elements, which influences the quality of garden use. Solar energy is the most abundant energy source, and it is closely linked to the environment and climatic conditions (Almorox *et al.*, 2021; An *et al.*, 2023). The introduction of solar energy in urban furniture design constitutes a pillar of socio-spatial urban sustainability. Solar urban furniture is a key to urban energy efficiency, which is one of the crucial issues for sustainability

(Anthopoulos; Kazantzi, 2022). The degree of sunshine in Guelma is excellent all year round; this climatic condition is an opportunity that can help the city design quality public gardens with solar urban furniture.

The results of the sociological evaluation indicate that the quality of the public garden is influenced by the design of urban furniture. The sociological assessment of the use of the three gardens studied through their urban furniture leads us to the following ideas: Firstly, the existence of a reciprocal relationship between the sociological parameters of gender, age groups, and the conceptual and typological aspects of urban furniture. Secondly, the seating function is important in a public garden, and the two factors: climatic environmental, energy, and the quality of urban furniture have a direct impact on the attendance of users in a public garden in the case of the city of Guelma. Thirdly, the presence of a close relationship between the positioning of urban furniture (environmental and energy aspects), the user (sociological aspect), and the quality of urban furniture. In other words, the plant density provides more opportunities to have comfortable urban furniture, especially benches, which fulfill the primary function of a public garden by offering shadier and cooler spots. The other idea is summarized in the aspirations of the users of the studied gardens to have the most diverse, comfortable, and well-developed urban furniture elements, in parallel with technological development and in response to the challenges of contemporary sustainable urban design.

5 CONCLUSION

The assessment of the quality of use of public gardens in the city of Guelma was conducted based on several dimensions: spatial, climatic, energetic, and sociological. An analysis of the urban area showed the existence of various entities, with a noticeable clustering of furniture elements in the area, including the public gardens. From an architectural perspective, the three gardens under study Esanawbre, Mustapha Séridi, and Guehdour - exhibit distinct variations in terms of their historical background, size, shape, accessibility, incorporation of natural elements, and, more specifically, the design of the urban furniture. The climatic assessment indicate that there is a direct relationship between the architectural design of the furniture and the microclimatic conditions of the garden, which must be studied to be an element marking the quality of use. The energy consumption in the three gardens is solely measured through urban lighting poles and is inversely proportional to the surface area of the gardens. Based on the sociological assessment, we can deduce that there is a strong correlation between the use of a garden and its urban furniture. This correlation is determined by factors such as the frequency of use, the level of micro-climatic comfort, the quality and variety of urban furniture. Although these parameters are insufficient, users persist in frequenting Guelma’s public gardens, cultivating a strong connection with nature.

Enhancing the design of urban furniture is essential to ensure user comfort and improve the design of a public garden by aligning with a contemporary urban design perspective for public gardens through their furniture. Perceived as an essential component in the development of public gardens in Guelma, which is connected to various social, economic, and environmental dimensions. Street furniture represents a challenge to improve the usability of a public garden. Faced with this perspective, the design of urban furniture must be based on certain criteria. The user is an important urban dimension and must be taken into consideration in the design of urban furniture, through their opinions, expectations, and needs. To remedy the anomalies found in the design of each garden through urban furniture, and with the aim of optimizing and promoting the quality of use of public gardens through their urban furniture, introducing contemporary sustainable urban design into their urban furniture is a key issue. one of the pillars of this approach is the introduction of digital design through connected urban furniture. In addition, energy autonomy is a lever for contemporary design, which translates into the introduction of smart energy design based on the use of renewable energies in urban furniture, including solar benches and solar pergolas. These prospects can promote the sustainability and quality of use of public gardens through sustainable contemporary urban furniture.

REFERENCES

Adolphe, L. (2023). Gestion intégrée de l'environnement urbain et résilience : De la ville à la ville durable. Publisher ISTE Editions Ltd.

Alhefnawi, M. A. (2022). Integrating the biophilia physiognomies in the context of Neom smart city in Saudi Arabia. Acta Scientiarum Polonorum Administratio Locorum, 21(2), 159-171. https://doi.org/10.31648/aspal.7064

Allameh, E., & Heidari, M. (2020). Sustainable street furniture. Periodica Polytechnica Architecture, 51(1), 65-74. niversity of Isfahan, Ostandari street, 83714 Isfahan, Iran. https://doi.org/10.3311/PPar.12674

Almorox, J., Voyant, C., Bailek, N., Kuriqi, A., & Arnaldo, J. A. (2021). Total solar irradiance's effect on the performance of empirical models for estimating global solar radiation : An empirical-based review. *Energy, 236*, 121486.

Alonazi, M., Beloff, N., & White, M. (2019). Exploring Determinants of M-Government Services : A Study from the Citizens' Perspective in Saudi Arabia. 627-631. https://doi.org/10.15439/2019F75

Angers, M. (1996). Initiation pratique à la méthodologie des sciences humaines. Centre Educatif Culturel, Montréal.

Anthopoulos, L., & Kazantzi, V. (2022). Urban energy efficiency assessment models from an AI and big data perspective : Tools for policy makers. *Sustainable Cities and Society*, *76*, 103492

An, Y., Chen, T., Shi, L., Heng, C. K., & Fan, J. (2023). Solar energy potential using GIS-based urban residential environmental data : A case study of Shenzhen, China. *Sustainable Cities and Society, 93*, 104547.

Bechlem, R., Djouad, F.-Z., & Salah-Salah, H. (2024). Morphological Analysis of Public Spaces and Their Contribution to Urban Resilience in Guelma, Algeria. *Journal of Mediterranean Cities*, *4*(1), 167-177.

Ben Dhaou, O., & Vasváry-Nádor, N. (2022). Integration of sustainable street furniture in Tunisian urban public spaces. *Pollack Periodica, 17*(1), 151-155.

Boulekbache-Mazouz, H. (2008). Lire l'espace public pour mieux l'écrire. Études de communication, 31, 93-110.

Babu, A. M., Kumar, T. S., & Kodati, S. (2021a). Construction Method of Urban Planning Development Using Artificial Intelligence Technology. *Design Engineering, 7*. https://www.researchgate.net/profile/Mahesh-Babu-Awari/publication/353794881_Design_Engineering_CONSTRUCTION_METHOD_OF_URBAN_PLANNING_DEVELOPMENT_USING_ARTIFICIAL_INTELLIGENCE_TECHNOLOGY/links/61125200169a1a0103ee1e5c/Design-Engineering-CONSTRUCTION-METHOD-OF-URBAN-PLANNING-DEVELOPMENT-USING-ARTIFICIAL-INTELLIGENCE-TECHNOLOGY.pdf?_sg%5B0%5D=started_experiment_milestone&origin=journalDetail

Cengiz, C., Karaelmas, D., & Dağlı, P. K. (2018). The Examination of Urban Furniture in Bülent Ecevit University Farabi Campus in Terms of Landscape Design. Bartın Orman Fakültesi Dergisi, 20(3), 465-476. doi:10.35378/gujs.532828

Dechaicha, A., & Alkama, D. (2020). A spatio-temporal cartography and landscape metrics of urbanization patterns in algerian low-sahara. The case of ouargla city. Journal of Fundamental and Applied Sciences, 12(3), 1235-1252.

Djouad, F. Z. (2010). L'étude du rapport ville/nature à travers la ville d'el kala (est algérien). [PhD Thesis, Annaba].

Djouad, F. Z. (2021). The Biophilic Approach to Qualify the Inhabitant-Nature Relationship in the Domestic Space : The Case of the City of El Kala, Algeria. Architecture and Urban Planning, 17(1), 103-111. https://doi.org/10.2478/aup-2021-0010

Djouad, F. Z. (2021). City–Nature Relationship in a World-Renowned Nature Reserve : The Case of El Kala National Park in Eastern Algeria. Journal of Urban Planning and Development, 148(1), 05021067. https://doi.org/10.1061/(ASCE)UP.1943-5444.0000814.

Duzenli, T., ALPAK, E. M., & ÇİĞDEM, A. (2019). Flexible design in urban furniture. Yıldız Journal of Art and Design, 6(1), 37-50.

Everitt, T., & Hutter, M. (2018). Universal Artificial Intelligence : Practical Agents and Fundamental Challenges. In H. A. Abbass, J. Scholz, & D. J. Reid (Éds.), *Foundations of Trusted Autonomy* (Vol. 117, p. 15-46). Springer International Publishing. https://doi.org/10.1007/978-3-319-64816-3_2

Guechi, I., Gharraz, H., & Alkama, D. (2022). Étude analytique de l'urbanisation et son impact sur la température terrestre (LST), à l'aide de données de télédétection et SIG, cas de Guelma (Algérie). مجلة العمارة وبيئة الطفل, 7(3), 78-93.

Grabiec, A. M., Łacka, A., & Wiza, W. (2022). Material, Functional, and Aesthetic Solutions for Urban Furniture in Public Spaces. Sustainability, 14(23), 16211. https://doi.org/10.3390/su142316211.

Hakimizad, S., Asl, S. R., & Ghiai, M. M. (2015). A review on the design approaches using renewable energies in urban parks. International Journal of Renewable Energy Research, 5(3), 686-693.

Juntunen, J. K., & Martiskainen, M. (2021). Improving understanding of energy autonomy : A systematic review. Renewable and Sustainable Energy Reviews, 141, 110797. https://doi.org/10.1016/j.rser.2021.110797.

Kaplan, A., & Haenlein, M. (2019). Siri, Siri, in my hand : Who's the fairest in the land? On the interpretations, illustrations, and implications of artificial intelligence. *Business horizons*, *62*(1), 15-25.

Li, X., Stringer, L. C., & Dallimer, M. (2022). The impacts of urbanisation and climate change on the urban thermal environment in Africa. Climate, 10(11), 164. https://doi.org/10.3390/cli10110164

Mohamed Hassanein, H. (2017). Smart technical street furniture design : Case study of'new cairo administrative capital. https://doi.org/10.21625/archive.v1i1.124

Nikitas, A., Michalakopoulou, K., Njoya, E. T., & Karampatzakis, D. (2020). Artificial intelligence, transport and the smart city : Definitions and dimensions of a new mobility era. *Sustainability*, *12*(7), 2789.

Nguyen, T. V. T., Han, H., & Sahito, N. (2019). Role of urban public space and the surrounding environment in promoting sustainable development from the lens of social media. Sustainability, 11(21), 5967. https://doi.org/10.3390/su11215967

Parks, S. (2018). A Toolkit, Luskin Center for Innovation. UCLA.

Pimentel, J. L. (2010). A note on the usage of Likert Scaling for research data analysis. USM R&D Journal, 18(2), 109-112.

Premier, A. (2020). Smart solar street furniture : Design, application, limits and potentials. Imaginable Futures: Design Thinking, and the Scientific Method, 54th International Conference of the Architectural Science Association, 2020. https://anzasca.net/wp-content/uploads/2021/03/99-Smart-solar-urban-furniture-design-application-limits-and-potentials.pdf

Prvanov. S. (2019). Geometry, Ergonomic, Digital Design and Production of Furniture for Public Spaces Research Studies of Street Furniture Design in Urban Areas). Kurdistan.

Ryan, C. O., Browning, W. D. (2020). Biophilic design. In V. Loftness (Ed.), Sustainable built environments. Encyclopedia of sustainability Science and technology series (pp. 43–85). Springer. https://doi.org/10.1007/978-1-0716 0684-1_1034

Ricart, S., Berizzi, C., Saurí, D., & Terlicher, G. N. (2022). The social, political, and environmental dimensions in designing urban public space from a water management perspective : Testing European experiences. Land, 11(9), 1575. https://doi.org/10.3390/land11091575.

Ristianti, N. S., Dewi, S. P., Susanti, R., Kurniati, R., & Zain, N. S. (2024). Using Biophilic Design to Enhance Resilience of Urban Parks in Semarang City, Indonesia. Nakhara: Journal of Environmental Design and Planning, 23(1), 402-402. https://doi.org/10.54028/NJ202423402.

Tarek, S., & Ouf, A. S. E.-D. (2021). Biophilic smart cities : The role of nature and technology in enhancing urban resilience. Journal of Engineering and Applied Science, 68(1), 40. https://doi.org/10.1186/s44147-021-00042-8.

Tereci, A., & Atmaca, M. (2020). Integrating Renewable Energy Systems into Urban Furniture for Recreational Spaces : A Design Proposal for Konya Adalet Park. Gazi University Journal of Science, 33(1), 1-12. https://doi.org/10.35378/gujs.532828

Yaning An, Tianyi Chen, Lei Shi, Chye Kiang Heng, Jinglin Fan.(2023), Solar energy potential using GIS-based urban residential environmental data: A case study of Shenzhen, China. Sustainable Cities and Society Volume 93, June 2023, 104547

Zheng, Z., Lin, X., Chen, L., Yan, C., & Sun, T. (2024a). Effects of urbanization and topography on thermal comfort during a heat wave event : A case study of Fuzhou, China. Sustainable Cities and Society, 102, 105233. https://doi.org/10.1016/j.scs.2024.105233.