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Using Augmented Reality and Geographic Information System to Improve Building Site Selection

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Abstract:

When designing, or developing any city, whatever its size, the biggest problem facing the architect is choosing the best location for public facilities within the urban fabric. To this day, no scientific computational method has been established to be used to find the best site from an architectural perspective for a public service building that takes advantage of new digital technologies.

The objective of this paper is to formulate a methodology that takes advantage of new digital technologies and standardizes a set of specific measurable metrics in form of 3D matrix.

This can be achieved by formulating a criteria for measuring the necessary factors required to distinguish between a set of candidate sites and find best suitable location for the construction of a specific building, based on Augmented Reality (AR) technology and benefiting from the data provided by the Geographic Information System (GIS) and trying to answer important questions: Are Augmented Reality (AR) technology an appropriate methodology to correctly find suitable location for newly constructed buildings? Will it really enhance the architect's experience and improve his performance? It appears that the use of digital technology in any applied field improves the accuracy and task completion time of the result, is this also true for the problem under discussion?

Accordingly, setting up clear and unified standard measuring criteria agreed upon all architect and urban planners as these measures will have tangible values, thus enriching the experience of both the client and the architect.

Key words: Digital Techniques, Augmented Reality (AR), Geographic Information System(GIS), Building Site Selection.

الملخص:

عند تصميم أو تطوير أي مدينة مهما كان حجمها فإن أكبر مشكلة تواجه المهندس المعماري هي اختيار الموقع الأفضل للمرافق العامة ضمن النسيج الحضري. وحتى يومنا هذا، لم يتم إعتماد طريقة علمية حسابية تستفيد من التقنيات الرقمية الحديثه ليتم إستخدامها في العثور على أفضل موقع من الناحية المعمارية لمباني الخدمات العامة.

الهدف من هذه الورقة البحثية هو صياغة منهجية تستفيد من التقنيات الرقمية الحديثه وتوحيد مجموعة من المقاييس المحددة القابلة للقياس عمليا وتمثيلها بشكل رياضي بسيط في شكل مصفوفة ثلاثية الأبعاد.

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ويمكن تحقيق ذلك من خلال صياغة معايير لقياس العوامل الضرورية المطلوبة للتمييز بين مجموعة من المواقع المرشحة وإيجاد أفضل موقع مناسب لإنشاء مبنى معين، وذلك بالاعتماد على تقنية الواقع المعزز (AR) والاستفادة من البيانات المقدمة من قبل نظام المعلومات الجغرافية (GIS) ومحاولة الإجابة على الأسئلة المهمة الآتيه: هل تقنية الواقع المعزز (AR) منهجية مناسبة للعثور بشكل مقبول على الموقع المناسب للمباني المشيدة حديثًا؟ هل سيعزز حقا تجربة المهندس المعماري ويحسن أدائه؟ يبدو أن استخدام التكنولوجيا الرقمية في أي مجال تطبيقي يؤدي إلى تحسين دقة النتيجة وزمن إنجاز المهمة، فهل ينطبق هذا أيضًا على المشكلة قيد البحث؟

بناء على ذلك، يتم بهذا الورقه البحثية وضع معايير قياس واضحة وموحدة متفق عليها بين جميع المعماريين ومخططي المدن، بحيث سيكون لهذه القياسات قيم ملموسة واضحة، مما يثري تجربة كل من العميل والمهندس المعماري فيما يتعلق بإختيار أفضل موقع مناسب لإنشاء مبنى جديد.

الكلمات المفتاحية: التقنيات الرقمية، الواقع المعزز، نظام المعلومات الجغرافية، اختيار موقع البناء.

پوختە:

لەکاتی دیزاینکردن یاخود بەرەوپێشبردنی هەر شارێك ــقەبارەکەی هەرچەندە بێت-ئەوا گەورەترین گرفت کە ڕووبەڕووی ئەندازیاری بیناسازی دەبێتەوە بریتییە لە هەڵبژاردنی باشترین شوێن بۆ بینا گشتییەکان لە چوارچێوەی ڕشتەپێکهاتەی شارستانیدا، هەتا ئەمڕۆش پشت بە شێوازێکی کرداریی ژمێرەیی نەبەستراوە کە سوود لە تەکنیکی ژمارەیی نوێ ببەستێت تا لەڕووی بیناسازییەوە بەکاربهێنرێت بۆ دۆزینەوەی باشترین شوێن بۆ بیناکانی خزمەتگوزارییە گشتییەکان.

ئامانج لەم لاپەڕە توێژینەوەییە بریتیە لە داڕشتنێکی مەنهەجیی کە سوود لە تەکنیکە ژمارەییە هاوچەرخەکان و یەکخستنی کۆمەڵێك پێوەری دیاریکراو دەبەستێت کە شیاوی ئەوەن بەکرداری بپێورێن و بە شێوەیەکی بیرکاریی سادە و لە شێوەی ڕیزکراوە (ماتریکس)ی سێ ڕەهەندی بنوێنرێن.

ئەمەش دەکرێت بەهۆی داڕشتنی چەند پێوەرێکەوە بەدی بهێنرێت بۆ پێوانی یاریدە پێویست و خوازراوەکان بۆ جیاکردنەوەی نێوان کۆمەڵە شوێنێکی پاڵێوراو و دۆزینەوەی باشترین شوێنی گونجاو بۆ دروستکردنی بینایەکی دیاریکراو، ئەوەش بەپشت بەستن بە تەکنیکی کەتواری بەهێزکراو (AR) و سوود وەرگرتن لە زانیارییە پێشکەشکراوەکان لەلایەن سیستەمی زانیارییە جوگرافییەکان (GIS) و هەوڵدان بۆ وەڵامدانەوەی ئەم پرسیارە گرنگانە: ئایا تەکنیکی کەتواری بەهێزکراو (AR) بەرنامەیەکی گونجاوە بۆ دۆزینەوەی شوێنی گونجاوی بینا تازە دروستکراوەکان بەشێوەیەکی پەسەندکراو؟ ئایا بەڕاستی ئەزموونی ئەندازیاری شارستانی بەهێز دەکات و بەجێهێنانی باش دەکات؟ وادیارە کە بەکارهێنانی تەکنەلۆژیای ژمارەیی لە هەر بوارێکی جێبەجێکارییدا دەبێتە هۆی چاککردنی وردی و ڕێکی ئەنجامەکە و کاتی ئەنجامدانی کارەکە، ئایا ئەمە بەسەر ئەو گرفتەشدا جێبەجێ دەبێت کە ئێستا لە بواری ئەم لێکۆڵینەوەیەدایە؟

لەسەر بنەمای ئەمە، لە میانەی ئەم لاپەڕە توێژینەوەییەدا چەند پێوەرێکی پێوانە دادەنرێن کە ڕوون و بەرچاو و یەکخراون و سەرجەم بیناسازان و نەخشەدانەرانی شارەکان لەسەریان کۆکن، بەجۆرێك ئەم پێوانانە بەهاگەلی بەرجەستە و ڕوونیان دەبێت، ئەمەش ئەزموونی هەریەك لە کارکەر و ئەندازیاری بیناسازی دەوڵەمەند دەکات لەوەی پەیوەستە بە هەڵبژاردنی باشترین شوێنی گونجاو بۆ دروستکردنی بینای نوێ.

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Introduction

When the place is associated with the world of architecture, its name changes to (architectural place), and thus it develops in an open, natural space into a functional space with measured limits, dimensions and design criteria (Thuwaini, 2000).

This place is affecting and being affected by a set of changing data such as the environment, the economy and the political factor, in addition to standards of beauty and taste, which moves the place to a rank Disciplined integrated system, which requires that every decision in the building must be measured from several functional, formal and architectural aspects (Thuwaini, 2000).

Before taking any decision to construct a building or public service facility, it is the responsibility of the architects to decide among the proposed sites for the construction of this building, to choose the best site among them based on several factors, by conducting a comprehensive analysis of the sites with the aim of setting standards for implementation of the best design respecting the physical and environmental requirements of the site. Contextual analysis is a research activity that looks at the conditions of a project site, including any current or potential future conditions. This requires to provide information about the site before starting the decision-making process so that it includes pre-made solutions to expected problems (Simon, 1981).

Architectural site analysis analyses factors such as site location, size, topography, zoning, traffic conditions, and climate. The analysis also needs to consider any future changes to the site's perimeter, such as changing roads, changing cultural perceptions, or other significant building developments near the site. Understanding the context of the site is important because it allows the designer to integrate the new building with the existing foundation of the site. It also helps identify any problems with the site and how to avoid or resolve them when they arise. Site analysis requires thorough research of all available data on the site, otherwise incomplete site analysis can lead to a sub-optimal choice due to a lack of information and insight about potential issues within the site (Vasquez, 2022).

These data of any architectural site can be classified into below general factors (criterions): Visual Access, Location, Context of neighbourhood, The zonings and size, Legal information and documentation, The natural physical features, The man-made features, Circulation, Utilities, Climate, Sensory, Human and cultural, and Public Service Utilities (Sharma, 2022).

Due to the importance and nature of information and its vital role in the architectural and urban design processes of architects, planners and environmental conservation experts, a digital system known as Geographic Information System (GIS) has been developed to offer the possibility of linking any quantity or set of data for an urban location with the absolute geographical coordinates or those specified by the user. Thus, these systems are an advanced tool used to manage all forms and analyses of spatial knowledge.

Digital Technique's

GIS are defined as the systems that acquire, store, analyse, manage and display data related to and related to the characteristics of a place, and digital applications related to these systems act as tools that allow the user to create interactive queries, analyse spatial information, and edit data Create maps,

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with the ability to present results in multiple formats for all these procedures, and provide realistic analytical cases about the real physical environment (Santos et al., 2021).

GIS technology can be used by a variety of disciplines and fields, such as urban planning, resource management, asset management, historical and heritage facilities, archaeology, cartography, scientific investigations and analyses, environmental impact assessment, criminology, geographical history, management, marketing, logistics, perspective mapping, and other fields. GIS combines physical elements such as buildings and streets with metadata and then correlate them with the urban area topology (Xhafa & Kosovrasti, 2015).

One of the most important digital systems that can be linked with the geographic information system to take advantage of the data it provides in an interactive and visual way is the Augmented Reality (AR) system (Carmigniani & Furht, 2011).

Augmented Reality (AR) is a real-time direct or indirect view of a physical real-world environment that has been enhanced (augmented) by adding virtual computer-generated information to it. AR is both interactive and registered in 3D as well as combines real and virtual objects, as demonstrated in Figure 1 below. Another way to define AR is to say that it is a medium in which information is added to the physical world in registration with the world. Although there are various definitions of AR, most of them agree that there are three characteristics that define AR. First, it combines the real world with virtual additions. Second, it is interactive in real time. Third, it is registered in 3D (Craig, 2013).

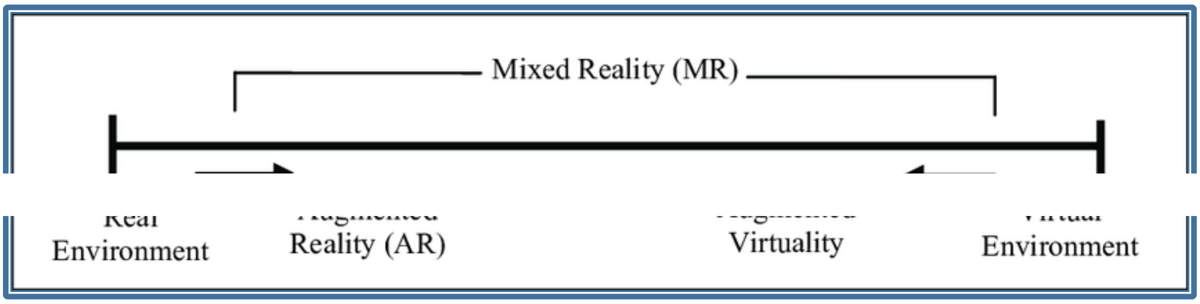

Fig (1) *Reality-Virtuality Continuum* (Carmigniani & Furht, 2011)

Conventional Technique for Deciding Building Site

In this paragraph, the main steps of the conventional methods of deciding building locations will be briefly illustrated to be compared later with the proposed method that depend on digital systems. These steps include:

1) Primary Data Collection, where information related to Location, Legal Information, Utilities and Climate should be gathered before even visiting the site (Edward, 1983).
2) On-site data collection: Include information on visiting the site and what to look out for maintaining a list of items to keep on the lookout for that needs to be completed when on site. This would include items based on the previous categories that have been discussed to enrich data about site, The Neighborhood Context, Site and Zoning, Natural Features, Man Made Features, Circulation, Utilities, Sensory, Human and Cultural, and Climate. It is extremely important for the planner to venture to the site himself and note some important details himself. Such details

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include the general topography of the site and any significant shift in ground level. He or She should also pay attention to any clues as to what could lie beneath the surface. For example, marsh grasses can suggest a high-water table, another example is that a sticky soil is evidence that the subsoil on the site is clay. There could be evidence of previous projects on the site, such as rubble. Other potential problems (particularly those regarding services) can be picked up in a topographical survey or by other types of professional reports, it would be good to consider the hazards that could be on or surrounding the site. It is worthy to mention that the collected information depends entirely on the personal view of the engineer who might be interested in factors that could be not important to other, which means that the type of information that is available to one of them could be completely or partially for the others for the same site (Lynch and Hack, 1984).

3) Data Analysis: Diagrams are the best way to present the collected large amount of data. The representation of data can be done in plans, sections and elevations, perspective, or isometric. Taking into consideration to pick the best approach to represent data in a well manner, emphasis the information that is important to communicate (Sharma, 2022).
4) Presenting Site Analysis: The parameters that need to be considered when looking at a site drawing have to be translated into presentation form to facilitate understanding the considered factors that may include patterns of streets, scale and hierarchy, use of land, typologies, relationships with the neighborhood, surfaces and materials, natural and man-made features, circulations and movement within and surrounding, entry levels, public vs. private space, and climate history (Irwin, 2015).

Based on what is collected, analysed and presented, the architect will compare the proposed sites based on his personal analysis of the factors mentioned above.

It is worth to mention that this opinion of the architect can be contradicted by another one based on the same information which came as a result of the lack of a measurable mechanism governing the decision where a standard criteria that facilitates taking decisions related to the signing of buildings by a group need to be developed and architects take this process away from the personal decisions that are disputed (Vasquez, 2022).

A question rises here and this paper will try to answer: Is the access to digital technologies in the fields of engineering sciences especially those related to construction work is an effective and practical way to make the process of selecting sites for the proposed buildings?

Proposed Method for Selecting Site Based on Digital Systems

In recent years, huge technical leaps have taken place in the field of information systems (IS) and digital systems (DS), which allowed the provision of a various and big amount of data and integrating them with digital platforms and made them available to everyone on the Internet. The most prominent IS that can be beneficial in the field of or research is the geographical information system (GIS) which is used by many digital systems suitable for engineering fields (Xhafa & Kosovrasti, 2015).

This paper presents an aspect for measuring one of the main necessary factors - which is the Visual Access in our case study - for differentiating between a set of proposed sites proposed for construction of a specific building, based on Augmented Reality (AR) technology and benefiting from the data provided by the Geographic Information System (GIS) (Santos et al., 2021).

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The aspect proposed in this paper depends on observing a three-dimensional model of the proposed building by the AR system integrated within the real world of each of the candidate sites from different levels to cover all observing angles and the requirements of the involved aspects (Thomas et al., 2001).

The proposed method was applied to an urban square containing two candidate sites for constructing of a public service building where a comparison is required between the two sites based on the visibility of the site from the boundary kinematic axes using the aspect mentioned above which is based on measurable engineering mathematical method using Augmented Reality technology that takes advantage of the Geographic Information System to collect required data.

The urban square has been abstracted into a three-dimensional model Figure (2), Figure (3) and Figure (4), Figure (5) showing the two candidate sites.

Fig (2) 2D Image of Urban Square (Google Earth). Urban (Researcher)

Fig (3) 2D Abstract Model of the Selected Square with Candidate sites (Researcher)

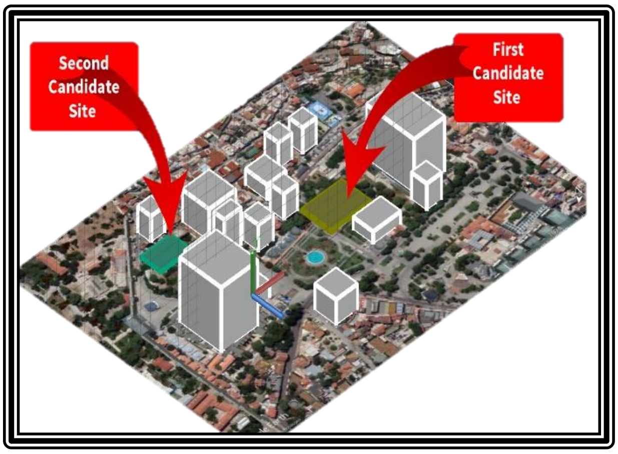

Fig (4) 3D Image of Urban Square (Researcher)

Fig (5) 3D Abstract Model of the Selected Urban Square with Candidate sites (Researcher)

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The method depends on measuring the designated factor (Visual Access in our research) for each site at measuring points on different horizontal and vertical levels, these points represented by making the center of the proposed site a center of a hypothetical circle as shown in the Figure (6), Figure (7), and Figure (8).

The vertical and horizontal level's dimensions are selected based on nature of the site like site size, proposed building height and the heights and dense of kneeboard objects.

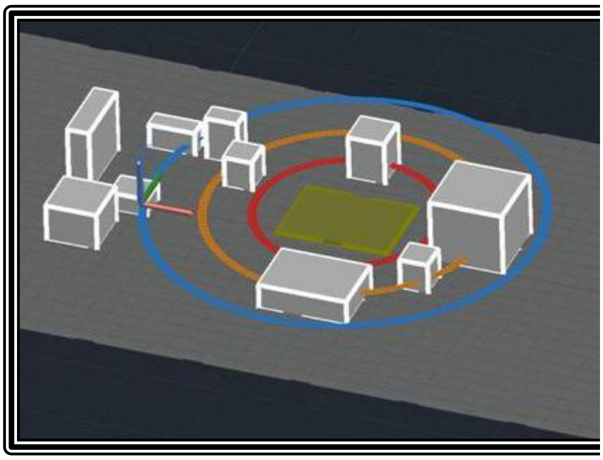

Fig (6) First Proposed Location, Horizontal Axes Levels 1, 2 and 3 (Researcher)

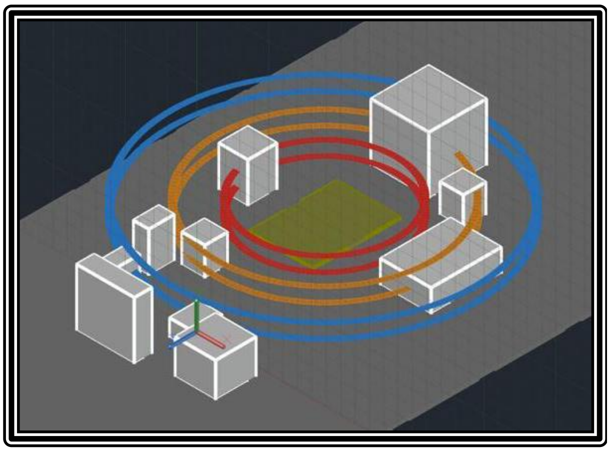

Fig (7) First Proposed Location, Horizontal Axes Levels 1, 2 and 3
with Vertical Axes Levels 1 and 2 (Researcher)

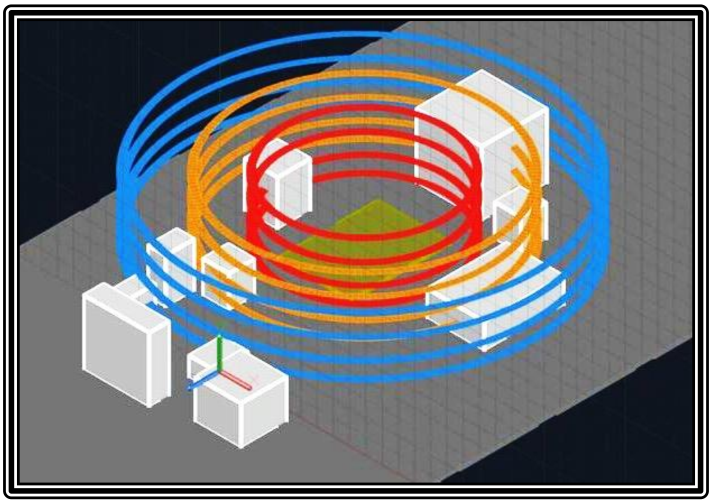

Fig (8) First Proposed Location, Horizontal Axes Levels 1, 2 and 3
with Vertical Axes Levels 1, 2, 3 and 4 (Researcher)

These hypostatical circles are divided into 36 segments, generating 36 measuring points for each level as shown in the Figure (9) and Figure (10).

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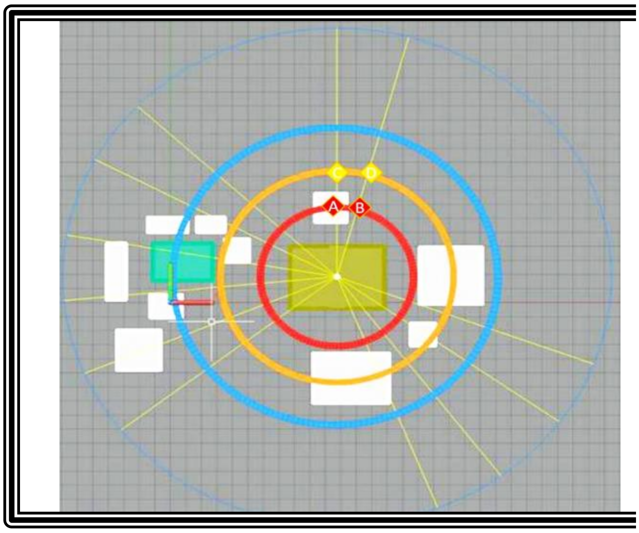

Fig (9) Measuring points on First Proposed Location, Horizontal Axes Levels 1, 2 and 3 (Researcher)

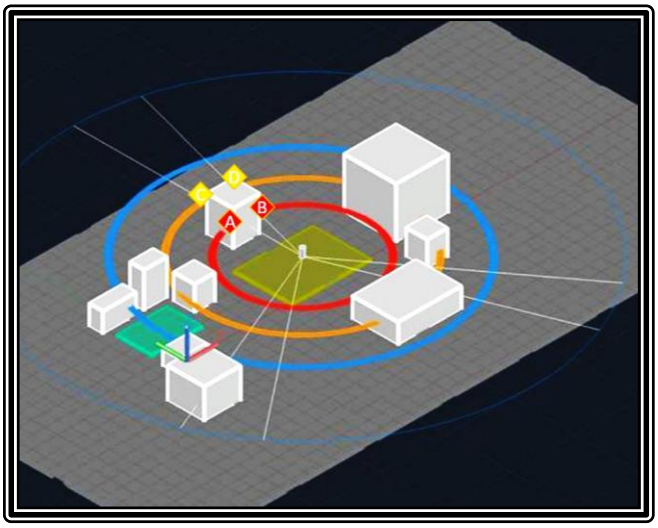

Fig (10) Perspective of Measuring points on First Proposed Location, Horizontal Axes Levels 1, 2 and 3 with vertical level 1 (Researcher)

For each point, a value is given for each criterion (factor) by either an appropriate sensor reading or a value of this criterion from the GIS for this point. In this case study, a visual access can be observed by the front visual sensor of AR system by navigating through decided measuring points using AR navigation system that get the topographic info, man-made features and kinematic axes from well-known GIS which is Google Earth.

The set of these values - for each criterion - is saved in a form of a three-dimensional matrix, the first dimension in which represents the vertical level of the measuring point and the second dimension represents the horizontal level of the measuring point while the third dimension represents the measuring point index (1 to 36) on the defined hypothetical circle starting from North and moving clockwise. Figure (11) is an example.

Point A = $C_1(1,1,1)$ = *Measured Value of* C_1 *Criterion Sensor at point 1,1,1*
Point B = $C_1(1,1,2)$ = *Measured Value of* C_1 *Criterion Sensor at point 1,1,2*
Point C = $C_1(1,2,1)$ = *Measured Value of* C_1 *Criterion Sensor at point 1,2,1*
Point D = $C_1(1,2,2)$ = *Measured Value of* C_1 *Criterion Sensor at point 1,2,2*

Fig (11) Matrix Example (Researcher)

As it clear from Figures (9) and (10), considering the criterion of Visual Access the values of mentioned points are as Fig (12) shows.

DOI: http://dx.doi.org/10.25098/7.2.18

C_1 Criterion is Visual Access *Point A = $C_1(1,1,1) = 0$* *Point B = $C_1(1,1,2) = 1$* *Point C = $C_1(1,2,1) = 0$* *Point D = $C_1(1,2,2) = 1$*	*Where* *0 means no visual access* *1 means positive visual access*

Fig (12) Matrix Example with Values (Researcher)

At the end of the measurement phase, the researcher will have a three-dimensional matrix for each different criterion for each candidate site.

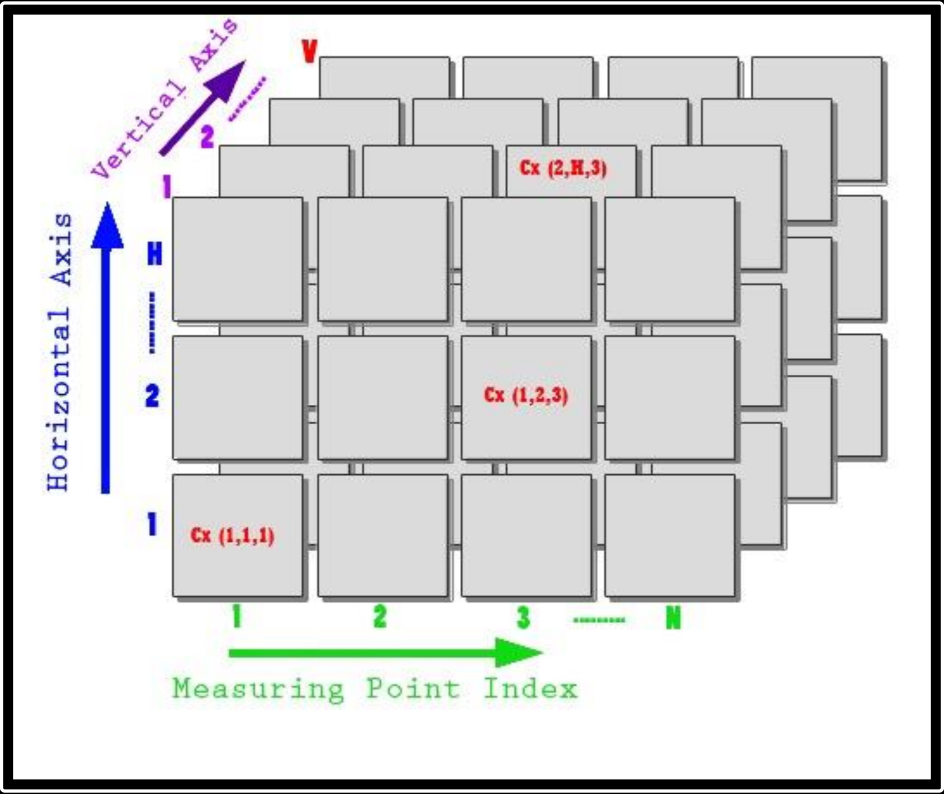

Fig (13) 3D-Matrix Representation of Criterion x for Site y (Researcher)

The comparison then made between sites by calculating the mean value for each matrix, which will represent the value of a specific criterion. Site with biggest criterion values is the best and can be safely selected.

Site A_Criterion 1_Value = $\overline{CA1}$

Site A_Criterion 2_Value = $\overline{CA2}$

………

Site B_Criterion 1_Value = $\overline{CB1}$

Site B_Criterion 2_Value = $\overline{CB2}$

Fig (14) Criterion Value Calculation (Researcher)

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Volume (7), Issue (2), December 2023
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Case Study

An urban square with two candidate sites shown in Figures (15) and (16) have been chosen for this case study.

For each of the two candidate sites; 36 Measuring points where distributed on each horizontal/vertical level with 4 horizontal levels chosen with radiuses of (100, 150, 250 and 400) meters. Vertically 3 levels where selected with heights of (1.8, 5, 10) meters above ground level of the candidate site. These values have been chosen based on nature of the sit as explained before.

In order to facilitate the understanding and filling the 3D matrix; the measuring points on first horizontal level are marked A1 to A36, second horizontal level B1 to B36, third C1 to C36 and the forth D1 to D36. Same approach was used for second and third vertical levels.

By surfing through these (36*4*3) measuring points by aid of navigation tool of the AR a value is given by the front camera sensor to each point where 1 means that there is clear view of the candidate site from the measuring point while 0 means that there is an obstacle in the line of sight of the candidate site from that measuring point.

Fig. (15) Measuring Points of The 4 Horizontal Levels of The First Vertical Level for The First Candidate Site (Researcher).

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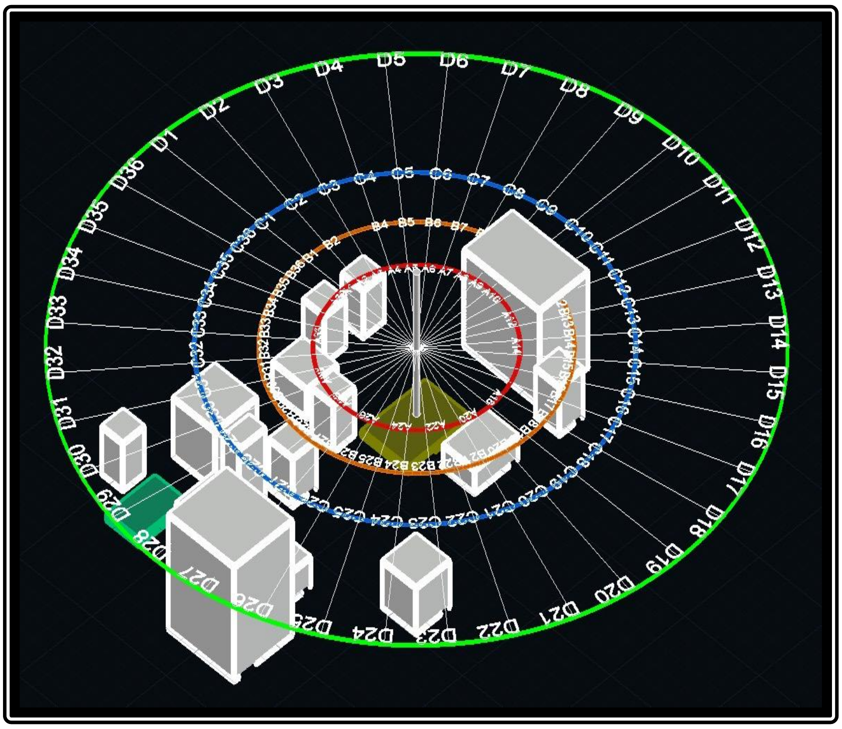

Fig. (16) Measuring Points of The 4 Horizontal Levels of The Third Vertical Level for The First Candidate Site (Researcher).

The Values then imported in an Excel sheet as in Figure (17) that represent the 3D matrix where a table is formulated for each vertical level. The rows represent the horizontal level and the columns represent the measuring points on each horizontal level.

Sum of each row represent number of measuring points that have clear visibility of the candidate site for each horizontal level while the sum of each column represent number of measuring points that have clear visibility of the candidate site for each horizontal ray across all horizontal levels.

An extra table is constructed to calculate the number of measuring points that have clear visibility of the candidate site for each vertical ray across all vertical levels. All these measures reflects not only the number of measuring points on different horizontal/vertical levels but also the deviation feature of the visibility moving across these horizontal and vertical levels.

Finally, a single value has been calculated by calculating the mean of the constructed 3D matrix that will describe all these features which will be considered as the weight of the desired criterion (Visibility Access) for this site.

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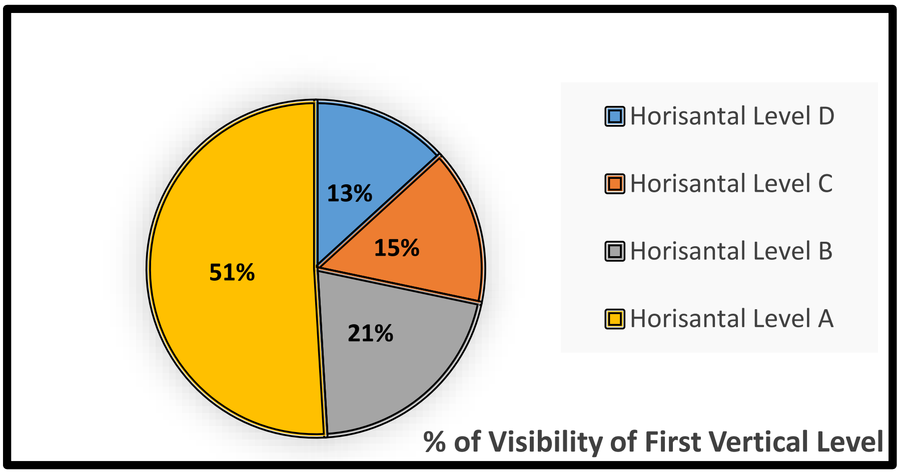
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN
1				Measuring Points																																				
2				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	Sum of Each Horizontal Level
3	Vertical Level 1	Circles (Horizantal Level)	D	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	7
4			C	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	1	0	0	0	0	0	0	0	0	8
5			B	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	11
6			A	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	1	27
7			Sum of Horizontal Ray	1	1	1	1	4	4	4	1	1	1	1	1	1	1	0	0	0	0	0	0	4	4	2	2	4	4	2	3	1	1	1	0	0	1	0	1	53.36805556
8																																								
9																																								
10				Measuring Points																																				
11				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	Sum of Each Horizontal Level
12	Vertical Level 2	Circles (Horizantal Level)	D	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0	0	0	1	1	1	1	0	0	11
13			C	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	1	0	0	1	1	1	1	0	0	12
14			B	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	0	0	17
15			A	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	29
16			Sum of Horizontal Ray	1	1	1	1	4	4	4	1	1	1	1	1	1	1	0	0	0	0	1	1	4	4	2	2	4	4	2	3	1	1	4	4	4	4	0	1	69.47916667
17																																								
18																																								
19				Measuring Points																																				
20				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	Sum of Each Horizontal Level
21	Vertical Level 3	Circles (Horizantal Level)	D	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	29
22			C	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	31
23			B	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	31
24			A	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	36
25			Sum of Horizontal Ray	4	4	4	4	4	4	4	1	1	1	1	1	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	4	4	4	4	4	4	4	4	127.8819444
26																																								
27																																								
28				Sum of Vertical Rays																																				
29				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	Sum of Each Horizontal Level
30			D	1	1	1	1	3	3	3	0	0	0	0	0	1	1	1	1	1	1	1	1	3	3	1	1	3	3	0	0	1	1	2	2	2	2	1	1	47
31			C	1	1	1	1	3	3	3	0	0	0	0	0	1	1	1	1	1	1	1	1	3	3	1	1	3	3	1	3	1	1	2	2	2	2	1	1	51
32			B	1	1	1	1	3	3	3	0	0	0	0	0	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3	3	1	1	2	2	2	2	1	1	59
33			A	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1	1	1	3	3	3	3	3	3	3	3	3	3	3	2	2	3	1	3	92
34			Sum of Horizontal Ray	6	6	6	6	#	#	#	3	3	3	3	3	6	6	4	4	4	4	5	5	12	12	8	8	12	12	7	9	6	6	9	8	8	9	4	6	250.7291667

Fig. (17) Values of All Measuring Points for The 4 Horizontal Levels and 3 Vertical Levels of The First Candidate Site (Researcher).

A lot of information can be driven from the table in Figure (18) like the percentage of visibility for each horizontal ray and also for the four horizontal levels in each vertical level of each candidate site as shown in Figure (5-4).



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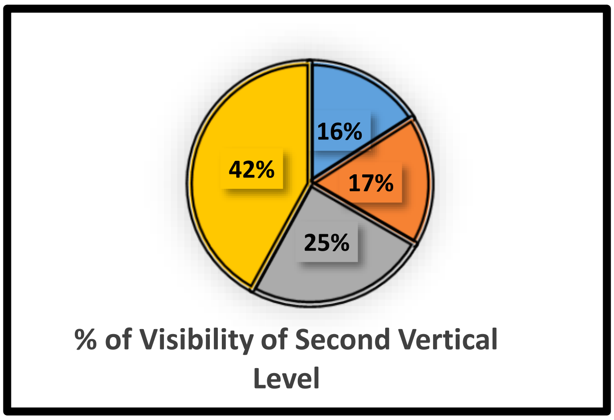

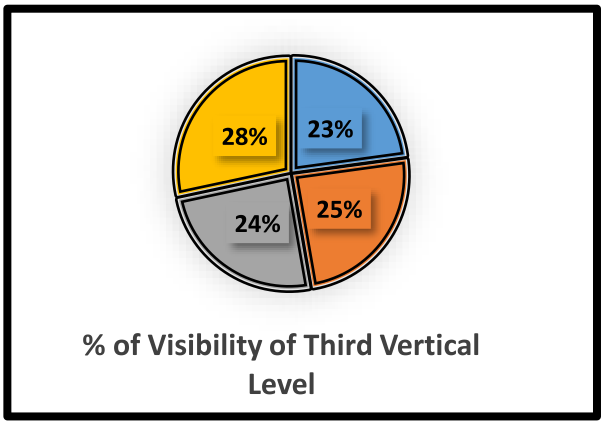

Fig. (18) Percentage of Visibility for the 4 Horizontal Levels and 3 Vertical Levels of The First Candidate Site (Researcher).

Conclusion

Through the results extracted from the proposed method, it was found that the use of the Augmented Reality system effectively contributed to enrich the process of standardizing the necessary aspect for differentiating among list of candidate sites for the establishment of a public service building within an urban square. It is considered an important step that contributes to facilitating decision-making by architects and urban planners working in the field of selecting and determining sites for the construction of new buildings within the urban fabric of existing cities.

This paper opens the way to focus on integrating the uses of digital technologies in the field of architecture and urban planning for existing cities that need to develop their existing complexes by adding new buildings, where decisions can be taken by architects with modern, scientific and standardized criteria based on clear values, which distances the decision apart from individual opinions of people.

It is worth noting that the adoption of Augmented Reality technology is an important entrance to the field of architecture by making it interconnected with the world of digital information and new scientific approaches.

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