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Landscape Design within Green Spaces: A case study of Salahaddin University ,Erbil

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ABSTRACT

Urban university environments often suffer from insufficient and poorly designed green spaces, which negatively affect users' psychological well-being, comfort, and overall campus experience. At Salahaddin University-Erbil, the presidency area lacks functional and well-planned greenery, limiting its effectiveness as a restorative and social space. This study aims to assess the current landscape conditions and develop a sustainable landscape design proposal for the presidency of Salahaddin University-Erbil. The research adopts a case study approach combining site analysis, field measurements, and direct observation with an online survey conducted among 70 students and employees to evaluate user needs and perceptions. A basic draft has been developed, with the assortment of plants clearly defined within it. Aside from a broad list of trees and shrubs; however, plants have also been designed for the current project. This initiative is to create a sustainable, contemporary and as tidally pleasing landscape that benefits both (academic staff, employees, and students) and the local system.

The findings indicate a significant deficiency in greenery quality, accessibility, and supporting facilities such as shading and seating areas. Based on these results, a comprehensive design proposal was developed, integrating both softscape and hardscape elements. The proposed design increases tree coverage by 56% and shrub coverage by 99%, while incorporating functional features including pathways, shaded seating areas, and water elements to enhance environmental performance and user experience. The study concludes that integrating sustainable landscape principles with user-oriented design can substantially improve the ecological, functional, and visual quality of university spaces. It is recommended that the proposed design be adopted and implemented with professional maintenance strategies to ensure long-term sustainability and effectiveness.

This proposal protects the green environment, which is beneficial, relaxing, and visually appealing to students and other users.

***Keywords*:** Green University, Open space, landscape, Environmental sustainability, Salahaddin University -Erbil.

INTRODUCTION

Sustainable greenery appears to satisfy current demands to some extent in order to stand against the predicted improvement in quality of life for the current and future global climate change **[1]**. A well-designed urban landscape based on green standards incorporates eco-friendly infrastructure that may successfully handle urban challenges in the context of changing climate **[2]**. Additionally, landscape design or green areas provide habitat for a variety of wildlife **[3, 4]**. In this instance, integrating campus buildings and landscapes is crucial to creating a well-designed space with distinct emotional baselines that foster a feeling of attraction, safety, and beauty while also making the university environment objective and readable for both the university and the people who live nearby **[5]**.

Urbanization and climate change have significantly reduced the availability and effectiveness of green spaces, especially in highly populated areas **[6]**. This reduction has negatively impacted environmental quality, biodiversity, and human well-being **[7]**. University presidency as a campus should have enough outdoor greenery space to create a healthy environments and energy conserving resources, waste reduction, ultimately protecting the environment **[8]**. Landscape design according to Uzun and Ad **[9]** is defined as location making, including structures such as open and

green areas, pedestrian routes, and parkin . Place marking refers to things that contribute in giving a campus its specialties from other campuses in respect to location, such as plants, outdoor furniture, and landmarks **[10]**.

Urban parks, in reality, do play an essential part in relaxing and protecting urban ecology as whole **[11]**. It is also known to be a major component of urban landscaping and low-carbon release. However, one may realize that having too many parks are generally a sign for feature indicator for many cities and towns, as well as its capacity to offer citizens relaxation, in natural of nature, and a distinctive open space **[11]**.

The university green areas have lately gained a place on the list of essential urban green spaces, getting more focus than in the past. Previous studies suggest that green space decreases the fear of unlawful and unpleasant actions, therefore it is the action of improving the sense of safety **[12, 13]**, and substantial influence on the quality of life on campus **[14]**. According to a study by Gheibi, et al. **[15]**, students who use campus green spaces more frequently have more energy to engage in social activities than those who do not. Furthermore, Emmanuel and Olufemi **[16]** have stated that the campus landscape and outdoor areas have the capacity to foster relationships between students, raise the standard of the university community, and promote students' psychological and social behavioral values.

Plants' moderation roles in reducing hostility and aggressive behavior lead to increased self-control and decreased unlawful behavior **[17]**. A "sustainable university" is defined as a higher education institution that operates in accordance with it is environment **[18]**. Green universities, in particular, are predicted to have the greatest impact on sustainability performance due to their increasing popularity **[19]**.

Plantation retain carbon dioxide, which reduces the urban heat island effect **[20]**. The primary functions of the university's outdoor spaces are: facilitating student social activities such as seating, studying, social gatherings, dining, and sports; regulating the internal environment of adjacent buildings by ensuring optimal conditions for daylighting, ventilation, thermal comfort, and views; managing the movement of pedestrians and vehicles **[21]**. In fact, university presidency reflects the balance of its surroundings, and the buildings all should contribute to an enjoyable setting for both students and academic staff and even any attendance. Natural factors and structures show the level of integration into the town's constructive web **[22]**.

The present project is an investigate the garden design of SUE by it is components (Hardscape and Softscape) considering the local environment, develop a sustainable climate of university infrastructure sites. This includes open space, greenery area, and development criteria, beside that forwarding a landscape design suitable for the Universities dignity, a health-promoting environment by analyzing and proposing healing gardens within the context of campus planning and architecture have been forwarded. It is also aimed to enhance environmental performance and user comfort based on planting more native and climate-adapted plants.

Materials And Methods

Description of the Study Area

The study area is the presidency of the Salahaddin University-Erbil, which is a public university located in Erbil (Hawler) province in Kurdistan region, Iraq (Figure 1). It is located in the South-East Erbil, 8.5 km from the city center, with an average elevation of 419 m above the sea level at latitudes 36.1478, and longitudes 44.0298. The offices and buildings are surrounded by small gardens, which have yet to be properly developed to reflect the University's spirit. The fundamental difficulty with present gardening is that grasses and trees have been planted randomly, and even traditional landscaping patterns have not been practiced.

This is a residential neighborhood with a girl dormitory to the right and a college of basic sciences to the left, as well as a residency area in the back and front (figure 1.). SUE was chosen for the current case study due to the enormous piece of neglected land surroundings and within the colleges. Another factor was the university's location, which can have a significant role in enhancing the environment and increasing urban resilience to climate change by planting more trees and creating more gardens. Thus, the entire area is around 25,000 m^2, while the total green area is about 3310 m^2, make up only 13.24% of the total green area.

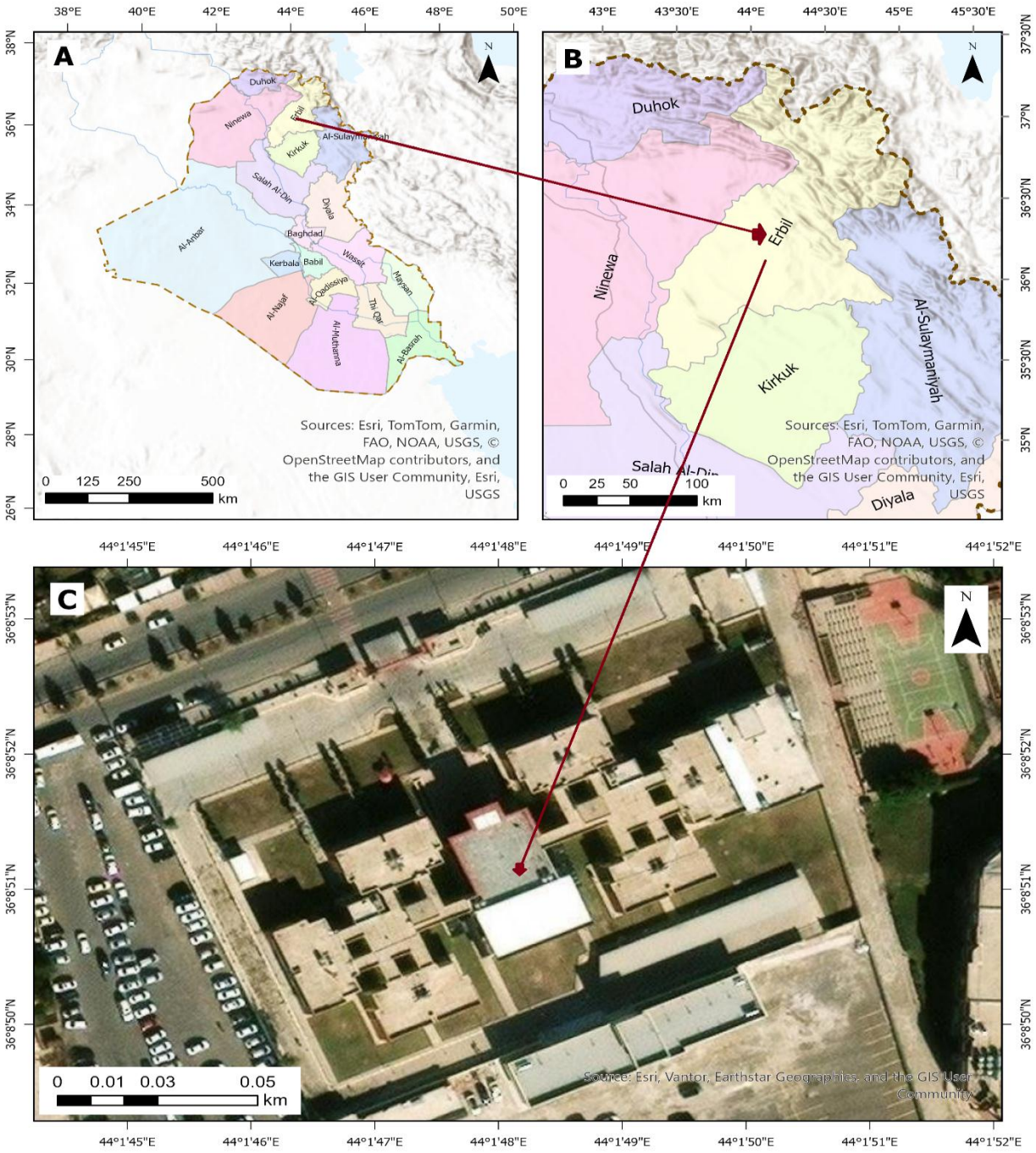


Figure 1. Illustration maps of the research area. (A.) General map of Iraq. (B.) Erbil (Hawler) governorate including all its boarders. (C.) The Presidency of SU-E (location of the study spot).

Climate condition of the study area

Erbil province is characterized to be semi-arid environment **[23]**. The average yearly rainfall is approximately 350-400 mm. There are 15 years of climate conditions were used to choose the most appropriate type of plantation deciduous or evergreen for the area in terms of irrigation requirements, drought resilience, and growing habits. As seen in table 1, temperature, humidity, and precipitation have changed dramatically over the current 15 years, according to available data.

Table (1): Metrological data of Erbil city from 2009 to 2024.

Year	Air temperature ℃			Rainfall (mm)	Wind speed (m/sec.)	Humidity (%)
	Min.	Max.	Avg.			
2009	5.5	42.5	22.2	311.9	2.2	45
2010	4.0	42.0	23.7	233.76	2.36	45.91
2011	4.0	43.0	21.8	286.2	2.14	49.83
2012	3	41	22.0	230.7	2.11	49.08
2013	2	41	23.2	387.1	1.46	51.16
2014	6.1	42.7	22.2	345.2	0.52	50.91
2015	4.5	43.4	22.1	344.7	1.008	50.33
2016	4.1	43.4	22.1	323.3	1.49	49.66
2017	3.3	43.8	23.7	265.1	1.4	49.16
2018	6.6	42.0	22.9	642	3.9	40.7
2019	6.0	40.8	21.7	446.2	3.7	40.9
2020	5.6	42.7	22.5	422.3	3.9	37.3
2021	6.2	42.7	22.8	247.8	3.9	32.1
2022	4.2	42.9	22.0	211.8	1.41	50.4
2023	4.3	42.9	22.2	339.0	1.43	53.5
2024	3.0	42.0	20.8	598.2	1.8	48.8

Data Source: Erbil Meteorological Station, 2025

The minimum recorded precipitation was 211.8 mm in 2022, while the maximum was 642 mm in 2018. The highest air temperature 43.8 ℃ was in 2017, and minimum 2℃ was in 2013, whereas, ranged humidity between minimum 32.1% to 53.5%. Average monthly sunlight hours are roughly 8.35 hours per day Jirjees **[24]**. In general, the study location has cold rainy winters and hot, dry summers **[25]**.

Soil type of the study location

To estimate the majority of the physical and chemical attributes, soil samples were combined from eight different locations using Auger in 30 cm deep and brought to the laboratory, then the chemical and physical properties were measured based on the method by Carter and Gregorich **[26]**. Table 2 illustrates that soil is calcareous with a silty clay loam structure. The amount of organic matter is a little low; it is obvious that the plants will grow well if organic matter is added throughout the plantation process. The pH level is a bit high (alkaline soil) which we may face some mineral deficiencies like iron (Fe), zinc (Zn), manganese (Mn), and copper (Cu), if treatments such as acidification to lower the soil pH, not been practiced to reduce it **[27]**. Thus, the present study plan is adding organic fertilizers to the soil and replacing the soil with a mixture of low pH soil. We also recommend to add sulfur or other acidifying materials during the growing plants and new garden establishment.

Table (2): Some physical and chemical properties of soil samples of the study area.

Parameters	Value	Unit
pH	8.47	-
Electrical Conductivity (EC)	0.29	dS m^{-1}
Nitrogen	78.12	mg. kg^{-1}
Phosphorous	4.23	mg. kg^{-1}
Potassium	18.12	mg. kg^{-1}
Calcium carbonate ($CaCo_3$)	16.17	%
Organic matter	1.2	%
Bulk density	1.01	g. cm^{-3}
Magnesium	30.72	mg. kg^{-1}
Calcium	70.4	mg. kg^{-1}
Chloride	42.6	mg. kg^{-1}

CEC	24.33	cmol+. kg^{-1}
TEXTURE		
Sand	17.66	%
Silt	47.05	%
Clay	35.29	%
Soil type: Silty Clay Loam		

Data source: University of Duhok, laboratory of Soil and Water department, 2024

Outline of the case study

The project was performed first, by detecting both softscape and hardscape of the study location through measuring the number of gardens, trees, shrubs and the total area of lawns. Then, the outline of the entire area was manually measured using steel measuring tapes (10 m) for the short distances and Invar tape (50 m) for longe distances. This process, starting with a rough sketch and moving to a measured plan. In landscape design, interior design and architecture, the procedure commences with an unscaled conceptual sketch and advances to a scaled plan, providing functional efficiency, spatial precision, and proportional harmony (Weaver et al., 2024). Later, all the measured data was arranged on the paper to draw the measuring plan with the scale 1:250, where the entire area is around 25,000 m^2, while the total green area is about 3310 m^2, make up only 13.24% of the total green area.

After finishing the measurements, a survey performed in 2024-2025 with a list of questions. A two-section survey form including 17 questions, which was arranged after carefully reviewed by some academic staffs. It includes several different related questions according to it is important role in landscape design studies based on the method by Silber, et al. **[28]**. The survey was prepared in the google form and the form link was sent to numbers of SU-E members (employs, academic staffs and students), whom regularly in touch with the study location. Also, a QR code was created and hanged in the front doors and main entrances where people entering the study location to those may have not been relevant to the university employees and staff. Every randomly filled questionnaire response was excluded or people out of our requirements are excluded as it is seen in table 3.

Table (3): Background of the survey responders

Characteristics	Gender		Age		Level of Education	
Composition (%)	Male	58.6%	≤ 24	5.7%	Uneducated or illiterate	0.0%
	Female	41.4%	25-35	24.3%	Diploma	3.1%
			36-45	44.3%	Bachelor	38.4%
			46-55	20%	MSc	24.3%
			> 56	5.7%	PhD	34.2%

Graphic design and computer software applications

The current master plan's graphic depiction has been created after the entire research area has been meticulously measured, taking into account the needs of the participants as well as the local climate. The graphic representation of the current master plan has been created using AutoCAD application 2021 **[29]** (figure 2). The master plan's readability was further improved by the symbols, textures, colors, line weights, and explicit labelling. Also, the principles of the graphic design conducted based on Bertauski **[30]**. Then, the computer-Aided Design (CAD) software of AutoCAD application 2021 **[29]** was used to create 2D drawings and renovate the places were needed. To determine the precise location on the map and produce map figures, additional programs such as ArcGIS version 10.8.1 were also used **[31]**. The cross-sections of several garden maps were created using another free web program called BioRender (https://BioRender.com).

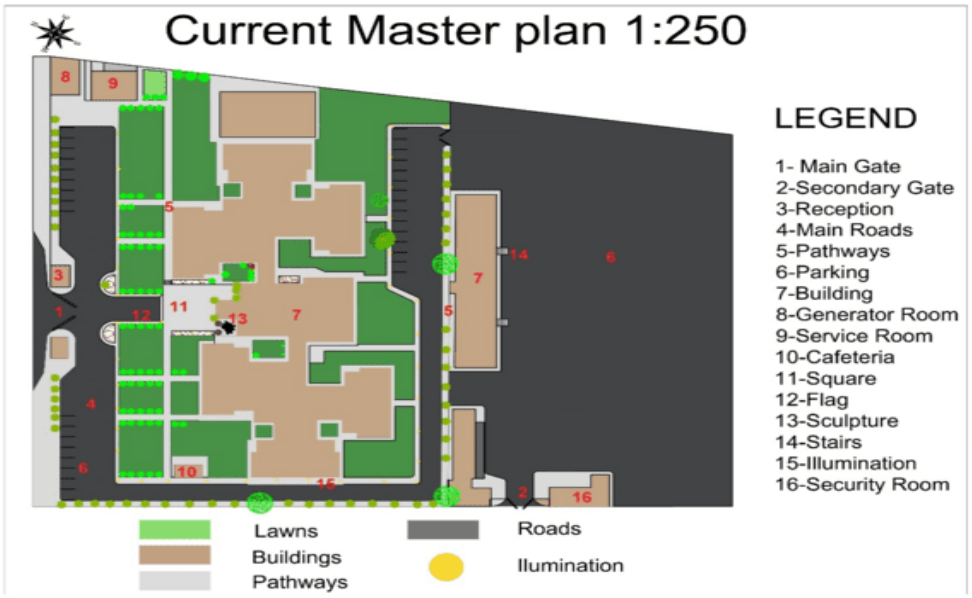


Figure 2. The current master plan for the Presidency of Salahaddin University-Erbil (Old design)

Results And Discussion

Greenery situations and role of small gardens in improving greenery in Erbil city

The Kurdistan region of northern Iraq is situated within a semiarid zone that has been significantly impacted by global change over recent decades. Thus, Erbil city as one the region's largest cities where the air temperature 45°C and humidity levels have dropped to 10% during summer. Thus, the government has a part in enhancing greenery by establishing new parks, gardens, and future green buildings. Today, the vegetation cover in Erbil's relies mostly on the available public parks, such as Sami Abdulrahman, Shanadar, Bakhi Shar, Peshmarga, Hawar, Mnara, etc., all of which are designated for rest and recreation, is roughly 11.6% **[32]**. To improve vegetation in the city, all brown fields have recently been reclaimed to develop new parks and planting trees. Green space development is especially important in a city with relatively few small parks in the current study **[33]**, as illustrated in figure 3.

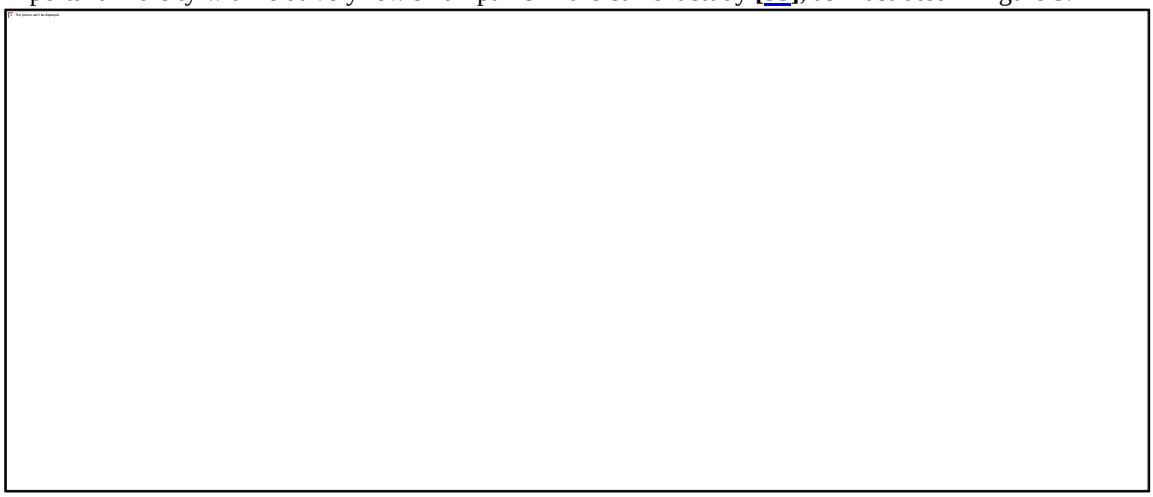


Figure 3. The total green areas in Erbil's city (April and May)

Source: Hassan, et al. **[32]**

Although, greenery may influence and effect as a large public gardens, meanwhile any greenery can improve the environment in surrounding area **[34]**. Additionally, there is currently a greater demand for growing plants and improving vegetation than there is for facility services in both public and private gardens.

As can be seen in the figure 4, the majority of the survey participants (55%) require increasing greenery area more

than other facility services for the SUE gardens. This might be because this place has many daily visitors and they surely need a place to rest and spend time for a short period during staying for their daily routine as a public university.

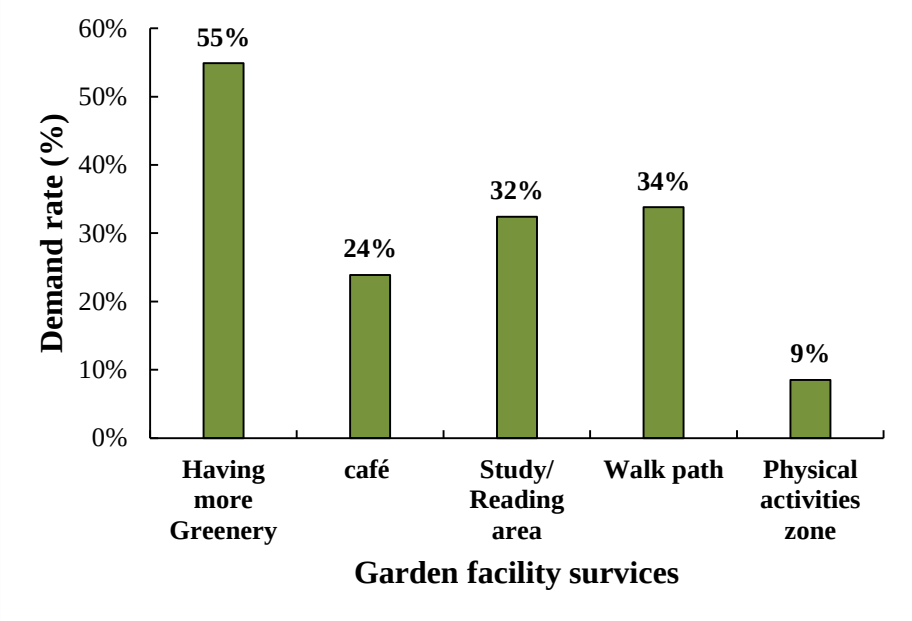


Figure 4. The participants' demands for the new landscape design of the presidency garden to be more attractive.

Therefore, the total area of the presidency of Salahaddin University-Erbil is around 25,000 m^2, whereas the overall green area is only 3310 m^2 which is accounted for only 13.24% of the total green area. Based on the proposed master plan, the percentage of the greenery area is jumping to above 20%, through growing more trees, shrubs, and flower beds.

The planned softscape components for the case study

Growing plantations serve a variety of goals, including as aesthetics, the environment, biodiversity, and the provision of a natural space for people to relax. Soft landscape vegetation could be trees, shrubs, herbs, or a combination of diverse plant types **[35]**. Based on one of our survey questions of "Have you ever been into gardens and open spaces at the presidency of Salahaddin University-Erbil?", as can be seen in figure 5, around 26.80% of people who visiting SU-E presidency are not interested in visiting the current available green areas.

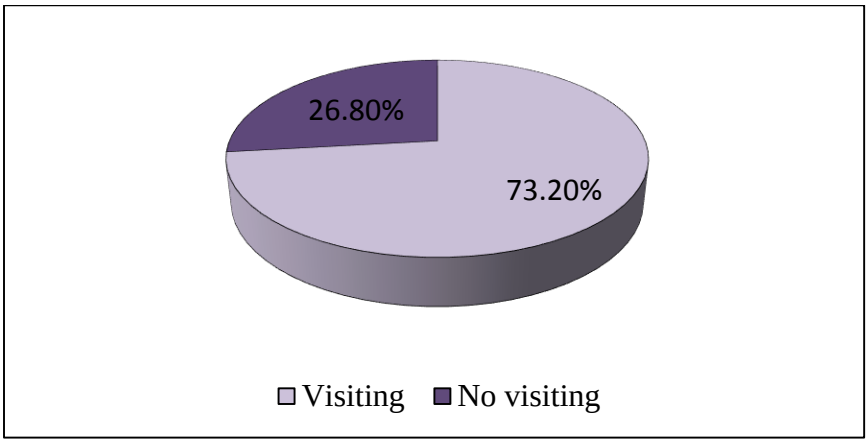


Figure 5. SU-E gardens visiting percentage (Author)

As a result, the majority of respondents gave the overall current gardens a neutral to unsatisfactory rating in terms of appearance, design, shaded, quality of existing greenery, accessibility for all users (including the people with disabilities), and other factors as shown in Figure 6.

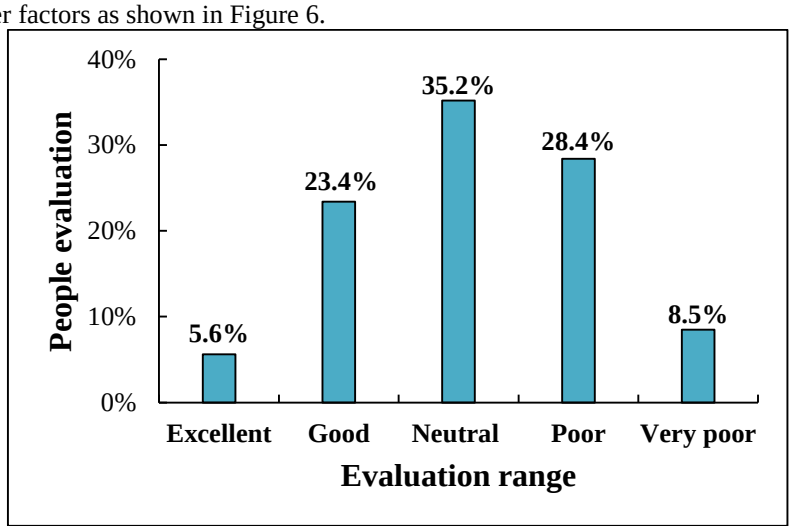


Figure 6. 4 Participants' evaluation for the current garden design of SU-E

In the multiple-choice survey questionnaire, increasing the total number of trees, particularly native trees, was the most common participant demand in the proposed garden design, which was about 59%, while non-native trees and shrubs, and flower beds were accounted for 56% and 55%, respectively (figure 7).

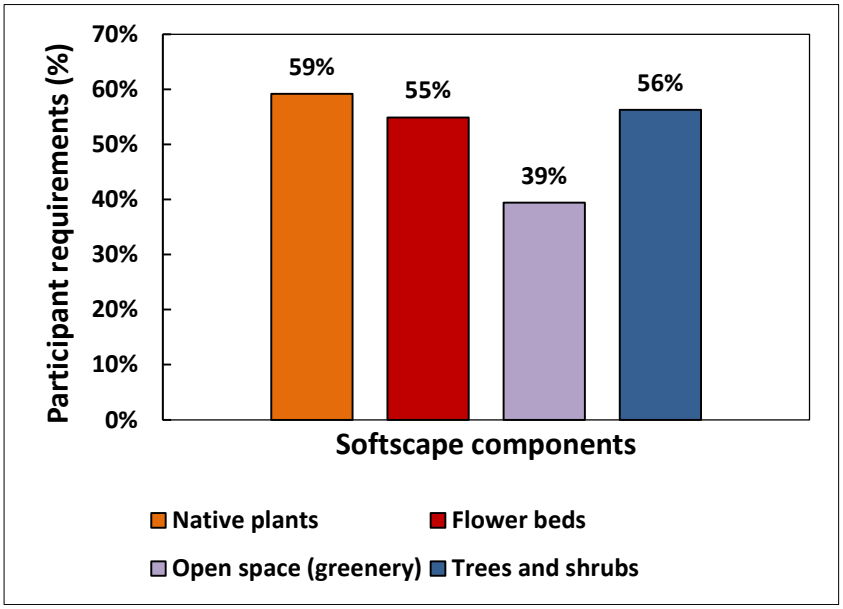


Figure 7. The participants requirement for improving the softscape of the gardens or green open space at the presidency of Salahaddin University-Erbil

To enhance vegetation cover, the number of trees and plants, a dendrological plan based on a graphic design was created. Because these plants can readily adapt to the local climate and survive in difficult environments, they were chosen based on their potential to adapt to the Erbil plant hardiness zone, which is 9a **[36]**. Other plants, such as succulents, climbers, and cacti, are also chosen for specific areas in order to give gardens a contemporary aspect.
So that, after carefully reviewing all the survey suggestions, a more developed, detailed, and experienced design have been created. The existing master plan is based on a two-dimensional approach (mainly lawns), whereas the proposed master plan incorporates a three-dimensional strategy, including a full canopy (trees), understory (shrubs and flowers), and ground layer (lawns) (figure 8).

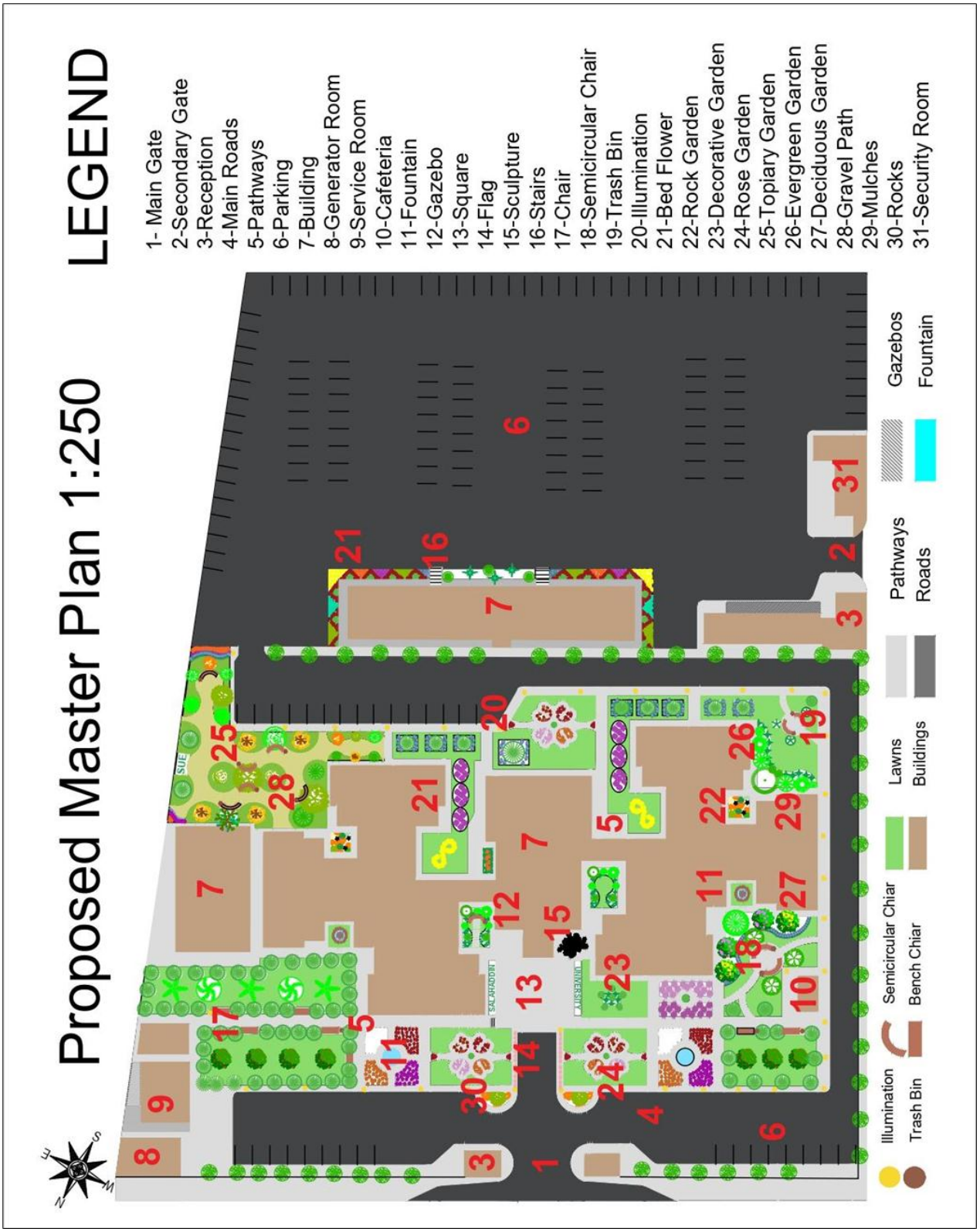


Figure 7. The AutoCAD map of proposed master plan for the entire study area of SU-E (Author)

Tree selection for the current master plan

Trees are the main softscape components taken into consideration in any greenery sides. Trees include both evergreen and deciduous ones, this is because trees provide greater shade then cooler air temperature, provide cleaner the air, prevent dust and some pollutants **[37]**. Furthermore, they can have a considerable role in mitigating wind velocity, therefor it will end up with suitable living space **[38]**. Beside considering the principles of landscape design such as form, texture and color as described area by Patel, et al. **[39]**, in accordance with these study plans, the most commonly selected trees for the result concerned area are native, drought and heat tolerant, cold hardening, and large canopied trees, as can be seen in table 4.

Table (4): List of suggested trees in the proposed master plan for the SUE garden design including the Landscape typologies for the study area

Scientific name	English common name	Landscape typologies					
		H	S	FP	ST	B	WB
Carpinus betulus	Hornbeam	✓	✓	✓	✓		
Cercis siliquastrum	Judas tree			✓	✓	✓	
Cupressus arizonica	Arizona Cypress	✓			✓	✓	✓
Cupressus sempervirens Var.Pyramidalis	Italian cypress	✓		✓	✓	✓	
Dalbergia sissoo	North Indian rosewood		✓		✓		✓
Ficus benjamina	Weeping fig	✓	✓	✓		✓	✓
Lagerstroemia indica	Crape myrtle	✓		✓	✓		
Ligustrum japonicum	Wax leaf privet	✓		✓		✓	✓
Olea europaea "Bonsai"	Common Olive Tree			✓		✓	
Phoenix canariensis	Canary Island date palm			✓	✓		
Pinus brutia	Turkish pine		✓	✓	✓		✓
Pinus halepensis	Aleppo pine		✓	✓	✓		✓
Pinus nigra	European black pine		✓	✓	✓		✓
Pinus pinea	Italian stone pine		✓	✓	✓		✓
Platanus orientalis	Oriental plane tree		✓	✓	✓		✓
Washingtonia robusta	Mexican fan palm			✓	✓		

H :Hedge ST :Street tree
S :Shade B :Border
FP :Focal point WB :Wind break

The proposed design increased the number of trees from 80 to 180 trees. Other tree features such as insect susceptibility, growth habit, maturity size, moisture requirements, and soil pH requirements have also been taken into account while selecting the most appropriate trees for the SUE gardens and surrounding environment. As a landscape designer, landscape typography was another element in selecting those trees, as well as knowing where to grow and why they were growing in that specific location, whether as a hedge, street, shade, border, or for all of the above, depending on the tree.

Shrub plant selection for the current master plan

Shrubs in garden design can improve landscape balance in terms of size, color and form, texture, and seasonal variation. It can be utilized to distinguish between public and private spaces, resulting in a safer and more pleasant environment for users. Shrubs assemble elements and produce a cohesive and compositional harmony. They are not only a decorative addition to gardens; they also play a crucial role in improving the garden's functionality, ecology, and user experience **[40]**. In the present proposed garden, it will make up the mid-story layer in respect to higher stratification of the plantation this serves as a barrier boundary.

Thus, a variety of shrubs have been suggested for decorating the existing gardens as a border, hedge, ground cover, focal point, container plant, topiary garden, and rock garden plants. As it can be seen in table 5 more than 15 family shrubs are used in proposed plan.

Table (5): List of suggested shrubs in the proposed master plan for the SUE garden design including typologies

Scientific name	English common name	Landscape typologies						
		H	FP	TG	RG	B	CP	GC
Buxus microphylla	Japanese box	✓	✓	✓	✓	✓	✓	
Buxus microphylla "Faulkner	Box Faulkner	✓	✓	✓	✓	✓	✓	
Cycas revoluta	Sago palm		✓		✓		✓	
Euryops pectinatus	Golden daisy bush	✓		✓	✓	✓	✓	
Euonymus japonicus	Japanese spindle	✓		✓	✓	✓	✓	
Euonymus fortunei	Japanese spindle	✓	✓	✓		✓	✓	✓
Juniperus x Pfitzeriana	Juniper Gold Coast	✓		✓	✓		✓	✓
Jasminum sambac	Arabian jasmine	✓	✓					
Lavandula angustifolia	English lavender	✓		✓	✓	✓	✓	
Myrtus communis	Myrtle	✓		✓	✓	✓	✓	
Nandina domestica	Scared Bamboo	✓	✓			✓	✓	
Pinus mago	Dwarf mountain pine		✓	✓			✓	
Photinia x *Fraseri*	Red tip photinia	✓	✓	✓		✓	✓	
Pyracantha cocciena	Indian Firethorn	✓		✓		✓	✓	
Rosmarinus officinalis	Rosemary	✓	✓	✓	✓	✓	✓	
Rosa 'Black Magic'	Rose bm		✓				✓	
Rosa chinensis var. minima	Mini Rose				✓		✓	✓
Rosa damascena	The Damask rose	✓	✓			✓	✓	
Thuja orientalis " aurea Pyramidalis"	Arborvitae	✓	✓	✓	✓	✓	✓	
Thuja orientalis "Aurea nana"	Oriental Arborvitae		✓	✓	✓	✓	✓	
Viburnum lucidum	Laurustinus	✓	✓	✓				
Yucca elephantipes	Spineless Yucca		✓		✓		✓	
Yucca flaccida	Adam's needle		✓		✓	✓	✓	

H : Hedge GC: Ground cover
FP: Focal point CP: Container plant
TG : Topiary Garden B: Border
RG: Rock garden

Principles of Cacti and Succulent Selection in the Softscape Components

Due to the geographical constraints of the research location, some small spaces are available in building corners or neglected areas. Designs such as rock gardens have been developed to maintain the spaces green while also decorating the entire area. To insure the proper plants survive in such spaces, some cacti and succulents species, thus the total number of cacti and succulents' is estimated to be around 25 plants, as shown in (table 6) was among the first choice since they can thrive in environments with limited water and space, and they require frequently less-maintenance **[41]**.

Table (6): Cacti and succulents' species for the narrow space gardens in the presidency of SUE including landscape typologies

Scientific name	English common name	Landscape typologies					
		FP	MP	RG	B	CP	GC
Agave americana L.	Century plant	✓		✓	✓	✓	
Echeveria elegans R.	Mexican snow ball		✓	✓	✓	✓	✓
Echinocactus grusonii	Golden Barrel Cactus	✓	✓	✓	✓	✓	

FP: Focal point B: Border
MP: Mass planting CP: Container plant
RG: Rock garden GC: Ground cover

Other plants such as climbing plant (*Jasminum sambac* L.), also known as Arabian jasmine, was also chosen to improve the greenery area for other purposes as a design tool due to its beauty and blossoming smell, as well as its ability to cover unappealing walls or undesired surfaces and transform them into living surfaces. The plant can provide dappled shade for the dining areas. It can be used to divide garden areas (for example, separating a grass from a dining area). Aside from its tolerance to severe environments, it can enhance air quality and filter out airborne contaminants by producing oxygen.

On the other hand, every current garden open space has its lawns. Lawns make the gardens look pleasant; it has a fundamental component of landscape gardening. Despite playing an important role in demonstrating broader open space, aesthetics, and environmental functions, lawns are typically viewed as a green carpet in traditional garden designs **[42]**. A mixture of lawn species (table 7) has been suggested for the proposed master plan in order to have a year-round green space, erosion control, and species that can adapt to the current environmental situation. However, according to Ignatieva, et al. **[43]**, lawns need greater maintenance and irrigation. The total amount of lawns has been reduced in this study in order to create more seating areas, reduce the irrigation and less maintain requirements.

Table 7: List of selected lawn species for the garden open spaces at the presidency of SUE including the landscape typologies.

Scientific name	English common name	Landscape typologies			
		GC	ST	EC	MG
Lolium perenne ”Esquire” *Poa pratensis* ”Evora” *Festuca arundinacea* ”Tomahawk” *Festuca arundinacea* ”Starletta”	Mixture permanent turf grass	✓	✓	✓	✓
		GC: Ground cover ST: Sport turf		EC: Erosion control MG: Mixed grass	

Hardscape Components (Functional areas) within the SUE presidency

A landscape gardening not only includes living plant materials in the garden, but also the interaction of soft and hardscape elements. Professional landscaping may also include ground surfaces (paving, concrete), grading, and land formations. The landscape may feature a blend of natural surface, including ponds, and hard surfaces, such as pavers, walkways, or brick patios **[44]**. Thus, hardscape refers to buildings, paths, cafés, benches, seats, sculptures, water features, fences, and shelters **[45]**.

The main portion of current project was designing a survey data to see the demands of the people who visiting or working in the presidency of SU-E. The facts clearly reveal that hardscape sections are the primary reason for employees and visitors abandoning the president of SU-E gardens to stay, this might be due to the lack of seating and shading area, facilities like café, restrooms…etc. Hussein and Kareem **[46]** explain that these services are necessary in public spaces not only for employees and visitors, but also for the elderly and disabled.

Having more shading area and reducing the hardscape components can easily reduce the climate temperature in the area. This is because some materials used in hardscape components are from metals, concreate, and asphalt results in storing store more thermal energy than other elements **[47]**. As a result, choosing natural or less energy-saving materials is critical in the construction of sustainable hardscape components, as demonstrated in this study by selecting materials from nature and materials with the least ability to absorb heat, such as wooden materials, and using the least amount of asphalt for pedestrian pathways, seats, and shading.

As shown in figure 8, the majority of the multiple chosen survey, the around 69% of the participants have claimed on the missing the main and necessary facility services like shade and shelters, followed by study ground 51%, benches and seating areas 48%, aquatic area 42%, café 34%, pathways 23%, sculpture 17% in the current design and they ask for the importance of the facilities to have in the new design.

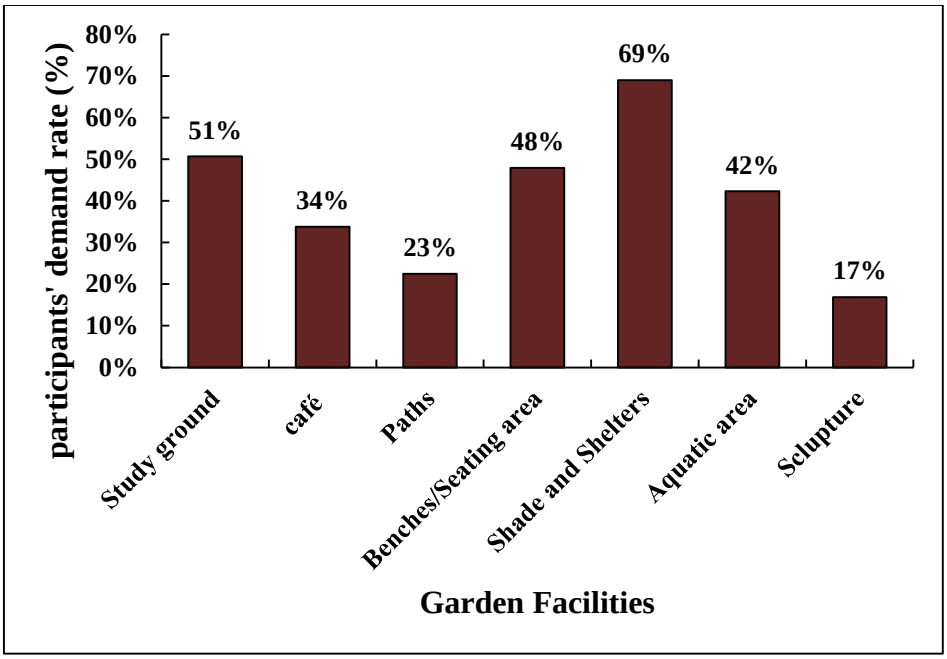
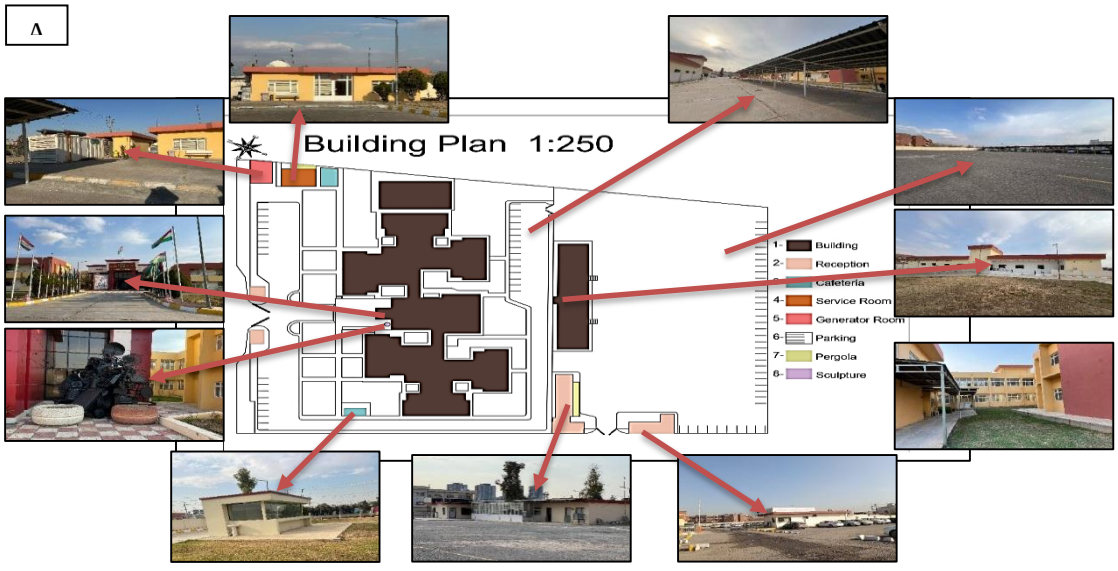


Figure 8. Demand for hardscape facility requirements to be added to the university's garden

The participants' requirements, which were specific people who visited and worked in the area on a regular basis, were considered when the new landscape design for SUE's presidency was proposed. These gardens are now utilized solely as a decorative area to display lawns and a few trees surrounding the buildings. In order to accomplish the basic garden requirements, which should have in any public settlement camps, all the necessary facilities starting from the main gates to the security rooms have been reconsidered to be available in the gardens and open green areas as can be seen in the figure 9a and b.



B

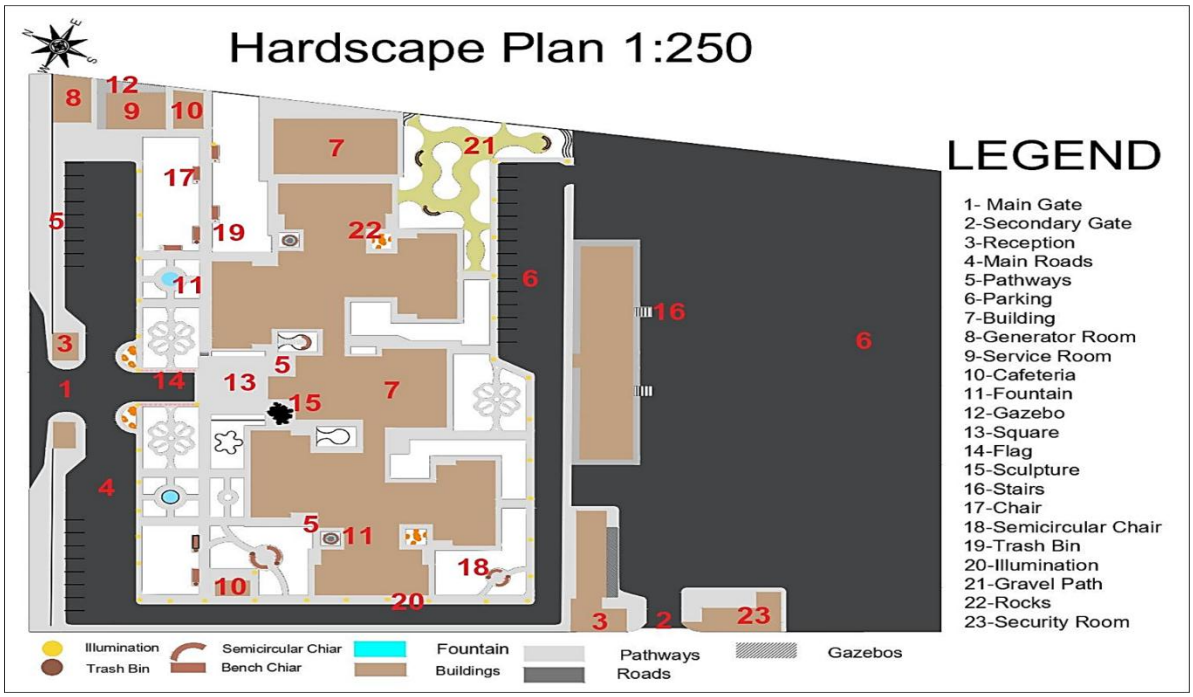


Figure 9 (A, B). A. the current needs for the facility services. B. hardscape plan for the new landscape design of the SUE study area

Pathways/ Pedestrian way

Pedestrians are separated into main and secondary paths. The suggested design made few changes to pedestrians; however, certain essential aspects were considered in the proposed design, such as changing steps to slopes to be more accessible to even disabled people and easily accessible to all the facility services **[46]** (figure 10). Bricks and concretes are the primary materials utilized to create paths into the gardens that connect the lounging areas, cafés, and other facility areas. However, to connect small area to the larger garden sizes, concretes have been used as the primary materials.

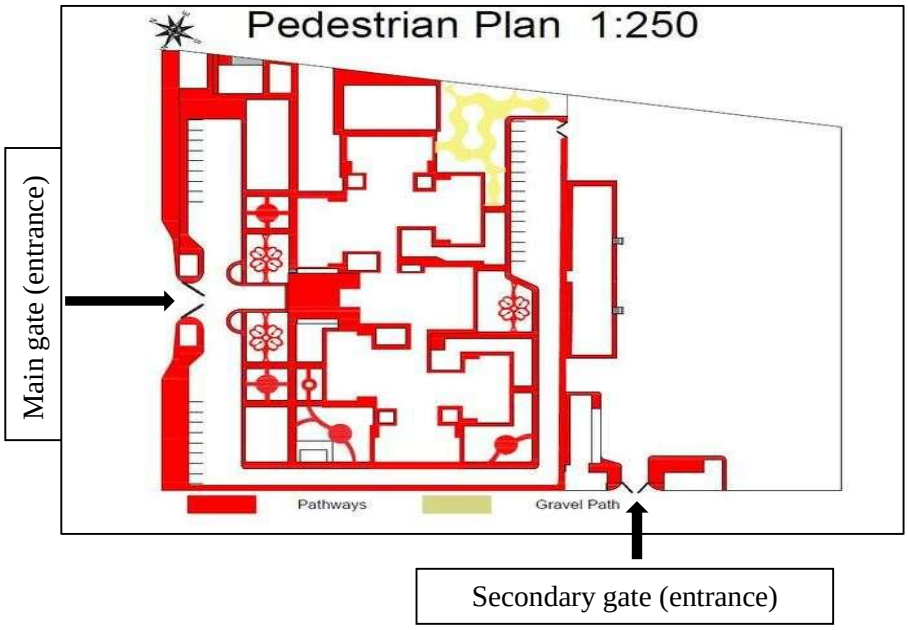


Figure 10. Main and secondary pedestrian pathways in the suggested master plan

Resting and Meeting spaces

According to our survey, the majority of participants (48.4%) believe that there is no enough place to stay within greenery spaces SUE presidency, which may be the main reason for them to complaint. They also complained about having a minimal shaded space in the area, which make up 42.2% of the respondents. Accordingly, places under shelters, open spaces of cafés, and along pedestrian roads, have been established in proposed design (figure 11).

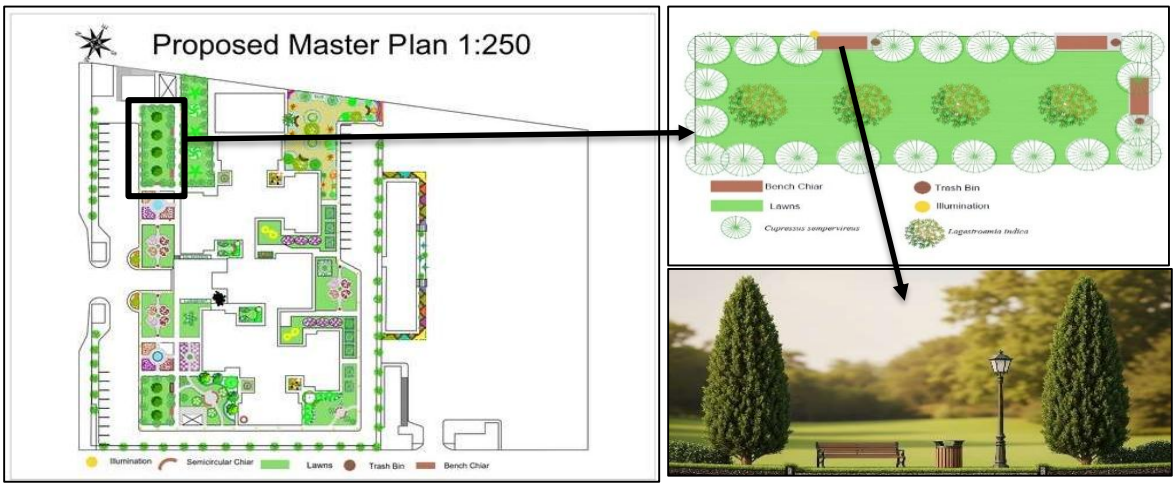


Figure 11. The resting and recreation areas in the suggested master plan

Water elements (Fountain)

Water elements do attract visual attention and fill gaps in their absence, although they also have additional effects, such as improving the surrounding environment **[48, 49]**. Dober **[50]** mentioned that water motion would create a peaceful atmosphere. Aside from its beauty and natural surrounds, water is vital for gardens in arid locations because can bring humidity into the atmosphere, which is beneficial to the surrounding plants and temperature reduction. In order to give a sense of movement and refreshment to the gardens, two symmetrical garden fountains have been created close to the main buildings to offer more aesthetic value to the gardens, as shown in (figure 12a, b). Although, the main role of the water element is decoration **[51]**, our aim is to create and improve natural ecosystems and help biological habitats in the study area.

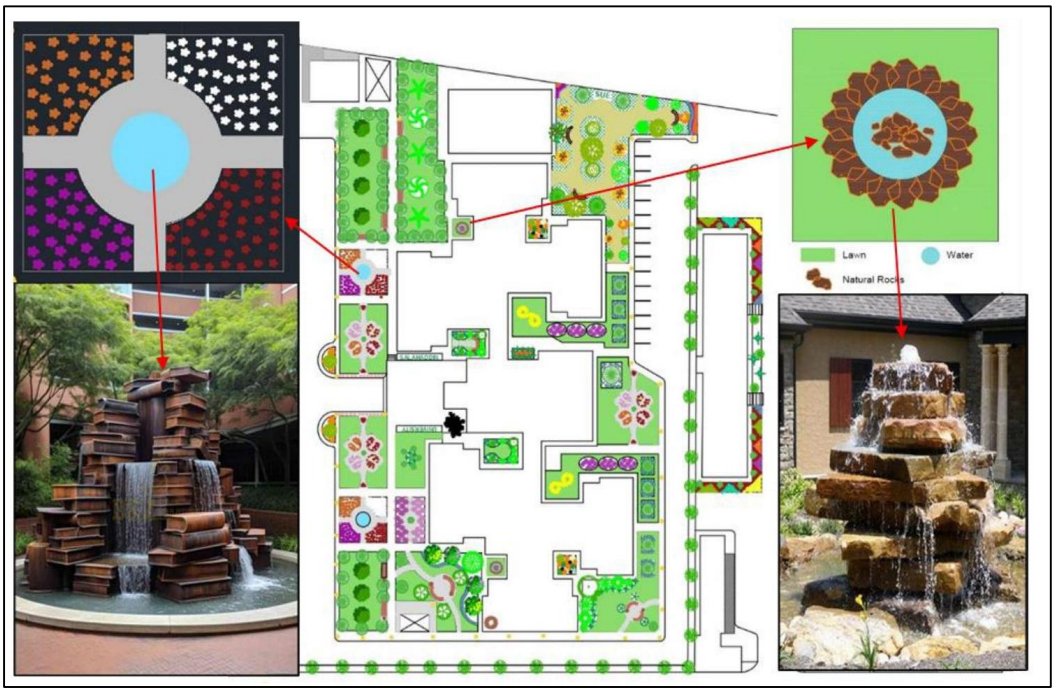


Figure 12. Fountain examples for the proposed master plan (Author)

Other facilities Services (Lightening, garages, café, toilets (Restrooms), Bicycle track, waste baskets…etc.)

The variety of facility services is critical to be available in gardens and open spaces for visitors and staff to utilize while waiting and resting, such as a café and restrooms. Other facilities, such as garages and bicycle tracks, have been placed close to pedestrian walkways, so that visitors can readily access the gardens and buildings. Lighting is vital for visual experiences at night and on dark winter days, and it can also be used to embellish a location around a fountain by reflecting tree images and showing an artificial lighting background. Waste baskets are necessary for maintaining the cleanliness of the vegetation area and are a sustainable approach to collect waste and dispose of trash.

Conclusion

A comprehensive investigation of landscape design at Salahaddin University-Erbil reveals that the current setting does not adequately address users' environmental, functional, and psychological needs due to insufficient greenery and poor design. The study emphasizes the importance of well-planned green spaces for enhancing campus comfort and social interaction. A proposed sustainable landscape design seeks to increase vegetation, incorporate shaded seating, paths, and water elements, and features various gardens. Notably, two natural rock fountains are included to improve microclimate and provide a calming atmosphere. The design aims to enhance air quality and noise reduction, promoting environmental sustainability. A questionnaire reflects a 98% acceptance rate among stakeholders, indicating potential for long-term ecological, social, and educational benefits and positioning the university as a leader in sustainable landscape development.

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تصميم الحدائق ضمن المساحات الخضراء: دراسة حالة جامعة صلاح الدين ، أربيل

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الخلاصة
غالبًا ما تعاني البيئات الجامعية الحضرية من نقص في المساحات الخضراء المصممة بشكل جيد، مما يؤثر سلبًا على الرفاهية النفسية والراحة والتجربة العامة للطلاب في الحرم الجامعي. في جامعة صلاح الدين-أربيل، تفتقر منطقة الرئاسة إلى المساحات الخضراء الوظيفية والمخططة بشكل جيد، مما يحد من فعاليتها كمساحة استعادة اجتماعية. تهدف هذه الدراسة إلى تقييم الظروف الحالية للمناظر الطبيعية وتطوير اقتراح تصميم مستدام للمناظر الطبيعية لرئاسة جامعة صلاح الدين-أربيل. يتبنى البحث نهج دراسة حالة يجمع بين تحليل الموقع، والقياسات الميدانية، والملاحظة المباشرة مع استبيان عبر الإنترنت تم إجراؤه بين 70 طالبًا وموظفًا لتقييم احتياجات المستخدمين وتصوراتهم. تم تطوير مسودة أساسية، مع تحديد واضح لمجموعة النباتات داخلها. بصرف النظر عن القائمة الواسعة من الأشجار والشجيرات؛ فقد تم تصميم النباتات أيضًا للمشروع الحالي. تهدف هذه المبادرة إلى إنشاء منظر طبيعي مستدام وعصري وجذاب من الناحية الجمالية يستفيد منه كل من (الهيئة الأكاديمية، الموظفين، والطلاب) والنظام المحلي .
تشير النتائج إلى وجود نقص كبير في جودة المساحات الخضراء، وإمكانية الوصول إليها، والمرافق الداعمة مثل مناطق الظل ومناطق الجلوس. استنادًا إلى هذه النتائج، تم تطوير اقتراح تصميم شامل يدمج بين عناصر المناظر الطبيعية الناعمة والصلبة. يزيد التصميم المقترح من تغطية الأشجار بنسبة 56% وتغطية الشجيرات بنسبة 99%، مع دمج ميزات وظيفية تشمل الممرات، ومناطق الجلوس المظللة، وعناصر المياه لتحسين الأداء البيئي وتجربة المستخدم. تخلص الدراسة إلى أن دمج مبادئ المناظر الطبيعية المستدامة مع التصميم الموجه نحو المستخدم يمكن أن يحسن بشكل كبير الجودة البيئية والوظيفية والبصرية لمساحات الجامعة. يوصى بتبني التصميم المقترح وتنفيذه مع استراتيجيات صيانة احترافية لضمان الاستدامة والفعالية على المدى الطويل.
هذا الاقتراح يحمي البيئة الخضراء، وهو مفيد ومريح وجذاب بصريًا للطلاب والمستخدمين الآخرين.

الكلمات المفتاحية: الجامعة الخضراء، المساحات المفتوحة، Landscape، الاستدامة البيئية، جامعة صلاح الدين ، أربيل.