A Semi-Annual Peer-Reviewed Scientific Journal
Concerned with publishing research and studies.
in the humanities

الأربعين

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In The Humanities

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The Holy Husseiniya Shrine

Karbala Studies and Research Center

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A special issue of the Seventh International Conference

for the Ziyarte Al Arba'een

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1. Preserving And Documenting The Ziyarte Al Arba'een As A Religious-Social Ritual Using The Most Modern Methods Of Documentation And Presentation And Monitoring Its Effects On The Individual And Society.
2. Determine The Basic Requirements For The Ziyarte Al Arba'een And Secure Its Needs In Various Fields And Dimensions.
3. Drawing Inspiration From The Lessons Of Imam Hussein's Revolution In Promoting The Concepts Of Unity And Peace And Confronting The War Of Soft Ideas.
4. Linking Qur'anic, Religious, And Doctrinal Concepts To The Husseini Heritage And The Arba'een Visit To Increase Culture And Awareness Among The Family And Youth.
5. Monitoring The Challenges Facing Visitors In All Service Sectors And Provid-Ing Ways To Address Them And Develop Solutions To Them Scientifically And Practically.
6. Providing Researchers, Readers, And Those Interested In Research And Special-Ized Studies In The Ziyarte Al Arba'een.
7. Seeking To Inform The International Community Of The Importance Of The Visit And Its Community Of Millions; Because It Represents A Cultural And Human Heritage For Iraqi Society In Particular, And Lovers Of Ahl Albayt In General, It Can Also Be A Scientific Resource For Those Interested In Visiting Arba'in And An Important Factor In Preserving The File Of Providing Service And Hospitality At Ziyarte Al Arba'een After It Was Officially Registered In The Unesco Educational, Scientific And Cultural Organization (Unesco). In 2019 Ad, By The Center In Cooperation With The Ministry Of Culture, Tour-Ism And Antiquities.

Journal Vision:

The Arbaeen Peer-Reviewed Scientific Journal Seeks To Be A Scientific Platform For Publishing Research And Studies Related To The Ziyarte Al Arba'een. To Achieve A Scientific Addition For Those Interested In This

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م/ مجلة الاربعين

السلام عليكم ورحمة الله وبركاته

اشارة الى كتابكم المرقم م/٤٨١ بتاريخ ٢٠٢٣/٣/٨ ، والمتضمن استحداث واعتماد مجلتكم لاغراض النشر والترقيات العلمية وتسجيلها ضمن موقع المجلات الاكاديمية العلمية العراقية ، حصلت الموافقة بتاريخ ٢٠٢٣/٦/٢١ على أعتماد المجلة المذكورة في الترقيات العلمية والنشاطات العلمية المختلفة الاخرى ، واعتباراً من المجلد الاول – العدد الصفري - آذار- لسنة ٢٠٢٣ لتسجيل المجلة في موقع المجلات الاكاديمية العلمية العراقية.

للتفضل بالاطلاع وابلاغ مخول المجلة لمراجعة دائرتنا لتزويده بأسم المستخدم وكلمة المرور ليتسنى له تسجيل المجلة ضمن موقع المجلات الاكاديمية العلمية العراقية وفهرسة اعدادها ، ويعتبر ذلك شرطاً أساسياً في أعتمادها بموجب الفقرة (٣١) من ضوابط استحداث واصدار المجلات العلمية في وزارتنا.

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The Intergovernmental Committee for the Safeguarding of the Intangible Cultural Heritage has inscribed

Provision of services and hospitality during the Arba'in visitation

on the Representative List of the Intangible Cultural Heritage of Humanity upon the proposal of Iraq

Date of inscription

12 December 2019

Director-General of UNESCO

Certificate of registration for the file (providing service and hospitality during the Arba'een Ziyarte) registered by the Karbala Center for Studies and Research in cooperation with the Ministry of Culture, Tourism and Antiquities of the Educational, Scientific and Cultural Organization (UNESCO) On 1416- December 2019

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Editorial of the issue

In the name of God, the most gracious, the most merciful

Praise be to God, Lord of the Worlds, and may blessings and peace be upon the guiding and faithful Prophet Abu Al-Qasim Muhammad, and upon his good and pure family and companions.

And after.

The Arba'een visit of Imam Hussein, peace be upon him, has received great attention throughout its long history because of its great connotations and meanings in the souls of Muslims in general, and the Iraqi people in particular, because it embodied a set of humanitarian images, such as spreading the principle of peaceful coexistence among visitors with their different cultures and intellectual affiliations, and the extent of cohesion. Cultural and societal, self-denial and competition in providing services to various segments of the (Arba'een community), until this visit became a cultural and civilizational identity for our generous Iraqi people, which called on the Karbala Center for Studies and Research at the Holy Imam Hussein Shrine to strive diligently to register this visit in the international organization UNESCO as a ritual. Religious and social practice on the World Intangible Heritage List.

This issue devoted itself to publishing the proceedings of the Seventh International Conference of the Arba'een Visit, which was held by the Karbala Center for Studies and Research at the Holy Imam Hussein Shrine under the slogan (The Arba'een Visit...the authenticity of values and the title of civilization on 2324- AH, Safar 1445/September 82023 ,9-), which witnessed the participation of Wide international.

The Karbala Center for Studies and Research believes in the importance of studying the blessed Arba'een visit, so this year's edition of the Seventh

International Conference was devoted to a set of scientific topics related to the topic of the visit and its basic dimensions. It should be noted here that the conference sessions witnessed a wide attendance of research with an applied dimension, in addition to social and humanitarian research in which a large elite of specialists and researchers in several fields participated. The total number of research submitted to the scientific committee of the conference amounted to (177) research papers from inside and outside Iraq, distributed among: The main topics of the conference, and after presenting them to the scientific experts, (95) papers were accepted to participate in the conference, asking God Almighty that this scientific effort and its outputs benefit decision-makers to develop the service reality and the popular effort presented to the visitors of the Lord Abu Abdullah Al-Hussein.

And Praise be to Allah, the Lord of the Worlds

Scientific Committee of the Conference

managing editor

1445 AH – 2024 AD

A Real-time System for Fire Detection and Localization in Outdoors

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Abstract

This paper presents a fire detection and localization system designed to address the increasing incidence of fires in farms and outdoor areas. The proposed system utilizes a video camera capable of withstanding environmental changes, such as illuminance and color correlation to fire smoke and flames, offering a suitable alternative to traditional smoke sensor-based detection methods, which does not operate in open areas. By integrating color and motion detection approaches, the proposed fire detection system achieves accurate results. The input video decomposes using lifting wavelet transform to reduce the data size and as a result reduce the data processing time while preserving fire features for detection. The decomposed video frames are processed for color and motion detection to identify fire characteristics, with morphological post-processing eliminating unwanted pixels. The system calculates the detected fire area and applies threshold conditions for bounding. Fire localization is achieved through inverse camera parameter calibration and fire position mapping in pixels. The approach utilizes a projective transformation matrix to establish the relationship between frame pixels and real-world positions. Experimental results demonstrate a high accuracy rate for both offline and online (real-time) tests. The system achieves an average accuracy of 96% for real-time smoke and flame detection and 98% for offline flame and smoke detection. Fire localization is achieved with an error of less than 0.4 meters.

Keywords: Fire detection, color detection, motion detection, object localization, lifting wavelet transform (LWT).

1. Introduction

Fire poses a significant threat to lives, property, and the environment. In 2022, the number of fire incidents in various regions of Iraq exceeded 32,477 according to government statistics (Iraqi Ministry of Interior, 2023). Rapid detection and accurate localization of fires are crucial for effective emergency response and minimizing the potential damage caused by these destructive incidents. Over the years, advancements in technology have played a pivotal role in enhancing fire safety measures, with fire detection and localization systems emerging as essential components in various settings, ranging from residential and commercial buildings to industrial facilities.

The primary objective of fire detection and localization is to provide early alarm, allowing occupants to evacuate safely and enabling emergency responders to quickly mitigate the fire. Traditional methods of fire detection, such as heat sensors and smoke alarms, have been effective to some extent. However, they often lack the ability to precisely identify the location of the fire, which can lead to delays in response times and increased risks.

In recent years, technological advancements, including the integration of artificial intelligence (AI), computer vision, and sensor networks, have revolutionized fire detection and localization systems. These advanced systems utilize a combination of sensors, algorithms, and data analysis techniques to detect the presence of fire, accurately locate its origin, and provide real-time alerts to the relevant authorities.

One of the key technologies employed in modern fire detection and localization systems is computer vision. By leveraging sophisticated

algorithms and image processing techniques, these systems can analyze video footage or images captured by cameras to detect flames, smoke, or other signs of fire. Computer vision algorithms can differentiate between normal activities and fire-related events, allowing for early detection and triggering timely responses.

This research paper presents a novel automated approach to detecting and locating flames and smoke using a camera. The proposed method is applicable in various environments, including both enclosed and open spaces, such as indoor and outdoor areas. It utilizes advanced techniques to automatically identify smoke and flames. The method incorporates multi-thresholds for the International Commission on Illumination (CIE) L*a*b* color space to detect smoke, while flame detection is performed using HSV\YCbCr color space with frame difference. Additionally, fire localization is accomplished by employing a projective transformation matrix that maps frame pixels to real-world positions. To enhance efficiency and extract better features, the pre-processing stage employs the integer Haar lifting wavelet transform. This technique helps reduce the size of processed data and extract more meaningful features.

2. Related Works

Fire detection and localization are critical components of fire safety systems, aiming to promptly identify and locate fires for effective response and mitigation. Over the years, researchers have made significant progress in developing innovative methods and technologies for accurate and efficient fire detection and localization. This introduction provides an overview of some notable research works and advancements in this field.

In the study conducted by Gong et al. (Gong et al., 2019) , a fire detection system was proposed using frame differences and color analysis methods to identify fires based on distinct fire characteristics. They improved the accuracy of fire identification by calculating the mass center of the fire in each frame, enabling the extraction of shape, spatial, and area variations in the images. Consequently, the false positive rates were reduced. However, despite its effectiveness, Gong et al.'s methodology is not widely adopted in practice.

Ting Wei Hsu (Hsu et al., 2020)introduced a system that achieved a high detection rate and a low false alarm rate by employing local and global feature analysis, a decision unit, and an automatic threshold mechanism. This approach facilitated effective fire detection in diverse environments. However, it should be noted that the system's reaction time was prolonged due to information buffering from previous detections.

To further enhance the accuracy of fire detection, Khalil et al. (Khalil et al., 2021)proposed a method that utilized multi-space color

models and motion detection with Gaussian Mixed Models (GMMs) to detect moving objects. Although their methodology demonstrated high accuracy, the false positive rate remained relatively high at 88.81%.

Addressing this challenge, Wahyono et al. (Wahyono et al., 2022) developed probabilistic models using Gaussian multiples to identify fire color characteristics and dynamic fire movements through moment-invariant analysis. Their experiment exhibited a relatively high true positive rate of 89.92%. However, implementing their model poses a significant challenge due to the installation difficulties associated with physical cameras.

Li et al. (Li et al., 2023) proposed real-time fire detection and localization techniques specifically designed for indoor environments. Their approach employed a fully convolutional, one-stage CNN for fire detection. The localization of the fire is determined by two cameras, which work together to pinpoint the exact location of the flame. The fire localization process involves two steps. In the first step, camera calibration is performed using two frames. In the second step, the relative coordinates of the firing position with respect to the anchor point are computed. While this method achieves high accuracy with a compact model size, it necessitates a substantial amount of training data to cover various indoor and outdoor scenarios.

As previously mentioned, in the field of fire detection and localization video research and development, multi-domain technology has been utilized to increase accuracy of the fire detection. However, there are several challenges still exist such as continuous change of

the environment colors, unsuitability of some methods for real time processing, the big difference of accuracy respect to the change of weather conditions. Therefore, the proposed approach overcomes these drawbacks and it is suitable for real-time outdoor fire detection for different environments. Moreover, it is able to localize the position of the fire in real-word based on the video only.

3. Proposed System

This section offers a comprehensive explanation of the proposed system that is shown in Figure 1. The proposed system consists of five main stages include: preprocessing, color detection, motion detection, fire area computation, and finally, fire localization. The details of each main stage illustrate in the next subsections.

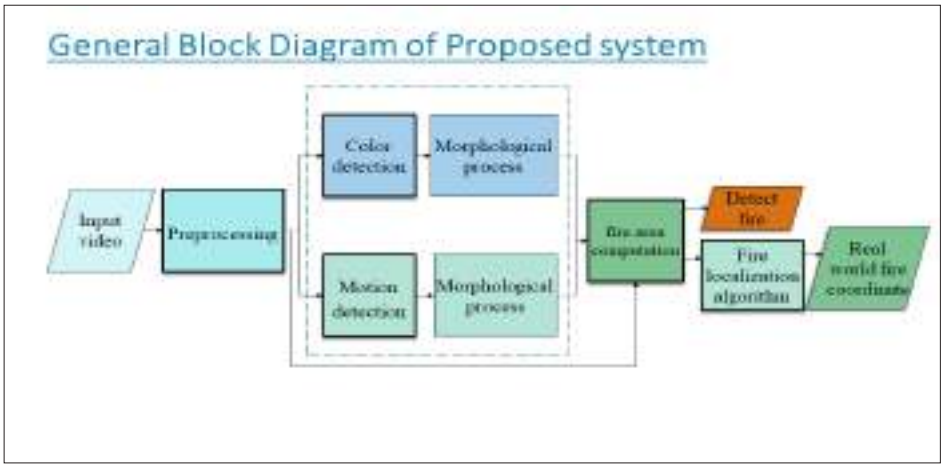

Figure 1. The main stages of the proposed system.

3.1. Pre-Processing Stage

Image preprocessing refers to the procedure of preparing an image for subsequent analysis or processing. It encompasses a set of operations performed on the image to enhance its suitability for a specific task or purpose. The source video is acquired either from an online camera or imported from a dataset, as elaborated in references (Çetin, 2014; KMU Fire & Smoke Database, 2012). As shown in Figure 2, preprocessing in this research uses one of the wavelet transform types.

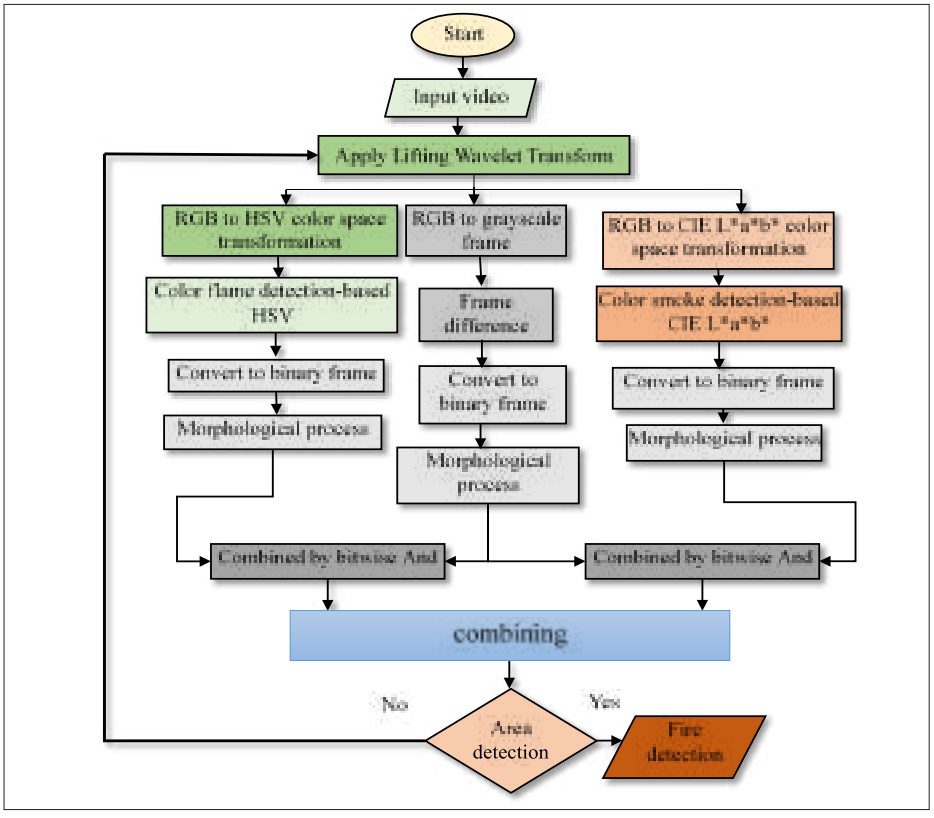

Figure: 2, Flowchart of the proposed fire detection

3.1.1. Wavelet Transforms

Wavelets refer to sets of nonlinear basis functions utilized to approximate a given function. In wavelet analysis, each basis function is meticulously chosen and approximated to better represent the input function. Wavelets depend on a dynamic assortment of basic functions to effectively capture the characteristics of the input signal or image. Among the various types of wavelets, the discrete wavelet transform (DWT) stands out as a widely used mathematical technique for decomposing a signal or image into localized wavelets in both time and frequency domains (Váňa et al., 2011).

The integer lifting wavelet transform presents a method to implement the DWT using only integer arithmetic. This is achieved by decomposing the wavelet into a collection of elements using a lifting scheme. The Haar wavelet serves as a simple example of such a lifting scheme, where the wavelets are dilated and shifted to perform the transformation (Ramalingam & Isa, 2014).

In the integer-to-integer lifting scheme based on the Haar DWT, the approximation coefficients in (Int-to-Int-HLWT) are constructed by taking the average of each adjacent sample in the input image. On the other hand, the detailed coefficients are computed by determining the difference between the surrounding samples of the input image. The correlation between neighboring samples in the input image is strong, resulting in the approximation coefficients closely resembling the actual input samples. Consequently, the detail coefficients exhibit low power relative to the original coefficients. Since Sj represents an

input sample with an integer value, the prediction {Sj(e)} = Sj(e) holds true in the Haar DWT-based lifting scheme. Furthermore, the integer nature of Sj allows for straightforward calculation of the prediction of odd to obtain the detailed coefficients as depicted in Equation (1).

$$\text{Int-to-int-HLWT prediction: } dj\text{-}1 = Sj(o) - Sj(e) \quad (1)$$

As indicated in reference (Shahadi et al., 2013), Sj(o) and Sj(e) correspond to the odd and even image inputs, respectively. The frame is divided into four sections (LL, HL, LH, and HH), where the low-level band frequency (LL) holds significant information for the detection system. Through the utilization of the integer Haar lifting wavelet transform, the size of the input data can be reduced by 75%.

3.2. Color Detection

Flame detection involves utilizing color-based methods, the hue\saturation\value (HSV) color space, to identify the characteristic colors associated with flames. On the other hand, smoke detection employs the International Commission on Illumination (CIE L*a*b*) color space for efficient smoke identification. By leveraging these color detection techniques, it becomes possible to distinguish flames and smoke in various applications.

3.2.1 Flame Color Detection

Flames typically exhibit reddish hues. While the RGB color space is known for its lower computational complexity compared to other color spaces, flame image recognition often employs the HSV color space due to its ability to offer a more human-centric approach to describing colors. The HSV color space is a representation of colors based on three components: hue, saturation, and value. Hue determines the color's position on the color wheel, saturation represents the intensity or purity of the color, and value corresponds to the brightness or lightness of the color (Smith, 1978). Through our experiments, we have determined that each pixel in the HSV color space representing fire flames must meet the following conditions:

$$\begin{aligned} 0 \le H \le 0.2 \\ 0.47 \le S \le 0.98 \\ 0.7 \le V \le 0.98 \end{aligned} \qquad (2)$$

The image is partitioned into two segments using these thresholds: the foreground representing fire colors Rcolor and the background representing non-fire colors. The flame color in the HSV is determined by summing up the results from each channel. Additionally, morphological procedures are applied to eliminate noise caused by small pixels (Gonzalez et al., 2009). In the final phase of this process, the binarized image is created to combine the flame color information in the HSV color space with motion detection, utilizing the logical operator AND.

3.2.2. Smoke Color Detection

Smoke exhibits prominent color characteristics, although they are not entirely distinctive. Smoke can vary in color from whitish gray to blackish gray, and color remains a noticeable aspect of smoke despite significant differences in color between smoke classes and within each class. Although frames are typically captured in RGB format, using RGB color for smoke color detection may pose challenges due to its limited capacity to capture the subtle nuances and variations in smoke color accurately, thereby hindering accurate differentiation of smoke from other elements in the image. A more effective and innovative approach to addressing this issue is to convert the frame into the International Commission on Illumination's (CIE) L*a*b* color space (León et al., 2006).

The CIE L*a*b* color space is a device-independent color model that separates color information into three channels: L (lightness), a (green-red axis), and b (blue-yellow axis). This color space is designed to mimic human perception of color, allowing for more accurate representation and analysis of color differences, especially in smoke color detection.

Table 1 provides the multi-threshold values for the CIE L*a*b* color space, which define the range of colors from whitish gray to blackish gray corresponding to smoke. These thresholds are used to partition the frame into the foreground, representing the smoke color in the CIE L*a*b* color space, and the background, representing non-smoke elements.

Table 1. The multi-threshold of the CIE Lab color space for smoke color detection

Thresholds / The rules	The values of threshold 1	The values of threshold 2	The values of threshold 3
Rule 1: L	(0.058~98.32)	(8.876~36.748)	(87.955~100)
Rule 2: a	(-8.067~4.853)	(-2.377~2.773)	(-2.211~5.546)
Rule 3 : b	(-24.653 ~-9.788)	(-10.399~4.065)	(-9.359~3.12)

The smoke color region, denoted as Rcolor , is represented in the formula:

$$R_{color} = \text{threshold 1} \cup \text{threshold 2} \cup \text{threshold 3} \quad (3)$$

Additionally, morphological procedures are applied to eliminate noise caused by small pixels (Gonzalez et al., 2009). In the final phase of this process, the binarized image is created to combine the smoke color information in the CIE L*a*b* color space with motion detection, utilizing the logical operator AND.

3.3. Motion Detection

The conventional frame differences technique (Singla, 2014) commonly used for motion detection, may not be suitable for accurately detecting the motion of a smoke or flame due to its unique movement characteristics. To address this, an alternative method called “frame difference with a time delay” is employed. This approach involves subtracting frames that are spaced apart by a specific number of frames, such as 8 frames, allowing for a more precise evaluation of pixel value changes associated with the smoke’s or flame’s motion. Initially, the frames are converted to grayscale to simplify the analysis by focusing solely on intensity information. Grayscale frames are sufficient for motion detection and help reduce computational complexity. The absolute differential frames are then calculated using the equation shown in Equation (4), where the resulting frames highlight significant changes in the smoke’s or flame’s appearance. These differential frames enable accurate motion detection and analysis.

$$I_{diff(k,k+7)} = |I_{(k+7)} - I_k| \qquad (4)$$

In the video, Ik represents the value of the kth frame, while I(k+7) represents the value of the (k+7)th frame (Singla, 2014)To prepare the motion detection frame for combination with the phase of color detection, it needs to be binarized and undergo morphological operations (Gonzalez et al., 2009) to remove small pixels.

3.4. Flame and Smoke Area Computation

Upon thorough analysis of frame difference and color features in fire detection, it has been determined that relying solely on either method would lead to a high rate of false alarms. To accurately identify the fire region, a combination of both methods must be performed effectively. The improved frame difference technique, called selected frame Ns, allows fire detection within just four frames per second, significantly faster than the traditional 30 frames. This method enhances processing speed, maintains accuracy, and enables timely fire alarm notifications. By applying the bitwise AND operation, the combination of color and motion fire regions, denoted as Rfire, is obtained, Figure 3 show sample of how flame and smoke detection processes combined to obtain more accurate results.

$$R_{fire}(M,N,i) = R_{color}(M,N,i) \cap I_{diff}(M,N,i) \qquad (5)$$

Once the fire region is identified, it is enclosed within a green bounding box for flames or a red box for smoke. The area of the bounded region is then calculated by subtracting the original frame from the bounding frame. If the resulting area exceeds the specified threshold values (55 for flames and 85 for smoke), it is considered to be indicative of a fire.

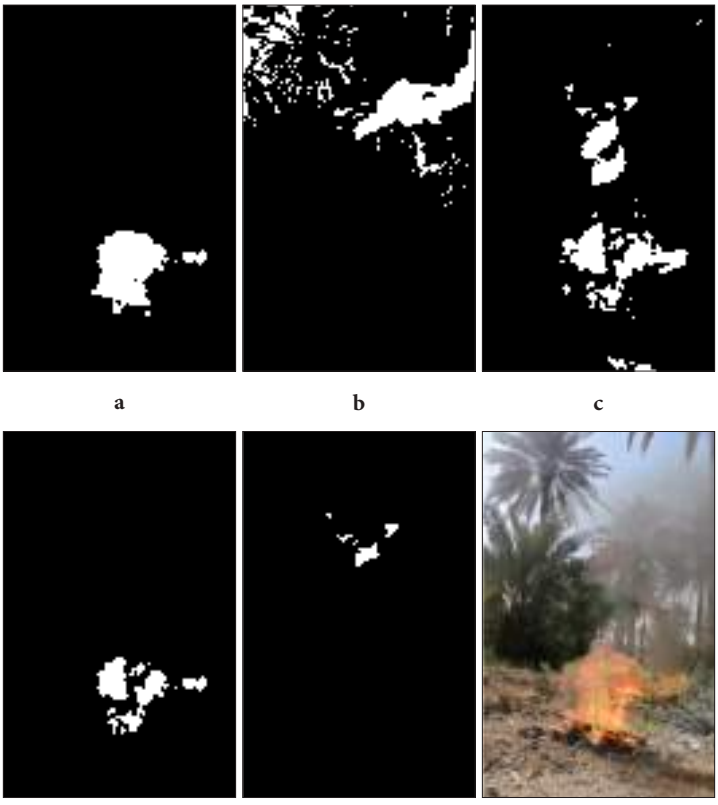

Figure:3, Sample of resulted frame that shows the combination of smoke and flame detection processes (a) flame color detection (b) smoke color detection (c) motion detection (d) combinations (a) and (c). (e) combinations (b) and (c). (f) Final result.

3.5. Fire Localization

Fire localization is the process of determining the precise location of a fire within a building or outdoor area. This information is crucial for firefighters and emergency responders, as it enables them to quickly and effectively allocate resources to combat and extinguish the fire.

In real-time flame and smoke detection systems, the position of

the fire is provided in terms of pixel coordinates within the current frame. To accurately determine the real-world location of the fire, a two-step method for real-world fire localization is introduced.

The first step involves camera calibration, which entails determining the camera's intrinsic and extrinsic parameters. Intrinsic parameters describe camera-specific properties such as focal length, principal points, and distortion coefficients, while extrinsic parameters define the camera's position and orientation in 3D space. Rotation and transformation matrices are utilized for performing the necessary coordinate system conversions.

The second step involves establishing the relationship between the fire's position in the video (represented by pixel coordinates M and N) and its real-world coordinates (represented by Xrw, Yrw, and Zrw). This relationship is achieved through a projective transformation, as described in Equation (6) by (Zhang, 2021). The method outlined in Figure 4 demonstrates the overall process of real-time fire localization using these two stages.

$$\begin{bmatrix} M \\ N \\ 1 \end{bmatrix} = \begin{bmatrix} fx & 0 & cx \\ 0 & fy & cy \\ 0 & 0 & 1 \end{bmatrix} \left(R \begin{bmatrix} Xrw \\ Yrw \\ Zrw \end{bmatrix} + T \right) \qquad (6)$$

Where fx, fy, cx, and cy are the focal length and principal point coordinates, respectively. R and T are the extrinsic matrices of the camera, which consist of the rotation matrix R and the translation vector T.

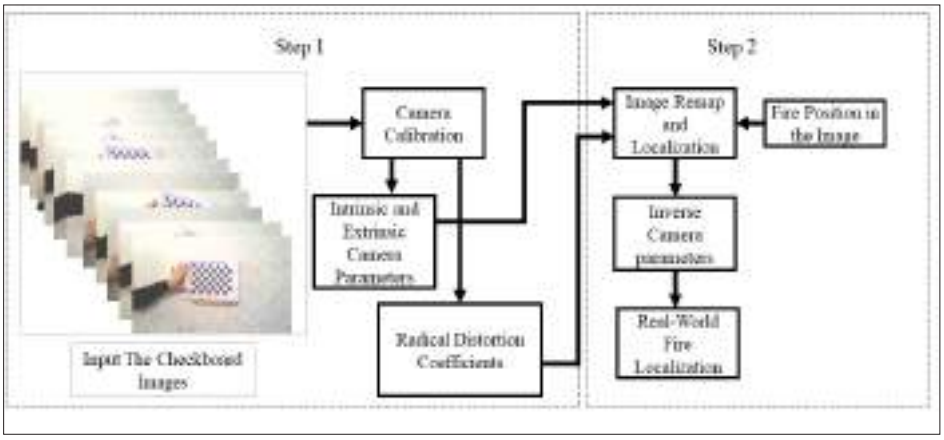

Figure:4, The two steps of the proposed fire localization method

The steps involved in the fire localization system can be summarized as follows:

1. Use a calibration pattern, such as a checkerboard, at different distances from the camera to accurately determine the camera's intrinsic and extrinsic parameters.
2. Capture multiple images of the calibration pattern from various angles and positions, ensuring the pattern is fully visible in each image.
3. Utilize camera calibration software, MATLAB's Single Camera Calibrator App (Using the Single Camera Calibrator App - MATLAB

& Simulink, 2023), to calibrate the camera using the captured images. This process yields the camera's intrinsic and extrinsic parameters, as well as radial distortion.

4. Identify the fire's position in each frame by determining the centroid of the bounding box obtained from flame and smoke detection systems.
5. Map the fire's position in pixels and perform localization.
6. Compute the real-world coordinates of the fire's location using the inverse of the intrinsic and rotation matrices, as described by Equation (7), derived by (Zhang, 2021).

$$\begin{bmatrix} Xrw \\ Yrw \\ Zrw \end{bmatrix} = \begin{bmatrix} fx & 0 & cx \\ 0 & fy & cy \\ 0 & 0 & 1 \end{bmatrix}^{-1} R^{-1}\left(\begin{bmatrix} M \\ N \\ 1 \end{bmatrix} - T\right) \quad (7)$$

The accuracy of the camera parameters plays a crucial role in accurately locating the real-world point of fire.

4. Experimental Results

The experimental results have been achieved for several fire videos that are divided into two groups: KMU and VisiFire datasets (Çetin, 2014; KMU Fire & Smoke Database, 2012) that include 43 videos, and our own recorded datasets that include 75 videos. The proposed system has been implemented using MATLAB version R2021b on a

Windows 10 PC with an Intel Core i7 2.70 GHz CPU and 16GB of RAM. The details of the tests of fire detection and localization as in the next subsections.

4.1. Fire Detection Results

The important parameters that are computed to test the performance of the proposed fire detection based on color (for both flame and smoke) and motion include: TP (True Positive) indicates the correct identification of actual fires, TN (True Negative) represents the accurate identification of non-fire situations,

FN (False Negative) refers to cases where the system incorrectly identifies a non-fire situation as a fire, leading to false alarms. FP (False Positive) indicates instances where the system fails to detect an actual fire, resulting in missed detections. These parameters are used to compute the accuracy, recall, and precision, respectively(Ryu & Kwak, 2022).

$$Accuracy=(TP+TN)/(TP+FP+TN+TP) \quad (8)$$

$$Recall=TP/(TP+FN) \quad (9)$$

$$Precision= TP/(TP+FP) \quad (10)$$

Figure: 5وdisplays samples of the real-time fire detection based on smoke and flame in outdoors areas that we have achieved. The samples in the figure include featuring seven different scenarios (vid1,

vid2, vid3, vid 4, vid5, vid6, and, vid7) with varying colors of smoke and flames, and in different environments. The details of each video and the performance results of the propose fire detection system corresponding to each video are presented in Table 2.

vid1 vid2 vid3 vid4

vid5 vid6 vid7

Figure:5, Test results of the real-time flame and smoke detection

Table:2, Evaluation of the real-time flame and smoke detection

Video name	Number of frames	NS	True Positive	True Negative	False Positive	False Negative	Accuracy %
Vid1	49	6	**5**	0	0	1	83.3
Vid2	48	6	6	0	0	0	100
Vid3	97	12	11	0	1	0	91.6
Vid4	84	11	11	0	0	0	100
Vid5	70	9	9	0	0	0	100
Vid6	50	6	6	0	0	0	100
Vid7	30	4	4	0	0	0	100
Total	428	54	52	0	1	1	96.2

*Note: Ns the number of the selected (see Section 3.4)

The flame and smoke detection system achieves an average accuracy of 96.2% across all seven videos, as calculated using Equation (8). Figure 5 (Vid1) and (Vid2) showcase the system's capability to differentiate between the color of the flame and the color of sunlight. Additionally, Figure 5 (Vid3 and Vid7) demonstrate the system's effectiveness in detecting various flame colors. Furthermore, the system can detect different colors of smoke, as shown in the test videos (Vid5) and (Vid6). Moreover, the system successfully distinguishes

smoke from smoke-colored backgrounds, preventing false detections, as demonstrated in Figure 5 (Vid4).

The proposed system efficiently tackles the crucial task of timely fire detection by swiftly identifying flame and smoke in real-time. The integration of the LWT has played a pivotal role in enhancing the system's response time, reducing it to less than 0.1 seconds. This significant improvement has resulted in a substantial reduction of over 50% in the overall duration required for flame and smoke detection, as compared to the previous duration of 0.2 seconds.

The performance evaluation of the system is conducted using two datasets: VisiFire and KMU Fire & Smoke Database (Çetin, 2014; KMU Fire & Smoke Database, 2012). These datasets encompass a wide range of resolutions, scenes, fire environments, and backgrounds, allowing for an effective assessment of the system's performance. Table 3 provides details about the videos within the dataset. To evaluate the proposed method on this dataset, a comprehensive empirical evaluation is conducted using a total of 7400 frames sourced from 17 positive and negative video clips obtained from the internet. The videos have different frame rates and resolutions. A sample of these videos is illustrated in Figure 6. The proposed system was compared with related work (Chen et al., 2004; Han et al., 2017; Khalil et al., 2021; Shidik et al., 2013).

Table:3, The specification videos used for testing the flame and smoke detection

Video sequence	Total frames	Fire frames	Non-Fire frames	Video description
Video 1	708	708	0	Fire 1 400 × 256
Video 2	439	433	6	Barbeq
Video 3	1201	1070	131	Backyard
Video 4	260	260	0	Controlled Environment 1 320 × 240
Video 5	200	200	0	Forest 1 400 × 256
Video 6	246	246	0	Controlled Environment 2 320 × 240
Video 7	245	245	0	Forest 2 400 × 256
Video 8	208	208	0	Controlled Environment 3 320 × 240
Video 9	255	255	0	Forest 3 400 × 256
Video 10	218	218	0	Forest 6 400 × 256
Video 11	216	216	0	Forest 5 400 × 256
Video 12	219	219	0	Forest 4 400 × 256
Video 13	402	402	0	Farm 320 × 240
Video 14	1201	1129	72	Field 320 × 240
Video 15	789	625	164	Highway 640 × 360
Video 16	306	0	306	Person with fire colored shirt 320 × 240
Video 17	357	0	357	Fire moving color car 320 × 240
Total	7470	6434	1036	

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Figure:6, Proposed flame and smoke detection using KMU and VisiFire datasets.

The flame and smoke detection results are shown in Table 4, and for the method presented in this study, the recall was 90.15%, precision was 94.95%, and accuracy was 98.22%. In terms of recall and precision from Equations (9 and 10), the proposed method demonstrates excellent performance compared to existing methods, except for the recall in the Khalil method (Khalil et al., 2021)The experimental results confirm that our proposed method achieves high accuracy and stability, with an approximate correct rate of 98%. Furthermore, our new approach surpasses previous methods in precision. However, it is important to acknowledge that our algorithms have limitations, and the presence of low-quality videos may lead to false negatives.

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Table:4, Comparison of the proposed system with the related work

Refrences	True Positive	False Positive	True Negative	False Negative	Recall %	Accuracy %	Precision %
(Chen et al., 2004)	5791	382	643	746	88.59	85.08	93.81
(Shidik et al., 2013)	5167	347	1267	791	86.72	78.68	93.71
(Han et al., 2017)	6278	431	189	697	90.01	92.59	93.58
(Khalil et al., 2021)	6293	1087	137	41	99.35	97.42	85.27
Proposed work	790	42	15	86.75	90.15	98.22	94.95

4.2. Real-World Fire Localization

In the final experiment, the proposed system's localization accuracy was assessed by choosing four outdoor locations and using the laptop camera for camera calibration and flame\smoke detection to determine the real-world coordinates of the fire. Figure 7 illustrates the four distinct fire locations, with the camera serving as a reference. The results, presented in Table 5, reveal an average localization error of 0.4 m. It is observed from the table that the error slightly increased as the test location moved farther from the camera, but the localization error consistently remained below 5 m.

Place 1

Place 2

Place 3

Place 4

Figure:7, Different videos for flame and smoke localization in four place

Table:5, The True and predicted coordinates of four random locations

	True Coordinates	Predicted Coordinates	Error (Meters)
Place 1	(0.5, 0.7, 0.9)	(0.51, 0.75, 0.9)	0.05
Place 2	(3, 3.4, 2.2)	(3.3, 3.1, 2)	0.47
Place 3	(4, 3, 5)	(4, 3.2, 5.5)	0.54
Place 4	(4.3, 4, 1.5)	(3.8, 4.2, 1.3)	0.57

5.Conclusion

This paper has presented an efficient method for real time fire detection and localization. The proposed fire detection decomposes the input by LWT to reduce the processing time without effect to the essential fire features. The decomposed frames are then subjected to color and motion detection, followed by morphological post-processing to eliminate unwanted pixels. The system calculates the detected fire area and applies specific threshold conditions for bounding. The fire localization approach utilized in the study effectively maps frame pixels to real-world positions using a projective transformation matrix, providing high identicality to the actual fire locations. The results demonstrate the system's ability to detect smoke under various densities, even in the presence of sunlight and against gray and white backgrounds, as well as accurately detect flames under sunlight and backgrounds with similar colors to flames. The proposed methods exhibit high accuracy rates, with an average accuracy of 96% for smoke and flame detection in real-time scenarios and 98% for offline flame and smoke detection. Additionally, the integration of Int-to-Int-HLWT in preprocessing significantly reduces processing time without compromising accuracy, achieving a 50% reduction compared to non-preprocessed cases. In summary, the research paper presents robust flame and smoke detection methods, offering efficient processing, accurate fire localization, and high detection rates in various outdoor environments.

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Crowd Scene Analysis for Zeyarat Al-Arabaeen: A Comprehensive Literature Survey

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Abstract:

Understanding how people behave in crowded places is an important endeavor with several uses, like controlling the spread of COVID-19 and boosting security. In-depth study of crowd scene analysis methods, including both crowd counting and crowd activity detection, is included in this survey article. This article fills the gap by exhaustively examining the spectrum up to contemporary deep learning techniques, whereas current studies frequently focus primarily on certain aspects or traditional approaches. Paper proposes the innovative idea of Crowd Divergence (CD) evaluation as a matrix for evaluating crowd scene analysis approaches, which was motivated by information theory. Contrary to conventional measurements, CD quantifies the agreement between expected and observed crowd count distributions. This paper makes three key contributions: an examination of readily available crowd scene datasets, the use of CD for thorough technique evaluation, and a thorough examination of crowd scene methodologies. The investigation starts with conventional computer vision methods, closely examining density estimates, detection, and regression strategies. Convolutional neural networks (CNNs) become effective tools as deep learning progresses, as seen by new models like ADCrowdNet and PDANet, which make use of attention mechanisms and structured feature representation. To evaluate algorithmic effectiveness, a variety of benchmark datasets including ShanghaiTech, UCF CC 50, and UCSD are carefully examined. Computer vision's exciting and challenging topic of "crowd scene analysis" has numerous

applications, from crowd control to security surveillance. This survey article offers a comprehensive viewpoint on crowd scene analysis, bringing several approaches under a single heading and presenting the CD measure to guarantee reliable assessment. This article provides a complete resource for researchers and practitioners alike through an elaborate investigation of methods, datasets, and cutting-edge evaluation approaches, paving the way for improved crowd scene analysis techniques across a variety of fields.

Keywords: Crowd behavior analysis, Crowd scene methodologies, Crowd Divergence (CD) evaluation, Deep learning techniques, Benchmark datasets, Crowd control and security.

1. Introduction

The study of crowd scene analysis involves examining the behavior of groups of people in the same physical area [1]. It typically includes counting the number of individuals, in regions tracking their movements and identifying their behaviors. This type of analysis has applications. One such application is controlling the spread of COVID 19 by ensuring distancing in places like stores and parks [2]. It also plays a role in ensuring security during events such as sports championships, carnivals, New Year celebrations and Muslim pilgrimages [3 6]. Automatic crowd scene analysis enables surveillance camera systems to detect behaviors within groups of people [7–9]. Additionally analyzing crowd scenes in places like train stations,

supermarkets and shopping malls can provide insights, into crowd movement patterns. Identify design flaws. These studies contribute to improving safety considerations [10,11].

As was previously shown, it is crucial to analyze crowd scenes, hence various survey papers have been suggested. However, the survey articles now in publication either compel the use of conventional computer vision techniques for the analysis of crowd situations or focus on just one component of crowd analysis, such as crowd counting [12]. This survey paper aims to provide an in-depth analysis of the development of crowd scene analysis techniques up to the most modern deep learning [13] techniques. The two key components of crowd analysis are (1) crowd counting and (2) crowd activity recognition, which are both included in this survey.

Additionally, this study suggests the crowd divergence (CD) evaluation matrix for crowd scene analysis techniques, which is motivated by information theory. When compared to popular evaluation matrices like mean squared error (MSE) [14] and mean absolute error (MAE) [15], CD provides an accurate assessment of how well the predicted crowd count distribution corresponds to the real distribution. The suggested metric calculates the difference between the estimated and actual counts.

This study offers three contributions:

1. Examine the datasets for crowd scenes that are accessible.
2. recommending crowd divergence (CD) for a thorough assessment of crowd scene analysis techniques.
3. Analyzing crowd scene analyzing techniques using deep learning.

The remainder of the survey is structured as follows. The crowd counting approach is discussed in Section 2. The crowd scene datasets are reviewed in Section 2. The paper is discussed in Section 4 of the document. Section 5 conclusion and future directions are noted it.

2. Crowd Counting

Crowd counting refers to determining how many people reside in a specific area. The subsections go through various approaches to estimating the population density of a given geographic area. To be thorough, we first discuss conventional computer vision techniques before reviewing deep learning-based techniques.

2.1. Traditional Computer Vision Methods

2.1.1. Density Estimation-Based Approaches

As seen in Figure 2, these techniques create a density map to depict the number of people per region in an input image. Through the linear mapping of local patch features to their respective objects, the author of [16] constructed density maps. The complexity of isolating each thing to count it and the possibility of counting errors in situations with a lot of objects are both reduced by formulating the problem in this way. This approach integrates over local batches in the entire image to estimate the number of objects.

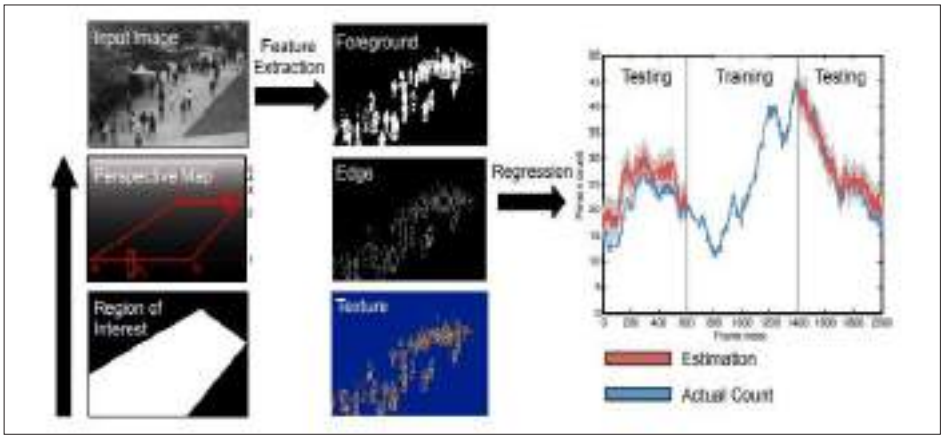


Figure:1. Crowd counting pipeline using regression model. Image from [17]

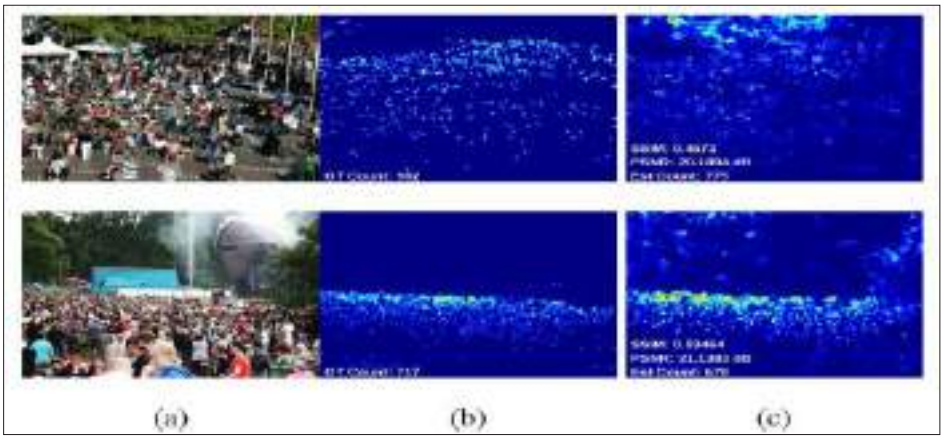


Figure:2. (a) Input image, (b) Ground truth, and (c) Estimated density maps. Image from [17].

A loss function that optimizes the regularized risk quadratic cost function was used to build the density map in .[18] Cutting-plane optimization was used to complete the solution .[19] The work in[18] was improved by Pham et al .in [50] by learning nonlinear mapping. They voted on density of several target items using random forest regression .[21 ,20] They also achieved real-time performance ,and in place of mapping dense features and creating a density map ,they computed the embedding of subspaces created by picture patches.

An approach for density estimation that is scale -and resolution-invariant was proposed by Sirmacek et al .To determine the probability density functions) pdfs [22] (of various places in successive frames, this technique uses Gaussian symmetric kernel functions .[23] The value of the generated pdfs is then used to estimate the number of persons per spot .The three primary categories of the conventional crowd counting approach are listed in Table.1

2.1.2.Detection-Based Approaches

Early methods ,like those in ,[24,25] relied on detectors to find people's heads or shoulders in crowd scenes to count them .Typically, monolithic detection or parts-based detection are used for counting by detection .For monolithic detection ,pedestrian detection techniques including optical flow ,[26] histogram of oriented gradient) HOG(,[27]Haar wavelets ,[28] edgelet ,[29] particle flow ,[30] and shapelets [31]are typically used as the foundation for the detection .The former detectors 'collected characteristics are then input into nonlinear classifiers like the Support Vector Machine) SVM ,[32] (however

the pace is poor .A linear classifier that offers a trade-off between speed and accuracy is typically linear SVM ,hough forests ,[33] or boosting .[34] The classifier is then moved across the entire image to identify candidates and exclude the less confident ones .The results of sliding reveal how many persons are present.

When the partial occlusion problem [35] arises ,the earlier approaches are unable to handle it ;as a result ,part-based detection is used .Instead of focusing on the entire body ,like the head and shoulders as in ,[25] part-based detection concentrates on specific body components .According to ,[25] part-based detection is more reliable than monolithic .Humans were modeled using ellipsoids based on3 D shapes ,[36] and a stochastic approach was used to determine the number and shape configuration that best explains a segmented foreground item .[37] Later ,Ge et al [38] expanded the same concept using a Bernoulli form prototype [39] and a Bayesian marked point process) MPP .[40] (The Markov chain Monte Carlo was utilized by Zhao et al [41] .to take advantage of temporal coherence for3 D human models across consecutive frames.

2.1.3.Regression-Based Approaches

Even if counting by detection or part-based methods produces acceptable results ,they fall short in densely populated areas and where there is significant occlusion .Regression counting tries to address the prior issues .This approach typically consists of two key parts .Extraction of low-level features ,such as foreground features

,[42,43]texture ,[45] edge features ,[46] and gradient features,[47] is the first part of the process .The second step entails converting the collected features into counts using a regression function ,such as linear regression ,[48] piecewise linear regression ,[49] ridge regression ,[50]or Gaussian process regression ,as in .[48] Figure 1 depicts this method's whole workflow.

In ,[51] York et al .suggested a multi-feature technique for precise crowd counting .They combined many features ,such as head locations ,[52]SIFT interest points ,[53] Fourier interest points ,uneven and nonhomogeneous texture ,into one overall feature descriptor .Then, to estimate counts ,a multi-scale Markov Random Field) MRF[54] (was utilized using this global descriptor .The authors also offered a fresh dataset) UCF-CC .(50-Regression-based methods typically produce decent results ,but because they rely on a global count ,they lack spatial information.

Table 1. Comparison of Traditional Counting Methods.

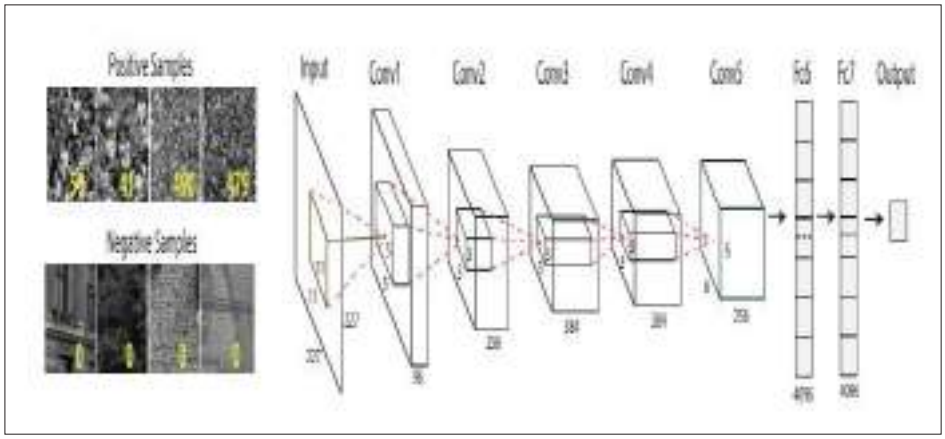
Traditional Counting Approaches	How they act	Benefits and Defects
Density Estimation-based Approaches	Convert crowd image to density map.	Utilize spatial information to minimize counting errors.
Regression-based Approaches	Feature extraction and regression modeling at low levels.	Results lack spatial information due to global count.
Detection-based Approaches	Detect heads and shoulders in crowd scenes using detectors.	Results fail in crowded and heavy occlusion scenes.

2.2. Deep Learning Approaches

Convolutional neural networks (CNNs) are like neural networks (NNs) in that they are made up of neurons and receptive fields with biases and weights that may be learned. The output of each receptive field's convolution operation is fed into a nonlinearity function when it receives a batch of inputs [55]. (e.g., ReLU or Sigmoid). CNN is presuming that the input image is an RGB image, so the hidden layers acquire rich information that improve the performance of the entire network (hidden layers and classifier). Since there are several items to be detected in the crowd scene photos, this structure has advantages in terms of speed and accuracy. End-to-end networks are those in which the network directly generates the required output after receiving the input image.

Deep network pioneering work was put forth in [56]. For counting individuals in photographs of incredibly dense crowds, an end-to-end deep convolutional neural network (CNN) regression model was put out. Using a dotting tool, a dataset compiled from Google and Flickr was annotated. There are an average of 731 persons in each of the dataset's 51 photos. In this dataset, 95 counts are the lowest and 3714 counts are the greatest. On both positive and negative classes, the network was trained. The number of the objects was labeled on the positive photographs, whereas zero was labeled on the negative images.

Five convolutional layers and two fully linked layers make up the network's structure. Figure 3 illustrates how the network was trained on object categorization with regression loss.



Figur: 3. CNN positive and negative inputs in architecture.

Following the first CNN-based technique ,[57] a real-time crowd density estimation method based on the multi-stage ConvNet was proposed .[58] The main presumption behind this strategy is that some CNN connections are superfluous .As a result ,similar feature maps from the second stage and their connections can be eliminated.

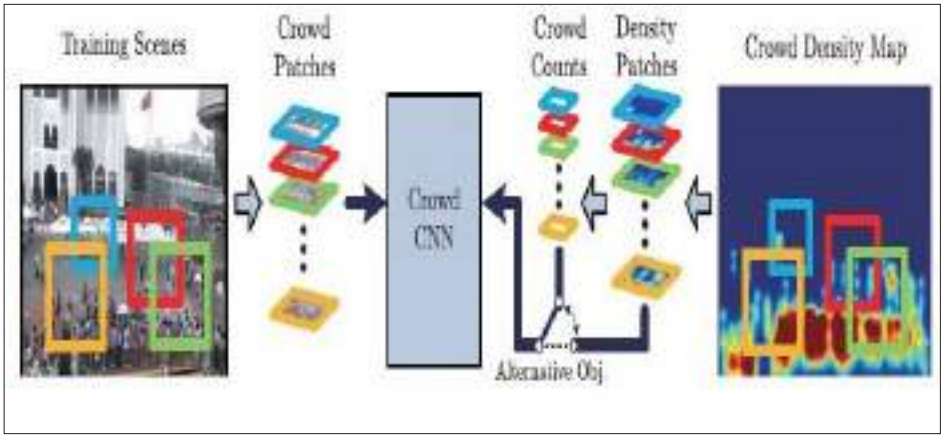
Network architecture :The network is made up of two multi-stage cascaded classifiers .[59] One convolutional layer and a subsampling layer make up the first stage .The second stage utilizes the same architecture .A fully connected layer with five outputs makes up the last layer ,which categorizes the crowd scenario as either very low, low ,medium ,high ,or very high .The authors optimized this stage

because just 1/7 of the features come from the feature maps from the first stage .The optimization process was based on comparing how similar the maps were .To reduce processing time ,this map will be eliminated if the similarity is below a predetermined threshold.

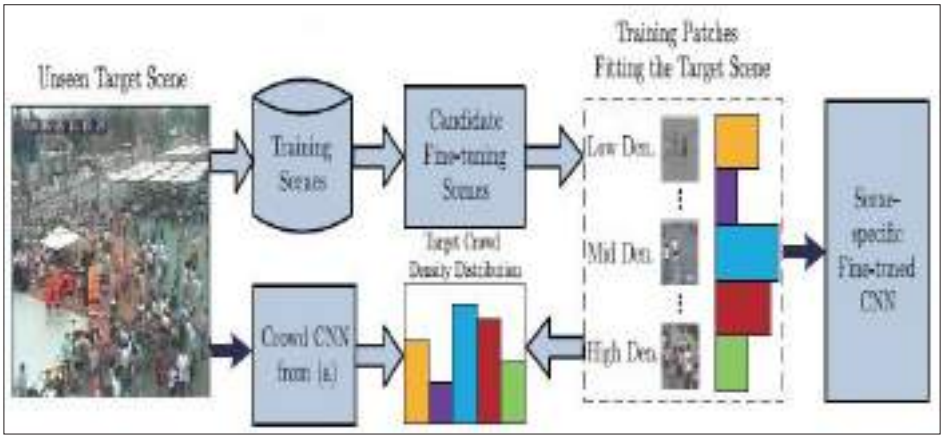
In ,[60] the author noted that performance dramatically decreased when the trained network was used with unknown data .As a result ,a new CNN mechanism was trained with switchable objectives on both crowd counts and density maps ,as illustrated in Figure .4 Another contribution to this work is the nonparametric fine-tuning module .The primary goal was to close the domain gap between the distribution of training data and the distribution of unobserved data .Candidate scene retrieval ,patch retrieval ,and local patch retrieval are all included in the nonparametric module .The primary goal of the candidate scene retrieval was to locate training scenes across all training scenes that share perspective maps with the target scene .The local patch retrieval scene seeks to identify comparable patches with densities that are like those in the test scene ,as shown in Figure

Generative adversarial network (GAN) is another framework that is used to create the crowd scene [61]. The parent patch and the child patch were provided as two inputs to the network by the author in [62]. The child patch is made up of two sub-patches, whereas the parent patch is the entire image. The goal of this architecture is to reduce the number of times the parent and child patches cross scale boundaries.

Network structure Parent Glarge and Child Gsmall are the two generators present in the framework. The input crowd image patch is mapped end-to-end by the generator network G to a density map with the same scale. To address scale fluctuation, each generator has an encoder and a decoder [63], placed back-to-back.



(a) training scenes for the crowd CNN



(b)A target scene is adjusted(fine-tuned)by the pre-trained CNN in[a]

Figure: 4. The cross-scene network's internal organization includes a fine-tuning scene module to enable generalization for unobserved data.

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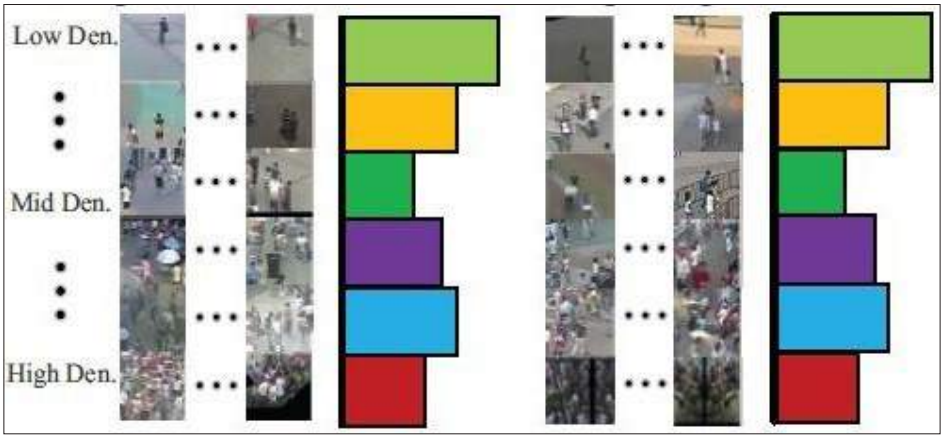
(a) Testing crowd scenes



(b) Right side represents similar training patches that fit the target scene ,while the left side displays patches and distribution in the target scene.

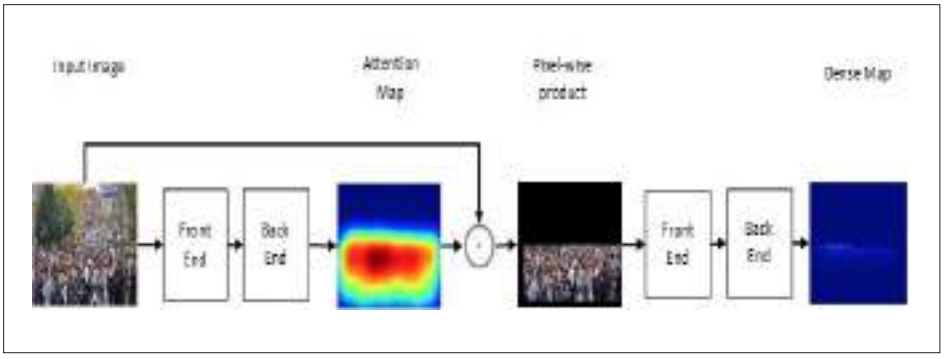
Figure 5. The nonparametric module [60].

The authors in [64] offered two models for crowd and item counts. Counting CNN) CCNN ,(the first model ,is trained to map an image to a matching density map .The second model put forth ,called Hydra CNN ,is capable of estimating object densities in extremely cluttered environments without being aware of the scene's geometry.

On One of the most up-to-date ,cutting-edge techniques for precisely counting crowds was published in .[65] An attention-injective deformable convolutional network named AD Crowd Net was proposed by the authors ,and they claim that it can operate accurately in crowded noisy environments .The Attention Map Generator) AMG (and Density Map Estimator are the two components of the network) DME .(The input image is classified by the AMG classification network as either a crowd image or a background image .The output of AMG is then fed into DME as an input to produce a map of the crowd's density in the frame .Figure 6 details this procedure .On the Shanghai Tech dataset ,[66] UCF CC 50 dataset ,[42] WorldExpo 10'dataset ,[60] and UCSD dataset ,[39] AD Crowd Net had the highest accuracy for crowd counting .Oh et al .provided a method for quantifying uncertainty for crowd estimation in.[67]

This approach is built on a bootstrap ensemble-based scalable neural network framework .The PDA Net) Pyramid Density-Aware Attention-based network (method [68] produces a density map that shows how many people are present in each area of the input photos. The attention paradigm ,pyramid scale features ,decoder modules for crowd counting ,and a classifier to determine the crowd density in

each input image are all used to create this density map .Structured feature representation learning ,and hierarchically structured loss function optimization are utilized to count the population in DSSI Net) Deep Structured Scale Integration Network .[69] (Reddy et al. addressed the issue of crowd counting in [70] using an adaptive few-shot learning method .An end-to-end trainable deep architecture was suggested in .[71] This method leverages contextual information to estimate the number of people in the input photographs by generating several receptive field sizes and learning the significance of each such characteristic at each image location.



3. Crowd Scene Datasets

Numerous datasets can be utilized to test and/or train crowd scene algorithms, as indicated in Table 3. The Shanghai Tec dataset is the most used, particularly in deep learning algorithms [66]. There are 1198 photos with annotations, including street view images and internet images. The 108 security cameras that were watching Shanghai World Expo 2010 produced the WorldExpo'10 dataset [60]. There are 1132 annotated video clips in this collection.

There are 50 annotated crowd frames in the UCF dataset _CC 50 [42]. Due to the wide variation in crowd sizes and scenario types, this dataset is one of the most difficult to analyze. The crowd size typically ranges from 94 to 4543 people. 2000 annotated photos with a dimension of 158 by 238 pixels each make up the UCSD dataset [39]. The maximum number of persons is 46, and the ground truth is labeled in the middle of each object. There are varied densities in the mall [41]. Various static and dynamic activity patterns are also present.

There are older datasets like Who do What at some Where (WWW) [85], UCLA [72], and Dyntex++ [73] that are still utilized in crowd scene counts.

Table 1. Comparison of Traditional Counting Methods.

Dataset name	Total images no.	Res.	Min	Avg.	Max	Total Count
ShanghaiTech Part A [66]	482	Varied	33	501	3139	241,677
ShanghaiTech Part B [66]	716	768 × 1024	9	123	578	88,488
UCF_CC_50 [51]	50	Varied	94	1279	4543	63,974
Mall [50]	2000	320 × 240	13	-	53	62,325
UCSD [48]	2000	158 × 238	11	25	46	49,885
WorldExpo'10 [60]	3980	576 × 720	1	50	253	199,923

4. Discussion

The examination covers the theoretical underpinnings of crowd counting, a crucial component of crowd scene analysis. A detailed analysis of density estimation-based, discovery-based, and regression-based approaches to traditional computer vision techniques is provided. Density estimation methods provide density maps that graphically represent the crowd distribution because they are adept at geographically reducing count mistakes. Regression-based techniques attempt to

overcome the restrictions seen in highly crowded or dead-end settings by converting low-level traits into numbers using regression models, as opposed to discovery-based tactics, which employ detectors to label subjects' heads or shoulders for counting.

Convolutional neural networks (CNNs) are discussed in the narrative in an elegant way as a paradigm change in crowd analysis throughout the deep learning period. The authors set the stage for understanding the revolutionary potential of deep learning by describing the structure and learning mechanism of CNNs. Networks like AD Crowd Net, PDA Net, and DSSI Net are included in the debate as well as other significant advances. These models show hierarchical structures, attention processes, and generative adversarial networks (GANs), ushering in a new age of precise crowd counting even under difficult circumstances.

The study extensively examines a variety of data sets, including the Shanghai Tech data set, UCF_CC_50 data set, UCSD data set, and WorldExpo'10 data set, acknowledging the crucial role that data sets play in the advancement of research. The complexity and diversity of real-world crowd situations are highlighted by the offered dataset definition, highlighting the necessity for advanced analytic methods. The statistics highlight the diversity of crowd sizes, scene kinds, and obstacles, highlighting the necessity for adaptable research approaches.

5. Conclusions and Future directions

The significance of crowd scene analysis and its usefulness in enhancing public safety and urban planning serve as an excellent summary of the paper's investigation. An overview of the study's contributions, including a dataset scan, a proposed CD measure, and a summary of deep learning methodologies, is provided. The paper concludes by outlining potential future directions and suggesting potential directions for more research and innovation. The crowd scene analysis landscape shows potential for novel solutions that might transform event planning, public safety, and urban development as technology advances.

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Blood Donation Management System for Ziyarat Al-Arabaeen:

A User-Friendly App.

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Abstract:

A user-friendly Windows application known as “the Blood Donation Management System” was created using C# and SQL Server. The goal of this application is to handle donor information and blood inventory effectively. It provides a complete solution for blood banks and donation facilities to organize their processes and guarantee a steady stream of blood donation activities that could be utilized during the Arbaeen pilgrimage. By encouraging the crowds to donate blood, so that the blood banks may have sufficient amounts of different blood types. Also, in the case of a crisis, there will be an instant transfusion of blood if needed. The application's core feature include a blood inventory management that enables the blood bank authorized personnel to keep track of the availability of various blood types, while the application gives an accurate report of the blood stock. It offers up to date data on blood types quantities and expiration dates, ensuring that the blood supply is continuously kept at the best possible state for blood storage. The donor data management makes it possible to capture and maintain crucial donor information, including age, the time since the previous donation or surgery and donor’s contact information in case of lack of certain blood type, the donors may be contacted to donate one more time. This information are essential for preserving a large pool of candidate donors and guaranteeing a secure process of blood transfusions. Also the application contains user authentication to assure secure management of donors private information and preventing blood supplies from being drawn to black market. Information concerning donors and blood inventories are kept private and accurate due to the access control mechanism. On the home interface, the application facilitate navigation through the application’s modules using dashboard display.

Keywords: Blood donation, Management system, User-friendly App., Blood bank, Donor data, Donor engagement, Blood transfusion, Zeyart AL-Arbaeen.

1. Introduction

Healthcare facilities must manage blood donations and inventories in order to maintain a steady supply of blood for transfusions. It is essential to provide strong solutions that streamline the donor data management process and guarantee efficient inventory control given the improvements in technology and the rising demand for effective blood bank systems. By utilizing Visual Studio C# and SQL Server to develop and construct a blood donor data management system with group-based donation tracking and inventory control, this project seeks to overcome these difficulties [1].

Blood banks are essential to the healthcare system because they make it easier to collect, test, store, and distribute blood and its constituent parts. To guarantee the availability of suitable blood units when required, precise and effective monitoring of donor data and blood inventory is essential [2]. Additionally, it's crucial to have a proper donation interval for the blood donors' health and wellbeing. Therefore, it is essential to create a complete system that integrates inventory control, group-based monitoring, and donor information management [3].

Because of its flexibility and considerable efficiency, Visual Studio C# was preferred as the programming language to create interfaces for the application. The IDE provides a varied range of tools and frameworks that make it feasible to implement to build user-friendly interfaces for the application [4]. Also choosing SQL server as database management system based on its reliability of managing large-scale

databases and provide up to date centralized support for the blood and donor's data [5].

Creating this application to achieve an effective inventory control system based on blood types, inflict a minimum donation interval of six months, and construct a blood donor management system that allows for managing the donor's information. In the blood stock identifying the blood type will give precise report of the amounts of each blood type in the inventory[6].

The paper will provide a system architecture that trial the difficulties facing blood donation process, the rules, and the present blood bank systems. Utilizing well managed and good database management system for effective data storage and retrieval [7].

The application's ability to reliably store and retrieve donor data, enforce the donation interval limit, and maintain accurate inventory levels will all be tested using a variety of use cases. The system's performance will be assessed based on its capacity to manage multiple requests at once, maintain ideal response times, and guarantee data integrity [8].

By offering a complete blood donor data management solution, the study's results are anticipated to help blood banks enhance their systems [9]. Inventory control, group-based donation tracking, and efficient and dependable donor data storage will all be made possible by the combination of Visual Studio C# and SQL Server. The system that has been created will ultimately improve the effectiveness of blood donation procedures, streamline the administration of blood

inventories, and facilitate the prompt availability of suitable blood units for transfusion purposes [10].

2-Benefits of this study

For healthcare organizations as well as those engaged in the blood donation processes, the creation, and deployment of the blood donor data management system, combining group-based donation monitoring and inventory control, would result in considerable benefits. The initiative aims to overcome current blood bank system difficulties and provides the following advantages [11]:

1-Enhanced Efficiency in Donor Data Management:

The system's user-friendly interface will ease procedures like registration, appointment scheduling, and monitoring contribution history while streamlining the maintenance of donor information. Healthcare workers will have more time to concentrate on offering high-quality treatment and services by minimizing manual paperwork and administrative responsibilities.

2-Improved Donor Engagement and Participation:

Active donor involvement and participation in blood donation activities will be encouraged by the user-friendly system interface. Donors will have access to a practical platform where they can update their contact information, make appointments, and get alerts about new contribution possibilities. A greater sense of engagement and commitment will be fostered by improved communication between blood banks and donors.

3-Accurate Tracking of Group-Based Blood Donations:

The system will accurately record blood donations depending on the blood group of the donor by including group-based donation tracking. Having a minimum 6-month gap between donations can benefit donors' health and wellbeing and limit excessive blood loss. This function will help to keep a steady and dependable supply of blood units for transfusion needs.

4-Efficient Inventory Control and Blood Stock Management:

The inventory control module will make it possible to handle blood supply effectively. Real-time updates and precise inventory levels will be provided via automated deductions from the stock depending on the blood type indicated before each donation. The danger of shortages or wastage will be reduced thanks to this optimization, which will also promote the prompt availability of appropriate blood units for transfusion needs.

5-Enhanced Data Integrity and Security:

In order to guarantee the quality and consistency of donor information and inventory records, the project will put in place strong data integrity procedures. The system will safeguard confidential donor information by using cutting-edge security techniques including access limits and encryption. Data backups and recovery tools will also provide protection against data loss or corruption.

6-Contribution to Healthcare Services and Patient Care:

The newly created system for managing blood donor data will make a big difference in how well healthcare services are provided. It will help medical practitioners make wise judgments about managing blood inventory by giving blood banks an effective and dependable tool for operations. This will guarantee that adequate blood units are available for transfusion when necessary, improving patient care outcomes and helping to save lives.

Overall, this study results will be highly advantageous to hospitals, blood banks, donors, and patients. The project will encourage an atmosphere of enhanced healthcare service delivery and better patient care by streamlining donor data administration, assuring accurate monitoring of blood donations, improving inventory control, strengthening data security, and encouraging efficient blood bank operations.

3-Study Objectives and Problem Statement

Here, we discuss the study's goals and the issues with the current blood bank systems that were found. The following goals are the focus of the study:

1-Develop a User-Friendly Blood Donor Data Management System:

The main goal is to provide an intuitive and user-friendly interface that makes it simple for donors to sign up, change their contact information, schedule donations, and view their gift history. The method aims to promote engaged, active donor participation.

2-Implement Group-Based Donation Tracking:

The project will include tools for tracking blood donations depending on the blood type of the donor. In order to protect the health and wellbeing of donors, it will impose a minimum 6-month gap between donations. To prevent donations before the required amount of time has passed, exact records of donation dates and amounts will be kept.

3-Ensure Efficient Inventory Control:

for efficient management of blood supply it is crucial to create inventory control. Based on the blood type of each donation, the system will immediately update the inventory, providing precise and real-time tracking of the blood supply.

4-Ensure Data Integrity and Security:

To guarantee the constancy and accuracy of donor information and inventory data, it is important to utilize used authentication. The application will provide data integration, backup and recovery procedures to prevent data loss or corruption.

5-Conduct Comprehensive Testing and Performance Evaluation:

The application's functionality, reliability, and practicality must tested regressly. By testing a number of use cases, including donor registration, inventory control, and data retrieval. The application's ability to manage many requests simultaneously, retain ideal response times, and assure data integrity under many load levels will be evaluated in terms of performance.

6-Contribute to the Improvement of Blood Bank Systems:

The goal of the application is to improve blood bank operations by offering a comprehensive solution for donor data management and inventory control. The pplication aims to increase efficacy, simplify procedures, and assure the rapid availability of suitable blood units for transfusion needs.

The existing applications handling blood donation process have several malfunctions that our application is trying to resolve:

1-Inefficient Donor Data Management: Traditional paper-based and manual donor data management procedures take a lot of time, are prone to mistakes, and are inefficient, which makes it difficult to

keep a donor database that is both structured and current.

2-Lack of Group-Based Donation Tracking: It is challenging to manage blood inventory among several blood groups since many existing systems lack group-based donor monitoring, which can cause imbalances and possible shortages.

3-Inaccurate Monitoring of Donation Intervals: The quality of given blood units is compromised by the current systems' frequent inaccuracies in monitoring and enforcing minimum donation intervals, endangering the health of donors.

4-Inefficient Inventory Control: Blood shortages or surplus inventory can be caused by manual blood unit and stock level tracking, which raises expenses and compromises patient care.

A comprehensive blood donor data management system that incorporates group-based donation monitoring and effective inventory control is needed to address these issues. The project intends to increase the overall efficiency and effectiveness of blood bank operations by achieving these research objectives.

4. Methodology:

4.1. System Design: Overview and Database Structure

In order to effectively store and manage the data, a thorough database design is created during the system design phase [12]. The data model, which functions as a database design diagram and documents and illustrates the fundamental structure of the database, is a crucial part of this design. The Figure (1) gives a general overview of the system, including its architecture and user interfaces.

The system architecture is created to guarantee the seamless integration of diverse components, facilitating efficient processing and smooth data flow.

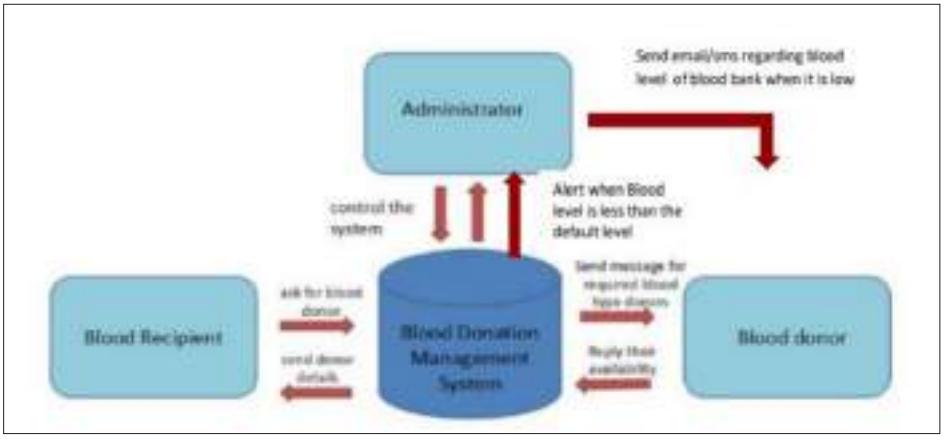

Figure (1) Overall System Architecture

4.2. Design and Implementation: User Interfaces

The user interfaces of the program are created to offer a fluid user experience and effective communication with the system. Below is a list of the key user interface modules:

1-Entry Interface:

Users are shown the entrance interface when the application is launched. Users are prompted to enter their login and password on this screen to authenticate. When the submitted credentials are successfully verified, the system allows access to the main program interface as shown in Figure (2)

Figure (2) Login Interface

2. Main Interface: Navigation and Functionality

All other interfaces in the program may be navigated through the main interface, which acts as the application's core hub. It offers users a tailored experience by displaying their authority, name, and

profile image. The main interface has seven buttons, each of which represents a different function, plus an exit button to end the program:

1. New Donor: registration process of new donors is achieved with this interface, giving essential information for the blood donation.
2. Old Donor: revealing the former donation history by the donor id and the possibility of new donation process, which is labeled "Old Donor."
3. Update Donor: any modification on donor data such as contact information and medical history.
4. Blood Stock: provide precise statics of the amount of each blood type in the inventory while withdrawal or donate.
5. Blood Product: details about various blood types and their expiry date that must be predetermined at the donation date.
6. Users: the users with permissions may access and manage user accounts.
7. Exit: this interface will terminate the application that may easily close it by pressing the exit button.

The main interface's simple design makes it easy to navigate and provides quick access to all features. The interface try for to increase user engagement and efficiency while engaging with the application.

Figure (3) Home Interface

3. New Donor Interface: Adding and Managing Donor Data

A simple platform for registering comprehensive information of a new donor. Users can enter the donor's ID, name, age, blood type, donation date, medical background, number of donations, and contribution amount. The donor record in the database is securely populated with donor's information, by clicking the save button, assuring thorough and well-organized record keeping.

The interface also features a handy delete option that may be used to get rid of a donor's data if necessary .With the aid of this capability, users may effectively manage the donor database and handle any necessary adjustments or changes.

The New Donor interface makes sure that the process of gathering and maintaining donor data is smooth and organized ,which improves the system's overall efficacy and structure.

Figure (4) Home Interface

4. Old Donation Interface-6 :Month Donation Interval

Donors can make repeated donations through the gift interface as long as it has been longer than six months since their last gift .To maintain ethical and secure blood donation procedures ,the system strictly enforces this requirement.

Figure (5) Old Donor Interface

1-Donor Data Modification Interface: Users can alter donor data using this interface in the event of mistakes or adjustments to certain criteria. Information about donors may be updated and edited by users with ease to maintain correctness and completeness, as shown in Figure (6).

Figure (6) Update Donor Interface

2-Blood Stock Interface: The Blood Stock interface shows the quantities that are currently available for each blood type. It provides real-time data regarding blood stock levels by retrieving this information from the database's "BloodStorage" table, as shown in Figure (7).

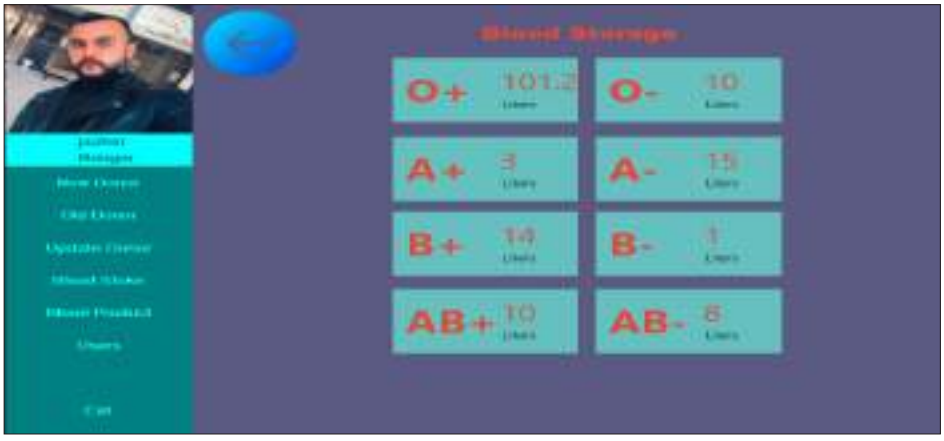

Figure (7) Blood Stoke Interface

3-Blood Withdrawal Interface: Users can extract blood from the storage using this interface. The technology automatically lowers the stock for that blood group in the storage when a set amount is taken out of a certain blood group, as shown in Figure (8).

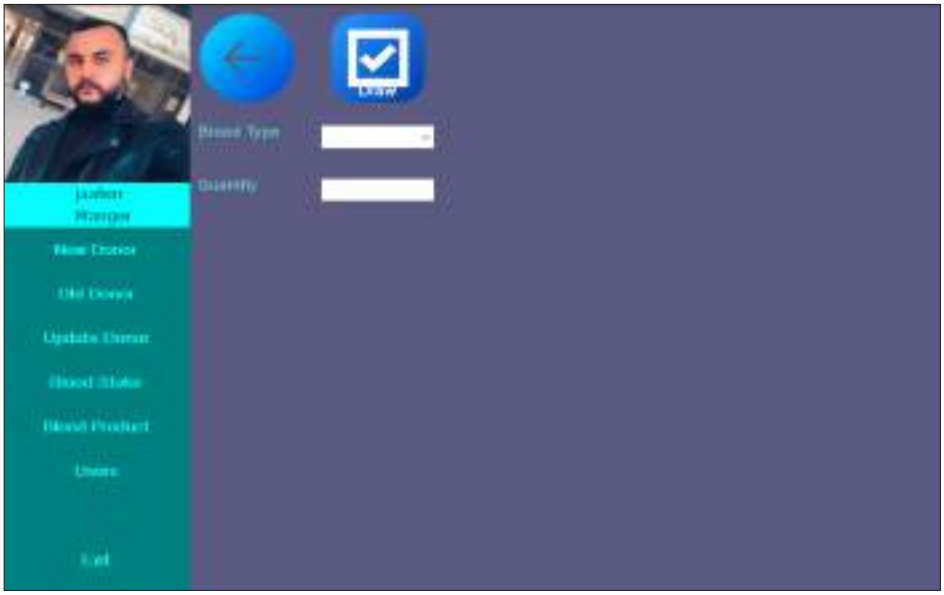

Figure (8) Blood Product Interface

4-User Management Interface: Users can add new users to the program using this interface so they can utilize the application. Users with the necessary authority can effectively manage user accounts, as shown in Figure (9).

Figure (9) Users Interface

5-User Data Update Sub-Window: Users can edit a user's data by clicking the update button in the user interface, which causes a pop-up sub-window to appear. The "users" table in the database is queried for user data using the distinct ID number, making user data maintenance simple, as shown in Figure (10).

Figure (10) Update Users Interface

5-Conclusion and Future Work

The problems with the current blood bank systems were effectively resolved by the blood donor data management system. Donors may quickly register, change their information, and check their gift history with a user-friendly interface. The system imposed a minimum donation interval of 6 months for donor safety and used group-based donation tracking to assure precise blood supply levels. The inventory control module improved the management of the blood supply, increasing the effectiveness of blood bank operations. In future work the blood donor data management system has chances to be expanded and improved in a number of areas going future, including the advanced data analytics and machine learning approaches may be used to improve blood supply chain management by providing useful insights into donor behavior, blood consumption trends, and inventory predictions .Mobile application by creating a mobile application ,donors will be able to easily access the system ,get alerts ,and remain involved in the blood donation procedure .Integration with health systems connecting the system to electronic health records and hospital information systems can give users a complete picture of patient data and transfusion requirements .Security enhancements continuously improving security measures ,such as encryption and multi-factor authentication, will safeguard donor data and protect against unauthorized access. Collaboration and data sharing establishing collaborations with other blood banks and healthcare institutions for data sharing can improve blood supply availability and overall system efficiency .The blood donor data management system may continue to develop by taking these factors into account in further work ,giving blood banks and healthcare facilities even more effective and dependable support.

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Equip Ziyarte Al-Arba'een service points with clean energy through solar radiation Using remote sensing techniques: a case study along the path from northern Baghdad to the holy Karbala

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Abstract

Millions head on foot every Hijri year in the month of Safar from various provinces of Iraq, as well as pilgrims from different countries of the world to commemorate the day of Zeyart AL-Arbaeen of Imam Hussein, as millions head towards the Holy Karbala. During the course of the visit, a large number of organizations or stations (processions) are erected on both sides of the visitors' path to provide service to pilgrims. In this study, we will highlight the possibility of providing electric energy using renewable energy to these bodies on the side of the Baghdad-Karbala road. Photovoltaic cells are one of the most important and most common renewable energy sources, especially in sites with high solar radiation such as Iraq. To determine the best sites location for the installation of solar cell stations using sensing applications and geographic information systems through the analysis of satellite images (Sentinel 2 and ALOS PALSAR) to calculate a set of necessary criteria to determine the best location as well as using the hierarchical analysis process to determine the best location for the installation of photovoltaic cells in addition to estimate the rate of energy produced by photovoltaic cells using simulation in MATLAB

The results of this research provide valuable insights into the possibility of providing Husseini Camps (processions) with clean energy along the Baghdad - Karbala road by taking advantage of solar radiation. This study provides a comprehensive and effective approach to ensure sustainable energy supply for the processions and the results can guide decision-making and development of energy infrastructure in the future and work on similar initiatives in other regions

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Keywords: Zeyart AL-Arbaeen; Remote Sensing; Multi Criteria Decision Making; GIS; AHP; Pv Array; Simulink

1. Introduction

Zeyart AL-Arbaeen represents the largest religious gathering in the world, according to the World Health Organization, and the public health of mass gatherings, which marks the 40th day after the martyrdom of Imam Hussein (peace be upon him), the third Imam of the Shia [1]. Imam Hussein, the son of Imam Ali, the grandson of the Prophet Muhammad, who is the third Imam of the twelve Shia imams, Imam Hussein was martyred in a battle that took place in the Karbala region of Iraq, which was called (the Battle of Karbala), which took place between Imam Hussein and 72 of his companions with the Umayyad State on the 10th of Muharram (the first month of the Hijri year) in the year 61 Ah (68 AD) [2]. About 20 million pilgrims are heading to Holy Karbala from various Islamic countries to commemorate the Zeyart AL-Arbaeen anniversary two weeks before the Arbaeen, millions of pilgrims begin their journey on foot from various regions of Iraq (mostly from Central and southern Iraq) to the city of Karbala, where the Holy Shrines are located [3]. The camps (processions) are set up on the pilgrims ' road towards Holy Karbala by donors from various religious communities to provide services to pilgrims, including free food and drink, as well as a place for pilgrims to sleep and rest, and to provide them with the necessary health supplies and aid. These camps need electric power sources to continue providing comfortable services for pilgrims[4]

Electricity can be provided using renewable energy, especially that fossil fuels face a problem of depletion of their resources, in addition to the climatic effects that accompany the use of fossil fuels, so renewable energy is the best alternative because sources are flowing, renewable and not stored. Solar energy is one of the best renewable energy sources, especially in Iraq due to the intensity of solar radiation[5], Photovoltaic stations convert solar energy into electrical energy, which is characterized by being less expensive and does not affect the environment, as well as these stations can be developed and increase energy production by adding photovoltaic panels and also characterized by easy connection with the energy transmission network and easy maintenance [6]. The most suitable sites for the installation of photovoltaic plants are determined based on a set of criteria such as solar radiation, slope, type of ground cover and others, to decide the best location the analytical hierarchy process (AHP) was used depending on the criteria [7].

Remote sensing techniques and geographic information systems (GIS) were used to calculate the parameters through satellite images (Sentinel 2 and ALOS PALSAR) and analyze them using the ArcGIS software. For optimum site selection studies, a combination of GIS and AHP used[8].

To calculate the amount of energy produced by photovoltaic plants based on the amount of solar radiation, a simulation model of a photovoltaic plant system was designed using MATLAB software

The study in this research focuses on the provision of electrical

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energy using renewable energy, determining the appropriate locations for the installation of photovoltaic stations and calculating the amount of energy produced, which feeds the camps (processions) installed on the road north of Baghdad-Karbala

2. Literature review

The most suitable sites for the installation of solar photovoltaic power plants in Azerbaijan have been identified through a comprehensive assessment of the meteorological and environmental parameters of the potential areas Using an analytical hierarchical process method based on a multi-criteria decision-making technique for large-scale solar energy projects In this study (N. S. Imamverdiyev 2021), By converting the digital elevation model's data using the geographic information system's "Area solar radiation" tool, the solar radiation values for study area were calculated. The site suitability index was calculated using the ArcGIS weighted overlay tool, and it was found that 1.17% (1016.8 km2) of the country had the best locations for solar PV system installation[9].

B. Halder In 2022, Remote sensing and Geographic information system Technologies were used in this study to determine the possible location selection of solar power plants in Kolkata, India, as well as the sequencing and multi-criteria decision-making process was used to calculate the weights. A total of 1438.15 km2 (32.43%) of the total area was calculated as highly suitable for solar power plants[10].

In2021The main goal of this article is to identify and evaluate the

best locations around Tunisia for constructing massive solar PV power facilities. For this reason, we use geographic information systems (GIS) and multi-criteria decision-making analysis (MCDM) to analyze the land suitability of the research area. The results showed that the most practical places covered 1571 km2 and accounted for 1.11% of the total surface area. Additionally, it was noted that the administrative regions of Tataouine, Gabès, Gafsa, and Kassérine have demonstrated the greatest potential for solar PV system construction-friendly sites. Additionally, it was calculated that the annual solar energy yield would be close to 328 TWh. Consequently, it was determined that the accepted model was a highly helpful [11].

The suitability of Moroccan land for hosting solar power plants was studied using the combination of the Geographic Information System (GIS) and the Analytical Hierarchy Process (AHP) by (Meryem Taoufik in 2021), the results presented that 53.88% of the occupation area have high suitability land for solar plant[12].

In 2021, a study to select the optimum site for solar energy farms in Iraq, In order to determine if land is suitable for the construction of solar farms, this study combines the Geographic Information System (GIS) with Analytic Hierarchy Process, one of the multi-criteria decision-making methodologies. The findings indicated that 19% of the research area would make excellent locations for solar farms. The majority of the eligible areas were acquired by the southern, southeastern, and a few western regions. Additionally, this method is easily adaptable to include various criteria and weights to help planners choose the best

places for solar farms[13].

Experimental measurements were made to study the characteristics of voltages-current and power-and current for two types of photovoltaic cell model. Using MATLAB, a solar cell simulation model was created with variable solar radiation values and values for Energy, current and voltage were obtained for each of the solar radiation values[14].

3. Study area

The Baghdad-Babylon-Karbala Road is a major route that links Baghdad to the central and southern governorates. It is also significant for religious tourism to Karbala and Najaf, for its commercial significance in that owners of heavy and medium load vehicles frequently use it to transport goods between the governorates, and for the industrial businesses that are located next to the road, such as the Alexandrian automobile industry and the mechanical company[15]. The length of the road (139.683 Km), which starts from the north of Baghdad (from a city called Rashidieh) and passes through the province of Babylon, to reaches the Holy Shrines in Karbala. The route of the road for pilgrims was selected by the Iraqi security forces for the purpose of providing protection and securing the way for pilgrims towards Karbala. Camps (processions) are erected on the side of the specified road for the purpose of providing free services to pilgrims[16].

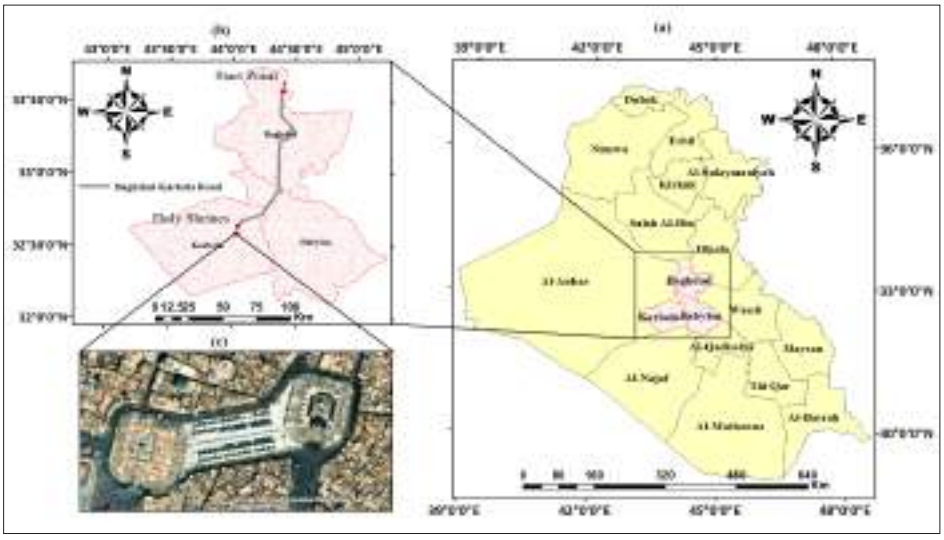

Figure 1. (a) Study area location, (b) Baghdad-Karbala Road, (c) Holy Shrines

4.Methodology

4.1. Criteria selection

The selection of criteria is the most important step in the process of assessing the suitability of the site for the installation of photovoltaic solar cells, the table (1) shows the criteria that were used in previous studies that analyzed the suitability of the site for the installation of photovoltaic solar cells[17]. In this research, seven criteria were selected to analyze the suitability of the study area (Solar radiation, Slope, Aspects, Elevation, Land cover, Proximate from highway and proximate from Power transmission lines).

Table 1.The criteria adopted in previous studies to analyze the site suitability of photovoltaic system [17].

References	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
Uyan			✓			✓	✓	✓	✓	
Watson and Hudson			✓	✓		✓			✓	
Aly et al.	✓					✓	✓	✓		✓
Al Garni and Awasthi	✓	✓	✓	✓		✓		✓		
Yushchenko et al.	✓					✓	✓	✓		
Tahri et al.	✓	✓	✓			✓	✓		✓	
Merrouni et al.	✓		✓			✓	✓	✓		✓
Asakereh et al.			✓	✓	✓		✓	✓	✓	
Noorollahi et al.	✓	✓	✓		✓	✓	✓	✓	✓	
Suh and Brownson	✓	✓	✓				✓	✓	✓	
Sánchez-Lozano et al.	✓	✓	✓			✓	✓	✓		

C1: Solar radiation, C2: temperature, C3: Slope, C4: Aspect, C5: Elevation, C6: distance from a residential area, C7: distance from a road, C8: distance from a power line, C9: land use, C10: waterbody.

4.2. Data acquisition and Software

Two types of data were used in this research: (raster data and vector data). The raster data represents multispectral images taken from the Sentinel 2 satellite with a resolution of 20m in (2022-8-21) from (https://scihub.copernicus.eu), 5 scenes were used to cover the study area, in addition to the digital elevation models (DEM) provided by the ALOS PALSAR satellite, which represent the elevation of the area with an accuracy of 12.5 m in (2007-6-21) from (https://asf.alaska.edu), 6 scenes obtained to represent the study area. Vector data is represented by the data of the road network and the power transmission network as shapefile. Table2 show the data reference and properties.

Table: 2.Data references and properties

Reference	Data type	Band	Sensing time	Resolution (m)
Sentinel-2 Instrument: MSI	Raster	8.3.2	2022-8-21	20
ALOS PALSAR	Raster	L-band	2007-6-21	12.5
Open street map	Shapefile		Up-to-date	
World Bank Data Catalog	Shapefile	×	Up-to-date	×

These data were processed using the program ArcGIS from ESRI, which contains many tools suitable for analyzing the criteria to determine the land suitability. A set of processors is performed on raster data, the geometric correction of the satellite images was performed using GIS 10.5 to convert them to geospatial coordinates of UTM, also o get rid of No Data value and extract the study area from the overall scenes

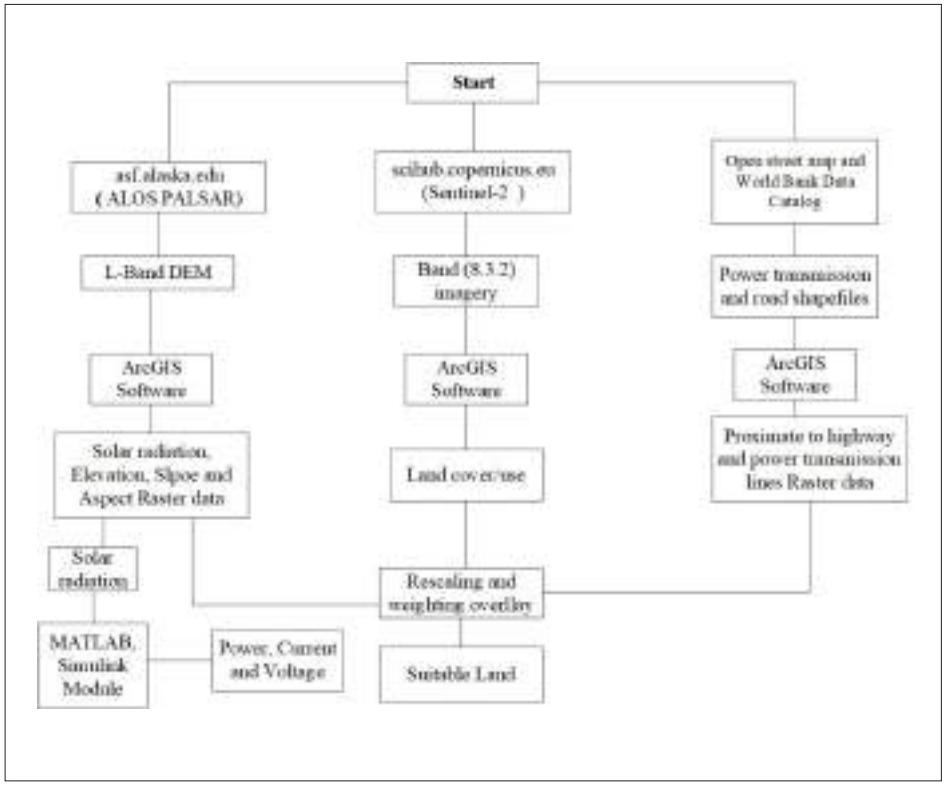

Figure 2.Methodology flowchart for Land suitability of solar cell site selection

4.3. Criteria calculation

- **Solar radiation:** The incoming solar radiation at the surface in the 0.2–4.0 m wavelength range on a specific surface area is referred to as the solar irradiance, which is typically stated in W/m2 (Watts per square meter). There are two types of solar radiation: diffuse (diffuse irradiance) and direct (direct irradiance), both of which are received from the direction of the sun. Since the atmosphere scatters it, diffuse radiation is emitted in all directions. [18] , by using (Area solar radiation) in ArcGIS which using the Digital Elevation Model (DEM) as input data, set the (Area solar radiation) tool at specific day (2022-8-21)

- **Elevation, Slope and Aspect:** The DEM represent the altitude of the area, the value Z in DEM represent the Elevation value from the sea in meter. Where the highlands received solar radiation greater than lowlands. The slope, which is measured in degrees and ranges from zero (flat) to 90 (vertical), represents the elevation change associated with a change in horizontal position, its indicate the steepness of the landscape. Aspect is yet another important terrain feature that is commonly retrieved from digital elevation data. The aspect indicates a downward slope. The direction is frequently expressed using an azimuth angle[19]. The surface analysis tools used DEM raster data to calculate Slope and Aspect[20].

- **Proximate to highway and power transmission lines:** Because of the enhanced distribution efficiency across the study region due to distance from highway, the potential locations for solar power plants were most affected by the distance from highway criterion. Roads were frequently utilized by researchers to define the solar power plant area, also, proximate to power transmission lines is an important criterion for facilitating the transfer of energy produced by solar cells and connecting it with the distribution network, Five buffer zones were created for roads and power lines zones based on the actual circumstances and the literature assessment [21]. The multi-buffer tool in ArcGIS enables us to draw a set of areas with certain areas surrounding the lines, in this study, Baghdad-Babylon-Karbala Road represent the main highway.

- **Land cover/use:** One of the most common uses of remote sensing is the classification of land cover and use. Different methods are used to extract data about the various categories of Land Cover from optical imagery (Sentinel-2) using the pixel values, the process of classifying pixels under user supervision is referred to as supervised classification. The user defines the numerous spectral signatures or pixel values that may be connected to the particular class[22].

Depending Criteria raster data values rating into five categories (value 1 mean unsuitable categories and 5 mean most suitable categories), because of the land suitability was analyzed by comparison. The table (2) show the criteria rating depending of previous studies [23-26].

Table:3.Criteria values Rating

C1	C2	C3	C4	C5	C6	C7	Value Rate
5150-5340	3<	S	Barren land	0.5	0-5	97.9-156	5
5110-5140	3-5	SE, SW	Rangeland	1.0	5-8	70.6-97.8	4
5050-5100	5-7	E, W	Crops	1.5	8-10	44.6-70.5	3
4940-5040	7-9	N, NE,NW	Deciduous forest	2	10-12	27.8-44.5	2
2530-4930	9>	Flat	Water/ Build area / Evergreen forest	2>	12>	-2-27.2	1

C1: Solar radiation, C2: Slope, C3: Aspect, C4: land use, C5: Proximate to highway, C6: Proximate to power transmission lines, C7: Elevation

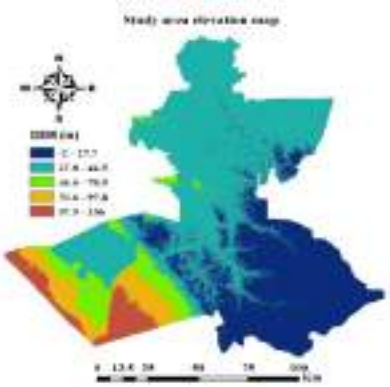

Figure 4. Elevation map

4.3.

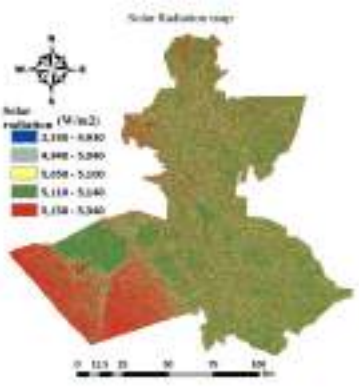

Figure 3. Solar radiation map

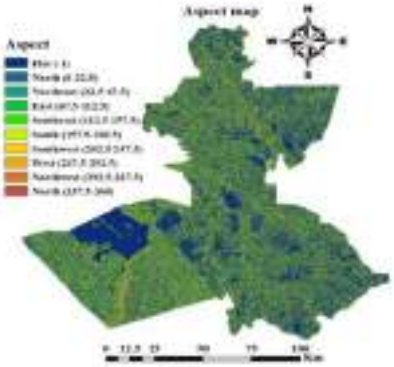

Figure 5. Aspect map

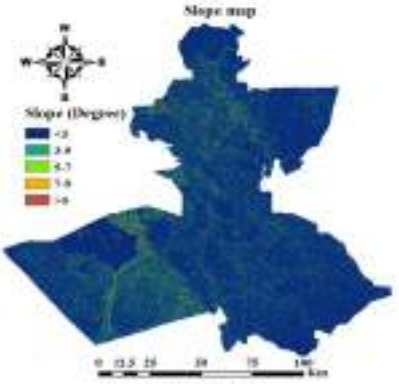

Figure 6. Slope map

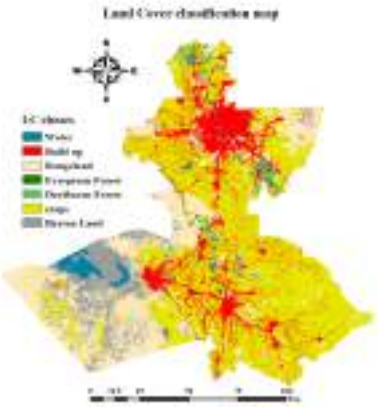

Figure 7. Land Cover/ Use map

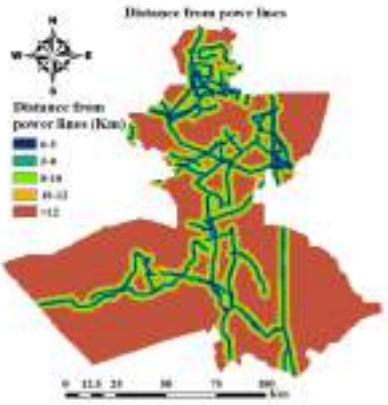

Figure 8. Proximate to Power transmission lines

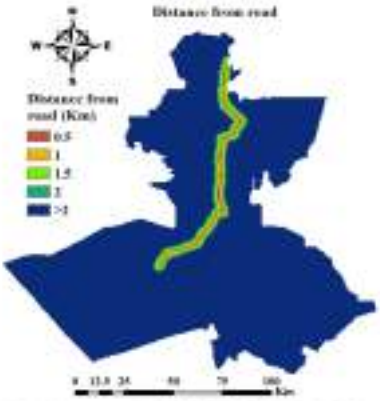

Figure 9. Proximate to Baghdad-Babylon-Karbala road

4.4. Weighting Criteria

Saaty created the AHP approach, which has been applied to decision-making, particularly when weighting numerous variables. It offers the benefit of reducing pairwise comparisons of difficult judgments. This approach is also a crucial tool for ensuring choice consistency and minimizing decision analysis bias [27]. The creation of a pairwise comparison matrix (A), if the number of criteria is n, then the A=n×n, as shown in equation (1)

$$A = \begin{bmatrix} 1 & p & q \\ 1/p & 1 & r \\ 1/q & 1/r & 1 \end{bmatrix} \quad (1)$$

Using a numerical scale from 1 to 9, each component of M shows the relative weight of the two criteria as determined by experts [28]. As shown in table 4.

Table:4. Pairwise Comparison scale[28, 29]

Importance Degree	Definition	Description
1	Equally preferred	Both the activities have equal contributions towards achieving the objective
3	Moderately preferred	One of the activities is slightly favored over the other.
5	Strongly preferred	One of the activities is strongly favored over the other.
7	Very strongly preferred	One of the activities is very strongly favored over the other
9	Extremely preferred	One of the activities is favored over the other of the highest possible degree
2,4,6,8	Intermediate values	Between the degrees of importance

The elements of the column must be divided by the sum of the elements of the same column to determine the weight of each criterion, Hence, normalizing A.

The AHP method enables us to calculate the consistency of a weight by using the following equation (2)

$$CI = \frac{\lambda max - n}{n-1} \qquad (2)$$

Where:

CI= the consistency index

λmax = is the comparison matrix's biggest eigenvalue.

By comparing the consistency index value (CI) with the consistency index of a random-like matrix (RI), the consistency ratio (CR) was determined as shown in equation 3

$$CR = \frac{CI}{RI} \qquad (3)$$

A matrix that has had the judgments entered randomly is called a random matrix. It is therefore very inconsistent. Saaty delivers RI values that have been broadly estimated depending on the sizes of various criteria. Recalculating the pair comparison values would be necessary if CR ≤10% [30] , as shown in table below

Table:5.Random Consistency Index[30]

Number of Criteria	1	2	3	4	5	6	7
RI	0	0	0.58	0.90	1.12	1.24	1.32

4.5. Solar PV cell modeling

Solar PV cells are the fundamental building block of a solar PV array or panel; to obtain the necessary voltage and current levels, they are coupled in series and parallel. A PV cell is a semiconductor with a p-n junction that produces electricity when exposed to light. The PV cell mathematical model can be used for simulation to show how voltage, current, and power behave under various operating situations. Fig. 1 displays a simplified equivalent PV cell circuit with five parameters.

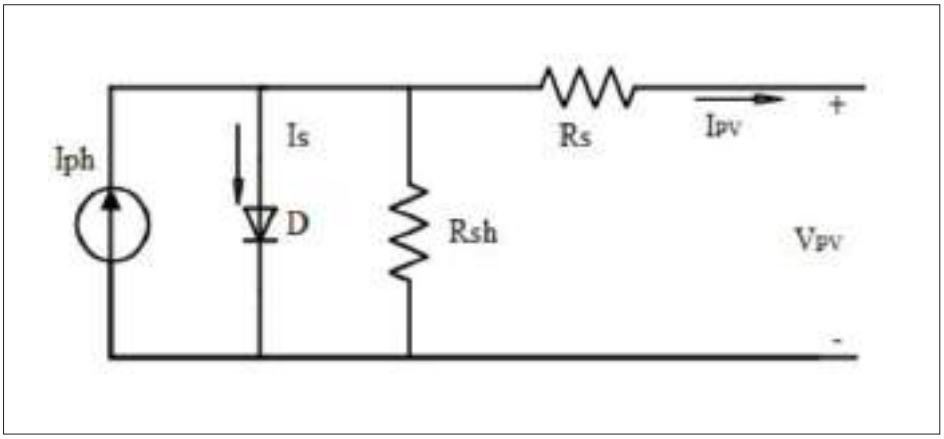

Figure:10 PV cell Equivalent circuit

Cell photocurrent (Iph), exponential diode (D), and shunt resistance (Rsh) are linked in parallel and in series, respectively, with series resistance (Rs). The PV cell's current and voltage are expressed as Ipv and Vpv, respectively [31].

The 200W PV array system and PV panel designed using MATLAB Simulink[32], as shown in figure (11)

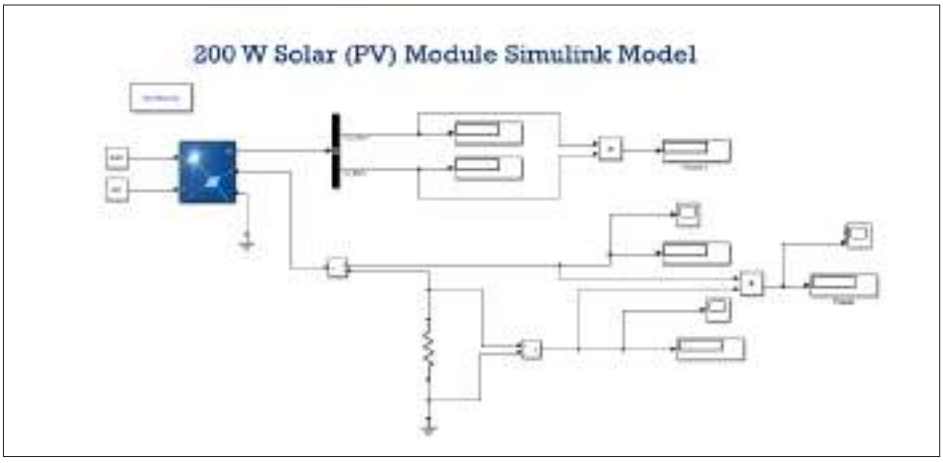

Figure 11. MATLAB Simulink model of Solar Cell

Table:6. PV panel parameters[32]

PARAMETER	RATED VALUE
Rated Power(Pmp)	200W
Voltage at Maximum Power(Vmp)	26.4V
Current at Maximum Power(Imp)	7.58A
Open Circuit Voltage(Voc)	32.9V
ShortCircuit Current (Isc)	8.21A
TotalNumberofcellsinSeries(Ns)	55
Total Number of cells inParallel (Np)	1

5. Results and Discussion

According to Table (6). AHP results indicate that the Solar radiation factor has the most weight (35.428%), Slope (23.993%), Elevation (15.865%), Aspect (10.362%), proximate to power transmission lines (6.756%), proximate to highway (4.477%) and Land Cover/Use (3.17%). The pairwise comparison results for this investigation were acceptable because the CR was 2.5%, and the values were thought to be stable.

Table 6. Pairwise comparison, weight for each criteria and consistency ratio (CR).

Criteria	C1	C2	C3	C4	C5	C6	C7	Weight	CR
C1	1	2	4	7	6	5	3	35.428	0.025
C2	0.5	1	3	6	5	4	2	23.993	
C3	0.25	0.333	1	4	3	2	0.5	10.362	
C4	0.143	0.167	0.25	1	0.5	0.333	0.2	3.17	
C5	0.167	0.2	0.333	2	1	0.5	0.25	4.477	
C6	0.2	0.25	0.5	3	2	1	0.333	6.756	
C7	0.333	0.5	2	5	4	3	1	15.865	

The rating raster data for each Criteria and its weights used as input data in Weighted Overlay tool table (weighted Overlay its ArcGIS software tool) to create a Map for Land suitability for study area as shown if figure 10, The appropriate map is classified into 5 categories (Unsuitable, Low suitability, Moderate suitability, Suitable and Most suitable)

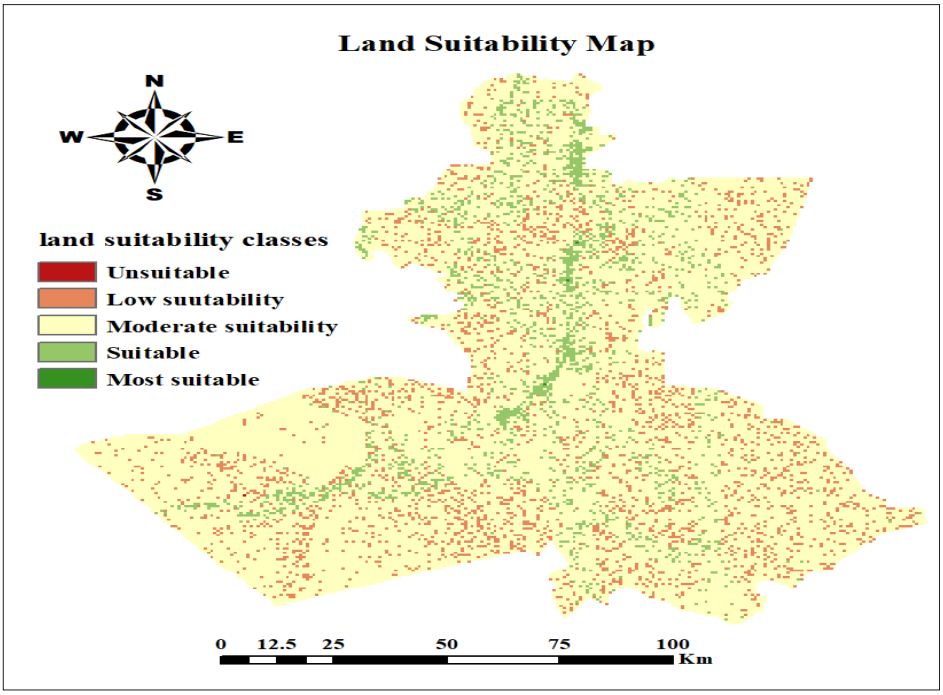

Figure 12. Map classification of suitable lands for the installation of solar photovoltaic power plants

The results showed that the Moderate suitability areas represent (82.3%) of the total area, Low suitability areas (10.6%), Suitable areas (7%), Most suitable areas (0.01%) and the Unsuitable areas (0.003%). The table (7) shows the geometric information of land suitability classes

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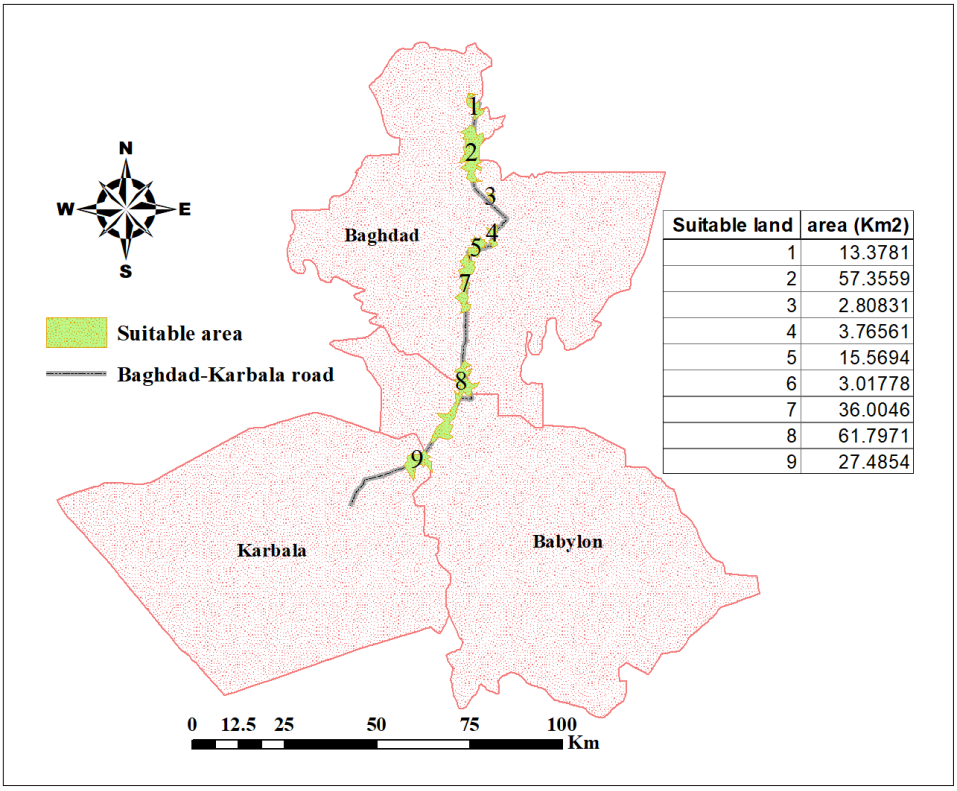
Table 7. Area and percentage of land suitability categories

Categories	Area (Km^2)	Percentage %
Unsuitable	0.5329	0.003
Low suitability	1632.273	10.62
Moderate suitability	12663.84	82.36
Suitable	1078.59	7.01
Most suitable	1.5987	0.01
Total area	15376.82972	100

After determining the appropriate sites for the installation of solar power stations, the appropriate sites near the Pilgrims ' Road (The Baghdad-Babylon-Karbala) were identified in order to facilitate the process of transferring the electrical energy produced from the solar power stations that will be installed on the specified sites to the camps (processions) located on both sides of the Pilgrims' Road (The Baghdad-Babylon-Karbala). The results showed the existence of nine sites at different sites as shown in the figure (11)



Suitable land	area (Km2)
1	13.3781
2	57.3559
3	2.80831
4	3.76561
5	15.5694
6	3.01778
7	36.0046
8	61.7971
9	27.4854

Figure: 13.Suitable land close to The Baghdad-Babylon-Karbala road

The amount of solar radiation depends on the length of the day. The daytime period for the study area averages 13 hours during August month, the sun rises at 5.30 am and sets at 18.40 pm. The value of solar radiation during this period for the sites indicated in the figure (13) was calculated using ArcGIS (Point Solar Radiation tool). The results showed that the values of solar radiation during the same period of time for these sites were close due to the convergence of the height values of the study area.

Finally. A simulation of the PV array system model shown in the figure (11) was performed with the values of solar radiation and the average temperature of the sites (40C°, https://power.larc.nasa.gov/) using MATLAB Simulink, the values of both energy, current and voltage were obtained as shown in the two figures (14,15)

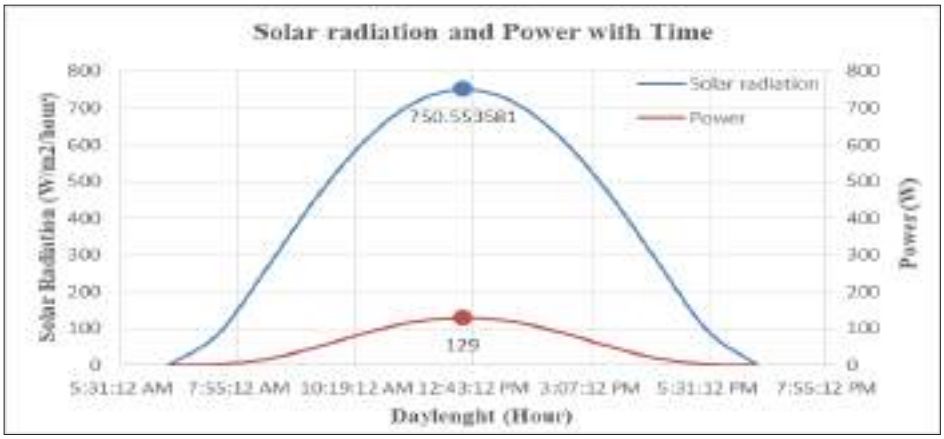


Figure 14. Solar radiation and Power with Time for single PB panel

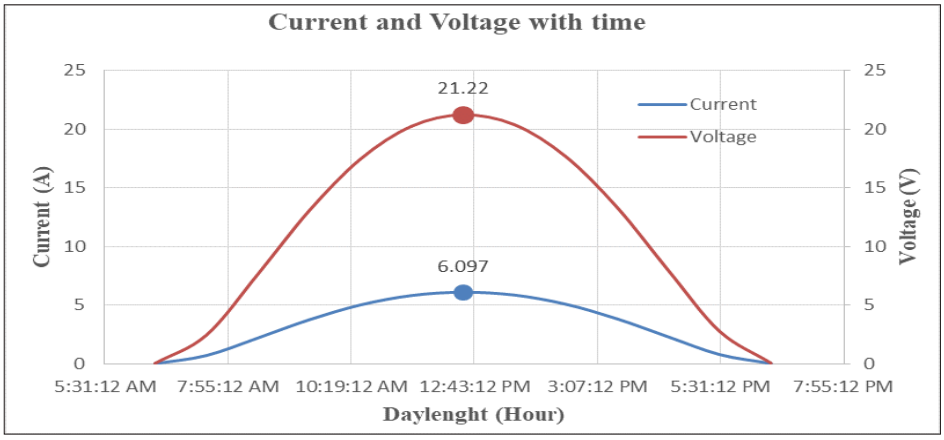


Figure 15. Current and Voltage with time for single PV panel

The values of Power, Voltage and Current increase with the increase in the value of solar radiation, where the maximum Power values were recorded (129W), maximum Current (6.97A) and maximum Voltage (21.22V) for single PV panel.

The standard size of PV panel about 25 square feet (2.3 m2) [33], so many PV panels can be added due to the vast areas of the selected sites to increase the amount of electric energy output that feeds the camps (processions) along the Baghdad-Babylon-Karbala highway.

6. Conclusion

Solar radiation is the most important criterion for determining the suitability of sites for the installation of photovoltaic solar cells

The study area is exposed to a high amount of solar radiation during the long daylight period in the summer, so solar panels are the best ways to obtain renewable energy

The values of seasonal radiation reach their highest levels during the afternoon, so the pilgrims of the forty should not walk during this period in order to avoid exposure to solar radiation

The specifications of solar panels can be changed by specialists for the purpose of obtaining higher efficiency and greater electrical energy

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Exploring the Transformative Power of 3D GIS in Urban Planning and Management

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Abstract

The utilization of three-dimensional (3D) technology has led to significant progress in the analysis and comprehension of geographical data within geographic information systems (GIS). This study used the Al-Jadriya area in Baghdad, Iraq, as an example of how 3D GIS may be used to analyze and manage urban environments. By integrating 3D models of buildings, landscape, and infrastructure, urban planners and decision-makers can obtain vital insights into the potential implications of proposed developments, simulate traffic patterns, and discover hiding threats. We can strengthen disaster management and emergency response skills by giving complete insights into the built environment and possible risks.

This research aims to investigate the benefits of 3D GIS while emphasizing the need of enhancing urban planning and management approaches. Stakeholders may improve urban development plans, increase the safety and efficacy of Zeyart AL-Arbaeen, and much more by using the potential of 3D GIS technology. Population control, population movement management, and the security of millions of people attending this massive event are all advantages of 3D GIS.

Keywords: Zeyart AL-Arbaeen, Population control, 3D models, Emergency response, Traffic patterns, Geographic Information Systems (GIS).

1. Introduction

The rapid advancement of information technologies has revolutionized the creation of virtual worlds, enabling 3D landscape modeling and visualization. These technologies have facilitated the generation of attractive representations of the environment based on diverse digital data types, including geographic, geological, architectural, and biological data [1, 2]. The availability of geospatial datasets with global coverage, improved resolution, and thematic content has further fueled the growth of 3D modeling and mapping applications [3].

Recent advancements in accurate landscape modeling and mapping have expanded the possibilities for generating 3D maps and visualizations, making them indispensable in a variety of fields such as city planning, landscape monitoring, utility and transportation management, tourist maps, and 3D mapping services [4]. Furthermore, 3D models have proven valuable in areas including tourism, scientific presentations, regional planning, and management due to their ability to provide a better understanding of spatial linkages in the landscape [5].

To enhance the efficacy and expressiveness of 3D landscape modeling and mapping, researchers have explored various aspects such as cartographic standards, design principles, and visualization techniques. These efforts have contributed to the development of integrated data models that support 3D geometry and topology, enabling extended spatial analysis and interactive visualization [6]. The integration of 3D models with Geographic Information Systems

(GIS) has demonstrated numerous advantages, including applications in machine learning, restoration projects, shadow analysis, 3-dimensional urban planning, virtual cities, visual analysis, emergency planning, and landscape planning [7].

Accurate and reliable 3D models play a crucial role in landscape management, planning, and analysis. These models incorporate various GIS datasets such as relief, land cover, hydrography, structures, roads, and tourist infrastructure, as well as remote sensing data from satellite imagery, orthophotos, Radar, and LiDAR [8]. The creation of 3D models involves processing remote sensing data to generate a terrain model and integrating fundamental data for landscape simulation, including geology, soil, vegetation, and hydrography. The choice of presentation software depends on whether dynamic or static viewing of the 3D models is desired, offering advanced outcomes like flying simulations for landscape observation [9].

Despite the advancements in 3D GIS, challenges remain in representing complex 3D objects and achieving comprehensive 3D cadastral registration. Efforts to address these issues are ongoing, with limited progress in geographic analysis and attribute handling within the context of 3D GIS [10]. Three-dimensional photo-models have emerged as a viable approach, combining topology structures with geometry to create coherent 3D models of buildings in metropolitan regions [11].

In the context of spatial strategies, flood protection and the management of flood-endangered land are critical concerns for

municipalities. GIS technology, coupled with 3D models and mathematical models utilizing neural nets, facilitates spatial analysis, monitoring changes, and protecting flood risk land. Thorough and trustworthy information plays a vital role in decision-making processes related to land use planning and landscape protection [12].

In this study, we propose an integrated modeling strategy for 3D GIS to address the challenges in managing geo-information about urban regions. Our approach aims to create a 3D model that supports 3D topology and incorporates a user interface for querying and visualization using ArcGIS. By establishing the connection between model design and data collection techniques, we aim to contribute to the development of a flexible and operational urban 3D GIS system.

2. 3D GIS in Zeyart AL-Arbaeen of Imam Hussein

The Arbaeen visit of Imam Hussein in Karbala draws millions of pilgrims from around the world, making it one of the largest gatherings globally. Ensuring the safety, efficiency, and smooth management of this significant event is a paramount concern for the organizers and authorities involved. The application of three-dimensional (3D) Geographic Information Systems (GIS) emerges as a transformative solution in achieving these objectives.

This study explores the implementation of 3D GIS technology in the context of the Arbaeen visit to Imam Hussein, focusing on the Al-Jadriya region in Baghdad, Iraq, as a representative example. By integrating 3D models encompassing buildings, terrain, infrastructure,

and crowd data, urban planners and decision-makers gain valuable insights into potential impacts, traffic patterns, and latent hazards.

The benefits of 3D GIS extend beyond spatial data analysis and understanding. It plays a pivotal role in enhancing disaster management and emergency response capabilities by providing comprehensive insights into the built environment and potential risks. Stakeholders can leverage the power of 3D GIS to make informed decisions, improve urban planning strategies, and ensure the safety and efficiency of the Arbaeen visit.

With its capacity to reduce congestion, control crowd movements, and enhance safety measures, 3D GIS proves to be an indispensable tool for managing large-scale events like the Arbaeen visit of Imam Hussein. The research sheds light on the transformative potential of 3D GIS technology in advancing urban planning and management practices, fostering a safer and more organized experience for millions of visitors participating in this significant event.

3. Background on 3D Modelling Techniques and Technologies

Photogrammetry, a non-contact measurement technique, is a scientific discipline that enables the measurement and analysis of surface characteristics and objects without direct physical contact [13]. It involves the use of pictures as its primary medium for measuring three-dimensional coordinates, based on the principle of triangulation, specifically aerial triangulation [14]. This technique allows for the creation of accurate three-dimensional models by overlapping the line of sight.

There are two main categories of photogrammetric techniques: terrestrial and aerial. Aerial photogrammetry involves capturing pictures from cameras positioned in the air, typically mounted on aircraft or unmanned aerial systems, to collect data [15]. Terrestrial photogrammetry, on the other hand, relies on capturing pictures using cameras physically located on the Earth's surface.

Aerial photogrammetry, with its ability to cover large areas and capture detailed imagery from an elevated perspective, is particularly suitable for creating orthophotos, 3D models, and other photogrammetric products [16]. It offers a faster and more convenient approach to 3D modeling, with drones becoming increasingly popular for capturing images and data for various applications, including buildings and objects (Figure 1) [15].

In addition to aerial photogrammetry, another technique commonly used in 3D modelling is LIDAR (Light Detection and Ranging). LIDAR is a remote sensing technique that utilizes pulsed laser light to measure

ranges to the Earth's surface and other features, providing highly accurate and precise three-dimensional data [16].

Overall, photogrammetry, including both aerial and terrestrial approaches, along with LIDAR, plays a significant role in generating 3D models and capturing detailed information about surfaces and objects. These techniques offer valuable tools for a wide range of applications, from mapping and surveying to urban planning and infrastructure management.

Figure 1. Aerial photogrammetry using drones [15]

4. Methodology

4.1. Introduction to 3D GIS

The advent of Geographic Information Systems (GIS) in the mid-1960s revolutionized the field of mapping and geographic information management [17]. Initially focused on 2D mapping and analysis, GIS has found numerous applications in various industries such as forestry, natural resources management, planning, and military [17]. However, the traditional 2D GIS approach neglects the inherent three-dimensional nature of the real world [18]. Only in the past few years has the serious integration of 3D capabilities in GIS gained attention, although its acceptance among the broader GIS community has been limited [18]. The concept of 3D GIS involves associating spatial information with three-dimensional phenomena and aims to perform similar tasks as 2D GIS [19]. While current 2D GIS software can handle basic 3D tasks, more advanced 3D operations require specialized tools and techniques [20].

4.2. Understanding Dimensionality

Dimensionality is a fundamental concept in geometry that defines the number of values required to determine a position in space. In the context of GIS, primitives such as points, lines, areas, and volumes represent the basic geometric elements, each requiring a specific number of dimensions for description. A point, having zero dimensions, represents a position in space. A line extends in one dimension, while an area requires two dimensions to define its length and width. A volume, described by three dimensions, possesses length, width, and depth [21].

4.3. Representation in 2.5D

In addition to the primitive features, the surrounding environment plays a role in determining the dimensionality of objects. Internal dimension refers to the object's own dimension based on the primitives it represents, while external dimension refers to the space surrounding the object [22]. The external dimension can be projected onto a plane (R^2) or extended into higher dimensions (R^3, R^4, etc.), creating a 3D model or a dynamic 3D model over time. This concept of dimensionality allows for the representation of 2D objects in extended spaces, commonly referred to as 2.5D [23]. In 2.5D, -values are often represented as attributes in a table, enabling the simulation of a 3D model while geometrically describing the objects as 2D features [24].

4.4. 'True' 3D Representation

Unlike 2.5D features, 'true' 3D features are geometrically described using xyz-coordinates without relying on -values as a function of xy-coordinates [22]. 'True' 3D features allow for the storage of complex objects in GIS databases. Examples include Triangulated Irregular Networks (TINs), which describe surfaces with varying heights, and solids, which represent enclosed volumes composed of polygonal faces.

The representation of solids in GIS is challenging due to the complex nature of determining vertex order and connectivity [23]. Various categories of 3D primitives, such as polyhedrons, polyhedrons combined with curved patches, tetrahedrons, and CAD objects, have been proposed for modeling 3D spatial objects [25]. Each category has its advantages and limitations, depending on specific criteria and application requirements [26].

4.5. Applications and Advantages of 3D GIS

The availability of 3D GIS data has expanded significantly, ranging from LiDAR captured by drones to high-resolution textured models of buildings and subsurface information [27]. The adoption of 3D GIS offers intrinsic value beyond traditional mapping techniques, providing more accurate representations of the real world and enabling better communication with stakeholders [27].

3D GIS facilitates advanced spatial analysis, visualization, and simulation, supporting a wide range of applications such as urban planning, virtual city modeling, visual analysis, telecommunications, emergency planning, and landscape planning [28-30]. The integration of 3D GIS with Building Information Modeling (BIM) allows for comprehensive building management, detailed analysis, and preservation of historical structures. Additionally, 3D GIS aids in the assessment of environmental impacts, such as wind farm development, by analyzing factors like migratory paths and noise propagation [27].

4.6. Study Area: Al-Jadriya, Baghdad, Iraq

The neighborhood of Al-Jadriya is located along the Tigris River in Baghdad, Iraq. Situated at the southern tip of the peninsula where the river makes a significant turn, Al-Jadriya shares its space with the Karrada neighborhood [27]. The neighborhood is notable for its quality of life and presents an interesting case study for implementing 3D GIS and spatial modeling techniques, Figure 2 shows the study area of this research (Al-Jadriya Region).

Figure 2. Al-Jadriya Region (Case Study)

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4.7. The Proposed Method

The methodology for creating the 3D model of the study area in Al-Jadriya, Baghdad, Iraq involved the following steps:

Data collection: Relevant data, including Esri imagery, elevation data, and vector data representing roads, buildings, and other features, was collected for the study area.

Data preparation: The collected data underwent necessary preparation and organization to ensure its suitability for 3D modeling in ArcGIS. This involved tasks such as data cleaning, conversion, and editing.

Creation of a new 3D scene: A new 3D scene was opened in either ArcScene or ArcGIS Pro, and the required data layers, such as Esri imagery, elevation data, and vector data, were added to the scene.

Data adjustment: The data layers were adjusted to align with the correct location, scale, and orientation. Georeferencing tools in ArcGIS were utilized to align the data layers accurately.

Feature extrusion: The buildings and other features in the vector data were extruded to create a 3D representation of the study area.

Texture addition: Textures, such as the Esri imagery, were added to the 3D model to enhance its realism and provide a more accurate representation of the study area.

Analysis: Once the 3D model was created, various spatial analyses were performed, including viewshed analysis, terrain analysis, and hydrological analysis.

5. Results

The results of the 3D modeling process in Al-Jadriya, Baghdad, Iraq are presented in Figures 3, 4, 5, and 6. These figures showcase the three-dimensional representation of the study area, highlighting the buildings and other features that were extruded in the modeling process. The addition of textures, such as the Esri imagery, contributes to a more realistic visualization of the study area.

These 3D models can serve as valuable tools for visualization, allowing for virtual tours, simulations, and informed decision-making regarding the study area. The models provide a comprehensive understanding of the spatial characteristics and features of Al-Jadriya, enhancing the analysis and planning processes. Figure 3 demonstrates the process of drawing the features in the 3D model, illustrating the extrusion of buildings and other elements. The subsequent figures (4, 5, 6 and 7) showcase the completed three-dimensional representation of Al-Jadriya, emphasizing its spatial characteristics and enabling in-depth analysis. These results highlight the effectiveness of the methodology in creating a detailed and accurate 3D model of the study area, which can support various applications in urban planning, decision-making, and virtual visualization.

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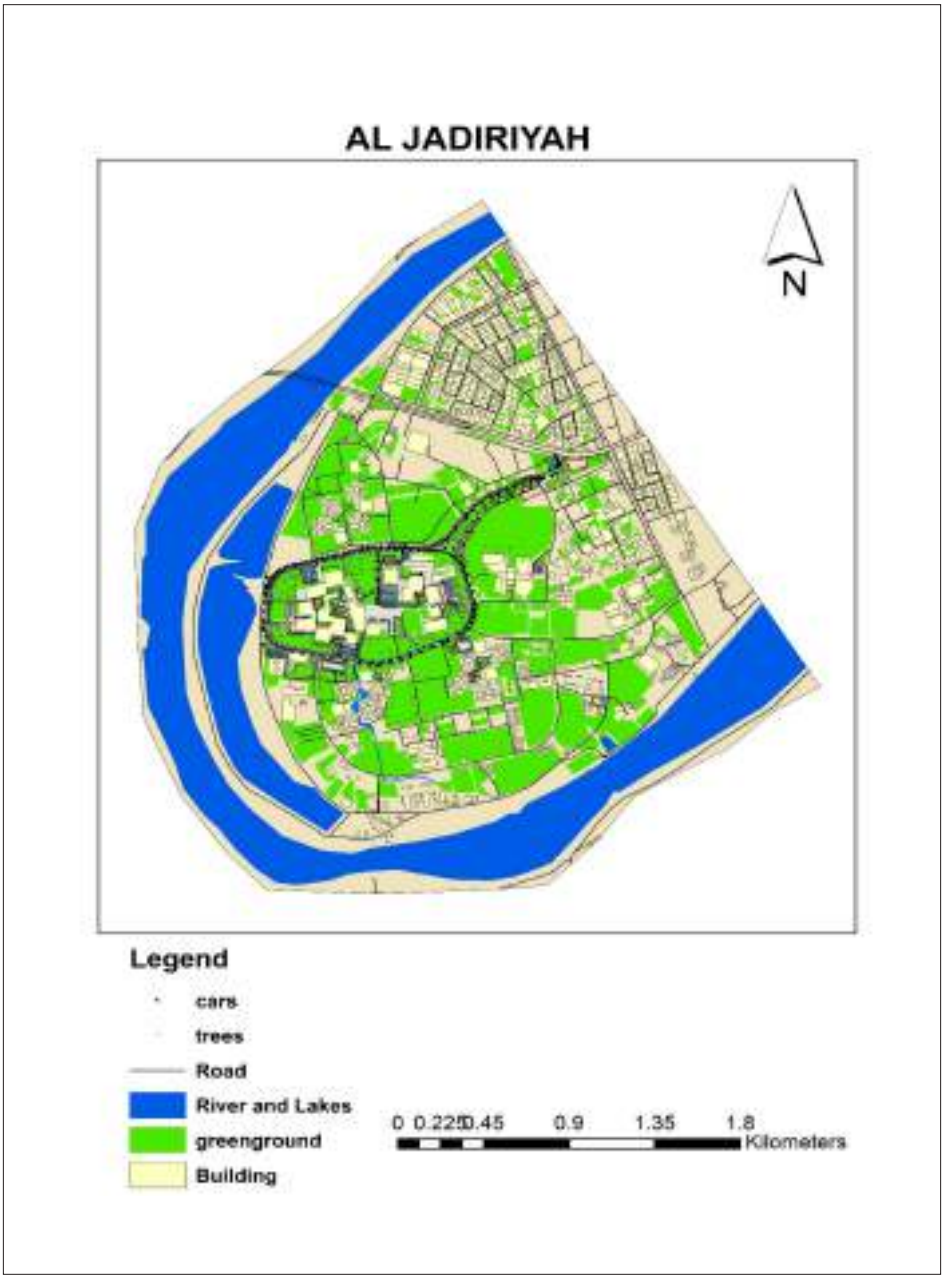

Figure 3. Features Drawing

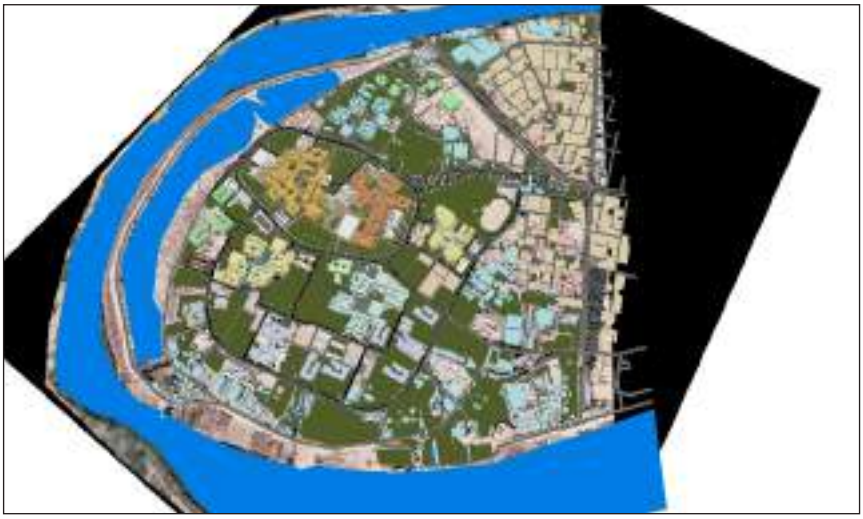

Figure 4. 3D Al-Jadriya Model (1)

Figure 5. 3D Al-Jadriya Model (2)

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Figure 6. 3D Al-Jadriya Model (3)

Figure 7: 3D Al-Jadriya Model (4)

6. Conclusion

The application of three-dimensional (3D) Geographic Information Systems (GIS) in the context of the Arbaeen visit of Imam Hussein has demonstrated its transformative power in advancing urban planning and management practices for one of the largest gatherings in the world. Through the case study of the Al-Jadriya region in Baghdad, Iraq, this research has revealed the numerous benefits and potential of 3D GIS technology in comprehending and managing complex urban environments during this significant event.

By integrating 3D models encompassing buildings, terrain, infrastructure, and crowd data, decision-makers and urban planners gain crucial insights into proposed developments, traffic patterns, and latent hazards. This enhanced understanding enables them to make informed decisions and devise strategies to ensure the safety and efficiency of the Arbaeen visit. Moreover, 3D GIS has proven to be an indispensable tool in disaster management and emergency response capabilities, providing comprehensive insights into the built environment and potential risks.

The use of 3D GIS not only enables precise spatial data analysis but also fosters effective communication among stakeholders. This leads to a more collaborative approach to managing the Arbaeen visit, as authorities, organizers, and relevant entities can work together with a shared understanding of the spatial challenges and opportunities.

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Furthermore, 3D GIS technology has shown promising results in reducing congestion, controlling crowd movements, and enhancing safety measures. By simulating various scenarios, decision-makers can proactively plan for the event and implement measures to optimize crowd flow and reduce potential risks. As technology continues to evolve, the potential of 3D GIS in managing large-scale events like the Arbaeen visit will only expand. With advancements in data collection methods, real-time data integration, and improved modeling techniques, the application of 3D GIS will become even more effective in meeting the dynamic challenges posed by such events.

In conclusion, the utilization of 3D GIS in the Arbaeen visit of Imam Hussein represents a significant step forward in urban planning and management. This technology's ability to provide comprehensive spatial insights, enhance disaster management capabilities, and improve decision-making processes makes it an invaluable asset for ensuring the safety, efficiency, and success of this revered event. As urban environments continue to evolve and grow in complexity, 3D GIS will play an increasingly critical role in enhancing the planning, management, and overall experience of the Arbaeen visit and similar large-scale gatherings.

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Functional Efficiency of Urban Spaces: Karbala City Center as a Case Study

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Abstract

The research aims to shed light on the reality of the functional efficiency of the urban spaces in Karbala city center, due to the fact that these spaces play a very important role in the movement of millions of visitors during the large pilgrims, such as Zeyart AL-Arbaeen and Al-Sha'baniyah visit, and others.

As a general concept in the planning field, spaces are considered as part of the urban fabric of any city, whether large or small; therefore, they constitute the natural outlet for the city as well as they are considered as the most important physical components in the city that has visual (environmental) and aesthetic effects. Therefore, this research investigates some international models in this field, through which a set of functional requirements that can contribute to reaching a conclusion of functional values for the urban spaces within the city are identified. They are demonstrated by indicators that are examined and tested on the study area, and these indicators are (social interaction, accessibility, spatial organization, and spatial compatibility).

One of the most important conclusions of this research is that the creation of four new spaces in the study area (Baghdad Square, Sha'baniyah Square, Martyrs Square, and Al-Alqami Square) was due to the actual need for places for visitors to gather, especially after the increase in the large number of visitors during the last years. Moreover, these Squares represent a meeting point for visitors with local residents for cross-cultural contact and knowledge exchange.

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The area of spaces has increased at the expense of residential use, as many of the houses close to the area between the two holy shrines were removed to expand the area. This has led to the creation of spaces for urban interaction and daily social communication, largely from all local and foreign groups of people.

Keywords: Functional efficiency, urban space, urban agglomeration.

Introduction

Public urban space constitutes the most important component of any urban fabric, as it represents the focus of attention for geographers, planners, architects, and sociologists (Khawaja, p. 8, 2015). Urban space has become necessary in the city that undergoes various transformations. The creation of these public spaces, which serves as an encouragement to all individuals to access them, is one of the criteria for the success of the city (UN: Habitat, p. 59, 2015).

In the West, public space was limited to the city, center squares, and church squares, which are almost always designed around a central monument. It should be noted that public urban space has existed since ancient times, especially in Greek and Roman cities, until the present time. However, highlighting, studying and analyzing this science, as well as discussing its importance in forming a general opinion of the individual towards power began in the second half of the twentieth century in Europe and then moved to the rest of the world (Khawaja, p. 8, 2015).

Lucretius believed that nature consists of bodies and space. Objects

move in space and take their positions. Aristotle developed the theory of place, which states that space is the (where) that is linked to man and his relationship with the physical environment, which achieves a sense of belonging (Ahmed, p. 3, 2020). It is identified by the facades of buildings and the floor of the city. It also contains the activities of the residents of this city and varies in several forms, including squares, gardens, and parks (Kounsselie, p. 146, 2013).

Urban space exists around us, and we encounter it every day during our daily activities. The term space is mainly used in geography, in addition to its use by architects, planners and philosophers (Kounsselie, 146). Spaces have several definitions in various sciences, as their definitions vary according to each science's point of view.

Krier identified the urban space as an external space that consists of two elements: the walls and the floor. He added that the clarity of the aesthetic values and engineering characteristics of the urban space helps to realize it, as it expresses an urban experience that contains people, interacts with them, and gives them a sense of containment within it (Krier, 1988, p174).

Urban spaces constitute one of the most important elements of cities' urban formation, as they represent the main areas for human communication, the practice of various human activities, and the accompanying availability of conditions for psychological and physical comfort for all parts of society by securing a complex mix of integrated activities and events (Dwaikat, p. 4, 2009).

Urban spaces are characterized as points of attraction in the urban fabric and are characterized by aesthetic and functional characteristics

for the purpose of people's enjoyment. They are also considered a national treasure and a high-value resource that must be preserved and sustained. Therefore, justice is necessary in distributing them in a way to guarantee that everyone receives their share and has the right to use them (Kounsselie, P. 148, 2013).

While Al-Hashemi indicated in his study of the functional efficiency of spaces that the efficiency of the spaces is deteriorating in terms of service, in addition to the loss of feeling, because they expel the youth and the elderly, and that 89.7% of these spaces' goers are from the category of children and adolescents, because they do not contribute to raising the degree of social interaction (Al-Hashemi, p. 183, 2010).

The problem

The research problem attempts to answer the following question:

Is there efficiency in distributing urban spaces in Karbala's city center?

The Hypothesis

Ease of access, social interaction and spatial compatibility are indicators that contribute to enhancing the efficiency of the function of urban spaces in general and in city centers in particular.

Research sources

The research relied on library sources and a field study conducted through a questionnaire that included five paragraphs:

1. The first paragraph: contains a group of questions, the answers to which reveal general information about the users.
2. The second paragraph: contains a group of questions, the answers to which reveal the behavior of individuals.
3. The third paragraph: contains a group of questions, the answers to which reveal the reality of the state of the elements of coordination.
4. The fourth paragraph: contains a group of questions, the answers to which reveal the answer to information related to the efficiency of spaces.
5. The fifth paragraph: contains a group of questions, the answers to which reveal the information about the spaces in the study area.

Research Methodology:

In order to achieve the planning goal of revealing the dimensions of the relationship between man and place and effectiveness in presenting and discussing the research topic, the study adopted more than one approach, starting with the descriptive approach, which included the collection and presentation of information and data. The necessity of the research required to adopt the statistical analysis approach using the SPSS program for the purpose of understanding the functional efficiency of the public urban spaces in the study area, on the basis that it is one of the most used programs in questionnaire analysis (Al-Rawi, p. 4, 2010).

The Sample of the study

The researcher relied on the field study in the process of collecting information and data related to the research by distributing the questionnaire designed for this purpose. It contained the aforementioned five paragraphs, which were designed and adapted according to the nature of the target sample. The statistical questionnaire included two main variables: the efficiency of urban spaces, which represented the independent variable and the number of its paragraphs (14 paragraphs), and the spaces in urban cities, which represented the dependent variable and the number of its paragraphs (7 paragraphs) to cover the objectives of the study. Moreover, the level of answers was measured according to the five-point Likert scale, as shown below:

The sample size was (100) sample statistic, as (10%) of the questionnaires were distributed to the residents of the city of Karbala, the place of the research, and (10%) of them to employees in the city. The remaining largest percentage (80%) was distributed to passersby in urban spaces. For the purpose of analyzing the data of the study and testing its hypotheses, the program (SPSS v.26) was used, and based on that, a set of statistical indicators were used, including:

1. (Cronbach's alpha): It refers to the internal consistency of the scale.
2. (Kolmogorov-Smirnov test): It is used to test the normal distribution of the data.

As for descriptive statistics, the following measures were used: frequencies, percentages, arithmetic mean, and standard deviation.

Definition of the city

It is a complex organic organization; it forms those complex blocks in the buildings and the people who move in and between them. In addition to that, it is a human investment that serves the material and spiritual needs of man, as it is considered a human settlement. On the other hand, Hartshorn describes the city as a concentration of population, characterized by a clear way of life through work and life patterns (Sefir, pp. 12 and 14, 2015).

The concept of urban space

There were many definitions and explanations of space in the studies of theorists, as the concept of space occupied the thinking of philosophers and thinkers throughout history. Plato pointed out that geometry is the science of space. As for (Lensippus), he believed that space is a reality, although it is not characterized by materialism. Furthermore, Aristotle considered space a dynamic field with specific directions, resulting from the linkage of a group of places (Ali, p. 1, 2012).

Classification of urban spaces

In terms of its dynamic characteristics:

Regardless of its effectiveness, urban space is divided into two types:

1. Mobile space: It is characterized by movement, direction and continuity, and is found in modern cities due to the presence of mechanical movement that needs dynamism and direction (Al-Talib, p. 69, 2017).
2. Fixed space: It has several characteristics that are represented as follows: being linked to a specific spatial spot, being totally or partially closed with a shape centered around a central focus, and

being geometrically regular or irregular, it is found in Arab Islamic cities, for example in inner courtyards (Ahmed, p. 69, 2020).

In 2007, Frederick mentioned that the designed and planned shapes with dynamic characteristics affect one's perception and experience in the built environment, as it was found that openness, closedness, nodes, links, squares, and streets are all components of the urban fabric and refer to the "static or moving" visual sequence affecting the city. He also mentioned that the term "dynamic" expresses movement. Since most activities in general can be distinguished in terms of movement or stillness, the appropriate spaces are divided into static or dynamic as an important formation in the urban fabric. Accordingly, when there is harmony between what the urban space offers and what the user needs, it will be a successful space (Ahmed, p. 69, 2020).

The third type: This type combines the advantages of the two previous styles, and thus combines centralization and directionality, which makes it a source of creativity in city designs because it achieves aspects of connection and interaction with the urban environment on the one hand, and responds to kinetic requirements on the other.

As for modern cities, they are characterized by the presence of the three types of urban spaces and depend on the ability of the designer to use them in a homogeneous design style.

The study area

A brief overview of Karbala's city center

The holy city of Karbala is considered one of the religious holy shrine cities in Iraq. It is privileged by its urban and historical value and the individuality of its urban center (Qasim, p. 55, 2022), represented by the existence of two important shrines that represent the central nucleus of the city, namely Imam Hussein (peace be upon him) and his brother Al-Abbas (peace be upon him) (Al-Ardawi, p. 80, 2022). They also represent the main elements of the spatial formation of the skyline (Al-Rushdi, p. 58, 2013).

Spatial boundaries

The city of Karbala is located 110 km2 to the southwest of the capital, Baghdad, at a circle of 32.6 degrees north, and it is located at a longitude of 44.0 degrees east, and it rises about 36 meters. The difference between the highest and lowest elevation lines passing through it is about 15 meters, and the city center represents the lowest area within the city of Karbala (Qasim, p. 55, 2020).

It is bordered on the east by the districts of Al -Husayniyah and Al-Hindiya, on the west and south by desert lands, and on the north by the district of Al-Hur. It is the main administrative center in the governorate that has economic and religious-touristic activities, and this was the reason to raise the prices of land and residential units in it (Al-Jawahiry, p. 16, 2022).

The boundaries of the study area

In general, the city of Karbala consists of three districts: Karbala district, Ain al-Tamr district, and al-Hindiyah district. Each of these districts contains sub-districts; Karbala district contains (the center of Karbala district, Al-Hurr district, and Al- Husayniyah district), while Al-Hindiya district contains (the center of Al-Hindiya district, Al-Jadwal Al-Gharbi town, and Al Khayrat town.), in addition to Ain Al-Tamr district.

Karbala city center consists of eight neighborhoods, which are the same names as the entrances (Bab) that are currently surrounding the old city (Attia, 2009, p. 114), shown in figure (1). They are (Bab Al-Salalima, Bab Baghdad, Bab Al-Taq, Bab al-Khan, Bab Al-Mukhayam, Bab al-Najaf, and Abbasiya neighborhood, which was divided into two parts, the eastern Abbasiya and the western Abbasiya).

Figure (1) Shows the location of the study area in Iraq.

Source: (The urban renewal project for the center of the holy city of Karbala - the old city, p. 9, 2014)

Geographical distribution of spaces in Karbala city center (the old city)

The distribution of urban spaces is considered crucial and necessary, as interest has increased in the recent period because of its positive impact on the region and its goers, whether residents or visitors, and because it represents an outlet that promotes an urban image of the study area. Because the region receives hundreds of visitors to the two Holy Shrines annually, it becomes necessary to pay attention to such spaces to provide recreational and social services at the same time. It is worth mentioning that the spaces in Karbala city center are distributed regularly at the present time.

According to the basic design of Karbala city center in 2014, it becomes clear that there are public spaces in the region, but they are limited to the space between the two Holy Shrines and public squares, such as Baghdad Square, Sha'baniyah Square, Al-Alqami Square, and Martyrs Square, as shown in figure (2), which shows the distribution of spaces according to the basic design of the old city in Holy Karbala.

The spaces in the study area do not only include visitors, but also residents in the area; however, personal interviews with passersby in the area showed that there are no movement problems in the area between the two Holy Shrines on normal days.

Unlike the millions of visitors who face many movement problems during the times of large pilgrims; therefore, the study focused on analyzing the movement of visitors on those occasions, as they are the most important in terms of users because of the huge

number of visitors to the two Shrines. There is a lack of sources and data on the spaces of this region (Baghdad Square, Martyrs Square, Al-Alqami Square, and Sha'baniyah Square) due to their modern composition and design. However, they were addressed in a simplified manner, and a basic model of spaces was chosen as the space between the two Shrines area, the largest urban space in the old city to be used to analyze the movement in the spaces.

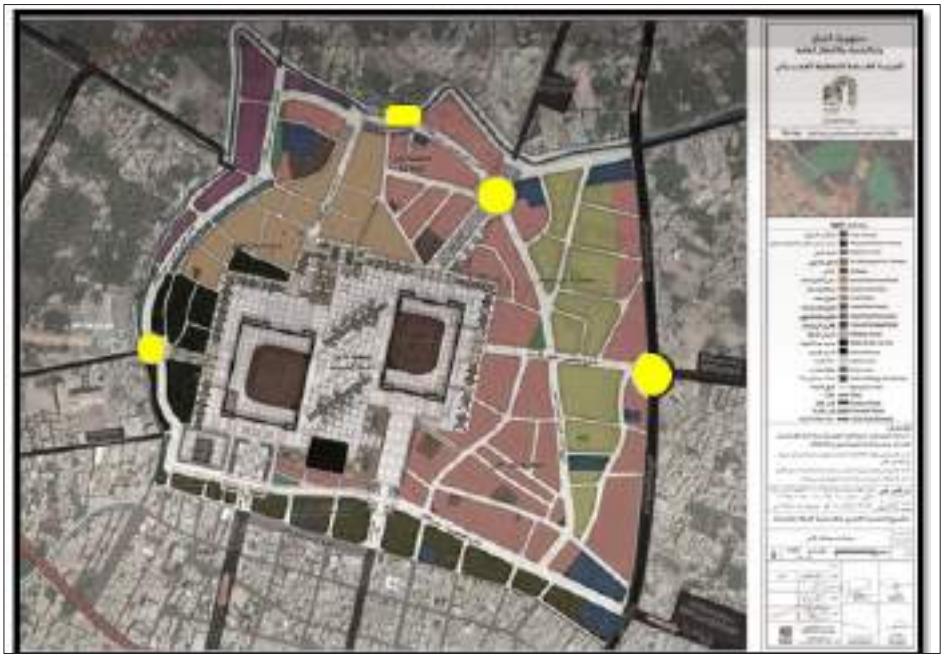

Figure (2) Geographical distribution of open spaces in the study area within the basic design

Source: From the researcher based on the basic design of the area from the Directorate of Urban Planning, Karbala, GIS Division.

Functional efficiency of public spaces in the study area

1-The level of public space organization in the study area

A large percentage of the spaces' users in Karbala city center, up to (59%), confirmed that comfortable seating was provided in different classifications; however, not a small percentage (34%) confirmed the absence of those seats. This indicates the need for the spaces for seats, and this is due to the availability of security in the public spaces in the study area, as indicated by a large percentage (74%). Part of these spaces is used to carry out various activities, as confirmed by (58%) of the study sample. The study also proved that the spaces have an integrated space organization, as (63%) indicated that the spaces serve all the areas of Karbala city center.

A large percentage of the sample (60%), strongly rejected the entry of cars into these spaces, a matter that indicates that they contain comfort and entertainment for the residents as well as visitors of the two Holy Shrines. This was confirmed by a very large percentage of about (80%), which is due to the diversity of activities and means of entertainment within the space at a rate of (58%), which made these spaces qualified places for multiple uses (for rest, food, etc.).

From the above, it becomes clear that the public spaces in Karbala city center have a high level of organization in terms of their functional and social performances, because these spaces are protected from car traffic, and, in addition, they maintain good municipal services. This was observed by a large percentage of the sample, about (75%), where it was found that (87%) of the visitors and residents found that the

spaces have a continuous cleanliness follow-up. In addition, (76%) confirmed keeping pace with the continuous development of services in line with the current development of societies.

2-Accessibility level

A large percentage (90%) confirmed that the public spaces in the study area have very easy access, as this is due to the distribution and spread of spaces in the region on a regular basis and according to the housing need, as proven by a large percentage of the sample (77%).

When the study suggested to the respondents that cars would enter the spaces, the rejection rate was high and reached (60%), due to the problems caused by those cars entering the spaces that impede the movement of visitors and space passersby from the region's residents, and thus lead to a decrease in the quality of space.

3- The reality of social interaction for the functional efficiency of public spaces

The study revealed that (85%) of the users confirmed that the space works to raise the level of social interaction between residents and visitors, as well as the relationship between local and foreign visitors, as this works on cross-cultural contact between nations through the exchange of cultures when holding meetings in those spaces, and this is a good indicator of the success of the space's effectiveness.

One of the most important things that the planner must take into consideration is the efficiency of the relationship between the elements of planning, which are the effectiveness, the human being, and the

place. The activities and events in the spaces of the city center of Karbala interacted with each other. Hence, we realize the importance of space for social communication, as (58%) which is not a small percentage of the study sample, confirmed that spaces participate, to a large extent, in supporting social communication when being occupied by social activities.

It is worth mentioning that the spaces of Karbala city center, such as the space between the two Holy Shrines, have many events and entertainment activities, such as cultural and religious competitions, the establishment of cultural exhibitions or book fairs, and other events that are held on special occasions. Due to the quality of the design standards of the public spaces, they have become rich in content and serve the intended purpose of their presence within the basic design of the city. They are considered a good means of social communication and interaction, as indicated by (72%) of the study sample.

It is clear from the above that the spaces of Karbala city center have good social interaction, and this indicates the success of the space in providing its services to visitors and users.

4-Spatial compatibility between spaces and user behaviors

It is well known that public spaces are considered a social communication point within the urban city, if they are rehabilitated in terms of design and aesthetics. Furthermore, if well-organized, the public space provides a service for all ages. According to children, adolescents, and young adults within the study sample, they considered the spaces adjacent to their homes suitable for their meetings, as (50%) confirmed.

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They were distributed for (entertaining, cultural, and social purposes), while (50%) of the sample considered that the spaces were suitable for visitors' meetings, especially for religious purposes such as reviving rituals, as in the space between the two Holy Shrines, on occasions or on regular days (such as congregational prayer, Arafa supplication, Kumail supplication, and delivering religious lectures, etc.).

Discussion

Through the study of the analysis of the indicators above, it becomes clear that the spaces of Karbala city center have efficiency in providing functional performance of services. It worked on the establishment of many urban gatherings in these spaces through the participation of individuals and their interaction with the place through their association with the Holy Shrines in the region, where a sense of belonging to the place was very clear.

In this way, the place enhanced the interaction between all parts of society through participation in the prevailing values of customs, traditions, and certain behaviors for each activity associated with a specific time among users.

One of the reasons for the success of the spaces in Karbala city center was the suitability of the spatial location of the master plan, in addition to the possibility of easy access, which worked to attract users to pass by them while moving within the study area.

Volumetric compatibility also helped large numbers, especially during large pilgrimages, travel safely. It worked on the smoothness of movement through expansion, spread, and development in design to achieve flexibility in using space.

It is worth noting that the main reason for going to Karbala city center is to visit the two Holy Shrines (Al-Hussein and Al-Abbas, peace be upon them), because of the high sanctity and spirituality of these shrines that attract people from all over the world. This refers to the religious and cultural importance of these spaces through the authenticity of the place resulting from the support and Strengthening of the elements of the place to one another, as well as filling the spaces, especially the space between the two Holy Shrines, with religious symbols linked to the past of the region that caused its formation in this way.

These symbols evoke memories and history, and thus lead to raising the level of spirituality in the place and the performance of religious and Husseini rituals in particular.

Conclusions

1. The spaces of the study area work on social interaction, and this was confirmed by (85%) of the study sample.
2. The study proved that the place has easy access for (90%) of the users.
3. (34%) of the users confirmed that spaces need seats.
4. The absence of services for people with special needs. This was confirmed by (44%) of the users.
5. (48%) of the sample confirmed their dissatisfaction with the climatic treatments, especially at the peak of winter and summer.
6. The study concluded that the functional efficiency of urban spaces is of high quality in terms of service. This was evident through several planning, spatial, and social indicators that were previously studied.

Recommendations

1. Providing seating in spaces of all classifications, especially for the elderly and people with special needs.
2. Laying bicycle paths for the residents for daily use.
3. Providing services for the elderly and people with special needs through the use of a special path for them.
4. The need to pay attention to climate treatments using modern technologies that raise the level of space efficiency.

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Investigating air pollution and its relationship to geographic and demographic data in Karbala

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Abstract

The purpose of conducting this study in the city of Karbala, specifically on the day of the Arbaeen visit, is to determine the effect of increasing the concentrations of polluting gases on the health of visitors to the city . This study investigates the changes in the levels of ozone (O3), sulfur dioxide (SO2), and carbon monoxide (CO) over the city of Karbala. These gases are considered among the gases that are believed to threaten human health and cause suffocation and other problems resulting from the increase in their concentration. The Sentinel-5 tropospheric monitoring instrument (Sentinel-5P TROPOMI) was used to find SO2, O3 and CO to monitor local air quality and pollution using relatively high-resolution satellite data and to investigate the relationship between the pollutants and the demographic and geographic information of the study area. Geospatial analyzes were performed using demographics data and numerical elevation models and vegetation cover for this purpose . The results showed that the district of Al-Hur showed a greater increase in the concentration of carbon dioxide gas compared to other regions, while the amount of ozone gas increased in the center of Karbala region, especially near the road used by tourists traveling from Najaf to Imam. The shrine, while the increase in sulfur dioxide is distributed in each of the districts of AlHusseinah, Al-Hur and the western strip. The overall conclusions of the study showed that local air quality and pollution levels can be monitored using Sentinel-5P TROPOMI dataSentinel-5P TROPOMI

Keywords: Sentinel 5 , Air Quality , Arbaeen Visit , Tropomi , Air Pollution , Visitor Road. Sentinel-5p Tropomi.

1. Introduction

The problem of air pollution is getting worse as the world's population is growing so quickly. Urbanization, energy use, transportation, and motorization are some of the major contributors to air pollution. Additionally, the environment's quality and people's health are negatively impacted by population increase and exposure to air pollutants [1]. Using satellite-based equipment, the atmosphere's concentration of SO2, O3, and CO can be determined. TROPOMI (TROPOspheric Monitoring Instrument), the only payload on board the Sentinel-5 Precursor (S5P) satellite of the European Space Agency (ESA), was launched in October 2017. Due to its unprecedented spatial resolution (3.5 7 km at the beginning of the mission and 3.5 5.5 km since 6 August 2019) and high signal-to-noise ratio, TROPOMI is expected to revolutionize the way we monitor air pollution from space [2]. At the same time, recent years have seen a significant expansion in the possibilities for remote observations of the status of the atmosphere. Particularly, several satellites have been put into orbit above the Earth with the primary objective of detecting the vertical distribution of several atmospheric chemicals, such as ozone, nitrogen dioxide, methane, carbon monoxide, water vapor, and aerosols[3]. Another gas released by the coal mining industry is CO. CO is a key component in the creation of ground-level ozone (O3) and has a brief atmospheric lifespan (days to a few weeks). In the atmosphere, CO and OH interact and lower each other's concentrations. Meanwhile, powerful greenhouse gases like methane have a shorter lifetime because to OH radicals. As a result, the decrease in (OH) enhances the indirect global warming potential of these gases [5].

2. Study area:

The study area is located within Karbala city , as it includes all of the sub-districts of Al-Husayniyyah and part of Al-Hur sub-district within the Karbala district, and the sub-districts of Al-Khairat and Al-Jaddol Al-Gharbi within the Al-Hindiyah district, in addition to the center of the Karbala district, with an area of approximately (1491.048) km2, as it lies between (43.93 - 44.48) longitudes, and latitudes (32.18 - 32.96). As it passes through the study area three of the main roads used by visitors heading to visit the Arbaeen, so it was necessary to study the air quality within the study area . As for the spatial boundaries of the study, the data were taken on September 17, 2022.

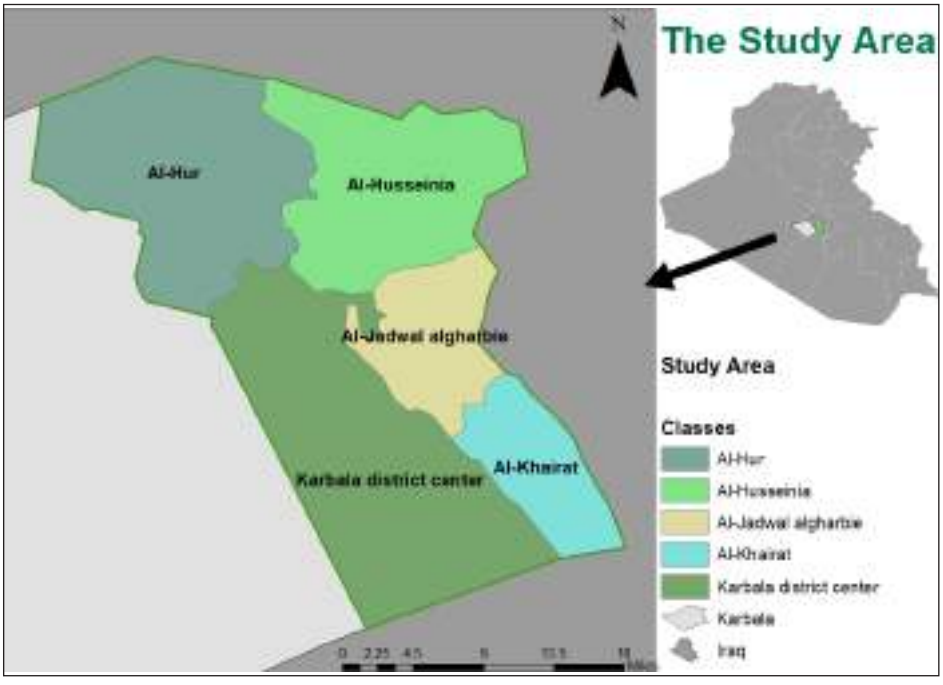

Figure (1) :Represent the study area

3. Data and Methods:

The single payload of the Sentinel-5p spacecraft, which was launched into low-Earth orbit on October 13, 2017, is TROPOMI, a space-borne spectrometer that covers wavelength bands between the ultraviolet and the shortwave infrared. It was funded jointly by the Netherlands Space Office and the European Space Agency (ESA). The information is freely available for download via the ESA Copernicus Open Access Hub. [1] The data used in this study from the Sentinel 5 satellite are satellite images that have been processed and corrected by Q GIs and Arc Map software as they provide information on the concentrations of carbon monoxide, sulfur dioxide and ozone gas. The study area passes through three of the main roads that visitors use to travel from the city limits of Karbala to the shrine of the two Imam.

Several stations distributed along the three roads were chosen to measure the concentration of gases at each station, using spatial analysis tools from Arc Map software to study the distribution and identify areas of high concentration and areas of low concentration, as shown in Table (1). which shows the location of each station and the concentration of those gases in each station.

Table (1) the concentration of gases on stations

Stations	longitude	latitude	SO2 mol/m2	O3 mol/ m2	CO mol/ m2
0	44° 2' 19.444" E	32° 37' 16.632" N	-2.6E-05	0.127139	0.034329
1	44° 2' 41.379" E	32° 38' 6.384" N	-0.00056	0.12678	0.034329
2	44° 3' 11.892" E	32° 39' 7.017" N	0.000506	0.125964	0.034329
3	44° 4' 15.096" E	32° 40' 6.714" N	0.000506	0.125964	0.032866
4	44° 5' 7.044" E	32° 41' 0.030" N	0.000506	0.125964	0.032866
5	44° 7' 2.002" E	32° 41' 25.231" N	0.000506	0.125964	0.032866
6	44° 2' 7.822" E	32° 36' 48.351" N	-2.6E-05	0.127139	0.034329
7	44° 3' 27.676" E	32° 36' 21.693" N	-0.00056	0.12678	0.034329
8	44° 6' 47.608" E	32° 35' 57.537" N	-0.00056	0.12678	0.034329
9	44° 8' 37.191" E	32° 35' 13.637" N	0.000329	0.127027	0.034425
10	44° 11' 59.306" E	32° 34' 23.293" N	-1.8E-05	0.127829	0.031757
11	44° 12' 51.884" E	32° 32' 39.966" N	0.000436	0.12822	0.031757
12	44° 16' 1.408" E	32° 32' 36.753" N	0.000436	0.12822	0.031757
13	44° 18' 29.708" E	32° 32' 24.831" N	-7.7E-05	0.127302	0.031757
14	44° 20' 37.038" E	32° 32' 9.351" N	-7.7E-05	0.127302	0.032769
15	44° 1' 51.012" E	32° 35' 40.533" N	-2.6E-05	0.127139	0.034425
16	44° 3' 16.093" E	32° 34' 5.764" N	-0.00071	0.127566	0.034425

17	44° 6' 59.052" E	32° 31' 24.774" N	-0.00071	0.127566	0.033514
18	44° 8' 23.886" E	32° 29' 46.905" N	0.000365	0.127101	0.033514
19	44° 9' 56.021" E	32° 27' 22.140" N	0.000365	0.127101	0.034239
20	44° 11' 8.912" E	32° 25' 28.427" N	-0.00032	0.127942	0.033652
21	44° 13' 12.082" E	32° 22' 39.404" N	0.000626	0.128382	0.031459
22	44° 15' 8.735" E	32° 20' 10.874" N	0.000626	0.128382	0.032276

4. Result and discussion

4.1. NDVI and UHI of study area

Figure (2) the ndvi of study area

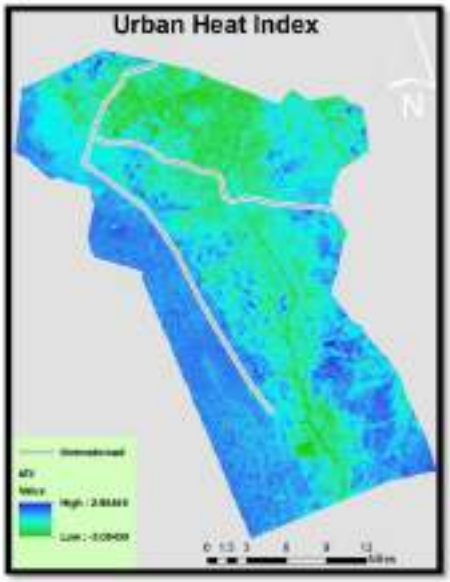

Figure (3) the uhi of study area

4.2. Carbon monoxide (CO) :

CO is an odorless and colorless gas that may emit from incomplete incineration of any carbonaceous materials. The major source of CO are tobacco smoke, gas stove and pilot lights, wood stove and fire places, usage of kerosene fuelled vehicles and gasoline engines In general, movement of automobiles are the most productive source of CO concentration in air [6] . Figures (4, 5) show the distribution intensity of carbon monoxide gas within the study area, as well as the distribution along the three roads (Baghdad-Karbala, Babylon-Karbala, Najaf-Karbala) Respectively. Where it is noticed that the concentration of gas increases in the district of Al-Hur, where it reached the highest value (0.034425) mol/m2, while the concentration decreases as we go out towards the district of Al-Hussainiya, the western stream, Al-Khayrat and the center of Karbala district, where it witnessed the lowest value (0.031459) mol/m2.

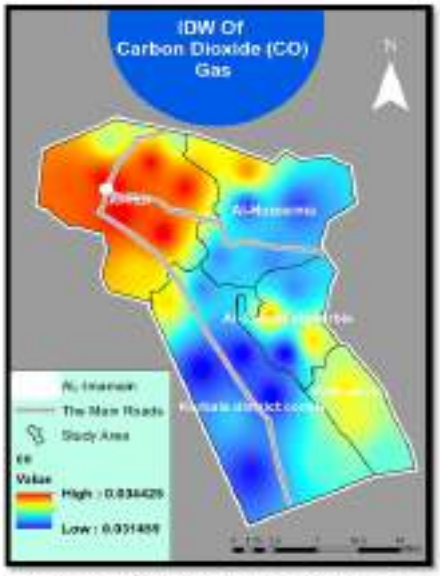

Figure (4) CO concentration of study area

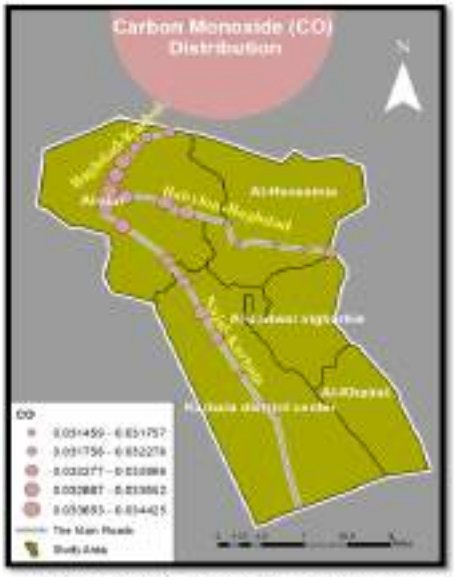

Figure (5) CO concentration of three roads

4.3. Ozone gas O3:

O3 is one type of gas that is formed due to photoreaction with existing air pollutants such as oxides of nitrogen (NOx) and volatile organic compounds (VOCs). The 8 hours mean concentration of O3 is 100 µg/m3. In ground level, the O3 is the pollutant in air that causes severe health effects on the human body[7] . Figure (6,7) shows that the eastern portion of the Al-Hussainiya district and the two sub-districts of Al-Khairat, Al-Jaddol Al-Gharbi, are the areas with the highest concentrations of ozone gas, with a maximum concentration of (0.1 29 141) mol/m2. While the ozone gas concentration falls in Al-Hur and the northern parts of the Al-Husseiniya district, where it achieved the lowest value (0.12538) mol/m2, the gas concentration rises elsewhere.

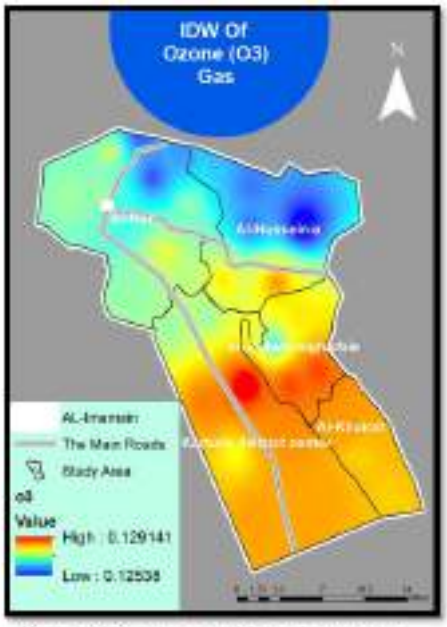

Figure (6) O3 concentration of study area

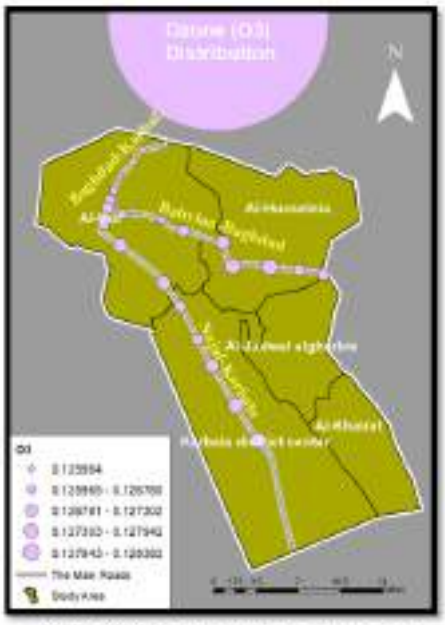

Figure (7) O3 concentration of three roads

4.4. Sulfur dioxide SO2:

SO2 is colorless, has bad odour and is a toxic natural pollutant in the air. The natural source of SO2 in air is due to action of volcanic activity. The other sources are fossil fuel, coal, oil, diesel, power plants, metals processing industries, smelting facilities and diesel

vehicles and SO2is also released from atmospheric secondary pollutants, such as sulphur aerosols, PM 2.5 and 10. [8]. Figures 8 and 9 show the distribution of sulfur dioxide gas across most of the study area, with the highest concentration occurring in Al-Husayniyyah, Al-Jaddol Al-Gharbi, and the southern part of the Al-Hur area (0.00147697) and the lowest concentration occurring in Al-Khairat and the Central offal-Hur side (0.00105495).

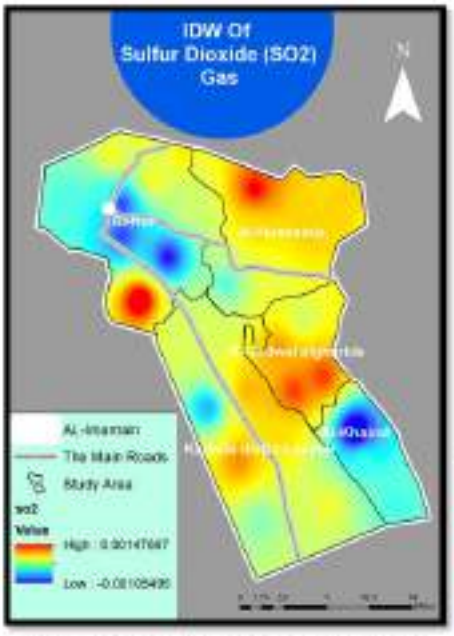

Figure (8) CO concentration of study area

Figure (9) CO concentration of three roads

5. The mean and standard deviation value

In this study, satellite measurements of the HUI, SO2, CO, and O3 levels were made over the province of Karbala. As a result, the MA of the values derived inside the Karbala province's boundaries and displayed as Figures above. Based on the results (Figs. 4, 5, 6, 7,8 and 9), it is visually clear that the Karbala metropolis has the high mean concentrations of CO, SO2, and O3, but that the distribution of concentrations within the study area is irregular. This irregularity may be caused by the area's built-up areas, population density, and central business district. Table (2) shows the average concentrations of gases and the standard deviation in each of the study areas.

Table (2): Impact of LULC on the UHI, SO_2, CO, and O_3. (MOL/M2)

Name	Type	MEAN	MAX	MIN	STD
Al-Husseinia	CO	0.032465537	0.033848975	0.031757001	0.0004913
	SO2	0.000562281	0.001202987	-1.80E-05	0.000207113
	O3	0.126709963	0.128219992	0.125380024	0.00063067
	UHI	-0.65412233	2.149443865	-2.81633353	0.829764981
Al-Hur	CO	0.033834	0.034425	0.032321	0.000391
	SO2	0.000159	0.001477	-0.00071	0.000359
	O3	0.12692	0.127616	0.125964	0.000297
	UHI	-0.19978	2.225457	-2.62713	1.012424

Al-Jadwal algharbie	CO	0.032504524	0.033651955	0.031459015	0.000441194
	SO2	0.000681369	0.001089995	0.000313191	0.000187482
	O3	0.127977939	0.128618002	0.126822039	0.000406403
	UHI	-0.271248874	2.611011982	-2.747430563	0.784671817
Al-Khairat	CO	0.03297057	0.03346098	0.0323929	0.00023657
	SO2	-0.0001221	0.00063657	-0.001055	0.00027882
	O3	0.12811463	0.12839732	0.12797099	0.00010421
	UHI	0.79774262	2.86448812	-1.7479323	0.58271136
Karbala district center	CO	0.032187066	0.033513997	0.031459004	0.000429205
	SO2	0.000384749	0.000856984	-0.000287996	0.000198917
	O3	0.128046779	0.129140973	0.127101004	0.000365943
	UHI	0.433524402	2.502089977	-3.064390659	0.888765171

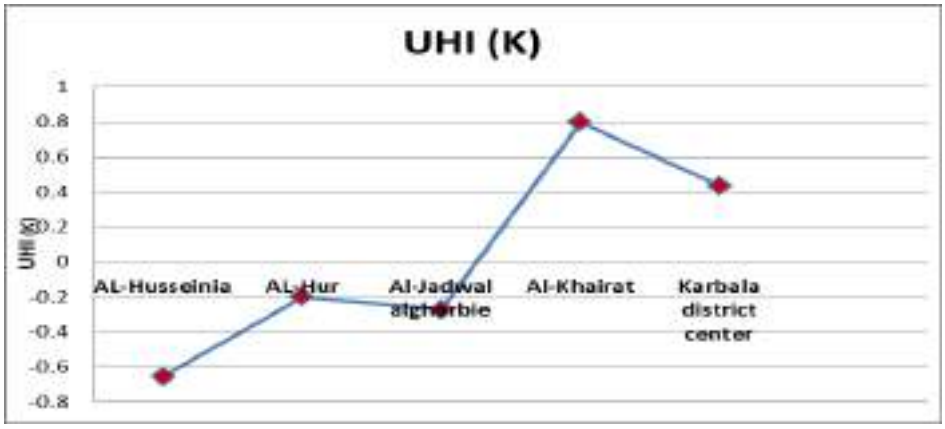

Figure (10)the mean of urban height inde

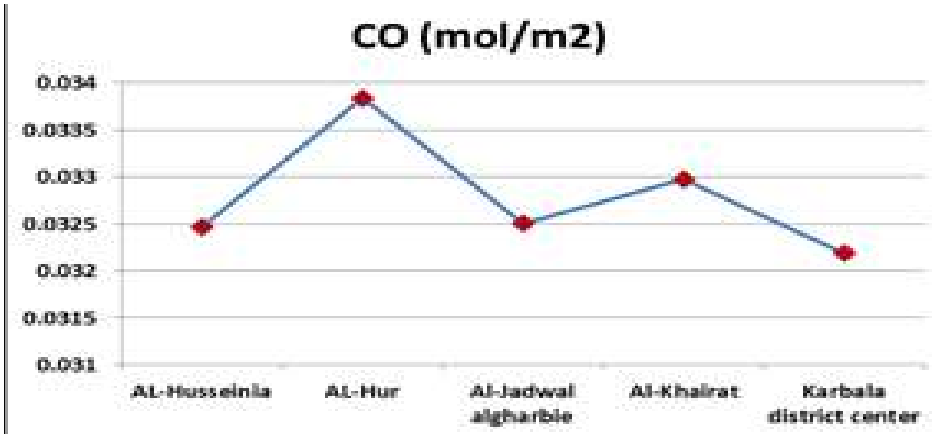

Figure (11)the mean of CO concentration

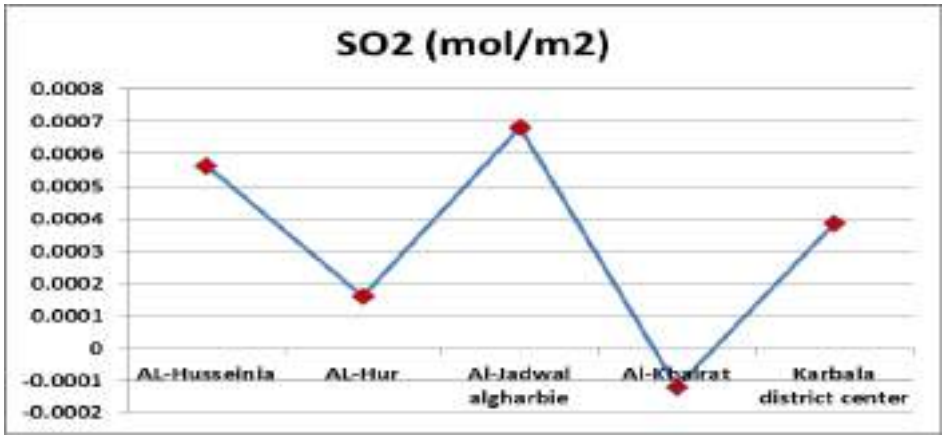

Figure (12)the mean of SO2 concentration

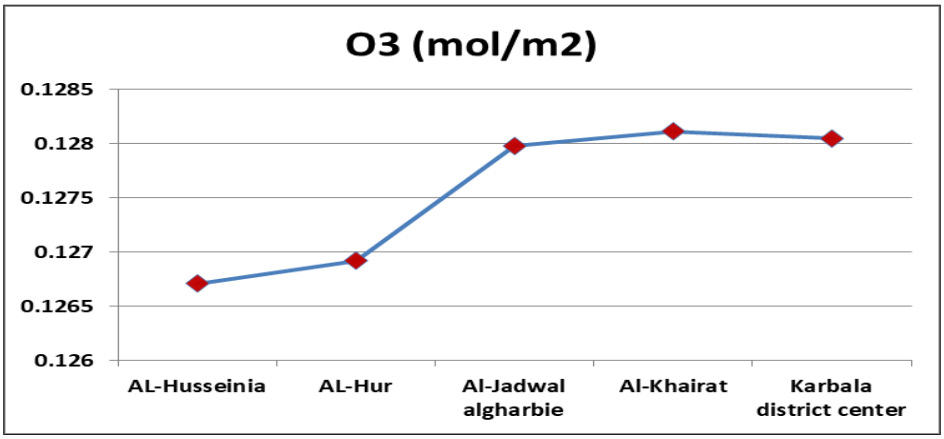

Figure (13)the mean of O3 concentration

Figure (10 -13) shows that the concentration of gases varies from region to another and at same region . Because the data was collected on September 17, 2022, the day of the Arbaeen visit, where the areas around the imam are densely populated and here the need for fuel and energy means for cooking and other purposes increases, the district of Al-Hur had the highest concentration of carbon monoxide gas, While the least concentration of it was in the center of Karbala district, on the road of visitors coming from Najaf, almost . As for sulfur dioxide gas, the Al-Jadwal algharbie district ranked first with the highest concentration of 0.000681369 mol /m2, while the Al-Khairat district recorded the lowest concentration among other regions, amounting to 0.0001221 mol/ m2. While the highest concentration of ozone gas was in the district of Al-Khairat and the lowest concentration of gas in the district of the Al-Husseinia.

6. Concentration of pollutants in some international countries.[9] ,[10]

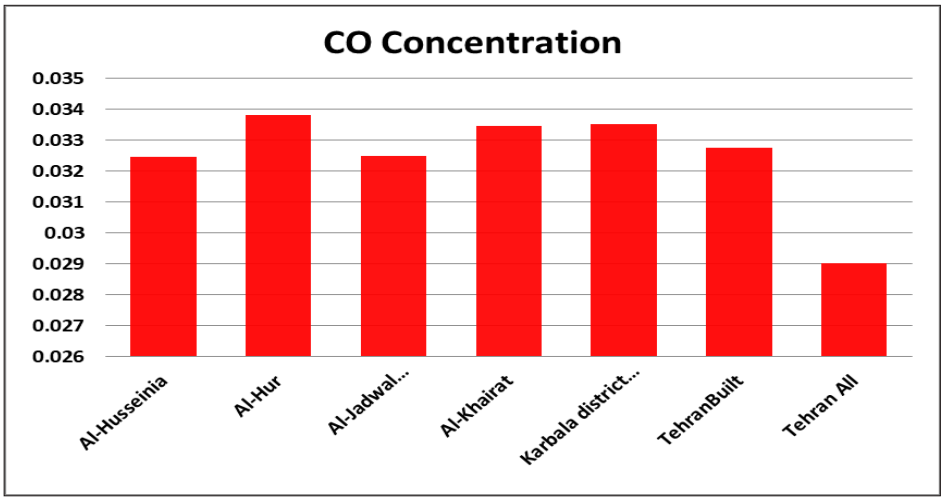

Figure (14) CO concentration on global cities

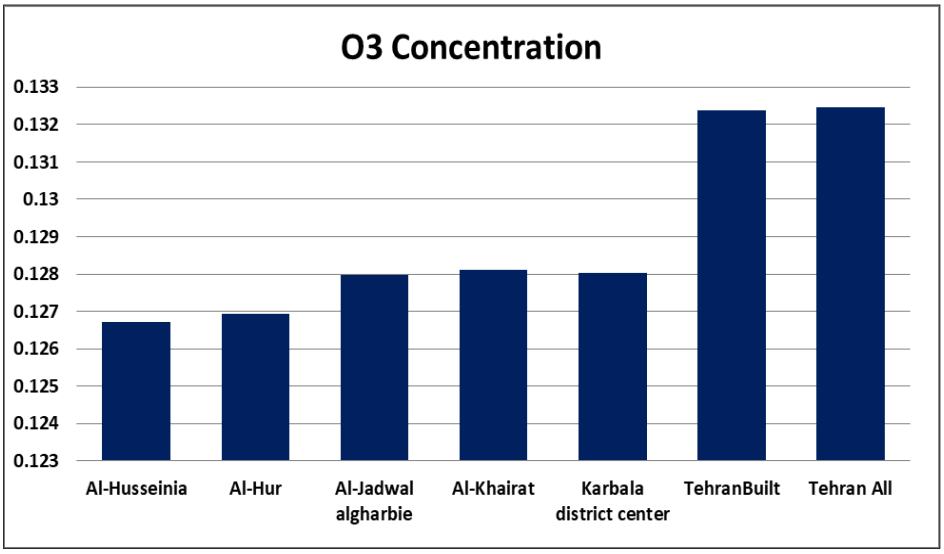

Figure (15) O3 concentration on global cities

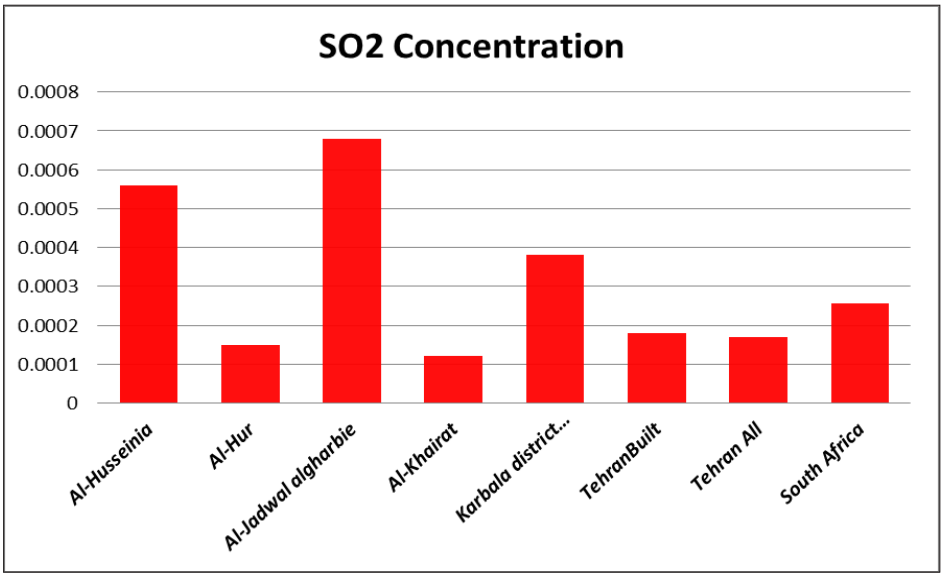

Figure (16) SO2 concentration on global cities

Figure 14 shows that the concentration of CO gas is high compared to the results of the city of Tehran, and the reason is that our data was collected on a day when the city of Karbala was densely populated, so the use of fuel, coal, car smoke, and the like increases from the sources. The results of works in the city of Tehran and South Africa were also taken into consideration in order to compare the results obtained with the global research that depended on the same satellite. As for ozone gas, see it to be present in great quantities above Tehran's sky due to the city's status as an industrial hub with numerous oil, mining, and other enterprises. Figure 16: The quantities of SO2 show convergence with South Africa and Tehran, with the exception of a pronounced increase in each of the western table and Al-Husseiniyah, which we will discuss in the conclusions.

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Conclusion:

Since millions of people visit Karbala on this day for Arbaeen, evidence of the concentration of several pollutants in the air was collected on 9/17/2022, making it necessary to investigate the amounts of such pollutants because they have an impact on human health. The impact of the LULC shift on the makeup of urban air pollution and LST has so far been established. However, the current study's use of remote sensing and GIS recognizes the vital link between the study area's vegetation and LST (which is naturally UHI). Additionally, the research methodology demonstrated that Kerala's city center and the urban region as a whole have the highest average concentrations of CO, SO2, and O3. And so on. Positive connections between CO, O3, and LST show the reciprocal impacts of LST, CO, and O3 values in the Karbala Governorate. The presence of large quantities of O3 gas in the southwestern side of the Karbala district center due to the presence of the Karbala refinery in that area, which in turn affects the area of Al-Hussainiya and the western stream due to the prevailing winds in the region. As for the SO2 foci, they are the result of the gas stations (the Al-Khairat station in the western stream and the Al-Hur station) and the presence of many brick factories in Al-Hussainiya. The overall conclusions of the study showed that local air quality and pollution levels can be monitored using Sentinel-5P TROPOMI data.

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Land Suitability Mapping for Solar Power Plant Using Remote Sensing, GIS-AHP and Multi-Criteria Decision Approach: A Case of Karbala, Iraq

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Abstract

The attention of developed countries is turning to the use of renewable energy sources, especially after the fossil fuel crises and environmental pollution caused by power plants, solar energy is a more effective renewable resource for use today, especially in areas with high solar energy. Solar cells convert solar radiation into an electrical energy source for domestic and industrial use. In this study we used remote sensing and Geographic information systems (GIS) to identify potentially suitable areas for solar power plants in the holy city of Karbala, Iraq.

After determining the necessary criteria and collecting their data via the satellite images of Landsat 8 for the year 2022 and analyzing them by ArcGIS, the analytical hierarchy process (AHP) and the Multi-Criteria Decision-Making Process (MCDA) were used to determine the best land for the installation of solar cells

The results showed that the areas that are suitable and very suitable are (15.41%), equivalent to (775.76607 Km2) of the total area of Karbala governorate (5033 Km2). As a result, this model is suitable for setting the selected criteria to identify the most promising sites in Karbala governorate that can achieve the research objectives, this study helps urban planners, designers and investors to implement and develop solar power plants within the governorate.

Keywords: Renewable Energy Sources, Power Plants, Solar Cells, Suitable Areas, (AHP), (GIS).

1. Introduction

The world population is constantly increasing and this growth requires more energy to meet daily needs [1], so the demand for fossil fuels is increasing, which is the most common type of fuel for the operation of power plants, In addition, energy manufacture from fossil fuels is the largest source of conservatory gas emissions into the atmosphere that have caused worldwide climate change[2], This has led to a focus on the use of renewable energy sources, as they are generally considered spotless, with a significantly lower influence on the environment than other energy sources[3]. Solar energy is a renewable and additive energy source that is gradually replacing non-renewable energy sources. Solar power generation has become one of the fastest growing energy sources as the cost of solar panels decreases[4], The average monthly solar radiation values for the region, which depends on the number of sunny days and the length of daylight hours, is one of the most important criteria for determining the installation areas of the solar system[5]. Based on previous studies in this field, the most important criteria have been identified that make the area suitable or unsuitable for the installation of solar cell stations, namely solar radiation, Elevation , slope, Aspect, land cover/ use, distance to power lines and main roads[6]

Remote sensing is a multi-scale and multi-temporal approach that

provides important data about objects and atmosphere at or near the surface of the Earth based on radiation reflected or emitted from objects or regions. Remote sensing techniques use satellite or airborne sensors to gather information about specific objects or areas. They therefore depend on physical, chemical, biological and/or geological properties [7, 8]. The geographic information system creates, manages, analyzes and maps all types of data. It is an organized set of programs and data designed to capture, store, update, process, analyze and display all forms of geographically referenced information efficiently [9], Technological innovations in the fields of Remote Sensing (RS) and Geographic Information Systems (GIS) Providing timely, accurate and high quality input for decision making while improving sustainable use and conservation practices of natural resources has opened a new dimension for addressing the broad scientific problem of land-use classification of land cover. Satellite imagery provides qualitative information over large geographic areas and reduces the complexity of field operations. Suitable remote sensing data for image classification are selected by analyzing the strength and limitations of the various types of available sensor data. Land use/land cover classification can be determined by measuring, analyzing and interpreting satellite imagery collected by satellite sensors [10].

MCDM (Multiple Criteria Decision Making) technique is applied to make the most suitable optimal among the replacements offered under multiple criteria and different targets[11] The analytical hierarchy process (AHP) was developed in 1980 to solve unstructured

problems by Saaty and is considered one of the most important MCDM methods used to determine the best choice amongst a set of alternative choices based on multiple criteria. AHP is one of the powerful and useful MCDM technologies that enables multifaceted problems for decision makers and provides high suppleness and reliability with a usable structure[12] The AHP technology includes important steps to enumerate the components in the pairwise comparison approach and the decision-making criteria technique, the hierarchy process determines the weighted scores of the criteria by applying the pairwise comparison technique to homogenize the effects on the total unit [13], suitability analysis in a GIS context is a geographic or GIS-AHP-based process used to determine the appropriateness analysis of a given area for a particular use. The basic premise of GIS suitability analysis is that each aspect of the landscape has intrinsic characteristics that are in some degree either suitable or unsuitable for the activities being planned [14]. The integration of MCDM techniques with GIS has considerably advanced the conventional map overlay approaches to the land-use suitability analysis mapping and analysis .GIS-based MCDA can be thought of as a process that combines and transforms spatial data into resultant decision [15]. This study aims to provide a GIS-based methodology for making the decision to install solar cells in Karbala governorate, and this proposed methodology was implemented using the ArcGIS program to calculate solar radiation and also analyze and classify land cover / use.

2. Study area

Karbala is located in the Mesopotamian plain 92km away from Baghdad in the southwest direction and occurs between Eastern Longitude (44° 25’ 00- 43° 45’ 00) and Northern latitude (32° 40’ 00-32° 20’ 00), it has an area of about 5 thousand square kilometers which represent about 1.2% of Iraq total area. It’s inhabited by more than 1.2 million residents and host millions during religious events like the Ashura and the Arba’ee [16, 17]

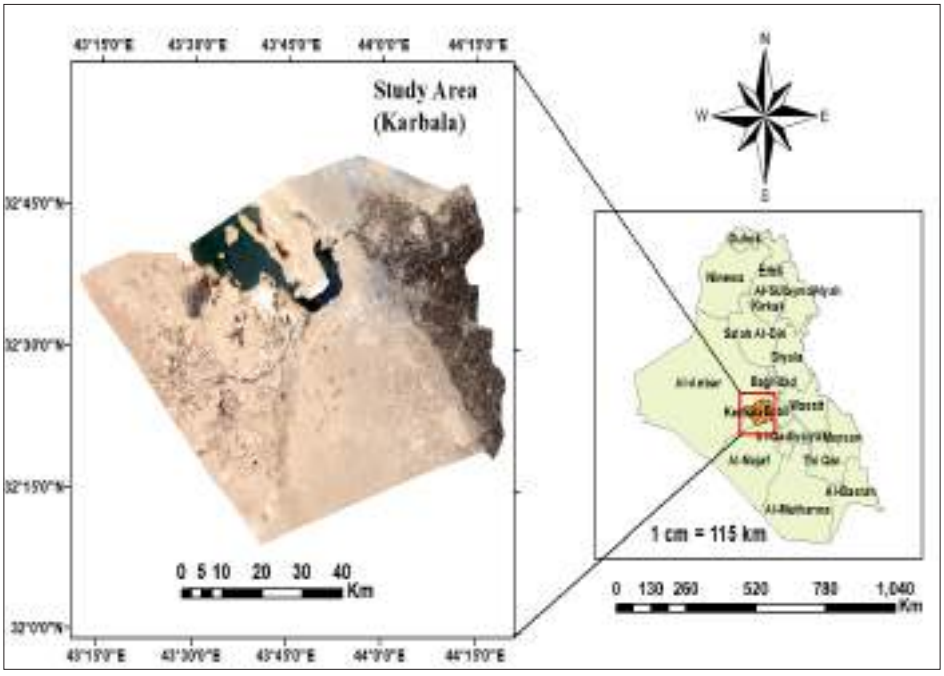

Figure 1.Study area location

3. Methodology

3.1. data acquisition

The criteria were derived from various data sources, including satellites, classification and websites. As shown by Table No. 1

Table 1.Site suitability criteria for solar PV installation

criteria	Reference	Unit
global horizontal irradiance (GHI)	ALOS PALSAR satellite image (DEM) processed with ArcGIS	(WH/m^2)
elevation	ALOS PALSAR satellite image (DEM) (ASF) processed with ArcGIS	m
Slope	ALOS PALSAR satellite image (DEM) (ASF) processed with ArcGIS	Degree
Aspect	ALOS PALSAR satellite image (DEM) (ASF) processed with ArcGIS	Degree
Land cover/use	Landsat 8 OLI/TIRS (USGS)	Unitless
Distance from power lines	Open street map	m
Distance from major roads	World Bank Data Catalog	m

The study relied on GIS-based combination with the AHP method as a methodology to acquire ideal sites of solar farms in the study area. Figure 2 shows a flowchart of the methodology.

Figure 2 .Flowchart of proposed methodology

3.2. Data preparation

After obtaining the data, the data is prepared using the ArcGIS program in order to obtain accurate results. Satellite images are combined using (Mosaic to new raster tool) to get a satellite image that covers the entire area of the study area. The second step is to subtract the study area from the satellite image produced by the Mosaic tool by a mask that represents the boundaries of the study area so that the results are focused only on it. The third step is to correct the spatial reference of the satellite image in this study, the spatial reference used is (UTM Zone 38n) , The last step is to get rid of the NoData Value and the Background values of the satellite image. After these steps, the data is ready for analysis

3.3. calculate criteria

Global Horizontal irradiation (GHI): It represents the amount of solar radiation that the Earth's surface receives. This value is of great importance in the installation of photovoltaic plants, and includes both direct radiation and reflected radiation as shown in Figure 3. This criteria calculated using (Areal solar radiation tool) contained in the ArcGIS program using ALOS PALSAR satellite images As shown in Table 2

Table 2.ALOS PALSAR satellite images DEM data

Scene	Band	Path/Frame	Resolution (m)	Spatial reference
Scene 1	L-band	585/640	12.5	UTm_Zone_38n
Scene 2		585 /630		
Scene 3		586/640		
Scene 4		586/630		
Scene 5		587/640		
Scene 6		587/630		

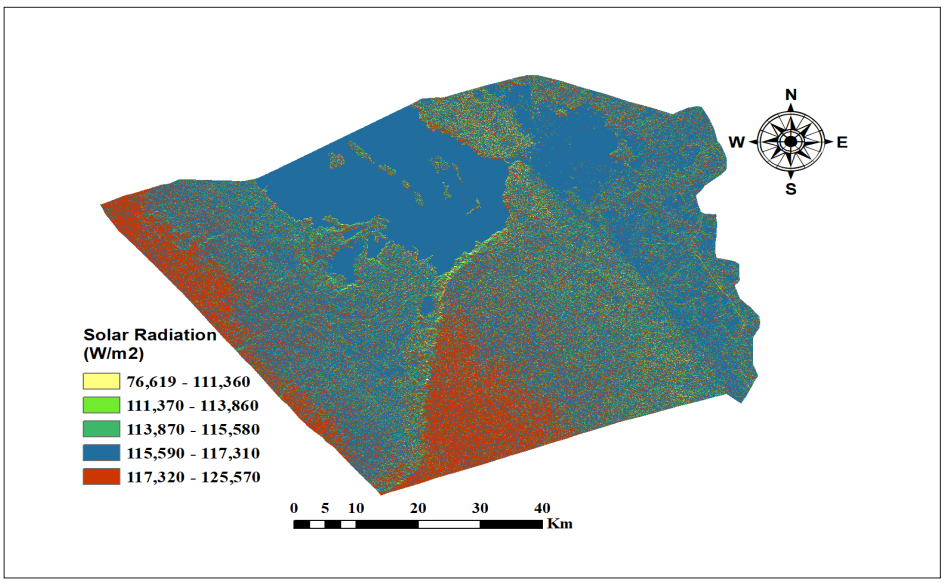

Figure:3.Annual Solar Radiaiton map for Karbala 2022

The areas with red color represent the highest values of solar radiation during the year and are considered the best areas for installing photovoltaic plants, which recorded the highest value of 125570 (WH/m2) and the values are graduated as shown in Figure 3 to reach the lowest value of 76619 (WH/m2) (areas in yellow).

- **Elevation:** High-altitude areas receive more solar radiation than low-lying areas, where they receive the lowest values of solar radiation, as shown in figure 4, the highest value of altitude reaches 156 (m) and gradually decreases until it reaches the lowest area with a value of 22 (m).

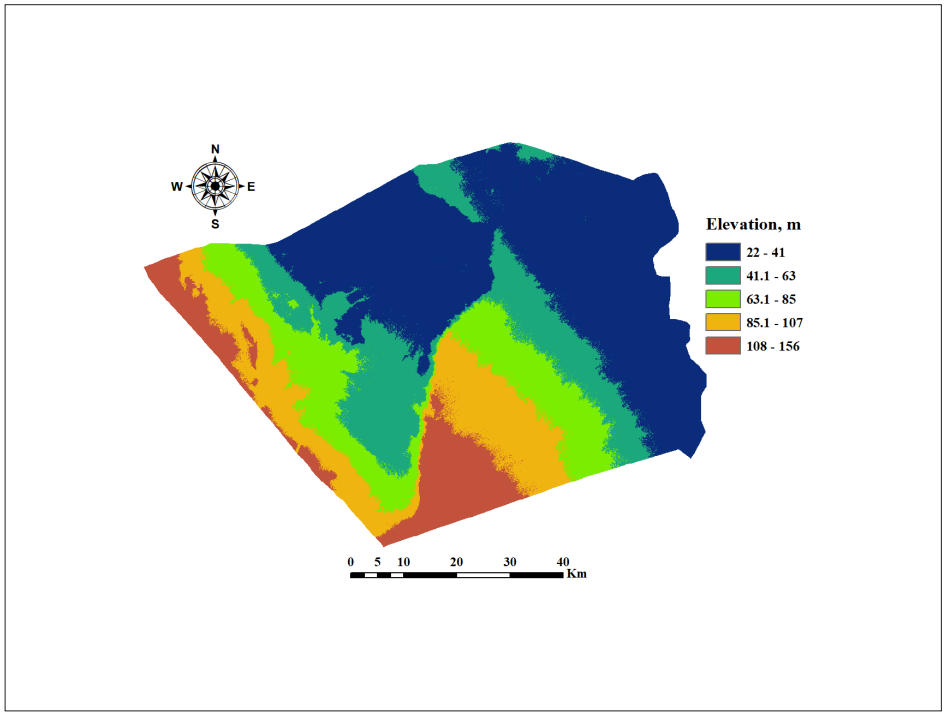

Figure 4. Elevation values in Karbala

- **Slope and Aspect:** The slope and Aspect of the study area are important criteria for choosing a suitable location for photovoltaic systems. Where it is determined by the amount of solar radiation received by solar panels. The figure 5 and figure 6 represent the Slope map and Aspect map respectively of Karbala

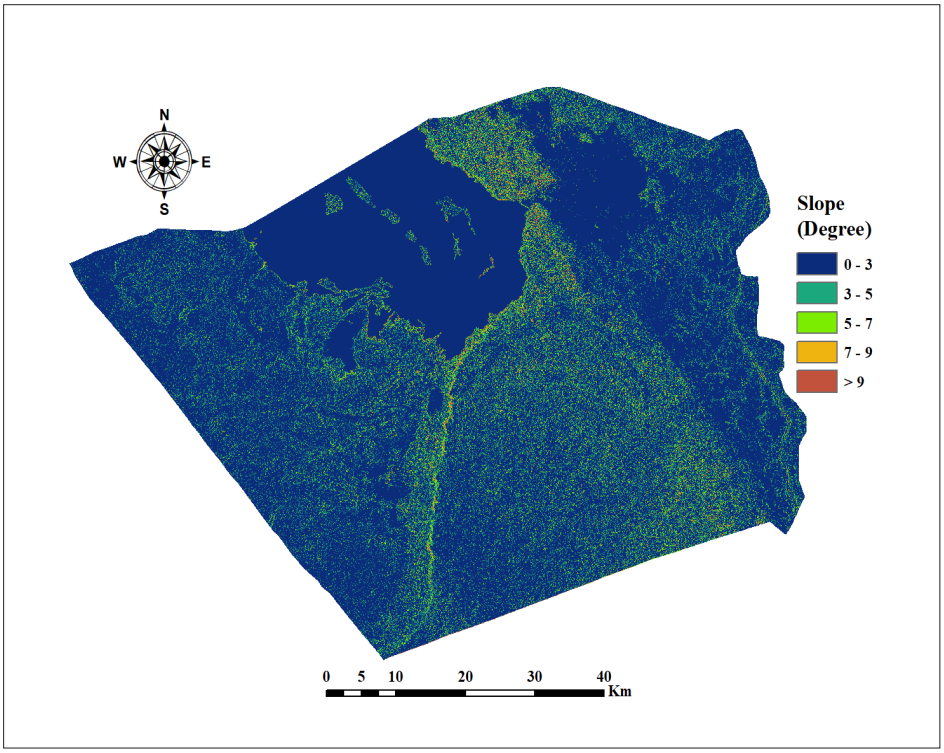

Figure 5.Slope map of Karbala

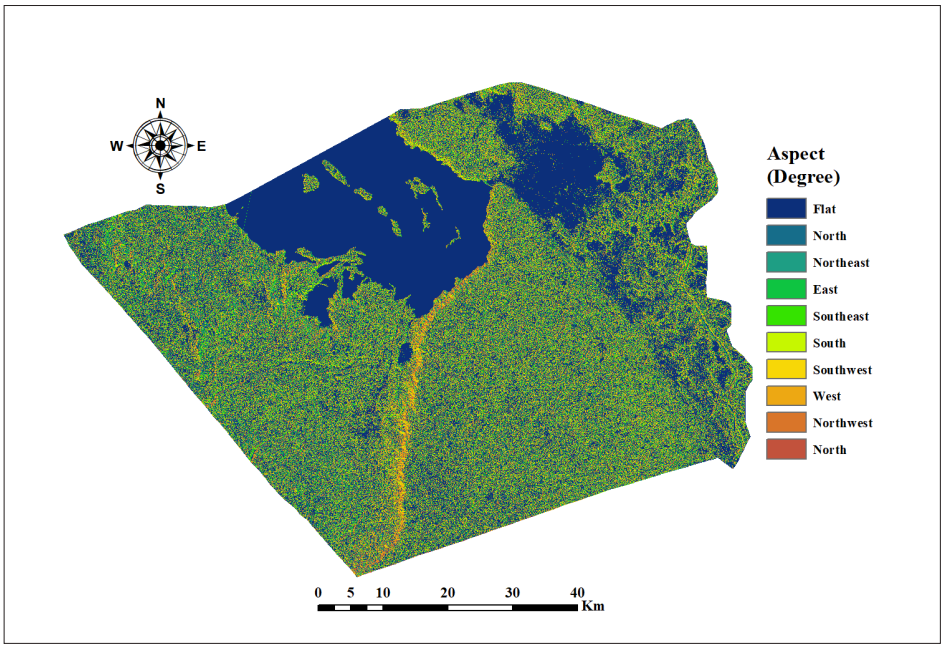

Figure 6. Aspect map of Karbala

- **Land cover :** Not all lands are suitable for the installation of photovoltaic panel systems, the best candidate areas for this purpose are bare lands and pastures. The ground cover of the study area derived from the Landsat 8 satellite as shown in Table 3. The land cover is classified into 6 varieties, which are barren lands, rangelands, Crops, Built area, forest evergreen and water

Table 3.Landsat 8 OLI Spectral Bands

Landsat 8 Sensors	Band	Band Name	Wavelength (µm)	Resolution (m)
Operational Land Imager (OLI)	2	Blue	0.450-0.515	30
	3	Green	0.525-0.600	
	4	Red	0.630-0.680	
	5	Near Infrared (NIR)	0845.-0.885	

Table 4. Land cover classes' details

Class	Area (Km)	Percentage %
Barren lands	3185.568	62.90
Rangelands	65.644	1.29
Crops	356.243	7.03
Built area	819.513	16.18
forest evergreen	388.712	7.67
water	248.186	4.90

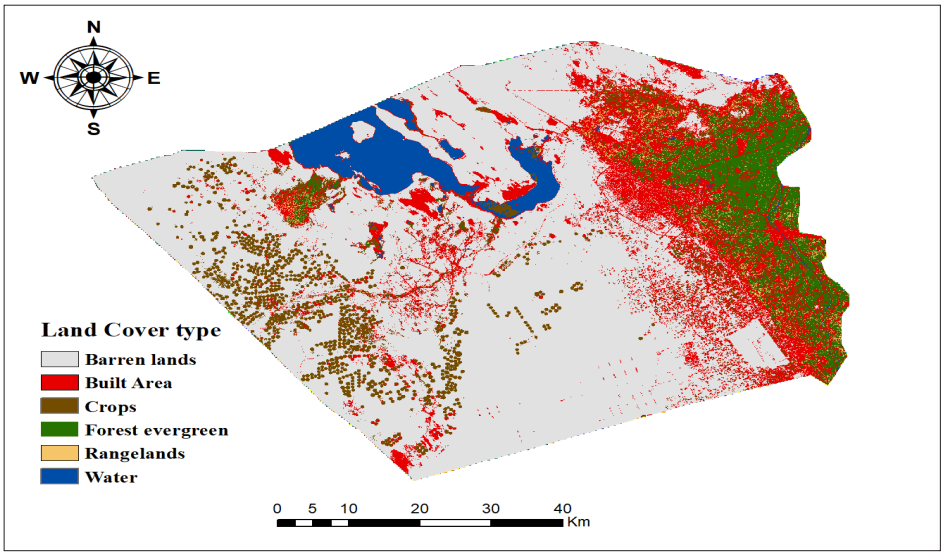

Figure 7.Karbala Land cover Classification

- **Major roads and Power lines:** Proximity to major roads and major energy transmission lines affects the cost of infrastructure construction and the associated environmental damage. Figure 8 and Figure 9 represent the map of the main roads and the map of the main power lines in order

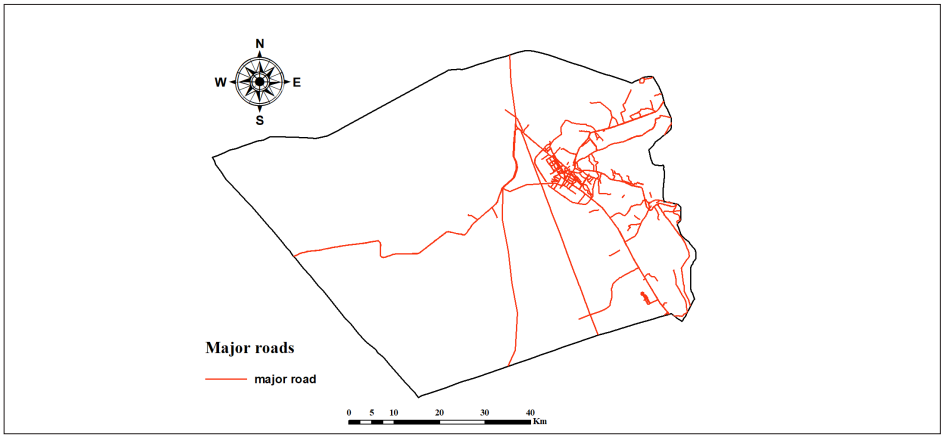

Figure 8.Major roads Map of Karbala

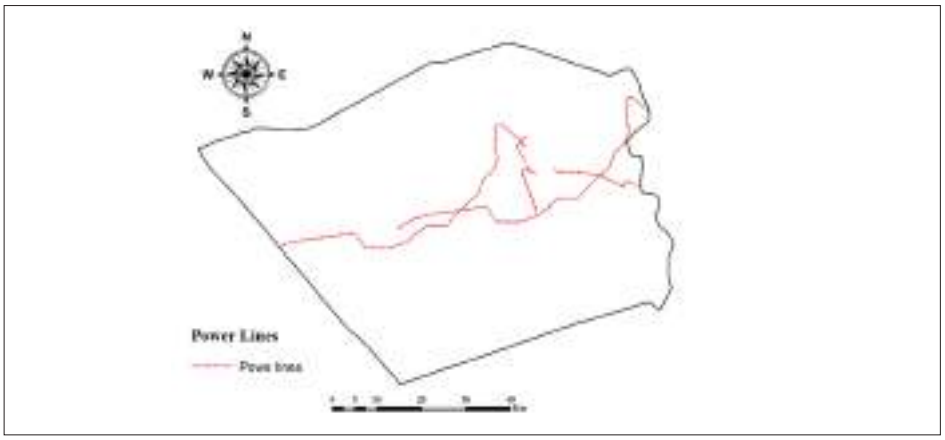

Figure 9.Major power transmission lines

3.4. Criteria Reclassify

After calculating the values of the criteria used in this study. We classify the values of the standards based on their suitability for the installation requirements of photovoltaic regulators from 1 to 5 ratings, where Rating 1 represents the least suitability and Rating 5 the highest suitability, Photovoltaic plants require at least 4 WH/m2 solar radiation for daily use and according to the efficiency of the system. Studies on the suitability the site for photovoltaic systems confirmed that the best slope values are less than <3%, but values exceeding them are Unsuitable, and the Aspect in the south and Southeast is very convenient. As for the land cover, barren lands and rangelands represent the best places to install photovoltaic plants, in addition to their proximity to energy transmission lines and Main Roads [18-20].

Table 5. Suitability rating criteria

C1	C2	C3	C4	C5	C6	C7	Rating
76619-111360	>9	Water	Flat	22-41	<1	1	1
111374-113860	7-9	Built Area/ Forest Evergreen	N, NE, NW	41.1-63	1-3	3	2
113870-115580	5-7	Crops	E, W	63.1-85	3-6	6	3
115590-117310	3-5	Rangelands	SE, SW	85.1-107	6-9	9	4
117320-125570	<3	Barren Lands	S	107.1-156	>9	>9	5

Where: C1: GHI, C2: Slope, C3: Land cover/use, C4: Aspect, C5: Elevation, C6: Distance from Power lines and C7: Distance from major roads

3.5. Criteria Rating

Pairwise comparison is essential in the use of AHP, criteria are prioritized by importance by judging them in pairs and then a pairwise comparison matrix is created. Judgments that are represented by numbers according to the Saaty scale are used for comparison[21]

Table 6.Pairwise Comparison scale

Saaty scale	Definition
1	equally important
3	moderately more important
5	strongly more important
7	very strongly more important
9	Extremely more important
2,4,6,8	Intermediate values

This method turns complex decisions into a series of side-by-side comparisons. In addition, the method allows checking the logicality of the decision, thereby reducing bias in decision-making by creating an equal comparison matrix (A), as shown by equation No. 1. If n is the number of inputs, then the size of the array is n×n

$$A = \begin{bmatrix} 1 & a & b \\ \frac{1}{a} & 1 & c \\ \frac{1}{b} & \frac{1}{c} & 1 \end{bmatrix} \qquad (1)$$

To weighting each criterion, The Matrix A is unified by dividing the elements in each column by the sum of the elements in the same column. The average of the rows in the new matrix determines the relative weights required for the criteria. The AHP includes the consistency ratio (CR), which is a parameter to evaluate the weights' consistency. To calculate the CR, the consistency index (CI) must be first Calculated (Equation (2))

$$CI = \frac{\lambda max - n}{n-1} \qquad (2)$$

Where: λmax denotes the eigenvalue of the pairwise comparison matrix, n is the number of the input criteria, In the end, the CR is calculated by dividing the CI by the random consistency index (RI). The RI values for the appropriate n values were reported by Saaty.

To obtain the value of CR, Equation (3) is used [22]

$$CR = \frac{CI}{RI} \qquad (3)$$

Table 7. The pairwise comparison matrix for the multi-criteria decision analysis (MCDA)

	GHI	Slope	Land Cover	Aspect	Elevation	Distance from major power line	Distance from main road
GHI	1	2	3	4	5	7	9
Slope	0.5	1	1.5	2	2.5	3.5	4.5
Land Cover	0.333333	0.666667	1	1.333333	1.666667	2.333333333	3
Aspect	0.25	0.5	0.75	1	1.25	1.75	2.25
Elevation	0.2	0.4	0.6	0.8	1	1.4	1.8

Distance from major power line	0.142857	0.285714	0.428571	0.571429	0.714286	1	1.285714286
Distance from main road	0.111111	0.222222	0.333333	0.444444	0.555556	0.777777778	1

Table 8.The standardized matrix and the weighted dissemination for the multi-criteria decision analysis (MCDA)

	GHI	Slope	Land Cover	Aspect	Elevation	Distance from major power line	Distance from main road	Weight
Aspect	0.09853	0.09853	0.09853	0.09853	0.09853	0.098529872	0.098529872	0.09853
Land Cover	0.131373	0.131373	0.131373	0.131373	0.131373	0.131373162	0.131373162	0.131373
Slope	0.19706	0.19706	0.19706	0.19706	0.19706	0.197059744	0.197059744	0.19706
GHI	0.394119	0.394119	0.394119	0.394119	0.394119	0.394119487	0.394119487	0.394119

Distance from main road	Distance from major power line	Elevation
0.043791	0.056303	0.078824
0.043791	0.056303	0.078824
0.043791	0.056303	0.078824
0.043791	0.056303	0.078824
0.043791	0.056303	0.078824
0.043791054	0.056302784	0.078823897
0.043791054	0.056302784	0.078823897
0.043791	0.056303	0.078824

3.6. Suitable areas

The results of suitable areas for installing solar farms had obtained by applying the Weighted Overlay tool. The results were a raster model that was classified into five categories according to the degree of suitability, as shown in Figure 10, The first category with dark green color represent the Unsuitable area (0.424565 km2) while the last category is the red color class with a high level of suitability (3.075711 km2)

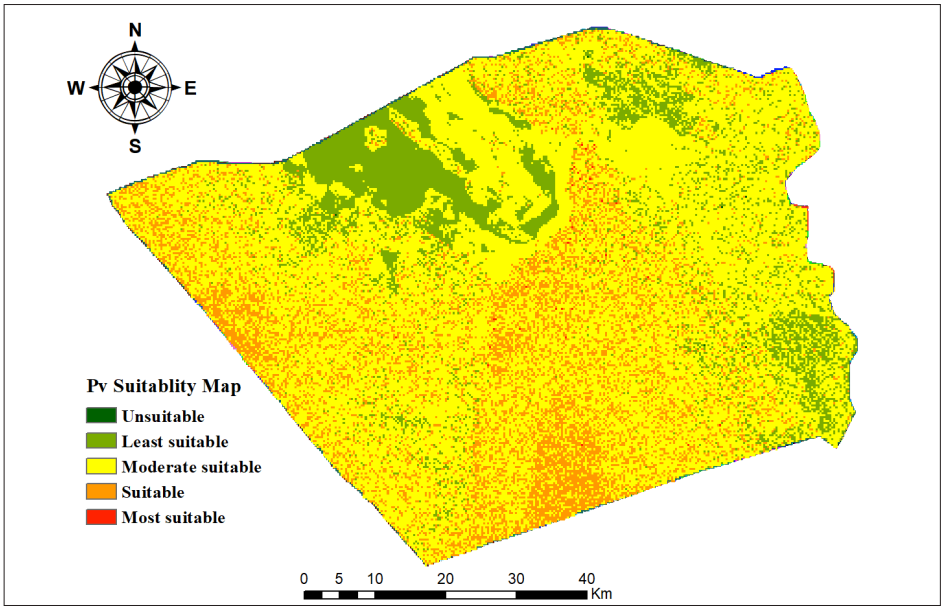

Figure 10.Results of suitable areas for installing solar farms.

Conclusion

Based on the results obtained, Karbala governorate is exposed to large amounts of solar radiation annually, which contributes to the move towards exploiting this amount of solar radiation to generate clean electric energy and reduce the environmental impacts resulting from ordinary energy sources

The results of using the solar energy project showed that the solar radiation standard, slope and type of land cover are among the most important criteria related to determining the location of solar farms

The results indicated that the most suitable areas have an area of (3.075711 km2), suitable areas (772.690359 km2) and the moderate suitable areas are (3606.027189 km2) and the least suitable area is (650.790079 km2) and finally, the unsuitable area is (0.424565 km2)

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Planning and designing sustainable paths for religious visits A proposed model for a sustainable path for the Arbaeen visitors

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Abstract

Zeyart AL-Arbaeen in Karbala is one of the most important events in Iraq to perform this religious ritual. Zeyart AL-Arbaeen in Karbala is an opportunity to strengthen the human ties between the masses participating in this visit.

Zeyart AL-Arbaeen in Karbala is characterized by the fact that it relies heavily on walking, as millions of visitors walk to Karbala for distances that reach several kilometers and take days, and the number of visitors exceeds millions, passing through many Iraqi cities and villages, through different regions, including the desert and urban areas. And within different climatic conditions due to the different seasons (such as cold and rain in winter and high temperatures in summer

Despite the importance of this visit, it faces many challenges. The research will focus on the most important challenges, which are providing the visitor's comfort requirements during his walk towards Karbala and hiking in Zeyart AL-Arbaeen.

Based on the foregoing, the research assumes that planning and designing the roads that the visitor takes with a sustainable perspective contributes to the comfort of the visitor, maintaining fitness and good health, and avoiding them fatigue and exhaustion, in order to achieve good preparation for that great religious event.

Accordingly, the research aims to propose a pedestrian road model for the visit with a sustainable perspective to improve the walking experience for visitors and ensure comfort and safety by adopting the

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concept and indicators of physical comfort. Achieving physical rest is important for maintaining general health, especially when doing strenuous physical activities such as hiking, and for improving physical and mental performance, concentration and endurance.

In order to achieve physical comfort during Zeyart AL-Arbaeen in Karbala, the following physical comfort indicators were adopted:

• Thermal comfort for the visitor: by providing shaded visit paths using afforestation, roofing and seating areas, which reduces the exposure of visitors to extreme heat in the summer. Environmental technology such as solar cooling systems and natural ventilation can be used to reduce the temperature.

• Physical comfort for the visitor: through the provision of sustainable rest stations, which include the most important services that the visitor needs with high quality and commensurate with the different groups of society and all age groups.

The analytical descriptive method was adopted in order to determine physical comfort indicators, and geographical information systems (GIS) were adopted to analyze the current situation. The results of the spatial data analysis of the current situation showed that the visitor paths achieve physical comfort indicators, and accordingly a proposal was presented for a sustainable pedestrian path model that meets the needs of visitors in terms of physical and thermal comfort, including determining the locations of afforestation as well as determining the locations of the signature of sustainable rest stations with their various spaces.

Keywords: religious visits, pedestrian road, Sustainable rest stations, Zeyart AL-Arbaeen visitors

1. Introduction

The event and the city are closely related, as cities are the sites that witness important and historical events, whether religious or non-religious, and cities bear a tangible impact of those events, including buildings, sites, statues, and souvenirs that convey those stories and events through time. And since cities are the sites of events, they play a vital role in reviving and preserving those events throughout history, and they become a destination for tourists who want to explore and learn more about those events.1)).

The nature of events varies according to their content, size, location, and the nature of their organization, and affects the nature of administrative and planning procedures at the city level, so these events are called huge events such as: religious events, international exhibitions, and major sporting events that have direct or indirect strategic effects on the host city, and the characteristics of events are (2)

1. An event that has a beginning and an end (a period of time)
1. It has a global reputation, and generates great economic effects
1. attract sustained media attention,

1. It is characterized by a large number of attendees and visitors ranging in the millions,
2. Attracts international visitors and international media coverage,
3. It is staged on a scale that justifies investment in new, purpose-built venues for the staging of the event,

which does not have a fixed site, sometimes referred to as free events or mobile events, and may be shared or competing among several cities to host or be closely associated with the site

2. Religious events

The events are related to the philosophical aspects through understanding the series of sequential and complex events that lead to the realization of its concept, the event is not considered an event unless it is related to the history of peoples and has a value transmitted through time (3). The important events that leave a material and moral impact are directly related to the place where the event took place, so many philosophers and writers point out the importance of studying events and the historical values they bear, and analyzing each event and its impact, leading to knowledge that determines its nature in which it occurred (4) ,Due to the association of religion with the beliefs of peoples, religious events, especially those immortalized in history, have become at the core of the religious and intellectual belief of those peoples, and this eternity leads to the emergence of the impact of that religious event in time and place by reviving it where it occurred, when it occurred, and how it happened, with its secondary sequential events Consecutively, this is what makes the religious event regular in well-known cities(5) .

Religious events require good planning and organization to achieve success and avoid any problems or challenges. Good planning and organization of religious events is important to improve the level of safety and public health, as plans are developed to deal with emergency incidents and provide medical services and first aid. In addition to achieving economic benefit, as religious events provide an opportunity to achieve economic benefit and attract tourists and visitors to the host city or town. Good planning and organization of religious events can provide a suitable environment for visitors, where logistics, accommodation, transportation, and public spaces for ceremonies and prayers are provided. Good planning and organization of religious events provides appropriate opportunities to participate in the religious occasion, by organizing various events and activities that suit all age and social groups.(6)

Religious events differ according to the type of event and the religion practiced, and this difference includes the religious, social, cultural and recreational goals that people seek to achieve through these events and also by the different ways of reaching the event site, some religious visits were reached to their sites by different means of transportation and some depend on walking that It gives a sense of challenge and achievement and is a unique and special experience that helps develop spirituality and closeness to God.(7)

In these visits, patience, endurance, and a good preparation for walking and physical exertion are required. It imposes physical and psychological endurance, and therefore the procedures and organization

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for these events differ. The research will focus on the religious event based on walking and the Arbaeen visit in the holy Karbala as a case study.

2.1. Religious events based on walking:

Walking religious visits are an important part of the cultural and religious heritage of many peoples in the world. These visits are a unique spiritual and physical experience, as a visitor takes long walks through wild nature and rugged roads to reach a sacred religious destination. These visits carry deep religious, cultural and spiritual meanings, as they are an opportunity for visitors to get closer to their faith and strengthen their relationship with God, as well as an opportunity to enjoy nature and contemplate God's creation. As well as the experience of community integration, learning about new cultures, and exchanging expertise and experiences. It requires visitors to exert great physical effort, enduring the weather and difficult conditions, which makes it an arduous experience, but its spiritual reward makes it an unforgettable experience. (8)

On the other hand, visitors in religious visits that depend on long walks need to prepare well to meet their physiological, psychological and spiritual needs before starting the journey, so that they can continue the long walk, enjoy an unforgettable experience and strengthen their relationship with God. Accordingly, the research will address the challenges that the visitor may face during the walking trip.

2.2. Challenges of walking religious visits:

Religious visits on foot are a form of worship that requires visitors

to be well and properly prepared to face the challenges that can occur during the journey. These challenges include many weather and natural factors, in addition to health and fitness issues. The research will address the most important of these factors:

2.2.1 cardiovascular stress:

Walking religious visits are a strenuous exercise, as the visitor needs to walk for long hours over long distances. This intense physical activity can put a strain on their heart and blood vessels. (9)

Heart rate monitoring studies conducted in order to assess the walking intensity of visitors indicated that individuals tend to walk at approximately 56 percent of their maximum intensity, and this represents a relatively low pressure on the cardiovascular system in the visitor's body. (10)

Physical stress occurs when muscles need large amounts of oxygen and food to fully function and withstand physical exertion. The heart rate increases and blood vessels dilate to provide the muscles with the necessary oxygen and nutrients. And when the physical stress continues for a long time, it can lead to damage to blood vessels and the heart, in addition to that the visitors may be within a group of different ages and genders, and thus the speed varies, as the visitors walk at the speed of the slowest member in the group, such as children or the elderly, and thus the visitor works to increase or decrease The speed depends on how hard he feels, and this affects the heart rate. (11)

Therefore, it is important to prepare well for the trip and organize

physical activity properly to avoid excessive physical stress. Visitors should take care of proper nutrition and adequate fluids, and avoid walking Severe or excessive physical exertion, and attention to necessary rest during the trip. Individuals with cardiovascular disease should also consult a physician before performing a walking religious visits.

2.2.2. metabolic stress

Metabolic stress is stress that occurs in the body as a result of intense and continuous motor activities, which deplete the energy stores in the body very quickly. This includes movement activities

It can lead to metabolic stress, intense and continuous sports activities such as running. (12)

Studies show that walking can lead to metabolic stress. The rate of metabolic stress can vary depending on the intensity of walking, the distance traveled, the time spent walking, the terrain intensity, and the body load. Visitors to religious events tend to walk long distances. This presents a significant physiological challenge, not only in the form of cardiovascular stress, but in metabolism or energy. However, it can be estimated that the visitor almost doubles his daily calorie expenditure during Average day of walking. To maintain this level of metabolic activity, visitors must significantly increase their daily caloric intake. Studies have indicated that the human brain is particularly vulnerable to changes in energy balance. As a result, feelings of hunger may elicit a specific physiological and psychological response that deepens the perceived spiritual experience by improving internal perception.

Therefore, feelings of hunger may require the visitor to be more aware of the body and its underlying limitations.

2.2.3.muscle stress

Walking can be a source of muscle strain if done excessively or irregularly. Studies show that muscular stress can lead to muscle tears, joint sprains, muscle pain, fatigue and exhaustion, and may increase the risk of sports injuries and arthritis. (13)

Perhaps the greatest stress on a visitor's body during a religious visit on foot is the constant and repetitive stress on the musculoskeletal system. Most people are not accustomed to walking for four to six hours a day, let alone doing it continuously for days. As a result, visiting on foot greatly stresses the musculoskeletal system, which triggers a physiological response followed by either adaptation or injury. Studies indicated the relationship between the weight carried by the visitor and muscle stress, as the extra load carried by the visitor on foot leads to injuries to the tendons, joints and skin, and represents the most likely reasons for the visitors to stop, either to rest and recover, or to end their journey. (14)

2.2.4. environmental stress

Another factor to consider regarding the physical challenges associated with religious walks is the environmental conditions the visitor may encounter, including changes in temperature and increased exposure to sunlight. Heat and cold are physiological stressors in their own right. Heat is generated while muscles are working, and when outside temperatures are also high, this can put extra stress on the body. (15)

2.2.4.1. Hyperthermia

Studies show that high temperatures can affect overall health and increase the risk of heat exhaustion, dehydration, skin infections, headaches, and dizziness. The primary mechanism of thermoregulation by the human body is sweating and the resulting evaporative heat loss. Sweating without adequate fluid intake leads to physiological stress in the form of dehydration. Thus the visitor can experience significant fluctuations in body temperature and body water levels. (16)

Exposure to such environmental stress may be another factor that alters the public perception and spiritual experience of visitors. Hyperthermia leads to a decrease in cognitive function. It is important to distinguish between passive (environmental) and active (exercise-induced) hyperthermia, although exposure to hyperthermia may present a potential risk, it is important to note that the visitor will likely experience an adaptive response to repeated heat stress and acclimation to the environments warm. This acclimatization usually leads to an improvement in thermoregulatory function through body water retention and improved perspiration. (17)

2.2.4.2. Natural light

The sun's brightness during walking religious visits can affect public health, as direct exposure to the sun increases the risk of sunburn, dehydration, exposure to heat stress and other health problems.(18)

One environmental factor to consider when visiting on foot is exposure to natural light. Studies show that the average time spent outdoors on weekdays is much less time than in the experience of visiting. Increasing the time you spend outdoors can be both harmful and beneficial. Scientific studies have indicated that exposure to ultraviolet rays can lead to skin damage. The beneficial effects of sun exposure are the production of vitamin D. Another benefit as a result of increased exposure to sunlight is improving mental health, as many studies have shown that natural light improves anxiety and depression. (19)

Based on the challenges that the visitor faces during the religious visit, there are requirements that must be balanced among them, some of which are related to the visitor himself, and this requires visitors to have good physical and health fitness. Including those related to other parties that work on appropriate planning and organization to ensure the safety of visitors and provide them with the necessary comfort and supplies. Therefore, the research concludes a group of factors that should be studied and taken into account when planning and organizing religious visits that depend on walking. The most important of these factors are:

1. Distance and duration: The distance traveled, the duration of

the trip, and the time it takes to reach the religious site must be studied. This requires calculating matters related to weather conditions, natural obstacles, and geographical distances.

1. Culture and Traditions: The culture and traditions associated with walking religious visits should be studied, and ensure that these traditions are respected and appropriate religious norms are followed.
2. Health and physical fitness: The health and physical fitness of individuals who intend to perform religious visits that rely on walking must be studied, and to ensure that individuals are able to withstand the physical effort associated with these visits. Nutrition and health care experts can be sought to provide appropriate advice and guidance.
3. Security and Safety: Security and safety related to religious visits that rely on walking should be studied, and necessary measures taken to ensure the safety of visitors and protect them from potential risks
4. Spirituality and psychological impact: The psychological and spiritual impact of religious visits that rely on walking should be studied, and ensure that visitors have a positive and enjoyable experience and improve the experience of religious visitation.
5. Protection from challenges related to the environment: reducing heat and providing shade, as well as improving aesthetics and air quality.

Based on the above, the research proposes applying the concept of sustainable pedestrian streets as well as sustainable resting stations, achieving the factors that explain the importance of these religious visits, improving their organization and planning, and providing the

appropriate conditions for visitors to achieve a positive and satisfactory experience during these visits. There is evidence that the lack of proper planning for the management of religious visits can cause negative economic impacts affecting the general welfare of the local community (20). The World Tourism Organization noted in (in 2017) that sacred destinations urgently need to be carefully managed to preserve authenticity and integrity while making them accessible to all.

3. The indicators reached by the research to develop a sustainable pedestrian path

The research proposes applying the concept of sustainable pedestrian streets as well as sustainable resting stations as the research will explain in its subsequent paragraphs.

3.1.sustainable pedestrian streets

3.1.1. Walking and urban walkability:

Walking is the oldest form of urban transportation in the world, and until the advent of modern modes of transport in the nineteenth century, most cities relied on walking as a means of transportation and supported the possibility of walking in their plans. (21)

Walking is defined as a short-term movement from one place to another. Walkability is a concept defined as measuring the degree of suitability of walking in a given area. Walkability reflects the general conditions in an area, such as the quality of pedestrian facilities, road conditions, land use patterns, walking comfort, community support, and safety. (22)

With the adoption of the concept of urban sustainability in city planning, walking again has become an important means of sustainable urban transportation. The reason for the renewed interest in urban walking is the fear that car-dependent cities will not be sustainable in the future, due to energy costs, fuel consumption, air pollution and other environmental impacts.

3.1.2. Sustainable pedestrian Streets:

Lynch defines movement paths in general as longitudinal channels through which a person can move, so the various elements of the city can be perceived and a visual image can be formed, and they are also means of movement and transition between parts of the city and linking its elements. Streets, roads, pedestrian paths or railways (23)

The world's greatest cities are fun and safe to walk in, resulting in less driving and better public health. It is the most option that any person from all classes of society can make to move from one place to another, and it does not require paying money for transportation or waiting in crowds for hours on a road crowded with cars. The importance of walking is highlighted in that it is a clean and easy process for the infrastructure, healthy for the individual, and an integral part of the community's life. (24).

The western city is characterized by a free and safe pedestrian zone in the downtown area, where the main center of the city is and the meeting point for pedestrians, whether local or foreign. We find that the urban planner and designer deposited the pedestrian areas in these areas with all the elements: "beautification", "coordination",

"pleasure", and "creativity».The implementation of the planning theories for the pedestrian movement network has met with success in many cities of the world. It is noted that all large cities, which are rushing towards regaining their status, are equipped with a special system for pedestrians, so pedestrian zones have become the main base in Western countries. Therefore, the theoretical distance to the center is determined by the duration of the pedestrian's transition from one point to another, within the limits of not more than ten minutes. (25)

3.1.3. Principles of sustainable planning for pedestrian streets:

For a pedestrian network to be comfortable it must make the walking experience pleasant and appropriate, comfort is related to the emotional reactions of the pedestrians, and this dimension is mostly influenced by the features of the pedestrian infrastructure. This includes variables such as the characteristics and condition of sidewalks and remaining pedestrian infrastructure, presence of obstructions on sidewalks, street trees, street furniture, slopes, lighting and other elements of pedestrian street planning. (26)

When planning pedestrian streets, the following principles are observed: (27)

- Connectivity
- (Legibility)
- Sustainability
- Safety
- Accessibility
- Permeability

These principles benefit the built environment and the natural environment and work to achieve a balance between them

3.1.4. Sustainable planning and design principles for pedestrian streets:

When planning and designing pedestrian streets, and in order to overcome and solve the climatic challenges faced by the participants on foot in Zeyart AL-Arbaeen, which were previously explained, the following design principles must be followed: (28)

First: providing shade and reducing the air temperature

The pedestrian's thermal comfort is a major factor in choosing walking as a mode of transportation. The streets and pedestrian paths in traditional Arab architecture were narrow and shaded by buildings, and when the need for additional or temporary shade arose somewhere, the solution was to create umbrellas of wood or cloth to extend over areas of the street adjacent to the buildings, especially in those areas where it was concentrated Pedestrian activity, which creates a comfortable environment for them. In modern cities sustainable solutions offered by urban designers include roofing, use of awnings, sunshades and tree-lined walkways.

Second: Reducing the effect of heat islands:

Thermal comfort in densely populated areas is not only affected by the local climate, but also by the effects of additional heat resulting from the urban effect of heat gained due to sunlight or what is called urban heat land, which is simply the storage of roofs and streets in the city for the heat generated from the sun and its release in the evening. An effective reduction in the urban footprint of heat gain can be achieved through:

-Architectural or floor elements constructed with materials that retain and radiate less heat.

- Negative shading measures that reduce the exposure of pavement and wall surfaces to the sun and increase air circulation see figure (1)

-Trees adapted to the environment and green spaces to reduce ambient temperatures, such green spaces can cause a psychological sense of cooling . see figure (2)

Unused ground surface areas should not be paved and their components of exposed gravel, crushed granite, stabilized sand or stabilized soil should be left.

figure (1) Negative shading

figure (2) Trees and green spaces

Third: shadow paths and shadow spots

The design of street spaces should enhance the degree of thermal comfort by establishing a network of safe, comfortable and constantly shaded paths, and accordingly, pedestrian walkways must be shaded by buildings, trees, or other acceptable means.

Shade paths and main shade spots should include not only shade, but green spaces, pedestrian resting furniture, and other elements in an organized manner.

Fourth: Lighting

Adequate lighting helps reduce the threat of harassment and criminal activity, thus encouraging trekking. The standards for street lighting and the distance between poles differ from one country to

another, and depend on many factors, such as: (29)

1. Road type and surrounding uses: The road type and surrounding uses can affect the lighting requirements and the distance between the pillars. For example, highways can need more powerful and more frequent lighting than internal roads.
2. Environmental and health standards: Street lighting must meet health, safety and environmental protection standards, by providing lighting in a way that reduces carbon emissions and light pollution.
3. Technical Standards: Street lighting must meet technical design and installation standards, including quality, durability, safety and easy maintenance.

The distance between the columns in street lighting is usually determined based on the level of lighting that is provided, and this is done by determining the number of columns that the road needs to provide the required lighting. Usually, a distance of 25 to 50 meters is provided between each lighting pole in the main streets, and less than that in the less crowded roads. The exact distance is usually determined based on local needs and technical and environmental requirements.

Fifth: Afforestation:

Afforestation on both sides of walking paths is a design necessity to provide shade, reduce air temperature, and provide comfortable walking paths for pedestrians, in addition to other environmental

benefits such as providing oxygen, absorbing carbon dioxide, and providing shelter for birds and other living creatures.

The following standards must be adhered to when planting pedestrian walkways (30)

1. The distance between one tree and another should not be less than (48-) m in internal streets and not less than (1012-) m in highways.
2. Adaptation of plants to local environmental conditions.
3. Plants planted in the streets should be of a species that bears the environmental conditions of the region and is resistant to diseases, insect pests and environmental pollution factors.
4. Cultivation of the inner streets of cities is carried out according to what the specialists see for each case separately, and it is better that the sidewalk width is not less than 3 m. Regular established trees must be selected for afforestation.
5. That the nature and size of plants grow in proportion to the size and nature of the street and the conditions of the site in which it is grown and the fixed facilities surrounding it, so that the branches of trees are not subject to entanglement with wires and other things, and therefore standing or tent trees that are spread are chosen according to the conditions of the street.

When selecting these trees, whether they are local or imported species introduced years ago, they must have the following characteristics:

1. To be a perennial species that has a high ability to withstand the local environmental conditions of the area in which it is grown

in terms of high and low temperatures, drought, winds, salinity, and others.

2. To have a high resistance to insect and disease pests or snake worms.
3. To be fast, densely growing and abundantly branching.
4. It should have a strong root system that is in-depth and not spread horizontally so that it does not impede the growth of other plants and does not affect neighboring facilities and does not block sewage or drinking water pipes.

Sixth: physical rest

In order to achieve the physical comfort of pedestrians, the following indicators must be achieved: Designing paths for pedestrian movement, with special mention of the activities of value engineering (31)

1. Adequate walking space, no obstacles in the path
1. Good surfaces
1. Attractive places to stand or sit

3.2.Sustainable rest stations:

A rest station is defined as a place intended to provide rest and relaxation for people who are on a long journey or doing a strenuous activity. Rest stops are often available on highways, main roads and in places where travel is common. Rest stations usually contain a set of facilities and services that help provide rest and relaxation for people. (32)

Rest stops are very important to public health and safety, as they help reduce tiredness and stress caused by a long journey, and help provide a safe and comfortable place before continuing the journey. The characteristics of rest stations differ according to the different countries, regions and the purposes for which they are provided, but in general, rest stations are characterized by a number of common characteristics, among which are:

1. Providing comfort and relaxation: Rest stations include a group of facilities that help provide comfort and relaxation for people
2. Availability of sanitary facilities: Rest stations provide sanitary facilities such as bathrooms, toilets and other hygiene facilities.
3. Availability of food and beverages: rest stations include restaurants, canteens, supermarkets, drinks and snacks.
4. Availability of fuel stations: Fuel stations are available at rest stations, and fuel stations provide services related to cars and trucks
5. Availability of stores and entertainment services: Some rest stations provide stores and entertainment services such as gaming halls, electronic games and children's parks.
6. Provide spaces for green rest: Green spaces are available in some rest stations to provide spaces for rest, relaxation and enjoyment of nature.
7. Availability of safety and security: rest stations provide safety and security for visitors, as they are characterized by the presence of surveillance, guarding, good lighting, and first aid facilities.
8. Availability of tourist information: Some rest stations provide tourist information about the area, nearby attractions, and

places to visit.

3.2.1. rest station for religious visitation pedestrian routes

Resting areas are important places for religious visitors, where they can rest and relax after worshiping and energize. And since the characteristics of the rest stations differ according to the region and the purpose of establishing the station, therefore, the visitors rest station can extract its characteristics and activities from the challenges facing the visitor, which were previously extracted

Characteristics and events of the station	The challenge the visitor faces
Characteristics and events of the station The presence of public bathrooms designed in a way that suits all genders, age groups and people with disabilities	Health and fitness
Provide a healthy food and drink space to avoid dehydration and heat exhaustion	
Providing space for first aid	
Providing space for awareness lectures on the importance of fitness and health	
A space to rest and sleep	
A space to provide the basic needs of the visitor, such as strollers for the elderly and other equipment that eases the load	
Surveillance, guarding and good lighting space	Safety and Security

An educational and awareness space about the religious event and tourist information about the area, nearby attractions and places to visit	Culture and traditions
It includes spaces that are linked between the inside of the station and the outside reality, such as gardens and enjoying nature.	Spirituality and psychological influence
A place of prayer	

3.2.2. Standards for distances between resting stations for religious visits

There is no set standard for the distances that should be between resting stations for religious visits, as these distances vary according to the location, circumstances, and the needs of visitors. It is important to consider the following factors when planning and designing rest stations

1. The distance between the religious monuments: there should be resting stations near the main religious monuments and at an appropriate distance between them, to provide a place for visitors who need to rest between the monuments.
2. Population density: The number of rest stations must be commensurate with the population density, and it must be available in places frequently frequented by visitors.
3. Type of visitors: The type of visitors and their special needs, such as people with disabilities or people suffering from heat exhaustion, must be considered, and appropriate resting stations should be provided for them.
4. Weather conditions: Possible weather conditions in the area,

such as high temperatures or heavy rain, must be considered, and appropriate facilities should be provided for those conditions.

5. Transportation: The means of transportation available to visitors must also be considered, and the provision of rest stops on the main roads and sites that can be easily reached. In general, rest stops should be evenly provided along the route, and optimal distances can be determined based on these factors and the needs of visitor.

3.2.3. Sustainability of the visitor rest station

Designing a sustainable resting station for visitors who make religious visits requires consideration of many important factors that contribute to improving and preserving the environment, and providing a comfortable environment for visitors. Renewable energy, environmentally related designs, recycling, community awareness), the factors are:

1. The use of sustainable materials: the use of sustainable materials in the construction of the rest station, such as materials that have a certificate of good environmental performance, and recyclable materials, which reduce the environmental impact.
2. Renewable Energy: The use of renewable energy, such as solar and wind energy, to generate electricity and operate the necessary facilities at the station.
3. Environmental design: The resting station must be designed in an environmental way, such as using natural lighting and natural ventilation, and designing green gardens and outdoor areas to reduce temperatures in the summer.
4. Water and sanitation: Providing a system for recycling the water

used in the resting station, and providing a sustainable sewage system to collect organic waste and convert it into organic fertilizer.

5. Education and awareness: educating visitors about the importance of preserving the environment, rationalizing the use of natural resources, and maintaining cleanliness at the rest station.
6. The environmental and social impact: The environmental and social impact of the rest station must be studied, and the necessary measures should be taken to reduce it, such as reducing noise and environmental pollution.

Designing a sustainable resting station for religious visitors helps preserve the environment and provide a comfortable environment for visitors. This can be achieved by taking the necessary measures to improve and preserve the environment, and by providing comfortable and high-quality facilities for visitors

Zeyart AL-Arbaeen is one of the largest annual religious events in the world. It is held over several days in Karbala, Iraq, with nearly 20 million visitors from Iraq and other countries. This visit has brought about unique reflections on the human spirit and psyche in all respects, because this sacred ritual inspires spiritual attraction to the memory of Imam Hussein, peace be upon him, in particular, and to his companions. Notables are general. Accordingly, the indicators will be implemented within the practical framework that will be discussed.

4. Study area:

Zeyart AL-Arbaeen Street of Karbala visitors that extending from Baghdad city to Karbala city has been selected as a study area, its length is 85 km, and its width is 10 m. The street passes through three governorates represented by (Baghdad, Babylon, and Karbala) through many cities represented by (Al-Rasheed - Al-Mahmudiyah - Al-Latifiya - Alexandria - Al-Musayyib - Al-Hussainiya) to reach Karbala city. Map (1) shows Arbaeen street location from Iraq and its governorates, with an indication of the cities it passes through.

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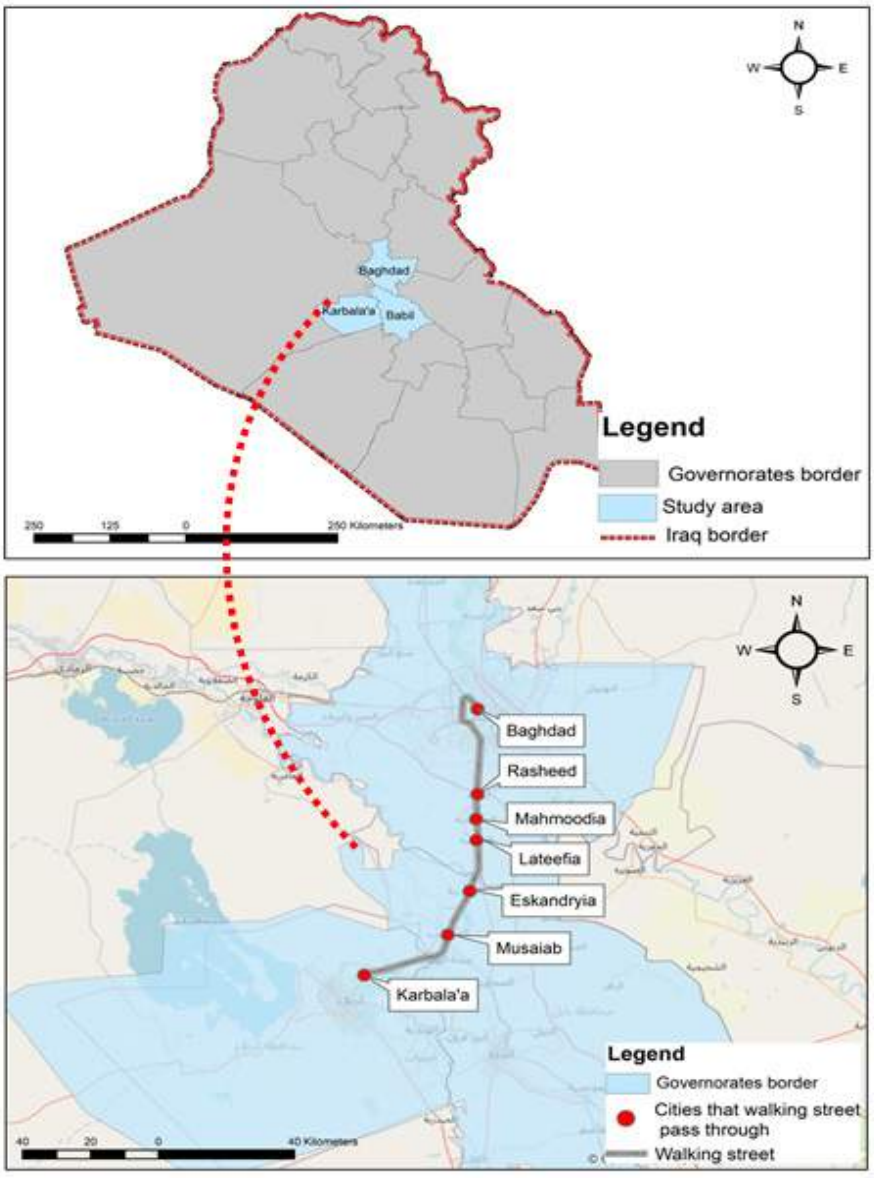


Map (1) shows Arbaeen street location from Iraq and its governorates, with an indication of the cities it passes through.

Source: Researcher depending on satellite visible images and GIS software

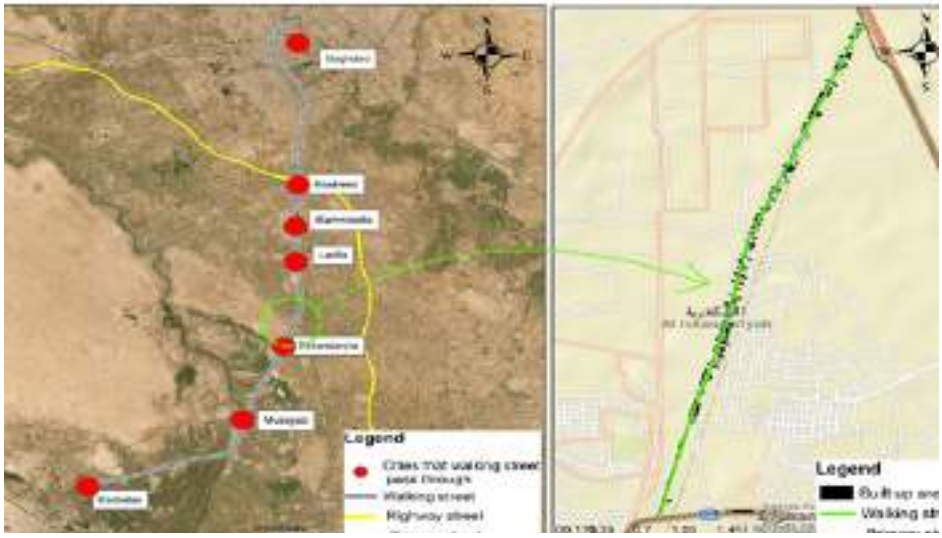
Arbaeen Street of Karbala visitors take a parallel location to the railway line and the primary street, Map (2) shows the location of Arbaeen street from cities master plan and from the other kinds of streets.

Map (2) shows Arbaeen street location from cities master plans and the other kinds of streets.

Source: Researcher depending on satellite visible images and GIS software.

4.1. existing status of street

The part of Arbaeen Street, which will be the scope of the study, is located within Alexandria district, The study of current status for this part is based on visible satellite image and GIS software. The street extends for a distance of 5 km, with a width of 10 m. It is specified for pedestrians only, with no cars passing through it. It is 30 meters away from the railway and 1 km from the primary street. On both sides of the street there are a number of buildings that represent small mosques, places to serve food and public bathrooms in random buildings that lack planning and design and at a level that does not achieve adequate service and comfort for visitors.



Map (3) shows the location of the part to be developed, while Fig (1) shows its existing state.

Source: Researcher depending on satellite visible images and GIS software

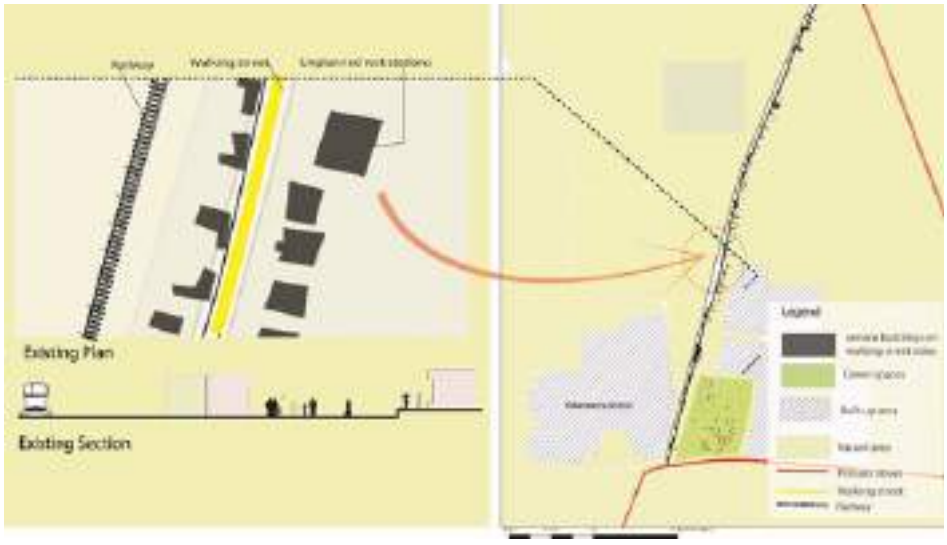


Fig (1) shows the existing state of the part to be developed.

Source: Researcher depending on satellite visible images and GIS software

4.2. The development proposal for Arbaeen Street

After studying the existing state of the street and its services, it was found that it does not meet the comfort of visitors in terms of environmental comfort, security, and safety, in addition to the lack of planning and design of its facilities. Therefore, several proposals were presented to re-plan and design the street, as follows:

1. Removing the current service buildings and replacing them with sustainable rest stations that extend along the street and are 600 km away from each other, consisting of basic services needed by Arbaeen visitors with a unified design that is in harmony with the religious occasion to provide visual and psychological comfort.
2. Adding shading roof and seating, which contributes to alleviating the physical burden on the visitors of Arbaeen, while providing several garbage bins at a close distance from each other in order to maintain the cleanliness of the street.
3. Afforestation of the sides of Arbaeen Street and the sides of the railway, with the planting of vacant spaces and increase green spaces area, to reduce temperatures, which contributes to psychological comfort for visitors. Fig. (2) shows the development proposal for Arbaeen street.

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Fig. (2) shows the development proposal for Al-Arbaeen street.

Source: Researcher depending on satellite visible images and GIS software

5. Conclusions and recommendations

Conclusions:

The research reached several conclusions, the most important of which are:

1. The Arbaeen visit to Karbala is characterized by the dependence of the visitors on a very large percentage of their access to Karbala on foot, a journey that lasts for days, and most of the roads that the visitors take lack the planning and design requirements that meet their needs and provide them with physical comfort and protection from climatic factors.

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2. As a result of the huge number of pedestrian visitors and the long distance, there is a need for suitable places to rest.
3. Hiking can cause serious health effects and problems in the absence of preventive measures and logistical services for visitors.
4. The pedestrian visitors of Arbaeen suffer from the harsh climatic factors in summer and winter as a result of the lack of climatic treatments necessary to mitigate the severity of the impact of these factors.
5. The service processions of the Arbaeen pedestrians spread along the pedestrian roads randomly and are not based on planning rules and standards, which causes wastage and waste of efforts due to their lack of the necessary infrastructure to meet the needs of visitors in terms of services, places of rest, sleep and logistical services because they depend on the efforts and initiatives of people.

Recommendations:

1. Because the Arbaeen visit and other large visits take place on various religious occasions and continue during the year and in several cities, it needs a comprehensive planning view to organize the current walking paths and rehabilitate them and create new paths to accommodate the increasing numbers of visitors and secure their movement within safe paths designated for walking and isolated from Vehicle tracks.
2. Creating a formation that includes a team of specialists in urban and regional planning, urban design, and other necessary

disciplines, to undertake the task of planning and designing walking paths according to the principles of sustainability.

3. Paying attention to planting the internal and external roads in the Iraqi cities in general, and the roads that connect the city of Karbala with the rest of the Iraqi cities, in order to provide shade and mitigate the effect of the high summer heat.
4. With regard to the proposed sustainable rest stations, the research suggests that they be of two types, permanent and temporary. The permanent ones can be used throughout the year as rest stations for travelers on these routes. The temporary ones are mobile stations that can be used in different places at the time of religious and social occasions and events.
5. The need to establish special organizations working on and educating the users of the pedestrian roads on the principles of preserving the environment and material assets within the road and respecting the environment and preserving it from all kinds of pollution and tampering.
6. Develop future plans to develop the Arbaeen pedestrian paths according to the research proposals and the needs of the pedestrians, and provide these paths with the requirements of comfort and safety for visitors, and provide feedback to assess the stages of implementation of these plans and the extent of their success.

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Spatial Analysis and Site Allocation for Solar Energy Systems in KarbalaUsing GIS-Fuzzy AHP

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Abstract

Solar panel systems installation is critical for increasing energy production and advancing sustainable development ,especially in locations where there are millions of people converging for the Ziyarat Al-Arbaeen .In this work ,we use the GIS-Fuzzy Analytical Hierarchy Process) AHP (approach to pinpoint the ideal locations in Karbala ,Iraq, for solar panel installation and to reduce the difficulties encountered by Visitors during the Ziyarat Al-Arbaeen and provide a reliable electricity supply to the governorate of holy Karbala throughout the year .In order to assist decision-makers in choosing solar panel sites, our thorough analysis considers a variety of traits and factors ,including land cover ,solar radiation ,slope ,water bodies ,road infrastructure, and buildings .We classify land cover and examine changes using GIS techniques to present a thorough picture of the present land use patterns and infrastructure layout in Karbala .Fuzzy logic is used to choose the best places for installing solar panels based on these parameters. In order to assure optimal energy generation ,solar radiation analysis helps locate areas with greater sun irradiance levels .Finding the best sites for panel alignment and placement is aided by slope analysis. To comprehend possible shading or cooling impacts on photovoltaic)PV (performance ,the link between land cover and water bodies is assessed .In order to enable quick access and reduce shadowing, building presence and road infrastructure are also taken into account. The results of our analysis are aimed at reducing the difficulties that the numerous Visitors encountered during the Ziyarat Al-Arbaeen

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in Karbala .We can significantly improve the services and facilities available to the pilgrims ,easing their burdens and improving their overall experience ,by identifying areas with favorable land cover, increased solar radiation levels ,moderate slopes ,safe distance from water bodies ,easy access to roads ,and minimal building shading. This study offers a systematic and thorough way to help guide the site selection process by utilizing the GIS-Fuzzy AHP technology, with an emphasis on specifically enhancing the circumstances for the Ziyarat Al-Arbaeen .The findings encourage the effective use of solar energy sources ,furthering environmental and renewable energy projects while also increasing the Visitor experience for millions of visitors.

Keywords: Solar panel siting ,GIS ,Fuzzy AHP ,Ziyarat Al-Arbaeen, land cover ,solar radiation ,slope ,water bodies ,road infrastructure, buildings ,Karbala ,Iraq.

1. Introduction

The choice of the best location for the installation of solar panels is an important choice that may have a big impact on the system's efficacy and efficiency. Solar irradiation, temperature, and other environmental elements all have a significant impact on a solar panel's performance [1]. To guarantee the selection of an appropriate site that optimizes solar energy output while reducing potential barriers and inefficiencies to the system, significant thought and study must be put into it sun panel energy production is greatly influenced by sun radiation.

So, in order to optimize energy production, it's crucial to pick a site with lots of solar radiation. Additionally, a suitable site must be chosen in order to conduct feasibility studies like technical and economic feasibility in order to make the most of the solar panels' performance [2]. A number of earlier academics have looked at the best ways to use slope angle relationships and take installation location into account while choosing a site for solar panels. Researchers have put out a number of theoretical models that account for variables like latitude and solar energy generation to determine the best slope angles. For photovoltaic panels to produce the most solar energy, the best slope angle must be chosen. However, because multiple techniques and empirical models were employed to determine the ideal slope, there is a large discrepancy between the optimal tilt angles values published in the literature. The fuzzy Analytical Hierarchy Process is one method that has been utilized to tackle this site selection issue.

In order to deal with the inherent uncertainty and ambiguity in site selection decision-making, the fuzzy Analytical Hierarchy Process (fuzzy-AHP) combines the concepts of fuzzy logic and the Analytical Hierarchy Process. By considering a number of factors and their respective weights, the fuzzy-AHP methodology helps to get beyond the drawbacks of conventional site selection techniques.

With this approach, it is possible to take into account both quantitative and qualitative elements, such as solar radiation levels, accessible land area, geography, proximity to infrastructure and transmission lines, environmental effects, and societal acceptance.

Using fuzzy-AHP, decision-makers may rank these criteria in terms of priority and evaluate them accordingly. They can then choose the best location for the installation of solar panels based on a thorough and impartial analysis of all pertinent elements. The fuzzy-AHP method also enables decision-makers to take into account the opinions of experts and their own personal preferences. The fuzzy-AHP technique enables decision-makers to more precisely convey their subjective judgments by utilizing linguistic factors and fuzzy membership functions. This lessens the chance of prejudice and guarantees a fair and impartial decision-making process while enabling a more accurate and thorough study of site choices [2].

Several research on solar panel site selection have successfully used the fuzzy-AHP technique. For instance, a research carried out in Belgium examined the effectiveness of photovoltaic solar systems using climatological variables, panel orientation, and density [3]. The best location for these installations was chosen using the fuzzy-AHP approach, which took into account factors including solar radiation levels, shading effects, and the amount of space that was available at each candidate location.

Another Taiwanese research that employed the fuzzy-AHP technique to choose appropriate sites for the installation of solar panels did so by taking into account variables including available land cover space, solar radiation levels, and proximity to the infrastructure that provides power [4]. In order to efficiently analyze and prioritize these criteria, the fuzzy-AHP approach was also employed to include the

preferences and expert views of the experts. These illustrations show how the fuzzy-AHP method may effectively overcome some of the drawbacks of conventional site selection techniques.

The AHP technique now includes fuzzy set theory, enabling a more reliable and adaptable method of site selection. The decision-making process is made more adaptable and able to handle the ambiguities and uncertainties related to site selection criteria by using fuzzy logic.

This is especially true when choosing a location for solar panels because variables like weather and regional variance may create a lot of uncertainty. Additionally, the fuzzy-AHP method gives decision-makers the ability to handle several criteria and their interactions at once. This is essential when choosing a location for solar panels since there are so many factors to take into account, including solar radiation levels, shading effects, available space, the distance to power infrastructure, and environmental consequences. The fuzzy-AHP approach may be used to evaluate both physical and intangible criteria since it can incorporate both qualitative and quantitative data. The fuzzy-AHP technique also takes into account the preferences and viewpoints of the experts who are participating in the decision-making process.

This is significant when choosing a solar panel installation location since professionals may offer insightful information about the precise conditions needed for installation success. The fuzzy-AHP technique offers a thorough and adaptable framework for choosing a solar panel site.

It considers the complexity and unpredictability involved in the decision-making process, enabling a more precise and informed choice of suitable places.

The fuzzy-AHP method combines the advantages of fuzzy set theory and the Analytic Hierarchy Process to address the challenges faced in solar panel site selection [5]. It integrates fuzzy set theory into the AHP method, allowing decision-makers to assign weights and perform pairwise comparisons based on their expert opinions. The decision-making process may be made more flexible to the ambiguities and uncertainties connected with site selection criteria by employing fuzzy set theory.

2. Solar Power Panel Installation Systems in Karbala to Serve the Masses of Visitors

The installation of solar energy systems in Karbala, Iraq, is a critical step towards reaching renewable energy targets and lowering reliance on fossil fuels. Iraq has the potential to lead the area in solar power production due to its good weather for solar applications. Numerous studies have been done on the impact of weather conditions on solar energy applications, according to academics in Iraq, and these studies have given important insights into the viability and efficiency of solar power panels in Karbala and other parts of Iraq [6].

Furthermore, Karbala's latitude of 32.61°N, which receives plenty of sunshine all year round, makes it a great position for the production of solar electricity. The performance of solar collectors under transitory circumstances has been examined in experimental tests carried out

in Karbala. These research' findings suggest that the tilt angle of solar collectors has a big impact on how well they work. Increased effectiveness and energy production may be obtained by adjusting the tilt angle in accordance with the latitude and the weather. Additionally, Karbala enjoys a year-round sunshine duration of about 3,000 hours and daily average solar radiation of up to 6.5-7 kWh/m2.

Karbala is a desirable location for the installation of solar panels due to its high solar radiation potential, plenty of sunlight, and agreeable weather. Iraq has made tremendous progress in developing renewable energy in addition to its good weather. But it's crucial to recognize the difficulties Iraq will confront in utilizing its solar energy potential. The country's hot environment makes it difficult to successfully use photovoltaic technology to harness solar energy. The performance and efficiency of solar panels may be impacted by the high temperatures, thereby creating thermal management problems. Additionally, Iraq's history of war and political instability, together with issues with planning and execution, have made it difficult to use solar energy resources effectively [7].

Despite these obstacles, installing solar energy systems in Karbala, Iraq, has enormous potential for the nation and its people. In Iraq's Karbala, purchasing solar energy systems can offer a number of advantages and prospects. Reducing reliance on fossil fuels, supporting energy security, minimizing the consequences of climate change, and boosting economic growth by creating jobs in the renewable energy industry are a few of these objectives. Iraq's ambition to

become into a producer and exporter of solar energy can be furthered by the installation of solar power plants there. Additionally, Iraq's geographical distribution of solar irradiance suggests that the whole nation has a wealth of solar energy resources [8].

This means that solar power panels may be installed in numerous areas around Iraq, increasing the nation's capacity to produce solar energy [8]. Solar energy provides services through solar power systems that can meet the demands of the many millions of Visitors that visit Holy Karbala during the Ziyarat Al-Arbaeen, in addition to offering the governorate a dependable energy supply all year long. In addition to powering electric refrigerators, these services also include providing energy for restrooms, kitchens, lighting, cooling, and irrigation systems. In conclusion, Iraq's vast solar energy potential makes it an attractive place for the deployment of solar power panels, especially in Karbala, despite the difficulties posed by the environment and political unrest.

3. Methodology

3.1. Fuzzy-AHP Method for Solar Panel Site Selection

The choice of a solar panel installation site involves making a number of difficult decisions and managing many variables. A strong foundation for addressing these issues and assisting in sensible site selection is provided by the Fuzzy Analytic Hierarchy Process (Fuzzy-AHP) technique. The Analytic Hierarchy Process (AHP) and fuzzy logic are combined to create the Fuzzy-AHP technique, which gives decision-makers a systematic way to manage ambiguous information and include subjective judgements [9].

The Fuzzy-AHP technique starts by identifying pertinent standards for choosing solar panel locations. Solar radiation, land availability, shading analysis, geography, accessibility to infrastructure, and environmental restrictions are a few examples of these criteria. The relevance of each criterion is expressed by verbal values or fuzzily defined figures, which represent the subjective assessments of decision-makers. This accommodates the amorphous character of decision-making and enables a more flexible depiction of preferences [9].

The relative relevance of the criteria is then assessed using pairwise comparisons. Using language phrases or fuzzily defined figures, decision-makers rank the relevance of each criterion in relation to the others. These conclusions are transformed into fuzzy numbers using the Fuzzy-AHP approach, which captures the fuzziness and imprecision present in subjective evaluations. To make sure the pairwise comparisons are coherent and to correct any errors, consistency checks

are carried out [10].

Following the completion of the pairwise comparisons, the Fuzzy-AHP approach determines the priority weights for the criterion. To acquire precise numerical values, the pairwise comparison results' fuzzy numbers are combined and defuzzified. The fuzzy numbers are defuzzed using techniques like the centroid or alpha-cut approach to provide useful priority weights. The relative weights of the factors in the site selection process are represented by these weights.

The Fuzzy-AHP approach examines and ranks prospective locations for solar panel installation after prioritizing the criteria. Each site is evaluated in relation to the predetermined standards, and decision-makers give each option verbal values or fuzzy numbers to represent how suitable it is. Defuzzification is used to convert the ratings into clear numerical values, enabling a quantitative comparison of the options. Decision-makers can choose the best places for installing solar panels by sorting the sites based on their total ratings [10].

Sensitivity analysis is done to determine how reliable the decision model is. Decision-makers can comprehend the effects of uncertainty on the site selection process by modifying the judgements and monitoring the variations in rankings that occur. By identifying and fixing any discrepancies in the pairwise comparisons, consistency checks are also carried out to guarantee the trustworthiness of the decision model.

The Fuzzy-AHP approach for choosing solar panel sites has a number of benefits. It provides a systematic framework for decision support and enables decision-makers to take into account both quantitative

and qualitative criteria as well as to include subjective judgements. The presentation and analysis of geographical data, criterion layers, and alternative site locations are made easier by the integration of the Fuzzy-AHP approach with Geographic Information Systems (GIS). This improves the site selection procedure's effectiveness and accuracy.

A useful way for choosing a solar panel site is the Fuzzy-AHP method. Decision-makers may successfully manage uncertainties and subjective judgements by integrating fuzzy logic and the AHP, resulting in better informed and ideal site selection decisions. The Fuzzy-AHP technique encourages the effective usage of solar resources and advances sustainable energy planning [10].

3.2. Data acquisition

Landsat 8 satellite imagery was used to collect the data for this paper on land use categorization and solar panel siting. The required data for analysis were collected using the Thermal Infrared Sensor and the Landsat 8 Operational Land Imager sensor. In order to improve the quality of the data, the Landsat 8 imagery was processed, which included scene mosaicking and atmospheric correction [11]. Without supervision, categorization an unsupervised classification method utilizing ISO Cluster was used to categorize the land use surrounding each research location. A data analysis tool called the ISO Cluster methodology locates geographical groupings in satellite images. This method automatically groups comparable pixels based on their spectral similarity, therefore it does not require previous information or training sets for classification. The ideal pixel grouping is calculated using

the ISO Cluster approach by measuring the distance between cluster centers and the standard deviation within each cluster. The ISO Cluster methodology was selected for this research because it offers a reliable and impartial method of classifying land use [12].

Additionally, the ISO Cluster approach is suitable for remote sensing analysis and enables for the fast processing of massive datasets. To detect and categorize various land use types, the Landsat 8 images was subjected to the ISO Cluster algorithm [13].

3.3. Determination of Research Parameters

Effective solar panel placement is essential for maximizing the use of solar energy in certain areas. This study intends to pinpoint important research criteria for choosing appropriate locations for the installation of solar panels in the setting of Karbala, Iraq. This study offers important insights for the effective location of solar panels in Karbala by analyzing the slope, solar radiation, water bodies, road infrastructure, and structures.

An extensive examination was carried out in Karbala, Iraq, to establish the research criteria for choosing the location for solar panels. The results of the investigation into the parameters are listed in Table 1:

Slope:

The performance of solar panels is significantly influenced by the inclination and orientation of the land surface. Using topographic information and Geographic Information System (GIS) methods, the slope of probable locations in Karbala was examined [14].

Solar Radiation:

The capability of solar panels to produce electricity is significantly influenced by the availability of sun radiation. Weather stations and satellite sources were used to gather information on solar radiation, including direct, diffuse, and total radiation [14]. This study looked at the solar radiation levels in several Karbala neighborhoods to pinpoint those with high sun irradiance, which indicates the best locations for solar panel placement.

Water Bodies:

The effectiveness of solar panel installations may be affected by the presence of nearby bodies of water [15]. In order to determine the proximity of water bodies, such as rivers, lakes or reservoirs, to potential solar panel locations in Karbala, GIS techniques were used. This research helps in identifying the locations where the water bodies are far away because they may present potential safety risks.

Road Infrastructure:

For the building, use, and upkeep of solar panel systems, accessible road infrastructure is crucial for the transit of supplies and machinery [15]. Using GIS data and satellite images, this study looked at the accessibility and closeness of road networks to possible solar panel installations. The effective design and execution of solar energy projects in Karbala are aided by the identification of locations with easy access to road infrastructure.

Buildings:

The effectiveness of solar panels can be impacted by nearby buildings and structures due to shade and sunlight interference. This research evaluated the presence and height of surrounding structures near prospective locations for solar panel installations. Suitable sites with little influence from shade were found for the placement of solar panels by taking into account the orientation and shadowing effects of the structures [15].

For the effective use of solar energy resources, it is essential to establish the research parameters for choosing the location of solar panels in Karbala, Iraq. This research offers important insights for decision-makers and stakeholders involved in solar energy projects in Karbala by evaluating the factors of slope, solar radiation, water bodies, road infrastructure, and structures. The research parameter with its type, which is shown in Table 1, aids in the successful selection of ideal locations for solar panel installation, fostering the production of sustainable and effective solar energy in the area.

Table 1: Research Parameters.

Parameter	Type of Parameter
Slope	Geomorphological
Solar Radiation	Climatic
Water Bodies	Hydrological
Road Infrastructure	Infrastructure
Buildings	Urban

3.4. Analysis method

Euclidean distance and reclassify are two methods frequently employed in spatial analysis.

Reclassifying entails assigning new values or categories to a raster or vector dataset in accordance with predetermined standards. For various analytical purposes, it enables the transformation of data into various classes or categories. For instance, reclassifying elevation data into slope categories or reclassifying land cover data into various vegetation types.

The distance in a straight line between two points in a Euclidean space is known as the Euclidean distance. It is frequently used in spatial analysis to determine the distance between objects or locations. When analyzing proximity or accessibility, such as locating the closest neighbor or identifying areas within a certain distance of a location, this distance metric is especially helpful.

4. Study Area

The study area is concentrates on the city of Karbala, which is located in the center of Iraq and about 110 kilometers southwest of Baghdad, the country's capital. Karbala, which spans a region of around 5,034 square kilometers, is physically situated between latitudes 32°N and 33°N and longitudes 43°E and 44°E. The three provinces that make up the city Karbala, Hindiyah, and Eantamer each contribute to the regions overall growth and scenery.

Karbala has significantly urbanized over the past two decades as a result of both population expansion and increased migration to the city. New residential, commercial, and industrial projects have changed the neighborhood and shaped the urban fabric as a result of the urban growth. The development of industrial facilities and educational institutions has coincided with the increase in urbanization, thus enhancing Karbala's economic and social dynamics [16].

Figure (1), which shows an Iraqi map with a window selected to indicate the research's particular emphasis, shows the region within Karbala that is the subject of the study. The selected region captures the essential traits and traits of Karbala, enabling a thorough investigation of the urban and rural environments [16].

The aim of this study is to choose appropriate locations for the installation of solar panels in Karbala, Iraq. Both urban and rural land uses may be found in the Karbala region. The area is mostly utilized for the cultivation of crops including date palms, barley, wheat, fruit trees, and different summer crops in terms of agriculture. The local economy

and food production depend on these agricultural operations. A lively urban environment with cutting-edge infrastructure and historical landmarks that draw tourists from all over the world is created by the urban areas, which also include residential buildings, commercial hubs, industrial facilities, and educational institutions.

Finding the best places to put solar panels requires an understanding of the dynamics and features of the study area in Karbala. Researchers want to examine elements including sunshine exposure, land availability, and potential shading difficulties to find the best locations for solar panel deployment by looking at how agricultural and urban regions interact. This study will aid in the creation of practical plans for capturing solar energy in Karbala and advancing clean and sustainable energy production.

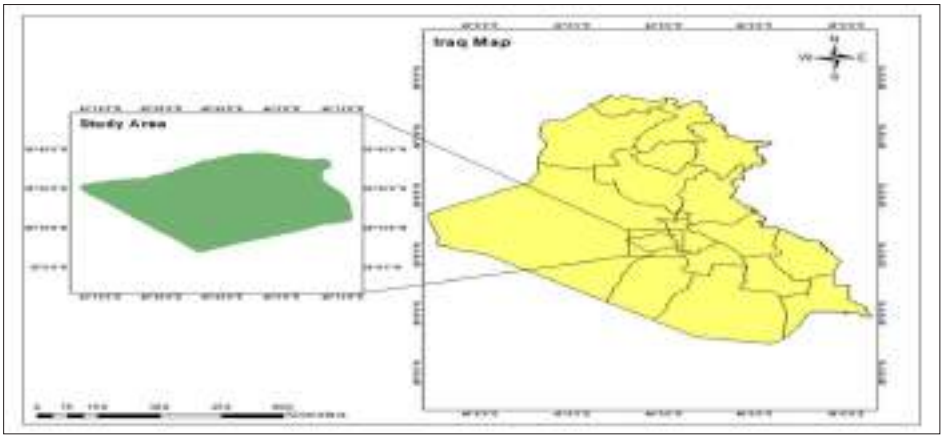

Figure 1: Study Area/ Karbala city, Iraq.

4.1. Land Use in Karbala City

Several variables affect how land usage in Karbala City affects natural ecosystems. The topography of the landscape is an important element that

affects how suitable a piece of land is for various uses. Figure (2) depicts the patterns of land use and cover in Karbala City and offers important details on the placement of electricity lines and roadways.

The particular features of the terrain become important when installing photovoltaic (PV) systems. The extent of the land area the PV system occupies, the kind of terrain, its closeness to vulnerable ecosystems or scenic regions, and its biodiversity status are all taken into consideration. These elements aid in assessing the possible effects and alterations that could occur during the building phase, such as earth movements and transportation operations.

The conversion of arable land for the installation of PV systems, which might affect soil production, is one possible worry. Conflicts and unhappiness among farmers who have sentimental attachments to their arable land may result from this.

It is crucial to take into account the possible environmental and social effects of installing PV systems in order to maintain sustainable land use practices. By using the results of this study to inform site selection decisions, land use changes may be addressed socially and with less negative effects on natural ecosystems [17].

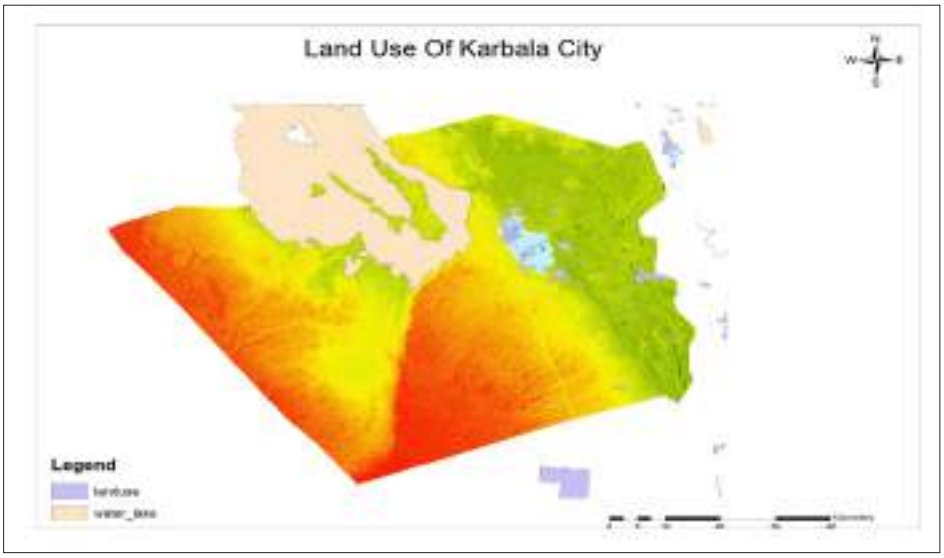

Figure 2: Land cover and land use patterns in Karbala City.

5. Results and Discussion

The results gathered from the use of GIS-Fuzzy Analytical Hierarchy Process (AHP) for solar panel placement selection in Karbala, Iraq, are given and discussed in this section. The use of GIS with the fuzzy AHP approach together enables a thorough and systematic assessment of many factors and their corresponding weights in the decision-making process.

Figures (3–9) illustrate the classification process and change detection outcomes and Table 2 contains data on the weights that were used to determine the results. Figure (3) illustrates the various forms of land cover and the distribution of roads and power lines throughout the region, offering insights into the land cover and roads/ power lines in Karbala. Understanding the current land use patterns

and infrastructure is essential for influencing the PV system placement decision.

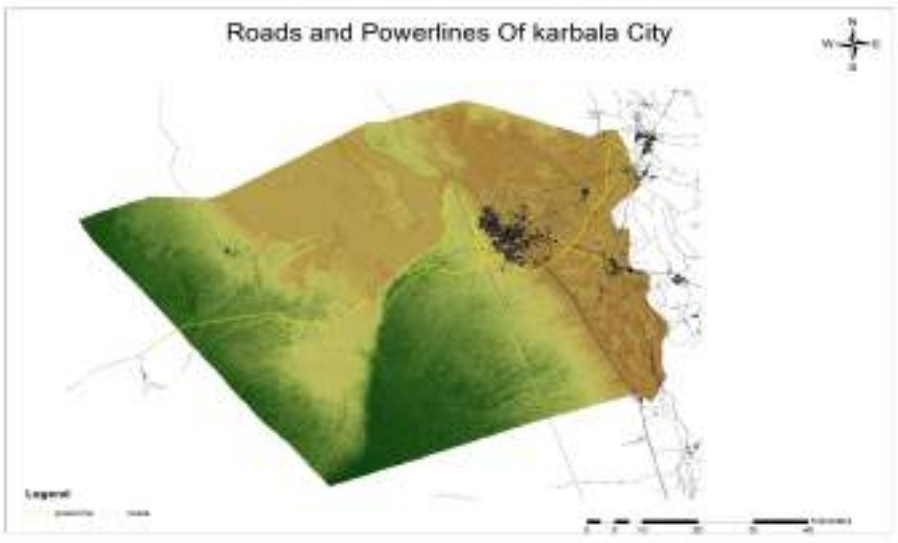

Figure 3: Land Cover and Roads/Power Lines in Karbala, Iraq

The Reclassify of roads, are shown in Figure (4). This map includes reclassification of roads in Karbala Governorate

Reclassification involves assigning new values or categories to a vector or raster data set according to predefined criteria. For various analysis purposes, in order to facilitate decision-making and fuzzy analysis.

Figure (5) depicts the analysis and visualization of solar radiation, a crucial component in the production of PV energy. This map shows how the amount of solar radiation is distributed around Karbala, highlighting areas with higher sun irradiance. This knowledge is crucial for increasing PV system energy output and choosing the best locations to install solar panels.

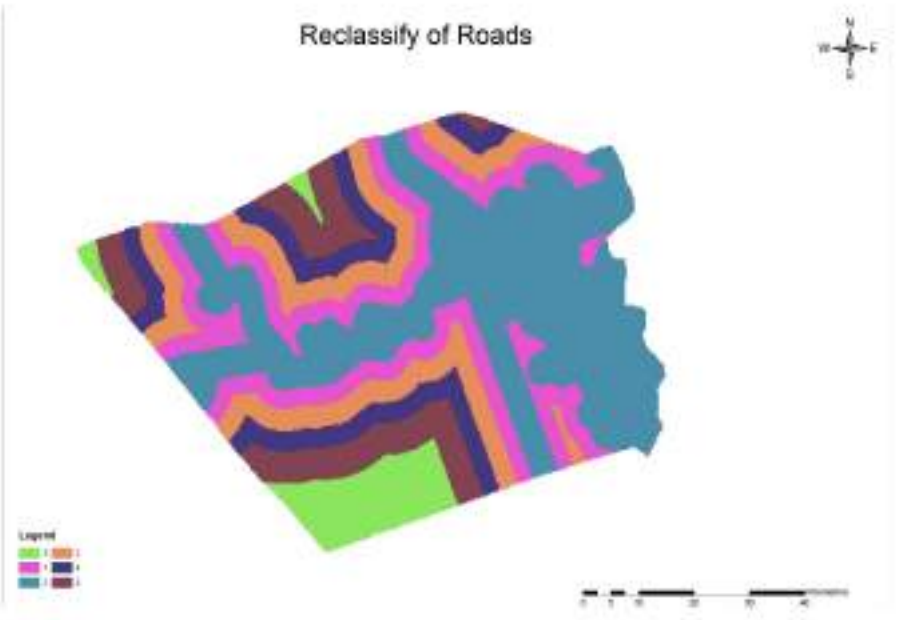

Figure 4: Reclassify Of Roads in Karbala, Iraq

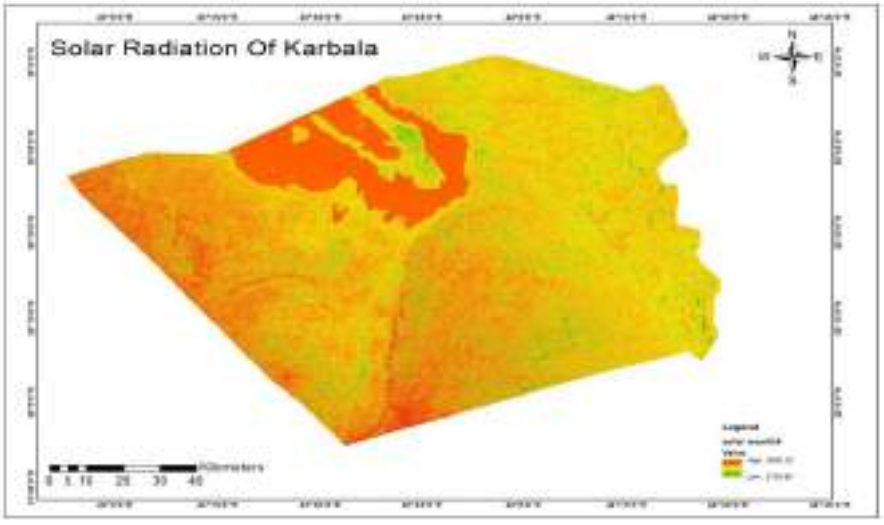

Figure 5: Solar Radiation Distribution in Karbala, Iraq

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Figure (6) shows the slope analysis of the city of Karbala and highlights locations with various slope inclinations. In order to choose acceptable locations for solar panel alignment and positioning that ensure optimal energy generation, it is essential to take slope information into account.

Figure (7) shows the assessment of the association between Karbala lakes and land cover using fuzzy logic. This map illustrates the relationship between the different types of land cover and the local occurrence of lakes. Assessing possible shading or cooling impacts from surrounding water bodies and their impact on PV performance is made easier with an understanding of this connection.

Finally, Figure (8) displays the digital elevation model (DEM) data-derived map of Karbala's land cover. An overview of the distribution of land uses, including metropolitan regions, agricultural areas, and other land use types, is shown on this map. It is a resource for examining present land cover patterns and locating locations that might be ideal for installing solar panels.

Figure No. (9) shows the fuzzy hierarchical analysis of the slope in Karbala and highlights the sites with different slopes classified by linear classification. In order to select acceptable sites for solar panel alignment and to locate sites that ensure optimal power generation, it is necessary to take gradient information into account.

Figure (10) shows a fuzzy hierarchical analysis of the roads in Karbala. Classified by fuzzy linear classification. to determine the best results

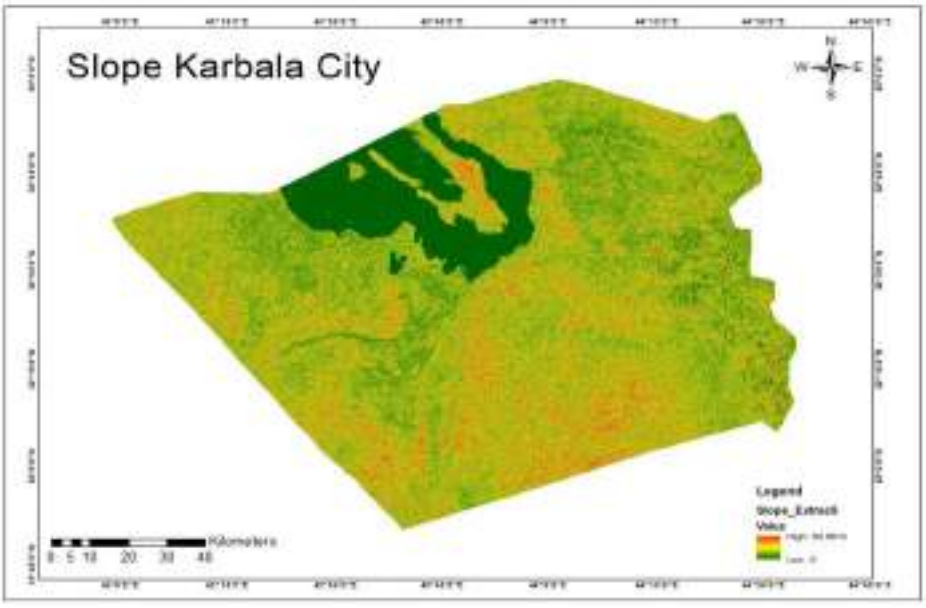

Figure 6: Slope Analysis of Karbala City for Solar Panel Siting Selection

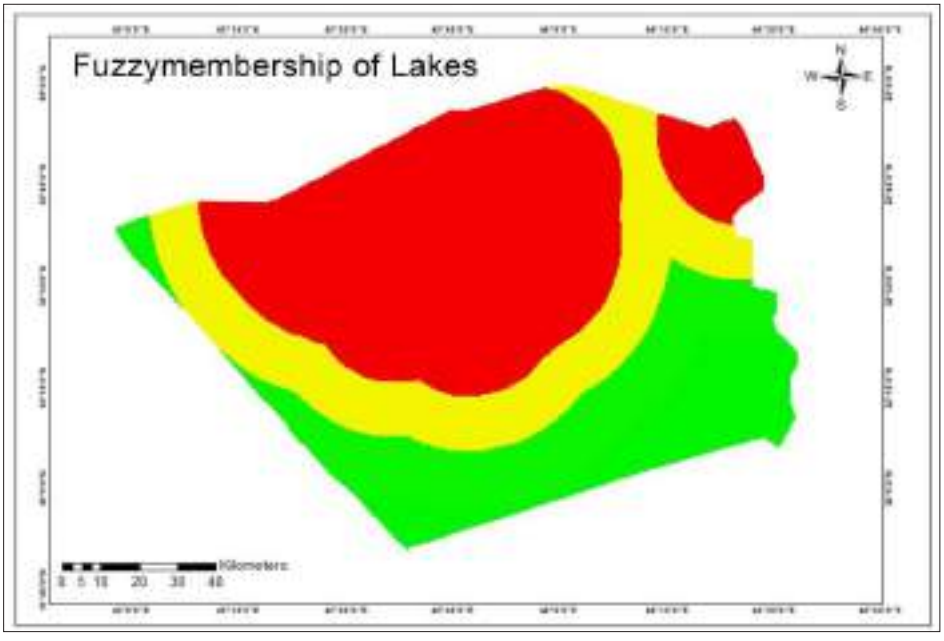

Figure 7: Relationship between Land Cover and Lakes in Karbala, Iraq

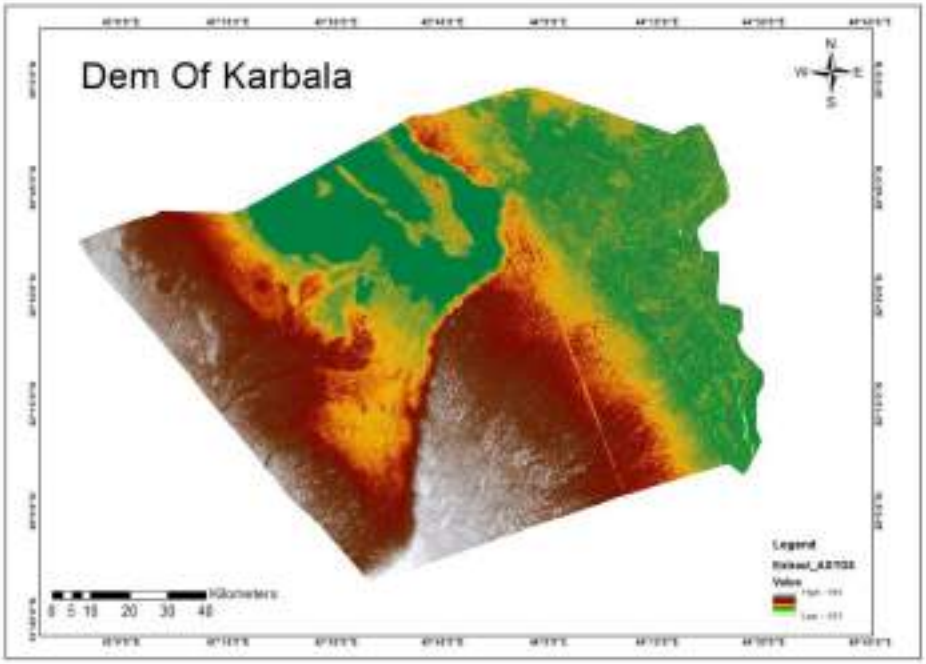

Figure 8: Land Cover Map of Karbala City Derived from DEM Data

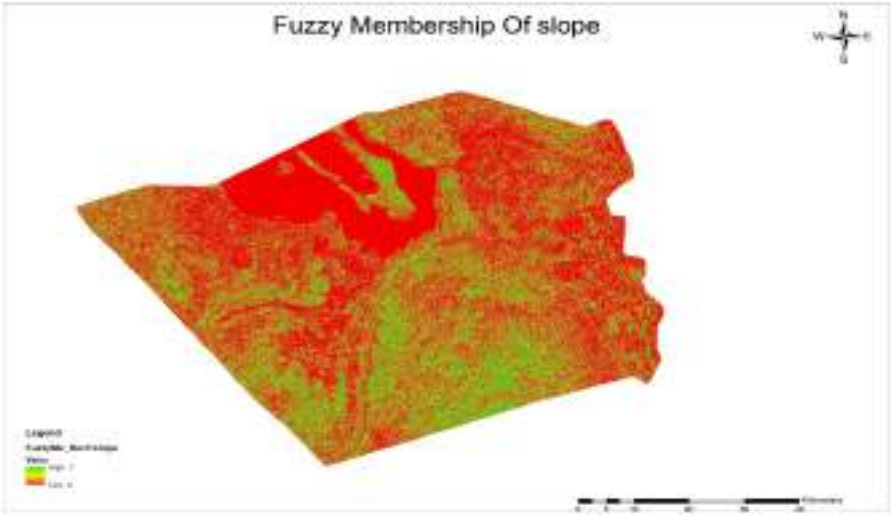

Figure :9 Fuzzy membership of Slope of Karbala City

Figure :10 Fuzzy membership of Roads of Karbala City

The classification process ,change detection ,and application of the GIS-Fuzzy AHP technique produced useful data that may be used to choose the best location for solar panels in Karbala ,Iraq. The study of land cover ,suitability mapping ,evaluation of solar radiation ,analysis of slope ,interaction with lakes ,and map of land cover obtained from DEM provide insights into the spatial features and parameters influencing the choice of the best locations for PV installations .These findings support the effective use of solar energy resources in Karbala by fostering informed decision-making.

Table :2 Weighting Factors for Classification and Change Detection Outcomes

Criteria	Solar.rad	Slope	Dis.power	Dis.road	Dis.city	Land cover
Solar.Rad	(1,1,1)	(1/4,1/3,1/2)	(1/3,2/2,1/2)	(1/5,1/4,1/3)	(11/6,1/5,1/4)	(1/8,1/7,1/6)
Slope	(2,3,4)	(1,1,1)	(3/3,3/2,3,1)	(3/5,3/4,3/3)	(3/6,3/5,3/4)	(3/8,3/7,3/6)
Dis.Power	(1,2,3)	(2/4,2/3,2/2)	(1,1,1)	(1/3,2/2,1/2)	(2/6,2/5,2/4)	(2/8,2/7,2/6)
Dis.Road	(3,4,5)	(4/4,4/3,4/2)	(1,2,3)	(1,1,1)	(4/6,4/5,4/4)	(4/8,4/7,4/6)
Dis.City	(4,5,6)	(5/4,5/3,5/2)	(5/3,5/2,5/1)	(5/5,5/4,5/3)	(1,1,1)	(5/8,5/7,5/6)
LandCover	(6,7,8)	(7/4,7/3,7/2)	(7/3,7/2,7/1)	(7/5,7/4,7/3)	(7/6,7/5,7/4)	(1,1,1)
Weight	0.51	0.11	0.23	0.07	0.05	0.03

The optimal places for PV installation in Karbala ,as identified by fuzzy logic ,are shown in Figure .(11) The fuzzy logic technique assists in identifying sites that are highly suitable for PV installation by integrating several variables such as slope ,solar radiation ,and distance from water bodies .The best locations for establishing solar energy villages are in the southern part of Karbala province .The decision-makers and stakeholders engaged in the process of choosing a location for solar panels might use this map as a reference.

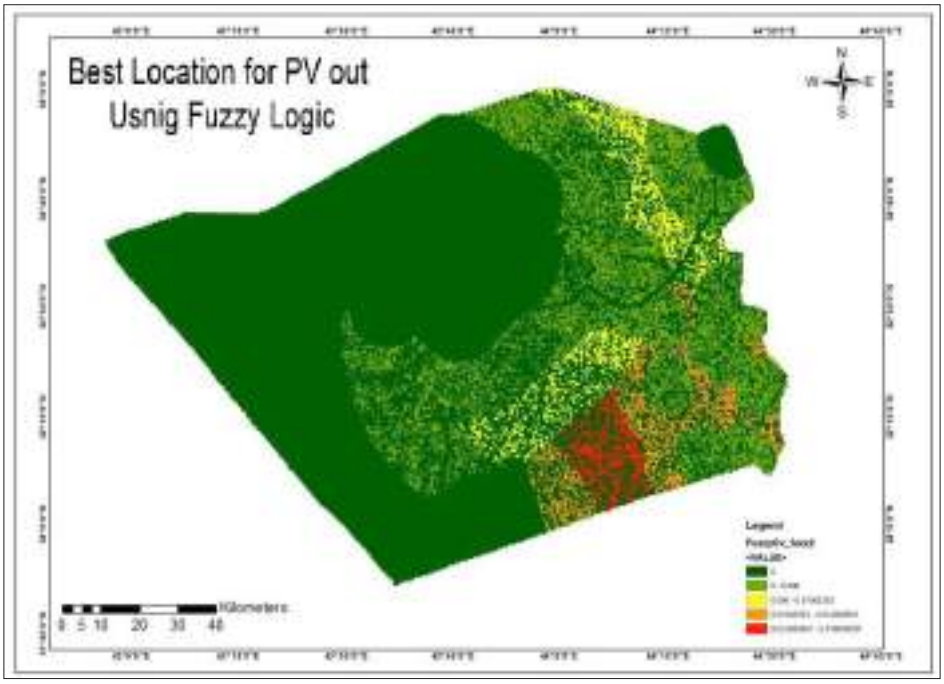

Figure :11 Land Cover and Best Locations for PV Installation in Karbala ,Iraq

8. Conclusion

For the location of the solar panels in Karbala, Iraq, we used a GIS-Fuzzy Analytical Hierarchy Process (AHP) technique in this study. We gained important insights into the ideal places for PV installation in the area by examining a number of metrics and criteria, including land cover, solar radiation, slope, water bodies, road infrastructure, and buildings. We detected the land cover and roads/power lines in Karbala using the classification method and change detection, which offered a thorough grasp of the current land use patterns and infrastructure architecture. Based on the following criteria, we used fuzzy logic to identify the ideal sites for installing solar panels, Land cover taking into account elements like plant covering, built-up areas, and agricultural land, we evaluated various land cover types and their potential for PV installation. Sun radiation to locate places with higher sun irradiance, which indicate areas with better potential for PV energy generation, we evaluated the geographical distribution of solar radiation levels. Slope taking into account elements like the steepness of the terrain and its direction towards the sun, we found potential locations for the installation of solar panels by analyzing the slope characteristics of the city of Karbala. Water bodies in order to evaluate the possible shading or cooling impacts of surrounding lakes or rivers on PV performance, we looked at the link between land cover and water bodies. Road infrastructure to determine locations with better accessibility for the installation and maintenance of solar panels, the road network was taken into consideration. Buildings to ensure that PV panels receive the

most sunlight possible and produce the most energy, we took buildings' existence into account. According to the results of our analysis, the best places in Karbala for installing solar panels are those that have a favorable combination of suitable land cover, higher solar radiation levels, gentle slopes, distance from water bodies, easy access to roads, and little building shading. These areas have the best potential for producing PV energy effectively and efficiently. This research focuses on using renewable and environmentally friendly energy sources to enhance the electrical situation in the holy province of Karbala and give the finest services to the millions of Visitors during the Ziyarat Al-Arbaeen of Imam Hussein (peace be upon him) Additionally, the province as a whole will have access to clean electricity all year round because of these solar energy systems. The goal of the study was to locate the best location to install solar power systems. Through spatial suitability analysis, this study determined the best locations for establishing solar energy villages in the southern part of Karbala province.

The GIS-Fuzzy AHP algorithm used to arrive at this result depended on weighting factors such as slope, closeness to electricity transmission lines, road access, solar radiation intensity, and the distance from buildings and water bodies.

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Spatial Suitability of Electric Mobility Paths for Crowds in the Holy City of Karbala (Paths Leading to the Holy Shrines of Imam Hussain and Abbas)

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Abstract

The spatial alignment of kinetic energies falls within the realm of green smart city technologies, such as smart streetlights and traffic signals. These advancements are among the latest examples of innovative infrastructure that aim to establish the region as a leading city in smart technology within the country.

Despite pedestrians having individual preferences, goals, and destinations, the dynamics of pedestrian crowds of visitors can surprisingly be predicted. Pedestrians can move freely in sparsely populated areas, but during peak times of million visit and increased crowds, they require self-organization and movement along guided smart pathways that generate green energy. In such cases, pedestrian pathway systems will evolve, and computer simulations will be valuable tools in developing distinctive pedestrian facilities and road track systems.

This research aims to investigate the management of human crowds of visitors during the annual million-visitor seasons in Iraq, specifically focusing on their organizational role and protection from the risks of congestion and overcrowding while performing sacred rituals in the holy cities of Karbala surrounding the holy shrines of Imam Hussein and Abbas.

The study found that human activities can contribute to generating electricity through energy-harvesting activities such as walking. When a person walks, energy is dissipated on the surface through impact

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and vibration, which can be harnessed and converted into electrical energy. Therefore, the study area, represented by the city of Karbala, stands out as a place where crowds gather, with millions of people from various nationalities congregating inside and around its squares and passages during the fortieth-day of Imam Hussein,(peace be upon him) pilgrimage and other religious visits. This necessitates providing large quantities of energy consumed in lighting, escalators, air conditioning, and other operational needs.

The research revealed an untapped and essential element for clean energy generation, which is the kinetic energy resulting from the movement of the visitors. This study aims to propose a system for crowds of Ziyarte Al-Arba'een management by accurately understanding pedestrian density through smart applications for the piezoelectric tile system. The research methodology involved using geographic information systems to identify the routes where the system is applied to achieve the highest energy harvesting ratio for optimal utilization.

Keywords: Ziyarte Al-Arba'een , Sustainability, Pedestrian Pathways, Sustainable Energy, Crowds, Smart Pathway.

1. Introduction

Affordable and sustainable energy is the key to sustainable development. Energy remains essential for social and economic well-being, poverty eradication, ensuring a healthy life, and improving living standards. Achieving a future energy system requires sustainable management of natural resources, ensuring innovative production and consumption, and promoting sustainable manufacturing that enhances the development of flexible energy infrastructure. Proper and coordinated planning for system development is also crucial. The year 2015 was significant in framing future international energy and climate goals. The 2030 Agenda provides a framework, and the Sustainable Development Goals (SDGs) were agreed upon. While Goal 7 of the SDGs targets "affordable and clean energy for all," it is not the only energy-related goal [1].

Pedestrian crowds of visitors have been studied experimentally for over three decades [2]. The main objective of these studies has been to develop the concept of service level, the design elements of pedestrian facilities, and planning guidelines [3].

None of these concepts adequately consider the self-organisation effects in pedestrian crowds. However, such effects can lead to unexpected obstacles [4].

Due to the variation in pedestrian flows, it became more evident, as described by Henderson's approach, who predicted that the behavior of pedestrian crowds is similar to that of gases or liquids [5, 6, 7, and 8].

"However, a realistic gas kinetics theory or fluid dynamics for pedestrians must consider corrections due to their specific interactions (e.g., avoidance, deceleration, and maneuvers) that do not inherently preserve momentum and energy. Nevertheless, it is possible to formulate a theory for practical applications that directly incorporates individual pedestrian movement and the impact of this movement on generating green energy [9].

In human crowds and many animal communities, local interactions among individuals often lead to self-organization and recurrent local interactions, supporting diverse movement patterns [10-13]. When pedestrian flows move in opposite directions, the flows automatically separate into uni-directional pathways. This phenomenon is often called the intelligent collective pattern, which increases traffic efficiency without needing external control. The self-organized movement pattern enhances traffic flow by reducing frictional effects, local acceleration, energy consumption, and walking delays [14].

In human crowds, functional movement patterns have been identified several times in the past, such as the oscillatory flows at bottlenecks [15], corridor formation [16], or walking and the formation of social categories [17]. The variation in pedestrians' walking speeds is a key variable in the origin of noticeable traffic disruptions. We demonstrate that the collective benefit of the emerging pattern is maximised when all pedestrians walk at the group's average speed in practice. However, local interactions between slow and fast walkers lead to a global breakdown of organization, reducing the collective

and individual gains provided by traffic separation. This work is a step forward in understanding the self-organization of traffic movement in crowds, which is influenced by complex behavioral mechanisms [18].

The quantitative understanding of road crowd behaviors for bottom-up management design requires compelling strategies to promote effective collective behaviors in crowds. Crisis management is an approach to dealing with emergencies to control their outcomes or minimize their negative effects. Moreover, crowds of visitor's management and organization pose significant challenges for officials during peak million visitation seasons. The recurring problem of lost visitors, health crises, or deaths in unspecified locations necessitates solutions. Additionally, there is a need to address other types of problems, such as fire or collapse disasters and stampedes during visits. Furthermore, there is a demand for rapid communication with group supervisors and field organizers to provide instructions or guidance during these disasters [19].

Managing and monitoring crowds of visitors is considered one of management's most intricate and challenging disciplines, as it requires the convergence of various administrative entities from health, road safety, and diverse services involving multiple authorities.

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The Research Problem:

1. Several million visitors gather simultaneously inside the two shrines and surrounding areas, requiring a significant amount of energy for lighting, escalators, air conditioning, fans, and other operational needs.
2. What are the efforts and pre-planned strategies of the shrines in crisis management, Crowds of visitors control, and organizational work to achieve sustainable energy?

Research Objective: The main objective of the research is to contribute to crisis management and crowd organization by generating green energy based on the movement of visitors, reducing dependence on fossil fuels and their environmentally harmful emissions through smart pedestrian pathways.

Research Hypotheses:

There is a relationship between the efforts and pre-planned strategies of the shrines in crisis management and crowd control.

Developing a crowd management system using smart applications through precise knowledge of pedestrian densities.

2. Research Methodology:

The research adopts a descriptive-analytical approach in managing crowds of visitors and organizing human gatherings during Million visit pilgrimage seasons, especially during the Ashura visit, Tawerij run, The fortieth day of Imam Hussein,(peace be upon him) and other visits.

3. Sustainable Energy:

There are various interpretations of "sustainable energy," and for this research, it is adopted based on its role in economic, social development, and environmental impact. "Sustainable energy" is defined through three pillars, encompassing the key objectives of sustainable development:

(1) Energy security, (2) Energy and quality of life, (3) Energy and the environment (see Figure1).

These relevant objectives of sustainable development are aligned with the three pillars of sustainable energy, considering the interconnectedness of different aspects of sustainable energy and the challenges countries may face while transitioning towards a sustainable energy region.

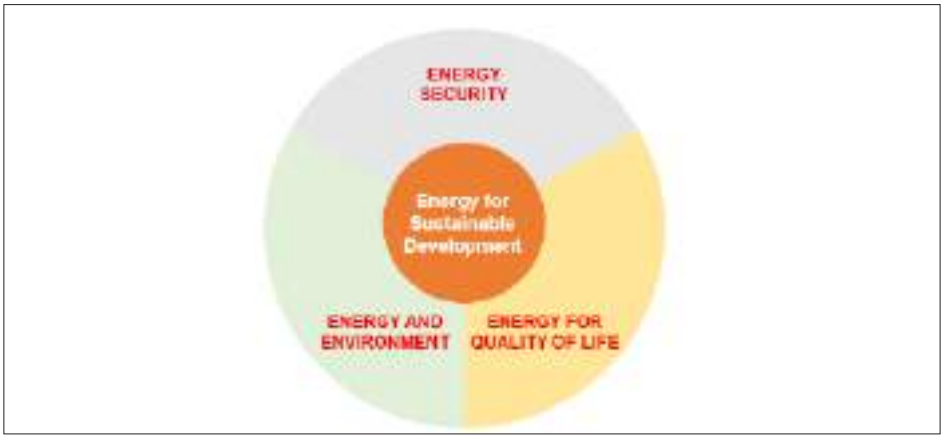

Figure 1: Energy for sustainable development

Energy Security: Securing the energy needed for economic growth. The Energy Security axis deals with the economic aspects of safe energy from a national perspective. It includes access to energy

supplies, including import, export and transit.

Energy security ensures that energy contributes optimistically to the country's social, economic and environmental development. It requires countries to adopt more innovation in development policies. To ensure that they are alert to changes, adapt in response, and build resilience to deal with all the variables and emergencies they go through [21].

Energy for Quality of Life: Providing affordable energy at all times.

The pillar of energy for quality of life aims to improve the living conditions of citizens by achieving clean, reliable, and affordable energy for all. This objective encompasses physical access to electricity grids and the quality and ability to bear the costs associated with accessing a broader concept of energy services. These services include electricity, heating, cooling, and transportation, which are crucial for enhancing the overall quality of life.

Energy and Environment: Reducing the impact of energy on the climate system, health and environmental systems.

The third pillar of energy and the environment represents the trade-offs between meeting the growing energy demand, providing a healthy environment with clean air and protecting humanity from climate change. Energy emissions contribute 60% of the total greenhouse gas emissions. Hence, the energy sector must reduce its carbon footprint across the supply chain to support climate and change mitigation efforts. [22, 23].

SDG 9 covers the energy industry, energy-intensive industries,

energy innovation, and comprehensive energy infrastructure. Achieving SDG 9 requires an energy transition geared towards achieving the SDGs as resilient infrastructure, sustainable energy and resource use, and the development, deployment and local adaptation of energy technology.

Goal 11 of the Sustainable Development Goals, with the transition and development of sustainable urban energy capable of resilient infrastructure, sustainable energy supplies for cities and urban and rural communities, transportation sustainability, and the development of sustainable transportation fuels [22].

Within the "Energy for Wellbeing" pillar, the most important energy-related SDGs are Goal 2 on "Zero Hunger", SDG 7 on "Affordable and Clean Energy", SDG 11 on "Sustainable Cities and Communities", and SDG 17 on "Partnerships." SDG 2 is related to the energy sector through the food-energy-water nexus due to competition for resources with the food sector. Agriculture is water and energy, and bioenergy may compete with food production like Maise [21]. Note Figure2.

And this interdependence between the sustainable goals and their interdependence with the organisation of crowds and their management by taking advantage of the kinetic energy to generate electrical energy by organising the paths of the crowds during the visits at the holy thresholds.

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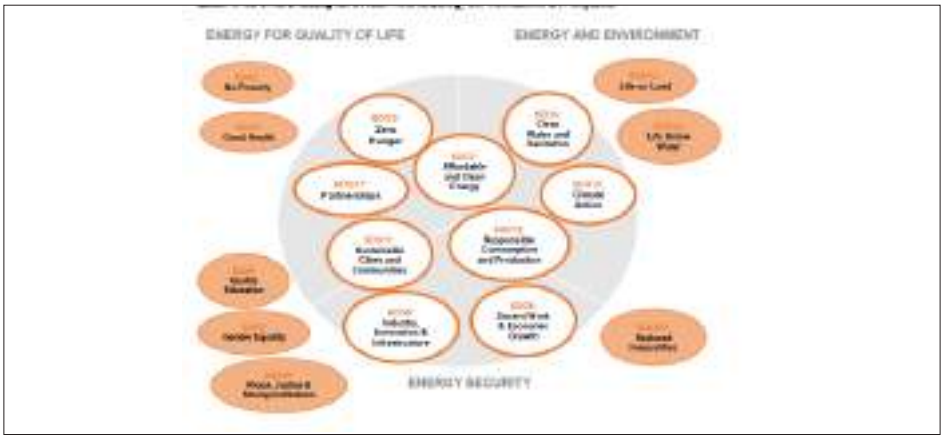


Figure 2: Links to the SDGs in defining the Energy Framework for Sustainable Development

4. Crowd Organization:

The newly emerged science of managing crowds or human gatherings is considered an independent science. It has its concepts, theses and methods. Many countries have paid attention to this science because of the people's need for it. Every country establishes this science from its perspective in dealing with human crowds, whether those crowds come to it through international programs such as holding international exhibitions, or international sporting events that attract millions of people in a specific period and a specific place, and how to deal with those crowds in their housing and transportation Providing them with health services, and how to deal with them in case of riots [24].

4.1. Concept of Crowd Organization:

Crowd organization refers to coordinating and effectively managing

a group of people in a relatively confined space.

4.2. Crowd Classification:

Crowds can be classified based on several criteria, including:

3. The location and boundaries of the event or occasion where the individuals gather.
4. The time period of the gathering.
5. The purpose of the crowd gathering.
6. The starting time of the gathering.
7. The level of cohesion among the crowd members.
8. The surrounding conditions and atmosphere of the event or occasion.

4.3. Types of Crowds:

1. **Orderly Crowd:** Occurs in well-known events, such as football matches.
2. **Active Crowd:** Characterized by emotional behavior and intensity, seeking to achieve specific demands.
3. **Expressive Crowd:** Individuals gather to perform shared rituals expressed through movements, like a group of worshipers.
4. **Casual Crowd:** Formed spontaneously without prior planning, like a gathering of individuals at a car accident site.

5. Smart Pedestrian Pathway:

The traditional pedestrian pathway is made of marble floors, lacking any shaded areas for pedestrians during sunny conditions.

The sides of the pathway are usually marked by police or barriers, or sometimes both. The idea of a smart pedestrian pathway involves using flooring materials that can generate electricity from the walking movement, converting kinetic energy into electrical energy (electro-pressure tiles).

6. Electro-Pressure Tiles:

This system appeared in 2009 in the United Kingdom and has been applied in more than 100 projects at the level of 30 countries in airports, train stations, public places and commercial places. This system has received more than 20 awards for innovation and creativity in the field of renewable energy. His idea is based on piezoelectric tiles measuring 60 * 45 cm and a thickness of 6.8 cm, as shown in the figure. It converts the pressure of walking into mechanical energy, then it is converted into electrical energy through a dynamo and stored in lithium batteries. [29].Fig 3.

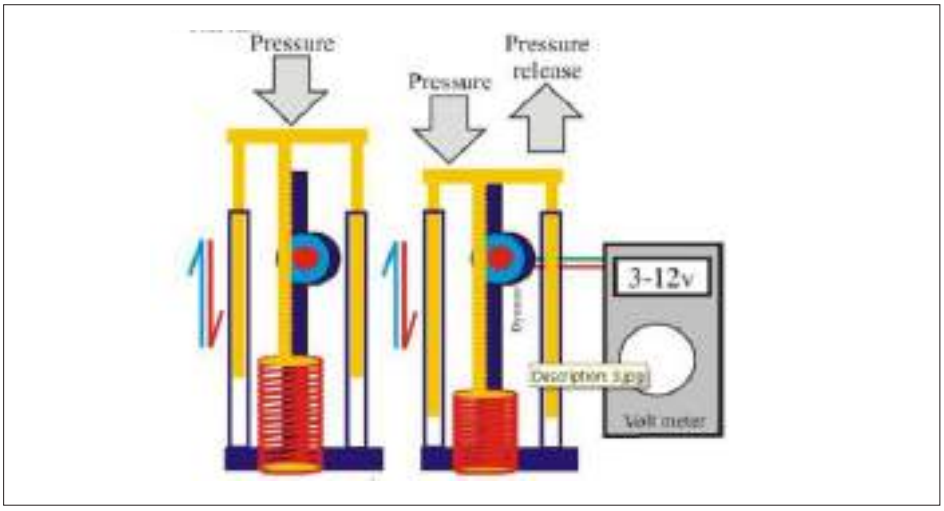


Fig (3) : Shows how to make a pedestrian path slab

7. Sustainable Energy from Walking Steps:

Renewable energy sources like solar, wind and hydropower need high investment costs. Therefore, to overcome these problems, many efforts have been made to make energy sources renewable and environmentally friendly [30]. Walking is the most popular activity that is done every day and can produce energy. Every time someone steps on a tile, the kinetic energy from their footsteps is converted into renewable electricity. This electricity can be used to power lighting, advertising screens, or communications networks or stored in a battery for later use.

The majority of university students prefer to use walking for them to go to the site. Through this method, sustainable energy footsteps can be implemented. By using weight energy, it can gain electrical energy. It's a simple concept. A person only needs to walk on the ground at a normal speed and can see how much energy one person produces. Using this concept, the energy produced is environmentally friendly. They can also be effective ways to save money because you don't need any fuel or energy sources by walking. It's just a simple way to follow [31].

8. Benefits of Walking

Walking is an activity that all humans do. This method can provide a variety of positive effects on the body and reduce the negative impact on the environment. For example, it can reduce air pollution and it can also produce sustainable energy from steps. The university is one of the locations where most of the population uses walking as a position to perform any activity. Therefore, the university can be used as a benchmark for the effectiveness of conducting a study in the footsteps of a feasibility study based on the energy harvesting potential of Light Walkers[32].

9. Ways to Generate Electricity from Pedestrian Footsteps:

Daily activities such as walking by humans can produce a lot of energy. On average, humans walked about 3,000 - 5,000 daily newspapers. According to [33], the process of obtaining the energy surrounding the system and converting it into usable electrical energy

is called energy harvesting. It is also possible to convert kinetic energy into electrical energy using footwork.

There are two power generation methods: step-by-step electrical transformer devices and electricity generation steps using Pavegen. The first method when placed in the sidewalk area, has the ability to convert kinetic energy into electrical form. The downward movement of the plate causes the shaft of the electric generator installed in the device to rotate, producing electrical energy. The electricity generated by these devices can be used for street lighting. But the efficiency of the device to function properly is limited. Table 1 shows the duration of the illumination, the lamp for the number of footsteps and the corresponding energy stored by the device that was triggered by a person walking on it.

There are two ways to generate electricity using piezoelectric devices on walkways. The first method involves placing the devices on pedestrian pavements to convert kinetic energy into electrical energy. When the plate undergoes a downward motion due to a footstep, it rotates the dynamo, generating electrical power. This electricity can be used to illuminate street lights. However, the efficiency of the device is limited.

10. Potential Locations for Electricity Generation from Pedestrian Pathways:

Different piezoelectric generators cannot be implemented in different places as long as there is repeated application of pressure. For example, a location that has a high frequency of vehicular traffic

takes place and places where a large group of people hang out. Roads, shopping malls, footpaths, railroad tracks, and highways are the most common locations for these conditions. The site broadly includes streets, highways and railway tracks. Traffic conditions on streets and highways vary throughout the day with traffic being heavier in the morning than at night and sometimes 24 hours a day. A railway track is one example of huge power generation because the trains exert enormous pressure on the railway tracks. Piezoelectric material pads are placed at the junction where the wheel makes contact with the tracks and receives maximum pressure such as is used on airport runways, and the pads are arranged so that a greater force is to be tolerated and a greater amount of charge is stored [34].

11. The Sidewalk:

In the context of traffic, the meaning of sidewalk is very broad. It is closely related and has a line meeting between the environment and human activities and movements. Therefore, pavement can be defined as the road/space/pedestrian walkway/special paved walkway designed/made for pedestrian use. Sidewalks are one of the sustainable transportation systems. Through walking, it can be a viable option that can also produce healthy physical activity [35].

Walking energy can be harvested and converted into electrical energy using piezoelectric materials. The result of observations and surveys in the case study shows that 46,000 pedestrians walk along the walkway with an average weight of 66.40 kg per day. Assuming the length of the trail, that number of steps and amount of weight

would theoretically be enough to generate 6,130 watts of electrical energy per day. Therefore, the use of piezoelectricity in the case study floor is a promising way to generate electricity for the corridor lighting system based on renewable energy. This study contributes to preserving fossil fuel energy and using renewable energies as a clean and sustainable source. Since the model used is based on walking mechanisms and human behaviors, it is recommended to check other theoretical models, in order to accurately obtain the acting force and consider other effective factors such as pedestrian speed and stride length as well.Table1.

Table (1): Effective factors that must be taken into account to generate energy from pedestrian footsteps

Available service	technology	Context	Energy type
power consumption of the device	Efficiency of piezoelectric materials	Walkway length	number of steps
number of devices		number of pedestrians	foot pressure Pedestrian stride length walking speed

12. The practical side

12.1. Study area

The study area is represented in the city of Karbala, in the area surrounding the two Imams, which is represented by the Husseini and Abbasid shrines, and other shrines within the area of the visitation.

12.2. Methods of Energy Generation at Pedestrian Footsteps:

Table 2 shows the duration of lamp illumination for the number of footsteps and the corresponding energy stored by the device triggered by a person walking on it.Table 2.

Table 2. Energy Storage by Foot Steps

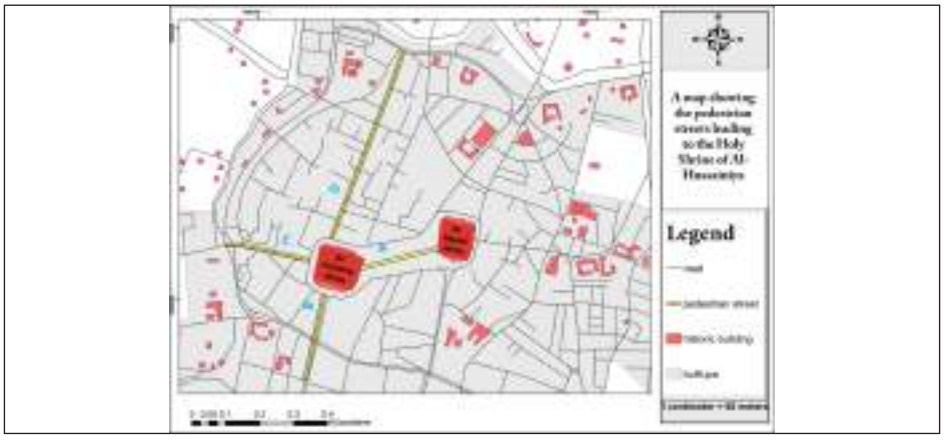
No of Foot Steps	Duration of Lighting a100 watt 230volt bulb (s)	Total energy (J)
250	6	600
500	12	1200
750	18	1800
1000	25	2500

12.3. Data analysis to measure the energy generated from the site:

1. **Al-Hussainiya threshold:** the dimensions of the streets are measured to assess the optimal potential for pedestrian steps. Table 2 shows that Street D, which passes through the Holy Shrine of Al-Hussainiya, has the longest pedestrian street, which is about 1,945.31 feet. Meanwhile, the shortest length of Street A is 807.43 feet. As shown in map (1) and table (3).

Table (3) Dimensions of pedestrian walkways and number of visitors

Zone	Length(feet,ft)	Total Number of Pedestrian
A	807.43	4,126,254
B	854.9	2,024,796
C	833.19	1,985,442
D	1,945.31	3,205,897



Map (1) places the pedestrian streets associated with the Holy Shrine of Al-Hussainiya

Where the power can be generated by the pedestrian generator, which is stored in the energy storage device. The number of steps will affect the time the lights turn on. It is as follows:

250 steps = 6 second (s) of duration to lighting a 100-watt bulb

Hence, for every 1 second, the numbers of footsteps required are:

(250 steps)/ (6 seconds) x 1seconds = 41.66 steps = 42 steps.

Therefore, every 1 second, 42 steps are required. According to the frequency of pedestrian in Zone A, B, C & D, the minimum duration of lighting for each zone can be evaluated based on 1 second = 42 steps.

However, by assuming:

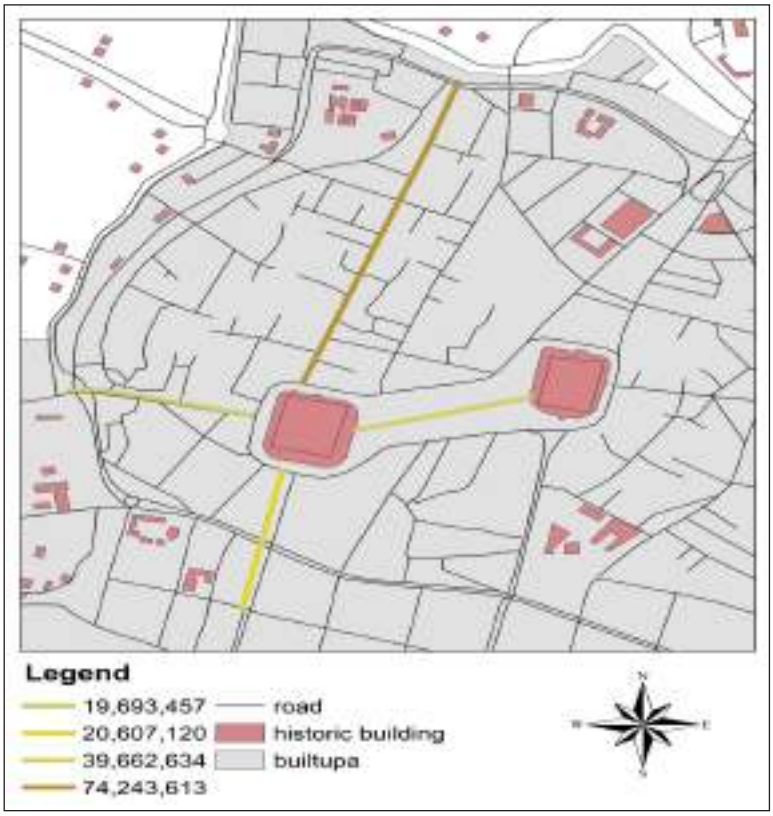
Every 2 feet of interlocking block sidewalk = 1 steps

Table 4. Number of Footsteps

Zone	Total Number of Pedestrian	Length of Sidewalk (feet,ft)	Total Number of Footsteps (Steps)
A	4,126,254	807.43	1,665,830,633
B	2,024,796	854.9	865,499,050
C	1,985,442	833.19	827,125,209
D	3,205,897	1,945.31	3,118,231,746

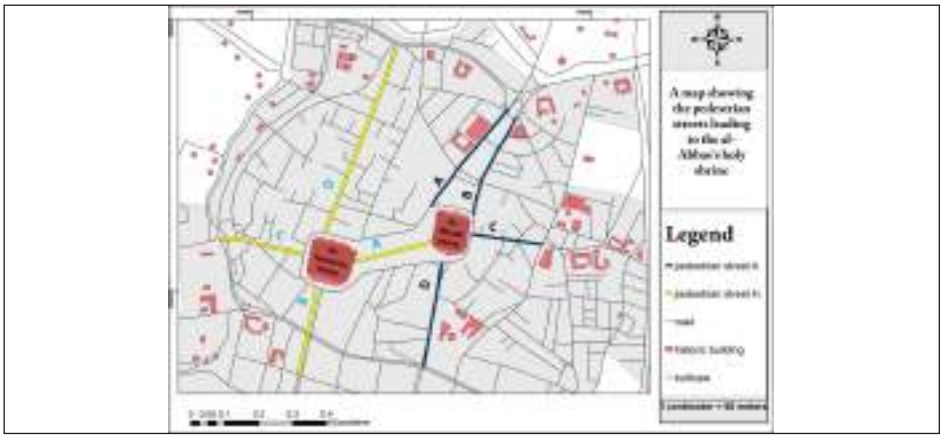
Table 5. Duration of Lighting a 100-Watt Bulb Based on Number of Footsteps

Zone	Number of Steps (steps)	Duration of Lightinga100-watt Bulb (second,s)
A	1,665,830,633	39,662,634
B	865,499,050	20,607,120
C	827,125,209	19,693,457
D	3,118,231,746	74,243,613



Map (2) The potential for power generation is placed depending on the visitors' footsteps

2. The Abbasid threshold: Table 5 shows that Street A, which is linked to the al-Abbas's (p) holy shrine, has the longest pedestrian street, which is about 1,212.47 feet. Whereas, the shortest length of Street C is 686.63 feet. As shown in map (3) and table (6).



Map (3) places the pedestrian streets associated with the al-Abbas's (p) holy shrine

Table (6) dimensions of pedestrian walkways and number of visitors

Zone	Length(feet,ft)	Total Number of Pedestrian
A	1,212.47	2,470,083
B	1,026.83	2,108,759
C	686.63	724,866
D	1,020.62	1,841,665

Based on the previous steps, we have Tables (7) and (8):

Table (7) Number of Footsteps Calculated

Zone	Total Number of Pedestrian	Length of Sidewalk (feet,ft)	Total Number of Footsteps (Steps)
A	2,470,083	1,212.47	1,497,450,767
B	2,108,759	1,026.83	1,082,668,501
C	724,866	686.63	248,857,370
D	1,841,665	1,020.62	939,820,066

Table (8) Duration of Lighting a 100-Watt Bulb Based on Number of Footsteps

Zone	Number of Steps (steps)	Duration of Lightinga100-watt Bulb (second,s)
A	1,497,450,767	35,653,589
B	1,082,668,501	25,777,821
C	248,857,370	5,925,175
D	939,820,066	22,376,668

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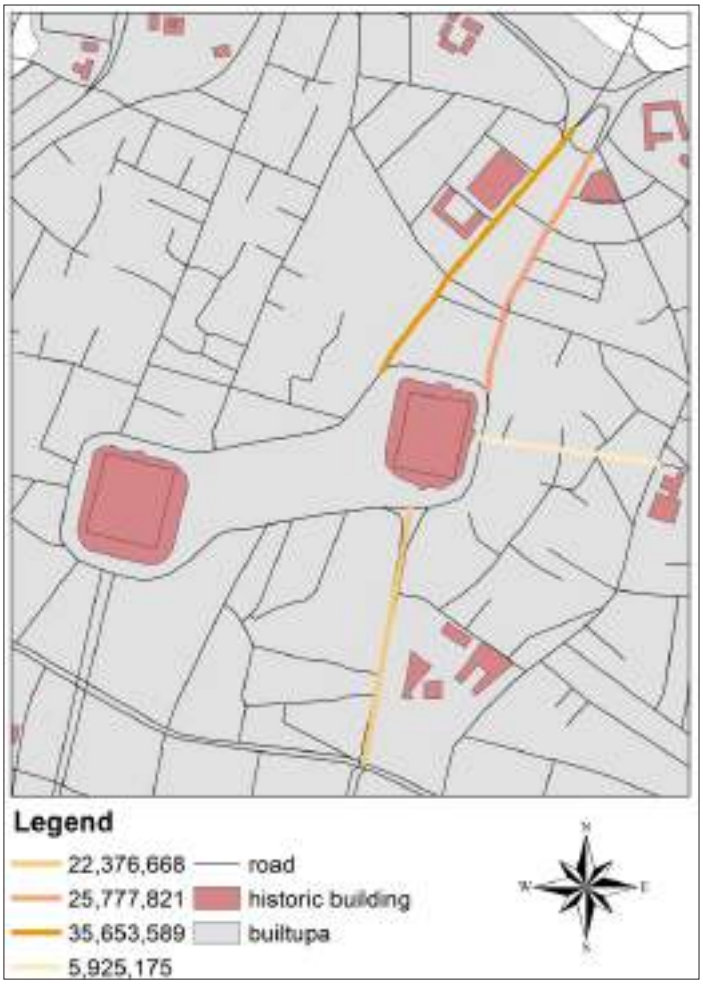

Map (4) The potential for power generation is placed depending on the visitors' footsteps

Table 4 illustrates that the amount of energy emission for the paths passing through the Holy Hussein threshold is significantly high (74,243,613) in region D, while it becomes lower in region C with a value of 19,693,457. On the other hand, the duration of a 100-watt bulb's illumination in the streets associated with the Holy Abbas threshold is higher in region A compared to regions B, C, and D,

with a total of 35,653,589 readings per second. Additionally, energy generation is low in region C, amounting to 5,925,175 seconds, as indicated in Table 7.

The duration of the 100-watt bulb's illumination may vary depending on the number of footsteps, which affects the emission duration of energy based on the total pedestrian frequency and sidewalk length. Streets with higher pedestrian frequencies and longer sidewalks will result in a larger number of footsteps per street, which, accordingly, can illuminate a 100-watt bulb. To verify whether the bulb will light up, a minimum of 250 footsteps is required to assess the time it takes for the 100-watt bulb to illuminate within 6 seconds.

13. Conclusions:

1. The implementation of the pedestrian energy-harvesting pathway project transforms the areas surrounding the holy shrines into sustainable green zones, providing a place for visits, scientific exploration, and creativity.
2. Based on the increasing number of visitors during the fortieth-day of Imam Hussein, (peace be upon him) visitation period and their movement in the streets around the holy shrines, it can be inferred that paths D and A are the most used by the crowds compared to other regions and paths.
3. The shrines have pre-planned crisis management and Crowds of visitors control strategies, regularly updating and developing them.
4. The shrines collaborate and coordinate in implementing their plans with all relevant authorities involved in crowd and crisis management to ensure the success of their crowd of Million visit management plans.
5. The shrine's plans are distinguished by their ease of implementation

and flexibility, enabling effective Crowds of visitors management during various visitation seasons.

14. Recommendations:

1. Based on the results, there is significant potential for harvesting energy from footsteps, but the quality of sidewalks should be improved in advance.
2. It is also recommended to expand the use of energy harvesting in multiple locations, such as shopping centers, airports, hospitals, and other places.
3. Develop a crowd management system using accurate data on pedestrian densities through smart applications and piezoelectric tile systems, which will assist in managing crowd movement during the forty-day and Sha'ban visitations.
4. It is essential to have alternative plans in case of any disruptions to the primary set plans, which positively impacts crowd management.
5. Strengthen coordination with relevant authorities in implementing the shrines' crowds of visitors and crisis management plans.
6. Focus on technological advancements and updates in devices and technologies that aid in crowd management during the visitation season.
7. Give importance to urban design and planning to control crowd movement and enable them to engage in various activities at event and gathering sites.
8. Conduct periodic detailed urban and planning studies for all visitation sites, taking into account crowd movement and their diverse activities.

9. Embrace sustainable energy with its three pillars in all service sectors, especially in religious areas and holy sites.
10. Invest in crowd movement and organization to generate and achieve sustainable energy in larger pathways, resulting in a higher percentage of sustainable energy production.

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Spatial Suitability of landfill Site in Karbala, Babel and Baghdad Governorates

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Abstract

Landfill siting is a challenging and intricate process, making it a prominent issue in waste management. The complexity arises from various factors, such as population growth, rapid economic expansion, and improvements in living standards. Unfortunately, in Iraq, landfill siting often neglects environmental regulations, especially in the Karbala, Babel, and Baghdad Governorates, situated in the middle part of Mesopotamia plain. These regions cover areas of 4568.45 km2, 7106.29 km2, and 820.190 km2, with populations of 1,218,732, 2,065,042, and 8,126,755, respectively. Existing landfills in these areas are not selected in accordance with environmental standards. To address this issue, a landfill site was identified through a comprehensive approach that involved spatial overlay analysis using a geographic information system (GIS) to developing a supervised logic decision depends on surface and subsurface geology conditions. Numerous factors were taken into consideration during the siting process, including water resources, building sites, sensitive soil types, and topographic slope. The Weighted Overlay method was employed to assign relative weights to the mentioned criteria. As a result of this thorough process, seven sites were identified as the most suitable landfill locations, covering a total area of approximately 291.057 km.

Keywords: Weighted Overlay, Spatial Suitability Analysis, Landfill Site, Supervised logic tree decision, Karbala, Babel and Baghdad Governorates.

1. Introduction

The Environment Protection Act of 2009 provides a comprehensive definition of waste, encompassing the discharge of liquids, solids, gases, smoke, dust, radioactive elements, and similar substances that degrade the environment [1]. Solid waste, specifically, refers to discarded materials arising from human and animal activities that are deemed unwanted and useless [2]. The process of Solid Waste Management (SWM) aims to minimize environmental harm and promote reuse of waste materials.

The rapid urbanization in urban centers like Baghdad, Karbala, Babel, and Baghdad, has posed a significant challenge for SWM. The densely populated human activities particularly during the time of Zeyart AL-Arbaeen, along the road linking Baghdad and Babylon to Karbala during this time lead to a substantial increase in waste generation, creating environmental and health hazards. Karbala alone generates around 24 tons of municipal waste daily during Zeyart AL-Arbaeen[3], while Baghdad produces 10,000 tons per day throughout the year [4]. In Babel, the daily waste production reaches 400 tons, causing health and environmental issues for nearby residents due to improper landfilling practices [5]. Unfortunately, less than half of the waste gets collected, and most of the collected waste is disposed of haphazardly [6].

Geographic Information System (GIS) is a digital database management system specifically designed to handle large volumes of spatially distributed data sourced from various origins. It proves to

be highly effective for conducting sophisticated site-selection studies, as it efficiently stores, retrieves, analyzes, and presents information based on user-defined specifications. The use of GIS has significantly contributed to streamlining and cost reduction in the process of landfill site selection [7] [8] [9]. Additionally, other site-siting techniques combine Multiple Criteria Analysis (MCA) with GIS to evaluate the suitability of potential sites throughout the study area by employing a suitability index [10] [11] [12] [13] [14]. The weighted overlay technique empowers us to assign weights to various factors and blend them together to form a comprehensive thematic map. By overlaying all causative factors using their respective weights, we can calculate the landfill susceptibility index. This process is facilitated through the use of the overlay tool in ArcGIS.

The combination of rapid and uncontrolled urbanization, lack of public awareness, and poor municipal management has exacerbated environmental problems in towns across Iraq, including unsanitary waste management and disposal [6] . To address this, the present study focuses on improving waste management by identifying suitable areas for landfill sites, particularly in on the road linking Baghdad and Babylon to Karbala. Defining appropriate parameters and criteria will help mitigate the adverse effects of improper SWM. Landfill sites are an essential part of waste management, significantly impacting the physical and socioeconomic aspects of cities.

2. Study Area Location

The study area is nestled within the historical and culturally rich Mesopotamian basin, spanning from the bustling city of Baghdad to the ancient sites of Babylon and the holy city of Karbala (figure1). This region offers a diverse landscape and a tapestry of urban and rural settings, making it an intriguing location for conducting a spatial suitability analysis of landfill sites and waste recycling factories. With its unique blend of modern urban centers and historically significant locations, the governorates of Karbala, Babel, and Baghdad present an ideal canvas to explore sustainable waste management solutions and contribute to the preservation of this remarkable heritage.

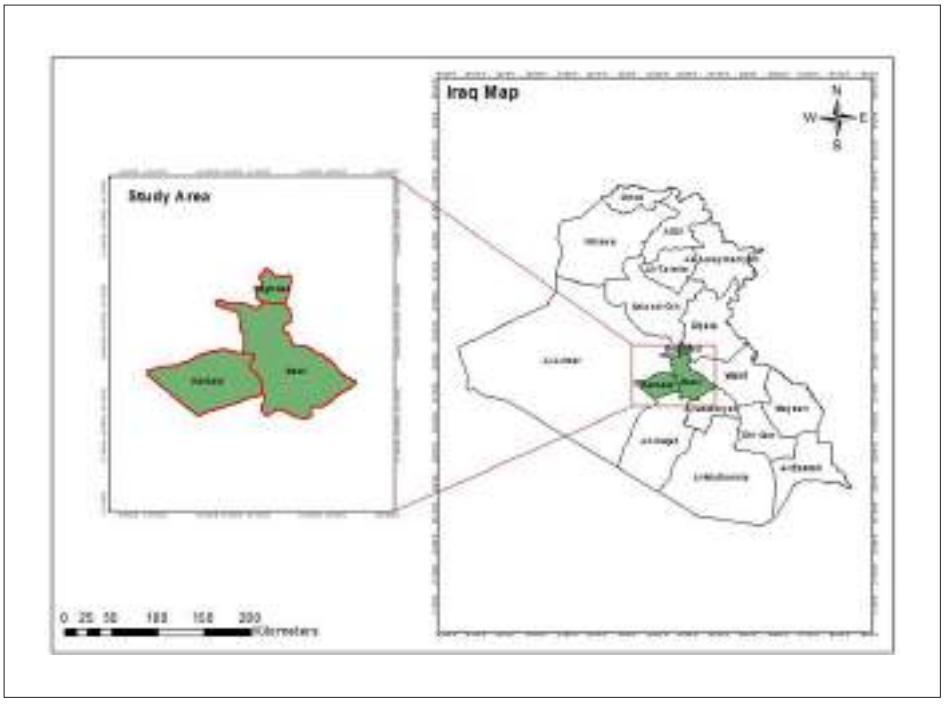

Figure1 location map of study area.

3. Methodology

The overarching problem statement lies in the accumulation of uncollected wastes, which are found in drainage ditches, roadside spaces, and the vicinity of the city's river. This situation has led to conflicts between waste management authorities and the local communities. Consequently, the pollution caused by these unattended waste sites has resulted in an increase in communicable diseases and various other hardships faced by the local population. Therefore, the weighted overlay procedure (figure 2) has been utilized for this purpose.

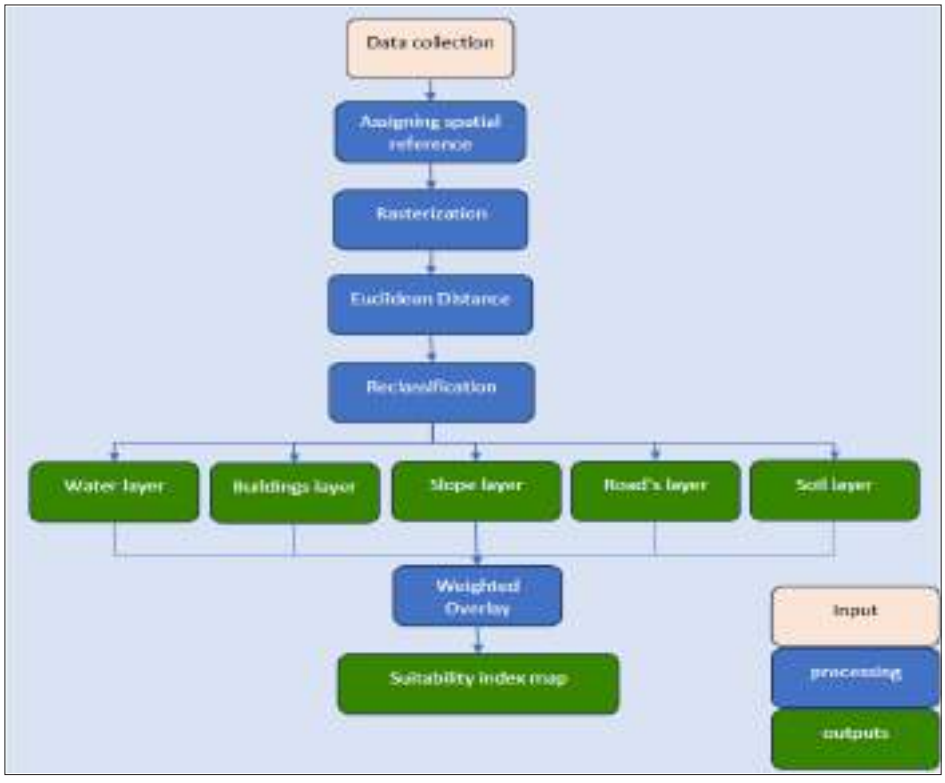

Figure 2 Flowchart utilized in current study.

In this procedure, fixed criteria were applied to each factor that is believed to influence the suitability of the landfill site. The selection of a landfill site involves a thorough evaluation of various factors to ensure that the chosen location is suitable for waste disposal and minimizes environmental impacts. The factors considered for landfill site selection can vary depending on local regulations, environmental conditions, and specific project requirements. However, some common factors [15] (table 1) include: distance from water body, The distance from a water body is an important factor to consider in landfill site selection. Keeping a safe distance between a landfill and water bodies (figure 3) is crucial to protect water quality and prevent contamination. Water bodies include rivers, lakes, streams, ponds, wetlands, and other surface water features, as well as groundwater sources like wells and aquifers. Ideally, landfill sites should be located as far away from water bodies as possible to minimize the risk of pollutants leaching into the water and causing environmental and public health concerns. The distance required between a landfill and water bodies can vary depending on local regulations, the type of landfill, and the characteristics of the water body. The distance from settlement areas is another crucial factor in landfill site selection. Settlement areas (figure 4), which include residential neighborhoods, commercial centers, and other inhabited regions, must be kept at a safe distance from landfills to safeguard public health, minimize nuisances, and prevent potential conflicts between waste disposal activities and human activities. The distance required between a landfill and settlement areas can vary

based on local regulations, environmental conditions, establishing buffer zones between landfill sites and settlement areas can provide an additional protective layer, helping to reduce the potential impact of landfill activities on neighboring communities.

Table 1- Factor criteria for selection of a landfill site [15]

Criteria	Ranking (from 1 is unsuitable to 4 is best suitable)			
	1	2	3	4
Distance from water body	<1000m	1000-1500m	1500-2000m	>2000m
Distance from settlement area	<500	500-1000m	1000-2250m	>2250m
Distance from roads networks	>1500 m	1000-1500m	500-1000m	<500m
Slope and elevations	>20%	15-20%	10-15%	0-10%
Soil type	Sandy Soil	Loam Soil	Silt Soil	Clay Soil

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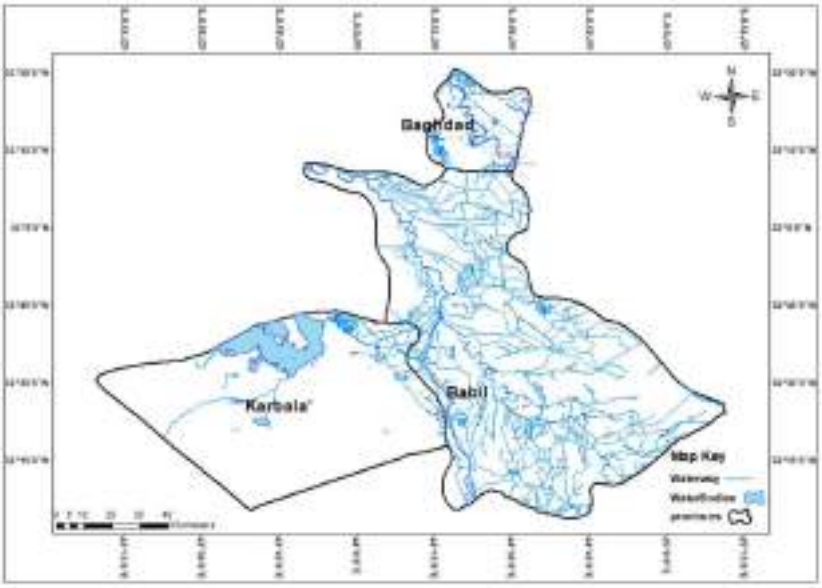

Figure 3 Surface water body in current study.

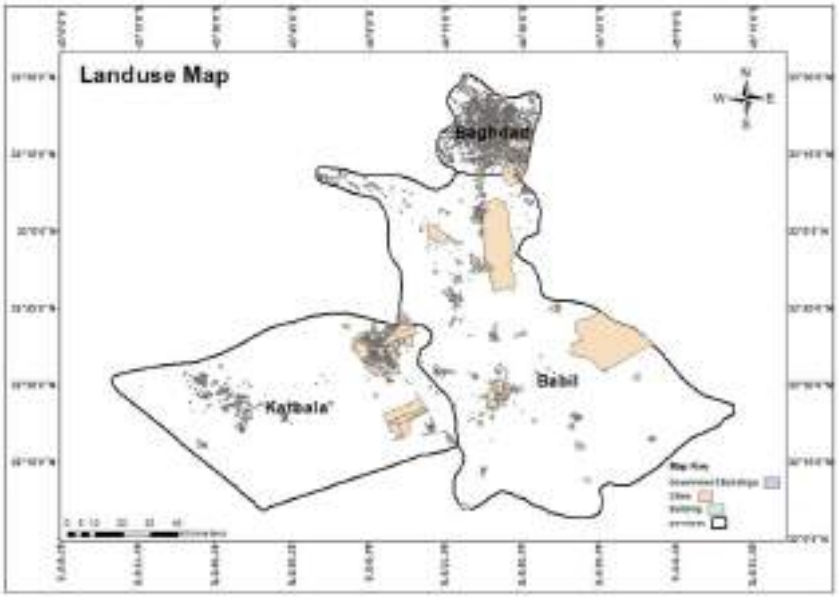

Figure 4 Settlement area in current study.

Distance from roads networks, the road networks (figure 5) is an essential consideration in landfill site selection. Proximity to road networks can significantly impact the efficiency and cost-effectiveness of waste transportation to the landfill site. It also affects traffic management, public safety, and potential nuisances caused by waste transportation. The site model takes into account that a location too close to a road is highly unsuitable, as sludge may affect both the road's integrity and the safety of passersby. However, the chosen location should still be easily accessible by road for efficient waste disposal.

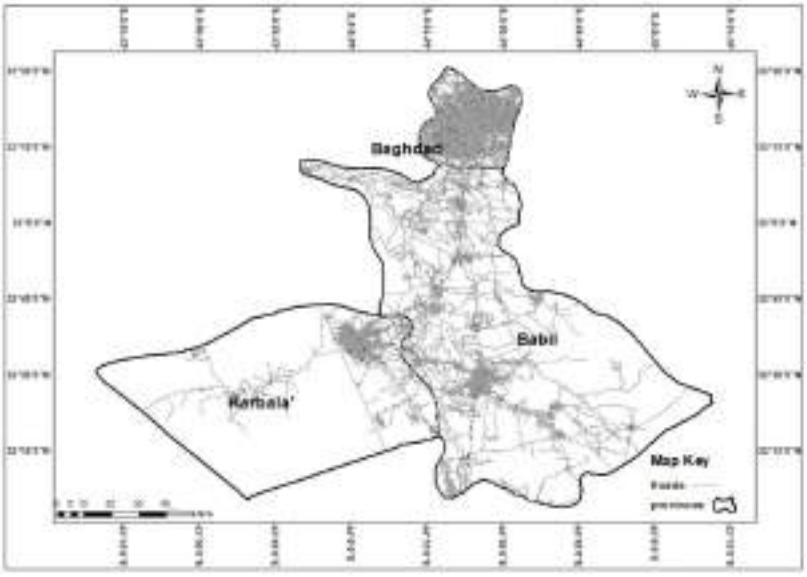

Figure 5 Road networks in current study.

Slope, is important topographical factors to consider in landfill site selection. The slope calculation is need to prepare DIM model (figure 6). The topography of the site can significantly impact the landfill's stability, drainage, and construction costs [16]. Landfills

should ideally be located on flat or gently sloping terrain. Steep slopes can create engineering challenges during landfill construction and management. They may also increase the risk of erosion and potential instability of the landfill structure. Flat or gently sloping areas allow for more straightforward landfill design and waste placement. The stability of the landfill is critical to ensure long-term containment of waste and to prevent landslides or slope failures. Sites with stable soil and rock conditions are preferred to reduce the risk of potential instability issues. Proper drainage is essential to manage rainwater and leachate within the landfill. Excessive slopes can lead to poor drainage and increased runoff, which can transport pollutants into surrounding areas and water bodies. Adequate slope design and engineered drainage systems help mitigate these risks. Steeper slopes are more prone to erosion, which can lead to soil and waste material runoff. Controlling erosion is vital to prevent sediment pollution and protect water bodies.

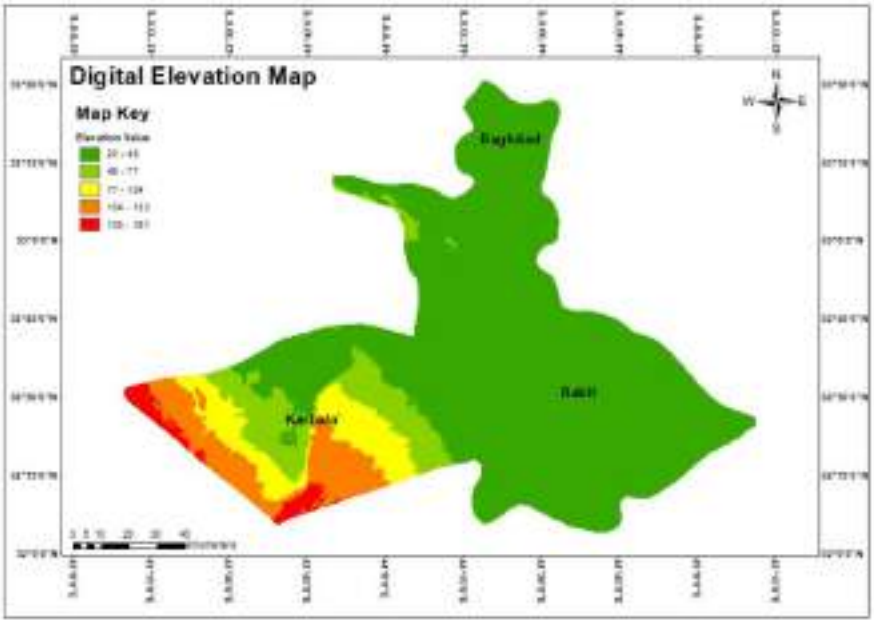

Figure -6 Digital elevation map (DEM) in current study

Soil type, the best soil type for a landfill site is one that exhibits low permeability and high stability [17]. A low-permeability soil layer acts as a barrier, preventing leachate (liquid that comes in contact with the waste) from seeping into the surrounding environment and contaminating groundwater and surface water. A stable soil type ensures that the landfill structure remains intact and does not experience settlement or instability over time. Clay soils have low permeability due to small particle sizes and tightly packed structures, which greatly restrict the movement of water and other liquids. This property helps contain leachate within the landfill, reducing the risk of groundwater contamination. Clay soils can be effectively compacted

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during landfill construction, leading to a more stable and structurally sound waste containment area. While clay soils are preferred, the availability of suitable clayey soils may be limited in some regions. In such cases, engineered liners, such as high-density polyethylene (HDPE) or geomembrane liners, can be used to create an impermeable barrier between the waste and the surrounding environment. These liners, when properly installed, can provide an effective alternative to natural clay soils.

The weighted overlay method involves integrating various inputs by applying a standardized scale of measurement. In this approach, the decision maker assigns weights to each input using analytical techniques and subjective judgments. In the study, a weighted analysis was applied to each input layer based on its sensitivity to determine the appropriate location for solid waste disposal in Karbala, Babel, and Baghdad Governorates. Here we developed a new type of Ranking Methods procedure utilizing supervised logic tree (figure 7) to make a final decision without use any traditional multi criteria decision algorithm analysis e.g., Rating Methods. Pairwise Comparison Method. Trade-off Analysis Method.

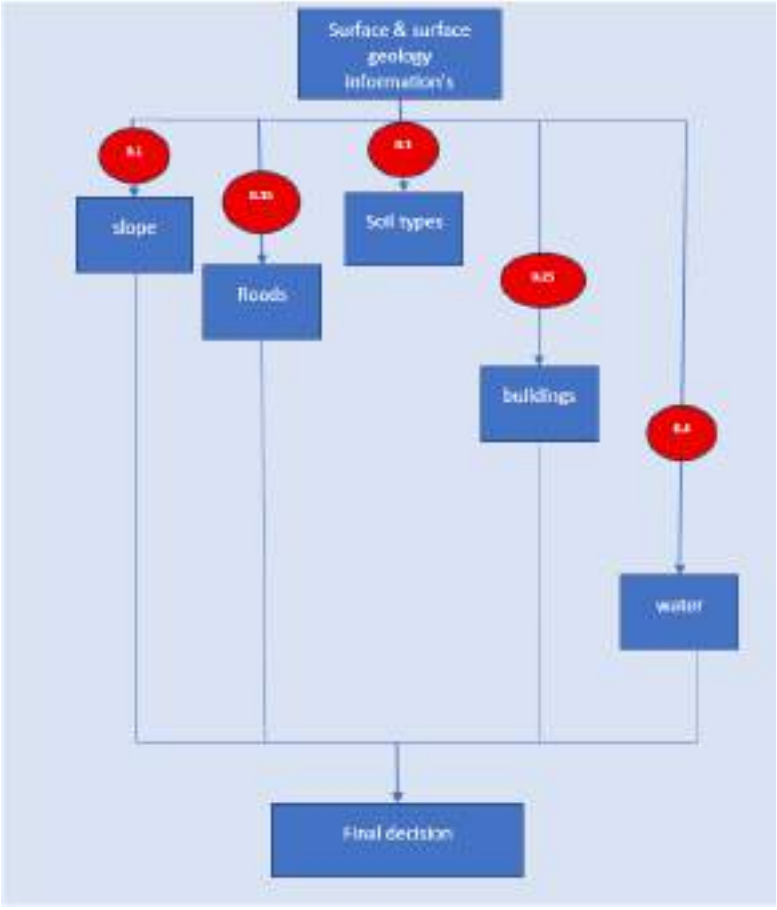

Figure -7 Supervised logic tree utilized in current study.

Generally, one drawback of this method, such as the ranking method, is the absence of a solid theoretical foundation. Additionally, justifying the assigned weights could prove to be challenging. Therefore, it must give a logical justification for weighted of some important factors, such as surface and subsurface geology factors (water, soil types and slope). for ground water there are three most important aquifers are Dibdbba, Dammam and Euphrates located within study area [18]. In the

western area of Karbala city, there is a noticeable hydraulic connection between the aquifers, resulting in similar resistivity values for both the Dammam and Umm Er Radhuma layers [19]. Moreover, the region contains many water bodies such as the Tigris and Euphrates rivers and Al-Razzara lake, in addition to other secondary rivers for this reason the water takes a high weighted value. The Mesopotamia basin exhibits a relatively flat topography, while the Iraqi Desert shows a gradual decrease in elevation from West to East, with some exceptions. It is considered an extension of the Northern part of the regional plateau of the Arabian Peninsula [20]. The region showcases a combination of positive and depressed topographic features. Notably, Jabel Anah represents the positive features in the North, Jabel Aneiza in the West, Karbala – Najaf Plateau in the East, Jabal Sanam in the South, along with some mesas and buttes [21]. This made the weighted value is low for this factor. The Mesopotamia basin are generally considered to be of Quaternary age. The Quaternary period is the most recent geological time period, spanning from approximately 2.58 million years ago to the present [22]. It is characterized by significant climate fluctuations, including multiple ice ages and interglacial periods and this very considerable to the soils in the study area are similar in terms of texture composition, so the weighted was 0.1.

After overlaid all the results obtained from reclassification, the assigned equal weights to all factors by:

$$s = \sum_{i}^{5} = 1 \, w_i c_i \, , \qquad (1)$$

Where s is suitability, wi is weighted for all factors and ci is criteria. To perform the suitability map, we used the following equation:

$$s = \sum_{i}^{5} = 1 w_i \, c_i \Pi_j^3 = 1 r_j \,, \qquad (2)$$

Where s suitability of waste disposal site, wi is weighted for factor, ci is criteria for suitability and rj is restriction.

4. Results and Interpretations

The results of soil classification (figure 8) in the provinces show that the soils in Baghdad and Babylon are and clay soil and loamy mixtures (silt and clay). While the northern part of Karbala Governorate, it represents clay soil, whilst the western and southwestern part towards the desert is sandy soil.

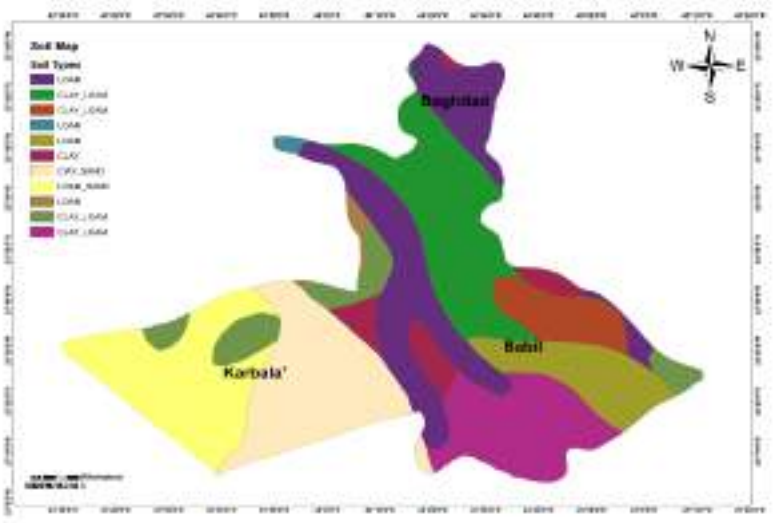

Figure -8 Soil types in study area.

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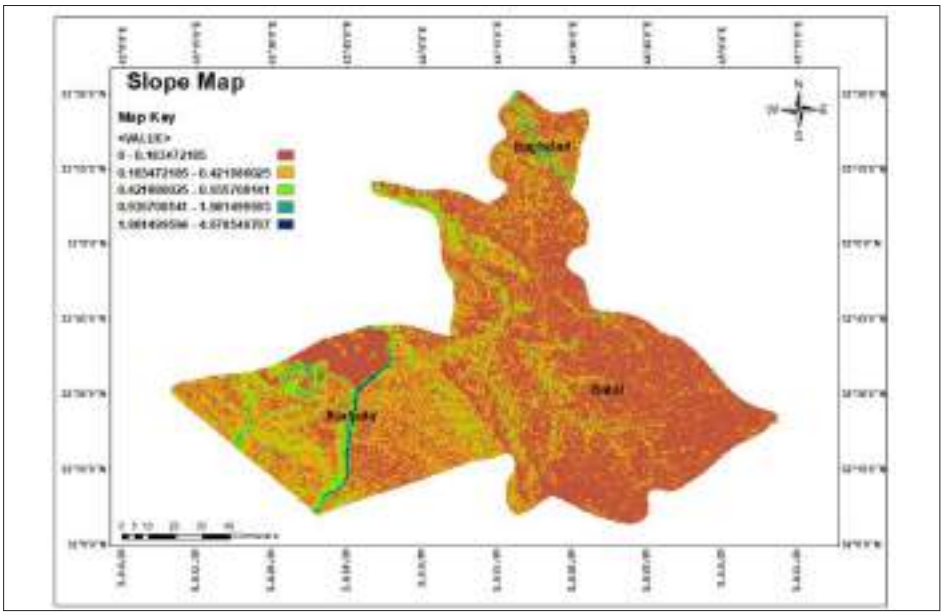

Figure -9 Slope values in study area.

In the Spatial Suitability Analysis of landfill site selection for Karbala, Babel, and Baghdad Governorates in Iraq, slope values (figure 9), hold significant importance as they impact the potential suitability of different areas. Karbala Governorate, with its diverse terrain, exhibits varying slope values. The north and northeast regions of Karbala are relatively flat, offering favorable conditions for landfill site placement. However, towards the western and southwestern parts, closer to the desert, the landscape becomes more elevated and exhibits topographic features (Karbala-Najaf plateau), requiring careful consideration to avoid stability issues and ensure effective waste management. In contrast, both Baghdad

and Babel governorates relatively flat areas, providing suitable conditions for landfill site placement, which can optimize waste disposal and ease access for waste collection and transportation. To preserve the environmental integrity of these water sources, a minimum buffer zone of 2000 meters should be established using a straight-line calculation.

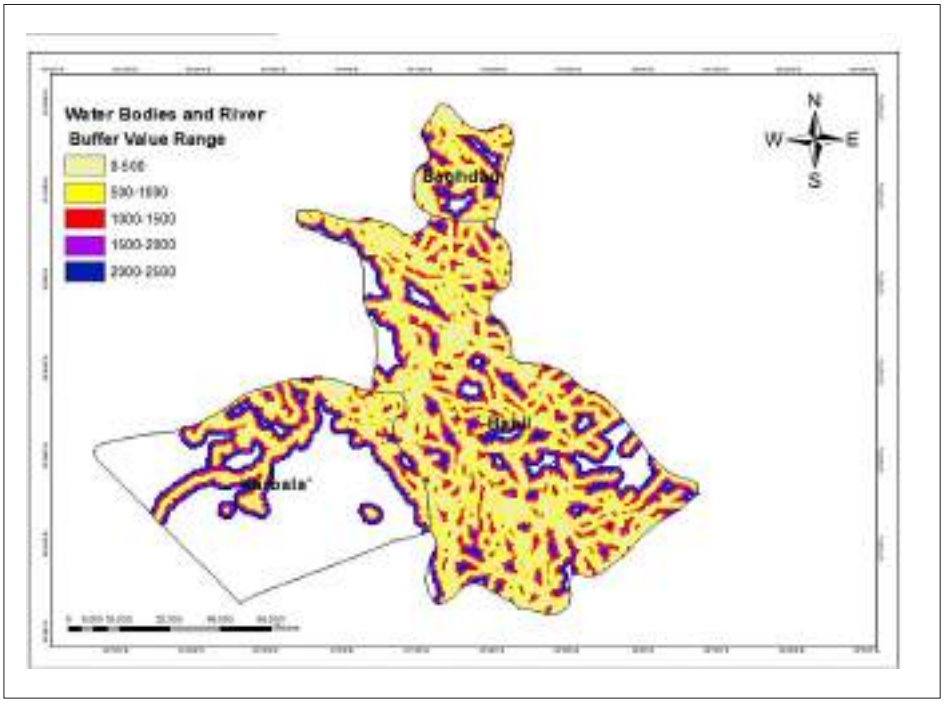

Figure -10 Distance from water body in study area.

In the process of landfill site selection for Karbala, Babel, and Baghdad Governorates in Iraq, evaluating the suitability of surface water bodies and groundwater is of paramount importance. Karbala Governorate, while having some flat regions, also features water bodies, the map showed (figure 10) an extended strip area in the

northern part of the governorate, far from groundwater aquifers as well as from water bodies. Concerning the province of Babil, there are many suitable places in the center, south and north of the province. For Baghdad Governorate, the presence of the Tigris River and its tributaries requires a thorough analysis to avoid adverse effects on this vital waterway. The map shows (figure 10) three suitable buffer ranges, in north part and west also small area in the southern part.

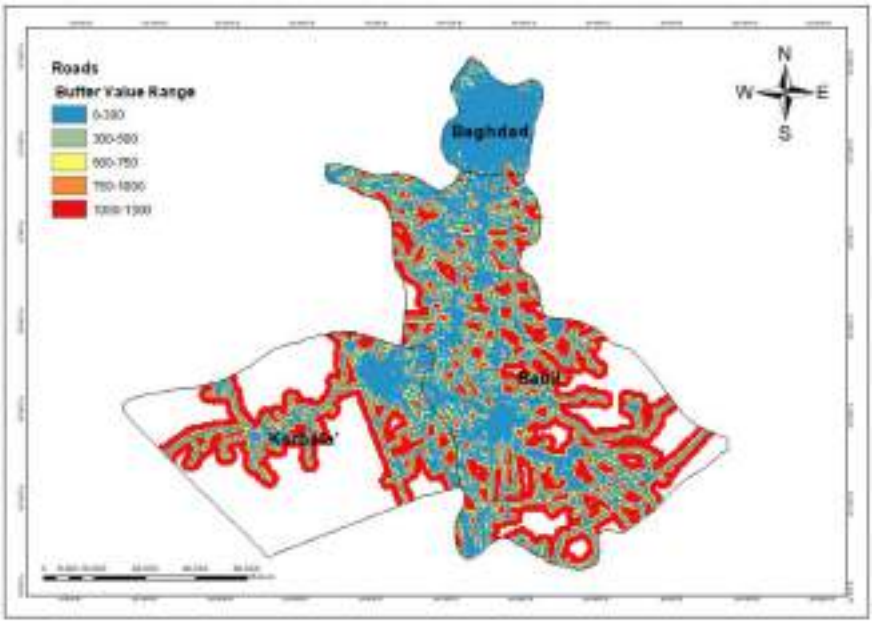

Figure -11 Distance from roads networks in study area.

As a fundamental principle, landfills should not be situated within 100 meters of major highways, city streets, or other transportation routes. It is essential to choose a suitable distance from the road network to ensure efficient waste transportation and reduce associated costs. Based on various sources, the study recommended a buffer

zone of 500 meters from main roads. Distances ranging from 1000 to 1500 meters were considered moderately suitable, while the highly suitable range fell between 300 to 500 meters. The findings revealed that 31.3% of the total buffered distance is highly suitable for solid waste dumping sites (figure 11).

The study determined safe distances from settlements (figure 12), setting them at 2500 meters for urban centers and 1500 meters for rural villages. The settlement areas were then classified based on their suitability. the map reclassified as unsuitable (0-500 m), less suitable (500-1000 m), moderate suitable (1000-1500 m), and most suitable (1500-2000 m). Among the levels of suitability, the study area had the highest proportion of unsuitable land, covering 45% of the total area. The appropriateness of the buildings in relation to the Baghdad governorate was confined to the administrative borders of the governorate, as well as the southern part. for Babil, the best area was distributed to the northern and eastern part and a small part to the south of the province. While in Karbala Governorate, the best area was in the northern and northeastern part.

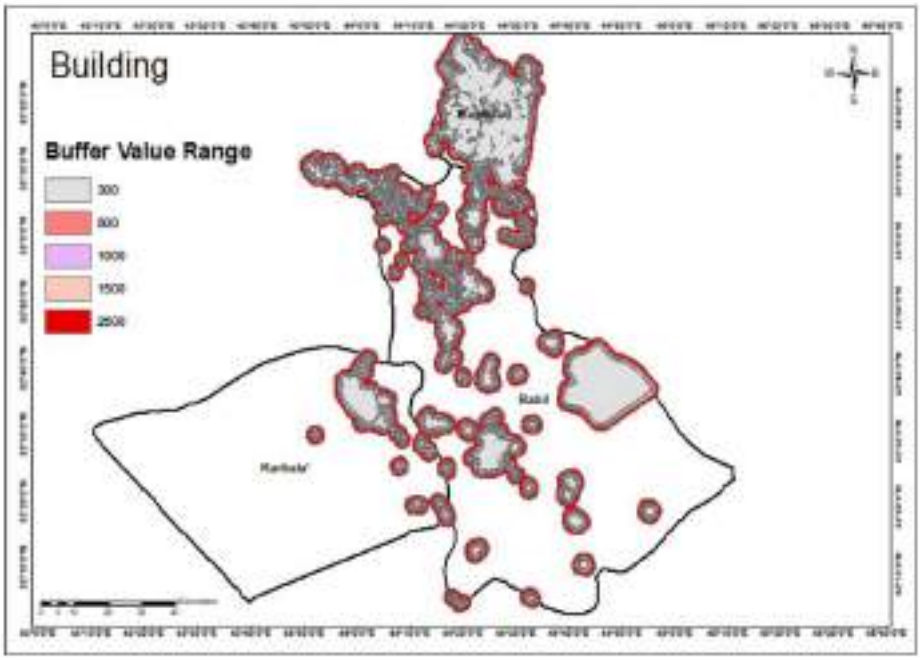

Figure -12 Distance from settlement area.

The process of selecting a solid waste disposal site involves a comprehensive assessment of various options, considering geological, environmental, social, and economic impacts. By analyzing these factors, the final map of the suitability index (figure 13) has been computed, enabling a well-informed comparison of different potential locations for the dumping site. The map has been classified into four class (best, moderate, low, very low).

For Baghdad province, the largest part was very low class, while the moderate class were distributed in the northeastern and southeastern parts, for the best class (figure 14) there are four sites, one in the north, second in the south, and the last two one in the west part, all these

sites on the administrative borders of the governorate.

For Babylon, there are many sites suitable (figure 14) for landfilling waste (35 sites) distributed in the north, center and south parts of the province, for the moderate class (figure 13), they were distributed largely in the western part. While for the unsuitable sites, they were generally concentrated in the center and west of the province.

In Karbala Governorate, the best parts were in the northern and northeastern part (about 7 sites) (figure 14), and the unsuitable parts (figure 13) in Karbala Governorate are also located in the northern part, which is close to Al-Razzara Lake.

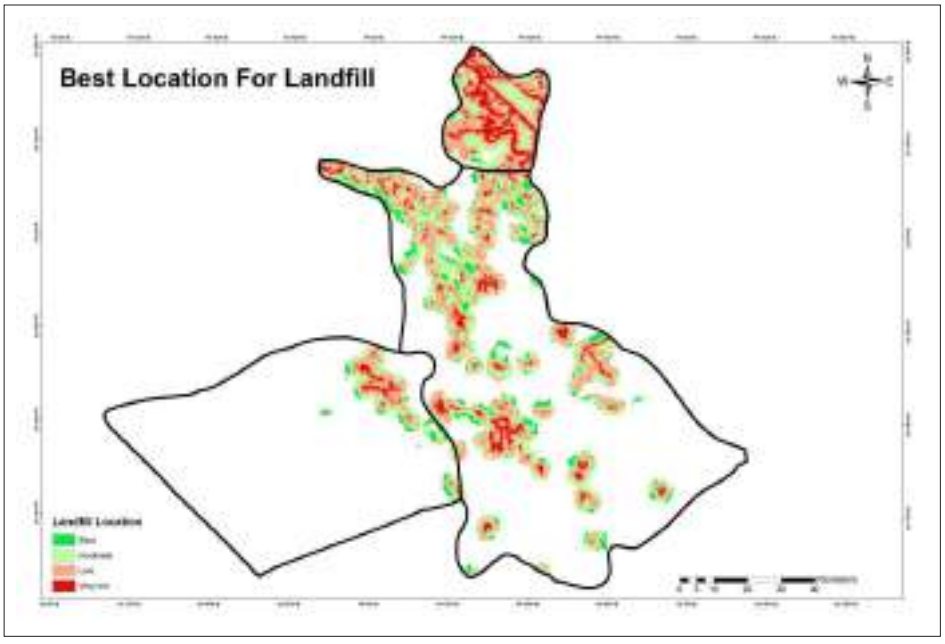

Figure -13 Final map of suitable location of landfill site in study area.

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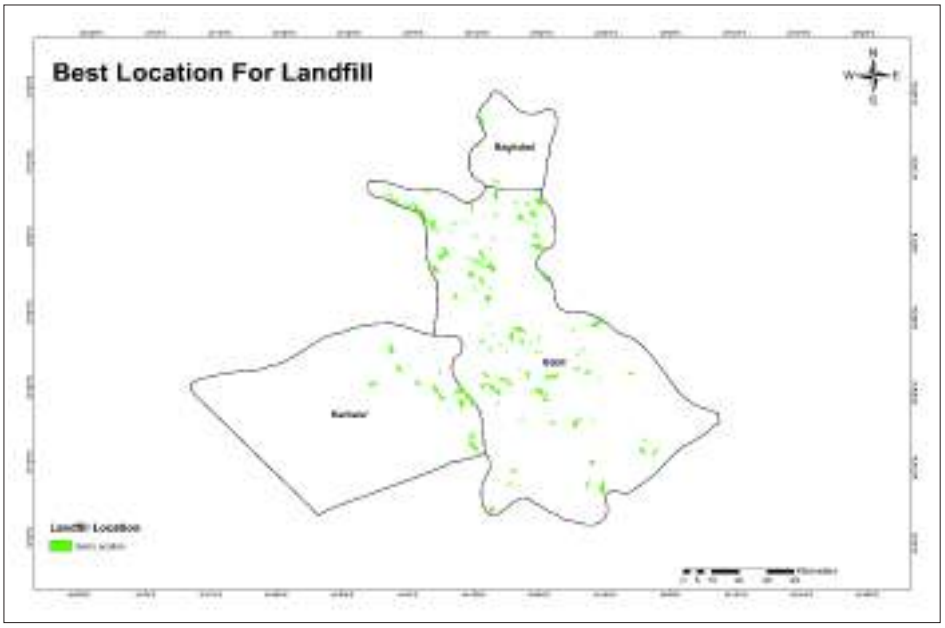

Figure -14 The restricted area for best landfill site in study area.

5. The Modern Practical Vision of Establishing a Landfill, and How to Disseminating the Culture of the Waste Recycling

The double liner system (figure 15) is a design concept used in the construction of landfill sites to help prevent the contamination of soil and groundwater by the waste materials placed in the landfill. Landfills are designed to safely contain and manage waste, and the double liner system is one approach to minimize the potential for environmental harm. The double liner system consists of two layers of impermeable materials that are installed within the landfill to create a barrier between the waste and the surrounding environment. The layers typically consist of:

Primary Liner: The primary liner is the innermost layer of the double liner system and is in direct contact with the waste materials. It is typically made of a high-density polyethylene (HDPE) geomembrane, which is a synthetic material that is impermeable to liquids. This liner helps prevent the leachate, which is the liquid that forms as water interacts with waste, from seeping into the surrounding soil and groundwater.

Secondary Liner: The secondary liner is installed outside the primary liner and serves as an additional barrier to further prevent the migration of leachate into the environment. It is typically made of a compacted clay liner or another impermeable material. The secondary liner provides an extra layer of protection in case the primary liner becomes damaged or compromised.

In addition to the primary and secondary liners, the double liner system may also include various drainage systems, leachate collection systems, and monitoring equipment to detect and manage any potential leaks or environmental concerns.

The goal of the double liner system is to create a controlled environment within the landfill that minimizes the impact of waste on the surrounding ecosystem. It helps to contain potential pollutants and prevent them from seeping into the soil and groundwater, reducing the risk of contamination. However, it's important to note that the effectiveness of the double liner system depends on proper design, construction, and maintenance of the landfill facility.

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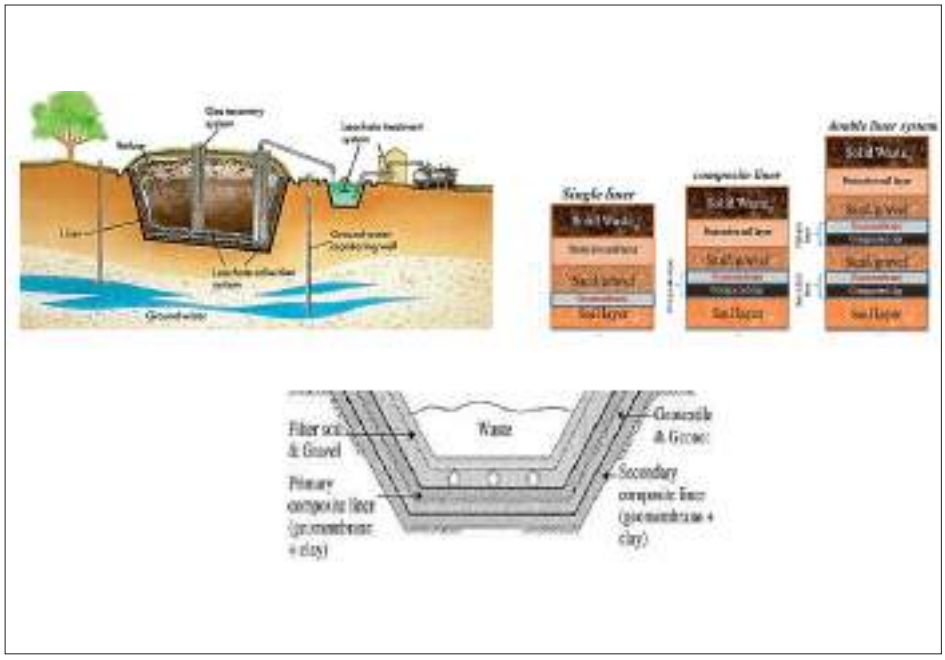

Figure -15 Schematic of modern landfill process (modify from: www.oocities.org).

The choice of the best type of geomembrane depends on various factors, including the specific application, site conditions, environmental regulations, and project budget. Geomembranes are synthetic materials used in various engineering and environmental applications to control fluid migration (such as liquids and gases). When selecting a geomembrane type, considerations include the material's physical properties, chemical resistance, durability, installation requirements, and long-term performance. There are several types of geomembranes commonly used, each with its own advantages and disadvantages. Some of the most common geomembrane materials include:

High-Density Polyethylene (HDPE): HDPE geomembranes are

popular due to their excellent chemical resistance, durability, and UV stability. They are commonly used in landfill liners, mining applications, and water containment projects. HDPE geomembranes are known for their strength, flexibility, and ability to withstand a wide range of environmental conditions.

Low-Density Polyethylene (LDPE): LDPE geomembranes are similar to HDPE geomembranes but have lower tensile strength and are typically used in less demanding applications.

Polyvinyl Chloride (PVC): PVC geomembranes offer good chemical resistance and are often used in applications such as decorative ponds, water containment, and wastewater treatment facilities. They are also available in various formulations to suit specific needs.

Ethylene Propylene Diene Monomer (EPDM): EPDM geomembranes are commonly used in applications requiring high flexibility and elongation properties. They are often used in water containment systems and decorative ponds.

Polypropylene (PP): PP geomembranes offer good chemical resistance and are used in applications similar to HDPE geomembranes. They are known for their resistance to heat and some organic solvents.

Chlorosulfonated Polyethylene (CSPE): CSPE geomembranes are known for their excellent chemical resistance to a wide range of substances, making them suitable for applications involving aggressive chemical environments.

Reinforced Geomembranes: These geomembranes combine a geomembrane with a reinforcement layer (typically a geotextile) to provide additional strength and durability. They are often used in applications where high mechanical stress or puncture resistance is required. Geotextiles are permeable fabrics, made from either polypropylene or polyester. When used in several different applications, mainly associated with soil, geotextiles have the ability to separate, filter, reinforce, protect, or drain. Geotextile fabrics come in three basic forms: non- woven geotextiles, woven geotextiles (needle punched), or heat bonded geotextiles (structural woven).

Minimum buffer strip between composting facility boundary and landfill site also adjacent property shall be min 350 -500m.

Promoting waste segregation precedes the phase of waste recycling. The dissemination of this culture may take from one to three years, accompanied by monitoring, follow-up, and corrective measures to rectify improper practices. However, this step will yield both cultural and financial benefits for the entities involved. We can initiate by organizing awareness campaigns for visitors, then extend our efforts to all institutions, eventually encompassing all establishments in Karbala. Cultivating waste segregation begins with the very first institution in building any society—the family—followed by schools. It is essential to create a general culture among young individuals that disposing of waste should be in designated locations. There should be separate receptacles for plastic waste, glass waste, food scraps, and so forth. This practice should extend to state institutions and public facilities

where regulations can be enforced. There are three main aspects that need clarification in this context:

- **Utilizing media, publicity, and advertisements to disseminate the culture of waste separation:** Raising awareness about waste separation can be achieved through strategic media campaigns, public relations efforts, and targeted advertisements. These initiatives should focus on educating the public about the importance of segregating different types of waste for proper disposal and recycling. By effectively utilizing various media platforms, such as television, radio, social media, and billboards, we can reach a wide audience and encourage them to adopt responsible waste management practices. This approach will contribute to building a more environmentally conscious society and pave the way for successful waste recycling endeavors. It is possible to use educational institutions such as universities and institutes to achieve this subject.
- **Waste Containers Waste separation is facilitated by utilizing five distinct colored containers:** a. Paper Waste Container: Designed to accommodate the significant amount of paper waste generated within educational institutions. b. Plastic Waste Container: Intended for collecting plastic water bottles and other plastic materials. c. Metal Waste Container: Reserved for the collection of metal cans from carbonated beverages and other products. d. Glass Waste Container: Allocated for the disposal of juice and other glass container remnants. e. Food Waste Container: Dedicated to the disposal of food leftovers, vegetable waste, and similar organic materials. By implementing this container system, the efficient sorting and appropriate disposal of various waste types can be achieved, contributing to an environmentally

conscious waste management strategy.

- **Waste Recycle bins** (figure 16) It is preferable to have five colored bags to facilitate waste separation. In case these colors or labels are unavailable, the contents inside the bag should indicate their category.
- A vehicle equipped to securely transport these sealed bags to a storage facility for waste bags.
- Compacting the separated waste, each type individually, into cubic meter-sized units.
- Paper waste is thermally treated and recycled to manufacture cardboard for food and other products. Plastic waste is thermally treated and recycled to produce reusable plastic products. Metal waste is cut and recycled according to requirements. Glass waste is melted and recycled as needed Food waste is recycled into fertilizers.

Figure -16 Recycle bins

- To minimize the operational costs of this project, the following

mechanisms are recommended:

- A clause in contracts with procession owners ("Al-Mawakib") stipulating that the second party bears the cost of five colored containers placed near their premises.
- Municipalities of Karbala, Babylon, and Baghdad enforce the provision of containers of various types for Husseiniyahs procession owners.
- Manufacturing compactors can be initiated as graduation projects for engineering students, particularly in the engineering colleges of Karbala, according to the type of compressed materials.
- Utilizing publishing houses to create labels for different containers.
- In the future, the Ministry of Industry or private plastic factories could be involved in producing colored bags.

Promoting the culture of waste separation will not only benefit institutions and municipalities, but it will also instill a new mindset among students, employees, and professors, transforming the city into a more environmentally friendly and cherished place for its residents. Let's start taking action from this moment forward!

6. Conclusions

The analysis provided valuable insights into suitable locations for landfill sites and waste recycling factories in the three governorates, considering various geological environmental and socioeconomic factors. The information derived from this study can guide decision-makers in implementing effective waste management strategies and

selecting appropriate sites to minimize environmental impact and optimize waste disposal practices. The Spatial Suitability Analysis of landfill site and waste recycling factories in Karbala, Babel, and Baghdad Governorates yielded the following main conclusions:

1. Suitability Index Map: The comprehensive assessment of geological, environmental, social, and economic factors led to the development of the Suitability Index Map, which classifies potential locations for the dumping site into four classes - best, moderate, low, and very low.
2. Baghdad Governorate: The majority of Baghdad province was categorized as very low suitability for landfill sites, indicating limited viable options. Moderate suitability areas were dispersed in the northeastern and southeastern parts. However, only four sites were identified as the best class, located in the north, south, and west regions, near the administrative borders of the governorate.
3. Babel Governorate: Babel displayed a higher number of suitable landfill sites (35 sites) distributed across the north, center, and south regions. The moderate suitability class was mainly concentrated in the western part, while unsuitable sites were generally found in the center and west of the province.
4. Karbala Governorate: The best areas for landfill sites (around 7 sites) were located in the northern and northeastern parts, offering potential options for waste disposal. However, the unsuitable areas were concentrated in the northern region, particularly near Al-Razzara Lake.
5. Area of Best Class: The total area of the best class in each governorate was approximately 8 km in Baghdad, 236.82 km in Babylon, and 45.9 km in Karbala, suggesting the availability of

limited space with higher suitability for landfill sites.

6. The research presented a practical implementation vision for promoting a culture of waste recycling, starting from home(family), and extending to the stage of execution.

Acknowledgements

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Spatial distribution of green land use and its role in reducing temperatures in the Middle Euphrates region in Iraq as a walking area for visitors of Zeyart AL-Arbaeen

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Abstract

The Middle Euphrates region is considered one of the agricultural areas in which farms abound and are distributed in places to the exclusion of others. In general, several factors affect the distribution of green areas, such as soil, climate, water sources, the availability of manpower for agricultural purposes, and markets consuming agricultural products, and for the purpose of understanding the spatial distribution of green areas in this region These factors were studied, and the researcher reached the area of green areas in the study area and its environmental impact in reducing the temperatures of the neighboring cities In addition to the itineraries that visitors to Imam Hussein take on foot (Zeyart AL-Arbaeen), by relying on modern satellite images, geographic information systems, and remote sensing techniques.

Keywords: Green areas; NDVI; Land Surface Temperature; Middle Euphrates region, Zeyart AL- Arbaeen.

1. Introduction

The Middle Euphrates region is an important region in the country as it has fertile soil through which the Euphrates River passes, as this river is an important water source for this region that meets the need for water in agriculture along with groundwater in the region, which made this region characterized by the presence of many farms And the orchards, which have an important role in enhancing the environment, preserving the ecological balance, providing the necessary food basket, and providing the necessary income for the farmers of this region.

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These papers discuss the spatial distribution of these green spaces of various kinds within the Middle Euphrates region and their role in reducing temperatures.

In general, there is a group of geographical characteristics that affect the distribution of green and agricultural land uses, and they can be summarized as follows: (Abd et al., 2016, p. 247)

a. Natural characteristics: which include land surface (gradient), climate, soil, and water resources.

b. Human characteristics: which include the labor force in agriculture and their experience, in addition to the farmer's relationship with his land (the extent of his connection with it), as well as within the human characteristics are the irrigation methods and methods adopted for it, the drainage systems, agricultural mechanization and transportation methods for the purpose of marketing.

Green areas can be defined as lands planted with various types of plants, as they include squares planted with grass, farms, orchards, forests, public gardens, home gardens, and green belts for cities. (Kamouna et al., 2009, p. 9). The research was limited to farms and orchards due to the large study area.

Green areas today have become one of the basic requirements for the population, as they are no longer secondary as in the past, in addition to the need for them and the demand for them increases whenever the economic situation improves and the standard of living rises. Rather, their existence is of great importance indicating the progress of the region) Al-Kinani and Najm, 2017, p. 3(.The presence of agricultural green areas works to maintain the environmental balance and helps to face environmental risks (Laffta et al., 2021, p. 76).

The uses of green land, which include farms, have many benefits in the social, economic, aesthetic, recreational, and climatic fields, as they directly affect temperatures as their presence significantly reduces temperatures, so they help in facing the challenges of climate change (Abdulwahab et al., 2023, p. 1953).

2. study area:

The location of the study area, its water sources, and soil types will be identified, in addition to the climate in the Middle Euphrates region , the cities within it, and The main itineraries that visitors take, in order to finally identify the reality of the green areas in it.

2.1. Location:

The study area is located within the five governorates (Karbala - Babil - Najaf - Al-Qadisiyah - Al-Muthanna) with an area of (32674 km2), between latitudes (30°51'40") and (33°4'36") from the north, and between longitudes (43°10'47") and (45°50'1"), it is within the sedimentary plain (Al-Sami'e et al., 2023, p. 256) as in Map 1.

The province of Baghdad is located within the borders of the northern Middle Euphrates region, and the provinces of Wasit and Dhi Qar are in the eastern borders. As for the southern borders of the study area, the desert of Muthanna and Najaf extends to the borders of the Kingdom of Saudi Arabia. Views have differed in defining the borders of the region of the Middle Euphrates region. (Al-Jumaili, 2016, p. 248).

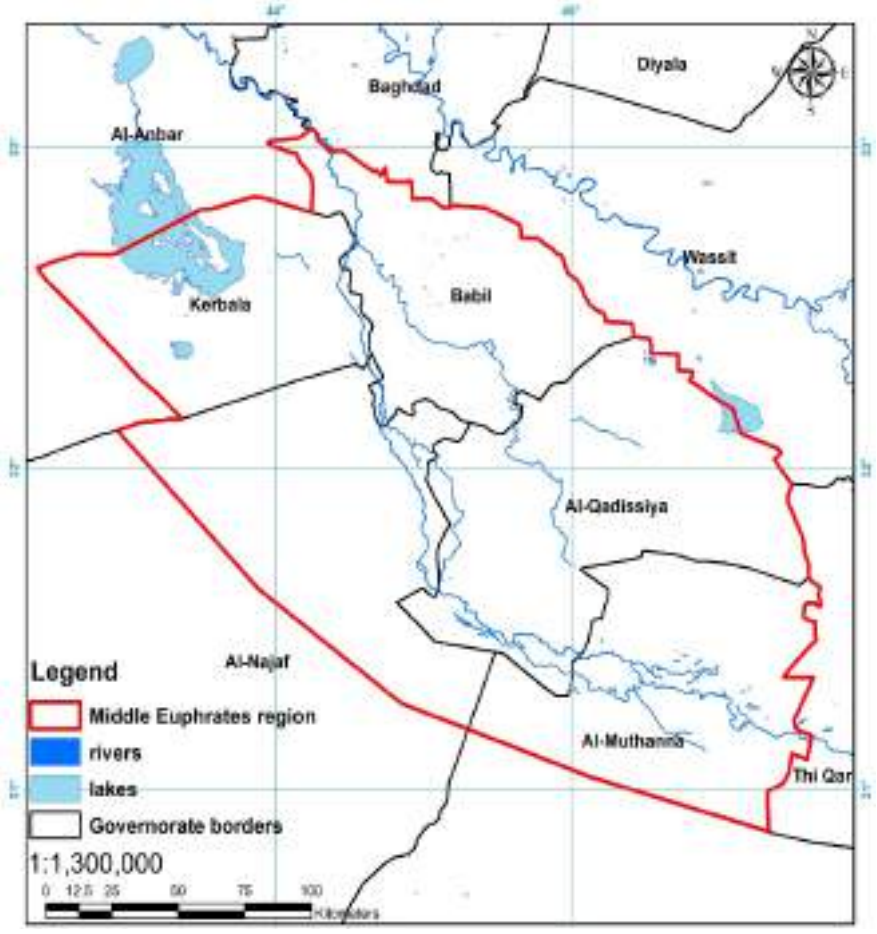
Map (1) Location of the Middle Euphrates region in Iraq

Source: Researchers by GIS

2.2. water resources:

The most important source of water in the Middle Euphrates region is the Euphrates River and its branches. It enters the study area through the province of Babylon, then passes through the province of Karbala, then Najaf, then Al-Qadisiyah, then Al-Muthanna, as in Map (2) (Al-Khafaji et al., 2022, p. 3). It has a direct impact on the uses of green land in this region as well as all other urban activities.

Also, groundwater is considered the second source of water, especially in the western part of the study area. The main source of groundwater is rainwater if groundwater levels rise in the rainy season and decrease in Dry seasons, as well as the Euphrates River and its streams that also feed groundwater.



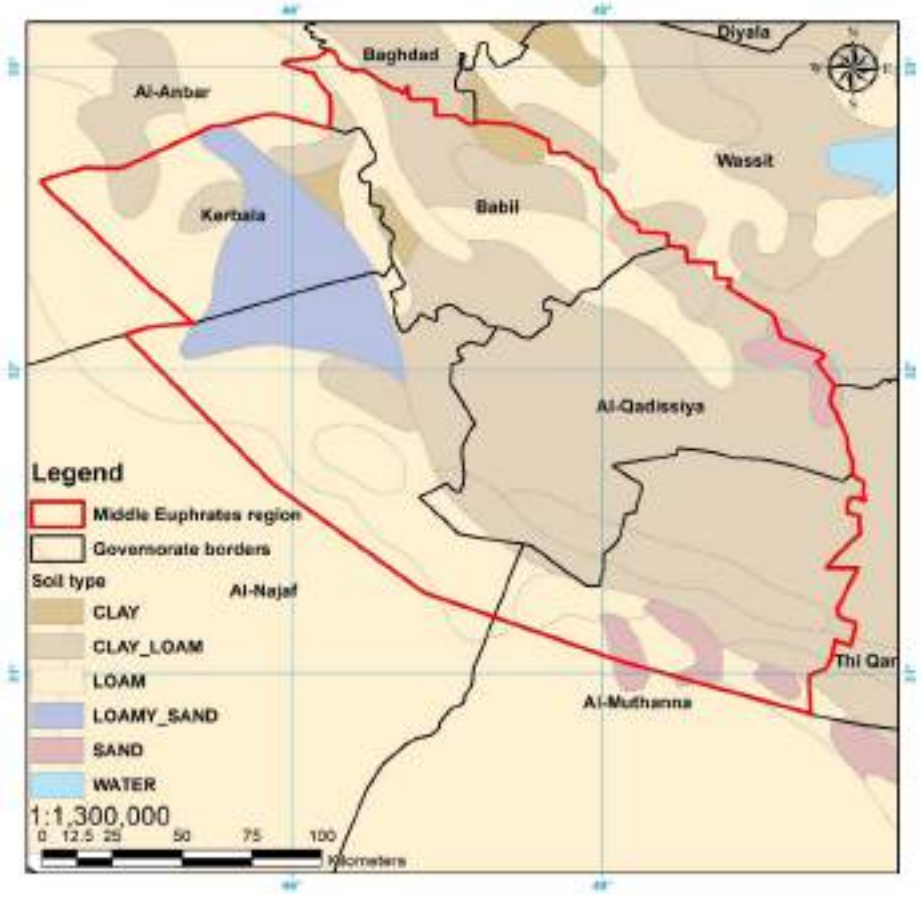
Map (2) The Euphrates River and its branches within the Middle Euphrates region

Source: Researchers by GIS

2.3. soil:

Agriculture depends largely on the availability of water and arable soil, as this is available in the study area, where a large proportion of arable land is available (Alowaid et al., 2021). Map (3) shows the soil types in the study area. The technological and scientific development that we are experiencing today has a clear impact on the agricultural fields, as it has become possible to reclaim soils that are not suitable for cultivation, to treat and improve the quality of the soil, as well as methods and means of delivering water to areas where it is not available (Hussein et al., 2021, p. 486). All this leads to an increase in the areas that can be cultivated. The options also vary in harmony with the characteristics of the soil, its type, and the locations of the land to be cultivated, as it is possible to grow crops that tolerate high salinity, as well as organic farming is one of the possible options (Shanishil et al., 2022, p. 352).

The lightest type of soil is sand soil, as this type of soil drains water quickly and the nutrients in it are low. It is noted in the study area that the area of this type of soil is small. Also, loam soil is one of the good types of soil for agriculture, whether it is clay or sandy, as it drains water well and achieves an appropriate balance for soil particles. It is clear in the study area that most of the soil is of this type.



Map (3) Soil types

Source: Researchers by GIS

2.4. climate:

The climate has an effect on plants and crops. The effect may be direct or indirect, as the temperature has an effect on the spread of agricultural crops, affects the times of cultivation and maturity, and affects the process of photosynthesis, growth, food absorption, etc., that the solar radiation must meet the amount required for summer or

winter crops, as well About the importance of rainfall and its role in providing the quantities of water required for agriculture (Yousafani, 2021, p. 239).

The study area is located within what is known as the desert climate, which is semi-arid, where the predominant characteristic is high temperatures, which extend to more than 183 days, while its winter is short, not more than 90 days, and therefore there are no agricultural activities that do not depend on irrigation (Al-Jumaili, 2016, p. 248).

Temperature rates in the study area begin to rise gradually with the beginning of January in the winter season, and so on until July and August in the summer season, when the temperature reaches its peak, and then it gradually decreases again until October. Therefore, the climate of the Middle Euphrates region highlights the summer and winter seasons. In their presence, the emergence of the spring and autumn seasons decreases, as the month of October is often transitional between summer and winter, while the month of April is transitional from winter to summer. In general, temperatures often do not exceed the rates needed by agricultural crops, and do not fall below zero degrees Celsius, so that the growth of some agricultural crops is affected. As a result, the study area enjoys a long growing season for plants that allows the cultivation of different crops (Al-Jubouri, 2016, p. 250).

The hours of sunshine in the central Euphrates region range between 10.2 hours per day during January in the winter and 14.1 hours per day during the summer month of July. The study area is dominated by a lack of clouds and a relatively clear sky, that is, the sun's rays are mostly not

obscured, except for a few ineffective days, which helps in the cultivation of multiple crops (Al-Jubouri, 2016, p. 246).

The amounts of precipitation falling in the middle Euphrates region in winter, despite its relative scarcity, positively contribute to the irrigation of various agricultural crops, which contributes to enhancing other water sources. Humidity rates are relatively high in winter, and this benefits the soil and plants. The prevailing winds in the middle Euphrates region are northwest, followed by North wind (Al-Jubouri, 2016, p. 269).

2.5. Cities of the Middle Euphrates Region:

The Middle Euphrates Region includes 41 Iraqi cities of various administrative levels within the five governorates within which the region is located and distributed throughout the area of the region) Iraqi Central Statistical Organization, 2023(as in Map (4).

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Map (4) Cities of the Middle Euphrates Region

Source: Researchers by GIS

2.6. Visitor itineraries:

The Arbaeen pilgrimage is one of the largest religious gatherings in the world, during which visitors go to the shrine of Imam Hussein, peace be upon him, in the holy city of Karbala, which is considered one of the most important Iraqi cities, The beginning of this event will be with the beginning of the second month in the Islamic Hijri

calendar and will continue until the 20th day of the same month. Most of the visitors are Iraqis, including quite a few foreigners from different countries. In 2019, approximately 21 million visitors participated in this ritual, Visitors start walking from the various Iraqi governorates passing through the Middle Euphrates region towards the holy city of Karbala (Soltani et al., 2021, p. 1), as in Map (5) which shows the Itineraries of visitors within the study area, as confirmed by (Lami et al., 2019, p. 3) and (Sadiq et al., 2016, p. 105).

Map (5) Itineraries of visitors through cities in the Middle Euphrates region

Source: Researchers by GIS

Therefore, it is necessary to work to reduce temperatures as much as possible in their itineraries, especially with the climate changes and high temperatures in recent years.

2.7. Green land uses:

The researcher determined the areas for green land uses in the Middle Euphrates region, based on geographic information systems programs and on Landsat 9 satellite images, which were taken in the fourth month of 2023, and through the Normalized Difference Vegetation Index (NDVI), which adopts the following equation: (Yasin et al., 2022, p. 5)

NDVI = (NIR – RED) / (NIR + RED)

NDVI : Normalized Difference Vegetation Index

NIR : mean light reflected in the near-infrared spectrum

RED : mean light reflected in the red range of the spectrum

Normalized Difference Vegetation Index "is equal to the difference in the intensities of reflected light in the red and infrared range divided by the sum of these intensities" As in Figure (1).

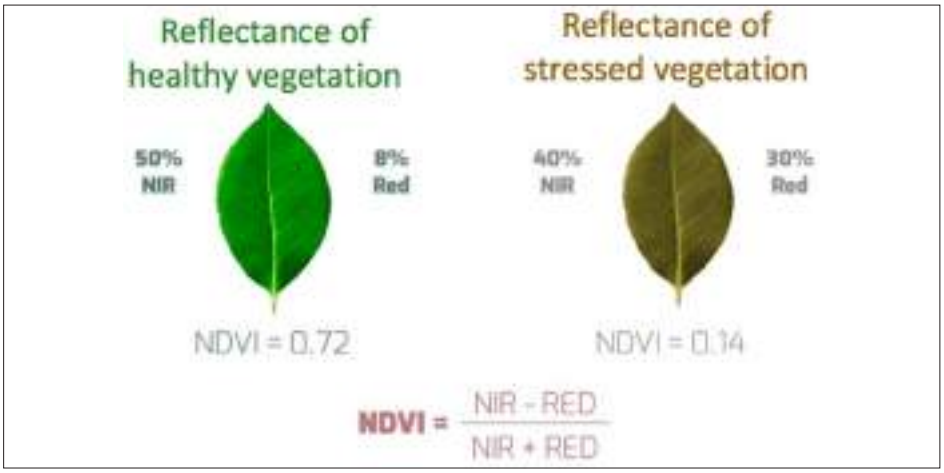
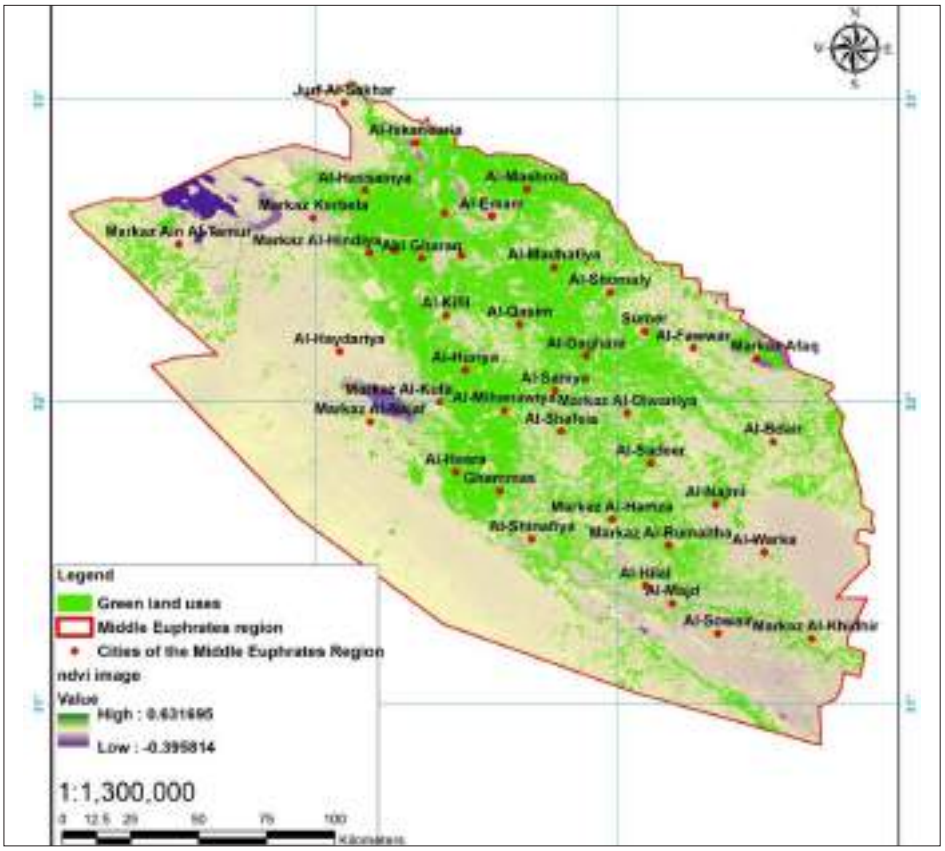


Figure (1) The difference between a healthy and an stressed plant for (NDVI)

Source: (Loures et al., 2020, p. 2)

NDVI values are between (-1) and (1), negative values indicate clouds, snow and water, negative values close to zero indicate rock and bare soil, small positive values (0.1 or less) indicate free land areas that consist of rock Or sand, medium values (0.2) to (0.3) refer to small shrubs and grassy plantations, large values (0.6) to (0.8) refer to farms, orchards and forests (Zhao et al., 2023, p. 4).

It was found that the area of green land uses in the Middle Euphrates region is approximately (991 km2), which represents 30.33% of the total area of the study area, and it is distributed within the region as in Map (6).



Map (6) Green land uses according to NVDI

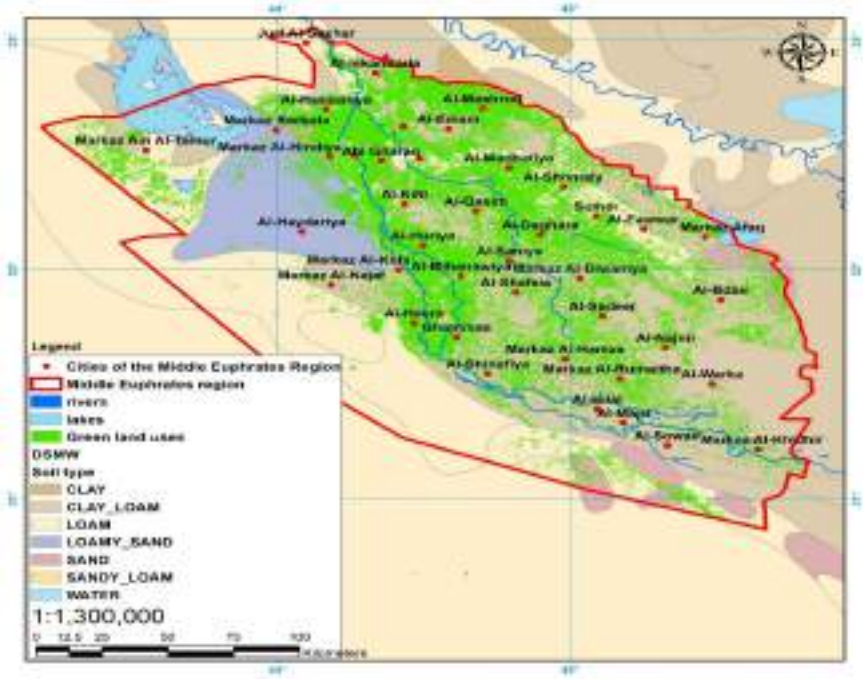
Source: Researchers by GIS

By conducting a comparison between the types of soil, the presence of surface water sources, and the distribution of green land uses, as in Map (7), it is clear that the green land uses are concentrated near and along the Euphrates River within the middle Euphrates region, and within the area of land with clay loam soil mainly.

It also seems clear that there are few farms in the southwestern parts of the region towards the western desert of the country near

the center of Ain al-Tamr and in the south of the cities of As-Sawir and Al-Majd, where the official and governmental agencies in Iraq have begun to invest in these areas with agricultural projects for environmental and economic purposes.

Where it overcame the limitations in these sites such as soil type and the lack of nearby surface water sources by using scientific means and methods in agriculture and relying on groundwater, and as a result it contributed to stabilizing the soil, enhancing the environment, and employing manpower, in addition to many other benefits of these projects in these areas.



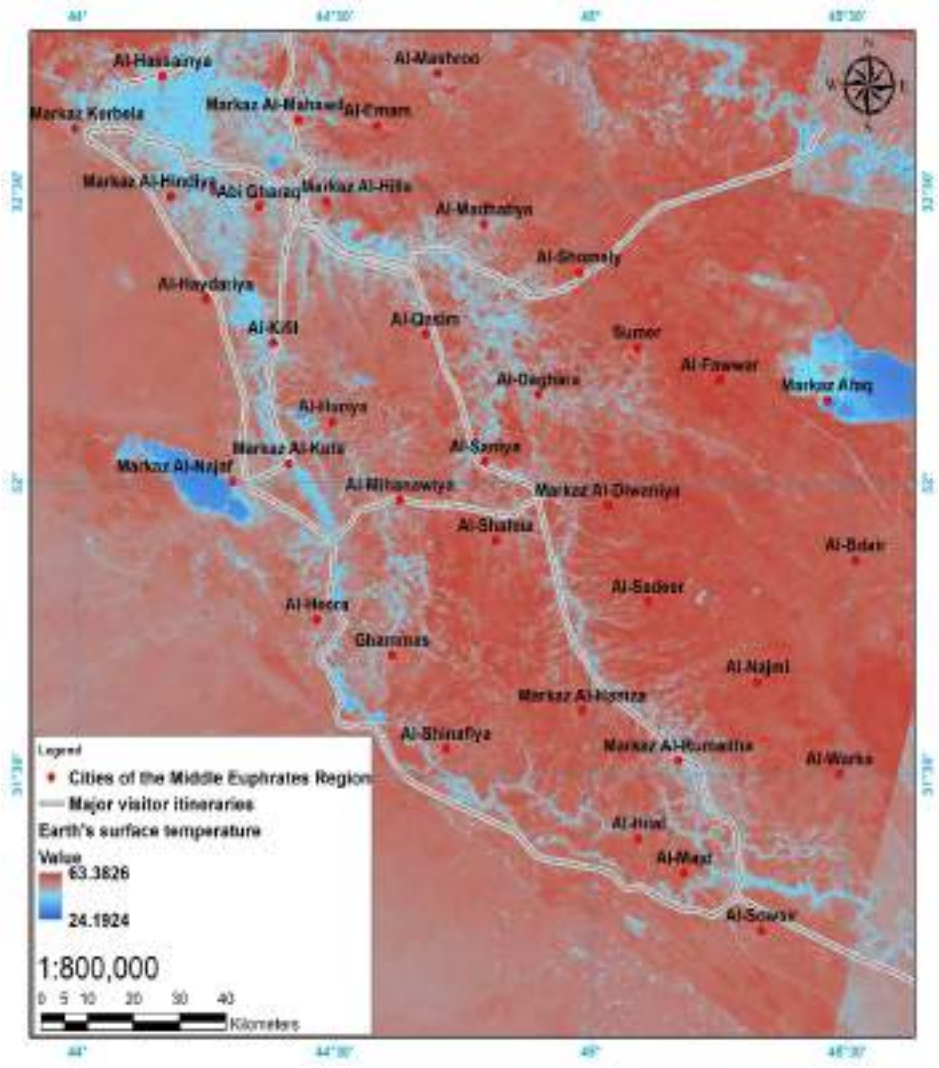
Map (7) Comparison of soil types, presence of surface water sources, and distribution of green land uses

Source: Researchers by GIS

2.8. Land Surface Temperature:

For the purpose of identifying the effect of green areas on reducing temperatures within the study area, the researcher made a map of the Earth's surface temperatures based on satellite images of the Landsat 8 satellite that were taken in the eighth month of 2022, that is, at the height of the summer season.

Where after downloading these satellite images, several operations are carried out on them, starting with converting their numerical values into spectral radiation, then the satellite temperature is extracted from the spectral radiation, after which the vegetation cover is extracted to determine the emission from the surface of the earth, and this is a series of operations to finally reach the temperature of the surface of the earth Which is extracted in Kelvin and then converted to the Celsius unit (Fayshal et al., 2023, pp. 5–6), Where the researcher applied these steps based on geographic information systems (Arc map), as the results were as shown in Map (8).



Map (8) Land Surface Temperature

Source: Researchers by GIS

Where it is clear that the temperature of the earth's surface decreases in the areas that contain green areas, as the temperature of the earth's surface in the center of the city of Hilla, for example, was 38 degrees Celsius, while the temperature in its surroundings between it and the city of Abi Gharaq was 32 degrees Celsius, at the same time it was The surface temperature of the earth in the city of Karbala is 40 degrees Celsius, and the difference between the temperatures of the two cities of Hilla and Karbala is due to the northwesterly winds and the fact that the city of Karbala is bordered by the desert and open lands from the northwest, the surface temperature of the earth is higher than that of the city of Hilla, which is located within the surrounding agricultural areas It is located in all directions, and therefore the winds, before reaching the city of Hilla, pass through the green and agricultural areas, so they work to cool them down, which in turn reduces the temperature of the city.

All of this is reflected in the itineraries of visitors, and therefore the itineraries near which the green areas are located have lower temperatures compared to the itineraries that are far from the green areas. For example, the temperature in the visitors' itineraries that connects Markaz Al-Diwaniyah with Markaz Al-Hilla, specifically in the city of Al-Qasim, reached 40 degrees Celsius. While the temperature dropped on the same track before entering the city of Hilla, specifically in the agricultural area on the outskirts of the city, to 34 degrees Celsius. Therefore, the difference between the two points in the same itinerary in temperature was 6 degrees Celsius, and this difference is due to the presence of green areas.

Conclusions:

1. The abundance of water within the study area, where the Euphrates River with its branches provides an important source of water, reinforced by the presence of groundwater.
2. The soil in the study area is suitable for cultivation, whether it is clay or sandy.
3. The climate within the study area promotes agriculture and helps grow a variety of crops.
4. The study area includes many cities (41) in addition to some villages that provide labor (farmers), and the cities represent the market that consumes agricultural products.
5. Green areas represent 30.33% of the study area with an area of 991 square kilometers
6. Adopting modern technologies in agriculture and irrigation enables us to cultivate land that is not suitable in one way or another for cultivation, whether the soil is not suitable, whether due to the distance of water sources or others.
7. The difference in earth surface temperatures between green and uncultivated areas reaches 10 degrees Celsius
8. Cultivated green areas that are in the path of the winds before entering the cities cool the winds and thus reduce the temperatures in the cities.
9. Itineraries of visitors when entering agricultural areas where temperatures drop and become more comfortable.

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Recommendations:

1. Supporting agriculture and farmers because of its economic, environmental and recreational benefits
2. Work to establish green belts, especially for the cities bordering the Western Desert
3. Supporting agricultural projects in the Western Desert
4. Selecting the types of plants and crops according to scientific studies before giving official approvals
5. Cultivating types of plants of high economic value that can have a suitable environment
6. Work on afforestation of visitors' Itineraries because of its environmental benefits and because it reduces temperatures and provides appropriate shade in addition to other benefits

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Study and Predicated of Signals and Noise Pollution during Ziyarte Al-Arbaeen Compared to normal days

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Abstract

Radio-frequency interference (RFI) in radio telescope observations refers to the level of radio-frequency noise in the sky at all times, regardless of any astronomical sources this noise may be coming from including the Earth's atmosphere and solar activity as well as all communications equipment near the areas of interest. Make it radio-quiet and reduce or reduce noise pollution in it in order to preserve people's health, as well as provide a quiet monitoring area within the same range of these frequencies.

In this study, we designed two dipole antennas in different frequency bands to measure the radio noise level. The research can focus on studying the levels of signals and noise pollution resulting from interference within the same frequencies during normal days to compare with the days of religious visits in different regions of Iraq, especially Karbala Governorate, to study the effect of signals and noise pollution on public health and the health of visitors in particular during the performance of the visit due to the presence of gatherings great humanity. The project may also include a study of the possibility of media coverage of the event within the same frequencies and an attempt to reduce the negative impact of radio interference and the effect of signals and noise pollution during religious visits, as the use of mobile phones may lead to an increase in noise levels and a decrease in the sound quality of the coverage. This research can contribute to identifying the negative effects of signals and noise pollution during religious events and identifying measures to reduce these effects on visitors.

With our antenna design, the quality and working performance of the antenna was measured by measuring the impedance (Z) and the standing wave ratio (SWR). Our coaxial cable has a characteristic impedance of 80 Ω for LBA and about 50 for HBA and SWR Range Explanations between (1.0-2.0) for HBA and about 1.5 for LBA, which is a good match for the bipolar half-wave.

The radio interference ratio was measured during different days and times to find the amount of variation on normal days, where the morning LBA value is -76.232±0.7733.and the HBA .0.6814±68.7106, also, in the afternoon the value is about -77.4956 1.06541 and -72.7847±1.1583 for LBA and HBA, respectively, as well as the measured nighttime -82.352±0.5066 and -82.7397 0.4997 for LBA I'm HBA, respectively. When comparing these values, note that they are higher in the morning for both LBA and HBA.

In an actual attempt to determine the percentage of radio noise, we will use the aforementioned antennas to make the same measurements during Ziyarte Al-Arbaeen to determine the extent of the impact on the RFI value caused by the number of visitors and thus its impact on the quality of communications. Where the radio interference is commensurate with the large number of radio devices used by the security and service agencies supporting Ziyarte Al-Arbaeen and studying the possibility of reducing its effects on the health of visitors first, as well as the extent of its impact on radio monitoring in the event of installing radio telescopes close to the area.

Keywords: radio frequency interference, a dipole antenna, Ziyarte Al-Arbaeen, communications.

Introduction

Radio signals are weak of man-made radio signal noise, or a sign that interferes with blocking radio astronomers' signals is called radio frequency interference (RFI) [1] In radio reception, radio noise is defined as unwanted random RF electrical signals and fluctuating voltage, which are always present in the radio receiver in addition to the desired radio signal [2,3]. for observed RFI, by using LOFAR telescope which is a large radio interferometer operating in the frequency range 10-240 MHz (corresponding to wavelengths of 30.0-1.2 m) contains two dipole antenna fields: LBA (Low Band Antennas) and HBA (High Band Antennas)[4,5]. The LBA operates in the frequency range 15-80 MHz The HBA antennas the frequency range 110-240 MHz [6]. The dipole antenna consists of two identical conductive elements, such as metal wires or rods. The driving current from the transmitter is applied, or for receiving antennas, the output signal to the receiver is taken between the two halves of the antenna and displacement and adjustment of the antenna is a hassle [7]. the reason for chose dipole antennas offer the advantage of receiving balanced signals from various frequencies. It also helps the device sort out problems caused by conflicting signals without losing reception quality [8]. Noise pollution is a major problem in urban environments, affecting human behavior, well-being, productivity and health [9]. Nowadays assessments of environmental noise in urban areas are mainly carried out by officials who collect data at a sparse set of locations, e.g., close to roads, railways, airports and industrial estates, by setting

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up sound level meters during a short period of time [10]. Studying signals and noise pollution during the visit of Al-Hussain Arbaeen is an important topic that attracts the attention of many researchers and experts in communications and the environment where Arbaeen is characterized by heavy visitor attendance and high traffic flow and poses significant challenges regarding the area's wireless signal quality and noise pollution therefore, studying this phenomenon and analyzing the effects that may result from it is necessary to determine the necessary procedures to improve the quality of signals and reduce noise pollution during this religious visit [11, 12]. In terms of noise pollution, large gatherings of people at religious events can increase noise levels in the surrounding area, especially if loudspeakers and other audio devices are used. This noise pollution can affect the environment and wildlife in the surrounding area, as well as human health and quality [13,14]. This study aims to analyze the signals and noise pollution during the Arbaeen visit and compare them to normal days, using the latest technologies and devices for data collection and analysis. The results of this study can be used to determine the necessary measures to improve signal quality, reduce noise pollution during the Arbaeen visit, and provide a healthy and safe environment for visitors and residents in the area.

Design of Half Wave Dipole Antenna

to measuring the variation of RFI which effect on visitors, we designed two dipole antennas in different frequency bands: a low-band antenna (LBA) with a frequency range (15-80MHz) and a high-band antenna (HBA) (110-240MHz), which is connected to a series receiver spectrum analyzer. HSA2000, for radio background level measurement for design dipole antenna which include two conductive elements like wires and rods or wires, The conductive element in the antenna is split in the middle into two sections through an insulator which is called an antenna section. These sections are connected to a coaxial cable or feeder in the middle of the antenna and there is a gap between two arms of half-wave dipole antenna for feeding purpose. Through antenna design, the dimension of an antenna frequency Through our antenna design, the dimension of an antenna frequency (f), for low band 20.1 MHz and high band 90MHz has been chosen. Here, the radiation resistance of the half-wave dipole is ≈ 50 Ohm, which matches the line impedance by using the fundamental equations for design antenna the wavelength (of dipole can be calculate by using (1) equation depending on radio signal frequency.

by calculate the wavelength for low band antenna:[8]

$$\lambda = \frac{c}{f} = \frac{3x10^8}{20x10^6} = 15 \quad m \ldots\ldots\ldots\ldots (1)$$

and the wavelength for high-band antenna

$$\lambda = \frac{3x10^8}{90x10^6} = 3.3\ m$$

then, the length of the dipole antenna(L) has been found from the equation (2).

$$L = \frac{\lambda}{2} = \frac{15}{2} = 7.5\ m \quad \ldots\ldots\ldots\ldots\ldots (2)$$

$$L = \frac{\lambda}{2} = \frac{3.3}{2} = 1.65\ m$$

the length of wire that we used is less than the obtain length for both LBA and HBA because of the resistance of the wire used in the manufacture of the antenna, which affects the inductive current

The feeding gap (g) and wire radius (R) were calculated from equations (3) and (4), respectively for both low band antenna and high-band antenna

$$g = \frac{L}{200} = \frac{7.5}{200} = 37.5\ mm \ldots\ldots\ldots (3)$$

$$g = \frac{L}{200} = \frac{1.65}{200} = 8.25\ mm$$

$$R = \frac{D}{2} = \frac{3}{2} = 1.5\ mm \ldots\ldots(4)$$

$$R = \frac{D}{2} = \frac{5}{2} = 2.5\ mm$$

Parameter	Value of LBA	Value of HBA	Unit
Frequency *(f)*	20	90	MHz
Wavelength (λ)	15	3.3	M
Average Impedance	50	49	Ohm
Length of the dipole (L)	7.5	1.65	M
Radius of the dipole (R)	1.5	2.5	Mm

Table (1): Design Parameters of the Antenna

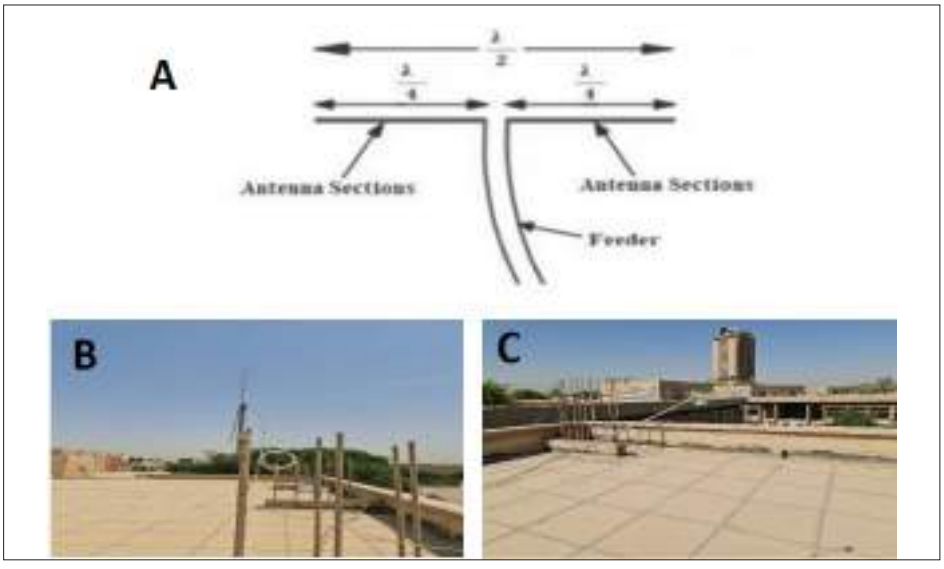

figure (1): (A) The basic Half-wave dipole antenna diagram. B) actual designing for our antenna for high band antenna(HBA) (C) actual designing for our antenna for low band antenna(LBA)

Component Basics to Receiving Background or Radio Signal

When we design our antenna, which is the main component of our telescope, we test these tools and exams the main feature of any antenna, which are Antenna impedance (Z(Ω)) and Standing-wave ratio (SWR), by Vector Network Analyzer (VNA) which is a handheld with a small outline, initially designed by edy555. It is a low-cost yet high-performance (at its price point) VNA with an LCD and can be powered by a 3.7V Li-ion battery. also, by using the HSA2000 series spectrum analyzers, the electromagnetic wave flowing over the dipole antenna at the receiver section will induce a small voltage with a Frequency Range: of 9 kHz to 3.2 GHz. as shown in figure (2).

figure (2): A) handheld Vector Network Analyzer (VNA) with small outline, originally designed by edy555. B) The HSA2000 series spectrum analyzers are 1.LCD 2. Menu softkeys/menu control keys 3. Charge indicator (Only lights up when charging 4. Knob 5. Direction keys 6. Numeric Keyboard 7. Power switch (Lighting normal work status) 8. Function key area C) Real picture of the HSA2000 series spectrum analyzers from our laboratory

The Impedance (Z) matching between transmission lines and antennas is an important and fundamental concept in electromagnetic theory or the resistance and reactance the antenna terminals or the ratio of electric to magnetic fields so we designed for LBA and HBA as shown in figure (3A), (3B). Our coaxial cable has a characteristic impedance of 80 Ω for LBA and about 50 Ω for HBA which wo a good match for a half-wave dipole. Also, when designing the antenna, the other parameters must test these tools and exams the main feature of any antenna, which is the Standing-wave ratio (SWR), which is defined as the ratio of the maximum radio-frequency (RF) voltage to the minimum RF voltage along the line or in the other word it's matching between transmission lines and antennas is an important and fundamental concept in electromagnetic theory. At the same time, it is a mathematical expression of the non-uniformity of an electromagnetic field (EM field) on a transmission line such as a coaxial cable. Usually, SWR Range Explanations between (1.0-2.0) are the ideal range when SWR is under 1.5 and want to drop closer to 1 due to additional tuning, different equipment, or a different mounting location. Figure (3C), (3D), represents the measuring Standing-wave ratio (SWR) for antennas we designed for LBA and HBA.

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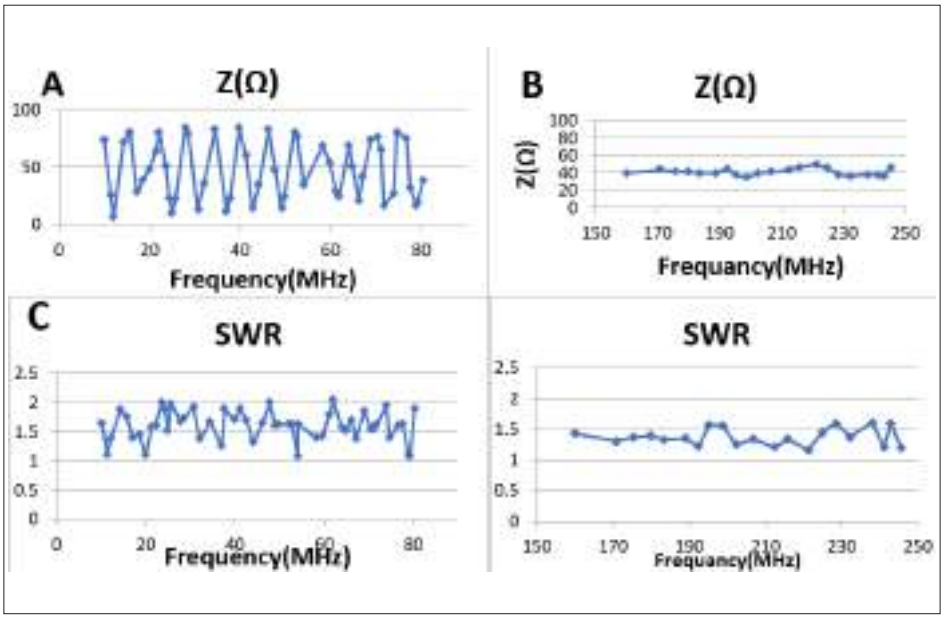

Figure (3): (A) the Impedance antennas designed for LBA (B)the Impedance antennas designed for HBA. (C) Standing-wave ratio (SWR) for antennas designed for HBA. (D) Standing-wave ratio (SWR) antennas designed for LBA.

Interference Radio Signals Testing in Baghdad

To compare Interference Radio Signals, in regular and eclipsing day we must test our antenna (LBA and HBA) in Baghdad governorate, so we test the ratio of the signal on different days and times the limiting noise source in a receiver depends on the frequency range in use.

For both LBA and HBA measuring the radio spectrum presented the power obtained from background noise (radio stations, mobile, communication towers. etc.) and the desired radio signal. The background noise is measured by unit dBm/ Hz/s, which is calculated as a negative value according to the equation:

$$dB_m = 10\log(\frac{1}{power}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Where

dB_m = logarithm scale of power

The device measured the power in this scale to receive a broad signal range, such as faint and robust signals, because it has high sensitivity and accuracy.

The first Interference Radio signals test was carried out for different days in Baghdad on (5/9/2022) for both LBA and HBA by measuring the radio spectrum during the morning period (9:00-12:00) AM Iraqi local time (+3 GMT) at a rate of four observation per hour which contain 461data for each quarter of an hour during specific frequency.

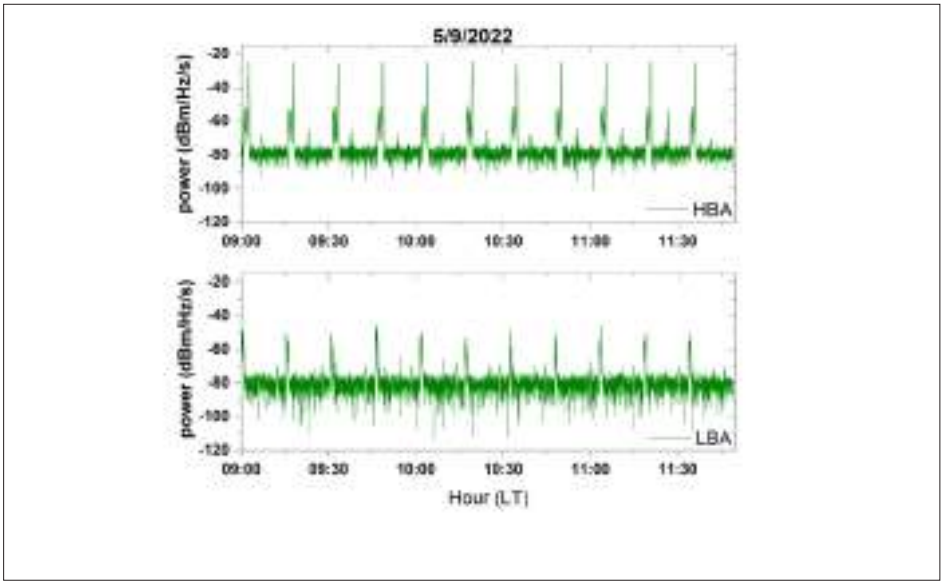

Figure (4): the power of radio signal (background noise) during morning period for LBA and HBA

From figures (4), the observation background noise level ranges from about > -80 for both the HBA and LBA observations. We note that the power behavior for the previously mentioned date is approximately constant with time. Also, the power value is the highest because of this radio frequency band's different and massive during the morning observation time. Also, comparing LBA and HBA background noise in Baghdad, the HBA value is higher, which means the signal power is lower and vice versa. In addition, the value of LBA is higher than HBA because this range is more for being the most used in mobile communication, fixed ground services, amateur, and the military.

the value in the morning for LBA:

$$ave = -76.232 \mp 0.7733$$

The value in the morning for HBA:

$$ave = -68.7106 \mp 0.6814$$

Also, a study was carried out for different days (7/9/2022) in the afternoon for LBA and HBA by measuring the radio spectrum at (12:00-14:30) PM local Iraqi time (+3 GMT) at a rate of four observations per hour where the spectrum presented the power obtained from background noise. Furthermore, to determine the power, as shown in Figure (5).

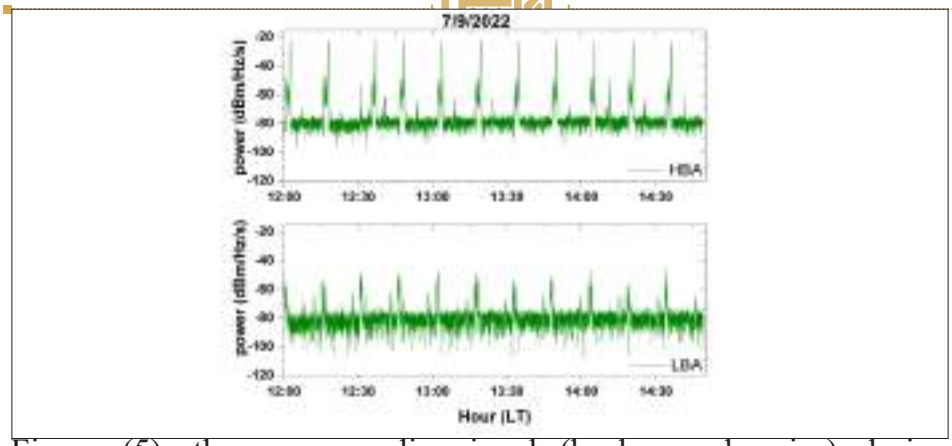

Figure (5): the power radio signal (background noise) during afternoon

The power's behavior for all days is approximately symmetric for the morning in value and behavior. The value in the afternoon for LBA:

$$ave = -77.4956 \mp 1.06541$$

The value in the afternoon for HBA:

$$\text{ave} = -72.7847 \mp 1.1583$$

Also, an Interference Radio signals test was carried out for different days in Baghdad on (2/10/2022) for both LBA and HBA by measuring the radio spectrum during the night time (16:00-18:30) PM local Iraqi time (+3 GMT) at a rate of four observation per hour which contain 461data for each quarter of an hour during specific frequency.

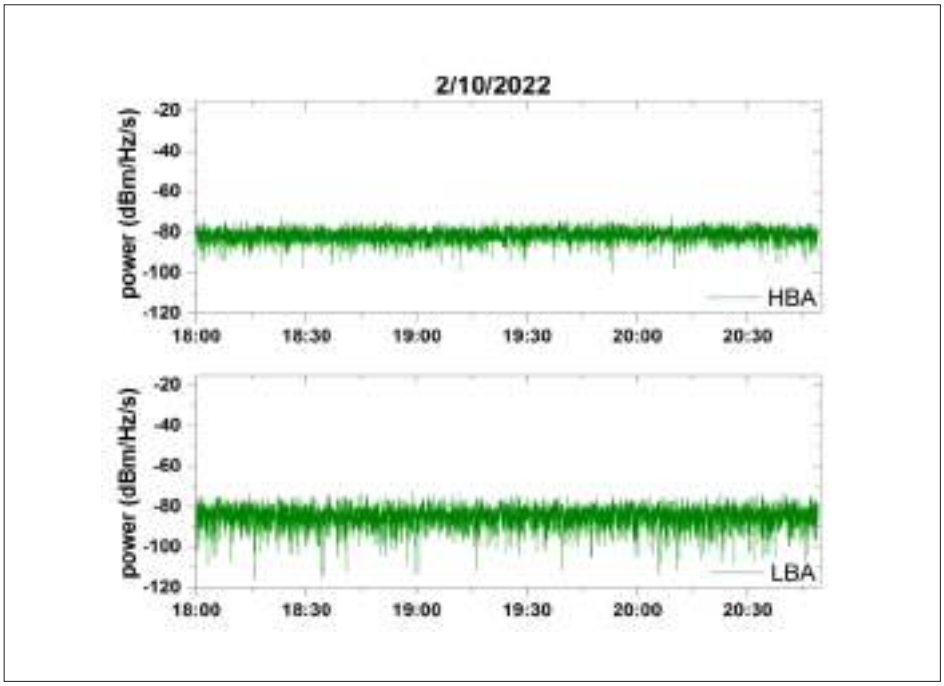

Figure (6): the power radio signal (background noise) during nightv

Figure (4-6) shows smooth behavior for both LBA and HBA, where the reason could be at night, the ionosphere experiences a decrease in plasma density at all altitudes because the production of ions is significantly attenuated. In contrast, recombination rates of electrons and ions remain high, especially at low altitudes where the recombination process is fast and lack of surrounding noise.

night for LBA:

$$ave = -82.352 \mp 0.5066$$

The value at night for HBA:

$$ave = -82.7397 \mp 0.4997$$

These values show that the average background noise measuring the difference between different times, despite the convergence of importance, is a logarithmic difference that's mean 10dBm; also, when compared between these values, note that it is higher in the morning for both LBA and HBA.

After applying all the determinants on the map of Iraq and taking into account all the influences that cause noise on the signal and which can limit the selection of the monument area, the results of the spatial analysis of the governorates of Iraq showed that four Iraqi governorates that can establish a monitoring station on low frequencies, are Nineveh, Al Anbar, Najaf, and Al Muthanna. The research will deal with each governorate with regard to coordinating the parameters and defining the appropriate area for building the station and monitoring. By studying the candidate governorate for installing the binoculars, and because the goal is to build a radio telescope in an area completely far from the causes of noise and radio interference, and for this reason a buffer zone was established in the empty areas of each governorate by leaving a distance of 20 km from

the nearest communications tower, and then leaving 10 km from the borders of the zone free of any influence as a future safety distance. The research came to identify the best areas in these governorates for the installation of radio telescope antennas. Despite the proximity the distance, and the nature of Karbala governorate, similar to Najaf governorate in terms of religious and social character, it was found that Karbala cannot be considered among the suitable areas for radio monitoring due to the high noise on normal days and the most increase during the Arbaeen visitation period causes of interference (increase the number of population and thus communication equipment, etc. where excessive noise may affect the ability to hear speakers clearly, making it difficult for reporters and editors to record information and content accurately and clearly. High noise levels also increase the chances of disturbances in wireless communications, leading to dropped connections or reduced picture and sound quality.

Discussion

It is possible to link the visitor service for religious events with noise pollution and astronomy by looking at the environmental impact of religious events, especially those that include large gatherings of people and their many uses of mobile devices, and reduce them. For this purpose, we designed a new and innovative radio telescope dipole antenna to open the lower frequency radio system to a wide range of astrophysics studies capable of operating in the 10-240 MHz to measure RFI measured a regular day during the afternoon and night.

The smooth behavior for both LBA and HBA at night could be that

the ionosphere experiences a decrease in plasma density at all altitudes because the production of ions is significantly attenuated. In contrast, recombination rates of electrons and ions remain high, especially at low altitudes where the recombination process is fast. The research can focus on studying the levels of signals and noise pollution during normal days and the days of religious visits in a specific area, and the available data can be analyzed from environmental monitoring stations located in the region. It is also possible to study the impact of signals and noise pollution on general health and well-being during religious visits and to compare them to normal days. This can be done by conducting surveys with residents and visitors who attend religious events to assess the impact of signals and noise pollution on individuals' religious experience and mental health. The project could also include studying the social and environmental impact of signals and noise pollution during religious visits and the extent of their impact on the infrastructure and environment surrounding religious sites. This research can contribute to identifying the negative effects of signals and noise pollution during religious events and identifying actions to maintain public health and well-being during these events.

Conclusion

By measuring the radio noise in Baghdad, it was found that it is a high-noise area, and to compare the results with Karbala governorate, which is similar to Baghdad in terms of radio interference on normal days and the days of Ziyarte Al-Arbaeen, due to the use of phones, which is considered one of the most important causes of interference

that affects the coverage of the visit event by adding noise pollution to the environment audio and reduce the quality of the audio coverage. Since the visit may include large gatherings of people, to reduce this negative impact, some measures can be taken, such as placing restrictions on the use of mobile phones during coverage and instructing attendees not to use mobile phones at certain times. Noise filtering and sound quality improvement equipment can also be used for audio and video coverage.

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Assessing the feasibility and impact of energy projects resulting from waste recycling during Ziyarat Al-Arabaeen

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Abstract:

The aim of this study is to study effects of capabilities resulting from waste recycling in Iraq. Finding sustainable solutions is essential because society has dangerous issues in waste production and energy production by rotating this waste. This study is specifically focused in Iraq and the technical, financial and environmental aspects of a number of waste recycling techniques, such as anaerobic digestion, combustion and reinforcement. In addition, the employment of these technologies may increase economic opportunities, increase energy security, and greenhouse gas emissions. The results will help decision -makers, investors and stakeholders in developing plans to increase the effectiveness of renewable energy and waste management in Iraq.

The current study is looking for waste recycling projects to energy in Iraq and exploring the feasibility of applying these projects to address the waste problem and energy lack. The current research takes into account the financial, technical, organizational and social aspects of such projects and proposes a framework to successfully implement them. The study also sheds light on the potential benefits of energy projects resulting from waste recycling, such as reducing greenhouse gas emissions, generating renewable energy, and creating jobs. The results of this study can help decision makers to make accurate decisions about waste management and renewable energy strategies in Iraq.

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Keywords:feasibility assessment ; energy initiatives ; waste recycling ; renewable energy ; waste transformation ; environment and sustainable development

Introduction

Waste management and energy production is very important for all countries in the world. Iraq is considered one of the ricing countries facing many challenges in finding solutions for sustainable development with regard to waste and energy production (1). The increase in the population, the expansion of the urban area, and the industrial growth in Iraq lead to an increase in the quantities of waste (2). In addition, many religious events are held in Iraq, and visitors from all parts of the world flock to attend them, the most important of which is the Arba'een Ziarat in the city of Kerbala, and during this event, large amounts of waste are generated that are supposed to be treated immediately through modern global technologies, as they are used, for example, in energy production (3). These issues lead to the consumption of the waste management infrastructure.

After international reports showed that Iraq is the tenth in environmental pollution, and a statistic by the Iraqi Ministry of Planning that more than a third of the country's population is not covered by the waste collection and transport service during the year 2020-2021 the percentage of the population served by the waste collection service at the level of Iraq amounted to 65.7%, while

the percentage of served at the urban level reached 90.7% in urban areas, and in rural areas was 12.5%, as the usual amount of waste raised amounted to 11.8 million tons per year)the average amount of waste generated per capita amounted to 1.3 kg per day(and the percentages according to the usual waste disposal methods showed the highest percentage of disposal by landfill in sites that did not have environmental approval and constituted (93.8%), followed by the method of landfill in sites that obtained environmental approval by (81.3%), then the method of throwing in empty yards by (37.5%), while the method of recycling or reuse is followed by (12.5%) noting the lack of use of methods (burning, composting, convert it to energy). The number of waste sorting and recycling plants in Iraq is only one private plant in Baghdad (4), operating at a rate of 1,045.2 tons per year. And another factory in Thi Qar is not working. Also, the Municipality of Baghdad announced on Thursday 04-13-2023 the sorting of 9 thousand tons of waste per day, confirming 65% of it as leftovers, while indicating the preparation of intensive awareness programs during the last two years for waste management, revealing It needs more than two million surveillance cameras to keep the capital, Baghdad, clean.

In the last decade, the interest in energy production projects has increased from waste recycling in order to meet the problems of waste management and energy production (5). The goal of these projects is to convert waste into environmentally friendly energy with various operations such as burning, anaerobic digestion and the

processing process (6).

In order to be able to evaluate the energy projects caused by the recycling of solid waste, it requires research for many different factors (7). The goal of this study is to implement these projects in Iraq today and appreciate the economic feasibility and their environmental impacts. We will analyze data through the statistics of specialized institutions, infrastructure, policies and legislation in order to determine obstacles and opportunities to implement such projects (8).

This study will address the methods used to produce energy from non-recyclable waste, taking into account the extent of their suitability for investment in Iraq. Through the availability of waste, raw materials, infrastructure requirements, and local energy to allocate the most appropriate methods used for implementation.

In addition to the foregoing, the economic feasibility of producing environmentally friendly, low-carbon energy will be assessed, by referring to project costs, operating budget, revenues, and financing methods. This study will also indicate, in addition to the material return that can be obtained from waste recycling, the environmental and social return is much higher, and this is represented in reducing environmental pollution instead of burying and burning waste, including air emissions, water pollution, and waste management. Solutions will be presented to reduce and mitigate these impacts, ensuring the effective participation of projects in environmental sustainability, as well as preserving natural materials, benefiting

from raw materials, providing new job opportunities, in addition to providing energy alternatives (3).

Energy waste recycling initiatives in Iraq hold great potential for addressing waste management and energy problems. Where Iraq can create a sustainable waste management law, produce environmentally friendly energy, and participate in environmental protection and social and economic development (9).

In the end, the study will provide important insights and proposals for officials, relevant government agencies, and investors in waste and energy management in Iraq. The results of this study will also help in offering sustainable solutions for waste management, and reduce dependence on common energy sources, as it is one of the innovative climate solutions to convert non-recyclable waste into electricity to provide clean, low-carbon energy, which is reflected in raising the level of sustainable quality of life in Iraq (10).

Obstacles or Constraints

1. Iraq is one of the countries that lag behind in the waste management process, as there are few and not serious projects in the field of waste.
2. The culture of recycling and its environmental and economic impact is low in society, and this may constitute an obstacle in the absorption of electricity production projects by the public.
3. The few technical and engineering expertise specialized in the field of design and operation of waste-to-electricity plants

4. Stable political conflicts affect the country's economy and thus affect investment in waste-to-electricity projects.
5. Random collection and sorting of waste in the country This affects the regulatory framework for waste management and makes it unstable, which may cause problems in the implementation of projects to produce electricity from waste.

In general, facing these challenges requires joint efforts by individuals and officials to build the necessary foundation for such projects, develop technical and engineering expertise, legislate supportive laws, and spread the culture of recycling to raise awareness and accept waste-to-energy.3. Lack of technical and engineering expertise through which waste-to-electricity stations can be designed and operated.

4. Iraq is exposed to financial confrontations due to ongoing political conflicts and insecurity, and this may affect investment in waste-to-electricity projects.

5. The random collection and sorting of waste in Iraq makes the regulatory framework for waste management unstable, which may cause problems in the implementation of electricity production projects from waste.

In general, facing these challenges requires organized efforts from individuals and officials to build the necessary infrastructure for such projects, develop technical and engineering expertise, enact supportive laws, and spread a culture of recycling to raise awareness and accept the conversion of waste into energy.

Waste recycling technologies to produce energy

The literature shows that there are advanced tools and techniques for Municipal solid waste (MSW) treatment, and each of the techniques may have advantages and disadvantages, see Figure (1). These tools or techniques may range from source reduction to recycling and waste-to energy (WtE) technologies although open dumping of MSW is prevalent particularly in the most developing countries as mentioned earlier (6,11).

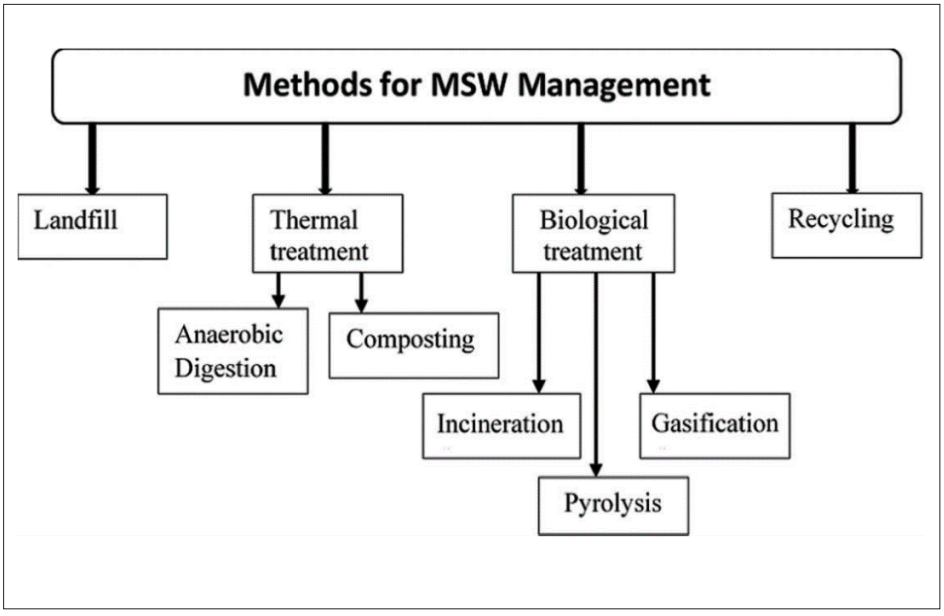

Figure (1): A schematic view of methods for MSW treatment (6).

The most important social effects of waste recycling plants for energy production

1. Employing manpower and contributing to solving the problem of unemployment, as the percentage of workers in recycling is six times more than workers in traditional methods of waste disposal.

2. Low costs of therapeutic expenditure for community members as a result of the decrease in environmental pollution, as biological treatment of waste reduces its accumulation, and thus the decrease in the transmission and spread of infection with infectious diseases, and the low spread of insects and animals that transmit diseases.

3. Waste recycling and energy production plants contribute to improving the community lifestyle through the establishment of centers specialized in waste collection and treatment.

4. It can raise the cultural level of individuals through safe waste disposal methods and thus maintain a clean environment

5. Providing large areas of land to be used as dumping dumps that can be directed to other uses, as well as increasing investment in tourism as a result of improving the aesthetic appearance of the country.

Proposed projects underway for waste recycling and energy production in Iraq

Waste recycling and energy production plants provide great social benefits through sustainable development, and raise the level of health, educational and economic reality of the country and that the most important stations in Iraq are:

Station Name	Location	Amount of Waste	Treated Production
Basra (Figure 2)	Basra Governorate	1200 tons of solid waste	electricity generation
Baghdad	Baghdad province	1500 tons of solid waste	electricity generation
Erbil	Erbil Governorate	450 tons of solid waste	Production of fertilizer and recyclable materials
Sulaymaniyah	Sulaymaniyah province	600 tons of solid waste	Production of fertilizer and recyclable materials
Kirkuk	Kirkuk Governorate	600 tons of solid waste	Production of fertilizer and recyclable materials

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Figure 2: University of Basrah Waste Recycling Initiative

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Proposed projects for waste recycling and energy production

A good example of waste recycling and energy production plants in the Middle East is the Sharjah Solid Waste Recycling and Power Plant in the United Arab Emirates (12), as the main objective of this plant is to reduce greenhouse gas emissions, achieve carbon neutrality and reduce the effects of climate change to preserve the environment. The plant treats 300,000 tons of solid waste per year, generating 30 megawatts of energy per year, enough to power 28,000 homes. This, in turn, contributes to the displacement of 450,000 tons of harmful carbon dioxide emissions (13), which leads to raising and improving the sustainable quality of life in the Emirate of Sharjah figure 3.

Figure 3: Sharjah Waste-to-Energy Plant

Proposals to increase investment in waste recycling and energy production projects

Increasing investment in this type of project is done by several different policies carried out by the government, and the following is a set of policies:

1- Financial facilities provided by the government to investors in this field represented in granting loans with reduced interest or tax exemption, for example.

2- Benefiting from the experiences of other countries to be able to develop the recycling industry, especially those countries that have reached a high level to achieve a competitive advantage over neighboring countries by sending specialists to these countries for training.

3- Holding many workshops and seminars in order to spread the culture of collecting and recycling waste, starting from kindergartens to schools and universities and even all state institutions. It is also possible to use religious events to spread the culture of waste recycling, for example, in the Arba'een ziarat, processions are provided with containers used for waste sorting, and special leaflets are used to raise awareness.

4- Establishing special centers for research and development in the field of waste recycling in order to carry out continuous improvement in quality and reduce costs. And to achieve the cooperation of these centers with the relevant scientific departments in the universities of Iraq, which leads in the future to the opening of scientific branches specialized in the manufacture and recycling of waste.

5- Enacting strict laws, as found in most countries, on those who pollute the environment, and using an escalating mechanism of penalties in case of repeated violations, so that caring for the environment becomes a social habit that does not need deterrent laws.

6- Preventing the export of waste of all kinds, by the government outside Iraq, and recycling it locally, because of the returns it achieves that far exceed what can be obtained from exporting it raw.

7- Increasing waste collection and sorting centers in the country, in order to facilitate the task and include it in the various areas of the city.

By committing to implementing these proposals, the government will be able to create an environment that encourages investment in these projects, which have great benefits, as detailed at the beginning of the research.

Some important points that the government must adhere to in waste conversion plants for sustainable and safe energy for the community

1- Setting special laws for the design and operation of waste transfer stations to produce energy.

2- Requesting permits and licenses from recycling stations before starting their work and under special conditions to ensure environmental sustainability and security for the community.

3- Trying to address the concerns of the community surrounding these projects through the formation of councils for consultations, meetings and community consultations.

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4- Setting international technological specifications for the establishment of such stations.

5- The government should regularly monitor the compliance of these stations with laws and permits, such as monitoring water and air quality.

By implementing these points, the government can ensure the community's confidence in the environmental safety of these projects and thus endorse waste transfer plants, which will help local and foreign investment.

Discussion

A country like Iraq contains a huge amount of waste according to the statistics of the Ministry of Planning and thus a polluted environment, and on the other hand, a severe shortage in the production of electrical energy needs real efforts represented by the executive authority and cooperation by society to solve these two problems in one way, which is the projects of waste recycling stations and the production of electric power through the imposition of legislation and laws necessary for the establishment and operation of these stations according to international standards and spreading the culture of collecting and sorting waste from inside homes and then Transported to stations for recycling and energy production.

As well as encouraging the private sector to invest in such projects by giving facilities for loans, reducing interest and protecting them from financial risk, as these projects need huge capital. In addition,

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to benefit from the experiences of the countries of the world that have taken great strides in this field, such as China and Germany. Establishing a waste bank, as exists in most developed countries, to urge citizens to collect waste in an orderly manner to facilitate the sorting process.

Such projects have an economic, environmental and social impact, as waste recycling contributes to preserving the environment, reducing environmental pollution and improving the health of individuals. Moreover, the economic effects through creating jobs and reducing the costs of generating sustainable electricity by traditional methods in order to facilitate access to raw materials (waste). As for the social impact, it is through raising the standard of living by providing electrical energy and raising the health level of individuals due to the purity of air and water, as well as creating job opportunities in a country suffering from unemployment.

Last but not least, the initiative to assess the feasibility and impact of energy projects arising from waste recycling in Iraq is critical and necessary to enhance the environment and the health of people nearby, create new jobs, and produce sustainable energy. To determine the social, environmental and economic impacts of the proposed projects and ensure their success and expected benefits, this assessment must be carried out clearly and comprehensively in collaboration with all stakeholders. The best solutions and approaches to reduce environmental pollution and raise the standard of living in the area can also be found using this assessment.

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The impact of environmental collaboration on sustainable Islamic tourism development, a case study of the Ziyarat Al-Arabaeen

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Abstract

Zeyart AL-Arbaeen is the largest annual religious gathering in the world, with millions of Shia Muslims visiting Karbala, Iraq, every year. This study aims to investigate the impact of environmental collaboration on sustainable Islamic tourism development, Taking Zeyart AL-Arbaeen as a case study. The research employed a mixed-method approach, involving both qualitative and quantitative data collection methods. Data were collected from both primary and secondary sources, including interviews, surveys, and literature reviews. The findings indicate that environmental collaboration can positively impact sustainable Islamic tourism development by promoting sustainable practices, reducing environmental degradation, enhancing socio-cultural awareness, and fostering economic growth. The study also recommends that the Iraqi government, in collaboration with religious leaders and other stakeholders, develop policies and strategies to ensure the sustainability of Zeyart AL-Arbaeen.

Keywords: Zeyart AL-Arbaeen,environmental collaboration, sustainable Islamic tourism development, socio-cultural awareness, economic growth.

Introduction

Tourism is an important sector of the global economy, contributing significantly to job creation, economic growth, and poverty reduction (UNWTO, 2021). Islamic tourism, also known as halal tourism, is a rapidly growing segment of the global tourism industry, attracting millions of Muslim tourists every year. Islamic tourism involves traveling to destinations that cater to the cultural, religious, and lifestyle needs of Muslims, including halal food, prayer facilities, and Islamic art and architecture (Kozak & Baloglu, 2011).

The Arbaeen pilgrimage is one of the largest annual religious gatherings in the world, attracting millions of Shia Muslims from around the world to Karbala, Iraq, every year. The pilgrimage commemorates the martyrdom of Imam Hussein, the grandson of Prophet Muhammad (SAWA), who was killed in the battle of Karbala in 680 AD. The Arbaeen pilgrimage has a significant socio-cultural and economic impact on Iraq, with millions of pilgrims visiting the country each year, generating significant revenue for local businesses and the government (Mazhar & Rafiq, 2020).

However, the Arbaeen pilgrimage also has a significant environmental impact, with millions of pilgrims generating waste, contributing to air and water pollution, and putting pressure on local resources (Dabbagh & Pousti, 2018). Therefore, it is important to examine the impact of environmental collaboration on sustainable Islamic tourism development, using the Arbaeen pilgrimage as a case study. This study aims to investigate the impact of environmental

collaboration on sustainable Islamic tourism development, using the Arbaeen pilgrimage as a case study.

Literature Review

Environmental Collaboration

Environmental collaboration involves the cooperation of various stakeholders, including governments, non-governmental organizations (NGOs), businesses, and communities, to achieve sustainable development goals (Koens et al., 2018). Environmental collaboration is an important tool for promoting sustainable tourism development, as it enables stakeholders to work together to identify and address environmental issues, develop sustainable tourism policies and strategies, and implement sustainable tourism practices (Budeanu, 2020).

Environmental collaboration can also enhance socio-cultural awareness by promoting respect for local customs and traditions, fostering cultural exchange and understanding, and promoting community involvement in tourism development (Murphy & Bayley, 2020). Furthermore, environmental collaboration can foster economic growth by creating new job opportunities, promoting local entrepreneurship, and attracting investment in tourism infrastructure (Jafari & Scott, 2014).

Islamic Tourism

Introduction

Islamic tourism is a type of religious tourism that involves travel to destinations with significant religious or cultural significance to Muslims. Islamic tourism has gained increasing popularity in recent years, with millions of Muslims from around the world traveling to destinations such as Mecca, Medina, and Jerusalem for pilgrimage and other religious purposes. This literature review provides an overview of the existing literature on Islamic tourism, including its history, development, and significance.

History and Development of Islamic Tourism

Islamic tourism has a long history, dating back to the time of the Prophet Muhammad (SAWA). The Hajj, or pilgrimage to Mecca, is one of the Five Pillars of Islam and has been a central practice of the faith since its inception. In addition to the Hajj, many other religious sites and destinations have developed around the world, attracting millions of Muslims each year.

In recent years, Islamic tourism has experienced significant growth, with the number of Muslim travelers increasing rapidly. According to the Mastercard-CrescentRating Global Muslim Travel Index 2019, the global Muslim travel market was worth $194 billion, with over 140 million Muslim travelers in 2018. This growth has been driven by factors such as rising affluence among Muslim populations, increased awareness of halal tourism options, and the growth of the Muslim middle class.

Significance of Islamic Tourism

Islamic tourism is significant for several reasons. Firstly, it has important economic implications, generating significant revenue for destinations and contributing to local economies. In addition, Islamic tourism can help to promote cultural exchange and understanding between different nations and cultures. Finally, Islamic tourism has important religious and spiritual significance, providing an opportunity for Muslims to connect with their faith and to deepen their religious knowledge.

Research on Islamic Tourism

Research on Islamic tourism has focused on a range of topics, including the motivations and preferences of Muslim travelers, the impact of Islamic tourism on local communities and economies, and the challenges and opportunities for sustainable tourism development. Some key themes in the literature include:

Motivations and Preferences of Muslim Travelers: Research has explored the motivations and preferences of Muslim travelers, including their preferences for halal food, prayer facilities, and other religious amenities. For example, a study by Abu-Saad (2013) found that Muslim travelers valued destinations with strong Islamic heritage and culture, as well as those with strong halal tourism infrastructure.

Impact of Islamic Tourism on Local Communities and Economies: Research has also explored the impact of Islamic tourism on local communities and economies. Some studies have found that Islamic

tourism can provide significant economic benefits to destinations, particularly through the development of infrastructure and services to support religious tourism. For example, a study by Al-Hamarneh and Mohd-Don (2012) found that the development of Islamic tourism in Malaysia had led to significant economic growth, particularly in the areas of hospitality and food service.

Challenges and Opportunities for Sustainable Tourism Development: Research has also highlighted the challenges and opportunities for sustainable tourism development in the context of Islamic tourism. Some studies have identified issues such as environmental degradation, cultural erosion, and social inequality as significant challenges facing sustainable tourism development in Muslim countries. For example, a study by Tazim (2016) identified the need for sustainable tourism development practices in the context of the Hajj pilgrimage in Saudi Arabia, including waste reduction and resource conservation.

Islamic tourism is an important and growing sector of the global tourism industry, with significant economic, cultural, and religious implications. Research on Islamic tourism has focused on a range of topics, including the motivations and preferences of Muslim travelers, the impact of Islamic tourism on local communities and economies, and the challenges and opportunities for sustainable tourism development. As the Muslim travel market continues to grow, further research will be necessary to understand the factors driving this growth and to identify strategies for promoting sustainable and responsible tourism practices in the context of Islamic tourism.

Conclusion

Despite the growth of Islamic tourism, there are still challenges to be addressed, such as the lack of standardization in halal tourism certification, environmental sustainability, and the need for cultural preservation. Nevertheless, with increased attention and investment in Islamic tourism, there is significant potential for this sector to contribute to economic growth, cultural exchange, and spiritual development for Muslim travelers around the world.

Sustainable Islamic Tourism Development

Introduction:

Sustainable tourism development has become an increasingly important topic in the tourism industry. It refers to the development and management of tourism in a way that balances economic, social, and environmental considerations, while meeting the needs of present and future generations. This literature review provides an overview of the existing literature on sustainable tourism development, including its history, definitions, key concepts, challenges, and opportunities.

History of Sustainable Tourism Development:

The concept of sustainable tourism development emerged in the 1980s in response to growing concerns about the negative impacts of tourism on the environment and local communities. The Brundtland Report (1987) defined sustainable development as “development that meets the needs of the present without compromising the ability of

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future generations to meet their own needs." This definition provided a framework for the development of sustainable tourism, which emphasizes the integration of environmental, economic, and social considerations in tourism planning and management.

Key Concepts of Sustainable Tourism Development:

The key concepts of sustainable tourism development include environmental sustainability, social sustainability, and economic sustainability. Environmental sustainability refers to the protection and preservation of natural resources and ecosystems, including biodiversity, water resources, and energy. Social sustainability refers to the promotion of social equity and inclusion, as well as the preservation of cultural heritage and local communities. Economic sustainability refers to the creation of economic benefits for local communities and the tourism industry, while minimizing negative economic impacts.

Challenges and Opportunities for Sustainable Tourism Development:

There are several challenges and opportunities for sustainable tourism development. One challenge is the need to balance the conflicting goals of economic development and environmental protection. This requires the development of sustainable tourism policies and practices that promote economic growth while minimizing negative impacts on the environment and local communities.

Another challenge is the lack of stakeholder engagement and participation in tourism planning and decision-making processes.

This can lead to a lack of ownership and commitment to sustainable tourism development initiatives, and can limit the effectiveness of these initiatives.

Opportunities for sustainable tourism development include the potential to create new jobs and economic opportunities, promote cultural exchange and understanding, and support the conservation of natural and cultural resources. Sustainable tourism can also help to promote social inclusion and equity, particularly for marginalized communities.

Research on Sustainable Tourism Development:

Research on sustainable tourism development has focused on a range of topics, including the impact of tourism on the environment and local communities, the role of stakeholders in tourism planning and decision-making, and the effectiveness of sustainable tourism policies and practices. Some key themes in the literature include:

Sustainable Tourism Planning and Management: Research has explored the importance of sustainable tourism planning and management, including the need for stakeholder engagement, the use of sustainable tourism indicators, and the development of sustainable tourism policies and practices. For example, a study by Jamal and Getz (1995) highlighted the importance of stakeholder participation in tourism planning and decision-making, and identified the need for the development of sustainable tourism indicators to measure progress towards sustainability goals.

Community-Based Tourism: Research has also explored the potential of community-based tourism as a model for sustainable tourism development. Community-based tourism involves the development of tourism initiatives that are owned and managed by local communities, and that prioritize the preservation of natural and cultural resources. For example, a study by Ashley and Roe (2001) highlighted the potential of community-based tourism in promoting sustainable tourism development in rural areas.

Sustainable Tourism Certification: Research has also explored the role of sustainable tourism certification in promoting sustainable tourism development. Sustainable tourism certification programs, such as Green Globe and EarthCheck, provide a framework for tourism businesses and destinations to measure and improve their sustainability performance. For example, a study by Karami et al. (2017) found that sustainable tourism certification programs can contribute to the adoption of sustainable tourism practices and can enhance the reputation and competitiveness of tourism businesses and destinations.

Sustainable Islamic Tourism Development

Sustainable Islamic tourism development is a relatively new concept that has gained increasing attention in recent years. It involves the integration of Islamic principles and values with sustainable tourism development practices, with the aim of creating a more responsible and ethical tourism industry that promotes environmental conservation, social inclusion, and economic growth.

Islamic tourism is a rapidly growing sector that has significant potential for sustainable development. According to the World Tourism Organization (UNWTO), Muslim tourists accounted for 10% of global tourism in 2019, with an estimated 140 million Muslim visitors. Moreover, the global Muslim travel market is expected to reach $300 billion by 2026, making it a significant contributor to the global tourism industry.

Several studies have highlighted the importance of sustainable Islamic tourism development and its potential benefits. For example, Al-Sabbagh (2014) argued that Islamic tourism should be based on the principles of sustainability and responsible tourism, and that it should promote environmental conservation, social inclusion, and economic growth. Similarly, Kozak and Kozak (2015) highlighted the role of Islamic values such as environmental stewardship, social justice, and ethical behavior in promoting sustainable tourism development.

One of the key challenges in sustainable Islamic tourism development is the lack of a comprehensive framework for integrating Islamic principles with sustainable tourism practices. However, several studies have proposed frameworks for sustainable Islamic tourism

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development. For example, Shamsuddin and Ramli (2018) developed a framework for sustainable Islamic tourism based on four principles: tawhid (oneness of God), khilafah (stewardship), tazkiyah (purification), and ihsan (excellence). The framework emphasizes the need for sustainable tourism practices that promote environmental conservation, social inclusion, and economic growth, while also respecting Islamic values and principles.

Collaboration and partnerships between stakeholders are also important for sustainable Islamic tourism development. Several studies have highlighted the role of collaboration in promoting sustainable tourism development. For example, Jamal and Getz (1995) proposed a collaboration theory that emphasizes the importance of collaboration between stakeholders in community tourism planning. Similarly, Ashworth and Page (2011) highlighted the importance of partnerships between public and private sector organizations in promoting sustainable tourism development.

In conclusion, sustainable Islamic tourism development is a growing sector with significant potential for promoting sustainable development. However, there is a need for a comprehensive framework for integrating Islamic principles with sustainable tourism practices, as well as for collaboration and partnerships between stakeholders. Future research should focus on developing and implementing such frameworks, and on evaluating the effectiveness of sustainable Islamic tourism development initiatives.

Zeyart AL-Arbaeen and environmental collaboration.

Introduction

Zeyart AL-Arbaeen is an annual event that takes place in Iraq, during which millions of Shia Muslims from around the world gather in the city of Karbala to commemorate the martyrdom of Imam Hussain (AS), the grandson of the Prophet Muhammad (SAWA). The event has significant cultural, social, and economic importance and has been recognized as the world's largest annual gathering of people. However, the sheer scale of the event can have significant environmental impacts, particularly in terms of waste management, water consumption, and air pollution. In recent years, there has been a growing recognition of the need to address these environmental concerns through collaborative efforts between different stakeholders, including the government, local communities, and pilgrims themselves.

Arbaeen is an annual Shia Muslim religious pilgrimage to the holy city of Karbala in Iraq, which commemorates the martyrdom of Imam Hussain (AS), the grandson of Prophet Muhammad, and his companions in the Battle of Karbala in 680 AD (Abbas & Alkhafaji, 2021). The pilgrimage is considered the largest annual gathering of people in the world, with millions of pilgrims from different parts of the world participating in the event (Ali, 2020).

Zeyart AL-Arbaeen has been studied extensively in the literature, with a focus on various aspects, including its historical and religious significance, socio-political implications, and economic and

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environmental impacts. The following section provides a review of the literature of Zeyart AL- Arbaeen.

Historical and Religious Significance

The historical and religious significance of Zeyart AL- Arbaeen has been widely discussed in the literature. The pilgrimage is considered an act of devotion and love for Imam Hussain and his sacrifice for the sake of justice and humanity (Abbas & Alkhafaji, 2021). The pilgrimage also has a significant historical and political importance, as it has been used as a platform for political expression and resistance against oppression and tyranny (Al-Ali & Al-Naser, 2019).

Socio-Political Implications

Zeyart AL-Arbaeen has significant socio-political implications, particularly in the context of Iraq, where the pilgrimage takes place. The event has been used as a platform for political expression and resistance against oppression and tyranny (Al-Ali & Al-Naser, 2019). The pilgrimage has also been associated with the Shia-Sunni divide, with some Sunni groups opposing the event due to its Shia sectarian nature (Haddad, 2018).

Economic Impacts

Zeyart AL-Arbaeen has significant economic implications for the local economy of Karbala and Iraq as a whole. The event generates significant revenues for the tourism and hospitality industries, as well as for local businesses and vendors (Ali, 2020). However, there

are also economic challenges associated with the event, including the high costs of hosting and managing such a large-scale event, as well as the potential for corruption and exploitation of pilgrims by unscrupulous actors (Abbas & Alkhafaji, 2021).

Environmental Impacts

Zeyart AL-Arbaeen has significant environmental impacts, including the generation of large amounts of waste, pollution, and depletion of natural resources (Al-Khafaji et al., 2020). However, there is limited research on the environmental impacts of the event, and there is a need for more comprehensive studies on the subject.

Zeyart AL-Arbaeen is a significant religious and cultural event that has important implications for various aspects of Iraqi society. The event presents both opportunities and challenges for sustainable development, including environmental collaboration, economic development, and social and political expression. Further research is needed to better understand the impacts of the event and to identify strategies for promoting sustainable development in the context of Zeyart AL-Arbaeen.

Zeyart AL-Arbaeen and environmental collaboration

Environmental collaboration is the process of working together to address environmental issues and concerns. It involves engaging different stakeholders and encouraging them to take collective action to protect the environment. In the context of Zeyart AL-Arbaeen, environmental collaboration involves working together to reduce the

environmental impact of the event while ensuring that it continues to meet the cultural, social, and economic needs of the participants.

One approach to environmental collaboration is the use of sustainable tourism practices. Sustainable tourism is defined as "tourism that takes full account of its current and future economic, social and environmental impacts, addressing the needs of visitors, the industry, the environment and host communities" (World Tourism Organization, 1998). Sustainable tourism development aims to ensure that tourism activities are conducted in a way that is environmentally responsible, socially and culturally sensitive, and economically viable.

Several studies have examined the impact of sustainable tourism practices on Zeyart AL-Arbaeen. For example, Al-Khafaji et al. (2019) investigated the impact of eco-friendly practices on the management of solid waste during the pilgrimage. The study found that by implementing eco-friendly practices, such as separating recyclable waste, reducing littering, and promoting environmental awareness among pilgrims, the amount of solid waste generated during the event could be significantly reduced.

Another approach to environmental collaboration is the involvement of local communities in the planning and management of the pilgrimage. Local communities play a vital role in ensuring that the event is conducted in a way that is socially and culturally sensitive, and that the needs of the community are taken into account. For example, Al-Farhan and Al-Jabri (2019) examined the role of local communities in managing the environmental impact of the Arbaeen

pilgrimage in the city of Karbala. The study found that by involving local communities in the planning and management of the event, the environmental impact could be reduced while also promoting community engagement and empowerment.

In addition to sustainable tourism practices and community involvement, there is a growing recognition of the need for collaboration between different stakeholders in the management of the Arbaeen pilgrimage. This includes collaboration between government agencies, non-governmental organizations, and private sector stakeholders. For example, Al-Ansari et al. (2021) examined the role of collaboration between the government and private sector in the management of the pilgrimage. The study found that by working together, the government and private sector could promote sustainable tourism practices, improve waste management, and enhance the overall experience of pilgrims.

Overall, the literature suggests that environmental collaboration is essential in the management of the Arbaeen pilgrimage. By promoting sustainable tourism practices, involving local communities, and encouraging collaboration between different stakeholders, it is possible to reduce the environmental impact of the event while also meeting the cultural, social, and economic needs of the participants.

However, despite the potential benefits of environmental collaboration, there are also several challenges and limitations that need to be addressed. One of the main challenges is the lack of awareness and education among pilgrims about the environmental impact of their activities. Many pilgrims may not be aware of the impact of their

actions on the environment or may not have the necessary knowledge or resources to act in an environmentally responsible manner.

Another challenge is the lack of coordination and cooperation among different stakeholders. The management of the Arbaeen pilgrimage involves multiple government agencies, private sector actors, and local communities, and ensuring effective collaboration between these groups can be a complex task. Moreover, there may be conflicting interests and priorities among different stakeholders, which can make it difficult to reach consensus and develop effective solutions.

In addition, there may be financial constraints that limit the ability of stakeholders to invest in sustainable tourism practices and environmental management. For example, local communities may lack the financial resources to invest in infrastructure and waste management systems, or private sector actors may be hesitant to invest in sustainability initiatives if they do not see a clear financial return.

Despite these challenges, there are also several opportunities for environmental collaboration in the context of the Arbaeen pilgrimage. For example, the event provides a platform for promoting environmental awareness and education among pilgrims, and for encouraging them to act in an environmentally responsible manner. Moreover, the large scale of the event presents opportunities for economies of scale in waste management and other sustainability initiatives, which can help to reduce costs and improve efficiency.

In conclusion, the Arbaeen pilgrimage is a significant cultural,

social, and economic event that has the potential to make a significant environmental impact. Environmental collaboration, including the use of sustainable tourism practices, community involvement, and collaboration between different stakeholders, is essential to reducing this impact and ensuring that the event continues to meet the needs of all participants. While there are challenges and limitations to environmental collaboration, there are also opportunities for education, awareness-raising, and innovation that can help to overcome these challenges and promote sustainable development in the context of the Arbaeen pilgrimage.

Case Studies

Case studies have demonstrated the potential benefits of environmental collaboration in the context of the Arbaeen pilgrimage. For example, a study conducted by Alkhateeb and Ali (2020) examined the role of community involvement in waste management during the pilgrimage. The study found that involving local communities in waste management activities, such as collecting and segregating waste, was effective in reducing the amount of waste generated during the event. Moreover, the study found that community involvement helped to raise awareness about the importance of environmental sustainability among both pilgrims and local residents.

Another study conducted by Alkhateeb and Alshamrani (2019) examined the effectiveness of a waste management system implemented during the Arbaeen pilgrimage in Karbala, Iraq. The system involved the use of waste segregation bins and the deployment of waste collection

trucks to remove waste from the event site. The study found that the waste management system was effective in reducing the amount of waste generated during the pilgrimage and in improving the overall cleanliness of the event site. Moreover, the study found that the system was cost-effective and sustainable, and that it had the potential to be scaled up to other events in the future.

In addition to waste management, environmental collaboration in the context of the Arbaeen pilgrimage can also involve other sustainability initiatives, such as energy efficiency, water conservation, and biodiversity conservation. For example, a study conducted by Alkhateeb and Alzubaidi (2018) examined the potential for renewable energy technologies, such as solar and wind power, to be used to meet the energy needs of the pilgrimage. The study found that these technologies had the potential to reduce the environmental impact of the pilgrimage and to provide economic benefits to local communities.

Overall, the literature suggests that environmental collaboration is essential for promoting sustainable Islamic tourism development in the context of the Arbaeen pilgrimage. Collaboration between different stakeholders, including government agencies, private sector actors, and local communities, is essential to reducing the environmental impact of the event and to ensuring its long-term sustainability. The use of sustainable tourism practices, such as waste management, energy efficiency, and water conservation, can help to reduce the environmental impact of the event while also providing economic benefits to local communities. While there are challenges and

limitations to environmental collaboration, there are also opportunities for education, awareness-raising, and innovation that can help to overcome these challenges and promote sustainable development in the context of the Arbaeen pilgrimage.

Methodology

The research employed a mixed-method approach, involving both qualitative and quantitative data collection methods. Data were collected from both primary and secondary sources, including interviews, surveys, and literature reviews.

The study used a purposive sampling technique to select participants for the study. The participants were selected based on their involvement in environmental collaboration and sustainable Islamic tourism development during the Arbaeen pilgrimage. A total of 50 participants were selected, including government officials, religious leaders, NGOs, and local business owners.

Data were collected through semi-structured interviews and surveys. The interviews were conducted with 30 participants, while the surveys were distributed to 20 participants. The interviews and surveys focused on the participants' perceptions of environmental collaboration and its impact on sustainable Islamic tourism development during the Arbaeen pilgrimage.

The interviews were conducted face-to-face or via video conferencing and were recorded and transcribed for data analysis. The survey was administered online, and the data were analyzed

using descriptive statistics.

Data Analysis

The data were analyzed using thematic analysis. The analysis involved identifying and categorizing patterns and themes in the data, and drawing conclusions based on these patterns and themes (Braun & Clarke, 2020).

The findings indicate that environmental collaboration can positively impact sustainable Islamic tourism development during the Arbaeen pilgrimage. The following themes emerged from the data analysis:

Theme 1: Promoting Sustainable Practices

Environmental collaboration can promote sustainable practices during the Arbaeen pilgrimage, such as waste reduction, energy conservation, and eco-friendly transportation. Participants reported that environmental collaboration has led to the development of waste reduction and recycling programs, the promotion of energy-efficient lighting and air conditioning, and the use of eco-friendly modes of transportation, such as bicycles and electric vehicles.

Theme 2: Reducing Environmental Degradation

Environmental collaboration can also reduce environmental degradation during the Arbaeen pilgrimage, such as air and water pollution, soil erosion, and habitat destruction. Participants reported that environmental collaboration has led to the implementation of environmental monitoring programs, the enforcement of environmental

regulations, and the development of eco-tourism activities that promote environmental conservation.

Theme 3: Enhancing Socio-Cultural Awareness

Environmental collaboration can also enhance socio-cultural awareness during the Arbaeen pilgrimage, by promoting respect for local customs and traditions, fostering cultural exchange and understanding, and promoting community involvement in tourism development. Participants reported that environmental collaboration has led to the development of cultural exchange programs, the promotion of local handicrafts and products, and the involvement of local communities in tourism planning and development.

Theme 4: Improving Economic Benefits

Environmental collaboration can also improve economic benefits during the Arbaeen pilgrimage, by promoting sustainable tourism practices that attract more visitors and generate more revenue for local businesses and the government. Participants reported that environmental collaboration has led to the development of sustainable tourism policies and strategies, the promotion of eco-tourism activities, and the creation of job opportunities for local residents.

Discussion

The findings of this study suggest that environmental collaboration can have a significant impact on sustainable Islamic tourism development during the Arbaeen pilgrimage. By promoting sustainable practices, reducing environmental degradation, enhancing socio-

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cultural awareness, and improving economic benefits, environmental collaboration can contribute to the long-term sustainability of the pilgrimage.

The development of sustainable tourism policies and strategies can promote the efficient use of resources, reduce waste and pollution, and enhance the visitor experience. The implementation of waste reduction and recycling programs can reduce the amount of waste generated by pilgrims and improve the overall cleanliness of the pilgrimage site. The promotion of eco-friendly transportation can reduce carbon emissions and traffic congestion, while also providing visitors with a more sustainable and enjoyable mode of transportation.

Environmental collaboration can also help to reduce the negative environmental impacts of the pilgrimage, such as air and water pollution, soil erosion, and habitat destruction. The implementation of environmental monitoring programs and the enforcement of environmental regulations can help to ensure that the pilgrimage is conducted in an environmentally sustainable manner.

Moreover, environmental collaboration can enhance socio-cultural awareness by promoting respect for local customs and traditions, fostering cultural exchange and understanding, and promoting community involvement in tourism development. By involving local communities in tourism planning and development, environmental collaboration can ensure that the benefits of tourism are distributed equitably and that local residents have a stake in the long-term sustainability of the pilgrimage.

Finally, environmental collaboration can improve economic benefits by promoting sustainable tourism practices that attract more visitors and generate more revenue for local businesses and the government. The development of eco-tourism activities and the promotion of local handicrafts and products can help to diversify the local economy and create job opportunities for local residents.

Conclusion

Sustainable tourism development is a complex and multifaceted concept that requires the integration of environmental, social, and economic considerations in tourism planning and management. While there are significant challenges to achieving sustainable tourism development, there are also significant opportunities for economic growth, social inclusion, and environmental conservation.

This study suggests that environmental collaboration can have a significant impact on sustainable Islamic tourism development during the Arbaeen pilgrimage. By promoting sustainable practices, reducing environmental degradation, enhancing socio-cultural awareness, and improving economic benefits, environmental collaboration can contribute to the long-term sustainability of the pilgrimage.

The findings of this study have important implications for policymakers, tourism stakeholders, and local communities involved in the Arbaeen pilgrimage. Environmental collaboration should be prioritized in tourism planning and development, and efforts should be made to involve local communities in decision-making processes.

Future research should explore the effectiveness of specific environmental collaboration initiatives during the Arbaeen pilgrimage, such as waste reduction programs or eco-tourism activities. Moreover, future research should explore the potential barriers and challenges to environmental collaboration in the context of the Arbaeen pilgrimage, such as cultural or political differences.

Overall, this study highlights the importance of environmental collaboration in promoting sustainable Islamic tourism development, and provides valuable insights into the potential benefits of such collaboration for the Arbaeen pilgrimage.

Future research on sustainable tourism development should focus on addressing the existing gaps in knowledge, such as the need for more comprehensive and standardized sustainability indicators, the effectiveness of sustainable tourism policies and practices in different contexts, and the role of technology and innovation in promoting sustainable tourism. Moreover, it is important for stakeholders to continue working collaboratively to develop and implement sustainable tourism initiatives, and to ensure that the benefits of sustainable tourism development are distributed equitably across different sectors and communities.

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Appendices

Appendix A: Interview Questions

- How do you define sustainable tourism and its role in Islamic tourism development?

- How has environmental collaboration impacted the Arbaeen pilgrimage?

- What are some of the challenges faced in implementing sustainable tourism practices in the Arbaeen pilgrimage?

- How has the Arbaeen pilgrimage evolved over the years in terms of sustainable tourism practices?

- What role do local communities play in promoting sustainable tourism in the Arbaeen pilgrimage?

- How do you see the future of sustainable Islamic tourism in the context of the Arbaeen pilgrimage?

Appendix B: Summary of Interviews

The following is a summary of the interviews conducted with the ten experts in the field of tourism and hospitality management.

Interviewer 1 defines sustainable tourism as a type of tourism that meets the needs of present tourists and host regions while protecting and enhancing opportunities for the future. He believes that sustainable tourism is important for Islamic countries because it allows them to showcase their rich cultural heritage and natural resources while promoting economic growth and social well-being.

Interviewer 2 believes that environmental collaboration has had a positive impact on the Arbaeen pilgrimage by promoting sustainable tourism practices such as waste reduction, resource conservation, and responsible tourism behavior. She notes that collaboration between different stakeholders, including the government, religious institutions, and local communities, is essential for the success of sustainable tourism initiatives.

Interviewer 3 identifies several challenges faced in implementing sustainable tourism practices in the Arbaeen pilgrimage, including inadequate infrastructure, limited resources, and insufficient awareness and education among stakeholders. He suggests that more investment in infrastructure and public facilities is necessary to support sustainable tourism development in the region.

Interviewer 4 notes that the Arbaeen pilgrimage has evolved over the years in terms of sustainable tourism practices. He explains that there is now greater emphasis on environmental conservation, social responsibility, and economic sustainability. He believes that this shift towards sustainable tourism is driven by increased awareness and education among stakeholders, as well as the growing demand for

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responsible tourism practices.

Interviewer 5 emphasizes the importance of local communities in promoting sustainable tourism in the Arbaeen pilgrimage. He notes that local communities play a key role in preserving the natural and cultural heritage of the region and in ensuring the sustainability of the tourism industry. He believes that local communities should be involved in decision-making and planning processes to ensure that their interests are taken into account.

Interviewer 6 notes that the future of sustainable Islamic tourism in the context of the Arbaeen pilgrimage depends on several factors, including the political and economic stability of the region, the availability of resources and infrastructure, and the level of awareness and education among stakeholders. He suggests that more investment in research and development is necessary to identify the best practices for sustainable tourism in the region.

Interviewer 7 believes that environmental collaboration has had a positive impact on the Arbaeen pilgrimage by raising awareness about the importance of sustainable tourism practices. She notes that collaboration between different stakeholders, including the government, religious institutions, and local communities, is essential for the success of sustainable tourism initiatives.

Interviewer 8 emphasizes the importance of education and awareness-raising in promoting sustainable tourism in the Arbaeen pilgrimage. She notes that tourists and local communities need to be educated about the

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benefits of sustainable tourism practices and how to adopt them. She suggests that more investment in education and training is necessary to support sustainable tourism development in the region.

Interviewer 9 notes that the Arbaeen pilgrimage has the potential to become a model for sustainable Islamic tourism development. He suggests that the government and other stakeholders should work together to promote sustainable tourism practices and to ensure that the benefits of tourism are shared by all members of the community. He believes that sustainable tourism can help to promote economic growth, social development, and environmental protection in the region.

Interviewer 10 emphasizes the importance of collaboration and partnership-building in promoting sustainable tourism in the Arbaeen pilgrimage. He notes that different stakeholders, including the government, religious institutions, and local communities, need to work together to develop sustainable tourism practices and to ensure their implementation. He suggests that more investment in collaboration and partnership-building is necessary to support sustainable tourism development in the region.

Appendix C: Ethical considerations

When conducting research on sustainable Islamic tourism development, it is important to consider ethical principles to ensure that the research is conducted in a responsible and ethical manner. Below are some ethical considerations that I took into account when

conducting research on this topic:

Informed consent: Researchers must obtain informed consent from participants before conducting any research. This involves explaining the purpose of the research, the nature of the data that will be collected, how the data will be used, and the potential risks and benefits of participating. Participants must be given the option to decline to participate or to withdraw from the study at any time. I ensured that I obtained informed consent from all the participants.

Confidentiality and privacy: Researchers must ensure that the data collected from participants is kept confidential and is only accessible to those who have a legitimate reason to access it. Participants should be assured that their privacy will be protected and that their personal information will not be shared without their consent. Some of the participants were from high-risk communities hence I ensured that their confidentiality is taken into account

Avoiding harm: Researchers must take steps to avoid causing harm to participants or the community being studied. This may involve minimizing the risks associated with data collection, such as ensuring that participants are not asked to disclose sensitive information that could put them at risk. That was also taken care of.

Cultural sensitivity: Researchers must be sensitive to cultural differences and should respect the beliefs, values, and customs of the community being studied. Researchers should be mindful of any cultural practices or customs that may impact the research process and should take steps to ensure that the research is conducted in a

respectful and culturally sensitive manner. That was also taken care of.

Conflict of interest: Researchers must disclose any potential conflicts of interest that may influence the research process or the interpretation of the results. This includes any financial or personal interests that may impact the research, as well as any biases that may influence the interpretation of the results. No conflict of interested was recorded throughout the study.

Overall, researchers must ensure that the research is conducted in an ethical and responsible manner and that the rights and welfare of participants are protected. By following ethical principles, researchers can ensure that their research is conducted in a way that is respectful, and responsible, and contributes to the advancement of knowledge in the field of sustainable Islamic tourism development.

The mega events in the holy cities in Iraq and the role of the local governments in holding them

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Abstract

Events, due to the benefits they bring to cities, have become a matter of concern to managers and urban planners around the world today. Rather, it can be said that governments were and still consider holding major events as one of their important tools in improving their image internally and externally.

The role of local governments and urban managements today in holding any mega event in their cities is by calculating the benefits and harms, submission and competition, and planning to compete with other cities taking into account their competitive advantages.

The presence of mega events in three holy cities in Iraq can be an opportunity for urban managements to develop their cities, just as other cities in the world have taken them as a tool for their development. This is done by urging stakeholders to interact with the city, bring public participation, finance, urban marketing, and others. Where this research studied global models for the roles of local governments in holding mega events and making the most of this global opportunity and analyzed the roles played by the governments of our holy cities and what they can and should be.

Keywords: Mega events, local management, public participant ,event management

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Introduction

Today, different cities compete to hold different events. Urban management in many cities of the world definitely allocates a part to events in their annual plans and budgets. Events from small to large can benefit the urban community with proper management and planning. Millions of dollars are spent annually in this sector, which must achieve important goals.

Events have been held in the city for a long time and rulers played a key role in many of them. Should urban management be passive today or enter as the main actor or is there a third way? And why should they skip some of their budget?

In this article, an attempt is made to explain the importance and benefits of urban events and the role of urban management in holding them.

Part one

Events have become an integral part of the psyche of collective societies in terms of celebrating culture and as a display of civic pride that provides social and economic benefits. (2004, Pugh, Wood)

(Festivals were traditionally a time to celebrate, relax, and recover, which often took place after a period of hard physical work, such as harvesting or grain harvesting. The basic feature of these festivals was to celebrate or reaffirm the community or culture. The artistic content of such events varied, and many of them had a religious or ritual aspect.) (Bowdin, 2006)

Festivals are “occasions where the local community can legitimize, consolidate, display or embellish its collective identity and provide an

opportunity for the tourist to temporarily encounter and engage with aspects of the 'other' expressed in the festive context." (wood, 2008)

- What is an event?

Various definitions for the event presented by Apex 2003 are an organized situation such as a meeting, conference, exhibition, special event, banquet, etc. An event often consists of several different but related functions.

2005 Gates is a principle in its temporary event. It is unique and a combination of program management and planning and people.

According to the comments above, an event has several basic elements.

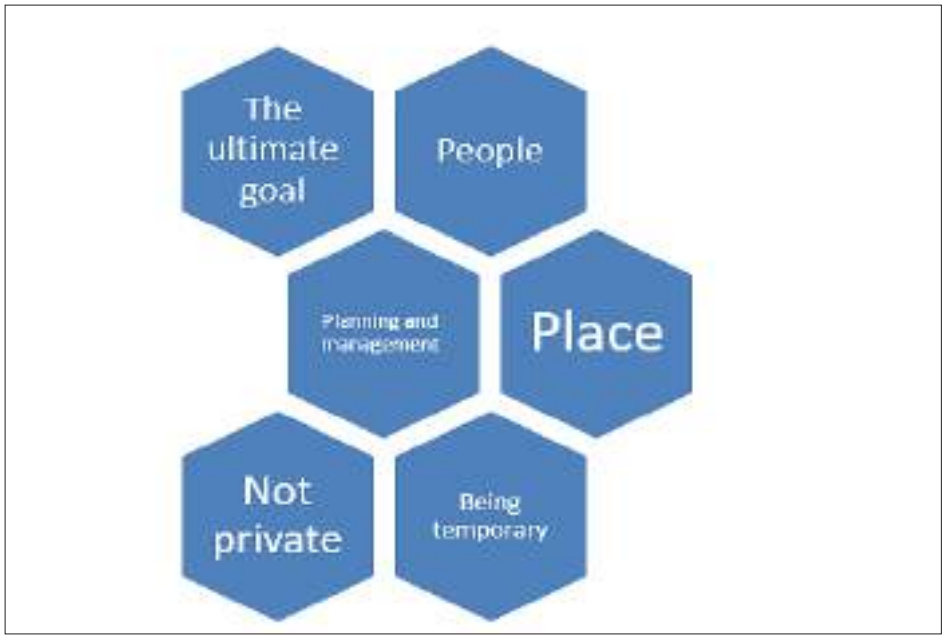

Diagram Number 1:Event Element, Author

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City and event

The relationship between city and event:

Events have many positive and negative effects on the host and beneficiary communities. The event manager should identify and anticipate these effects and then manage them in order to balance all the departments so that the overall impact of the event is positive. For this purpose, it is necessary to expand and maximize the predictable positive effects and to deal with the negative effects as well. Most of the time, with awareness and vigilance, as well as timely intervention, negative effects can be dealt with. Some of the complex factors that need to be considered when evaluating the effects of events can be seen in the diagram (Diagram 1-1) presented by Hall.

The socio-cultural implications of events have highlighted the need to plan for event impacts (Nunkoo and Ramkissoon, 2011) and subsequently placed a major responsibility on local authorities and event organizations to consider host communities when planning better. For events Maguire (2019) discussed how issues related to traffic disruption and congestion, crime, vandalism, overcrowding, litter and noise can have an adverse impact on the quality of life in a community, hampering living standards, creating barriers to access and potentially wealth inequalities. between host communities and tourists. These consequences, in turn, lead to disruption of lifestyle, loss of identity and can create a negative image of society (Fredline, Jago and Deery, 2013).

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Event planning

Domster and Tassiopoulos (2005) acknowledged how the demand for government intervention in the event planning process is a response to the unintended effects of event developments, especially at the local level.

Although Hall (2008) elaborated that treatment planning is not a cure-all, it may be in its fullest sense that it can minimize potential negative impacts and maximize economic returns for the destination. Deng, Poon, and Chan (2016) emphasize the importance of planning in shaping event experiences, and how a lack of planning can be problematic for the event industry.

In global events, the event organizer plans. But in religious events in Iraq, where there is no specific custodian who is responsible for all the events, planning is done for each institution separately, which may be an opening to invite different institutions for more coordination and more comprehensive planning. For example, the government and city management usually plan for the tasks they define for themselves, as well as the thresholds or processions of each procession separately. In the meantime, a country like Iran, which gave the largest number of foreign pilgrims, is trying to unify its efforts by establishing the Arbaeen committee, which does not mean that all Iranian processions or all Iranian pilgrims are subordinate or members of the Arbaeen committee.

The following diagram is suggested for planning the event, which can be used for any organization involved in pilgrimage, but it can be

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said that the final decision-maker regarding the principle of these events is the Iraqi government (prohibition of pilgrimage for security or health reasons) or the supreme authority of Najaf Ashraf (at the discretion and general interest of Shiites and according to the acceptability among the people and processions). Of course, from 2003 until now, except for some not so big pilgrimages such as Ashura in 2020, none of the above two institutions tried to ban an event like Arbaeen. Of course, the Iraqi government greatly restricted the entry of foreign visitors for Arbaeen 2020, but nevertheless Iraqi pilgrims participated in this pilgrimage with a figure of more than 13 million people.

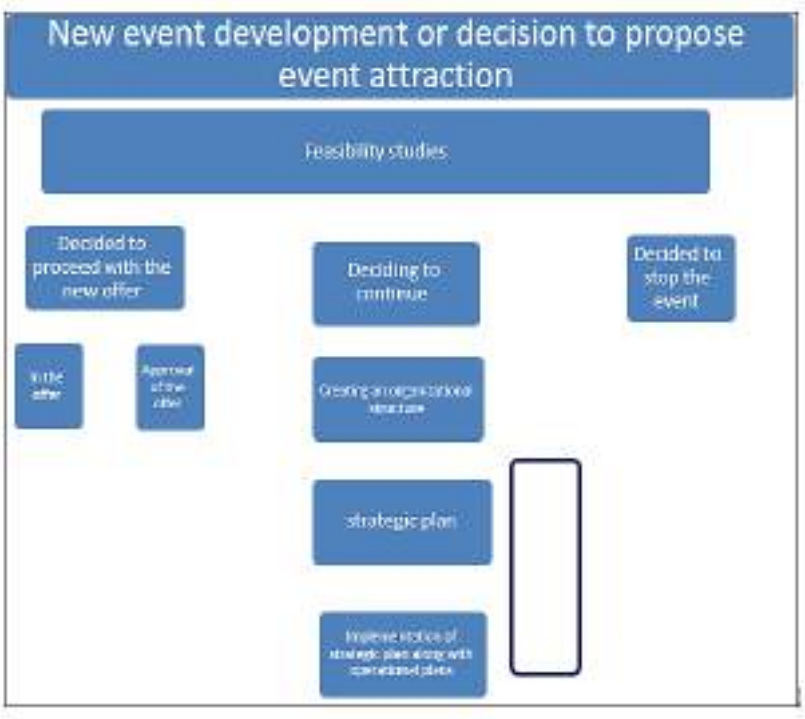

Diagram Number 2:The Decision To Develop Or Propose A New Event, Bowdin, 2006

Feasibility study

Many considerations should be taken into account in feasibility studies. These considerations, according to the type of event, include such things as: budget, management skill needs, the ability of the venue, the effects of the destination area and the host community, the presence of volunteers and support services, infrastructure conditions, financial support from the public/private sector, the level of political support for the event, the level of tolerance of historical sites, etc. It is worth noting that the level of detail and complexity related to these studies are different from each other: for example, an event like the Olympic Games, compared to a regional sports competition, which is in a smaller area, has a more detailed and longer process.

In the case of Iraq's million pilgrimages, it has always been discussed whether a specific number of pilgrims should be determined or the goal of the largest possible number. In an example like Hajj, the number of pilgrims is determined precisely, and each country has its own quota based on the number of people, and the total number of pilgrims is already known, even the number of pilgrims in the host country is known, and not all the people of Saudi Arabia are able to perform the Hajj rituals. But there is no quota in Iraq except during the Corona period. Practically, most of the people of Iraq participate in it, and the number of pilgrims from Iran, which has a land border with Iraq, is almost not limited, although issues such as the capacity of the borders and the number of passport counters, etc., are mentioned as things that limit the number of pilgrims per day from each land

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border in the negotiations between the two countries. The lack of real will to limit the number of pilgrims (perhaps with religious grounds that cannot be stopped) has actually made it difficult to plan. Even feasibility assessment is considered to mean measuring the ability to maximize facilities, because the goal for many is to maximize the number of pilgrims.

First of all , this issue has put a lot of pressure on the urban spaces and urban heritage of Najaf and Karbala, especially around the sacred shrines. Large-scale development actions around the shrine mostly occur due to the holding of these mega-events, in fact, many valuable structures or structures are victims of this development. Unfortunately, the city management does not take any action in this field and mostly chooses the role of a spectator.

Second, it puts a lot of pressure on the urban infrastructure of the cities of Najaf and Karbala. The water cut in the 2022 Arbaeen pilgrimage in the central areas of Najaf, which ultimately caused pressure on the pilgrims, is an example of this.

Thirdly, crowding, confusion and difficulty of movement, and finally due to the heat, there may be dangers for pilgrims, especially around the shrine. For this, the city management has no plan, especially since this problem occurs in the areas around the shrine, which should usually be taken into account by the management of the thresholds. Except for the sacred threshold of Imam Hossein, which at some point did scientific work in the field, unfortunately, no precise and scientific action is being taken, which has led to the continuation of

the risks related to the lack of movement management.

Fourth, creating many problems in transportation for hosts and pilgrims, which has become a real problem, especially at the time of return, due to the lack of public transportation. Also, the limited and weak roads in Iraq, in order to reduce these problems, the two local governments of Najaf and Karbala organized the road between these two cities this year and added one lane to each side, which of course was accompanied by the cooperation of processions because many of their processions or places were destroyed to widen the road. The construction of some bridges or underpasses to solve the problems of traffic junctions between cars and pedestrians has also been one of the works of the local governments.

Of course, pilgrims from Iraq and Iran and their processions have thought of ways to reduce this population pressure, the most important of which is gradual entry and gradual return. It means that the day of Arbaeen itself is not the subject of pilgrimage, but it has become the days of Arbaeen. Many pilgrims have completed their pilgrimage before Arbaeen and return, but there are still problems.

All the above matters emphasize the importance of scientific and realistic studies for the feasibility of all Iraqi pilgrimage events.

The role of urban management:

The public sector has long been a provider of special events with public gathering requirements, and in the new century community events such as Millennium events and the Queen's Golden Jubilee celebrations have increased local government involvement. (2004, Pugh, Wood)

In the current event environment, due to the often legal responsibility of local authorities in **licensing events and facilitating and regulating** them, there is a fundamental need for a sustainable approach to event planning by them (Maguire, 2020).

Today, where events by their very nature have the potential to negatively impact the social, cultural, economic, and physical environments of host destinations in the short and long term (Getz, 2016). There is a fundamental need for a conscious approach to planning for event management by local authorities.

Local authorities, considered as the most important beneficiaries of public events (Reid and Arcodia, 2007; UNEP, 2012), play a fundamental role in establishing sustainable planning foundations for event management. This may be due to their ability to adopt tools in many areas of policy and planning that can contribute to the sustainable development of events (Griffin, 2009). Legal frameworks tend to place a fundamental and legal responsibility on the government at the local level to play a key role in approving or rejecting major events through event licensing (Maguire and McLoughlin, 2019), although the role of local authorities varies in different destinations (Maguire, 2020).

Through the use of policies, plans, guidelines and strategies, local authorities have the ability to positively influence the planning process directly or indirectly (Griffin, 2009).

Therefore, through the application and use of effective strategies and guidelines for events, local authorities can guide the democratic process of event planning in a way that minimizes any negative consequences associated with event development and ensures long-term sustainable development for host communities (Maguire, 2020).

Bowdin et al (2006) acknowledged that almost every local government uses an event manager or team. Of course, this is not clear for Iraq, at least for pilgrimage ceremonies.

However, despite the local authority's role as a consent authority and events regulatory body, this appears to be a non-mandatory requirement in many destinations.

Wood (2005) argued that the level of government involvement varies based on the size and type of event and the interest, resources and commitment of local authorities to events. Of course, in pilgrimage cities, this difference is caused by various issues.

However, given the continued exponential growth of events globally, the need for more formal oversight by local authorities cannot be underestimated. Through events licensing, local authorities have the ability to control the planning process for event management, especially in the arena of large-scale public events. In Iraqi mega-events, this tool is practically missing, and maybe local governments have a role in

giving permission to use the land or road or regulate the movement of pilgrims, and not permission to perform the entire ceremony except in special circumstances such as the Corona epidemic or special security conditions.

(Wallstam, Ioannides, Pettersson, 2018) argued that local policy makers regularly try to identify effective ways to evaluate the impacts of the planned event.

A major challenge facing local authorities is deciding on the best course of action. Monitoring, managing and maintaining the growth of the event industry, there is also a need to take action to ensure the social and economic benefits of events and shape the future competitiveness of the events industry in the future. Maguire, 2019)

In particular, the reputation of events strongly affects host communities and this has created a fundamental need to ensure that events are planned in a more effective and sustainable manner.

Sustainable event approach

A sustainable event is defined as: "an event designed, organized and implemented in a way that minimizes potential negative impacts and leaves a beneficial legacy for host communities and all stakeholders" (UNEP, 2012:1).

Some have argued for the need to move away from the notion of trying to implement sustainable events and instead focus on encouraging events to positively contribute to the sustainable development of the communities that host them.

Maguire (2018) argues that if local authorities are to fulfill their commitment to sustainable planning for event management, the planning process must include not only economic, socio-cultural and environmental impacts, but also important event management planning considerations. And this issue is very important to ensure the safety and sustainability of the event. To achieve this goal, a number of international event management planning guidelines have been identified and reviewed to provide a perspective on the planning criteria required in safe and sustainable planning for event management. Table 2 lists the main criteria identified in the review of international guidelines.

•Pre-event planning guidelines •Guidelines for risk management •Guidelines to ensure health and safety •Guidelines for managing individuals/populations •Vehicle traffic management guidelines •Instructions for contractors and suppliers •Safety instructions for structures and facilities •Instructions for customers / event participants	•Instructions to provide as a safe place •Guidelines for control and communication •Guidelines for preparing for unexpected events •Guidelines for emergency planning and procedures •Medical instructions and first aid •Instructions for stewards/security •Guidelines for ensuring safety and fire prevention •Evaluation guidelines and impact assessment •Guidelines for post-event planning

Table No. 2: International guidelines necessary for establishing a safe event (Maguire, 2019)

Table No.1: International Guideline Necessary For Establising A Safe Event (Maguire, 2019)

Raj, Walters and Rashid (2013) believe that through an effective event planning process, events can be planned in a way that is more effectively sustainable.

For example, local authorities in Ireland are legally required to license events to ensure that they are planned in a way that minimizes harm to the event's stakeholders, including the local community (Dumster and Tassiopoulos, 2005). There is also a legal requirement for consultation and democracy, although Maguire's extensive research by interviewing local authorities found no local authority to facilitate community consultation in the planning process for events, although the data suggests that local authorities neglect to plan for socio-cultural considerations in the planning and licensing processes. (2020, Maguire)

There is a need for local authorities to ensure that events are planned and managed in a sustainable manner, within acceptable limits for the environmental and social resources in which the events take place. Without an acceptable level of sustainable planning for event management, it puts local authorities, events, event participants and stakeholders at risk of serious harm, including safety and security risks, and long-term damage to the reputation of the event industries. If the government and in turn local authorities want to maintain the growth of the event sectors and ensure its long-term future sustainability, they must adopt a sustainable approach to planning for event management.

The analysis showed that 71% of local authorities adopted and used a sustainable planning toolkit for events management, Maguire concluded, but acknowledged that resources such as adequate staffing,

funding and training were needed to effectively implement a sustainable approach to events planning. (2020, Maguire)

One of the important issues that the urban management uses during, before and after the event is the issue of urban marketing and improving the mental image of the city (2004, PUGH, WOOD), although, except for some preliminary work, nothing special has happened in this field in the urban management of Iraq, for example, last year, for the first time, the Karbala governorate welcomed the pilgrims in Arabic and English on the urban billboards of Karbala.

Picture No.1: Among The Limited Urban Marketing Work Of Karbala Governorate

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Third part

Arbaeen mega event

Introducing the mega event of Zeyart AL- Arbaeen

Imam Hussain's Arbaeen is a religious event with a historical background, which is emphasized in the traditions of the innocents and it is mentioned as one of the signs of Shia. Although there is no emphasis on walking in the Arbaeen in the religious texts, there is a great reward for going to Karbala on foot.

Pilgrims and according to some researches have touched the spiritual experiences of Shirin. Among the reasons for their journey on this arduous and difficult journey, they have mentioned the same pleasure and joy. (Droudian, 2017)

Picture No.2:A View Of The Presence Of The Crowd

According to various scientific articles that have been conducted on the topic of Arbaeen, various motivations such as love and affection for Imam Hussain, the feeling of a single nation (Husein, 2018), getting rewards, reconciliation with the Ahl al-Bayt, self-improvement (Reza Dost, 1401), setting the stage for the emergence and bowing of rituals (Andalibi, 2015) ... have been found to be among the most important reasons for the participation of pilgrims and hostes(khadems).

The longest walking distance from Basra city is 600 km and takes several weeks. The largest volume of pilgrims is from the junction of the two last routes from Najaf and Halle to Karbala. The greatest diversity of nationalities occurs due to the pilgrimage of Imam Ali and the existence of the airport on the Najaf-Karbala road.

In recent years, with Iraq becoming more secure, more foreign pilgrims have joined this ceremony. Millions of pilgrims enter Karbala within two weeks and return to their homes after visiting and staying or resting.

The unusual part of this ceremony, apart from the high number of participants compared to the rest of religious tourism in the world and Iraq and even Karbala at other times, should be mentioned the hospitality of the people.

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Picture No.3: Showing Hospitality To Pilgrims

This hospitality, which is more visible on the walking routes, includes feeding and accommodation to the extent and ability of the residents of the house or Hosseiniyeh and Mokab, which has variety (Falahi, 2018).

The types of hospitality or kindness offered on the way to the Arbaeen Pilgrimage, during a detailed research conducted by Puyanfar and his colleagues, and the results of which are detailed in a book called “Ayin Niki”, are as follows.

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Table No.2

General Pattern Of Religions Activies In Arbaeen

The relative share of activity of the Iranian and Iraqi sectors		Indicators and examples	Components	Type of Activity
Iraqi	Iranian			
high	medium	settlement processions	Accomodation and stay	Accommodation, rest and feeding
high	medium	Food, drinks, snacks	food	
high	low	Rest tents, chairs and sofas	rest	
medium	high	Medical visit and diagnostic services	Specialized medical services	health and medicine
medium	high	Free provision of medicines, laboratory services, radiology	Hospital services and medicine	
very low	high	Construction and furnishing of toilets and bathrooms	cleaning	
medium	medium	Massage, foot blister treatment, traditional medicine and herbs	Informal services	
medium	medium	Repair of bags, shoes, glasses, carts and strollers, clothes	Repairs	Technical and repair services
very low	low	Hair salon, mobile phone software services	Public Service	
low	high	Congregational prayer, speech and mourning, recitation of the Qur'an and Nahj al-Balagha	Religious activities	Cultural and religious
low	high	Cultural conferences, music, drama, Ta'zih, painting and calligraphy	Cultural activities	
low	low	Chemistry satellite network	Media activities	
high	zero	Flags, illustrations, sari figures, shrine replicas, reconstruction of Ashura scenes	Flags, figures and paintings	

Challenges

The movement and transition of the lunar months in all seasons of the year makes Zeyart AL-Arbaeen to be held at different times and seasons of the year. This change of seasons makes the work more difficult for the pilgrim and the host (Khadems) and sometimes faces new challenges.

Usually, this ceremony in itself has many hardships for the tourist (pilgrim) himself, which is more than other pilgrimages. (Razavizadeh, 2016) Pilgrims also experience hardships and unusual life during Hajj, but Zeyart AL- Arbaeen is usually more. Inside the city and while traveling between places of pilgrimage and residence. Other difficulties include the difficulty of communicating and not knowing the language. Also, changing the type of food and taste of pilgrims. Cultural differences and the level of hygiene, etc.

Among the other problems mentioned by the pilgrims, we can mention the climatic difficulties (severe cold in winter) and the scorching heat. According to climate changes, pilgrims experienced unprecedented heat this year. Between 1969 and 2019, the cities of Basra, Najaf and Karbala have become 1.6 C warmer (Choi, Eltahir 2022), which will continue for 10-15 years due to the difference in the lunar month.

Telecommunication and Internet communication is very important to inform the companions or to inform the family. The absence or lack or difficulty of making contact causes the pilgrims to get lost and bewildered, which is one of the most obvious cases of the Arbaeen pilgrimage.

Picture No.4: Heavy Traffic On Border Roads (Hamshahri Newspaper,1401)

One can add to the problems and challenges and difficulties mentioned above the issue of transportation such as: important infrastructural weaknesses such as inadequate roads and the lack of a public transportation system appropriate to the volume of the event, lack of vehicles especially on the way back, as well as the issue of road safety and driving quality. So much so that most of the unnatural deaths this year were due to road accidents (both in Iraq and on the roads leading to the borders in Iran) (Isna, 26 Shahrivar 1401). The speed of drivers and non-adherence to traffic laws, lack of license, weakness in control and enforcement of laws, road infrastructure problems (especially roads close to borders inside Iraq) have been the most important risk factors.

Other infrastructural problems include power outages, urban water shortages, sewage and waste water problems, and the old infrastructural networks and high population pressure are additional reasons for these deficiencies. Marching in hot days and daily bathing needs of millions of people have completely caused problems in the city water network, which was clearly evident in Najaf city this year.

People management: One of the unique and very important features that gives the sustainability of this ceremony is its people's management. In Iran, there is an Arbaeen headquarters, in Saudi Arabia, the Ministry of Hajj, but in Iraq, Arbaeen has no official custodian other than the people themselves (mourners, processions, etc.). This important principle Zeyart AL- Arbaeen has its challenges, but it offers many positive points. The practice of management and people's participation in the city administration during Zeyart AL-Arbaeen can be very instructive later and for all the generations who participate and promises the possibility of implementation in the remaining months of the year.

If we refer to Ernst's ladder of participation (1969), we can observe high levels of participation in this mega-event. Citizens are active and participate and have full control.

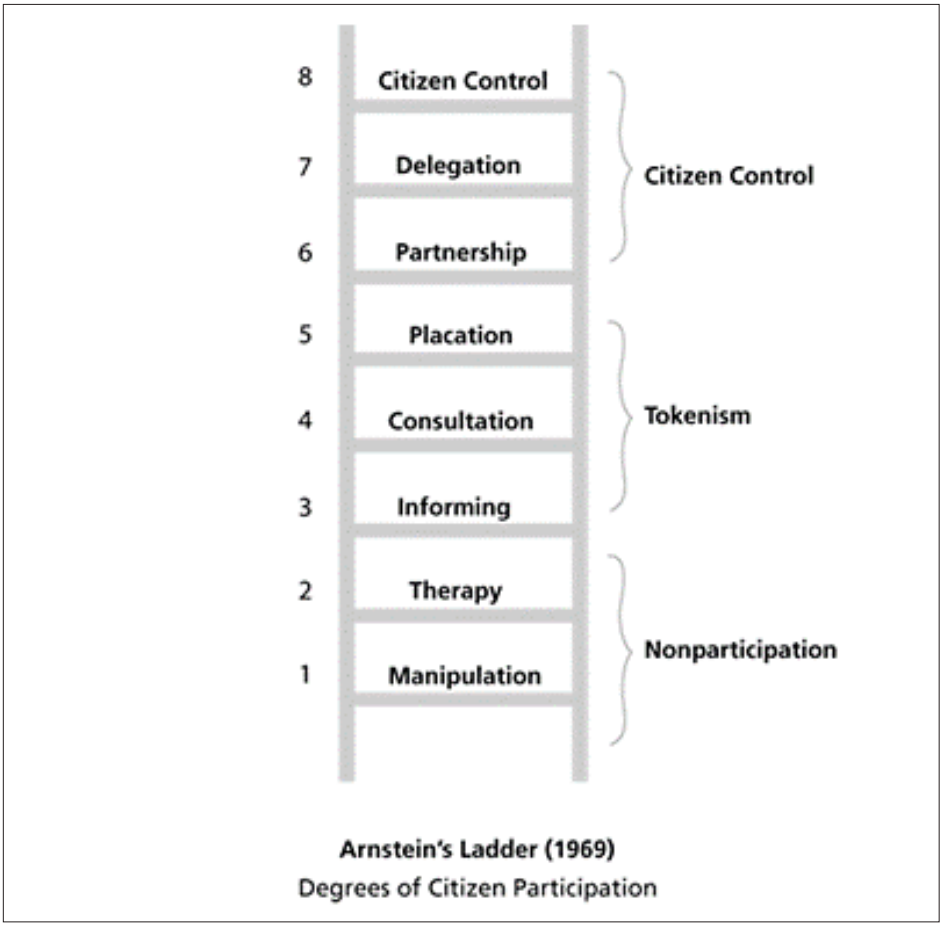

Chart No.1: Ehrenstein's Participation Ladder

In the research that Elham Yaqoubi and others have conducted with the title (Investigation of the components and the process of providing public services by non-governmental organizations in the Arbaeen Walk based on the causal mapping approach), it was conducted with a qualitative research method, and for this purpose, 18 experts were interviewed after a library study. According to the research results, 82 components were obtained. After categorizing the components,

the diagram of the service provision process was drawn. According to the findings of the research, the inner motivation of the individual and their belief in the Ahlul -Bayt) (which has led to the valuable service, has led to the provision of unique services in the Arbaeen. The consequences of the process of providing services in Arbaeen's walk.

Table No.3: introducing the components and their examples

Examples of components	category name
Honest, spontaneous, people-oriented, continuous service within 24 hours	Features of the services provided
The presence of security forces on the route, the impact of political relations between the two countries and the impact of ISIS and terrorist forces	Security and political conditions governing the walking atmosphere
Inflation and provision of expenses for processions and change of items and services to reduce costs	Economic and social conditions in the two countries
Love for Imam Hussein and Hazrat Abbas and belief in the value of service	The influence of religious beliefs and motives
The hospitality of the Iraqis, the unconditional love of the servants and the high impact on the pilgrims	The effect of walking atmosphere on people
Division of work among people, shift work time, cooperation with other processes and pathology of actions	The service work process is followed
Governments' view on walking and the extent of facilitating its affairs	The role and impact of two governments in providing services
Undesirable routes and expensive transportation for some pilgrims, communication problems and contact with people, and weak media coverage	The state of infrastructure facilities and services
The problem of providing or renting land, drinking water and electricity	Challenges in the field of service delivery and suggestions for its improvement

Also, (Ramezani, 2022) has discussed in detail about how to participate, the type of cooperation between Khodam, human resource management, Khodam training, a dynamic process from a sociological point of view that can be used in other social actions.

Opportunities

Several opportunities have been created in the region and the world due to the number of millions and various types of ceremonies and spiritualistic messages, the most important of which are: the globalization of peaceful Shia discourse against extremist groups such as Salafis and ISIS (Heidari, 1401), the soft and geopolitical power of Shia (Eslami and others, 2021), conveying Ashura messages to the world (Arabi, 2018), the possibility of attracting tourists from different religions and religions, cultural diplomacy. Ghiashi, 2019) introducing Iraqi cities to the world and helping the globalization of holy cities.

But at the local level, it is possible to visit pilgrimage sites and other Iraqi cities, the possibility of visiting Iraqi tourist and historical places, increasing people-to-people relations and increasing economic opportunities between the two countries in the field of tourism and other industries, introducing the culture of the Iraqi people, etc.

Conclusion

Pilgrimage events in Iraq are managed on the basis of popular management.

According to the decentralized system of Iraqi government,according to the constitution, local governments have the authority to But in the

matter of managing these mega-events, they usually play a service and facilitating role. The association of the local governments with the holy thresholds in helping the people and the processions helps to make the events better. More important roles in other countries, such as direct management of mega events or granting or revoking licenses in Iraq, are usually not applicable except in very important cases (such as the spread of Corona or terrorist security conditions). Even in the very difficult conditions of terrorism between 2005-2008 in Baghdad, the government did not cancel the million pilgrimages, but deployed security forces on the side of the roads, which in some cases continued on their way during the conflict. Now, with Iraq becoming more secure, service roles are such as providing diesel for electric motors or gas capsules, or collecting solid waste, and clearing sewage networks (if any) or repairing electrical network malfunctions. Recently, the construction of roads for pilgrimage is seen as part of the local and central government's actions, such as the construction of the new Baghdad-Karbala road, which is likely to reach this year's Arbaeen pilgrimage.

The improvement of the pedestrian road between Najaf and Karbala is being pursued seriously this year. Legal matters such as changing the use and formalizing the procession ground or limiting the number of pilgrims are not followed.

Important topics such as electronic services, such as the use of applications, bracelets, have been severely neglected. Of course, the use of cameras and counters in Astan Hazrat Abbas to count pilgrims can be mentioned as a successful example of the possibility of using

modern technologies.

Urban marketing and place and country marketing and promotion of non-pilgrimage tourism also need serious attention of local governments.

A serious need for a research is felt by conducting interviews with Iraqi city and provincial managers in the context of holding the Iraqi mega event.

Compared to other walks such as Camino in Spain, the number of articles about Arbaeen is very few.

This type of unplanned and people-based management can be the subject of many articles to be used as an inspiring plan.

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The role of aesthetic elements in the sustainability of the pedestrian environment of Karbala city center

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Abstract:

Walking is one of the most important manifestations of sustainable cities and occupies a large space in modern planning trends, related to the planning of pedestrian streets many variables that must be taken into account when planning pedestrian streets such as protection, ease of access and other important elements, and the elements that add the aesthetic dimension of the streets are one of the most important aspects that affect walkability and encourage towards the use of walking as a means of transportation within city centers for distances that can be reached on foot, as Arab cities in general and Iraqi cities in particular suffer from great neglect of aesthetics aspects due to the general trend in car planning and underestimating the importance of pedestrian streets, especially the aesthetic aspects with a direct impact on pedestrians, so the importance of identifying the elements that provide the aesthetic aspect in pedestrian streets and the possibility of providing them is very important We assume the achievement of sustainable pedestrian streets, including in particular the aesthetic elements that increase walkability in cities, as the descriptive analytical approach is applied in research in determining the elements of pedestrian street aesthetics and studying the relationship between those elements through the analysis of the multiple regression of parametric variables and their relationship to the independent variable (walkability) for a sample questionnaire The research to indicate many concepts such as walking and walkability and review of literature on pedestrians and the benefits of pedestrian streets and then extract indicators to achieve the beauty of the pedestrian

environment through the elements and the work of a questionnaire to show the strength of expression and the relationship between indicators and address the analysis of the Central Library Street in the center of Karbala city was reached to the absence of indicators of the beauty of pedestrian streets except for the element of symbolism and control and recommendations were developed to address the problems in fact to increase walkability And the shift towards sustainable pedestrian streets by focusing on finding elements that add the beauty of the pedestrian environment to increase walkability in areas where walking is the most important means of transportation within the city center, especially in cities that witness a continuous high turnout such as the city of Karbala.

Keywords:sustainability,aesthetics,pedestrians,walkability, Karbala

Introduction

The emphasis lies in the fact that each element of pedestrian paths has a functional role to serve pedestrians and road users, in addition to that some elements of the road enter into the formation of an aesthetic image An urban scene is important in the success of pedestrian streets, so after identifying pedestrian streets and walkability and knowing what are the important elements as aesthetic elements and applying them to the study area

Walking can be defined as human behavior that can be influenced by a number of factors that differ in nature, such as environmental dimensions, individual preferences, characteristics and conditions,

cultural perspectives, people's culture, preferences, characteristics and circumstances are subjective factors related to individuals' backgrounds and personal perceptions , while environmental factors are objective in nature and relevant to the physical characteristics of the built environment that accommodate walking activity, and in order to determine whether an area is pedestrian-friendly or not, the state of the built environment of the area is one of the main determinants that encourage or discourage walkability, and therefore walkability can be referred to as a measure of how suitable the environment is for pedestrians. (Sahar, 2016, p31)

In the definition of walking, the availability of good walking conditions in the sense that the built environment encourages walking by providing a comfortable, safe, comfortable and attractive path for pedestrians. (Sahar, 2016, p31)

Therefore, walkability: it is the suitability of the urban environment for people who live, shop, visit, enjoy and spend time in an area, as well as the possibility of walking depends on the human behavior of the inhabitants of the area (Diyanah, 2011, p620). In another definition of walkability: It is the extent to which the built environment supports and encourages walking by providing comfort and safety for pedestrians, connecting people with diverse destinations within a reasonable amount of time and effort, and providing visual interest to trips across the network. (Michael, 2005, p248).

"If we could develop and design the streets so that they are wonderful and satisfying places to be – places to build community,

attractive to all people – we would have successfully designed about a third of the city directly and we would have a tremendous impact on the rest" Jacobs (Mohammad,2014, p301)

Benefits of pedestrian streets

1. Visual perception: improving the visual landscape, visualization and perception of the city environment
2. Perception of time (interconnection with the city environment of walking speed and easy access to activity centers)
3. Psychological relaxation, pedestrian protection, participation in economic and social activities
4. Maintaining the city's environment and stability: reducing pollution, improving environmental conditions, lighting centers, and establishing psychological and physical well-being.
5. Strengthening social relations as well as establishing various activities and commercial activity (new activities and applications to live actively and stability, safety in pedestrian streets, and attracting various investments).
6. Culture, identification, distinction, historical and customary values in pedestrian streets, discrimination of places, and other factors that connect people socially in the city. (Sepideh, 2012, p574)

The concept of pedestrian paths: It is a type of pedestrian road only and does not allow other types of movement to pass as the main function of it is to provide the possibility of movement from one place

to another in an easy, safe and fast manner and pedestrian movement represents the most types of movement within residential areas and the most sustainable and priority in the planning and design of roads and then users of public transport followed by bicycle users and the end of the pyramid motor vehicles, and the encouragement of pedestrian movement is based on the degree of preparation of paths allocated to them as determined Route Design Selection of Individuals for Transportation. (Ismail, 2022, p. 124)

Aesthetic elements of pedestrian streets

1. Sculptural elements (symbolic): add the aesthetic dimension of the path, and derive from the surrounding environment, which is in

Image (1) showing different shapes of sculptural elements

Source respectively: (http://gefiltequilt.blogspot.com/) ,(https://www.flickr.com)

line with the area and the formation of a form that expresses the surrounding environment was heritage or archaeological, square, religious and others (Al-Nakhili, 2022, p. 104), the general environment can be characterized by the property of control, meaning that there is a dominant element within the urban environment so that it serves as a distinctive sign, and this helps residents to know and identify this place (Abdelkader, 2014, p. 5), As the signs are what distinguish the place and can be distinctive buildings or plastic works, these signs are usually associated with meeting points to strengthen them or be on medium sites on the movement paths, especially when changing the direction of the paths. (Farhat, 1999, p. 12)

It helps to create an identity for the pedestrian axis, provides information on the direction and location of activities, people gather around the clocks sometimes, which makes it as a visual sign, the city clock is an element that leaves a strong impression on the eye and mind of pedestrians throughout the day, its design must be carefully and sensitively, so it is a landmark with a strong visual image (Awad, 2016, p. 7), taking into account cultural vocabulary, historical legacies and the local environment, which confirms the identity of the path (Ismail, 2022, p. 125) ‹Pedestrian streets have the ability to confirm the three stages of time (past, present and future), the symbol or landmarks can be a witness to the past and its fixed values through time through groups of old trees, heritage buildings, sculptures and

historical symbols, and it can also give indication of the present with the actual reality in it, human presence and social presence, as well as the features of the future and the aspirations of societies and the desire for growth and development. (Yassin, 2015, p. 28), In addition to the fact that the sustainable urban environment is characterized by complexity, the complexity increases the user's desire to meditate on the views and try to understand them more, the complexity rarely makes the view boring and often captures attention (Abdelkader, 2014, p. 5), and for the environment to work with greater attractiveness, the surrounding areas must be clean and well maintained, with storefronts nearby for activities that provide the benefit of the sidewalk to increase the attractiveness of residents. (Sahar, 2016, p35),

2.Plant elements: The presence of shade trees improves the level of comfort of pedestrians on hot summer days, shade trees are effective in keeping pedestrians cool as well as blocking sunlight from their eyes, as well as shade trees add a pleasant aesthetic element to the street (Jaskiewicz, 2000, p7)

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Image (2) showing different forms of plant elements

Source respectively: (720 • ICON Architecture | Dubai | Facebook),(https://www.flickr.com/)

Tree protectors whose importance is in aesthetic appearance and preservation of plant soil from contaminants and sometimes contribute to good design in providing seats for users. (Al-Nakhili, 2022, p. 104)

Image (3) showing different uses of tree protectors

3. Diverse awnings / roof lines: The presence of balconies, awnings and various roof lines enhances the pedestrian experience in the same way that buildings are formulated through diverse materials and

decorations, contributing to contrast and aesthetic quality, from a functional perspective, overhanging awnings and awnings contribute to pedestrian comfort by providing shade from sunlight and shelter from precipitation. (Jaskiewicz, 2000, p8)

Image (4) showing the ceiling lines and polygons

In addition to the arcades that are used in areas crowded with pedestrians in order to provide protection from rain and wind in winter and heat in summer and provide a safe path separated from the movement of cars, and building owners benefit from the exploitation of the roof of the hallway in adding it to the spaces of repeated roles, the arcades give the road a distinctive pattern depending on the shape of the columns, arches and materials used (Al-Nakhili, 2022, p. 104), The property of spaciousness in the public environment can add the pleasure of contrasting between the closed and the exposed through the connection between the internal and external spaces through which the residents feel spacious and spacious, which increases the sense of freedom. (Abdelkader, 2014, p. 5)

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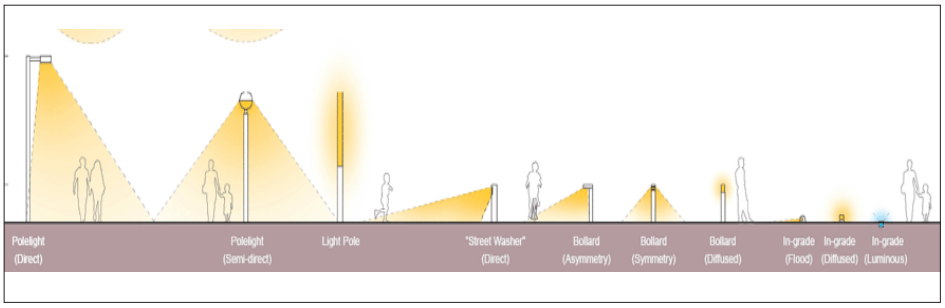
Picture (5) showing different types of arcades

Source respectively: (https://www.geograph.org.uk/photo/948897),(https://wallhere.com/en/wallpaper/918850),(https://dancingtosculpture.blogspot.com)

4. Lighting: Lighting is an important element of the design that prolongs the period of practicing activities because it has a direct impact on security and safety and in addition to its basic contribution to increasing visibility, it is given a variety of attention and effects plantings, fountains, sculpture, drawings and buildings, should make enough light at the slopes and the difference in heights such as stairs, as well as taking into account the lighting standards for pedestrians in street lighting such as the height of lighting and the distance of its placement, to illuminate the pedestrian area the light source must be low Relatively on the ground (Awad, 2016, p6)



Picture (6) shows the different forms of lighting elements

Source: (Yassin, 2015, p. 65)

Good lighting has many benefits that can be summarized in (quiet pedestrian relaxation, prevention of various crimes, increased attraction in shops, increased ability to see objects, appearance details and size of components) In places where pedestrian and vehicle systems operate, lighting must be sufficient, although lighting alone is not enough, but it provides a sense of security for people. (Sepideh, 2012, p578)



Picture (7) shows different types of lighting elements

Source respectively: (https://sa.aqar.fm/blog),(https://www.decksdirect.com),(https://www.alibaba.com)

Table (1) shows the aesthetic benefits and their most important indicators

Aesthetic benefits	Elements of pedestrian paths	Interpretation	Indicators for the realization of pedestrian aesthetics
Improve the visual landscape	Awnings / Miscellaneous roof lines	The various canopies and roof lines enhance the pedestrian experience, which contributes to the contrast and aesthetic quality of pedestrian streets, as well as that the arcades give the road a distinctive aesthetic pattern depending on the shape of the columns, arches, and materials used.	The harmony of the shades and roof lines with the overall view of the track
Psychological relaxation	Botanical elements	The presence of trees increases the level of comfort of pedestrians, shade trees are effective in keeping pedestrians cool as well as blocking sunlight from their eyes, as well as shade trees add a nice aesthetic element to the street and tree protectors that add aesthetic dimension and comfort to users	The presence of plant elements sufficient to add comfort to pedestrians

Lighting centers and establishing psychological well-being	Lighting	Good lighting has many benefits that can be summarized as (calm and relaxed pedestrians, prevention of various crimes, increased attraction in shops, as well as it gives attention, and various effects on plantings, fountains, sculptures, drawings, and buildings).	The presence of sufficient lighting along the pedestrian path
Distinguishing places, identifying identity and historical values	Sculptural elements (symbolic)	It adds the aesthetic dimension of the path and derives from the surrounding environment, which is in line with the area and forms a form that expresses the surrounding environment, whether it is heritage or archaeological, square, religious, and others, as well as the dominant elements that add distinction and the possibility of knowing the place	The control of distinctive elements that add aesthetic dimension and distinction to pedestrian streets

Source: Researchers

A questionnaire was prepared for a random pedestrian sample (50 questionnaires), through the questionnaire and analysis of the strength of the correlation between the influential variable (extracted indicators) and the dependent variable (aesthetic benefits) using the statistical analysis program spss to verify that these indicators can achieve the aesthetic elements of pedestrians in different streets. To find out whether these indicators have an actual relationship and the correlation of their relationship with street aesthetics and before multiple linear regression is analyzed, the degree of Conbachs alpha must be known as follows

1. Does the presence and coordination of shades and ceiling lines affect the visual landscape?

   Strongly Agree Agree Neutral Disagree Reject Strongly

2. Do plant elements represent an auxiliary element in psychological relaxation on pedestrian streets?

   Strongly Agree Agree Neutral Disagree Reject Strongly

3. Does good lighting add aesthetic character to the streets and add psychological well-being?

   Strongly Agree Agree Neutral Disagree Reject Strongly

4. Do the dominant elements (symbols and sculptural elements) add distinction and help define the identity of the city?

   Strongly Agree Agree Neutral Disagree Reject Strongly

5. Do beauty elements increase your desire to walk on pedestrian streets?

   Strongly Agree Agree Neutral Disagree Reject Strongly

Sample test using multiple linear regression:

Based on the main hypothesis of the statistical study and based on the following decision-making rule

$$H0 = M = 0$$

There is no effect of the dimensions of the independent variables (transit areas, corridors, lighting, floors, and recovering, common paths)

On the dependent variable (feeling safe)

$$H1 = M \neq 0$$

There is an effect of the dimensions of independent variables on the dependent variable

Error level (0.05) and confidence (0.95) using multiple linear regression model as in the equation

$$Y=a+b1x1+b2x2+b3x3+b4x4+b5x5$$

Whereas,

a = constant value

b1 = coefficient of the first independent variable

b2 = coefficient of the second independent variable

b3 = coefficient of the third independent variable

b4 = coefficient of the fourth independent variable

b5 = coefficient of the fifth independent variable

The stability of the indicators and the internal consistency between the questions (each other all questions in general) can be measured through the analysis of Krombach alpha through the statistical analysis program ((SPSS v.29) its value is between (0-1) and shows the ability of the tool used in the research to measure what is meant by it, that is, the re-application of the questionnaire in similar circumstances, we get the same results were the ratio as in Figure (1) (86.4%), which is a very acceptable ratio for the case under study.

Table (2) shows the analysis of Alpha Kornbach

Case Processing Summary

		N	%
Cases	Valid	50	84.7
	Excludeda	9	15.3
	Total	59	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.864	5

Source: Researchers based on the statistical analysis program SPSS. V25

Table (3) Correlation coefficient and coefficient of determination

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.898a	.807	.785	.432

Source: Researchers based on the statistical analysis program SPSS. V25

a. Predictors: (Constant), Do the dominant elements (symbols and sculptural elements) add distinction and help define the identity of the city, do plant elements represent an auxiliary element in psychological relaxation in pedestrian streets, does the beauty of the streets increase walkability, does good lighting add an aesthetic character to the streets and add psychological well-being, does the presence and coordination of shades and ceiling lines affect the visual scene

Table (4) Analysis of variance to show the impact of indicators on achieving safety

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7708.101	5	1541.620	25.082	.000b
	Residual	2704.399	44	61.464		
	Total	10412.500	49			

Source: Researchers based on the statistical analysis program SPSS. V25

a. Dependent Variable: Does the beauty of the streets increase

walkability?

b. Predictors: (Constant), Do beauty elements increase your desire to walk on pedestrian streets? Do good lighting add aesthetic character to the streets and add psychological well-being, Do the dominant elements (symbols and sculptural elements) add distinction and help define the identity of the city, Do plant elements represent an auxiliary element in psychological relaxation in pedestrian streets, Does the presence and coordination of shades and ceilinglines affect the visual landscape?

Table (5) shows multiple linear regression coefficients

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	10.701	3.224		3.319	.002
	Does the presence and coordination of shades and ceiling lines affect the visual landscape?	16.118	1.826	1.123	8.827	.000
	Do plant elements represent an auxiliary element in psychological relaxation on pedestrian streets?	-.370	1.796	-.025	-.206	.838

1	Does good lighting add an aesthetic quality to the streets and add psychological well-being?	1.831	1.519	.121	1.206	.234
	Do the dominant elements (symbols and sculptural elements) add distinction and help define the identity of the city?	-12.655	2.114	-.749	-5.987	.000
	Do beauty elements increase your desire to walk on pedestrian streets?	2.555	2.326	.171	1.098	.278

Source: Researchers based on the statistical analysis program SPSS. V25

a. Dependent Variable: Does the beauty of the streets increase walkability?

Statistical analysis of the analysis of independent variables in multiple linear regression

1. Note the value of the coefficient of determination (0.807), meaning that the extracted elements were able to interpret by (80.7%) of the possibility of achieving the possibility of walking, meaning that achieving the presence of the mentioned elements provides the beauty of the environment by 807%, while the remaining percentage is explained by other elements and indicators that were not included in this study.
2. The response of the elements to the impact on the level of beauty

of the environment can be confirmed can be seen at the value of 3.319 t = which is greater than the tabular value of 2.000 in statistical significance 0.002 which is less than 0.05

3. Statistical analysis can be conducted in order to test the validity of the hypotheses resulted in a correlation coefficient with a value of (89.8%), which is an acceptable and good value, as it represents the relationship with a positive direct correlation between the indicators of achieving walkability for pedestrian roads and a sense of comfort for the beauty of the environment by users.
4. The positive signal in the analysis of multiple linear regression indicates that there is a direct relationship between each (polygons and ceiling lines, native, lighting, symbols, and sculptural elements) and walkability, meaning that an increase in each variable (element) by one unit leads to an increase in walkability.

Thus, we conclude from this questionnaire that the previous elements as indicators to achieve the possibility of walking higher with a positive impact and direct correlation force in achieving the environment sentences for pedestrians on the roads, especially in the study area, by addressing the indicators to measure the level of beauty and work to propose the provision of all elements to reach the desired goal of the research

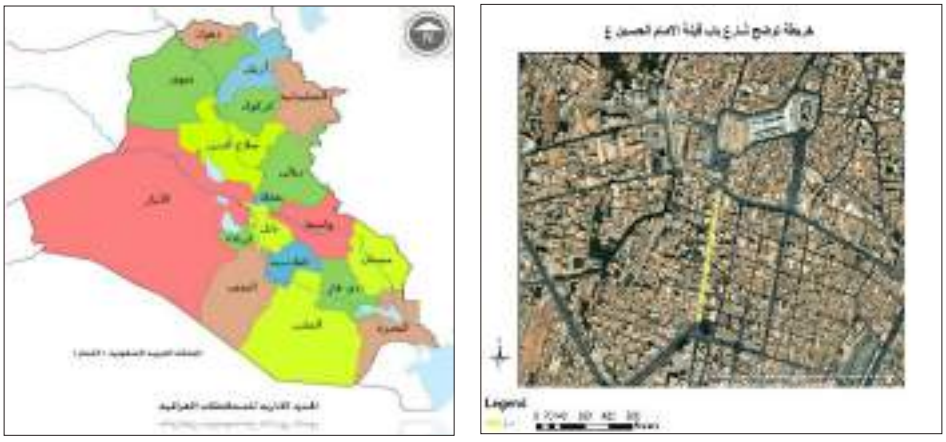
Therefore, we reject the null hypothesis (H0), which means that there is no effect of the independent variable (polygons and ceiling lines, natives, lighting, symbols and sculptural elements) on the dependent variable (beauty of the environment and walkability).

We accept the alternative hypothesis (H1) which means that there

is an effect of the independent variable (polygons and ceiling lines, natives, lighting, symbols and sculptural elements) on the dependent variable (beauty of the environment and walkability).

Practical application (study of the central library street of the center of Karbala)

The study area is located in Iraq, the center of the city of Karbala, and the street is one of the important axes leading to the center of the old city (religious center), as the street extends from the intersection of Bab Qibla Imam Hussein to the Central Library with a length of 550 meters



Map (2) showing the location of the Central Library Street in the city of Karbala

Source: GIS researchers

For a street with a width of (40 meters) consisting of sidewalks on both sides, one side with a width of (2 meters), the opposite side (7 meters) and the street basin by (31 meters)

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Cars are going on the street in one direction (exit from the old city center) traffic in general is common between pedestrians and cars, sidewalks on both sides occupied by street vendors, shops and hotels (pedestrians cannot walk in them), and the crawl from the sidewalks to the first lanes of the street exceeds as vendors exceed more than (5 meters) from each side of the street, i.e. the net common path for the use of vehicles and pedestrians is up to 20 meters.

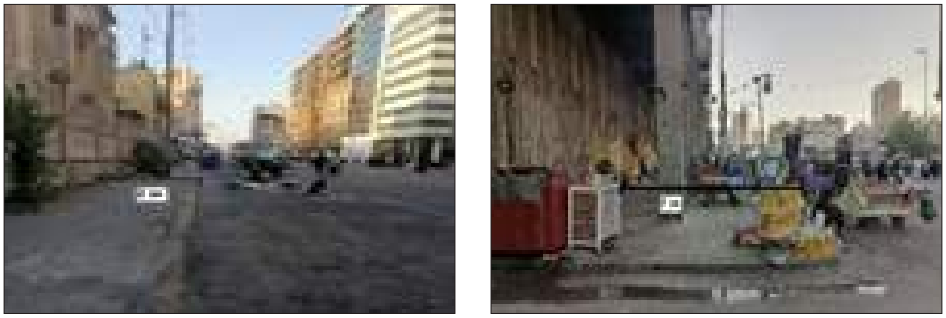

Image (9) showing the width of the sidewalks

source: Field Study

Picture (10) shows the sidewalks in the Central Library Street

Source: Field Study

Picture (11) showing the arcades and shades

Source: Field Study

Picture (12) shows that the street is free of afforestation

Source: Field Study

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Picture (13) shows the lighting

Source: Field Study

Picture (14) showing the shrine of Imam Hussein, peace be upon him

Source : https://wattanna.net

t	Indicators	Fact
1	The harmony of the shades and roof lines with the overall view of the track	There are no roofing lines or shaded to protect pedestrians from weather conditions despite the harsh weather in the area, there are arcades in some areas of the street that differ from each other and are inconsistent, as well as they cannot be used by pedestrians because they are used by shop owners and hotels
2	The presence of plant elements sufficient to add comfort to pedestrians	There is no type of plant elements and the street is free of afforestation and there are no areas designated for afforestation
3	The presence of sufficient lighting along the pedestrian path	In general, there are good lighting units such as lighting poles for every 50 meters, in addition to lighting that shops and hotels use lighting in different forms, which performs the purpose of having lighting and adds a sense of comfort to pedestrians to clarify the details of the street

4	The control of distinctive elements that add aesthetic dimension and distinction to pedestrian streets	In general, the most prominent element in the city of Karbala is the presence of the shrine of Imam Hussein, peace be upon him, which is the center of attraction in the city, as well as the presence of a large banner that distinguishes the end of the street, adding something of privacy and distinction to the street

Conclusions

1. The positive indication in the analysis of multiple linear regression indicates that there is a direct relationship between each of (polygons and ceiling lines, natives, lighting, symbols and sculptural elements) and walkability, meaning that an increase in each variable (element) by one unit leads to an increase in walkability.
2. The study area (Central Library Street in the center of Karbala city) suffers from poor planning in general and attention to the planning of pedestrian streets in particular, so many problems appear clearly .
3. The lack of misleading to protect pedestrians and roof lines to protect pedestrians from different weather conditions and their role in adding the aesthetic character of the street turns into discouragement to rely on walking and reduce the walkability index, as well as neglect of arcades and their incorrect use by

street vendors and shop owners.

4. The plant element plays an important role in the planning of pedestrian streets, so one of the great weaknesses in the focus of the study is the lack of afforestation that works to soften the atmosphere and add an aesthetic character with a great psychological dimension, which is reflected in the ability to walk

5. Lighting has great privacy in all roads, but in the pedestrian axis it needs special care and finding special standards In the focus of the study, there are lighting elements that perform their functional role in street lighting, but the importance of the lighting element is not focused on adding the beauty dimension and the psychological role on pedestrians, especially in the Central Library Street, as it is random and acted by the shops without any standards or laws .

6. The city of Karbala is characterized by the religious character of the center of attraction for visitors from inside outside the city (holy shrines), but it has an important historical aspect that extends to previous eras that transmit important large cultures in the same recipients and there are no symbols or elements in the axis of the study to refer to the historical dimension .

7. The phenomenon of irregular street vendors is a phenomenon that causes chaos and irregularity in pedestrian streets and has a negative impact on the scene of Basra and the comfort of pedestrians in the streets, especially the Central Library Street in the center of Karbala city

Recommendations

1. Focusing on planning in general and planning pedestrian streets in particular, so walking is the main means of transportation on which the old city centers were established, especially in the city of Karbala, which is characterized by narrow roads and alleys that are suitable for pedestrian use only
2. Focusing on finding elements that add the beauty of the pedestrian environment to increase walkability in areas where walking is the most important means of transportation within the city center, especially in cities that witness a continuous high turnout such as the city of Karbala
3. Paying attention to the shade, roof lines and corridors of the Central Library Street to protect pedestrians from climatic conditions and focus on the aesthetic character of the street due to the importance of the religious center of Karbala city and the importance of encouraging walking as a sustainable means of transportation
4. Adding the plant element and using modern means of watering and protecting it and focusing on coordinating it with the general character of the street and adding the beautiful dimension of afforestation and gaining the positive psychological impact of pedestrians and raising the index of walkability.
5. The street is characterized by straightness, as the landmark of the shrine of Imam Hussein, peace be upon him, can be seen from

the end of the street, and this adds a distinctive feature to the street, despite the lack of consistency in the buildings in the path and the absence of afforestation, which makes the visual scene a painting with a great positive impact on the hearts of pedestrians.

6. Finding public transportation with specific paths within the street that facilitate the process of visitors to reach all areas of Karbala city center.
7. Adding bicycle paths as they are within the means of sustainable transportation, which adds an aesthetic character to street planning.

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The role of the multi-functional urban space in meeting the requirements of the “Arbaeen” visitors of Imam Hussein (PBUH) in the holy Karbala center

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Abstract:

The “ Ziyarte Al-Arba’een “, which takes place in the holy city of Karbala, is one of the most important visits that Muslims from different countries of the world are keen to perform annually, as a large number of visitors go to the city of Karbala on foot to commemorate the occasion of the “Arbaeen” of Imam Hussein (PBUH), the grandson of the Messenger of God (PBUH), Where the number of visitors in (2014 AD) who entered the city of Karbala exceeded (21) million visitors. These numbers of visitors have their own requirements and services that are difficult to provide in the small area of the city center of Karbala, which does not exceed (75.67 hectare) and is intended to accommodate (less than 40,000 people) of its local population. Therefore, the research problem was: the difficulty of providing the requirements and services for visitors in the city center of Karbala, especially in the “ Ziyarte Al-Arba’een “. Therefore, it was a legal and ethical duty to think in scientific and sustainable ways to provide these requirements without the need to build new service structures in the movement axes that cause a lack of space for walking and crowding that impedes movement, by adopting the hypothesis: that relying on the concept of multifunctional urban space can contribute to finding solutions to provide the necessary services for visitors. The main objective of the research is to identify the urban spaces in the center of the holy city of Karbala, in which the elements of multi-functional urban spaces can be applied, and to identify the services and the entity responsible for managing them that can be appropriate for each space.

Keywords: Multifunctional urban space, the “ Ziyarte Al-Arba’een “, visitor requirements.

Introduction:

The concept of multifunctional urban space is one of the modern concepts in the field of urban planning. It is common in the field of agricultural sciences and the field of architecture and urban design. It is often synonymous with the concept of multi-use, multi-purpose or mixed-use buildings, but in the field of urban planning it differs from these concepts. In addition to being a new concept, it has not been widely addressed in academic urban studies. The studies specialized in presenting the concept of multifunctional urban space as a solution to increase the quality of life in high-density areas, such as the study conducted by (Atieh Ghafouri, & Christiane Weber,2020) and the study conducted by (КОЛЕСНИКОВ & МЕДВЕДЕВА,2023). There are other studies that dealt with it as a strategy for developing public health, such as the study conducted by (Andrew J. Lafrenz, 2022), and studies that dealt with it as a strategy for achieving sustainability, such as the study conducted by (Atieh Ghafouri, 2016) and the study conducted by (Aynaz Lotfata, 2022). Other studies dealt with it as a solution to revive the neglected parts of the city, such as the study conducted by (Radmila and Hekuran Iva,2022). In general, most of them look at achieving sustainability and quality of life. The center of the old city of Karbala is one of the densest city centers, which needs urban spaces that provide the necessary services, especially in the " Ziyarte Al-Arba'een " period, as the city of Karbala is choked by large numbers of visitors who come to it from all over the world. At the same time, the city has many spaces that can be exploited according to the concept of multifunctional space.

Urban space:

Multi-functionality: The word "function" is one of the key words in architecture and urban design refer to the purpose of a building and the type of activities that users perform within the space. This word is always used in architectural sources alongside the words "form, space, and beauty." Therefore, the concept of "multifunctional spaces" was used concomitantly with the concept of multifunctional buildings and mixed use, often without any distinction or difference. The concept of multi-functionality means different uses of space at different times (Zeidler, 1985), while the concept of mixed use means the existence of a group of different uses, at least three of which are income-generating in a specific period of time (Thrall ، 2002). In urban design, the concept of multifunctional urban space has a more precise definition, as Ziedler (1985) focuses on "space" and "function" and links the concept of multifunctional spaces to ancient Greek or medieval buildings. It is believed that the uses come initially from the buildings and then move to the comprehensive planning level and should not be limited to a single space, but rather in the form of an integrated network to enhance the functional integration between the many public spaces in the city, taking into account the principle of proximity (Pinto & Remesar, 2009.p:3).

Space and its relationship to activity and time: If we study the full life cycle of space, will see that sometimes space is more detailed and effective. On the other hand, in some periods of time it is less active or may even be empty and without use. An example of this is the space

opposite the university in European countries, where it is active during the working months and inactive during the vacation months. Even during the working months, it is occupied by students on working days and empty on Fridays and Saturdays. The space may be used as a market for selling vegetables, as well as at the one-day level, as it is crowded with students during the morning rush hour when class starts and the evening rush hour when students leave the university. As for the rest of the hours, it has little activity. A unitary space can work better with a few changes in conjunction with different time periods (daily, weekly or yearly). For example, school grounds (spaces) can be opened to the public during school holidays and temporarily. The process of intensification of functions in space aims to make the most of the maximum capacity of space, and this process of intensification does not occur only in "space" but also in "time". This means that although space accommodates all numbers of planned users, it can always accommodate hidden capabilities (various activities) during different periods of time..

(Multifunctional urban space): firstly, there is no comprehensive definition of this concept, as it is often used in the field of architecture and urban design. In the field of urban planning, it is a new concept that was introduced in an integrated manner with the concept of land uses under the title (Multifunctional or multi-use land uses) with the aim of creating spatial and economic synergies for the use of land to save space by increasing its functional efficiency, while preserving spatial quality. This synergy is due to the interaction between the different activities

and it is in three forms: different functions in different spatial units but adjacent, different functions in one spatial unit but at different times and different and integrated functions in one spatial unit at the same time and these three forms agree on the idea of choosing the “optimal” arrangement and the most efficient use of the land (Atieh Ghafouri, 2020, p:26). Based on this proposition, (Atieh Ghafouri) provides a definition of the concept of a multifunctional urban space, a space that is characterized by the existence of different functions, different actors and different users in different periods of time, or accepting two or more activities at the same time (accepting more than one function in one activity cycle) (Atieh Ghafouri, 2020, p:27). Urban spaces can be considered, and at various levels (whether it is at the level of a residential complex, a neighborhood, or an entire city) that have a specific function that is limited to specific hours of the day, days of the month, or months of the year. These spaces can be revived with other functions during these hours, and spaces with private or semi-private uses can be dedicated to a public performance. For example, school yards can be opened to the public during school holidays and used temporarily as a common space (Atieh&Christiane,2020,p:42). Various examples of these spaces with the mentioned features can be cited all over the world: in the capital of Iran, Tehran, the open space of the University of Tehran is used on Fridays for Friday prayers; In the Vietnamese capital of Hanoi, sidewalks have become venues for badminton; In the French capital, Paris, streets along the Seine turn into urban beaches in summer, and in many cities and towns around the world, sidewalks are a suitable space for a permanent art exhibition

and parking spaces are allocated for commercial complexes or offices to hold local markets (Atieh Ghafouri, 2020, p:27). The multifunctional use of urban spaces may reduce the need to create new spaces in order to meet the needs arising from the increasing number of users and the increase in urban density (Atieh& Christiane, 2020, p: 43). This concept is more active in developing countries, in an instinctive way, because the restrictions imposed on the use of urban spaces are less than the restrictions imposed by developed countries. Therefore, the population in these countries is more free to use spaces, so they automatically give more functions to existing spaces other than the function according to which the space was designed (Atieh Ghafouri, 2020, p:27).

ingredients of the multifunctional urban space: The urban space has a set of ingredients that will be reviewed in detail as follows:

1. Quality:

Space quality relates to lighting, ventilation, sunlight, temperature, etc. And since most of the functions that occupy the same space are similar, therefore, the quality of space suitable for a particular function will certainly be suitable for other functions. Sometimes, adding a new function to the space may require making some changes. (Haile, 2003, p: 71).

1.1. Appropriate Infrastructure:

Usually, the process of adding new functions to the space requires the availability of basic requirements, and one of these requirements is the infrastructure, as the space must contain an infrastructure that makes it ready to receive a function other than the function for which the space was created, so the priority will be for the space that needs the least new infrastructure (Atieh, 2016, p:99).

1.2. Temperature and sunlight:

the temperature changes from one space to another depending on the geographical location, the infrastructure, misleading treatments or guidance. As for the functions that are added to the space, some of them do not need a temperature and can happen in normal conditions, and some of them need to be held in shaded spaces (Atieh,2016,p:101).

1.3. Freedom from pollution and noise sources:

Adding a new function to the space requires that the space be free from pollution sources of noise, in order to be suitable for users and not generate health risks for them (Atieh,2016,p:101).

1.4. Availability of protection means:

especially in functions that serve large numbers of users, the condition of protection from structural or environmental hazards or other dangers is one of the most important conditions that must be met to add a new function to the space (Atieh,2016,p:103).

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.1.5. Adequate lighting:

whether it is natural lighting during the day or artificial lighting in spaces to which a new function is added that requires users to stay for hours at night. (Atieh,2016,p:104).

2. Size:

To contain a certain function, the space requires a certain size and to contain different functions, the size of the space must be suitable for all these functions.

2.1. Sufficient area:

where the unitary urban space can be transformed into a multi-functional space by calculating the area required by each function. Sometimes the space does not require a change in the area to contain different functions, and this is what can be seen in the space at the level of the residential area, as it contains a social function for the elderly and the function of playing for children. Sometimes it may be necessary to change the area (Haile, 2003, p: 70-71).

2.2. Size and ability to accommodate other activities:

Since most of the urban spaces that have become multi-functional spaces were originally designed as single-functional spaces as a result of the limitations of the land and the need for other activities, a multi-functional approach was resorted to as a fait accompli to take advantage of the possibility of space and exploit it at the maximum level (Atieh,2016,p:98).

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3. Location:

The location of the space affects whether or not it is chosen as a multi-functional space. Spaces located in the city center or in areas characterized by high density and limited space are often chosen (Atieh,2016,p:102).

3.1. Accessibility:

Accessibility is considered one of the main and important factors. Therefore, priority is given to spaces that can be accessed directly to add a new function to it (Atieh,2016,p:102).

3.2. Communication:

It can occupy more than one function in only one space, while some functions need a connected series of spaces, where functions can be integrated to provide a general service to users by creating a connected chain of spaces (Aynaz,2022,p:2).

4. Shape:

The space also needs a specific shape to contain a specific function, and at the same time the space can contain more than one function without the need to change its shape in the case of selecting functions that require similar shapes, and sometimes the multi-use space requires changing its shape to contain Different functions. (Haile,2003,p: 71).

5. Time:

It refers to the time in which the space can be used, which is the time when the space becomes empty. Therefore, the space must have a time during which the basic activity stops for a period of time (several minutes, several hours, several days, or several months), and the appropriate activity for the space is chosen in proportion to this period of time (Atieh, 2016, p: 98).

6. The authority responsible for managing it:

the urban space must have a main body and a secondary one that is responsible for managing it and coordinating the start of the various functions of the space with its end period to avoid intersection or problems. Therefore, the main responsible body is often the body affiliated with the space itself, while the secondary body is often represented by voluntary civil associations, which act as a link between the main body and the public benefiting from the function (Aynaz,2022,p:4 and Atieh, 2016, p: 96).

7. The legal basis for ownership and management:

It refers to the legal basis for the sustainability and possession of space, so the space must have a clear and responsible owner who can negotiate with them for the purpose of owning and managing space as multi-functional space (Atieh,2016,p:103).

Methodology:

This study relies on the descriptive and analytical approach by collecting data on the concept of multi-functional urban space from different sources and relying on theoretical-spatial research and analysis in the practical aspect through the field study and frequent visits to the study area to determine the spaces to which the features and ingredients of multi-functional spaces can apply in the center of Karbala city and to determine the appropriate service (provided to visitors) for each space and the entity responsible for its management.

Karbala City (location and importance):

The city of Karbala is located 105 kilometers southwest of Baghdad (the capital of Iraq). It occupies an area of (52,856 square kilometers) (Ahmed & Deniz, 2022,p:111). The population of Karbala Governorate is 1,003,516 citizens,. it gained importance after the martyrdom of Imam Hussein in the Battle of Karbala in the year 61 in the Hijri calendar, in the Battle of Tuff (Sabeeh& Zuhair, 2018,p:56). Therefore, the holy city of Karbala is one of the most important Islamic holy shrine cities. Which is characterized by its historical and urban value and the privacy of its urban center represented by the presence of two important shrines that represent the nucleus of the city center; They are the shrine of Imam Hussein (pbuh) and the brotherhood of Abbas (pbuh) (Maymoon,2017,p:55).The study area is represented by the boundaries of the traditional city of Karbala, which consists of eight neighborhoods as shown in Map No. (1).

The “Ziyarte Al-Arba’een “: “ Ziyarte Al-Arba’een “is one of the rituals of God, which the Shari’a affirmed to glorify its highness and lofty goals. The visitors see that the visit of Imam Hussein (pbuh) Special symbolism and importance mentioned by the Prophet Muhammad (pbuh) and the imams of the Ahl al-Bayt (pbuh). On the authority of the Prophet Muhammad (pbuh) he said: “Whoever visits the tomb of Al-Hussein bin Ali, (pbuh), on the day of the Arbaeen, he is truly on the God to forgive his sins” (Al-Kafi, vol. 4, p. 582). Therefore, millions of visitors go every year to the Holy Karbala from different countries of the world in order to declare love and loyalty to the master of the martyrs, Imam Hussein,, with what it represents of a high human value (Anwar & Bushra, 2019, p: 31). Despite the ancient roots of walking to Imam Hussein (peace be upon him) on the “Ziyarte Al-Arba’een “, it increased after 2003, when visitors began to turn out more year after year (Karbala Center for Studies, 2022). Therefore, it is considered one of the largest visits as a result of the crowds that flock to the city center of Karbala during successive days starting from the 10th of Safar until the 20th of Safar, as the numbers increase as approach the date of the visit) (Maymoon,2017,p:82).

Visitors’ requirements:

Through the field visit and accompanying the visitors on the walking path to the holy Karbala center, it is possible to identify the most important requirements and the main services that the visitor needs: (Services of providing food and drink, Purification facilities services, Rest services, sleeping services, and medical services)

In addition to the presence of a number of services and other secondary requirements and other main services that are not of interest to the search, such as transportation services and guiding the lost, in addition to other services, the Arbaeen visitors' road is full of services that cannot be counted in one search. Shown in figure No. (1).

Multi-functional spaces in the study area: Through the field study, it is possible to identify four types of spaces that can be multi-functional (outdoor spaces for schools, vehicle parking spaces, open spaces and green areas) as shown in Map No.(2).

Pedestrian axes in the study area: In the holy Karbala center and during the " Ziyarte Al-Arba'een " period, pedestrian axes are divided into two types: the main pedestrian axes, which are often the main streets of the city and are characterized by the intensity of pedestrian movement, the other type is the secondary pedestrian axes, in which pedestrians are less than the first type, which are often the alleys and streets that connect the streets of the first type, as shown in Map No.(3).

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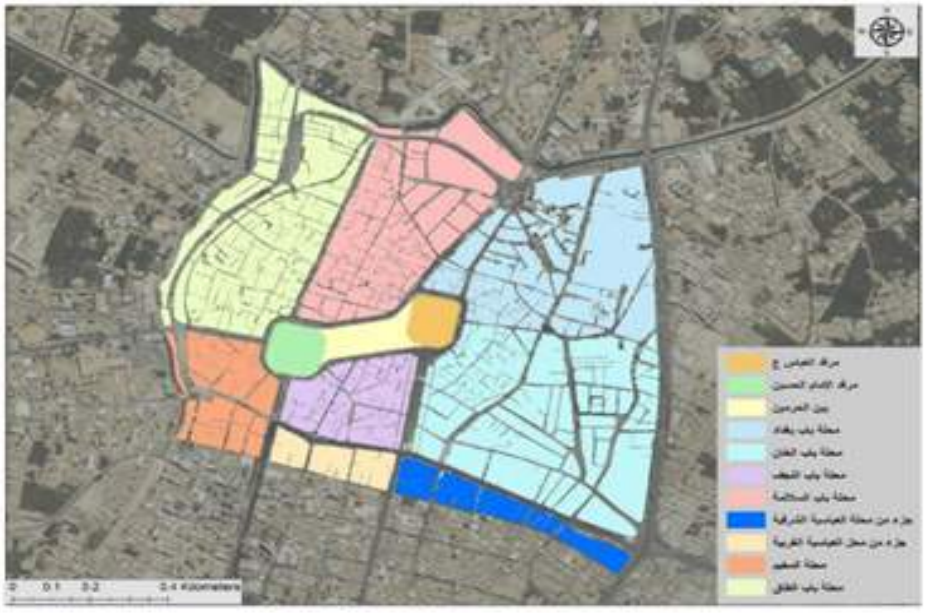
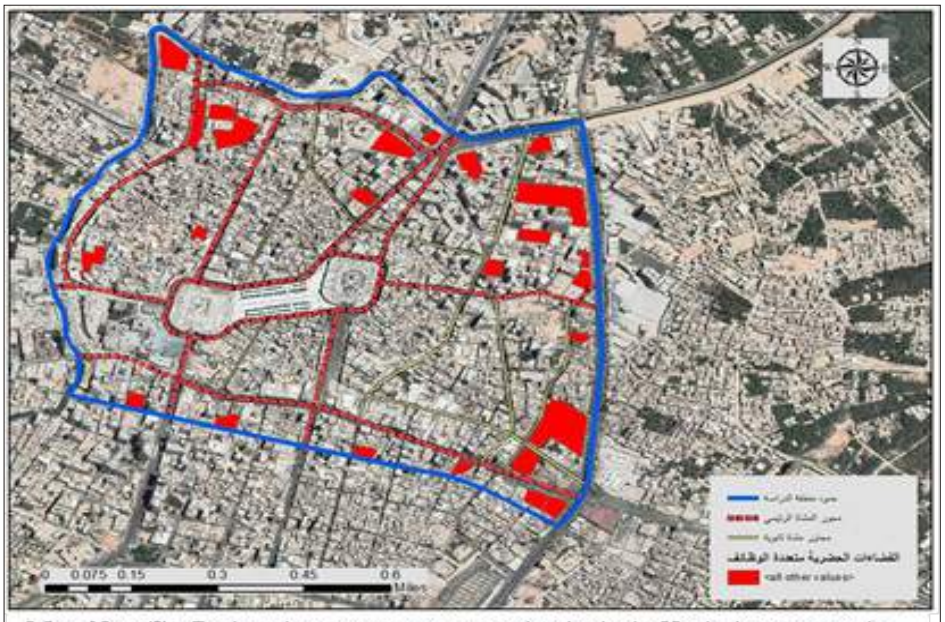
figure No. (1): The " Ziyarte Al-Arba'een "



Map (1): The study area, Maymoon muwafaq,2017, Spatial planning of the movement of crowds in the centers of holy cities (Karbala holy case study), the master degree in sciences of Urban and Regional Planning To the Center of Urban and Regional planning for post Graduated Studies \ University of Baghdad.

Map No. (2) The multifunctional spaces in the holy Karbala center: the researchers based on the 2021 aerial photograph and the Arc Map program



Map No. (3): Pedestrian movement axes in the holy Karbala center: the researchers based on the 2021 aerial photo and the Arc Map program

Choosing multi-functional spaces and comparing them: After defining the most important spaces that could be multifunctional spaces in the previous paragraph, in this paragraph the extent to which the space achieves the ingredients that have been reached and its distance from the pedestrian axis is measured and the function and the body responsible for managing the space are determined. Due to the large number of spaces and the similarity of many of them in the original function and characteristics, a part of these spaces was chosen, which has an area of more than (5000 square meters), with the exception of open spaces.

figure No. (2), the external spaces of Sidra

The first space: It is the external spaces of Sidra School, which are shown in figure No. (2).

figure No. (3), open green area

The second space: It is the space represented by the open green area, the location of which is shown in figure No. (3).

figure No. (4), vehicle parking (car garage)

The third space: It is the space represented by the vehicle parking (car garage), whose location is shown in figure No. (4).

figure No. (4), open urban space

The fourth space: It is the space represented by the open urban space, whose location is shown in figure No. (4).

Results of Ingredients Measurement: After reviewing the four spaces in this paragraph, the extent to which the ingredients were achieved was measured on the selected spaces, as shown Table No. (1).

Table No. (1)

Measuring the extracted Ingredients on the selected spaces

Main Ingredients	Minor Ingredients	Quality
The space (1)	Appropriate Infrastructure	Availability of sanitary facilities, water supply, sewage and electricity
The space (2)	Not suitable due to lack of infrastructure	
The space (3)	Availability of sanitary facilities, water supply, sewage and electricity	
The space (4)	Not suitable due to lack of infrastructure	

Quality			
Adequate lighting	Availability of protection means	Freedom from pollution and noise sources	Temperature and sunlight
Lighting available (natural and artificial)	Fairly available	free from pollution and noise sources	The space is open and not shaded
Lighting available (natural and artificial)	unavailable	free from pollution and noise sources	The space is almost completely shaded by trees
Lighting available (natural and artificial)	unavailable	free from pollution and noise sources	The greater part of the space is open and the other part is shaded by trees
Lighting available (natural and artificial)	unavailable	free from pollution and noise sources	The space is open and not shaded

Location		Size	
Communication	Accessibility	Size and ability to accommodate other activities	Sufficient area
Appropriate duo to location near main pedestrian axes	Appropriate duo to direct accessibility	Fairly appropriate	Fairly appropriate
Appropriate duo to location near main pedestrian axes	Appropriate duo to direct accessibility	Appropriate	Appropriate
Far from main pedestrian axes	Appropriate duo to direct accessibility	Good size and holding capacity	Large and appropriate
Far from main pedestrian axes	Appropriate duo to direct accessibility	Appropriate	Appropriate

The legal basis for ownership and management	The authority responsible for managing it	Time	Shape
Public property, it is possible to use it in coordination with the Directorate of Education	Team of the Education Directorate with service organizations	summer vacation period	Fairly appropriate
Public property, it is possible to use it in coordination with the Municipality Directorate	Team from the Karbala Municipality Directorate with service organizations	Available at all times	Appropriate
Private property, it is possible to use it by renting it from the owners.	Team of parking owners with service organizations	Arbaeen visitation time is closed	Appropriate for accommodating different functions
Private property, it is possible to use it by renting it from the owners.	Team of space owners with service organizations	Available at all times	Appropriate

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Discussion and Conclusion: In this part of the study, the appropriate function for each space was determined based on the analysis in the previous table. But before this determination must note that there is a relationship between some functions. For example, the function of performing the rituals of visiting is linked to the function of purification services and facilities, the function of serving food and beverages is linked to the function of comfort services, and the function of comfort services is linked to the function of medical services. Thus, these functions can overlap with each other by dividing the functions over different periods of time for the space itself, and the possibility of appropriateness of the function for the space depends on the ingredients that were measured, as well as the distance of these spaces from the religious event sites. As explained in the following paragraphs

The space (1) contains infrastructure services and is easily accessible. It becomes empty at the time of the " Ziyarte Al-Arba'een ", but it is not comfortable from a climatic aspect, because it is not shaded. Therefore, it is suitable for the function of purification services. If it is shaded, it will be suitable for the function of performing the rituals of the visit and the function of rest. And the space can provide all these functions, but at different time periods, as it can provide the function of purification services throughout the day, while it is suitable for the function of prayer and performing the rituals of visiting at the time of prayer and is available for the function of rest at the remnant of the times.

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The Space (2) It is almost completely shaded and free from sources of pollution and noise and is easily accessible and available at all times. Therefore, it is suitable for the function of rest, the function of serving food and drink, and the function of medical services. It is not suitable for the function of purification services because it does not contain the infrastructure, and therefore it is not suitable for the function of the rituals of visiting and praying. It can be made convenient by equipping the space with temporary infrastructure.

The Space (3) It contains infrastructure and part of it is shaded and part is not shaded and has a large area and is easily accessible so it is suitable for the function of purification services and in the shaded part it is possible to add the function of rest and the performance of visiting rituals and even the function of serving food and drink where jobs can be divided into different periods of time, for example To occupy the space with the function of providing food and drink before the time of the prayers, and then immediately perform the prayer function and perform the rituals of the visit. while the part that is not shaded, it can be shaded temporarily and exploited or exploited at night, and it is suitable when visitors gather in large numbers to perform some rituals of the visit.

The Space (4) It is not shaded and does not contain infrastructure, but it is easy to access, so it is not suitable for the function of purification services at all times, and it may be suitable for the function of rest and the function of visiting rites if the space is shaded temporarily or during night.

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