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Research Article

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An Assessment Model for Participatory Architecture: The Example of the Kuzguncuk Gardens


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Abstract: *It is crucial to evaluate the architectural production processes through the concept of participation because the thoughts and comments that emerge as a result of the evaluation will contribute to the current architectural environment. Since 1960s the integrity of theory, research, and practice that has been put forward combined with user-oriented architectural movements, has enabled new developments and potentials. For this reason, it is necessary to observe and evaluate user-oriented studies that aim to establish the integrity of theory, research and practice to unfold the results in all their complexity. The outputs of the research can serve as a reference for targeted polyphonic architectural production processes in the future. The proposed method makes these interaction networks visible, applying them to participatory architecture processes. In this way, today's design tools have the potential to involve participants in the process. The present study proposes the hypothesis that these potentialities can be demonstrated by observing, evaluating, re-discussing, and interpreting previous studies. The article seeks to evaluate the relationship between users' participation in architectural processes and the network of actors-stakeholders who take part in participatory approaches. The concept of participatory architecture is vital for future experiences of architecture in order to revive the development of architectural practice in Turkey. Therefore, to provide a guideline model for architects and researchers engaging in participatory architecture processes. The study's goals are: (1) clarifying the reasons of area defense with solidarity and evaluating the level of participation in architectural practice, (2) examining stakeholder typology assessments, and (3) observation participation techniques and tactics in processes. This research includes descriptive analysis of the Kuzguncuk Bostan Recovery and Protection Project as a case study and qualitative analysis examining participatory processes with the multi-dimensional model (EMParArc). Through this multi-dimensional model, this article emphasizes an alternative framework for the assessment of architectural participation methods in holistic processes that provide inclusive spaces in particular needers in Turkey and other non-develop and developing countries.*

Keywords: *Participation, Participatory Architecture, Participatory Design, Evaluation Model, Solidarity*

Katılımcı Mimarlık Üzerine Bir Değerlendirme Modeli: Kuzguncuk Bostanları Örneği

Özet: *Katılım kavramı üzerinden mimari üretim süreçlerini tartışmak ve değerlendirme yapmak oldukça önemlidir. Katılımcı mimarlık, aktörleri ve katılım yöntemleri ile çok boyutlu katmanları olan bir süreçtir. Bu süreç her katılımcı mimari üretim süreci için farklı ve eşsiz gerçekleşir. 1960'lı yıllardan itibaren kullanıcıyı odağına koymayı hedefleyen mimarlık hareketleri ile birlikte çeşitli ölçeklerde deneysel katılımcı mimarlık çalışmaları yürütülmüştür. Bu çalışmalar ile akademisyen ve mimarlık pratisyenleri tarafından çok paydaşlı üretimler ile ilgili kuram ve uygulama bütünlüğünü destekleyen söylemler geliştirilmiştir. Türkiye'de çok paydaşlı* yürütülen çeşitli çalışmalar mimari literatüre ve akademik ortama önemli katkılar

yapmıştır. *Dayanışma Mimarlığı Sergisi (2017) son dönemde yapılan çok paydaşlı mimarlık deneyimlerinin ortak bir söz söyleme adına bir araya geldiği bir kolektiftir. Çalışma, Dayanışma Mimarlığı Sergisi'nden yola çıkarak katılımcıların örgütlenmesi ve bir araya gelişlerine odaklanır. Katılımcılık ile ilgili söylemlerden geliştirilmiş bir kavramsal modeli ortaya koyar. Bu model, uygulanmış katılımcı mimarlık süreçlerinin değerlendirilmesinde bir araç olarak kullanılabilir.* Çünkü değerlendirme sonucunda çıkacak düşünce ve yorumların güncel mimarlık ortamına katkısı olacaktır. Çalışmanın amacı, (1) dayanışmanın ortaya çıkış sebeplerini ortaya çıkarmak, katılım düzeylerini değerlendirmek, (2) paydaş katılımını sorgulamak ve (3) süreçlerde izlenen yöntemleri gözlemlemektir. Çalışmada alan çalışması olarak Kuzguncuk Bostanı İyileştirme ve Koruma Projesi ele alınmıştır. *Metod olarak, tanımlayıcı ve niteliksel yöntemler ile katılımcılığı çok boyutlu olarak analiz eden, değerlendiren bir model ortaya konmuştur (EMParArc). Model, katılımcı mimarlığı değerlendirmede ve yeni üretilecek süreçlerde kullanılabilecek bir altlık olarak ortaya koyduğu alternatif çerçeveye vurgu yapmaktadır.*

Anahtar Kelimeler: *Katılım, Katılımcı Mimarlık, Katılımcı Tasarım, Değerlendirme Modeli, Dayanışma*

1. INTRODUCTION

The purpose of participatory architecture is to systematically combine the theories and practices of multidisciplinary design and to involve users in the planning and design processes of their physical environment. Thus, users become active individuals who are confident in shaping their environment. Planning action will turn into a learning process for both the designer and the user [1]. Other than users, there are many actors and stakeholders in participatory processes. This study researches the interaction of users and these actors and stakeholders within approaches to solidarity architecture, which is a participatory process.

Hacıalibeyoglu points out that participatory and its evaluation process is complex due to the nature of the concept of participation. Each participant has different values and backgrounds. Therefore, it is not possible for individuals to play a role in the same activity during the process. The inability to reach a definitive decision on the evaluation criteria makes this situation even more difficult [2]. The general lack of empirical evaluation for the quality of methods stems from confusion about the appropriate criteria for evaluation. There is no accepted assessment method and there are many different tools for measurement. Evaluation of participation practices is very significant for all participants [3]. Evaluation of participation studies is nothing more than the application of certain types of research methods used in evaluating social programs. Its purpose is to measure the effects of the program by contributing to the decisions to be made later regarding the program by reaching the target. Evaluation has an important place in terms of financial, practical, moral, and theoretical reasons. In addition, the evaluation of the projects serves as a reference point for future project processes in terms of strengths, weaknesses, potentials, and dangers.

Rosener emphasized that participation means sharing decision power for some citizens, while for others it means merely expressing an idea. He stated that if a definitive conclusion is to be reached regarding the assessment of the effectiveness of participation, the participation goals should be made clear to all participants [4]. The evaluation of project processes carried out in a transparent way will be just as accurate.

According to Habraken, the buildings represent a living-evolving environment that calls for a balance between the use of today's scientific potentials and the improvement of human relationships [5]. De Carlo focuses on the involvement of users as actor and relations between stakeholders such as workers on site in the design process in his articles and works [6]. He points out the significance of the social networks during the built environment construction process with actors, and its users [7].

Kroll became one of the key actors of participatory architecture who developed an application methodology through Habraken support theory. According to his approach, diversity of stakeholders bring creativity

and livability to built environments. The role of architects is to catalyze users' participation with the other stakeholders in the design process and to integrate the positive way of organization (Kroll & Jones, 1986). Participation was addressed in different scales such as architecture, and product design as well as city planning and interior design. For these theorists, the democratization of citizenship rights is an obligatory aspect of participatory activities [7]. Alejandro Aravena, uses participatory design principles to develop ideas and projects which consider the social, political, and economic advantages of users, also participated in such discourses [8]. Thus, Aravena is persuaded that it is time to discuss the relationship between architecture and other fields, such as environmental issues, and debate how these fields, rather than just architectural form, should inform projects [7].

Another valuable study on the active involvement of different actors in spatial production is the Spatial Agency book, project initiative and its website [9]. Spatial agency is defined as a network between lead actors of participation, independent researchers and designers. According to Till, the behavior of the architect, as one agent among others, should be to empower others for change [10]. The evaluation model for participation includes type, level, and actors of participation and is based on these theoretical approaches of goals, the power of society to shape the environment, the importance of social networks, the acceptance of diversity, interdisciplinarity in design, and the involvement of different actors.

The aim of this article is to find a proper way of evaluating participatory approaches in architecture and apply methodology in one case of the participatory approach. It is of great importance to evaluate participation through projects realized with a pluralist structure. It is also important to evaluate the collaboration techniques of the designer, user, and all other stakeholder actors in order to outline the lessons learned from carrying out the project through the process. Collaborations between actors and stakeholders should be observed and evaluated in terms of the participation ladder (1), typology assessment perspectives (2) and participation techniques (3). The process and the actors involved in the project need to be defined before the goal-oriented steps—that is, before the architectural result focuses on the product. The research questions about these parameters have been organized as the following: 1) Which step of the participation ladder is preferred for the participation method? 2) Which type of assessment perspective is used in the analysis of typology? 3) Which participation techniques are used for realizing the approach? The answers to these questions shaped the assessment approaches in this study. Kusumaningdyah & Purnamasari practiced that similar analysis methods on experimental participatory architectural project of "Kampung Layak Anak" process, Indonesia, in 2017 [11]. This research based process conducted with these steps of systematical method.

2. APPROACHES TO PARTICIPATION AND SOLIDARITY

When the literature was examined, we observed that there were papers, articles, and theses written on participatory architecture conducted by academicians, architects, and authors. Similarly, there are also studies that analyze and evaluate application studies made with the participatory architecture model and present a model based on it but do not have a specific framework. The present study, within certain limitations, defines the group by examining a specific area and proposes an evaluation model that discusses the participant relationships established and their causes and consequences. Limiting the exemplification of working with Solidarity Architecture Exhibition Groups is an important criterion for user focused design process assessment.

The comments of Sanoff about the different approaches to community participation centered on the fact that "resolving conflicts, and to supplement design and planning" [12]. According to Wulz, participation is a concept that covers different forms of decision-making by different individuals and groups [13]. Sanoff defines the main purposes of participation as involving people in decision-making processes' improving design, decisions and delivery by including the voices of prospective users; and promoting the sense of

community with common goals [12]. Burns & Taylor classify the experiences of participation in four categories; awareness, perception, decision-making and, implementation [14]. Just like these categories, Sanoff argues that there are four different stages of experience: goal-setting, programming, design, and implementation [12]. Some questions preparedfor participatory design process by Sanoff. 1) Why is this process needed? 2) How will the group work toward a solution? 3) How will decisions be made? 4) What is the schedule? 5) Who will receive and act on the final product? Godschalk et al. defined that the next section attempts to integrate all these ideas in the model for the assessment of participative solidarity groups [15].

3. METHOD -A MODEL FOR ASSESSMENT ON PARTICIPATIVE SOLIDARITY GROUPS

Evaluating participation and participatory architecture is possible with a multidimensional perspective. The participatory architecture models proposed by different theories, strategies, tactics and games, and the level of polyphony that emerges from them give us an idea as to the research on evaluation. This study's method can be categorized as an evaluation research aiming to analyze projects produced with a pluralistic understanding in terms of participation. Neuman defined evaluation research as applied research seeking to determine how well a program or policy is working or achieving its goals and objectives [16, 11]. In this way, a program or policy can be considered as the evaluation of the project process in the discipline of architecture. This study argues that projects done with the qualitative data collection method should be evaluated at every stage of the project through the resulting data and outputs. At the same time, this study evaluates quantitative data by using the observations and archived data of the executives/participants. Here, the descriptive method is used to analyze and evaluate the projects. This model proposes three levels for analysis: participation ladder analysis, stakeholder typology analysis, and participation techniques analysis. These levels were defined because of their interaction with the qualitative and quantitative characteristics of participation approaches. Each level of the study will be explained in the following paragraphs with their relevant details.

Participation Ladder Analysis: For participatory architecture, contextual events (the starting point of the process) and triggers (the factors that encourage participatory architecture and solidarity in the process) help determine the level of participation. The ladder level is affected by requests from within user groups, processes supported or blocked by administrations, and expert referrals. Arnstein classifies citizen participation by the level of power by examining the actual level of decision-making in many social upgrading programs, urban renewal, and empowerment against poverty in the United States [17, 18]. Arnstein's classification consists of eight degrees of participation: manipulation, therapy, informing, consultation, placation, partnership, delegated power, and citizen control. Tatlić explained these levels of participation in decision-making begin with the first two non-participatory degrees, manipulation and therapy, which are symbolic degrees for realizing imaginary interests through education and campaigns [18]. The next degrees, which can be defined as "degrees of tokenism," consists of one-way communication when it comes to informing the public, consultation without the need for implementation, and participation in the planning process without affecting the decision-making process. The final three degrees make up so-called citizen power: community partnerships in decision-making by financial participation, achieving influence in the decision-making process through community representatives, and civilian control of certain public institutions or settlements through the determination of their program.

Figure 1. Ladder of participation [17]

Stakeholder Typology Analysis: The second analysis is based on the study developed by Lee regarding Lefebvre's spatial philosophy [19, 20]. This analysis aimed to understand the relationship between the designer, the user group, and other stakeholders in the execution of the entire process, and the results at every stage of the process [2]. Interaction increases as the number of networks established by architects, users, and other actors involved in participatory processes increase. This will make interaction more meaningful.

	Typology Analysis
USER	Main user group Local supporting stakeholders Benefit / support progressive Supervision mentoring
STAKEHOLDER	Stakeholder group 1 Sub-stakeholders Stakeholder group 2 Sub-stakeholders Stakeholder group 3 Sub-stakeholders

Figure 2. Stakeholder typology analysis [19]

Participation Techniques Analysis: The types of relationships established by the participating stakeholders are important in terms of evaluation. Making inferences by observing the events organized, the content of the events, the language of communication with the user and the co-production process is valuable and unique for each process. The third analysis is based on the participation techniques theory developed by [12]. This analysis seeks is intended to understand the techniques/methods used at each stage of the process and how they result in different projects. Sanoff has defined the methods and techniques that can be used in participation processes in the chart shown below. The analysis of participation techniques should take place in three phases. The first is the quantitative data collection process. The second phase is the participatory

techniques in the design collaboration process. The third is the participation techniques in the technical collaboration process. In the first phase, quantitative data collection can be carried out according to the below list of questions. However, this list can be stretched, as each study has a different process. New questions can be added and existing ones can be removed [12].

Table 1. List of questions / sub-questions for the first phase of analysis of participation techniques [12]

Number	Quesitions	Sub-questions
1	Profile	Age Gender Adress
2	Frequency of use	-
3	Reason for the selection of area	-
4	Character of usage	Time spend Time preferences Type of user Type of activity Density of character
5	Perception of scale	Comfort Security Accesibility Cleanness Usage friendly
6	Aim	-

In the second and third phases, participant techniques are questioned with techniques developed using the methods and techniques developed by Sanoff.

Table 2. Methods and techniques of participation defined by Sanoff *[26]*

METHODS	Awareness Methods	Indirect Methods	Group Interaction Methods	Open Ended Methods	Brainstorming Methods
Techniques	·Exhibition ·Media tools ·Walks	·Survey ·Questioning ·Interview	·Workshop studies	·Public meetings ·Local media ·Planning voteing	·Classical brainstorming ·Brain products method ·Interactive brainstorming method

Dimensions of participation are used as part of the evaluation model for participatory architecture. In order to evaluate participatory architectural production, it is also necessary to consider the multiple dimensions of participation. It is possible to carry out an effective practice as a result of conceptualizing participation and associating it with architectural action. Sanoffand surveys that generated over 200 ideas for the riverfront. Idea-sharing sessions were also held with neighborhood focus groups to gauge the views of a cross-section of citizens about the future development of the riverfront. These activities culminated in a community workshop where 130 citizens began the planning process by revisiting the riverfront through a narrated photographic tour, and reviewing a video summary of the focus groups. Twenty-two groups then identified recreation objectives and located activities on a map of the riverfront. Workshop results formed the basis for a subsequent design proposal followed by implementation of the first phase.

[ABSTRACT FROM AUTHOR]; Copyright of CoDesign is the property of Taylor & Francis Ltd and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use. This abstract may be abridged. No warranty is given about the accuracy of the copy. Users should refer to the original published version of the material for the full abstract. (Copyright applies to all Abstracts. states that the dimensions of participation can be understood with simple questions asked to conceptualize it: who, what, where, how, and when [21].

- Who asks the question? Asking the users who will be involved in the participation (actors),
- What is the question: what will happen in the participation program (events)?
- How and when individuals will be involved? When will participation be requested in the planning process/es?
- Where; the accession process must affect the physical environment (location),
- Where should the participation path lead? Describe the goal and vision.

In this context, the dimensions of participation can be defined as event, place, actor/stakeholders, and process.

Event: The events that create the spatial need in the historical process trigger the individuals who constitute society and bring them together, thus constituting the first dimension of participation [22]. It is important to read the triggering events chronologically and to interpret them by associating them with the process in order to understand the development process of the project and to understand the underlying demand, need, and intention. Traveling to the past, not just reading the starting point of the process, helps build in-depth networks.

Location: It is possible for the individual to integrate with the social environment where s/he can share her/his past experiences and establish a relationship with her/his environment. The individual does not only have the knowledge of the city s/he lives in. In other words, "place," which is the environment in which the individual lives, is a complex phenomenon containing many memories, experiences, and emotions.

The concept of place: Place is defined as an outcome arising from the relationships of events, activities, concepts, and psychological-physical properties [23]. In the context of this definition, the definition of urban spaces cannot be made without determining subcomponents such as lifestyles, socio-cultural values, economic factors, educational status, psychological factors, and physical parameters of the individuals living in them.

From another perspective, the concept of place has a strong relationship with the act of building. The physical environmental conditions of the concept of place should be examined in terms of topographic and geographic data. In addition, the ethnic, cultural, and social values of the user of the place are important factors affecting the project process. The whole process is also affected by factors such as the architectural traditions of the place, structural styles and building traditions, materials to be used, and climatic conditions. In this sense, while examining the participatory project process, it is necessary to read and understand the place well to discover its potential. Only someone who understands the place well can reach the level of evaluating the existence, form, method, and function of the project there.

Actors: Actors represent a structural factor containing many ties during the participation process. According to van Randen, actors can be classified in ten categories. Especially these four different categories are crucial; designers, entrepreneurs, administrators, and users [24]. In addition, facilitator groups play a critical role in participation processes [22]. Designers take their own technical initiative. The necessary coordination between disciplines is required for the emergence of architectural products [25]. The organization within the design team also possesses a hierarchy and participation structure. This requires a strong planning process. The important task of the designer is to be able to set up the necessary work-sharing with the participant. Specialists from the disciplines related to architecture, such as design and engineering, like students and academics from architecture and design and can be included in this group.

Entrepreneurs create the necessary economic infrastructure for the realization of a project. They shape this infrastructure in line with the requests of financial experts and users. What an entrepreneur gains as a result of the process is important for understanding the starting point of the project. Entrenepeneurs prefer sustainable investments.

Local governments draw the necessary framework for the realization of the process and ensure the preparation of the necessary environment [26]. Central governments should encourage local governments by enacting the laws and laws necessary for the realization of such participatory models.

Users are urban participants to the extent that they are related to the environment in which they live. They have concerns aboutthe city, they live for the city, there is a reciprocal nourishment between them and the city. Residents intervene in the city so that their lives can continue. They get involved in the act of designing at the level of awareness. Participation provides great advantages in a democratic sense. Participatory design allows users to freely and objectively make decisions about their own lives.

Facilitators include foundations, associations, unions, chambers, non-governmental organizations, and independent local/national initiatives that can support gatherings. This group plays a key role in the organization, planning, and execution of processes. They can also be expected to raise awareness and encourage the public with solidarity movements.

Process: The act of architecture begins with an idea, need, or foresight. According to Hacıalibeyoglu, it can be conceptualized in four basic stages within a linear integrity consisting of decision, design, application, and usage stages [2]. It establishes a relationship before and after each stage in the process of linear progression. In other words, they can be described as complementary or as variants of each other. Reversals are always possible between processes. Experiences in the process create knowledge with feedback.

Described by Arditi & Gunaydin as the architectural production process cycle, the model refers to the building production activity; it describes it as a process divided up by phases of starting, design, construction, and usage [27]. This definition, which is called the structure production process and based on the idea that each phase is interactive and related to every other phase, has been conceptualized as a cyclical process consisting of nested phases [28]. The activities of people and acts on places have crucial impact on these architectural process.

4. EVALUATION MODEL FOR PARTICIPATORY ARCHITECTURE – "EMParArc"

The multidimensional structure in participatory architecture has a complex system. Each project has specific variables. The way every project is handled and interpreted by the specific approach of the architect is different, and therefore the organization of stakeholders is also different. This causes us to gain different experiences and results with changing conditions each time.

This study sets out from the proposition that participatory architectural work will be evaluated and their potentials, and positive and negative aspects, will be determined and guide the planned studies in the future. In this context, we made evaluations of different aspects of the process in line with the defined dimensions (event, place, actor, and process) and determined analyses. Figure 3 shows the conceptual framework of the participation ladder analysis, stakeholders typology analysis, participation techniques analysis and also indicates the interactions of the elements of these factors with the specific questions.

Figure 3. The framework of evaluation model for participatory architecture

Evaluating participatory architecture requires a cross-sectional study with a versatile perspective. Quantitative and qualitative data collection should be carried out meticulously and efforts should be made to obtain as clear, transparent, and accurate results regarding processes as possible. The researcher needs to analyze the categorization and objective perspective for each stage while evaluating the participatory processes. The evaluation should be performed with a skeptical approach, taking the situation of the stakeholders into consideration with a broad perspective. The results obtained by evaluating the projects carried out with the participatory architecture process should not be distorted. Incorrect results may lead to negative results by setting a wrong example for projects with large targeted participatory processes to be built in the future.

Relationship networks between dimensions of participation should be established and the cause-effect relationship should be evaluated. Contextual fiction will help to develop new participatory architecture models as well as obtain the correct outputs from the project. Therefore, it is necessary to examine all possible aspects of the process related to the project, actors, events, and relations of place.

It is critical to understand that the process is flexible and variable when evaluating participatory architectural work. In this context, processes may differ for different projects and groups. The user should be actively involved in the process as much as possible. The relationship established by the user and the designer is essential in participatory architecture. In addition, it is important for the designer and other experts to give

responsibility to the participating users in order to raise awareness and encourage society, which is one of the important goals of participatory architecture. However, the participation of other stakeholders may be extended or restricted in line with the scope and scale of the project. However, what is ideal is certain representatives from all stakeholder groups (user, designer, management, supporters, financiers, etc.) actively supporting the whole process to the extent possible.

A three-stage evaluation model for participatory architecture is defined in Figure 3 as a conceptual interaction framework model called "EMParArc." The three stages in the model have different parameters for the analysis of different factors, as listed in Table 3. The evaluation model for participatory architecture, the "EMParArc" case assessment form, was organized for assessment implementation in the case of participatory architectural approaches. The assessment covers three stages as defined in the conceptual framework of the model: participation ladder analysis, stakeholder typology analysis, and participation techniques analysis, as listed in the assessment template. Each stage has different components and each component can be evaluated as:

It is not existed: (no) - 0 point

It is partially existed: (partially) – 1 point

It is existed: (exist) – 2 points

The maximum points in each stage are defined in the assessment form. In the first stage, which is called participation ladder analysis, there are four different parameters in the total grade, in which one case of participatory architecture can have eight points. The second stage is stakeholder typology analysis, which has 26 parameters in different sub-categories, the maximum grade in this stage being 54 points. The last stage of the model, called participation techniques analysis, has a maximum grade of 22 points, as seen in Table 3.

Table 3. Evaluation model for participatory architecture (EMParArc) case assessment form template

	Evaluation Model for Participatory Architecture / Case assessment form					
Stage 1	**Participation ladder analysis**		TOTAL POINT of STAGE (8p)	**activities**	**Evaluation (0,1,2)**	**rung type**
	public inspection	public authority	0	decision mechanism	0	
	delegated authority			design cooperation	0	
	partnership			technic cooperation	0	
	convincing	symbolic participation		usage	0	
	advice					
	information					
	theraphy	no participation				
	manipulation					
Stage 2	**Stakeholder typology analysis**	**Evalaution 0,1,2**	TOTAL POINT of STAGE (54p)	Case information / case name		
	DESIGNER (16 point max)	0	0	DESIGNER		
	architect	0				
	designer	0				
	specialist	0				
	technique	0				
	advisor	0				
	support	0				
	academician	0				
	design student	0				

	ENTEPRENEUR (8 points max)	0		ENTEPRENEUR
	financer	0		
	investor	0		
	sponsor	0		
	supporter	0		
	LOCAL COMMUNTY-user (18 points mx)	0		LOCAL COMMUNITY-user
	user	0		
	practitioner	0		
	specialist	0		
	special groups	0		
	volunteer	0		
	ADMINISTRATION	0		
	International	0		
	national	0		
	local	0		
	FACILITATOR (12 points max)	0		FACILITATOR
	association	0		
	non-governmental organization	0		
	chamber	0		
	federation	0		
	individual initiation	0		
	volunteer	0		
Stage 3	**Participation techniques analysis**	**Evalaution 0,1,2**	TOTAL POINT of STAGE (22p)	Case information / case name
	QUESTIONS (8 points max)	0	0	QUESTIONS (8 points max)
	Who?-actors	0		
	What?-event	0		
	Where?-place	0		
	How? - process	0		
	PROCESS (4 points max)	0		PROCESS (8 points max)
	Decision	0		
	Design	0		
	Implamentation	0		
	Usage	0		
	DATA COLLECTION & ANALYSIS (6 points max)	0		DATA COLLECTION & ANAL-YSIS (6 points max)
	Qualitative data collection	0		
	Design collaboration analysis	0		
	technical collaboration analysis	0		
	TOTAL EVALUATION POINT	0		
	A	72-84		
	B	57-71		
	C	42-56		

The total point of the assessment can be 84 points if a case in every parameter of the three stages in the evaluation model is present. According to the total points of the evaluation after the assessment of the case, it can be awarded A class in the evaluation model for participatory architecture if it receives 72-84 total points. If the case receives 57-71 points, it is awarded B class and C class if it for 42-56 points. The minimum successful evaluation criteria is defined as 50% of the total points, which is based on the success criteria of the general approaches. Between 42-84 points divided three classes with regular and equal ratios. The rate of regular increase is 14 points. As a result, the evaluative scoring method is defined as 42-56 points for C class, 57-71 points for B class, and 72-84 points for A class. This evaluation method—which considers the participation ladder, stakeholders, and participation techniques as the evaluation parameter–shows an integrated approach to the problem of obtaining the participation levels in different types of projects.

5. TURKISH SOLIDARITY ARCHITECTURE EXHIBITION GROUPS AND THEIR PARTICIPATION APPROACHES

Especially the right to the city, the defense of space and the relationships it establishes are defined for the struggle of the most fundamental rights of the individual, life, housing, health and education. In addition to investor, designer, bureaucracy-oriented design practices, the organization of Another Workshop, Düzce Hope Workshop, Architecture for All, Kuzguncuk Garden, Assembly of Architects, Plankton Project and Yedikule Gardens Protection Initiative, which are groups that have participated in the Solidarity Architecture Exhibition in our country. Their schemes, purposes, tools, methods and environments are discussed. This discussion allows the positioning of the groups to define their relations with the users of the space they defend. In this context, a perspective and interpretation is made within a global and country conjecture by looking at questions such as “Why do they do not want to leave?” Or “Why should it be renewed?” Concepts such as rent-oriented urban developments, migration from the village to the metropolis, off-center architectural production, natural disaster are discussed in the context of groups. The relations of the participants and other actors are determined on the network system model established through the applied architectural practices of the groups. The applied participatory architectural practices made by the groups are first defined with a “project card” and then a “process analysis” and the relationships established by the participant.

The organization chart, status, actors, actor distribution, support and supporters, number of people, organic supporters within the Solidarity Architecture Exhibition Groups, Another Workshop, Düzce Hope Workshop, Architecture for All, Kuzguncuk Gardens, Assembly of Architects, Plankton Project and Yedikule Gardens Protection Initiative or inorganic bonds, working methods, working location differ and vary. It will be evaluated in terms of the relations established by the groups with each other as well as the relationships established within the group. An important evaluation criterion is the relationship that groups establish with the user. The relationship established with its user directly means the relationship it establishes with the space. Studies will be evaluated in different ways according to the type of defense mechanism by evaluating the areas where the studies are carried out. In this context, the applied participatory architectural works of Architecture for All, Plankton Project, Another Workshop for separate spaces in various locations. The applied participatory architecture of Düzce Hope Workshop, Assembly of Architects, Yedikule Gardens Protection Initiative and Kuzguncuk Gardens groups which work in one location.

The studies will be evaluated with their own classification. For the first group of works will be evaluated by each separate project and if one would like to see the average performance of the group in these separate projects and location they may look at the average of the different parameters. For the second group of works only one performance evaluation since each project established for one specific location. Only the case of Kuzguncuk Gardens which is in the second group will be explained in the following section by applying the general approach to this case.

Kuzguncuk Gardens

Kuzguncuk Ilya's Garden is on the Anatolian side of Istanbul in the district of Kuzguncuk on the coast of Bosphorous. It is a place where vegetable farming has been done in the city for years. Since the garden is a large green area in Kuzguncuk, it is considered important for urban transformation. After the Regional Directorate of Foundations leased the space to a foundation for 10 years in 1992, with the goal of building a hospital on the site, the residents of Kuzguncuk neighborhood began taking action to protect the garden. The hospital initiative was stopped by collecting signatures at street festivals and submitting the petitions to the relevant authorities [29]. The next attempt to build a private school was stopped thanks to the contributions of residents and professional chambers. With the activities of the chambers and the neighborhood, the municipality's zoning amendment was rejected and then a decision was made to stop the project. The garden remains a green space by virtue of having been allocated to a company as a plantation area between 2001-2011. In 2011, the Regional Directorate of Foundations attempted to reopen the garden to be used as a site for a private school.

At that point, the Kuzguncuklular (Citizens of Kuzguncuk) Association objected to the school project by organizing festivals. The association tried to share news of its struggle in various environments. With the effect of these studies, the private school allocation project was unable to get approval from the Board of Monuments. However, objections to the High Council of Monuments, who received approval and then the initiative to begin, continued. The self-initiative activities of the neighborhood continued to do urban agriculture in the area. The land was leased by the local municipality in 2014, causing some reactions against some projects of the municipality. Dündaralp stated that with the association's initiative, the municipality decided to go forward with the land development together with the neighborhood and, as a result of the evaluations and meetings, they decided the land would remain as a garden [29]. The areas not used for agriculture were set aside for sitting, playing, and walking activities.

Figure 4. Kuzguncuk Gardens in the Kuzguncuk Neighbourhood [URL-1] (re-illustration by authors)

"Driven by the community initiative, the Kuzguncuk Gardens exemplify how social, environmental, and heritage values can be successfully conserved through democratic processes, including collaboration, co-operation, and mediation of participatory planning and design processes. This piece of common land was able to be revitalized to sustain the collective spirit of the community [30].

Dündaralp gives the basic principles of planning and design were defined as follows from their experience. Dundaralp mentioned that nature should not be harmed when all kinds of add-ons are removed (1), natural materials should be used, not concrete (2), walls should be improved with drywall technique, though without using mortar (3), one should not interfere with any area that has the characteristics of a river (4), and according to the plant inventory, the green area should be protected and enriched (5) [29].

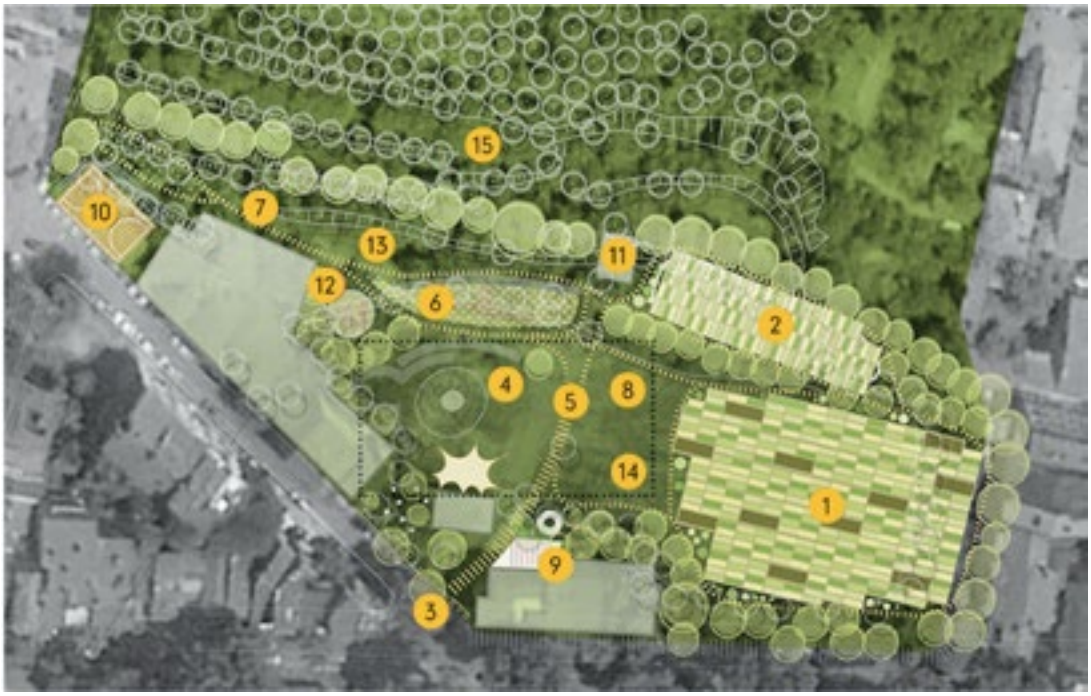

Figure 5. Site plan of the application project 1) garden(agriculture) 2) garden (agriculture) 3) entrance and service building 4) village square 5) pedestrian paths 6) playgrund 7) dog place 8) activity area / meadow 9) traditional water pump 10) sport field 11) library / kids' sand pool 12) kids' playground 13) recreation / excersize 14) disaster assembly area 15) natural pattern conservation region [29] [URL-2]

Dündaralp says of the Kuzguncuk Gardens project, *"If this study, which focuses on the right of use rather than the right of property, can force the parties to produce alternative models that can be kept alive without losing the values of the garden, it will be able to fulfill its task successfully by moving the parties to a new area of negotiation."* The project was made possible not only by the discourse of *"touching my greenery,"* but also by grasping the urban dynamics of the day and opening approaches to this field up for discussion, including how its own production, social, and economic models cannot be built on a single model without losing its current value [29].

The following evaluation was based on the evaluation of the architect of the project (Boğaçhan Dündaralp) using the general evaluation form prepared by the authors according to the framework of the study for the special case of Kuzguncuk Garden. As seen in Table 4, each stage of the evaluation has different total points and, according to this assessment, the project receives a total point score. The Kuzguncuk Gardens project, evaluated using "Evaluation Model for Participatory Architecture," received 47 points out of 84.

Table 4. Evaluation model for participatory architecture (EMParArc) case assessment form for Kuzguncuk Gardens Workshop

	Evaluation Model for Participatory Architecture / Case assessment form					
	Evaluation Model for Participatory Architecture / Case information **Case/Project Name: Kuzguncuk Bostan Recovery and Protection Project** **Year: 2014** **Location: Kuzguncuk-Üsküdar-İstanbul** **Area: 15.400 m2**					
Stage 1	**Participation ladder analysis**		TOTAL POINT of STAGE (8p)	**activities**	**Evaluation (0,1,2)**	**rung type**
under focus group control; execution of the project by the focus group with its own organizational network	8 public inspection	public authority	8	decision mechanism	2	*discussion and sharing of ideas, in place evaluation includes studies such as questioning the perception of the existing situation.*
delegated representation; on behalf of the production of the project by and under the control of the focus group; Execution of the process by transferring certain authority to skilled and expert stakeholders	7 delegated authority					
joint development; execution of the project with the stakeholder group as an active actor in the project processes	6 partnership			design cooperation	2	*user, local etc. groups; It is a sharing process that brings out their inspiration, ideas and creativity. It covers the studies of obtaining information about their dreams.*
persuasive production; Project production where the focus group benefits (the focus group passively monitors the process)	5 convincing	symbolic participation				
advice; Obtaining opinions from the focus group on the project to be carried out	4 advice			technical cooperation	2	*user, local etc. groups; It covers the process of sketching, freehand drawing, models and the transformation of ideas in his mind into a workable design.*

Information: to inform; only inform the focus group about the project	3 information					
improvement; imposing specific project ideas on the focus group	2 theraphy	no participation		usage	2	*in the process of use; observing life* *includes evaluation and archiving.*
Ensuring mandatory use of the project outcome product without involving a focus group with orientation	1 manipulation					
Stage 2	**Stakeholder typology analysis**	**Evalaution 0,1,2**	TOTAL POINT of STAGE (54p)	case name		
	DESIGNER (16 point max)	6	18	**DESIGNER**		
	architect	2		**Boğaçhan Dündaralp- Tülay Atabey-Berna Dündaralp-Lale Ceylan**		
	designer	1		design assistants		
	specialist	0		*designer/s and/or institution/s can be shared (optional)*		
	technique	0		*designer/s and/or institution/s can be shared (optional)*		
	advisor	0		*designer/s and/or institution/s can be shared (optional)*		
	support	2		design team suppoters		
	academician	1		academcians as a supporters		
	design student	0		*designer/s and/or institution/s can be shared (optional)*		
	ENTEPRENEUR (8 points max)	2		**ENTEPRENEUR**		
	financer	0		*individual/organization can be shared (optional)*		
	investor	1		Üsküdar Municipality		
	sponsor	0		*individual/organization can be shared (optional)*		
	supporter	1		Kuzguncuk Association		
	LOCAL COMMUNITY-user (18 points max)	5		**LOCAL COMMUNITY-user**		
	user	2		Kuzguncuk Local Community		

	practitioner	0		*information about the local community actor can be provided (optional)*	
	specialist	0		*information about the local community actor can be provided (optional)*	
	special groups	1		Kuzguncuk Association	
	volunteer	2		Kuzguncuk Local Community	
	ADMINISTRATION	0		*information about the local community actor can be provided (optional)*	
	International	0		*information about the local community actor can be provided (optional)*	
	national	0		*information about the local community actor can be provided (optional)*	
	local	0		*information about the local community actor can be provided (optional)*	
	FACILITATOR (12 points max)	5		**FACILITATOR**	
	association	0		*information/name about facilitators can be given (optional)*	
	non-governmental organization	2		Kuzguncuklular Association	
	chamber	1		Turkish Chamber of Urban Planners	
	federation	0		*information/name about facilitators can be given (optional)*	
	individual initiation	0		*information/name about facilitators can be given (optional)*	
	volunteer	2		Kuzguncuk Local Community	
Stage 3	**Participation techniques analysis**	**Evalaution 0,1,2**	TOTAL POINT of STAGE (22p)	case name	
	QUESTIONS (8 points max)	8	21	QUESTIONS (8 points max)	
	Who?-actors	2		*Were the actors defined and clear?*	YES
	What?-event	2		*Was the work to be done defined and clear?*	
	Where?-place	2		*Was the work area clear?*	YES
	How? - process	2		*Was there a schedule/schedule for the process?*	
	PROCESS (8 points max)	8		PROCESS (8 points max)	
	Decision	2		*Has the decision-making process been carried out?*	YES
	Design	2		*Has the design process been carried out?*	YES

	Implamentation	2		*Has the implementation process been carried out?*		YES
	Usage	2		*Has the usage process been observed/experienced?*		
	DATA COLLECTION & ANALYSIS (6 points max)	5		DATA COLLECTION & ANALYSIS (6 points max)		
	Qualitative data collection	1		*Was quantitative data collection study carried out?*		
	Design collaboration analysis	2		*Have design collaborations been evaluated during and/or at the end of the process?*		
	Technical collaboration analysis	2		*Have technical collaborations been evaluated during and/or at the end of the process?*		
	TOTAL EVALUATION POINT	47				
	A	72-84				
	B	57-71				
	C	42-56	**X**			

Participation ladder analysis ended with a total of 8 points out of 8. Kuzguncuk Garden had the following specialities at this stage: 1) Public inspection: Discussion and sharing of ideas, in-place evaluation including studies such as questioning the perception of the existing situation. 2) Partnership: User, local groups, etc.; it is a sharing process that brings out their inspiration, ideas, and creativity. It covers studies obtaining information about their desires. 3) Advice: User, local groups, etc.; it covers the process of sketching, freehand drawing, models, and the transformation of ideas from one's mind into a workable design. 4) Therapy: In the process of use, observing life includes evaluation and archiving. In the second stage, the "Stakeholder typology analysis," the project is evaluated according to the participation of different stakeholders. The project got 18 out of 54 points. Architects, designers, support people, academics, and design students participated in this part of the evaluation for designers. Usküdar Municipality, as the investor, and Kuzguncuklular Association, as the supporter, participated in the part of evaluation for entrepreneurs. Users, special groups, and volunteers made up the local community part of the evaluation. As for administration, there were two organizations: Uskudar Municipality and Kuzguncuklular Association. The Kuzguncuklular Association, Chamber of City Planners, and local citizens as volunteers were evaluated as the facilitators of the project. In the last stage, there were four questions about participation, four processes, and three data collection items. The Kuzguncuk Gardens project received 21 points out of 22 at this stage. The outputs of Kuzguncuk Gardens, which is the field study of the research, were visualized by creating a project card.

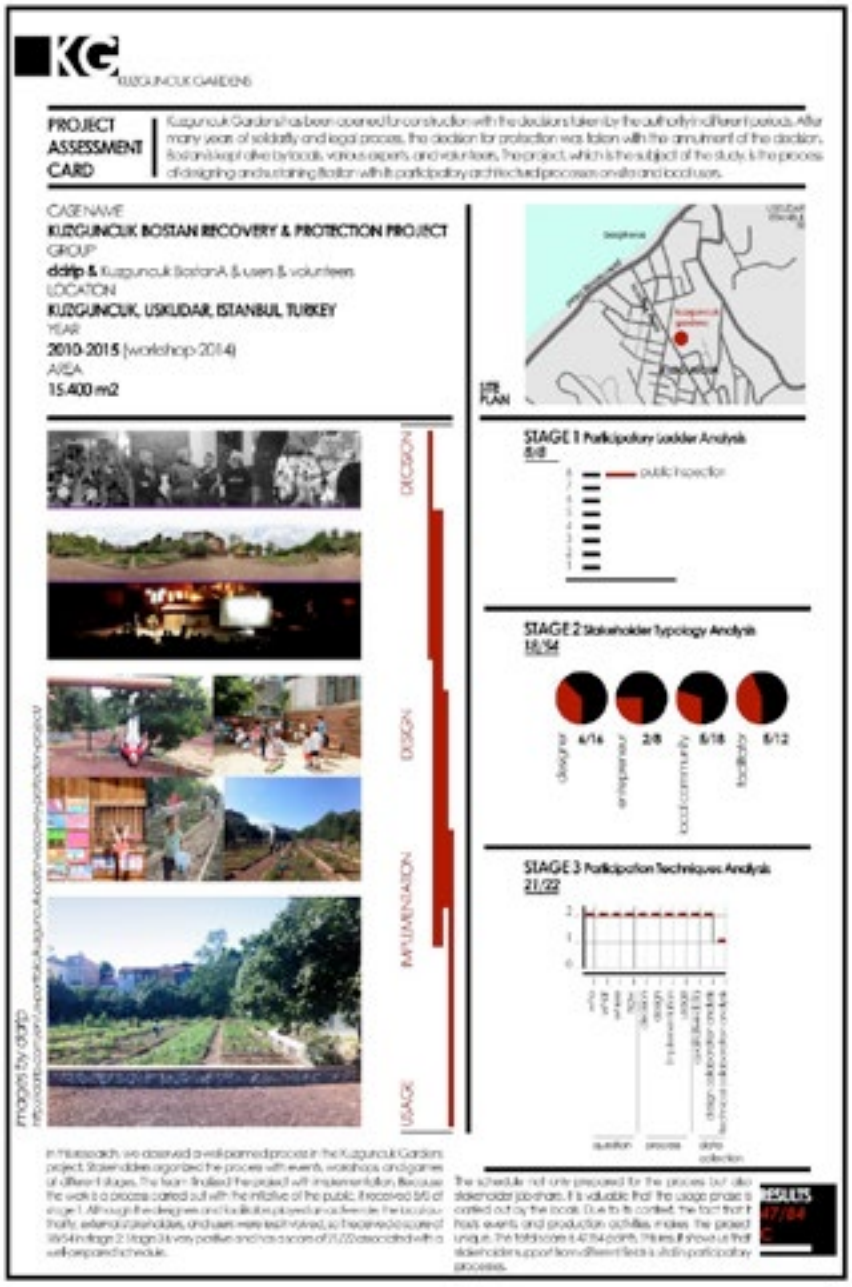

Figure 6. Evaluation model for participatory architecture (EMParArc) project card for Kuzguncuk Gardens Workshop

When the literature was examined, we observed that there were papers, articles, and theses written on participatory architectural studies made by academics, architects, and authors. Similarly, there are also studies that analyze and evaluate application studies made with the participatory architecture model but that do not have a specific framework that present a model based on these studies. To some extent, this present study defines the group by examining a specific area and proposes an evaluation model in which the participant relationships established, and their causes and consequences, are discussed. Limiting the exemplification of working with Solidarity Architecture Exhibition Groups is an important criterion for a sound assessment.

Because of this feature, the study differs from other studies. This article will hopefully serve as a model for future studies.

6. CONCLUSION - DISCUSSION

The article presents a model to examine the subject from different angles with a multidimensional perspective. The study encourages future groups that aim to produce within a polyphonic environment through participatory architecture in order to make good process management and planning decisions that extend throughout the whole process.

Some important points to be taken from the study have been clarified below:

• Kuzguncuk Gardens is a valuable public space for its local users. They harvest crops there regularly. Though the government has repeatedly tried to privatize the garden, the local community took a firm stand in solidarity for many years to preserve the site as a garden. With this effort, the legal processes came to an end with a favorable outcome. The users became conscious of the events transpiring. The local community and users take care of the gardens. Participatory architecture workshops helped to create a new environment that they can use based on their needs.

• Two key actors have a role in project processes. The first is stakeholders: architects and other designers, and experts, multi-sector collaborators (financiers, academics, associations, non-governmental organizations, associations, chambers, craftsmen and craftsmen), and governments (local, central, international). The second is local community actors: in other words, users. This group can be diversified in terms of places and events. There may be special groups such as women, children, students, the elderly and the disabled, as well as productions for the entirety of a specific local community. Facilitators represent the group that plays the main role in the project phase.

• Informal participatory local community can play a key role in the process. It encourages specialized groups with a solidarity style by providing support at the breaking points and difficult stages of the processes.

• It is necessary to use various participation techniques in design collaboration processes since not every individual involved in the process has the same educational and cultural background. Therefore, it is important to try to involve each individual as actively as possible in the process by choosing methods to communicate with different groups. In addition, developing new participatory techniques suitable for participant profiles beyond the current participation techniques in the literature will guide future studies and offer new opportunities for expansion.

• The necessary spatial productions can be realized for individuals and communities in need by developing a habit of organizing in extraordinary situations with collaborative, participatory architectural activities.

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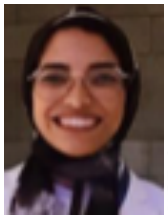
Public spaces under flyovers: Qualitative data analysis of users' interests in Heliopolis



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Abstract: *Global literature documents many urban agendas related to urban sprawl, traffic transit sequences, and flyovers. Changes in development patterns in Egypt have led to many lost spaces beneath flyovers, affecting the urban fabric. Despite these lost spaces under the flyovers, current Egyptian policies have transformed them into public spaces. This paper analyses the development scheme of some regions under newly constructed bridges in Cairo. This paper explores activities and landscape architecture under the flyovers and identifies their impact on the urban commons using quantitative methods, maps, surveys and semi-structured interviews with users' perspectives. When detecting previously selected states, bridge construction, and passive activities, the results indicate diverse experiences based on the age and species of neighbourhoods. The findings help identify the possible activities useful for the community and can enhance the quality of life. In building flyovers amidst the city's fabric, the recommendations have highlighted the importance of linking the neighbourhood's characteristics of urban configuration, landscape architecture, and socioeconomic parameters.*

Keywords: *Neighbourhood, aesthetic quality, public space, cognition process*

Üst geçitlerin altındaki kamusal alanlar: Kullanıcıların Heliopolis'teki ilgi alanlarının nitel veri analizi

Özet: *Literatür, kentsel yayılma, trafik geçiş sıraları ve flyover köprüleri ile ilgili çeşitli kentsel gündemleri belgelemektedir.Mısır'daki gelişim modellerindeki değişiklikler, flyover köprülerinin altında birçok kayıp alana neden olarak kentsel kumaşı etkiler.Flyover'ların altındaki bu boş alanlara rağmen, mevcut Mısır politikaları onları kentsel kamusal alanlara dönüştürmüştür.Bu makale Kahire'de yeni inşa edilen köprüler altında bazı bölgelerin kalkınma şemasını analiz etti.Bu makale, flyover'ların altındaki faaliyetleri ve peyzaj mimarisini gözden geçirir ve kentsel müşterekler üzerindeki etkilerini tanımlar.Amaç, toplum için yararlı faaliyetler olasılığını belirlemek ve yaşam kalitelerini artırmak için yaşa ve mahalle türlerine göre çeşitli ve çelişkili deneyimleri keşfetmekti.Bu araştırma, flyover'lar altında mevcut koşulları yaşayan katılımcıların haritalarını ve anketlerini kullanarak nicel yöntemler kullanmaktadır.Bulgular, heliopolis'in değerine göre imar planlarının nasıl değiştiğini ortaya koydu.Şehrin dokusunun ortasındaki köprülerin inşasında, bulgular mahallenin kentsel yapılandırma, peyzaj mimarisi ve sosyoekonomik parametrelerin özelliklerini birbirine bağlamanın önemini vurguladı.*

Anahtar Kelimeler: *Konut Mahallesi, estetik kalite, kentsel kamusal alan, biliş süreci.*

1. INTRODUCTION

The challenges of population, urbanisations related transport have grown in recent years and have increased the need for growth in the vehicle, including overpasses, as solutions to the existing traffic problems in Egypt. Generally, highways are an essential component of every city; they are often built-in responses to urban growth [1]. Consequently, the government in Egypt has decided to develop the infrastructure with road expansion and highway construction to make an easy traffic flow. Since 1970, bridge construction has been a leading issue in the Egyptian urban plan to solve many traffic problems [2]. According to Central Agency for Public Mobilization and Statistics, this culminated in 2972 bridges throughout Egypt. However, bridges/elevated highways divide neighbourhoods, create unfavourable impressions, and serve as physical and psychological obstacles that make walking uncomfortable [3].

Moreover, the massive expansion of flyovers led to various lost spaces—that might emerge under flyovers—affecting the social, cultural, urban fabric, and identity of the city they move through [4]. Chohan (2014) describes the flyovers and urban areas under them are considered dangerous, overbearing, harmful times [5]. Urban designers and architects have suggested that these places could be transformed into distinguished areas with visual pleasure to decrease the negative impacts [6, 7]. There was no attention given to the bridge aesthetics standards in Egypt and the excellent use of the places' underneath overpasses. However, recently, the government has become more conscious of the ideal utilisation of these places [8].

This study evaluates the uses and explores whether the construction patterns of the bridges are changing the urban context and pedestrians' needs in Egyptian cases. First, the study investigates how places cocooned the split community and/or trees to revitalise the area without losing car entry in the Heliopolis suburb district as a case study. Given this case study, the sections are characterised by distinctive architectural, urban, and environmental values. These cases draw attention to the importance of integrating the work between different stakeholders, including urban planners, highway agencies, the community, and other stakeholders, to conserve the public spaces. The rehabilitation or reclamation of public spaces is considered an essential solution and alternative for the areas under the flyovers, especially in the existing neighbourhood, to make the environment friendly.

In achieving the present study goals, the followings discuss three questions including:

- How do users of different ages and social classes cope with the activities in areas under flyover?
- How have places under the flyovers in Heliopolis changed although the context has a unique value and community?
- What are the design principles of landscape architecture and conventions guidelines that should be used to create a relevant neighbourhood in places under the elevated streets?

To attain these objectives, this paper investigates the development of Heliopolis based on the construction of highways and street expansion and how this improvement moves away from a coherent city fabric. Theoretically, this research investigates the theories of social areas, public areas, and urban layout ideas of what makes a city public space successful. This theoretical background discovers the causes and solutions for creating high-quality communities with social accuracy and the prevailing characteristics of these areas. Empirically, this research follows the qualitative method. The findings from qualitative surveys launched in early 2021 should provide evidence of the coherence of the city. Figure 1 describes the structure of this study.

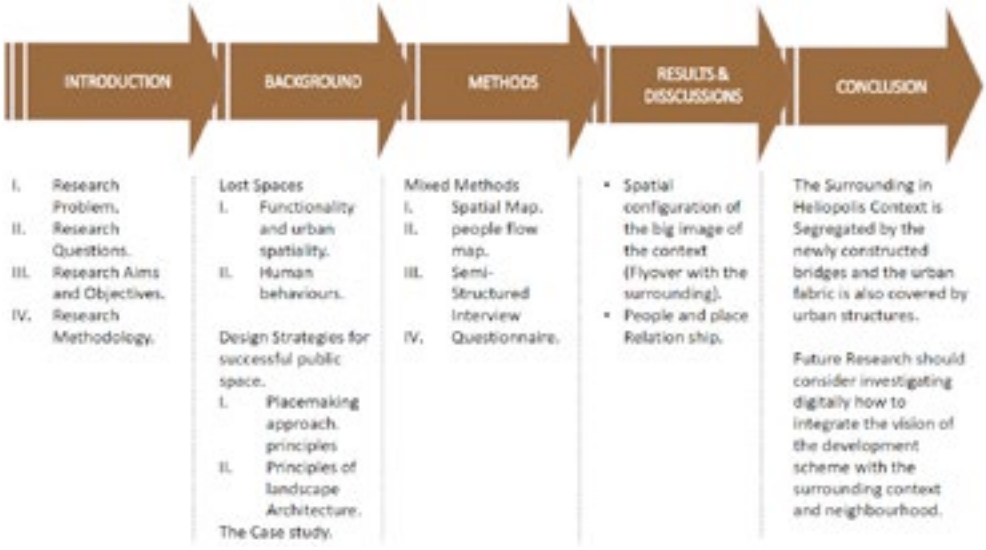

Figure 1. Research structure

2. LITERATURE REVIEW

This research tackles social spaces, public spaces urban design principles that take please convenient to users. This section aims to find out the causes and solutions for the debate of how to create the best communities to conserve the characteristics of these places, understanding landscape elements with referring to many scholarly views for identifying the factors of contemporary landscape in the context.

2.1. Functionality and Spatial Structure

Malterre-Barthes (2011) proposes five better spaces under elevated highways in densely populated towns [9]. In the early stages of exploring these places in literature. This typology is accommodated with no use [10]. However, the function of these places is determined by surrounding uses. Generally, the design of these places in cities is maintained by the local authorities. In some examples worldwide, these areas with services are mainly used for parking, and some benches and street furniture exist. In other instances, these places are used for industrial and business purposes. Finally, the literature describes these transit places as hubs for public usage like trains, depots, bus stop shelters [11, 12, 13]. Trancik [3] presents urban challenges in contemporary cities in his book *Finding Lost Space* in the same line of thinking concentrated on the centre of the city, the current planning position. Trancik's (1986) approach is to figure out the spatial relations between two and three-dimension and their use by the inhabitants. He also pointed out that the trouble with modern movement today has led to many unsuitable vacant lands. It left many dead spaces in cities. In this respect, "The usual urban development process treats buildings as isolated objects sited in the landscape" [3].

Trancik (1986) also mentioned that "designers of the physical environment have the unique training to address these critical problems of our day, and we can contribute significantly toward restricting the outdoor spaces of the urban core" [3]. Since there is a lack of appropriate architecture in the dispute between developers and architects, dead areas have a strong capacity for attracting people to abandoned places. There are numerous vacant, misused, or unused lands in virtually every city worldwide, and the gaps under elevated highways seem to be a significant portion of them. Although these outdoor areas are beautiful, attractive, or unities, planners today preserve them. In this line of allocation, "Lost space can be seen as the unstructured landscape at the base of high-altitude towers to the unused darkened area, away from the flow of pedestrian activities in the area". Trancik (1986) [3] described lost space in cities as unstructured patterns.

Furthermore, the lost areas are deserted waterfront train yards, empty military sites, and factory sites [3]. Practitioners in some cities ignore social contact in deserted places and repel any constructive social contribution, "these are undefined and have no observable boundaries and fail to connect the elements consistently" [3, p. 4]. He also referred to five critical reasons for the problem mentioned [3]:

- Increasing automobile dependency.
- The position of modern movement architects against open space.
- Urban-renewal zoning and land-use policies that fragmented the city.
- The ability of contemporary (governmental and private) institutions to take public and civic responsibility.
- The abandonment in the heart of the city in commercial, military, or transport locations.

Trancik (1986) has examined three key urban elements which focus on the success of these spaces. Three-dimensional frames define the area borders. The first border is the flyover structure, the enclosure level, and the human scale for the flyover structures. The pattern is the second type of border defining the places under flyovers that concern the textures, materials, and ground pattern composition.

Finally, the space borders are affected by complex scenes like benches, lighting poles, statues, plants, and all objects that focus on themselves.

1.1. Human Behaviour in the Urban Commons

In understanding peoples' behaviours, this section of the literature addresses the human problem. Several studies have concerned the way people behave in urban environments and explain how people interpret and communicate with these spaces.

Whyte (1980) has developed a research project into how urban spaces interact with people's experiences [14]. He watched various plazas and parks to see which worked for users effectively and which did not. Through behavioural observation, he detected those variables to explain the complexities of people's relationships and why they choose space rather than another. As the author called "triangulation", people seem to be drawn by some events, like musical acts or art installations, as the author called "triangulation", making strangers likely to talk. "Sculpture can have strong social effects. People are drawn to the sculpture, and drawn through it: they stand under it, beside it; they touch it; they talk about it" [14, p. 78].

Whyte (1980) concentrated on the movement of individuals inside urban areas and how double-sided instructions can influence or slow down movement speed in small conversations [14]. The attraction of people is the main factor; the bulk of people who sit, chat, or eat will make a sort of crossroads in the room, for example, through a food cart, and thus contribute to corners. Crowds add a sense of security and assurance in some open areas. Furthermore, its potential to create shade areas is a good shield and a sense of security; Whyte (1980) [14] deals with natural elements such as trees. Breezes are also essential for the liveliness of parks and public spaces, as are winds, heat, and water. Islands usually surround areas under the highways; thus, the street is essential for public space achieving. It must finish cohesively at the end of the square or public space. The connection between the findings of Whyte (1980) in his project and the ones described in the study brings us to the core of following people's behaviour patterns, which can be applied in public spaces. It is usually the ultimate preparation and application for building a large, socially entangled city.

There are numerous public spaces between buildings and roads in any city in the world. They are essential for people in the first place. They play a vital role in the behaviour of people. They affect the quality of their lives [15]. Therefore, it is an essential part of the construction process in the region. The literature analysis

showed that several writers had addressed the negative consequences. Bog communities propose the effects of these systems in six main categories [16]:

- Increased mobility and accessibility.
- The urban structure was dominant.
- Physical and psychological obstacles and visual invasions of separate privacy communities.
- Unclear and often misused space.
- Low natural light and under the elevated structure create a negative or lost space.

In the context of transforming places under the elevated highways into the public domain, practitioners may assign a goal for making a perfect public space where people gather and go immediately to escape from the lauds of the city [17, 18, 19]. The literature recommends the design of successful public spaces if we give one excuse to simulate successful public spaces where individuals interact and where individuals temporarily avoid the city clamour. The reason for this avoidance is that practitioners should make the places under the highway into public use. In addition, public space enables all people of different origins to use available space, regardless of their personal, social, and social contrasts [17]. In the same line of thinking, open spaces should accommodate variation and the proper flexibility and consistency for persons from all backgrounds [7, 20].

1.1. Design Strategies for Successful Public Spaces

When researching the social community and its connection to the urban types, the issue is why people go to public spaces. Many of the reasons people spend time in public areas are avoiding the urban crowd and the noise [21]. That is why they find places where they can practice any tasks that can fulfil their needs. To attract and meet the need to spend time in public places, we learn the market people seek in regions. Five critical reasons for the need for people are comfort, relaxation, passive participation, active involvement, and experimentation in the public space [22]. The design process might need to consider users' needs and how they can be met to prevent the misuse or displacement of people into areas. The Project of Public Space (PPS) website clarifies the place making challenges [23]. PPS researchers have attempted to develop the latest modern module to understand public space needs by recapping users' needs into four primary attributes which can be achieved to meet the public sphere, as illustrated in (Figure 2):

• In **access and linkage**, the entrance to areas is also an important issue. Dense neighbourhoods need more open public space for meetings, and people use which places are available if they are not accessible to social events [17]. However, elevated highways and bridges next to districts are primarily located in high-density high traffic flow areas. They are strategically located on the axial land of the vehicle-dominated road. A furthermore, it's hard to access. In addition, the relationship between these areas and the main street is mainly restrictive. If you are unable to access it, people are less likely to use the space. Until then, a direct connection between space and the environment must be established to attract many people. The literature review outlined the critical factor in the efficiency of the relationship between streets and public space. A great spot begins at the corner of the road; if it's a lively corner, it has a vibrant social life [14].

• In **comfort and image**, the sense of convenience is discussed by PPS in terms of what causes people to stay in a plaza or public place. The importance of this factor comes because they want an escape from the city's weather, calm the sight and hearing. However, several studies have emphasised these systems' adverse health impacts, particularly road-noise, a significant urban noise [24]. Noise is viewed as an environmental stressor and annoyance and is described as an "unwanted sound." Noise effects can be described as all the health and wellbeing effects caused by noise levels [25]."Environmental and government authorities have in recent years been particularly concerned about the noise levels of different travel modes because of the serious discomfort they are bringing to communities around them" [26].

Evidence from literature shows that the highways' visual consistency can act as physical and psychological barriers that create undesirable views [27]. The visual character makes the pedestrians' experience unpleasant [3]. In their book, *Safe Cities: Guidelines for planning, design, and management*, Whitzman & Wekerle [28] have actively taken this approach and began to get people familiar with the views of the highways. When most of our knowledge is obtained visually, these structures may provide a potentially positive effect measurement approach. Visual intervention, especially in urban environments, is the most significant effect of high systems. At the same time, highways will act as physical and mental obstacles that generate incredible views that disturb the pedestrian experience [3, 29, 30].

• The literature was reviewed for possible methods to the factors of uses and activities. In this respect, the practices inside the public space are among the main attributes of a successful play. They are the principal justification for people to turn a place into a group of components and a dynamic field of daily activity [31]. It is challenging to have a specific use or public action in these places, but it seems like it is widely overlooked to manipulate these remains. New cooperation, some of which may be temporal, and some become long-lasting, is being established by promoting and participating in urban activities that provide an alternate model of behaviour and reform routines and configurations [32].

• In sociability, the challenge here is what makes space is people's participation. Zygmunt and Tine said: "The key characteristic of the places' public but not civil' is the redundancy of activity, a space without individuals, just coordination, only static" [33]. Public spaces may be officially public and/or private, either in whole or part; they can essentially be people-oriented development. Therefore, the site programming can probably target user groups that use the space and promote various subgroups of the probable user community [17].

Figure 2. Placemaking principles. Source: the authors based on PPS

After reviewing the concepts of making the correct area under the highway, this article explores how people communicate and stimulate dialogue. The social level of contact between individuals is hugely varied and unstable. Still, it is essential to consider the model and the optimum atmosphere for a small conversation as a landscape architect. Whyte (1980) said it as 'triangulation,' as stated previously [14]. This method, whereby certain external stimuli bind people and encourage strangers to speak as though they did not [3]. Mainly from these two outlets, the following recommendations are taken. Other sources, such as safe cities: Whitzman and Wekerle (1997) recommendation strategy, design, and management, were included in the framework to improve or present additional concepts [28]. Many urban areas, neighbourhood parks, and linear park rules converge are shown in the topical sense. Where necessary, specifics are given. The subjects

discussed are design elements that include access, safety, programming, physical connection to communities, and nature. Figure 3 also shows the factors that can make nature be incorporated into an under-highway space. A previous deduction for assessing business value was decided by reviewing many literature materials, guidelines, and standards. The four main types of requirements are traffic, climate, economy, culture, and visual image.

Figure 3.The criteria for appearing the value of the transformation of the space under overpasses. (Improved by authors)

3. METHODS

3.1. The Case Study Heliopolis was one of Cairo's most outstanding impressive neighbourhoods since it was founded by the Belgian Designer Baron Emban in 1905 to end up about 8-10 kilometres. In Heliopolis, the entail design was prompted by the European urban and architectural style taken on the essence of quality of life and sustainable urban development [34]. Vast areas of green spaces attached the modes of public transit, including the upcoming electric tram lines that were planned to connect to the city centre [35].

Heliopolis incorporates western and eastern architectural and urban concepts, making it a unique neighbourhood [36, 29]. However, in the last quarter of the twentieth century, it faced a lot of encroachment, either by demolishing some of the distinctive historical buildings, or by changing its functions and land uses, or trespassing on many of its public, private spaces and green open areas [37]. These green areas were breath taking to residents and replaced by high-story residential towers, which increased by the increase of population and caused many problems that affected the image and culture of the city. Heliopolis consists of two major parts: Korba, the old city founded by Baron Empain, and the latest t supported [38]. Heliopolis consist of six districts: Al-Bustan, Almazah, Al-Muntazah, Al-Nozha, Al-Matar (the Airport), and Al-Sheraton. The total area of Heliopolis is 9.38 km2, with a 2.6 km2 [39]. Al Nozha District has a land area of 67.6 km2 and a population of 238,550 residents [40] (Figure 4).

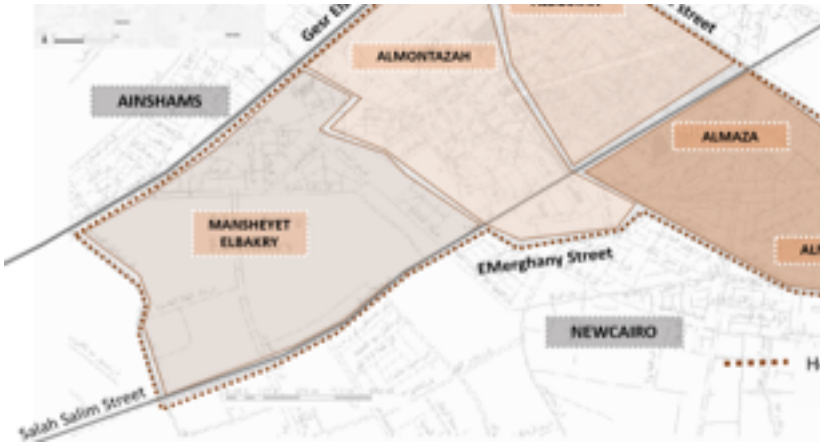

Figure 4. The central districts in Heliopolis. Source: The authors of the present work.

There was a significant change in the historical Heliopolis districts two years ago. Since September 2019, the construction process has begun slicing through Heliopolis's streets and urban fabric to achieve the national movement axis and road development plan, seeking to fix traffic problems [1]. Heliopolis development plans call for the creation of five bridges at intersections. Figure 5 represents the development of Heliopolis bridges. Besides, an extension planning scheme for street networks to reduce congestion, motion, and crossing. These new bridges cut through the residential neighbourhood to link the new cities east of Cairo e by cutting off the greenery alongside the sidewalks. The streets were expanded to five or six lanes after previously being just two lanes. Cairo Governorate and the Ministry of Transport placed a new reality on the citizens of Heliopolis almost immediately, with no consultation or community dialogue with the residents [41]. Building five new bridges over the sprawling and green squares sparked a substantial social uprising and public anger. According to data presented by the Heliopolis heritage project, the conversion of these avenues into psychopathic highways resulted in the removal of 375,065.36 m2 or a total of 95.3 feddans covered by trees and green areas [42] (Figure 6).

Following the criticism facing the cutting off of trees, another sustainable solution was implemented by the Egyptian Environmental Affairs Agency (EEAA) [43]. Green walls are to be built for the first time in Egypt inside the new bridges. The vegetation of the bridge columns may be a step in the fight against pollution. However, the cut trees on the roads cannot be replaced.

Figure 5. The road development highlighted the new bridges in Heliopolis; source: The authors of the present work based on Google satellite map in January 2020.

The government and authorities decided to take measures on the lost spaces under a flyover to construct elevated highways. The areas underneath the bridges have become bright sights, eliminating the once illegal means used to access these areas. Heliopolis neighbourhoods lack social facilities for their residents. The spaces can be used in small projects for young people ranging from cafes, shops, and restaurants. Designing space underneath an elevated highway; the biggest problem is getting people to go there. The use of these areas would also limit the number of offences/crimes committed there. Public spaces are not in people's language as they usually seek. People tend to use the area once they perceive it as an opportunity to explore it for themselves.

El Mahkama/Abu Baker Elsidiq elevated road was chosen as one of the case studies for three significant reasons. Firstly, it is the only case where discussions discuss planting the structure as a treatment of visual aesthetic value. Options to reconfigure the flow were already established because of that and to discuss how this affects space under the flyover. Secondly, its location in the context within different nature in a primary traffic movement in the centre links between the other areas. It brings users with different categories and characteristics because of the services and land use of the surrounding. Third, the first flyover finalised their construction works and open markets and activities in spaces under the flyover. This would aid in obtaining an actual first experience of the bridge so all prospective interviewees will have a fresh before-and-after vision of the city, so suggestions and impacts will be at the forefront of their minds. And open a discussion and prompt the concern of solutions that are applicable in certain situations.

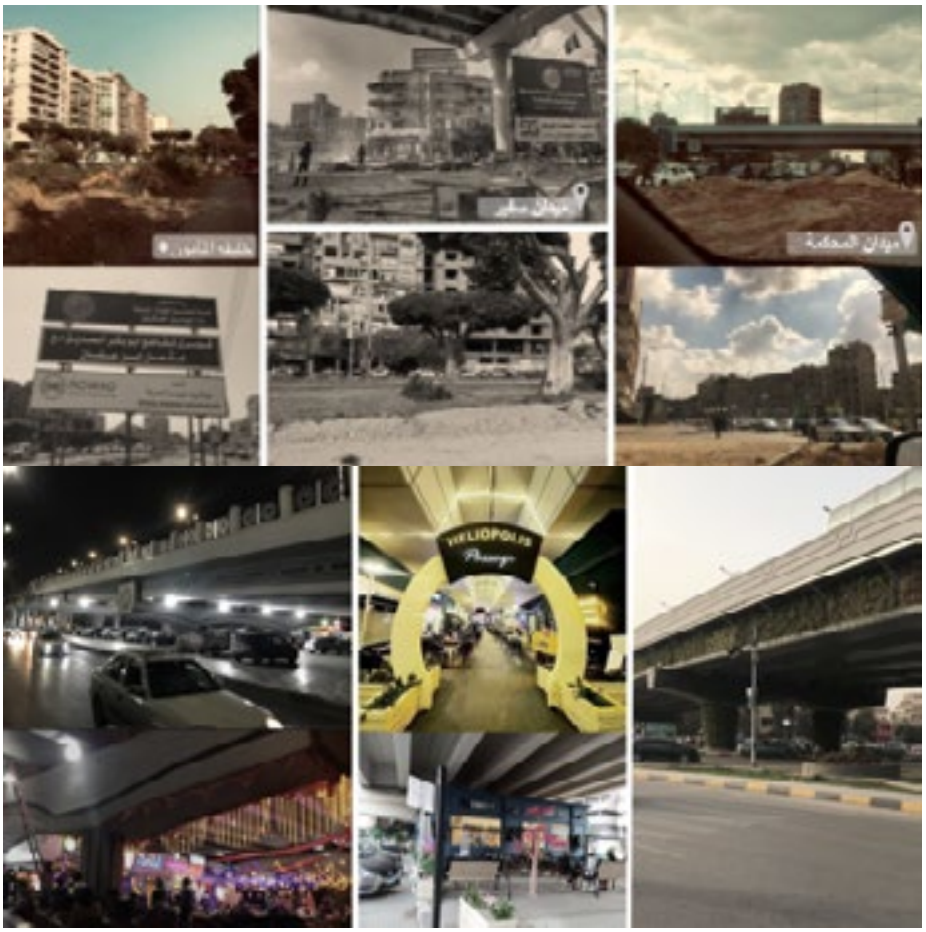

Figure 6. The phases of creating new bridges and development in Heliopolis urban fabric. (Photographed by authors).

Figure 7. The aerial shots show the difference between the Abu Baker Elsidiiq axis before and after the elevated highway/flyover construction.
Source Google Earth satellite map, August 2019 and January 2020

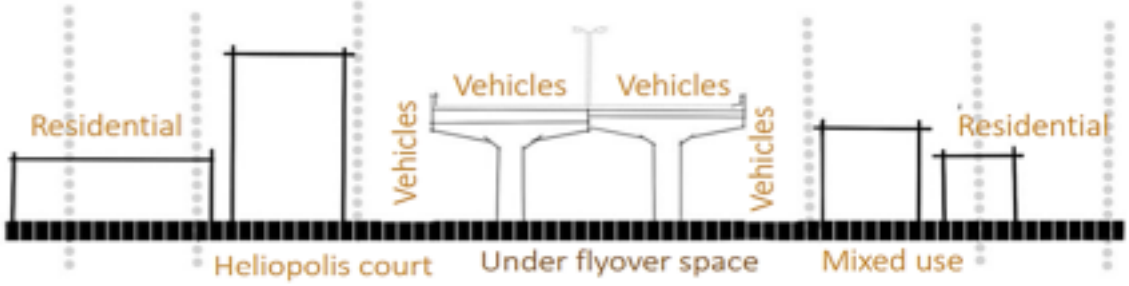

Figure 8. The longitudinal section of Abu Baker Elsidiiq axis in the urban context after the elevated highway/flyover.

Social services have been cut off for the people of Masr El-Gedida. Building a community hub that acts as a resource centre for people of all ages and socioeconomic backgrounds is the goal. People were generally in favour of making the bridge because it would help reduce traffic congestion. Still, there were also two significant criticisms: the loss of greenery due to its conversion to concrete and a loss of the neighbourhood's unique identity that draws people from all walks of life. Eventually, the ameliorating process should be oriented towards rebranding the community by accentuating the lost collective memory of the context. Besides, vegetation can vertically be on the bridge's pillars or the ground floor to simulate how it was before in different forms. In this regard, providing daily, weekly, or monthly activities for all ages can create convivial atmospheres in these places. Making public hearing sessions to listen to residents' voices can develop the neighbourhood into a more responsive environment. For such environments with active usage, residents can proactively initiate the interaction, and the area can be scaled up the pace on the level of enlivening the surroundings. This action can make the whole community socially entangled.

3.2. Data Collection

Quantitatively, this paper designed a survey that consists of three phases. The first phase is the demographic structure determines the different ages and types of the community used or have an experience in spaces under the flyover and their characteristics. The second phase evaluated the experiences of used areas under the flyover based on the placemaking approach. The third phase was to get how people and residents cope with the places under flyover from their perceptions and determine their perspectives' positive and negative impacts. The set of these survey questions is represented in the supplementary materials. This survey was asked to random samples from local communities or visitors of different gender and ages. The questionnaire aimed to evaluate the experience inside the spaces under the new bridges in Heliopolis and how the uses are homogeneous with the unique neighbourhoods' special characters in terms of coordination of the site elements.

The data collection also passed through another data collection stream using a structured interview with an expert in knowledge and shop owners and workers. This interview aimed to investigate the relationships within the context and the surrounding neighbourhood. The discussion included three questions for shop owners and workers followed by other three questions asked to exert as follow:

- Upon rehabilitating spaces under the elevated urban highways, what kind of problems do you face?
- Why has this activity been chosen to participate under the elevated urban highway?
- Can you list the process you needed to develop the space under the elevated urban highway?
- What are the positives and the negatives of having a highway passing over any neighbourhood?
- Are the positives outnumbering the negatives or vice versa?
- What are the social, environmental, and economic impacts of building highways and utiutilising spaces in Heliopolis?

The interviews were held during the three months following the bridge's opening and development using spaces under the flyover. The district's significant transition recently had happened when conducting these conversations with residents that were considered sufficient to deduce thoughts from the authors' perspective. General questions were asked to collect random samples of various genders, ages, and available profiles of local shop owners, workers, and field experts. The expected results from their responses to the interview questions were to determine how people think about the placemaking and rehabilitation approach for the areas under bridges. This interview is also targeted to investigate how respondents' experiences differ from each other.

3.RESULTS AND DISCUSSION

This research determined the difficulties associated with structure areas underneath the residual highways in Heliopolis at the specified location. It chose the experiences of area users and their attempts to address the absence of immediate demands in the vicinity. Building upon the research methods, the results figured out how users feel about and perceive their environment.

The survey by observation method and spatial analysis of current conditions showed no direct relation between the types of activities and facilities mentioned in the space and the user/community's needs and their satisfaction with their experiences in the area. As a result, the design of places does not consider pedestrian life and needs as providing direct and clear paths for pedestrian circulation. More attractive landscapes, proper seats, benches for the public, and comfortable paving materials; as the user feels safe, comfortable,

and belonging to space, more time can be spent in the areas and attract more people. Although these spaces' development makes them not considered a lost cause, they still don't meet or achieve all users' needs yet. These spaces have more potential to increase their quality and provide a successful, sustainable public space and vital point of attraction in the context.

Based on the casual interview occurred to find the user's feedback about the spaces under a flyover. This feedback is divided into two teams with different ages average. The first team with an average age from 18-30 years old, and the second average to 55 years old, the younger group, agreed with the idea and activities on the space. They just had one concern about the type of activities and facilities. They need to have various uses and wealthy the space with more attractive elements to be much better and enjoy the experience, not just like it. The older team didn't agree on development at all as it affects the built environment. They listed the effect of destroying Heliopolis's aesthetic value, cutting through the urban fabric configuration, cutting and removing the historical trees, and green spaces with asphalt (grey structures). They also mentioned how this affected the environment and increased the temperature without any concern about the pedestrian. They also find it difficult in crossing the roads to reach the spaces due to its expansion development. Some answers showed annoyance because of the noise coming from traffic and spaces below bridges, but others didn't feel this noise inside the space as the sounds from shops cover the outside noise. As it is not the optimum solution to solve traffic issues, they suggest that to improve and maintain the tram line as a sustainable way of transportation in the heart of the city, so the pressure of vehicle number decrease and creating tunnels instead of bridges to save the visual continuity of Heliopolis image.

Understanding a place under a highway bridge is difficult; the real issue is getting people to use it. People's dictionaries don't include public spaces in such noisy settings because they often seek out more traditional locations. However, as we discovered from the literature, it all comes down to how individuals connect with their city, and once they see an opportunity to do so, they will take advantage of it.

4.1. Spatial Findings

The analysis focuses on the interventions and adjustments made to the places under flyover by users of varying ages and understanding the constraints that space faces in meeting their growing needs. To map the progress in the site, the case is divided into two phases: the original state, which was dealt with because of the project's construction, design, and the current stage of urban formation. Field observations exposed the design's limitations. The first researcher of the present work made numerous visits to the site over three months following the launch of the areas under the flyover to assess their current state.

The observation of the phase before and during the development of the spaces under the flyover made many changes in the area. As for replacing the greenery in such a historical district and neighbourhood like Heliopolis, 550 trees from Abu Bakr El-Siddiq and replacing them with asphalt will slightly increase the temperature. This impact is a likely result of the absence of any environmental pre-assessment plan. There was no mention of interference to form the EEAA, which has not come across an efficient ecological impact assessment process. Also, they removed the Abd elAziz Fahmy tram line, which passed through Abu Bakr El-Siddiq street. The tram network is not used a lot nowadays as it has become a fewer proper means of transformation, but there were still two trams. In this phase, removing old tram lines was transformed into expanding roads to solve the traffic issues and congestion problems in Abu Bakr El-Siddiq.

Environmental assessments are influenced by planting and greenery. Still, they also have a visual effect on the district's image, designed with people in mind, increasing its aesthetic value. Planters put on sidewalks, and street corners should not create congestion or block pedestrian circulation. A rain garden is a garden bed in which the storm water solutions are installed and then recycled into the drainage system or allowed to soak into the ground below, minimising the need for potable water to water the plants—establishing rain

gardens aided in the environment's sustainability. The most controversial effect is the loss of trees, with all participants expressing discontent with it. Residents opposed the initial stages of construction due to the tree cutting and uprooting; nevertheless, officials failed to present a suitable alternative. Numerous residents have stated that these projects have altered their perspective of the neighbourhood. This has impacted the community's collective memory; the district is nearly a century old, and these structures have obscured and distorted the area's unique history.

In Figure 9, street furniture includes lighting fixtures, waste receptacles, benches, signage, and bicycle racks. Public courts were located near the walkway during this time. Pedestrian sitting (benches) is meant to serve as a waiting and resting area and a place for people to sit and speak while taking in their environment. Courts were frequently found in bus stations. Lighting for pedestrian pathways should contribute to making them more accessible and safer for pedestrians. This was not the case before or during the development process. Sidewalks were essential to the social fabric of Heliopolis's neighbourhoods. Because the sidewalk was well-maintained and exciting to use, people could run, walk their pets, and bike on it. Sidewalk curbs operate as barriers to prevent vehicles from riding up onto the sidewalk where they meet the street. That makes pedestrians feel safe. Neighbours built their bicycle infrastructure. Due to the absence of these facilities, it is challenging to create a sustainable and pollution-free roadway. The lack of garbage bins along the street is observed. These are strewn about in an non organized, deteriorated, and useless. It is appalling that signs are placed around the region. Several of them may be found in dangerous areas for pedestrians and dilapidated due to lack of upkeep. Even if there are no pedestrian lanes to consider, there are pedestrian signs.

The observation of the current configuration of the places is designed to have better use from the viewpoint of the shop owners and users. (Figure 10) illustrates a street section sketched on a site visit to allocate activities and interventions in the space and how people interact to understand the area better. Figure 11 shows a flyover section to determine the relationship between the landscape of the spaces under the flyover and the urban landscape of the surrounding context. Figure 12 also mapped the site observation that took place by the first author of this research. Her statement focused on the current condition of areas under the flyover to better understand activities and their relationship with the surrounding land use. Understand the land use and activities under the flyover and how they are related to the surrounding area. It's surprisingly straightforward to see how the land use under the flyover affects the kind of activities carried out in the area. Part.1 was surrounded by various land uses, administrations, and governmental services with large capacity, so actions were transitional while waiting and relaxing.

Activities in Part 2 (restaurants) are impacted by the mix of entertainment and residential activities on the site. Similarly, Figure 13 illustrate the detailed sections of the places under the flyover to determine the current condition of landscape elements in the case study area and their quality to deal with the development

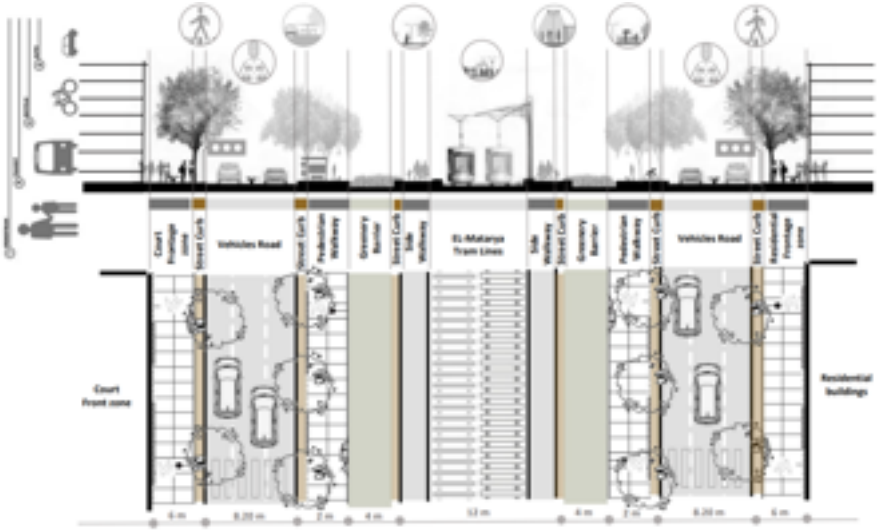

Figure 9. Layout and section an analyser landscape and street elements before the development process along Abu Bakr Elsiddiq Street. Source: The authors of the present work

The researchers of the present work observed that the area under the flyover is substantially loaded in the morning and that the parking zone is entire due to the proximity of the governmental building. From the observations of landscape features in the space beneath, it was found that they are overpassed. Trees and landscape strips faced a challenge in lack of greenery and trees, impacting environmental evaluations and influencing the weather. Although the bridge had a damaging effect on the district's overall image, planting its structure and columns improves its visual value. The absence of rain gardens will have a long-term adverse impact on rainwater and drainage processes.

Street furniture includes lighting fixtures, waste receptacles, benches, signage, and bicycle racks (Figure 14). Lighting: The spaces under the flyover are well lit, but lighting elements cannot be considered sustainable because they are not energy efficient. The areas under flyover are well lit, but lighting elements cannot be regarded as sustainable because they are not energy efficient. The pavement in this part is not suitable for disabled people or older adults' movement. That is due to the lack of a ramp. Curb height is not operating as a barrier to prevent vehicles from running over the spaces. That risks the user's life and makes them feel uncomfortable and unsafe. The difficulty of crossing the street is due to the over-speeding cars; almost all of them highlight the danger of space because of the speed. Sidewalks are indirect and unclear for pedestrians, leading users to interrupt the activities that occur under the flyover, as interactions occur under the flyover, as sidewalks are essential to the social fabric. It also makes the participants lose their privacy and the sense of the place and their hierarchy. Users use concrete tree surroundings as shaded benches for relaxing, sitting, and waiting for public transportation. They began to meet their requirements in the area beneath the flyover. For the safety of both automobiles and pedestrians, signage is an essential visual guiding and orienting tool. As a result of the wayfinding signs being clear and visible from all directions, it contributes to a pleasant urban atmosphere.

The findings showed that individuals intervene in the area for several reasons, including functional, aesthetic, and regional considerations. To meet users' immediate needs for accessibility, shop owners and users can work together to create accessible environments around businesses and restaurants. In terms of aesthetics, consumers desire to have an attractive, beautiful area that reflects a positive image of the space. Many public events and interventions are local, allowing users to expand their scope and sense of control over the place represented.

Based on the flow of people to these spaces, the results showed what draws more users to the area. Several maps of users on different days took place within a specific time range (Figure 15). Collecting a map of people's flow on the study field figured whether those uses are parts of the space or not and fully occupied. Based on the mapping of periods from 8:00 am-12:00 pm, 3:00 pm-5:00 pm, and 7:00 pm-9:00 pm, the focusing observation showed the number of people, their flow, and their location related to the spaces they used. The finding confirmed that the capacity of users is affected directly by the land use of the surrounding.

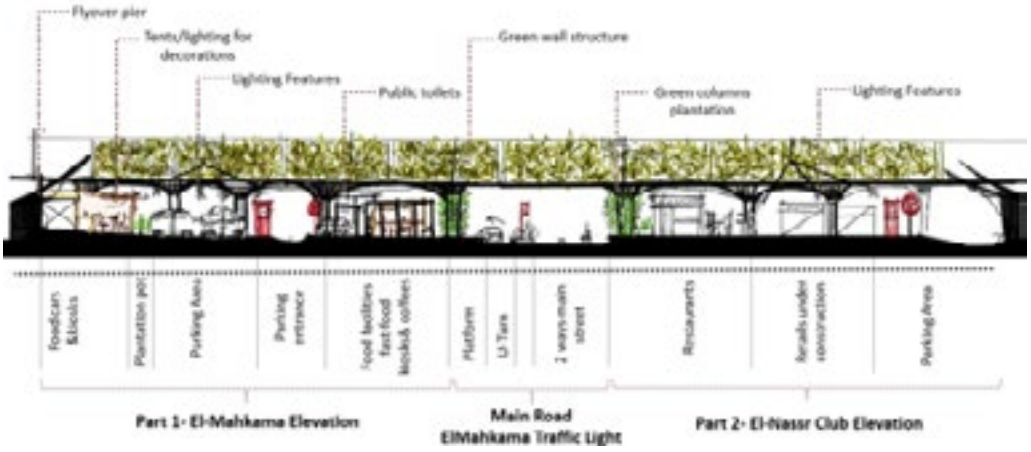

Figure 10. Elevation & sketch from observation of a field visit; shows the current situation of used parts of spaces under a flyover—source: the authors.

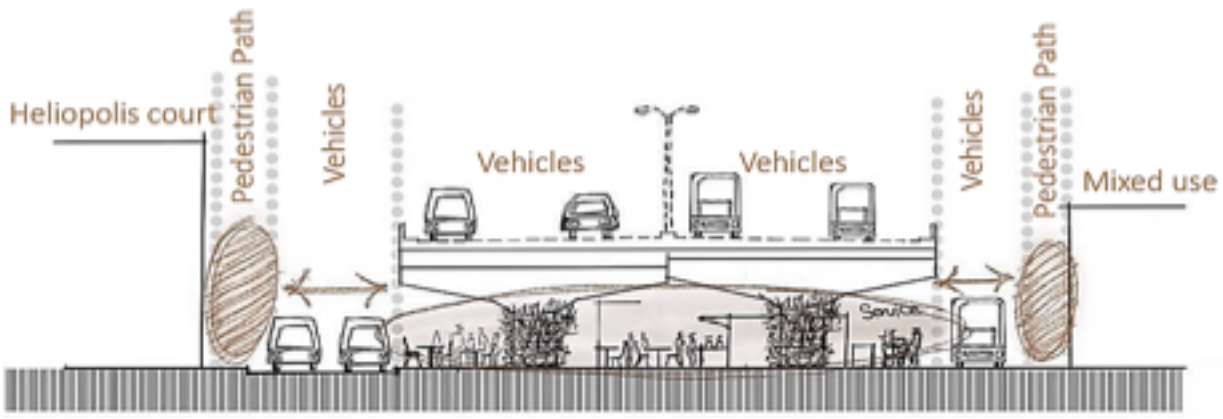

Figure 11. The longitudinal section of the relation between an urban landscape of the surrounding and geography of the spaces under the flyover. Source: Illustrated by the authors of the present work.

Figure 12. The uses and Activities mapping of the current condition of spaces under Abu Bakr El Sidiq (ElMahkama) Flyover (visual survey (observation). Source: The authors of the present work.

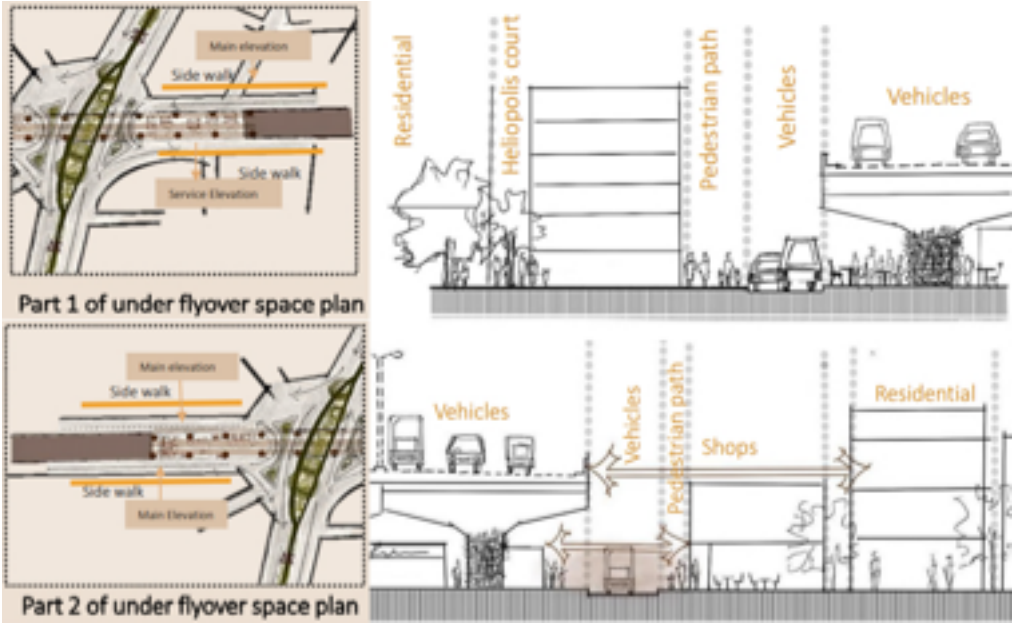

Figure 13. Detailed plans and sections show the relation between spaces under a flyover and the surrounding context of parts 1 & 2 of a landscape under the flyover (Illustrated by the authors of the present work)

Figure 14. The functional and visual analysis of landscape elements on the spaces of the focus area (the authors of the present work)

Figure 15. The pedestrian flow to space under a flyover at different timing of the day (based on Google Satellite Maps captured in 2021 by the authors of the present work)

4.2. Survey Results

This part of the research evaluates the experiences of the different users in places under flyovers and how the uses have a homogenised context. The purpose was to investigate the characteristics in the study area to understand how changes in physical traits influence users' perceptions. The questionnaire was launched to users and residents online in the methods applied with the focal points.

The first section of the site shows the demographic structure that collected the data about the space users. The results show that 82 respondents (35%) were males and 65% females who used these spaces. Six responses showed the ages of 35 to 55 years old, while the age range of responses from 18 years to 25 years old was 42 respondents. Thirty respondents' ages ranged from 26 years old to 34 years old. Understanding

the type of the survey participants and users who use these spaces and their characteristics helped interpret their needs. The results showed that 30 respondents from the space users, 22%, didn't use these spaces as they are residents in the area. However, a percentage of workers (6 %) who do jobs in the surrounding regions of surrounding offices use the parking areas in these spaces.

Furthermore, 35% of respondents show that they use that space for entertainment activities with friends and using the food facilities. In response to the actions provided in the area, 23% of residents pass through these spaces for daily activities. A small percentage of 6% of respondents selected using the surrounding activities and services around the places. These results explain why people are primarily drawn to open areas for eating and drinking.

The second, the survey analysed a thriving space that achieved its goals based on PPS's four primary core qualities of placemaking. This research illustrated the type of attribute to measure and how it was converted into indicators reflecting how much these attributes are achieved in the space to accommodate the users' needs in the current landscape environment and socioeconomic settings.

The access and linking indicators showed that private cars were the most common way to reach the space. In this regard, 62% of respondents use their cars as parking facilities in the area. Besides, the 2nd rank of 20% of respondents reaches the places on foot as it's easily accessible by walk. 15% use public transportation. This percentage is low as there are no stops near the space to make public transit accessible from the area. The safety and security rates were highly rated; the site was not safe while crossing even though it's easily accessible from all directions. In investigating the comfort and image, comfort in the spaces was at an average rate the aesthetic value of the areas under flyovers, but its needs to be cleaner. This research also shows that most respondents were not fully satisfied with bridge impacts on the city context (Figure 16).

The results of interviews and the survey users' satisfaction found that the rate of the young users who liked the experiences was much more than the order's experience evaluation. It depends on the type of users and the factor of design for pedestrians.

4.3. Interview Results

The results from interviews held responses to the given questions to both shop owners and workers on the one hand and mailing experts to schedule a consultation with them in the field of urban planning and design on the other. In the responses from shop owners and workers, an interviewee of a 36-year-old as a shop owner mentioned that:

"I used to spend an hour and a half in traffic every day due to heavy traffic, but now I take less than half an hour". He agrees with the concept of renting out kiosks and shops under flyovers to youth to provide them with work opportunities. However, he disagrees with using the places under flyover with similar marketing issues and affects their profits.

This previous response compared the status of activities under flyover with other activities on the shopping streets, focusing on the traditional cafes because of their loud atmosphere, and young people are used to sitting in noisy environments, despite traffic noise. The various ways to access these spaces aid in enticing users to participate in the activities. In a different way of thinking, an interviewee as a 32 years-old worker mentioned that

"It is a place I go to when I go through the city centres on my busy days. But it won't be my first option, mostly, if I go out. "

Figure 16. Results from the survey

In this respect, he thought that the space was not safe; a few accidents were still happening because of the high speed of traffic. Another respondent mentioned that:

(This isn't my first time here,) said another interviewee, (but space needs to be better reorganized. The area should be visible for each café; they're all related, and conflicts frequently occur between them.)

There can even be some security on the site since young people sometimes battle one another. It also requires cleaning and regular maintenance immediately adjacent to the street, making it dusty and polluted with car exhaust. The place is also boisterous. In the interview with experts in the field, one of our interviewees mentioned that

"The community in Saft El Laban opened coffee shops under the road. They are, however, continuously in danger of demolition when they are seen as unsafe and casual. There's a cleaning issue; I've seen a truck washing the green walls many times. I think that keeping them unused makes them dark, mysterious places for stunning waste so that it makes effective use of energy, but rather than commercialising might have been an exciting public space."

One of the interviewees, Egyptian architect, and urban planner, has scrutinised what he called the destruction of Egypt's urban fabric. He argues that elevated highways cut the urban fabric without regard for pedestrians, and their travel within the community creates plenty of issues. Is it more relevant for most traffic solutions to deemphasise health solutions? People who participated in the interviews revealed various strong use. They were unconcerned with granting permission for small businesses so long as they were under the supervision of the city government. They claim that there is a shortage of variety in business operations in the space under the flyover. In the same vein, another expert in urban planning and design explained the implication of public spaces under flyovers by saying:

"If experts want to improve traffic, they must follow the hierarchy in traffic roads before reaching the city centre if you want to link the areas". He adds: "Using it as intersecting lines cuts the urban fabric without regard for the residents of the neighbourhoods or pedestrians, and their travel within the community creates plenty of issues." There are several alternatives and solutions, he says. Even if the creation of uses and activities under lost spaces appeared because of the elevated highways, they do not consider the pedestrian life in the area.

To sum up, this paper figured out the importance of considering the places under flyover roads. Much attention should be paid to the context these bridges are passing by. The profound results from Abu Bakr El-Siddiq Bridge were tested as a case and confirmed our findings. In line with the PPS, the findings here prove the essential need to create suitable public spaces similar to the research purposes. The results also confirmed that Egyptian planning policies had faced challenges in solving the traffic issues concerning the whole image of cities. Besides, the results figured out a considerable number of shortages have come across since the end of research, fieldwork, and surveys. Finally, the results also proved the importance of focusing on the designers' views, the users' sense of space and their needs, and the right to act as their vital places. Based on findings from observations, questionnaires, analysis, and interviews, all of which aim to develop successful public spaces. It is founded on four foundational principles of the PPS used in this research as design values. The context and surrounding neighbourhood influence the activities that occur underneath the flyover areas. Table 1 summarises the concluded factors used to determine the design value through the tram line and the area under overpasses. This table also provides recommendations based on the current condition of the space under flyovers at each spot to transform it into an adequate public space that reflects community interests.

Table 1. Design implications of public spaces under the flyover. Source: authors

Values Before activities under flyovers		Inferences		Recommendations
		After activities under the flyover	Recommendation for a current condition	
Functional Values	Land use	• Street for Pedestrians and Tramlines network	• Motorized for parking and retails activities	• Mixed-use development • Streetscape-landscape must be appealing and practical.
Social Values	On-street activities	Relaxation activities	Recreational activities	Interactive activities Street furniture Input.
	Inclusiveness -	• Highly visited by youth age, but other periods with significant assets. • Children in every time especially school hrs. • High Footfall 2:00 – 4:00 pm	• Highly visited by middle-aged, but other ages with significant assets. • More minor children in every time. • High footfall	• Introduction of age centric infrastructure. • Redistribute traffic signals neat under the flyover. • Vehicle speed reduction in the entire focus streets near the flyover. • Peak hours traffic management.
	Services for community	Not applicable	• Shops • Toilets • Ramps	• Infrastructure for differently abled. • Variety in Vending types.
	Public security	Unsafe	The security comes from: • Shop Front • Street curb • Lighting • Sidewalk	• Barrier-free streetscape • Integrate curbs with gutters to control water runoff. • Shopfront zone. • Clear Sidewalks.
Economic Values	Dedicated spaces	Little Encroached Footways and street spaces.	Dedicated spaces are there but not managed well.	• Providing fixed stands for street • Providing public seating spaces.
	Storage	There were no shop kiosks, just vendors	A balance between total shops private storage and shared storage.	• Providing a designed service zone from the street.
	Water waste	N.A.	Private water but no Sanitation nor water disposal.	• Water & Sanitation facilities.
	Seating time frame	N.A.	During business hours, the shop permanently as active.	• Seating facilities for the public at any time.

Environmental Values	Trees and planting	Greenery and plantations bet tam lines and walkway Trees along the walkway	Removing trees and adding little artificial pots and tree surroundings at the entrance Planting bridge structure	• Planting shrubs and grass along with the unused spaces. • Along the sides barrier.
	Curbside green strip	No grass strips	No grass strips	•Providing to add a grass strip at the edges as a hedge for safety & privacy
	Rain gardens	Stripped rain gardens along with the green areas	No rain gardens	•Stripped rain gardens
	Management and maintenances	Lack of Maintenance	Maintenance of the green walls on the structure	• Provide maintaining the clean
	Permeable paving	Semi-Permeable paving	Semi-Permeable paving	• Use absorbent material & maintenance
Physical Values	Ramps	No ramps for disables	No ramps for disables	• Add ramps/ facilities for disables.
	Human scale	connections to their physical surroundings built environment.	Relation with the structure and street furniture.	• Consider human scale in the design process.
	shades	Natural shade pedestrianrians' walkway	structure shading along with the spaces under the flyover.	• N.A.
	Garbage bins	Little bins Along the sidewalk on trees	Through the street with irregular interval	• Frequenting Garbage's bins
	Crossing roads	Very little, only at nodes	Faded and unclear marking	• Support signals and stop controls. • Refuge island in some spots for clear crossing
Traffic Value	Travel mode	Lack of traffic control affecting the walkability	high pedestrian footfall but without infrastructure. shot trip distance and connectivity	• Controlling system for pedestrian flow and vehicles to prevent accidents - bus stops
	Parking	Carriageway markings are causing a street blockage.	Parking areas under the flyover	• Designing its approach with street
	Cycle lanes	No dedicated cycle lane to cater cycle flow on neighbourhoods	No cycle flow and lanes	•Dedicated spaces and ramps for bicycle parking

5. CONCLUSION

This research showed the impacts of bridges in the urban context of Cairo and argued for a way to turn the places under bridges into better positions. Since the lost areas below the highways are grounded global dilemma, this research has focused on the Heliopolis districts in Cairo, Egypt, as a case study. The surrounding context is segregated by constructing bridges passing through the urban fabric of Cairo. The impact of having the flyovers was recognised the segregation between city districts and neighbourhoods. However, our results from residents' and visitors' perspectives showed applicable opportunities in turning places under leftover streets into public places. The argument in the literature confirms that these places are lost spaces leftover lands of high economic value. Building upon the qualitative data, the selected cases assessed the implications of constructing bridges and the impact on the local context of Heliopolis. The results highlight the flyover's implications for everyday life, routes, and forms of transit.

Building on the research results, this research suggests creating a thriving public space in public space under flyovers is essential to turn these places from their unused areas into future potential usage. Integrated people's needs with streetscape/landscape components should be considered when creating a public space under a flyover.

Here we review some of the contributions which are related to this topic. The difficulty of investigating the effects of newly constructed flyovers has contributed to the lack of studies in this domain. This research has made substantial contributions to urban planning and design research. The lessons learned from investigating residents' and visitors' satisfaction showed the importance of turning the challenges of having flyovers passing through the city districts into opportunities. Besides, the critical contribution of this work is the solution it provides for reusing the lost spaces under flyovers.

One of the research limitations is collecting data about people's perceptions of constructing flyovers in different places in Egypt. This research highlights a future research direction of investigating the other cases in Egypt and comparing users' responses to the usage of the areas under flyovers. In future research, it is suggested based on the essential need to investigate digitally how to integrate the vision of the development scheme with surrounding neighbourhood preferences and interact with the context to add aesthetic value to the city's image.

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Architectural Heritage in Medium and Small Syrian Cities: Management Advanced Strategies for Postwar Recovery

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Abstract: During Syria's war, the architectural heritage suffered significant damage in many cities, ranging from minor damage to complete destruction. Moreover, the poor or absence of advanced heritage management that supports the recovery of these cities, especially in medium and small cities where attention has been focused on large cities, exacerbated the problem. The paper suggests directing attention to medium and small cities with traditional fabric. The city of Ariha, which has a population of 80,000, was chosen to study its current status, defining its architectural heritage and applying advanced architectural heritage management strategies that depend on advanced techniques and information technology. Reviewing International cases and extracting the best methodologies compatible with the Syrian context, such as reuse, GIS, laser scanning, and 3D modeling, which will contribute to preserving this heritage and help to make decisions to support the recovery of these cities during and post-war era.

Keywords: *Heritage, Management, Syria, Medium City, Ariha*

Orta ve Küçük Suriye Şehirlerindeki Mimari Miras: Savaş Sonrası Toparlanması için Gelişmiş Yönetim Stratejileri

Özet: Suriye savaşın sırasında, mimari tarihi eserleri birçok şehirde küçük hasarlardan tamamen yıkıma kadar geniş bir şekildede hasar gördü. Ayrıca, tarih eserlerin büyük şehirlerde odaklanması, küçük ve orta büyüklük şehirlerde ihmal edilmesi neden oldu ve bu sorunu büymesine neden oldu. Bildiri, geleneksel dokuya sahip olan orta ve küçük şehirlere dikkat çekilmesini önermektedir.80.000 nüfuslu Arihaa şehri, mevcut durumunu incelemek, mimari mirasını ve tarihi eserleri belirlemek ve ileri teknolojiler ve bilgi teknolojisine dayalı mimari mirası yönetmek için ileri stratejiler uygulamak için seçildi.Uluslararası geçmişteki vakaları göz önünde bulundurarak ve Suriye kültür ila uyumlu bir şeikilde çıkarmak üzere yapılacaktır. Yeniden kullanım şekilleri , lazer tarama, 3D modelleme gibi çalışmları yaparak mimari mirası ve tarihi eserleri kurunacaktır,Bu çalışmalar, mimari mirası ve tarihi eserleri korunmasına katkıda bulunur ve savaş sırasında ve sonrasında bu şehirlerin toparlanmasını desteklemek için kararların alınmasına yardımcı olur.

Anahtar kelimeler: Miras, Yönetim, Suriye, Orta Şehir, Eriha.

1. INTRODUCTION

Architectural heritage is the cultural properties and physical assets of cities, which explains the history and culture of the city as well as the aesthetic, architectural, symbolic, and urban identity aspects. Architectural heritage is a critical component that indicates the civilization experienced by the community and the events that have occurred in cities. We must preserve them and consider them in any intervention in the field of urban design and planning [1]. Neglecting the architectural heritage is a significant reason for its destruction [2]. The difficulty of accessing this heritage increases its deterioration. On the contrary, the ease of access supports the recovery of origin and the development of societies [3]. HBIM of the architectural heritage plays a vital role in preserving this heritage. It also reduces the risks of physical interventions in the future [4], and the responsibility for facilitating access to this heritage lies with the administrations and governments [3]. Information and communication technology play an essential role in accessing and developing cultural heritage [3], which constitutes a cornerstone of strategies for preserving architectural heritage. With this experience, awareness has emerged in Europe to reuse architectural heritage while preserving originality [2].

On the other hand, reusing architectural heritage causes a loss of originality in some cases [2]. Placing cultural heritage preservation on the priority list of politics and people is a new phenomenon [3]. Each traditional building was built to perform a specific function. Still, with the development of life, the change of use was an inevitable result of the operation of the building, which led to transformations and changes that occurred in this architectural heritage [2], and this is what makes digital 3D modeling a complex and challenging process [4]. To solve this problem, we must rely on tools to reconstruct in reality this heritage. It has an outstanding contribution to improving our understanding of this heritage and reduces errors to a large degree in the process of rehabilitation [4]. The reuse of the architectural heritage enhances the continuity of this heritage and its ability to live for more extended periods [2]; it has a significant impact on improving the economy of societies [2]. As a result, Architectural heritage management develops and becomes more efficient when it relies on advanced management tools and information technology development [5].

1.1. The Context

Uprisings in Arab Spring ousted or destabilized administrations while simultaneously exposing institutional fragility and cultural heritage vulnerability. In many cases, institutional structures and knowledge of cultural heritage protection were deficient, and regional turmoil weakened these institutions and procedures [6]. More than 30 armed conflicts have occurred in the Middle East alone since 2004 [7]. The war that took place in Syria in 2011 affected the country and its people at all levels. The cities had the largest share of destruction, and the architectural and urban heritage constituted an essential part of its fabric [7]. In most conflicts, Architectural heritage, representing specific religious, historical, or ideological traditions, is targeted indiscriminately as the reality right now in Syria [6]. Cultural heritage is considered representative of the identity of any society with its values and history. Therefore, its preservation is a critical issue linked to respect for the originality and nobility of the past [7]. Preserving urban and architectural heritage requires keeping society's values at all levels. Great awareness has emerged for all countries of the world in maintaining their values, of which the architectural and urban heritage represents the most significant part [7]. Literature reviews in Syria regarding the attention to architectural heritage and its management during the conflict seemed shallow and few. These were directed toward large cities. Also relied on traditional strategies in most of them. As a result, the deterioration of the architectural heritage increased. Its exposure to loss day after day, especially in North-Western Syria, the study's subject (revolution regions), where the bombing of cities and towns continued. The architectural heritage constitutes an integral part of its urban fabric, such as the city of Ariha, Sarmin, and others. Ariha was chosen as a case study. It is a medium-sized city which people were according to 2010 statistics, amounted about 80,000 people. It contains a traditional

canter and an urban fabric still inhabited by a large part of the population. It contains many architectural edifices such as mosques, baths, markets, and traditional courtyard houses. It is about five kilometers away from the conflict borders. The conflict and the bombing destroyed a part of this architectural heritage, in addition to the displacement of a part of its inhabitants. Thus, this heritage was neglected. Furthermore, the municipality's and concerned authorities' weaknesses and a lack of expertise and capabilities to manage this heritage add to the city's (municipality's) burden and, as a result, the difficulty of its recovery.

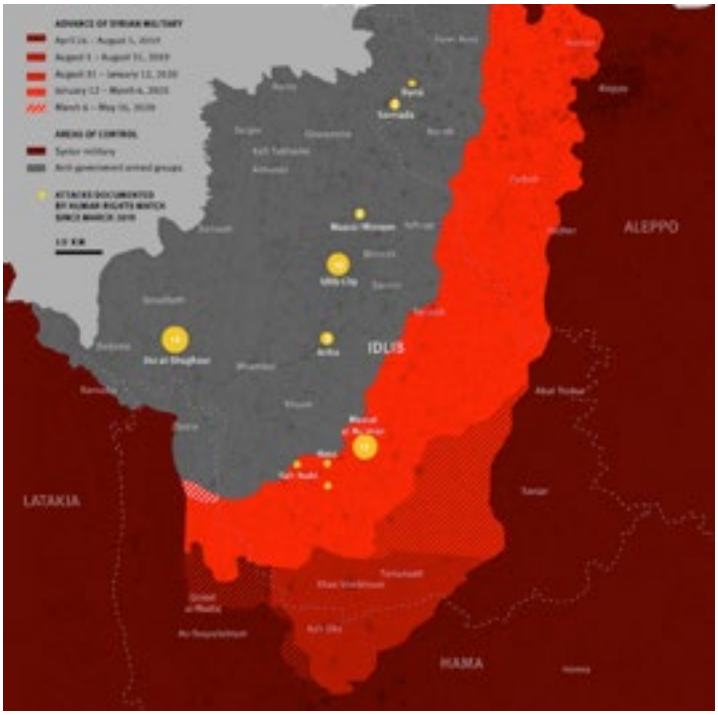

Figure 1. Areas of control in and around Idlib governorate.Human Rights Watch, Oct. 15, 2020

1.2. The Research Objectives

The research's primary goal is to draw attention to architectural heritage and its management in Syria's medium and small cities, which represent assets lost daily Because of the erratic nature of the situation and conditions in Syria, and the role these assets play. Advanced strategies based on modern and digital technology have been employed. This can provide multiple techniques for maintaining and managing these assets and finding alternative solutions compatible with potential conflict scenarios.

2. MATERIALS AND METHODS

- The research methodology is based on the following points:

Starting with a literature review of the advanced management of architectural heritage using modern technological techniques and the contexts of heritage management projects using these techniques and their applications at two levels, the first level is in Syria, where the study gap is identified, and the second level is global level to find out the best-advanced strategies used in the management of architectural heritage to determine the method that corresponds with the Syrian context and to set the priorities accordingly.

- Studying the case of Ariha city in terms of:

Knowledge, recording and understanding the site, mapping the architectural heritage (collecting data by field survey and observation, interviews, and Municipal records)[5]. Analysis of the current status of the Architectural heritage in the case study and assessing the damages of the architectural heritage caused by several factors: conflict, neglect, laws and legislation, and the interventions.

Value appraisal: Evaluate the historical, cultural, aesthetic, social, and other values of this heritage to see if we need a management plan (MP) or not (based on the evaluation criteria for social, historical, esthetical, and symbolic values)[5]. Evaluate the risks that architectural heritage may exposed to according to the risk analysis tool, developed by (Romão X, Paupério E, Pereira N "A framework for the simplified risk analysis of cultural heritage assets") Fig 2, to integrate into the suggested management strategy.

- Suggest methodologies that correspond to the case study.

Figure 2. Up. Proposed risk analysis methodology: Assessment of the level of vulnerability of the cultural heritage unit. Down, Proposed risk analysis methodology: Assessment of the level of risk of the cultural heritage unit.

3. LITERATURE REVIEW

3.1. In Syria

Researchers, Kousa and Pottgiesser, published their article *"Post Syrian-war material recovery, reuse, and transformation in the Old City of Aleppo"* on the historical center of Aleppo and the current state in terms of assessing the devastation during eight years of war, proposing in the paper some strategies for the recovery of the historical center by reusing and recycling the demolition and integrating it into the reconstruction plan for buildings of high cultural value such as the Great Mosque [8].

Researcher A. Belal published his article entitled *"Heritage in the challenges and solutions of the post-war period"*. He discussed the protection of cultural heritage and property using the geographic information system and historical mapping. Which will give a picture of the current status of this heritage and the possi-

bility of using it in the reconstruction process. The study was applied to the historical center of Homs city, and the methodology of the study consisted of several stages:

- Identification of cultural and historical sites
- Inventory of cultural and historical property
- Determining the degree of damage to cultural and historical sites
- Prepare a planning list and historical and cultural destruction database [9]

Also, in 2021, he published his article *"Post-war Planning for Urban Cultural Heritage Recovery"*, which Discussed the basic principles for the reconstruction phase, in which the city's historic properties and cultural identity are preserved. And developing countries, including Syria, suffer from poor experience in restoring architectural and urban heritage in historical cities and towns, especially after conflicts and wars. Therefore, they followed a particular methodology to recover this heritage. The process is represented in four axes: *"1- Documentation 2- Assessment of damage 3- Planning 4- Regulations of the legal framework"*. The author of his study suggested using an intervention algorithm to determine how to revive and reconstruct cultural heritage based on four factors: *" Degree of historical and architectural significance; Degree of damage/Physical condition; Functional use; Property rights and regulations* [7]". After reviewing the literature published on Syrian cities during the conflict period, which is related to architectural heritage management, most studies were directed toward large cities such as Aleppo, Homs, and Damascus. Only some of them relied on advanced tools such as geographic information systems to conduct a heritage survey, but there is a lack of other advanced tools such as reliance on satellites, laser scanning, 3D modeling, and virtual reality, and here the research gap appears.

3.2. Around the World

In their article *"Scan to BIM for 3D reconstruction of the papal basilica of Saint Francis in Assisi in Italy"*, the authors discussed the methodology and results of protecting architectural heritage. "The Papal Basilica and the Sacred Convent of Saint Francis in Assisi in Italy are "Using laser scanning technology to build more robust and practical tools for managing this heritage, such as BIM. Moreover, this site is characterized by complex features that make the issue of the safety and security of visitors a point of interest. Therefore, Internet of Everything (IoE) technology was developed to create an integrated system for security management and site safety. The interventions required to restore the architectural heritage require specific techniques and precautions. The restoration process includes a few steps:

- The starting point of assistance in all its details
- A comprehensive study of the developments that this heritage has undergone over time
- Develop and manage a strategy for interventions

For the project's successful management of the architectural heritage interventions, building information modeling must be used. Because it can prepare digital objects that achieve the possibility of linking with higher standards, operating rules, and connectivity between the different components and the structure. During the initial phase of assistance, surveying and management based on the BIM methodology led to producing a single database of this architectural heritage, thus facilitating the management and monitoring of interventions, and constantly updating the information [10].

We believe that using the building information modeling approach and Internet of things (IoT) technology is very important. It enables the production of digital objects and improves the safety status of an architec-

tural heritage site, especially in war and conflict environments where the risk is very high, as in the case study. In their article *"Advanced Geomatics and Conservation Management Plan for Preserving 20th Century Architectural Heritage"*, the author discussed the relationship between advanced management techniques and the conservation management plan, as well as the role and contribution of these technologies in preserving architectural heritage over the past decade (e.g., Laser Scanner, High Dynamic Range, GIS, intelligence vs. abundance, BIM, VT/IM, etc.). And the pros and cons of each approach with the objectives of the conservation plan are:

- Knowledge
- Value assessment
- Data sharing and dissemination of results
- Support for conservation and restoration activities
- Support for the planned conservation of buildings/facility management over time

One of the most important results of the study is that the implementation of the conservation plan using advanced techniques should be on two levels, the first: at the site level in general and the second: at the level of the architectural object [5]. It shows us the role of each of the advanced management tools. Thus, it determines the most appropriate means in the case study. On the other hand, it is critical to work at both the site and architectural object levels for an integrated approach to heritage management. In their article *"The virtual reconstruction of architectural heritage and its methodological application*" the authors say the virtual reconstruction of the architectural heritage alleviates the problems that occur in the actual reconstruction and restoration and gives a clearer picture of how to intervene appropriately. The changes that happen over time in architectural heritage make the study of virtual reconstruction so complex. It needs to depend on tools (elements of architectural graphic language as a starting point for the investigation of the patrimonial architecture: The essential elements we use in the architectural language are geometry, light, color, texture, space, function, and context) to reconstruct the architectural heritage virtually; also, it increases our understanding to this building and mitigates from mistakes in future reality rehabilitation.

The methodology of this article followed those stages:

- Starting from contrasting historical data that refer to the studied architecture's formal aspects. According to a chronological, structural, and typological order.
- Creating a digital database of graphic documents based on historical-graphic data and archaeological documents.
- In the case of missing buildings, consider the investigations and archaeological data as formal references.
- Research hypotheses will be formulated according to the consulted filed documentation, the digital database, and the analysis of archaeological remains if they exist.
- The digital models will be generated according to a degree of geometric abstraction that allows the proper understanding of the studied group of buildings.
- The digital modeling will allow rethink, flexibly, morphological aspects which were deducted from the initial hypothesis. So, conclusions that lead to further investigations could be established.
- Recovering history, in an updated graphic way, virtual images of non-existent assets.
- Allowing disclosure in scientific areas [4].

The use of virtual digital documentation is significant to ensure the preservation of the remaining fabric of the city and the possibility of its restoration in cases of destruction or various damages in war and conflict environments as a primary point. Secondly, rehabilitating the destroyed section in whole or in part is a step to restore it realistically. In their article *"Experiencing the Inaccessible A Framework for Virtual Interpretation and Visualization of Remote, Risky or Restricted Access Heritage Places"* The authors discussed the importance of databases and expertise in strategies for preserving architectural heritage significant role in strengthening the economies of countries. The importance of access to this heritage is of considerable importance in the development of societies and the heritage itself. This matter is not available in all cases of architectural heritage, as in the case of the Catacombs of San Vitorino, where the environmental situation is complex. This article confirms the critical role of information technology and communications with advanced management techniques in securing access to this heritage and its development, as the laser scanning technology was relied upon. Then the point cloud was processed by several programs [3] The use of laser scanning technology may be helpful in the long term to discover the caves located under the ancient city, which may be a city that was buried in previous eras, according to the testimonies of some residents and specialists.

4. THE CASE STUDY

4.1. Ariha City

The city of Ariha located in northwestern Syria in a strategic place that connects the interior to the coast and the presence of Jabal Al-Arbaeen, which completely overlooks the Idlib governorate and on the main roads M4 and M5, which also gave it tourist importance. It is 73 km away from Aleppo, 13 km from Idlib, 114 km from Lattakia, 25 km from Maarat al-Numan, and 329 km from Damascus. Its population in 1986 was about 28 thousand people, and in 2004 its population reached about 40 thousand people, according to the Central Bureau of Statistics. It covers an area of 1.5 km2, while the remaining historic fabric of the old city covers an area of 0.3 km2 and is located on the city's southeast side. Moreover, it contains Al-Arbaeen mountain, which adds tourism value to the city.According to some archaeological findings, the city of Ariha is an old city, as its history dates to the first millennium BC [11]. There is an archaeological mound that has not been officially excavated yet. One of the most important archaeological findings is a silver tray inscribed with the Last Supper of Christ; peace be upon him. There are also archaeological findings, including a group of pottery and glass dating back to the pre-Roman era.

The old city contains a mixture of buildings dating back to different eras, some dating before the Islamic conquest in 637 AD. Others were renovated during the Ottoman era. A large part of its historical fabric was utterly removed due to the organizational scheme in 1980, including khans, specialized roofed markets, Caesareas, and others.

Figure 3. Ariha map and the old city.

4.2. The Architectural Heritage

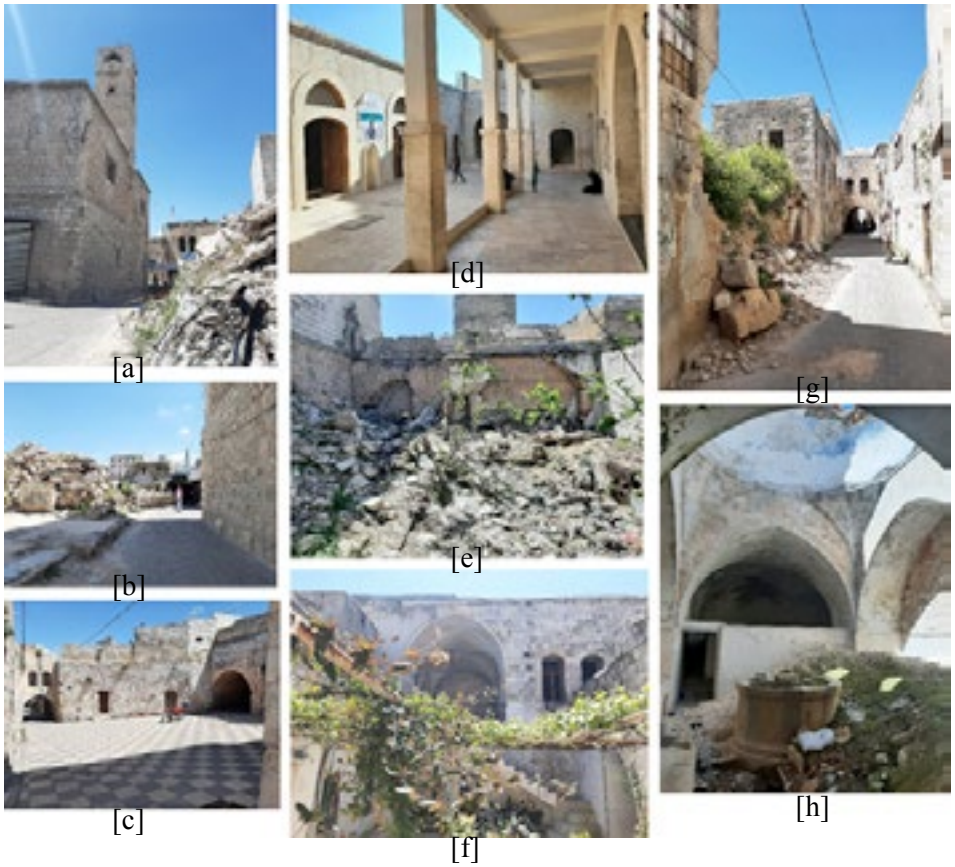

Figure 4. Architectural Heritage in Ariha city (current state)

Mosques

Grand Mosque's construction dates to before the Roman period when it was used as a temple, then a church, and then a mosque after the Islamic conquest. Some distorted inscriptions still lie on its walls, indicating that it was a building that preceded the Islamic conquests. But the mosque in its current form dated back to the Ayyubid period and was renovated in the Mamluk and then Ottoman eras, and it was newly restored in 2008. Adding a block covering half the courtyard area from the northern side of the mosque affected the historical value; furthermore, light damage to the northern facade due to the indirect bombing (Figure 4,5.a, d.1).

Al-Shebani Mosque its construction dates to the Mamluk period. Some of the interventions that affected the historical value of the building, such as the plaster works (Figure 5.2). Al-Takia Mosque its construction dates to the Ottoman period. It was obliterated, and the municipal replaced it with a new Mosque (Figure 5.3).

Ancient baths

There are now two historical baths in the city containing the elements of the Islamic bath. The first is called (The Small Bath), and it is still functional (Figure 5.4), and the second is called (The Wastani Bath) and it is severely damaged due to neglect (Figure 4,5.h.5). The largest hammam (bath) in the city, called (the Great Hammam or Al-Fawqani Hammam), was removed entirely due to the new organizational scheme in 1980 (Figure 5.6).

Zawiya (Small Mosque)

They are small mosques distributed within the alleys. They consist of a prayer hall, a small courtyard, an Iwan, and a group of rooms intended for residence for worshipers and Sufis, often with a water fountain, a well, trees, and plants in the middle. Including Al-Bayania, the widest, Sheikh Dweik and Sheikh Muhammad, and others. Some of them are still functioning, and others are neglected (Figure 5.7,8,9).

Sibat

It is the structure that covers areas above the streets of the old city in several structural ways, including the bed vault or the two intersecting vaults, and on top of it are rooms prepared for housing that open with windows on both sides (Figure 4.c,g). And now, there are remaining 11 Sibats spread in the streets and alleys of the old city.

Squares

There are three historic squares in the city. The first is called (Al-Armoutia) which still exists now, bordered by Sibats. And the city's residents still use it to hold popular events and meetings (Figure 4,5.c.10). The second one is called (the tanning square), a large square surrounded by a group of shops specializing in tanning leather. After implementing the organizational plan and opening a road at the edge of the square, most shops opened a gate on the road, which led to its neglect and the destruction of a large part of its landmarks (Figure 5.11). The third is called (Old Market Square), which was breached by the organizational chart, and a corner remained of which the old shops still surround it now (Figure 5.12).

Khans (Caravanserais)

A Khan consists of a vast yard surrounded by shops, topped by accommodation rooms, used for merchandise and trade. Three of them were removed entirely according to the organizational plan in 1980. Khan Al-Suq is the largest, with an area of 1,800 square meters, followed by Khan al-Qaysaria with 800 square meters, and then Khan al-Bazaar (Figure 5.13,14,15).

The old market

It consists of specialized roofed markets with a length of about 100 m that were entirely removed by the organizational plan in 1980 AD. In the east of the old city, near the Great Mosque, an unroofed market consisting of a group of trading shops distributed on both sides of the alleys. It was severely damaged due to the bombing, some of which continue to work (Figure 4,5.a,b.16,17).

Caesarea (industrial facility)

It is a specialized facility in the industry. It consists of a square surrounded by industrial stores, such as the manufacture of soap, leather, flour, grape molasses, and others. There are several Caesareas in the old city, some of which are under work and have light damage, and others are neglected. Several them were removed during the urban expansion in 1980. The most critical Caesareas are the first is Bit Abd Al-Kareem's Caesarea which was heavily damaged by the bombing. The second is Al-Harsone's Caesaria which is affected slightly by local community interventions (Figure 5.20,21).

Traditional residential homes

It forms most of the city's fabric. In general, the traditional house consists of an inner courtyard surrounded by residential rooms on two floors, a place for making bread, a cellar, and a groundwater tank. It was previously fed from the springs located in Jabal Al-Arbaeen by Roman channels. The bombing destroyed a large part of the residential fabric (Figure 4.e). Some houses have a large area and a spacious courtyard containing a water fountain, various plants, and an Iwan (Figure 4,5.f.19).

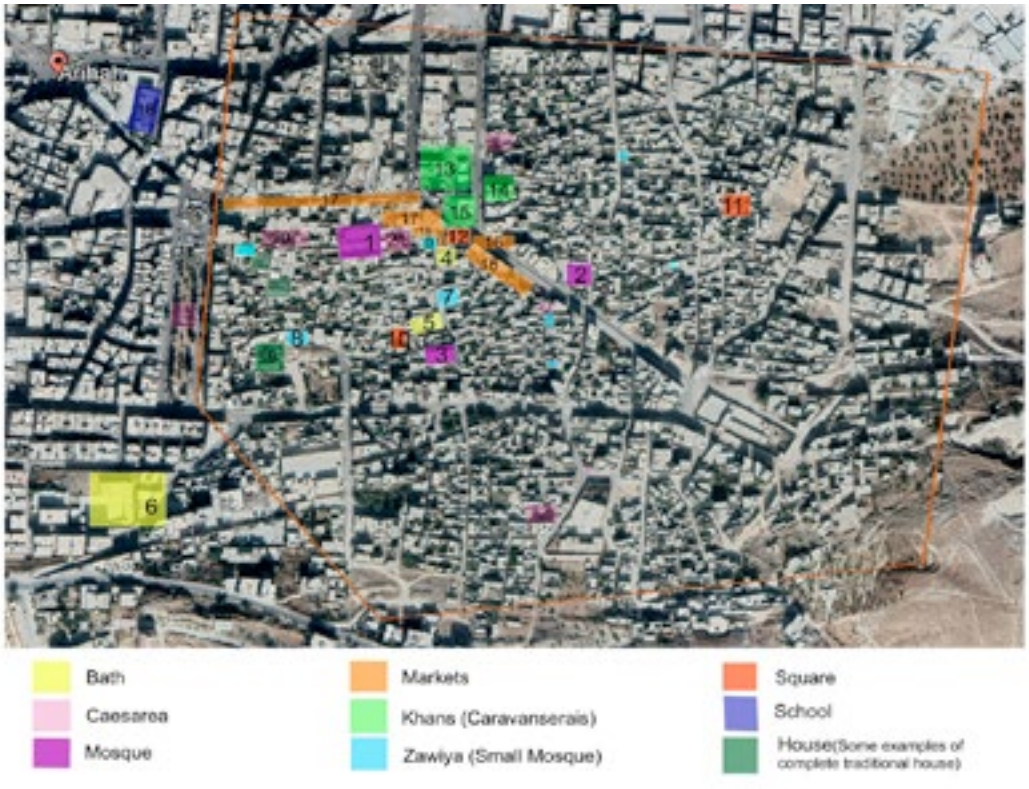

Figure 5. Distribution of architectural Heritage in Ariha city (the numbers correspond with table 1)

4.3. Assessment of Damage and Value

Assessment of architectural Heritage (the assets) in three categories (working - not working - removed). Damage is assessed according to 4 levels (slight – Medium-Heavy - Completely) as following:

- Light damage corresponds to the case where the cultural heritage unit only exhibits nonstructural damage (i.e., damage that will not affect the resisting system and the overall stability of the cultural heritage unit) [12].
- Medium damage corresponds to the case where the cultural heritage unit exhibits more severe nonstructural damage and suffers moderate structural damage (i.e., damage that will affect the resisting system of the cultural heritage unit without compromising its overall stability)[12].
- Heavy damage denotes severe structural damage to the cultural heritage unit that can make it unstable (i.e., the overall stability of the cultural heritage unit is jeopardized) or causes a partial or total collapse of the cultural heritage unit [12].
- Completely corresponds with the nonexistent of the building or destroyed 100% due to bombing or removal.

The cause of this damage according to 4 factors (negligence - conflict - law - intervention)

The value represents the local community's point of view about the architectural heritage assets.

Table 1. Assessment of Architectural heritage units (the current situation, Damage level, the reason, and value)

Assessment of Architectural Heritage Damage and Value														
N	Architectural Heritage	Name	The current situation		Damage				The factor				The value
			W	N-W	S		H	C	con	neg	leg	Inter	
1	Mosques	Great (Al-Kabeer)	•		•				•			•	historical, architectural, and religious
2		AL-Shebani	•		•							•	historical and religious
3		AL-Takia			•						•		memorial and religious
4	Ancient baths	The Small	•		•					•			social and historical
5		The Wastani		•		•				•		•	social and historical
6		Al-Fawqani						•			•		memorial value
7	Zawiyas	Al-Bayania	•		•					•			historical and religious
8		Sheikh Dweik	•		•					•			historical and religious
9		Sheikh Muhammad	•		•					•			historical and religious
10	squares	Al-Armoutia	•		•					•			social and historical
11		The tanning court-yard		•			•			•			industrial and historical
12		Old Market Square	•			•					•		social and historical
13	Khans	Khan al-Souq						•			•		memorial value
14		Khan al-Qaysaria						•			•		memorial value
15		Khan al-Bazaar						•			•		memorial value

16	The old market	roofed specialized markets							•			•	memorial value
17		unroofed market	•					•		•			socio economic and historical
18	School								•			•	socio cultural and historical
19	House	Kadah	•				•			•			Social, architectural And historical
20	Caesarea	Bit Abd Al-Kareem		•				•		•			economic and historical
21		Al-Harsone	•			•						•	economic and historical

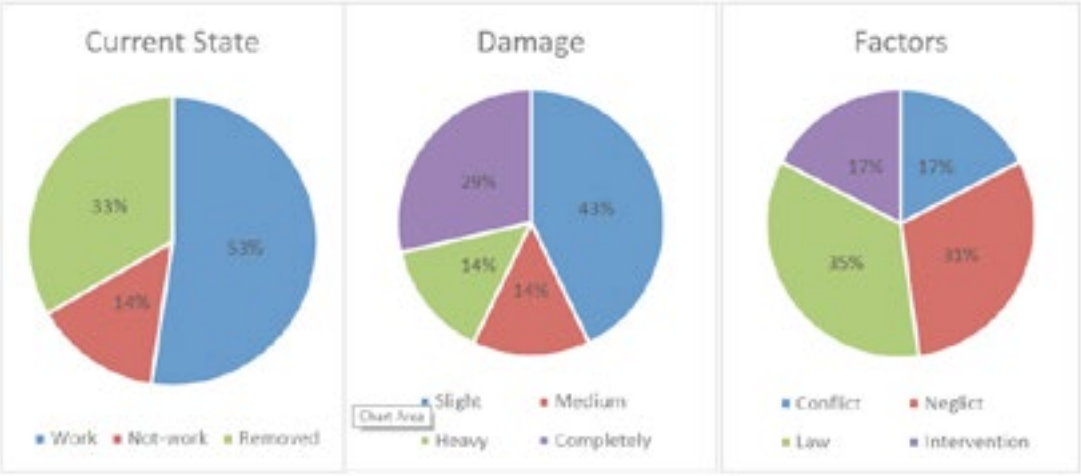

Figure 6. Current state, Damage, Factors (Analysis)

These percentages show:

- The current status of the architectural heritage in the city of Ariha.
- The percentage of damages for each level.
- The percentage of the impact of each factor on the state of the architectural heritage.

It constitutes a primary information base for building any decisions regarding the process of managing this heritage during the conflict period or after its end, on which the architectural heritage management strategy was built for the case study. The value analysis shows the importance of this architectural heritage to the local community and its role in defining the identity and culture of the community.

4.4. Framework for Conflict Risk Analysis on Architectural Heritage Units

We applied the risk analysis framework to architectural heritage units to determine the level of vulnerability first and then the level of risk second. Because of the city's proximity to the conflict border, the risk of bombing and attacks by warplanes is very high. Result of the field survey and evaluation of the city's directly bombarded areas (which included a large percentage of housing units), The damage was great. It cannot be restored due to the impact of the military weapon on the building materials and the original structure. Therefore, the level of vulnerability is the fifth. Since the level of vulnerability is the fifth. Regardless of the probability of the occurrence of the danger, the level of danger is the fifth Rv. As a result, the Rv level corresponds to a situation in which the level of risk is unacceptable and must be addressed as soon as possible. A more detailed analysis of the cultural heritage unit is urgently needed to identify risk mitigation measures.

4.5. The Strategy

The proposed strategy to deal with the heritage of Ariha city is divided into two parts:

Short term: Documentation of Architectural heritage by Digital Advanced tools and establishing a cloud database for the old city to preserve the records from the loss in the state of emergency conflict scenario. This documentation will be on two levels:

- city level, take action to mitigate risks (using GIS tool for collecting all information about the historic city, which does not need to show 3D modeling, design an interactive map, create a building card for architectural heritage).

- building level (create a 3D modeling for the significant historical building based on available tools like Laser scanning to be used in conservation work in the future if the conflict risks happen) .

Long term: Implementation of a protection plan for the architectural heritage that includes:

- Reconstructing the lost architectural heritage in virtual reality and consider the investigations and archaeological data as a formal reference. [4].

- Work on building the capacity of a dedicated team in the use of advanced technologies through training courses by specialists.

- Raising awareness of the importance of architectural heritage as a component of these cities to the community and local administrations through seminars and workshops to integrate stakeholders into the protection plan.

- Reconstruction of the damaged architectural heritage by default to be the basis for the real reconstruction after the end of the conflict.

5. RESULTS

Small and medium cities such as Ariha constitute a large geographical area. Therefore, the proposed plan can play a crucial role in finding solutions to preserve this architectural heritage, not only at the level of Syria and the countries of the Middle East but at the level of conflict areas in general.

At the level of the case study, a comprehensive field survey of the architectural heritage and traditional fabric of the old city in Ariha was carried out, during which all components of the city were documented, such as mosques, baths, Caesareas, traditional houses, squares, the old market, and others. Documenting the architectural heritage, which was completely removed in the past by-laws, a map was created showing the location of the architectural heritage within the city, also a table for this heritage, which was analyzed and concluded with the following results:

- The percentage of architectural heritage within the work is 53%. and this is an essential indicator of the importance of this heritage to the local community.

- The percentage of heavy damage is 14%. Therefore, the need to use advanced management strategies for reconstruction by virtual reality facilitates making appropriate decisions for the community before implementing accurate reconstruction.

- The impact of the conflict on the architectural heritage is 17% in a way that cannot be restored. My reliance on the field survey that I conducted and my experience in this field indicates the importance of developing a short-term plan to preserve the remaining architectural heritage in the city.

• The impact of laws and legislation on the architectural heritage is 35% in a way that cannot be restored. Therefore, the need to develop a long-term plan to integrate the architectural heritage into development plans based on advanced management strategies.

6. DISCUSSION

Architectural heritage management strategies based on advanced digital tools are necessary to document and preserve this heritage because of conflicts, especially in small and medium cities. There was no documentation of this heritage previously. Despite all restrictions, such as weak material capabilities and the absence of expertise in this field, it is applicable in Syria, which may be a promising aspect for more work and plans.

This study adds to a growing body of research that attempts to increase the level of knowledge about advanced heritage management tools and opens the way for new studies at the level of a large geographical area that contribute to the protection of the heritage and civilizations that were previously neglected.

7. CONCLUSION

This paper discusses the importance of medium and small cities that contain a traditional fabric in Syria as an essential component of the architectural heritage. The literature review in Syria showed the interest in large cities and the lack of reliance on advanced digital management except in a few cases and a lack of knowledge in this field. This study shows that these cities contain the same components of architectural heritage as large cities, such as mosques, traditional markets, caravanserais, hammams, and others. It also proved that this heritage was exposed to several factors that led to its removal or damage, such as legislation, neglect, conflict, and the absence of Advanced management. The percentage of damage due to the conflict and the absence of management was the lowest. However, the level of destruction due to the conflict was the highest, foreshadowing the complete loss of these assets. It indicated the importance of documenting. This heritage will be preserved in digital form for future reconstruction and rehabilitation if any of the conflict's risks occur.

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Urban Vertical Farming as a Path to Healthy and Sustainable Urban Built Environment


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Abstract: The issue of global warming and food insecurity are among the most problematic challenges of the 21st century. Meeting the current and future demands for food production and the willingness to survive is one of the recent problems the world is facing today. The fundamental concern of this article is to explore the significant role of urban vertical farms (UVF) in how they can pave the way for a healthy and sustainable built environment. Within this 21st century, issues such as climate change, bio-and environmental degradation, and other related man-made activities that lead to the loss of agricultural lands and vertical farms can be regarded as a sustainable alternative to conventional agriculture. Consequently, urban farming provides impeccable opportunities for the sustainable development of places such as urban cities and provides a form of moral support economically, socially and ecologically, and also addresses the recent changes brought to the general built environment by the COVID-19 Pandemic. The primary objective of this paper is to explore and introduce possible and various functions which support the ecosystem and how they affect assessable benefits for urban masses at different scales of solutions within the scope of urban vertical farming. In conclusion, this research has demonstrated that UVF can enhance the general well-being of the urban masses as well as ensure a healthy and sustainable urban built environment at different scales and capacities.

Keywords: *Urban Farming; Vertical Farming; Sustainable Development; Urban Cities.*

Sağlıklı ve Sürdürülebilir Kentsel Yapılı Çevreye Giden Bir Yol Olarak Dikey Tarım

Özet: Küresel ısınma ve gıda güvensizliği konusu 21. yüzyılın en önemli sorunları arasında yer almaktadır. Gıda üretimi için mevcut ve gelecekteki talepleri karşılamak ve hayatta kalma isteği, dünyanın bugün karşı karşıya olduğu güncel sorunlardan biridir. Bu makalenin temel amacı/ilgisi, kentsel dikey çiftliklerin (UVF) sağlıklı ve sürdürülebilir bir yapılı çevrenin yolunu nasıl açabilecekleri konusundaki önemli rolünü araştırmaktır. 21. yüzyılda, iklim değişikliği, biyolojik ve çevresel bozulma ve tarım arazilerinin kaybına yol açan diğer insan yapımı faaliyetler gibi sorunlar sonrasında/sonucunda dikey çiftlikler; geleneksel tarıma sürdürülebilir bir alternatif olarak kabul edilebilir. Sonuç olarak; kentsel tarım, kentleşmiş şehirlerin sürdürülebilir kalkınması için şüphesiz ki fırsatlar sunar ve ekonomik, sosyal ve ekolojik olarak bir tür manevi destek sağlar ve ayrıca COVID-19 Pandemisi tarafından genel yapılı çevreye getirilen son değişiklikleri ele alır. Bu makalenin temel amacı, kentsel dikey tarım kapsamında ekosistemi destekleyen olası ve çeşitli işlevleri ve bunların kentsel kitleler için değerlendirilebilir faydaları nasıl etkilediğini farklı çözüm ölçeklerinde araştırmak ve açmaktır. Sonuç olarak, bu araştırma UVF'nin farklı ölçek ve kapasitelerde sağlıklı ve sürdürülebilir kentsel yapılı çevre sağlamanın yanı sıra kentsel kitlelerin genel refahını artırabileceğini göstermiştir.

Anahtar Kelimeler: *Kentsel Tarım, Dikey Tarım,Sürdürülebilir Kalkınma, Kentsel Şehirler*

1. INTRODUCTION

Urban farming has an increasing demand and can be characterized as a global phenomenon. Its primary function is to feed the rapidly growing population. In some regions of the world, it relates to environmental issues and lifestyle [1]. Urban farming can be defined as a process of growing and distributing food products through the means of plant cultivation and animal husbandry in urban cities (Urban Agriculture Committee of CFSC, 2003). It is mainly characterized by food production, small urban farms, vertical farming, beehives, rooftop gardening, guerrilla gardening, allotments and other similar initiatives [2]. A common practice of urban farming in many cities is to engage people to produce food in limited and marginalized ways possible, and it varies between countries and cities. Examples of such cities practising urban farming are Chicago and the United Kingdom because they have done innovative projects to promote the sustainable development of urban farming.

Urban farming provides more opportunities for sustainable development of places such as urban cities and provides a form of moral support economically, socially and ecologically. However, there is a tricky striking balance between these three pillars of urban farming, directly related to sustainable city development [3]. The three pillars have a literal connection that reflects the potential influence of urban farming in urban cities. Socially, cities that are connected to the rural environment preserve a high level of environmental qualities that are due to the wide range of sociable spaces that are newly generated. The spaces serve as a meeting point for social activities concerning the urban natural environment, which adds a relative value. However, there is a radical change in multiple urban forms that are pragmatic and multifunctional. The growth of a city mainly relies on expanding extensive suburban peripheries, promising expressways, industries and significant commercial locations. Therefore, as a result, there is an increase in the growing consumption of food resources to manage and obtain a balance between food production and food consumption. Therefore, urban farming plays a vital role in the inflow and outflow of natural resources in a sustainable environment. Economically, urban farming enhances the new dynamics of land use, urban spaces, and innovative activities promotions in cities with high environmental competencies and economic value [4]. Urban farming has a positive aspect regarding sustainable city developments, including marketing stimulation initiatives, employment and tax income, productive land use and self-supply of food by urban farmers. Moreover, from an environmental perspective, urban farming provides and allows microclimate improvement and soil conservation, reduces pollution and increases biodiversity in environmental awareness, reduces pollution and global warming, and increases bio diversified environmental awareness [5].

Meeting the current and future demands for food production and the determination to survive is one of the most recent difficulties the globe is facing today. However, food is an essential need for the survival of living things and solely requires nutrition to grow. Most sustainability problems are due to the uncontrolled expansion of contemporary urbanized cities and their natural environment. The lack of urban planning practically results in more formal and informal rapid population growth of settlements. The excessive accumulation and consumption of soil, energy and mineral resources play an integral role in the urban environment. Undeniably, urban farming has a significant impact on sustainable city development. Therefore, urban farming has an increasing demand and can be characterized as a global phenomenon, which in some regions of the world, it has a relative relation to environmental issues like food security, farmland shortages, and urban population growth.

Urban Agricultural practices are simple and have a relevant potential to solve environmental issues partially. However, as the urban population rapidly grows and fertile land diminishes globally, a functional change in the food production sector is vastly needed, and vertical farming can be a new cultivating technique to positively contribute to both the people and their sustainable urban environment.

1.1. Objectives and Novelty of the Research

Nearly three-quarters of Europeans and more than half of the global population resided in urban areas in 2015. The United Nations predicts that by 2050, more than 66 percent of the world's population would live in urban regions, and 82 percent in Europe [6]. As cities get more dense, they don't always have better urban greenery. In addition to the loss of biodiversity, new regions are being developed, pollution is increasing, forests are disappearing, erosion is escalating, and fragmentation of ecosystems is occurring. When it comes to the ecological role of vegetation, a lot relies on the scale, resilience, ecological connections, and resistance of plant habitats to environmental changes. Even though urban ecosystems serve a vital function, they are vulnerable to the ever-expanding city's devastation. There is a pressing need to investigate the feasibility of incorporating greenery into new spatial systems in metropolitan environments where buildings and spatial planning are constantly changing. The world's population is currently expanding rapidly, particularly in developing regions like Africa, Asia, and South America. The United Nations predicts that by 2100, there will be more than 21 billion people on the planet. According to UN predictions, by 2050, 66 percent of the world's population would live in urban regions, and 82 percent of Europe's population will live in urban areas [58]. Food demand increases as the population grows. Most of the world's arable land has been exploited, with just 20% left as wasteland, where agricultural potential has essentially evaporated over the last several decades as a result of substandard land management practices. As a result of rapid urbanization, population shifts to cities, and a lack of arable land, new approaches to bio-architecture and agro-urban design are becoming more necessary [7, 8].

In order to preserve the environment's sustainability while simultaneously improving its quality, the human population must build a new quality of space. Currently, in the era of COVID-19, the broadly understood safety of urban residents has acquired a new meaning and sense in a multidimensional system. The implementation of modern smart solutions based on information and communication technologies may result in the emergence of new practical solutions in the field of shaping new, safe green areas, fulfilling a production function, but also important for recreation and leisure for urban residents. For this reason, we should consider the possibility of creating entirely new types of urban design systems.

The fundamental objective of this research is to determine the theoretical pattern of design principles involving vertical farming in urban environments. The study hypothesis is to believe that green in vertical systems may be a strategically planned network of multi-functional and multi- size green spaces, created and maintained in a manner that strives to deliver a broad variety of environmental and social services. The authors of the research think that urban vertical farming may promote connection between existing urban green zones, fight fragmentation, and boost ecological coherence. The study analysis in this article is aimed to illustrate if it is feasible to add diverse functions, supporting ecological and social services in a large-scale system of solutions in the area of vertical urban farming, and whether they influence demonstrable advantages for urban people.

1.2. Methods of the Research

The presented study is causal and involves a newly explored phenomena, vertical urban farming. The research technique was associated with case study analysis and comprised gathering and systematising data relevant to vertical urban farming, both empirical and theoretical, their structure, systematisation, and assessment. This research grew from subjective observations to thorough investigation of associated technology, existing and imaginative initiatives of vertical farming. In the preliminary stage, browsing the Internet (sites, blogs, movie clips) delighted and fueled the study by informing about contemporary projects that employ modern technology. This inspired rigorous analysis of general (secondary) and specialized (primary) literatures on vertical farming by utilizing several internet search engines and databases including Scopus, ProQuest, and Google Scholar. Researchers gathered almost 100 sources. These sources included 42 percent peer-reviewed academic journal articles, 28 percent books and book chapters,

6 percent theses, 9 percent conference papers, and 15 percent websites. Most of the evaluated material is quite recent, dated 2010–2022. The assessed projects came mostly from North America, Europe, and Asia.

The nature of the questions this study examines using a qualitative, constructivist research technique is exploratory. The qualitative feature of this research technique gives high emphasis to the context of the phenomena being examined, which led in the adoption of a case study approach (See Fig. 1). According to Yin (2009), a case study is an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident in order to understand the phenomenon and pertinent context in depth [9]. While an argument might be made that the first research question is more deductive, the study overall is of flexible design and experimentally driven, resulting in an inductive research technique that draws upon the openness and receptivity of the researcher.

Additionally, the researcher knows that the emphasis of this research is on a context-bound urban agricultural system and does not attempt to generalize the results of this study. Rather, the main purpose is to give information that contributes to increased knowledge of the examined phenomena, increasing the study's repeatability. The publication compiles difficult technical material and makes them accessible to the non-specialists. Collectively, by examining, arranging, and integrating material of diverse sources, the study seeks to give a deeper understanding of the philosophy and practice of vertical farming. This research explores the elements that, according to the authors, are directly and indirectly connected to the quality of life in the city, i.e., economic, social and climatic/environmental support for vertical farming.

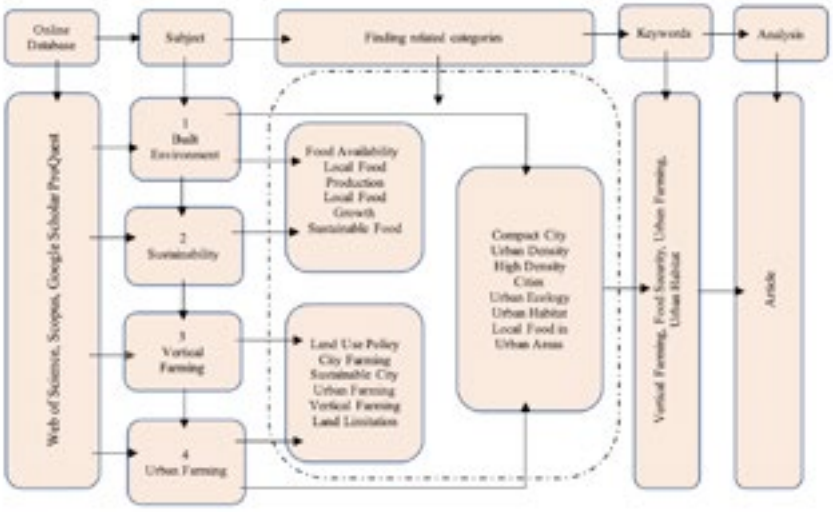

Figure 1: Research Process **(Improved by authors's)**

2. VERTICAL FARMING AND WHY VERTICAL FARMS?

Vertical farming (VF) seeks to employ the sustainable development of urban cities by addressing the rapid urban population growth. Therefore, vertical farming can be referred to as the construction of tall vertical structures with many levels of growing beds and artificial lightning serving as a form of energy or can be more defined as a multistorey vertical farm for food production. Thus, the vertical farm concept is farming up rather than farming out [10]. VF is a large-scale food production approach that uses cutting-edge greenhouse techniques and technologies to regulate ambient conditions and nutritional solutions for crops [11, 12]. VF is a farming technique that utilizes high-density food production in high-rise structures, allowing

for controlled development and actual yields using advanced greenhouse techniques and fertilizer solutions. Food is the primary motivation behind the evolution of all living things. However, there is still little urban footprint and fewer water and energy resources left behind when fuel, fibre or comparable commodities or services are given by artificially piling them vertically over one another rather than using natural resources. There are many ways to grow crops inside, such as in towers, on the slopes of buildings, and so on, but vertical farming (VF) is one of the most efficient methods because of its vertical structure that can accommodate plants and animals, and so on. It may also be used to keep them stacked on top of the other [13].

There are three types of vertical farming. In the first form, the construction of tall structures with many tiers of growth beds is frequently lined with artificial lighting. Several cities have embraced this strategy globally, and small-scale urban farms are cropping up for new and existing structures, including warehouses that owners adapted for agricultural activity [10]. The second form of vertical farming occurs on rooftops of old and new residential buildings, commercial and restaurants, and grocery shops [14]. Finally, the third form of the vertical farm is a multi-story structure designed with a broad concept. Many significant imaginative initiatives of this sort are emerging in the last decade. However, there has been no construction of any kind. However, it is crucial to highlight that the success of small-scale vertical farm projects and the maturing of their technology will undoubtedly pave the way for skyscraper farms in the future [15].

As far as the concept of vertical farming goes, it is not a new one. Some examples traced far back as Philon's seven ancient wonders of the world, Babylon's Hanging Gardens, are examples of this style dating from the prehistoric age built around 600BC [7]. American environmentalist and professor of public health Dickson Despommier enthusiastically revitalized the vertical farming idea in the early 1900s. He described Vertical farming as "the mass production of plant and animal life for economic reasons," as he described it. Hydroponics and aeroponics are two of the most sophisticated greenhouse technologies that may potentially be used to grow fish, poultry, fruit, and vegetables in the vertical farm" [16].

According to Al-Kodmany (2018), to respond to the aforementioned question, why vertical farms? It is significant to explore the following trends [17];

• Urban Density

In contrast to "horizontal" urban farming, vertical farming frees up areas for other urban activities (i.e., housing more people, services, and amenities). Demands for housing, health and hygiene services, work opportunities, and transportation will continue to rise as people move to cities. In addition to these challenges, an ever-increasing urban population raises the need for stable, readily accessible, and nutrient-rich food sources. As a result, the population of future megacities is predicted to be larger, poorer, and less developed than the current city population [18].

According to Ren et al. (2013), population density increases due to rapid and extensive city expansion. Therefore, the location of an urban farm is essential [19]. There are distinct regions in well-developed cities. As a result, they provide a wide range of city-based farming and food production [20]. Property is so expensive in metropolises that they tend to be densely populated. As a result, the development of structures for integrated manufacturing may assist in supplying residents [21]. Furthermore, VF may be performed year-round in a well-protected space, which is a huge benefit. Compared to traditional farming, VF enjoys several advantages, which elevate it to a higher and more influential position [13].

• Ecosystem

In order to sustain human and non-human life, the Earth's ecosystems must be maintained. Food, clean air, clean water, and a somewhat stable climate are necessities for human biology [22]. For millennia, humans have been intruding on natural ecosystems via agriculture. According to Despommier (2008),

farming is the most harmful practice [23]. The ecosystems play a significant role in the recycling and redistribution of nutrition. Although this function underlies the health of plant and animal species globally, the interruption of nutrient cycling may degrade soil fertility and lower crop yield [22].

The location of an urban farm is significant. There are distinct regions in well-developed cities. As a result, there are several opportunities for city-based agricultural and food production [24]. Vertical farming has the potential to increase food production efficiency and sustainability, conserve water and energy, improve the economy, decrease pollution, create new jobs, restore ecosystems, and ensure that everyone has access to nutritious, affordable meals. Pesticide use, crop rotation, polluted runoff, and dust are less likely to affect crops grown in a regulated environment than those grown in an uncontrolled setting [25].

• Climate Change

Climate change has led to a loss of arable land. Damage to the global economy has been exacerbated by the loss of important farmland due to extreme weather events such as floods, hurricanes, storms, and drought. The shrinkage of arable land has been worsened by global warming. Flooding, hurricanes, storms, and drought have decimated vital farmland, resulting in a reduction in the global economy [26]. For example, climate change can stress agricultural production, and Weather-related disasters are expected to become more frequent and severe due to artificial global warming. Many acres of agricultural land will be rendered unusable due to these disasters. Crop insurance against natural causes is a systematic way for governments to fund traditional farming [27].

In the United States, conventional farming uses more than 20 per cent of all gasoline and diesel fuel used for agricultural operations (e.g., ploughing, applying fertilizers, sowing, weeding, and harvesting). Food miles refer to the distance crops must travel to reach urban inhabitants in a concentrated area. Even more so because of global urbanization's rising distance between farmland and cities. Climate change has been exacerbated by greenhouse gas emissions from food transportation and farming [28].

• Economics

The vertical farm's proponents also claim that it would provide food at competitive pricing. However, traditional farming's growing costs are fast decreasing the price gap. Moreover, in urban locations, vertical farms may be strategically situated to sell food directly to the customer, cutting transportation expenses by as much as 60% [2].

With the help of cutting-edge technology and intensive agricultural techniques, vertical farms can significantly improve their output. Researchers have been calibrating, tuning, and modifying various factors, including light intensity, light color, space, temperature, crop and root, CO2 levels, soil, water, and air humidity, to optimize indoor farming. Aside from supporting the local economy, vertical farming presents a unique innovation opportunity. For example, in urban areas where fresh produce is limited, abandoned buildings may be transformed into vertical farms that supply nutritious food. Indoor farming's high-tech setting might also add to the activity's appeal. As a result, a new generation of farmers is being groomed via technology. In addition, the development of new agricultural technologies is given a boost by vertical farming. Last but not least, urban farmers might help re-connect people with nature in the city [29].

• Health

Conventional agricultural operations often emphasize profit and commercial gain at the expense of the damage done to human and natural environment health due to these activities. Furthermore, the soil is eroded, contaminated, and much water is wasted. More than half of the world's farms still use raw animal manure as fertilizer, which may attract flies and carry weed seeds or illnesses that can be spread to plants.

This can have serious health consequences for humans. As a result, people's health is negatively impacted by eating such food [7]. In addition, precise irrigation and efficient scheduling are critical features of indoor vertical farming, which uses a fraction of the water regular farming does. Water consumption will rise as the urban population expands. Thus, this may be a huge help. Because metropolitan populations are developing and using more freshwater, farmers are losing the agricultural water source that they need to grow crops. As temperatures rise and more droughts occur, the water problem worsens [30].

• Food Security

The problem of food safety is becoming more critical. According to demographers, urban populations are expected to multiply in the future decades. According to experts in land use (such as agronomists, ecologists, and geologists) [17]. Even in industrialized nations where fresh food supplies are scarce areas referred to as "food deserts" figuratively, food security is a significant concern. Food production methods are at the heart of the issue. As a result, urban farming receives more support to bridge the gap between food producers and consumers [31]. UN projects that the world's population will grow by 40% by 2050, reaching 9 billion. According to UN estimates, by 2050, 80 per cent of the world's population will be living in urban areas. A further 70 per cent increase in food production is expected to be required by 2050 when the world's population is expected to grow by 3 billion people [32].

The logic of vertical farming, you can grow more food in less area. VF may be run all year round Indoors in a well-protected environment. As a result of these advantages, VF farming is seen as superior to other traditional farming methods. VF can meet nutritional food needs [13]. VF is a significant source of food for a large local population. As a result, VF has made a significant effort to keep pace with the recent surge in the popularity of regional cuisine. Plants in VF may grow at any time of year. As a result, fewer crops are lost as compared to conventional farming. In addition, various kinds of plants grow on different levels of the usual form of city agricultural farm with the same square. In order to maximize the utilization of space, VF may be utilized everywhere in the city since it does not rely on weather conditions or soil conditions [13].

2.1. Vertical Farming Techniques

Vertical Farming (VF) is a large-scale agricultural system that allows rapid growth and planned production of crops by managing ambient conditions and nutritional solutions. With cutting-edge greenhouse techniques and technology [10, 11, 12]. Modern agricultural techniques have the potential to increase yields while using significantly less water. The form and arrangement of these high-tech farms will give each plant precisely calibrated nutrients while also ensuring optimum light exposure. Closed-loop farms would remove the need for toxic herbicides and pesticides while boosting nutrition and food value at the same time [33]. VF can be classified into three methods of production: hydroponics, aeroponics, and aquaponics [17].

2.1.1. Hydroponics

The hydroponic technique is a method of growing plants in water, either with or without sand or gravel as support, and is an environmentally friendly way to grow food without soil [17]. The water acts as a channel for distributing and absorbing mineral nutrition solutions. Due to its many advantages and low-maintenance nature, hydroponics has become the primary technique of food production in vertical farms today. Deep-water culture (DWC), nutrient film technique (NFT), and media bed technique (MBT) are all components of the hydroponic system [34] (See Fig. 2).

Hydroponics is now widely used in industrial agriculture and offers various benefits over conventional soil-based production. Soil-related cultivation issues might be eliminated or at least reduced by using this strategy (i.e., the insects, fungus, and bacteria that grow in soil). Because no animal excrement is utilized, it may also be a cleaner method. Additionally, hydroponics gives a more convenient technique for controlling fertilizer levels and pH levels time [33].

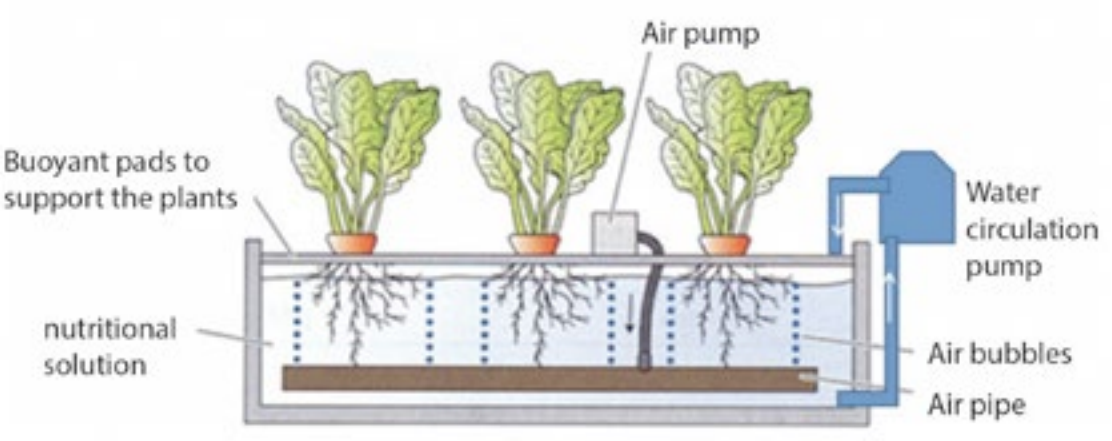

Figure 2. Basics of Hydroponic system [35].

2.1.2. Aquaponics

The hydroponics method is integrated with fish farming, producing a symbiotic link between the fish and the plants. The fish excrement flows into the hydroponic beds, providing nutrients for the plants. Hydroponic beds remove gases, acids, and chemicals from the water circulating between the fish tanks and the hydroponic beds (e.g., ammonia, nitrates, and phosphates). An essential part of this process is substrates, which offer nitrifying bacteria an ideal water filtration and nutrient recycling environment. Researchers believe that aquaponics has the potential to be a model for sustainable food production because of its efficient circular flow of resources (See Fig. 3). For example, water filtration by crops, waste products of one system serving as nutrients for the second, efficient water use, and reduced need for fertilizers and artificial chemicals [36].

This method has the potential to become a model for sustainable food production by meeting the 3Rs, according to researchers (reduce, reuse, and recycle). Many advantages include:

- It provides organic liquid fertilizers that support healthy plant growth;
- The waste products of one biological system serve as nutrients for another;
- It saves water because water is filtered and recirculated;
- The waste products of one biological system are used as nutrients for another. Particularly appealing in countries where water is scarce, this trait reduces or eliminates the need for herbicides and synthetic fertilizers [36].

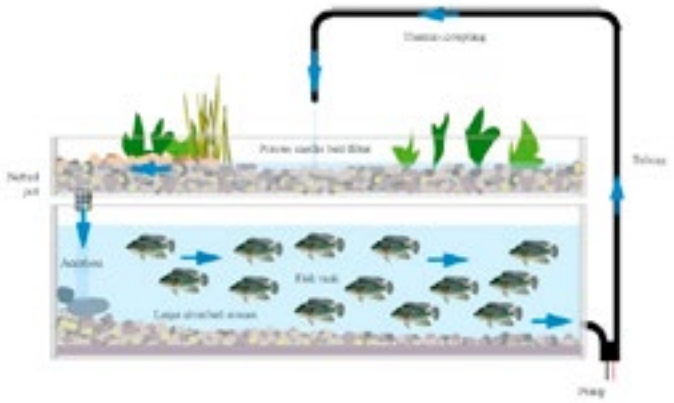

Figure 3: Basics of an Aquaponic System [17].

2.1.3. Aeroponics

The Aeroponics method is a substrate-free, air, water, and nutrient-based form of food production that promotes crop growing with minimal water or sunshine. One of the most successful and efficient food production methods is the utilization of mist to transfer nutrients throughout the root systems when water is not available [7]. It uses 95 per cent less water and takes up a fraction of the area of traditional agricultural techniques (See Fig. 4). However, the maintenance of aeroponics systems is a challenge. Aeroponics production requires a hands-on approach since the mist nozzles must be clean of bio-debris. However, the production system must be constantly monitored and maintained to ensure that the roots of the plants are not damaged by even the most minor changes in their surroundings.

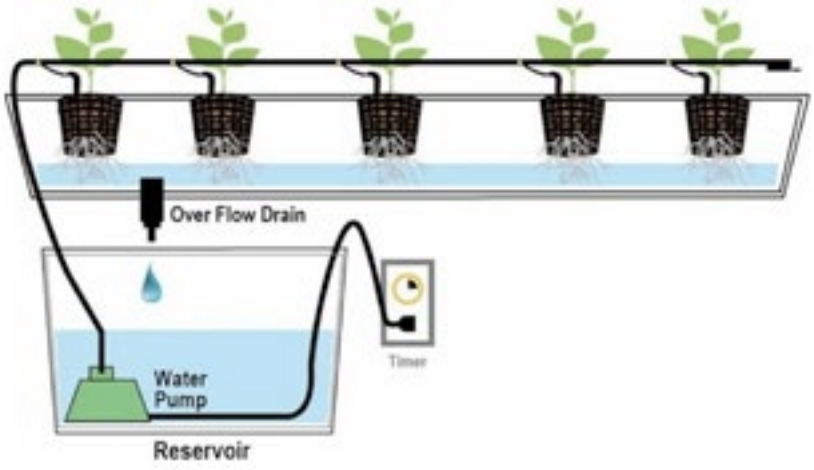

Figure 4: Basics of Aeroponic System [37].

Table 1. An over view of vertical farming methods adapted from Al-Kodmany, 2018.

Farming Method	Characteristics	Benefits	Drawbacks	Applicable Technology
Hydroponics	Soilless; water is used as a medium for growth.	Eliminates soil-related cultivation concerns, reduces the usage of fertilizers and pesticides, enables faster plant development.	The use of foreign inputs and pesticides, as well as a lack of oxygen to the roots of crops, may lead to tasteless produce.	Monitoring and computerized systems There are smartphones, laptops, and tablet computers. Apps for growing food; Systems and software for remote management (agricultural systems that are operated remotely); racks with moving conveyor belts and huge towers of automated racking; LED lighting systems that can be programmed; Solar, wind, geothermal, and other forms of renewable energy Anaerobic digestion; closed-loop systems Nutrient systems that can be programmed; AC/HVAC systems for climate control methods for reusing and recycling water Collectors for rainwater; The use of insect killing systems and robots.
Aquaponics	The integration of aquaculture and hydroponics	The symbiotic interaction between plants and fish is used to create a closed nutrition system. Fish 'waste' is rich in nutrients and provides food for plants, which in turn cleans the water for the fish.	A lack of oxygen reaching the roots might result in a tasteless product.	
Aeroponics	Hydroponics with nutrient solution mists is sprayed over the roots of plants during the Soilless method.	In addition to the advantages of hydroponics, it uses less water and promotes more aerobic plant development.	Algae and biofilm forming in the mist nozzles may quickly jam them. The system requires a lot of attention. System temperature changes are rapid because there is no medium or substrate to slow them down.	

2.2 Approach to Vertical Farming and Urban Gardening

The vertical farm is a modern city's counterpart, providing stability while accepting change rather than a single building. The vertical farm is a complex system for growing agricultural produce in an urban setting while also being a functional part of the urban system. The vertical farm is about hidden circuits of energy and materials, labour and resources, capital and infrastructure that modern cities rely on, not just a skyscraper with agricultural plots and food production. Food is only one aspect of the vertical farm that

consumers see, and it is the most apparent portion, while the rest of the industrial process is hidden [38].

On the planet, 80% of the land accessible for agriculture has already been farmed. The indication that natural expansions are dwindling in favour of agricultural areas. According to NASA, the increasing population has necessitated the provision of food, which the agricultural industry can provide. Every day, the total area of agricultural land in the world expands. Agricultural exploitations are displacing natural regions all over the world. By 2050, approximately 80% of the world's population will be living in cities. Therefore, If existing farming practices continue, an estimated 109 hectares of new land (about 20% more land than in Brazil) will be required to cultivate enough food to feed them [38].

The public's perception of the vertical farm is a ballet of food visibility. Food is the most dynamic and complicated system in the twenty-first century, necessitating a complex web of interconnections. "Eating is an act of agriculture", as Wendell Berry puts it. As a result, the vertical farm's primary function is to mediate the visibility of food production. Furthermore, the vertical farm teaches that interaction with the world has consequences, especially what an individual consumes.

A vertical farm design by Eric Ellingsen and Dickson Despommier shows a sustainable vertical farm design approach. The pyramid farm was a predecessor of the vertical farming concept [23]. It is designed to save space while reducing trash and providing food for an ever-increasing population. Harvesting edible fruits and vegetables are done on this vertical farm. It also uses waste to create an indoor fishery and aids in developing a chicken farm. Figure 5 presents a vertical farm design in Dubai. Looking closer at the design, some programmatic shelves contain a graze of colours. Despite this, some energy evaluations have indicated that urban agriculture can be a viable alternative to non-renewable and imported resources in urban growth initiatives [39]. According to Maassen (2017), increasing the participation of local renewable resources and assuring local inputs will promote sustainability [40]. Additional recommendations include increasing resource recycling and reuse, supporting renewable energy sources to replace fossil fuels, and improving input efficiency [41].

Figure 5. Showing vertical farm design in Dubai [23]

The vertical farm pyramid design has many different mixed-use purposes for people to live and enjoy the links between food and the city because it has an interwoven network of relationships in the twenty-first century. The anaerobic digest is a critical component of the vertical farm megastructure. Waste from humans and animals is used as a source of energy. All waste in the form of animal manure will be remediated through

the plant's roots system and reused as fertilizer at the complex, including chicken and hog production and aquaculture tanks for raising shellfish to tilapia. All waste in animal manure will be Phyto remediated through the plant's roots system and reused as fertilizer. Water recycling into a wastewater treatment facility and a potable urban reservoir from plant evapotranspiration and aquaculture tanks. Finally, the year-round vertical farm will produce fruits and vegetables, and the complex will feature residential units, restaurants, and commercial operations. On the exterior parts of the vertical farm, a public park will have a relationship between nature and public space. Figure 6 presents a section of various components of the vertical farm that will collect, filter, merge and redistribute urban energy [42].

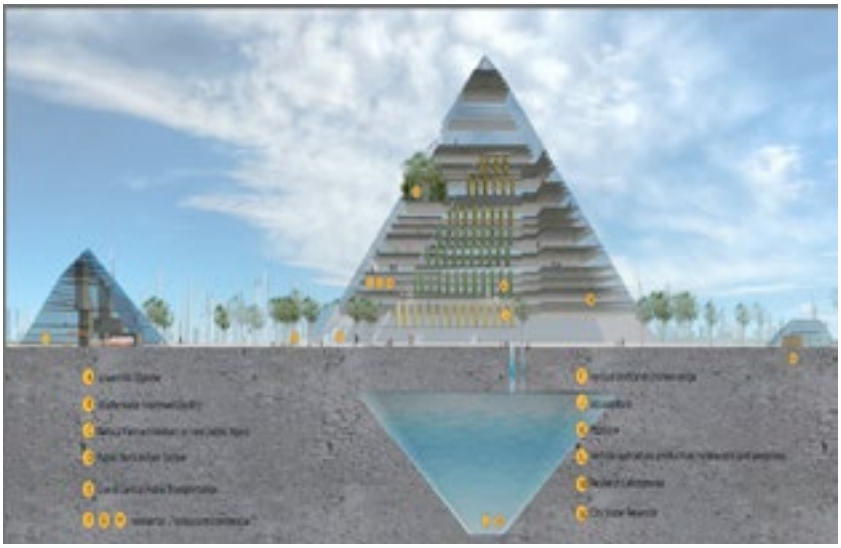

Figure 6. Showing a section of various components of the vertical farm [23].

3. URBAN FARMING AND SUSTAINABLE DEVELOPMENT

For decades, the rural built environment was linked to the traditional model of a compact, social, complex and efficient city, thereby preserving high levels of environmental quality. Moreover, the model generated spaces for sociability, that is, the boundaries that are ideal for economic activities of the urban natural environment. However, Viana-Cárdenas (2013) stated that the model has drastically changed since the second half of the twentieth century through the functional character of the city's urban form [43]. However, towards the end of the twentieth century, new urban realities were characterized by low-density industrial estates, with most residents living near highway and expressway intersections. The new model has a path to greater consumption of water, energy, materials, and soil resources. Thus, this path is contrary to sustainability, and only a few cities manage to balance inflow and outflow and consumption and production of natural resources. Due to the significant expansion of contemporary urban cities, most of the sustainability problems have a direct extension to the natural environment. For example, formal and informal settlements result from territorial expansion and a lack of planning. Therefore, in the same vein, mobility and traffic are part of the ecological problems contemporary urban cities are facing today. Moreover, the new urbanizations are generating abused landscapes that undervalue rural and natural heritage and primary activities such as agriculture.

However, to stop the unsustainability of urban cities, there are several national, regional, and municipal government projects worldwide. These initiatives address traffic control, trash management, sanitation, and water purification, among others. The outline of a network or green matrix in the interior and perimeter of cities stands out among these operations. The rebalancing of urban systems is based on a network of green

spaces surrounding urban centers made of rings and vegetable corridors that link and meld agricultural and forestry areas with inhabitants and neighborhoods. Within this green matrix network, urban and peri-urban farming plays a vital role as one of the essential strategies for urban sustainability. Consider the future city as a resilient and self-sufficient city that achieves "ecosystem" status by committing to urban agriculture [44]. However, cities that generate new land-use dynamics modify urban spaces and promote innovative activities such as urban and peri-urban agriculture become cities with high economic, social, and environmental competencies [44]. Hence urban farming can have a positive impact on sustainable urban cities. Urban farming can contribute to social development by providing urban food security, access to fresh and healthy food, personal well-being and direct involvement in (UA) which can result in physical, intellectual, and psychological benefits, personal skills (example, horticultural and communication skills), and a sense of place preserving the national rural image. In addition, urban faming benefits the environment by preserving urban soil, improving microclimate, reducing pollution (waste and nutrient recycling), increasing biodiversity, and increasing environmental awareness [5, 45] (see Fig.7). When the Pandemic broke out in March 2020, most cities were left with empty food store shelves, adding to the already high level of anxiety. The reason for this is because of the considerable distance between the farm and the market. Because of the disruptions to air travel and the closure of international borders, food supply networks were unable to function, which resulted in this predicament [47].

It takes lettuce, for example, around 30 to 45 days to mature in an open field, which means it has to travel about 2000 kilometres. While it takes just 12 days for urban indoor lettuce to develop and travel less than 50 miles, urban food production can reduce the supply chain gap and prevent future crises [47].

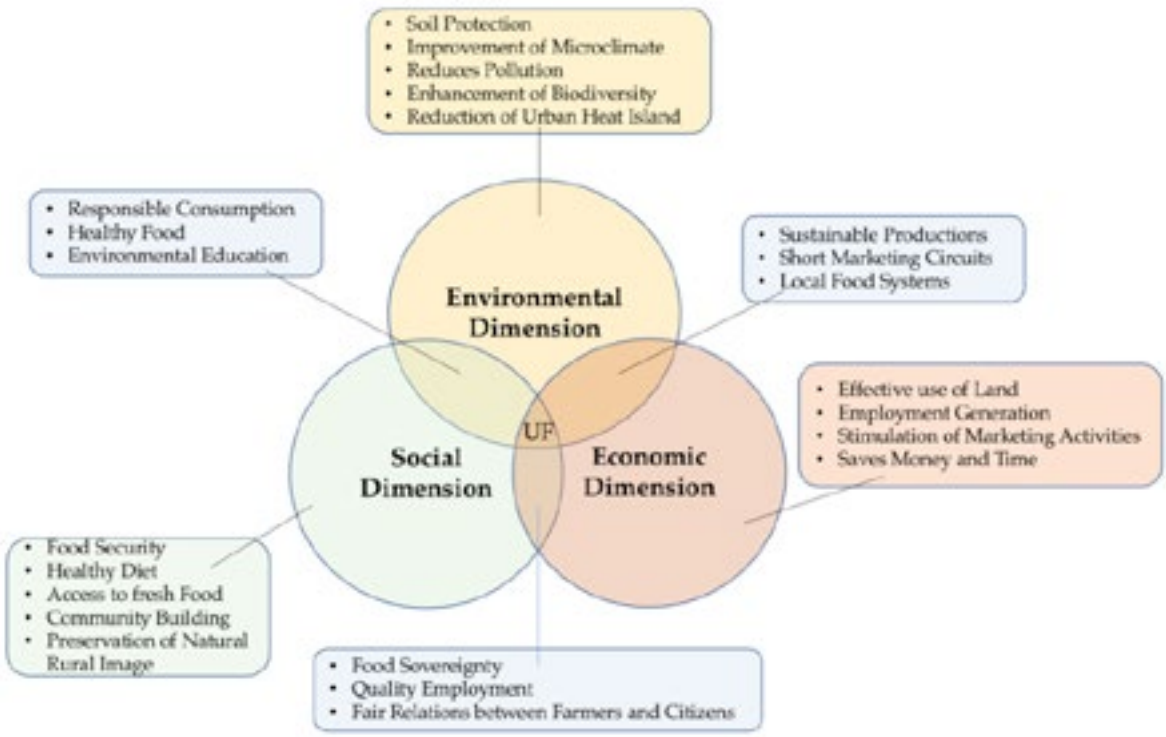

Figure 7. The vertical farm may offer opportunities in the three pillars of sustainability: social, economic and environmental (Improved by authors)

Social Dimension

Urban farming contributes to social development in a variety of ways by providing urban food security, a healthy diet, and access to fresh and healthy food; promoting community building (promoting integration and participation), cultivating personal skills (e.g., horticultural and communication); and preserving the national rural image [3, 5]. Employment possibilities may also be provided by the vertical farm. A team of architects, engineers, scientists, farmers, horticulturists, environmentalists, marketers, and economists is needed to build a vertical farm. Industrial, mechanical, and electrical engineers are required to develop water recycling systems, lighting systems, heating, ventilation and air conditioning (HVAC), seed and plant growth monitoring, and harvesting systems. Building databases and software applications will need the services of computer professionals [5]. As a result, the vertical farm creates new job prospects in fields such as biochemistry and biotechnology, as well as building, maintenance, marketing, engineering, and research and development to improve the technologies involved [48].

Economic Dimension

In terms of economic development, urban farming has the ability to use the land effectively; provide self-supply; generate employment; generate revenue; save time and money (reducing 'food miles'); stimulate marketing activities, and save time and money [5]. VF may also be able to use rainwater and recycle wastewater (grey or even black water), and Compost from the vertical farm may potentially be burned to generate electricity. Examples include the Plant Vertical Farm in Chicago and the VF plant in the Republic of Korea [49]. The vertical farm's cutting-edge production technologies minimize the need for potable water. By focusing on the plant's roots and limiting evaporation, they may be quite effective at irrigating plants [50].

Environmental Dimension

Urban farming provides a wide range of environmental benefits, including soil protection, improved microclimates, pollution reduction (waste and nutrient recycling), biodiversity enhancement, and an increase in environmental consciousness [40]. It can provide a year-round food supply that is unaffected by climate change, seasonality, or unfavorable natural disasters (e.g., hurricane, drought, and flood). Integrated fish farms eliminate waste (especially fish filets) from the environment [47]. Urban Heat Island (UHI) may be reduced, and climate change can be combated with the help of the vertical farm [24]. As a result, less energy is required to cool interior rooms during the summer, which reduces emissions of carbon dioxide. In addition, vegetation minimizes sound reflection. Therefore, the vertical farm may aid in noise absorption. Soil and vegetation may act as a sound insulator [32].

Agro-urbanism is predicated on the premise that urban areas can be repurposed to grow food in three distinct ways: intensively, by constructing vertical farms in skyscrapers using cutting-edge agricultural and construction methods, like Singapore's Sky Greens; extensively, by constructing farms in underdeveloped or degraded areas that are no taller than the surrounding structures; and dispersedly, based on existing structures and infrastructure that may be used for agricultural applications without the deployment of costly and complex new technology [51]. Multi-scale vertical farming was considered while looking at the application of agro-architecture in three dimensions (intensive, extensive, and dispersed). The chapter's findings show that vertical farms may operate in a city or a neighbourhood at different sizes based on a city's demands and financial possibilities.

Table 2. General principle Sustainable benefits of vertical farming (Improved by authors).

NO.	BENEFITS	SOCIAL	ECONOMIC	ENVIRONMENTAL
1.	Reducing the number of miles that food travels (travel distances)	improving air quality has a positive impact on both environmental and human health. Fresher, locally sourced cuisine is served to customers	Reduce the amount of energy, packaging, and fuel needed to move food	Reducing air pollution
2	Reduce water use for food production via the use of high-tech irrigation systems and recycling processes	Providing more people with access to safe drinking water	Cost reduction	Reducing the amount of water that runs off of traditional farms.
3	Organic waste recycling	Improve the quality of food and better health of consumers	Turn waste into a valuable resource	Reduce the amount of waste that must be disposed of in landfills to save the environment.
4	Creating employment opportunity	Involve farmers and their employees in a local community and social network.	Economic benefit to the community	People won't have to travel far to go to work, hence reducing their environmental impact.
5	Reduced fertilizers, pesticides and herbicides	Improve the quality of food and better health of consumers	Cost reduction	Improve the well-being of the environmental
6	Improve productivity	Time may be saved by reducing the amount of work that is repetitive and redundant.	Increase greater yields	Less space needed
7	Protect crops against flooding, drought, and storm damage from overexposure to the sun or other seasonal factors.	Food security improvement	Preventing an economic loss	Reduce environmental damage and agricultural clean-ups after a disaster
8	Product/produce control regardless of the season	Increasing accessibility all year round and meeting the needs of the local community	Provide year-round support for economic activity	Seasonally appropriate products may be made.
9	Usage of renewable energy	Air quality improvement	Cost reduction	Reducing fossil fuel
10	bringing nature into the urban environment	Health improvement, stress reduction, and improved mental health	Create employment in the city	Increase in biodiversity

11	promoting green and high-tech industries	Encourage higher education and the creation of highly-skilled employees	Providing employment opportunities for engineers, biochemists, biotechnologists, construction and maintenance workers, and researchers	minimize environmental damage and increase environmental performance by using "green technology."
12	Reduction of traditional agricultural activities	Improve the health of the citizens	Environmental harm can only be remedied through cost reduction	Natural ecological systems preservation
13	restoring and reusing dilapidated structures	Create chances for people to socialize with one another	Boost the economy	Enhance the atmosphere. Neighbourhoods should be cleaned up of blemishes and stigma.

4. MACRO, MESO, MICRO SCALE OF GARDENING

4.1. Macro Scale: City Vertical Farming

Presently, there are two distinct kinds of urban projects using vertical farming. Firstly, buildings and warehouses from the post-industrial era have been modified, while investments made with design principles are implemented from the start of the process. The structure and technology of planned buildings are created to allow for the development of plants, and the function of the building is already established. Engineering and environmental protection standards must be combined with the economic and utilitarian functions of buildings, but also aesthetics and widely known spatial order concerns must be considered in the design. Transport, storage, and packaging are part of the supply chain for fresh fruits and vegetables in contemporary cities [52]. During each phase, contaminants are created that impact waste generation and public health. Some communities are stepping up to meet the future challenges of an ever-increasing population and the requirement for an adequate food supply. These solutions are being created all over the globe. Examples of such solutions are the Forest City in Malaysia and Sunqiao in China. The whole 31.000 m2 post-industrial neighbourhood in Strasbourg is covered with vertical gardens. Because of this, the development of a contemporary multifunctional area, which will include housing, services and workplaces, is imminent. Using an integrated rainwater system, lush, irrigated gardens will be developed on the terraces of the residences [6].

The forest city, Malaysia, almost four times the size of Central Park in New York, four artificial islands in Singapore are being developed as a joint venture between the Chinese developer Country Garden and Esplanade Danga, a Malaysian property company (99.9 per cent of which is owned by the Sultan of Johor). It will be the most densely inhabited human settlement on the planet, with 700,000 residents. According to the vision plan, large structures would be covered entirely with greenery. In order to achieve the new city's high density, concrete high-rise towers will be used to create residential and office buildings, as well as malls and hotels. However, the negative environmental effect of the investment climate may exceed the advantages of establishing a new economic engine in Malaysia. Shipped-in sand used in construction may irrevocably impact the surrounding marine ecosystem [53].

In Sunqiao (China), Urban farming in the form of skyscrapers began construction on a new housing complex in 2017. According to an initial estimate, more than half (56%) of Shanghai's population consumes leaf vegetables, which do not need special care and can be grown in hydroponic and aquaponic systems. The district visualization shows floating greenhouses, green walls, and vertical façades are shown in the district visualization. Sunqiao's vertical farming system can help sustain the city's food supply chain and govern food distribution inside the city itself. The 100-hectare new housing development is located between Shanghai's international airport and the city's central business district [54].

4.2. Meso Scale: Neighbourhood Vertical Farming

In 2012, Singapore's Sky Greens became the world's first large-scale vertical farm to begin commercial operations. The 3R principle (reduce, reuse, and recycle) is followed in production because of the reuse of waste generated throughout the manufacturing process. Automation and ultra-modern lighting systems are used in subsequent municipal farms, assuring high yields and high-quality goods while minimizing environmental effects. Various farming concepts and economic strategies are being used in vertical farms across the globe.

Aero Farm, one of the biggest, is located in a decrepit New Jersey Hall. Aero Farms (USA), which has a total area of roughly 10,000 square meters, has begun commercial operations in the United States. The vertical farms have been designed so that the cultivation cycle is as short as possible while still ensuring high-quality products with the least negative environmental impact, using a patented aeroponic cultivation system in a completely controlled atmosphere with an ultramodern lighting system. There are 250 varieties of leafy green crops, such as arugula, kale, and spinach, layered 6 meters high on dedicated shelves. LED lights enable photosynthesis to occur (the intensity, length, and spectrum of which are designed to the individual needs of each species). Fresh veggies produced in this manner are sold to local businesses, restaurants, supermarkets, and educational institutions [55].

The Plantagon World Food Building in Linköping, Sweden, is a 16-story skyscraper intended as a vertical agriculture urban farm in urban environments with integrated solutions for energy, excess heat, trash, CO2, and water recycling. The greenhouse's trash will be composted at a nearby biogas facility, where it will provide the plantation with the energy it needs to continue operating. It is estimated that the World Food Building will produce 550 tons of vegetables per year, save 1100 tons of CO2 emissions, and use 13,000,000 gallons of water per year, enough to feed about 5500 people. An indoor farm will occupy a third of the structure, which will feature offices, restaurants, and a market selling vegetables and fruits [51].

The main idea of indoor farming is growing more with less, farming up rather than out [10]. Growing crops indoors was to create a suitable location for the crop that farmers were cultivating. As a result, crops grow better, faster, and without being affected by the weather outside in this controlled environment. The concept dates back to the first century when Romans who grew their vegetables did so in carts to shift them from outside to inside when the weather turned cold [56, 57].

Local vertical farms use a wide range of green architectural solutions, such as green roofs, green walls, and other small-scale projects. In addition, investors from all around the world may purchase micro-farms equipped with the newest technology. Some of them include multi-story systems for cultivating plants in a garden on balconies or rooftop terraces and a Cubic Farming system that is fully insulated from the environment [58, 59].

Gotham Greens, a commercial hydroponic vertical farm in New York City, is one example of a micro- and midi-scale investment in a single green roof. Constructed in 2011, Gotham Greens is a commercial hydroponic rooftop farm that provides food for New York and Chicago residents without pesticides [58].

Two-story structure in Greenpoint, New York, houses Gotham Greens, a 1394 square foot rooftop facility. Irrigation systems for Gotham Greens are based on reusing water, which is part of the city's recycling system and adds to the notion of a closed-loop environment. Innovative technology regulates the flow of water and fertilizer for crops on urban farms. The hydroponic Gotham Greens commercial farm employs modern controlled environment agriculture (CEA) technology to provide a year-round supply of fresh veggies to the local market, regardless of the weather conditions outside [60, 61, 62].

5. CONCLUSION

One of the world's most pressing issues today is the need for food, which has been examined in this research. When it comes to the three pillars of sustainability, environmental, social, and economic, urban farming may be a game-changer. Compared to traditional farming methods, vertical farming offers significant benefits over traditional methods. In the 21st century dilemma, the vertical farm provides an iconic production method and a new architectural type. The dominion of space in the future is also an element of it. Learning how to optimize indoor farms on Earth and ultimately transfer this technology to prospective space colonies is likely the first step in developing Vertical Farms. For a wide range of crops, new high-tech production techniques such as hydroponics, aeroponics, and aquaponics are challenging soil-based agricultural needs. Multi-tracking automated systems, recycling systems, and other greenhouse and supporting technologies will be developed in the future.

Modern cities are impacted by sustainable development and environmental care. In recent years, the idea of a green economy has gained traction. As cities grow, so does the concept of local production. Imports of items that may be produced locally are urgently needed in today's cities, stimulating the local economy and providing new opportunities in urban agriculture. Remote working and the COVID-19 epidemic have impacted the environment and alleviated the strain on cities, which has resulted in a shift in people's lifestyles and a greater appreciation for local goods. Now, the issue is how contemporary cities will be able to adapt to the changing social and environmental needs. Researchers set out to find a method of vertical farming that may help cities cope with the fast rise of their populations while also producing food that would be environmentally friendly. As a result, urban farming is becoming more popular and is now considered a worldwide phenomenon. The associated benefits and reasons for integrating organic architecture green techniques into our built environment will provide a massive collection of appropriate plant information and extensive plant directories for rooftop gardens and vertical greenery systems. Urban farming is not a replacement for conventional farming, but rather a supplement to the alternative agricultural production system, providing a product with precise specifications developed under regulated circumstances in a controlled environment. Depending on the present and evolving demands of city people, this product will evolve. Most cities that rely on food imports and have limited agricultural land are currently working to increase the efficiency of vertical cultivation and plant production methods, as evidenced by the research conducted for this paper. This work is being done at various scales, from city scale to building scale. With the help of urban vertical farms, it is possible to simulate a variety of designs for cities that are continually evolving. Aside from increasing yields and lowering production costs, newly constructed vertical urban farms will also enhance the quality of agricultural goods given to urban people, reducing the environmental damage that urbanization causes.

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Potential Contributions of Topology Optimization for Building Structures: A Redesign Case Study on Saint Voukolos Church



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Abstract: Topology optimization, which has been used in many sectors for a long time, has recently become one of the new research and application trends in the field of architecture. Topology optimization, which can be considered as a part of additive manufacturing, is one of the initiatives to reduce the use of materials during the construction phase by deciding on the architectural design processes. The topology optimization applied according to the load distribution of the structure also reveals unique forms for each structure. This paper aims to examine the potential contributions of a structure designed with topology optimization to the structure in terms of material and form and to create an exemplary model in this context. For this purpose, Saint Voukolos Church, one of the historical masonry buildings in İzmir/ Turkey, was selected and redesigned with topology optimization. The topological optimization of this structure, which was 3D modeled in Rhinoceros®, was made with tOpos®, and two (existing and redesigned) designs were compared in terms of structure, material, and form. As a result, it has been seen that the topologically optimized proposed structure can be built with much less material than the existing structure and more original forms can emerge.

Keywords: *Topology optimization, structural optimization, masonry, architecture*

Yapılar için Topoloji Optimizasyonunun Potansiyel Katkıları:Aziz Vukolos Kilisesi'nin Yeniden Tasarım Çalışması

Özet: Uzun süredir birçok sektörde kullanılan topoloji optimizasyonu, son zamanlarda mimarlık alanında yeni araştırma ve uygulama trendlerinden biri haline geldi. Eklemeli üretimin bir parçası olarak değerlendirilebilecek topoloji optimizasyonu, mimari tasarım süreçlerine karar vererek inşaat aşamasında malzeme kullanımını azaltmaya yönelik girişimlerden biridir. Yapının yük dağılımına göre uygulanan topoloji optimizasyonu da her yapı için kendine özgü formlar ortaya çıkarmaktadır. Bu makale, topoloji optimizasyonu ile tasarlanmış bir yapının, yapıya malzeme ve form açısından potansiyel katkılarını incelemeyi ve bu bağlamda örnek bir model oluşturmayı amaçlamaktadır. Bu amaçla İzmir/Türkiye'deki tarihi yığma yapılardan biri olan Aziz Vukolos Kilisesi seçilmiş ve topoloji optimizasyonu ile yeniden tasarlanmıştır. Rhinoceros®'ta 3 boyutlu olarak modellenen bu yapının topolojik optimizasyonu tOpos® ile yapılmış ve iki (mevcut ve yeniden tasarlanmış) tasarım; yapı, malzeme ve form açısından karşılaştırılmıştır. Sonuç olarak, topolojik olarak optimize edilmiş önerilen yapının mevcut yapıya göre çok daha az malzeme ile inşa edilebileceği ve daha özgün formların ortaya çıkabileceği görülmüştür.

Anahtar kelimeler: *Topoloji optimizasyonu, yapısal optimizasyon, yığma, mimarlık*

1. INTRODUCTION

Depending on the developing technology in design software, the building or building elements are also differentiated and become unique. Finding the form that the building will take under dead or dynamic loads has also emerged depending on the development of these technologies. According to Beghini et al. (2014) "Topology optimization is a mathematical, usually (but not always) gradient-based design tool which determines the location in a design domain to place material based on the loads and boundary conditions for a specific objective (i.e., a target deflection, compliance, etc.)."[3]. In other words, topology optimization in architectural use is a method for reducing the material used to construct of structures with specified design criteria. In the historical process, churches built in the gothic style can be considered the first examples of topology optimization in architecture. Gaudi's La Sagrada Familia and Eiffel's Eiffel tower designs are also among the most popular examples. While the main purpose of topology optimization for structures is to reduce unnecessary material during construction, another advantage is that each structure gives unique forms according to the determined parameters. Reducing the energy consumed with the savings from raw materials also ensures that these buildings are kind of sustainable. This study examines the potential contributions of structures designed with topology optimization in terms of material and form to the structure and the environment. In this context, after examining the previously studied topology optimization prototypes, building elements, and building samples designed and applied with topology optimization, what would have happened if Saint Voukolos Church in İzmir had been designed with topology optimization was examined. This selected church was modeled in Rhinoceros® and topologically optimized in tOpos®, one of the Grasshopper plugins. Optimization of the form that the church took under its load is seen in the 3rd chapter. The comparison of the existing structure and the optimized structure is examined in the conclusion part.

2. LITERATURE REVİEW

In this chapter, in addition to the prototypes and structural elements that have been studied with topology optimization, examples that have been built such as the Unikabeton project, the Qatar National Convention Center and the Akutagawa River Side Office Building will be examined.

Prototypes and Structural elements

The first of the examined samples belongs to Peng. He examined the results obtained by varying the height between the support and the beam, keeping the load, span, and thickness constant. It can be seen in Figure 1 that there is no main trunk formation in a, b, and c. Only branches can be seen [4].

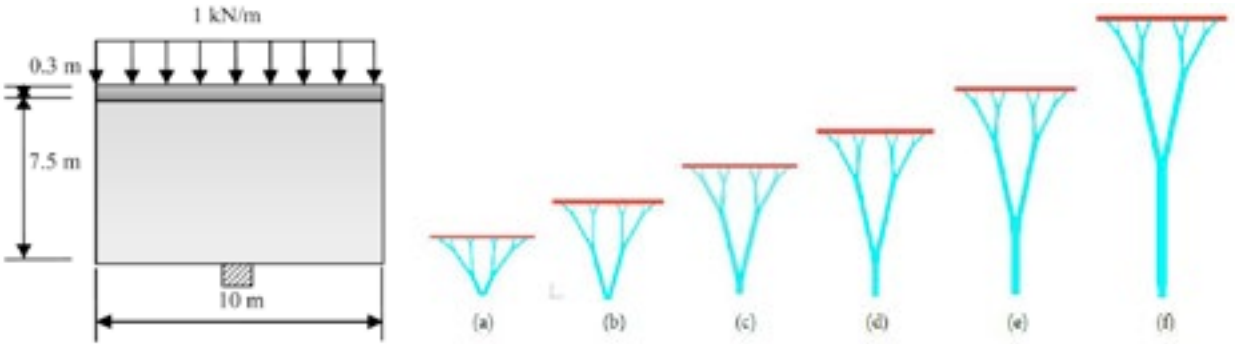

Figure 1. Topologically optimized dendriforms under different heights [4]

Another study by Peng is the topological optimization of a slab with multiple support points as shown in Figure 2. It has been observed that the column designs that transfer the load to the corner and middle supports of the slab on which the distributed load is applied differ [4].

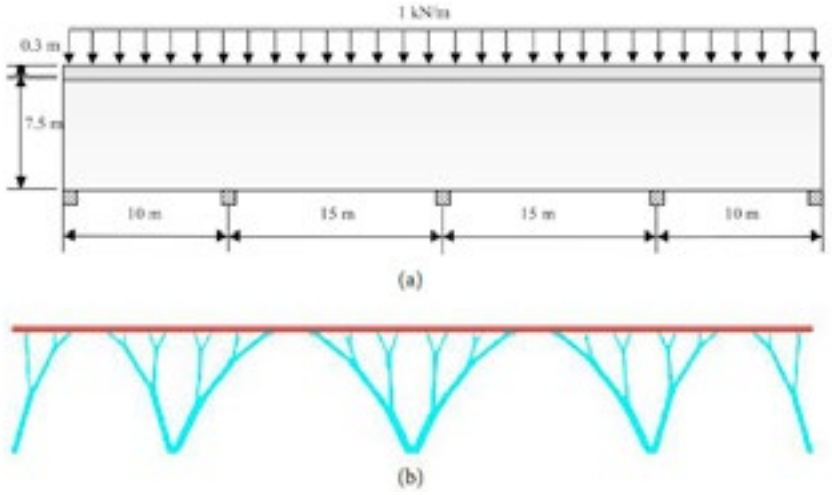

Figure 2. a) Design inputs b) Topologically optimized columns [4]

Bialkowski's study, on the other hand, has been examined again as a structural element. The behavior of the slab under 2 kN/m² has been studied on tOpos® by determining the point-supported state of the floor in certain dimensions in the first case (a), all the walls touch the ground in the second case (b), and the openings in the third case (c) as seen in Figure 3 [5].

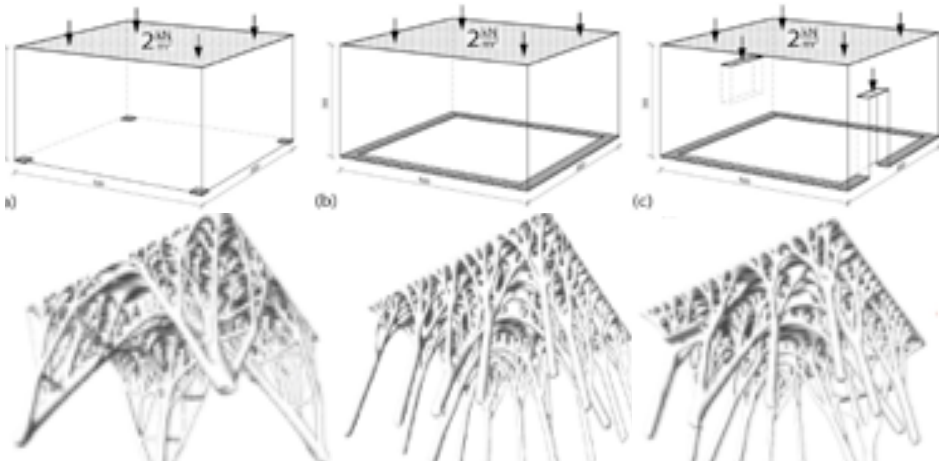

Figure 3. Boundary conditions and tOpos® results [5]

Oliveira and others' studies are on the construction themselves. After the mass study of the structure whose design criteria were determined, the support and load conditions were determined, and the results of the optimization were interpreted, and the final designs were obtained. Their first study was on high-rise buildings and their second study was on a bridge design. As seen in Figure 4a and 4b, the high-rise building, and the bridge optimization are trying to find optimal truss systems [6].

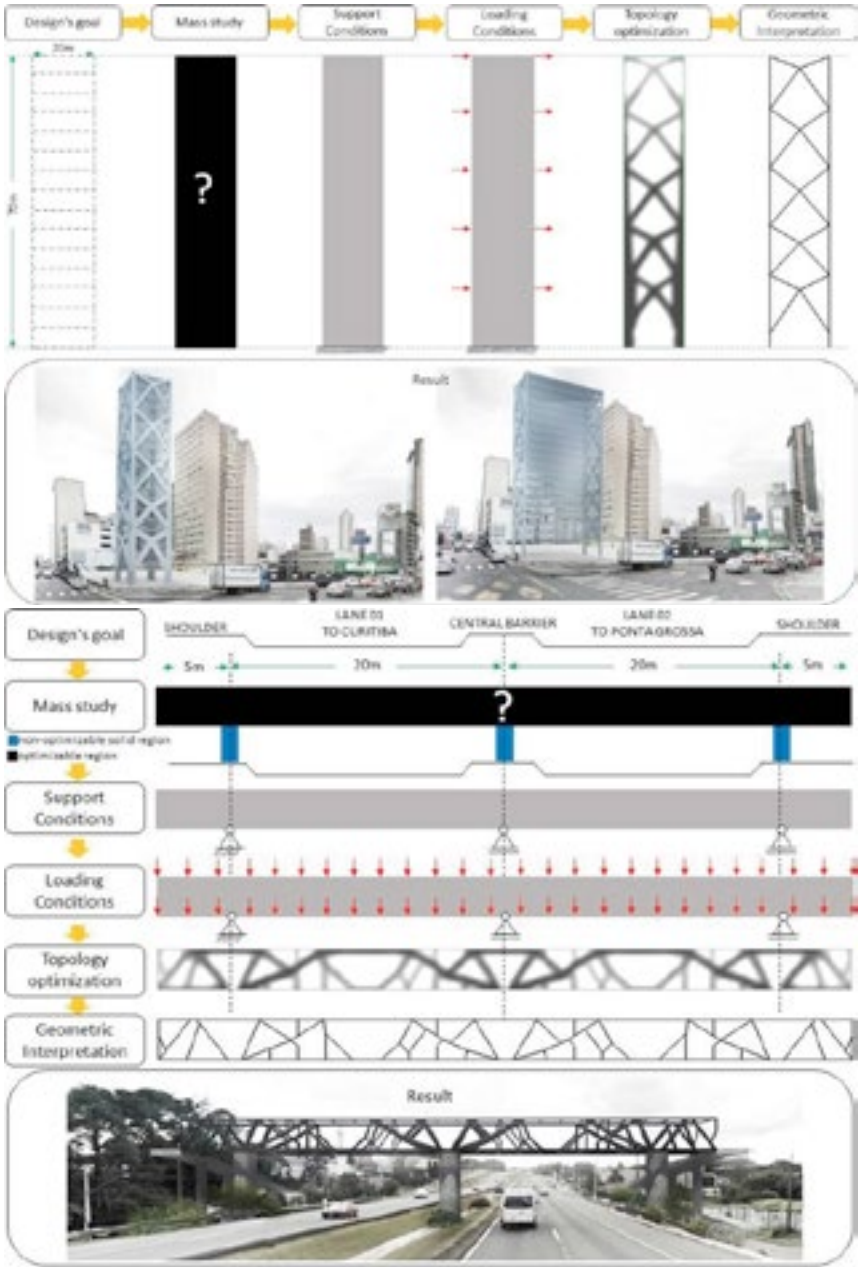

Figure 4. a) A high-rise building's truss optimization b) A bridge's truss optimization [6]

Unikabeton Project

Unikabeton project (Figure 5) is a topology optimization project for concrete structures designed and constructed by the Aarhus School of Architecture in 2007 [7]. EPSs were shaped with robotic CNC milling for the project, and these materials were used as molds. With robot CNC milling, the project explored how such structures can be realized efficiently with high precision and ease of mold making [8].

Figure 5. The constructed slab of the Unikabeton project [7]

12 x 6 x 3.3-meter concrete structure in the form of an asymmetrical, double-curved slab with triple column support was designed and optimized by topology optimization. According to the designers, this project achieved 70% material savings compared to the non-topology optimized structure [7].

Qatar National Convention Centre

Qatar National Convention Centre was designed by Arata Isozaki and, its construction was completed in 2011. The final design is 250 m long, 30 m wide and 20 m high. The tree-like structure, as seen in Figure 6 obtained in shape and topology optimization is formed by pipes supported by steel bars [9]. The dendriforms-like structure is the most challenging part of the structure design. Each component of the dendriforms must conform to optimal ways to transmit loads and also meet the functional requirements of the building [4].

Figure 6. The constructed slab of the Unikabeton project
Qatar National Convention Center and its carrier steel pipes [10]

Akutagawa River Side Office Building

The first example of ESO (Evolutionary Structural Optimization) being implemented is the Akutagawa River Side Office Building project in Takatsuki city. The construction of this four-story office building was completed in 2004. The ESO method has been adopted for the shape determination of the walls in this building. Two of its west and south-facing side walls were optimized using ESO and built with reinforced concrete. Dead and live loads and dynamic earthquake loads are taken into account. The results of the evolutionary design were then analyzed, and the structure was constructed as seen in Figure 7 [11].

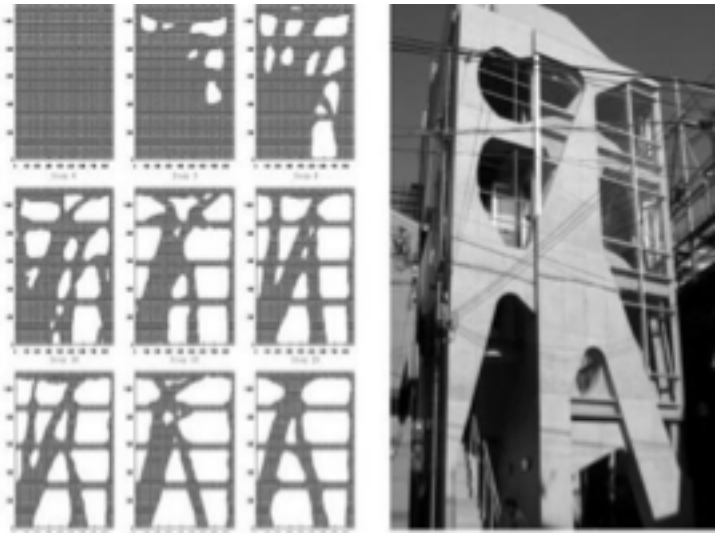

Figure 7. Akutagawa River Side Office Building's façade optimization [11]

3. CASE STUDY

As explained in the beginning part of the paper, this case study aims to show that the use of building materials can be reduced with the design that can be obtained as a result of topology optimization of an existing structure. The purpose of choosing a masonry structure is that the change in the form of the volume can be directly observed. The desired point is to reduce the use of materials necessary for the structure to stand under its load. In this context, Izmir Saint Voukolos Church which can be seen in Figure 8, one of the oldest masonry buildings in İzmir, was chosen. The results obtained for this masonry structure which was made of stone and brick will be compared with the existing structure in the conclusion.

Figure 8. Saint Voukolos Church [12]

The church is a Greek church built in Izmir in 1886. After the Greeks left the city with the population exchange, it was used for different functions such as a museum, opera house, and warehouse. After the restoration works carried out in 2010, it hosts various cultural and artistic events. The load-bearing system

of the building, which was built using stone and brick, is masonry. The plan scheme of this building, which was designed with the traditional church logic, is in the form of a cross and there is an apse [13]. At the entrance of the church, there is a welcoming place consisting of arched columns. There are no structural elements that are obscuring in the interior. The church's roof consists of vaults, and in the middle of the roof is a cone-shaped projection designed for the natural lighting of the church.

The methodology of this study is as follows. Section and plan of the church obtained from the restoration department of IZTECH are seen in Figures 9(a) and 9(b). Based on these drawings, 3D modeling was done. The 3D model of this church was modeled in Rhinoceros® on a 1/1 scale concerning its plan and sections. The openings placed in the desired places in the design of the church have been preserved and shown in the model. After modeling the vaults and the cone-shaped volume placed on the roof for natural lighting, the model is ready for optimization.

Figure 9. a) Section of Saint Voukolos Church b) Ground floor plan of the church [14]

After finishing the model, the topology optimization part was carried on. tOpos® is a 3D Topology Optimization plugin for Grasshopper. "It is using GPU for computation acceleration. It is based on CUDA technology provided by NVIDIA. The current version of tOpos® requires NVIDIA graphic card with Cuda Computation Capability (cc) higher or equal to 3.0."(food4rhino, n.d.). The topology optimization code for this optimization can be seen in Figure 10.

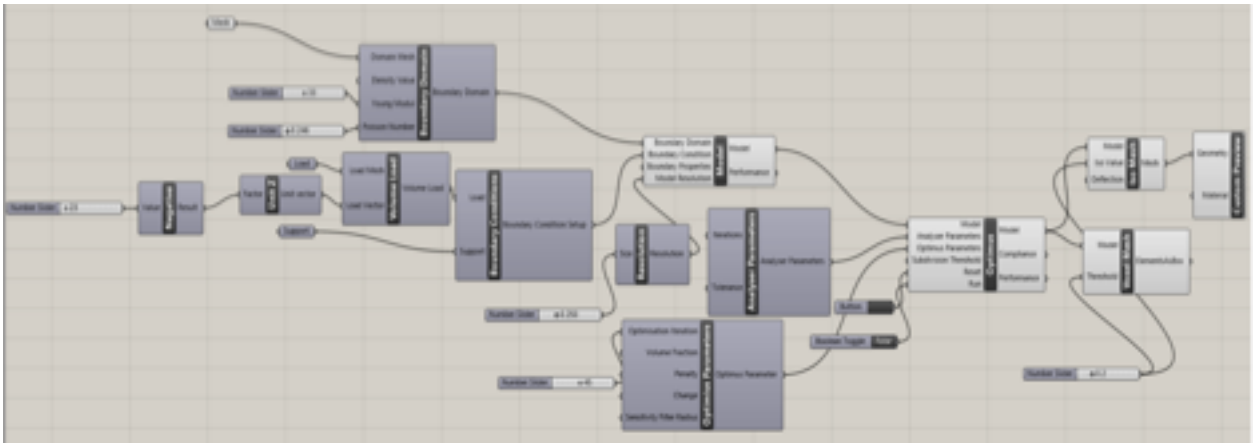

Figure 10. Grasshopper/ tOpos® code of the optimization

First, the structure and its features are defined. In Boundary Domain, the structure itself and its properties are defined. For example, for Young Module, the modulus of elasticity in tension or compression value of the material is defined as 33 GPA and for Poisson Number, the deformation in the material in a direction perpendicular to the direction of the applied force value is defined as 0.246. Then, the support and load conditions (as 23 kN/m²) are defined. In this part, since the form that the structure will take under its own load was wanted to be examined, distributed load tool was used. Then, optimization parameters were determined, such as iteration of optimization and resolution of the model. It has also been determined how to define the form that will be formed after the optimization is completed. Lastly, obtained optimized model has been softened with Weaverbird which is also one of the Grasshopper plugins. However, it should be noted that the obtained result will vary according to the parameters you defined in the tOpos®. For example, while young modulus and Poisson numbers will vary according to the building materials that are used in the construction; some parameters such as iteration, resolution, and how to define the form belong to the designers' decision.

Case Study Results

The form that the building will take under its load is shown in the figures below. Instead of using all the walls as load-bearing elements, the use of materials has been reduced with the help of branches and columns supporting and transferring the roof's load to the ground. One of the important points that should not be forgotten here is that this optimization focuses on the carrier system rather than defining a closed space. In Figure 11, the result of the optimization obtained by using the voxel mesh tool is seen.

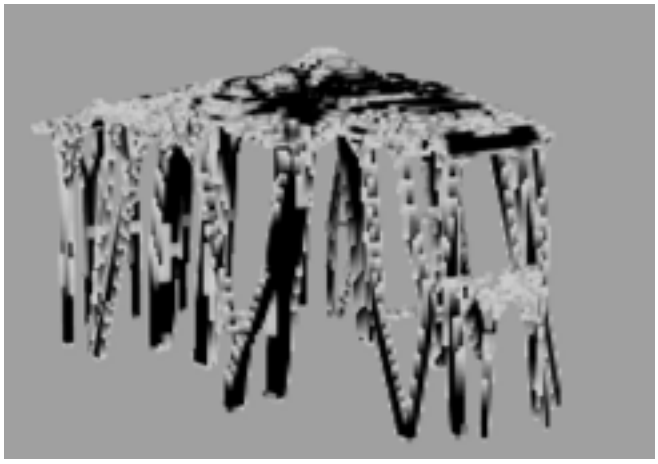

Figure 11. The first rough result from tOpos®

To make it more vivid and to be more defined architecturally, its softened versions with the Weaverbird plugin can be seen from different angles in Figure 12.

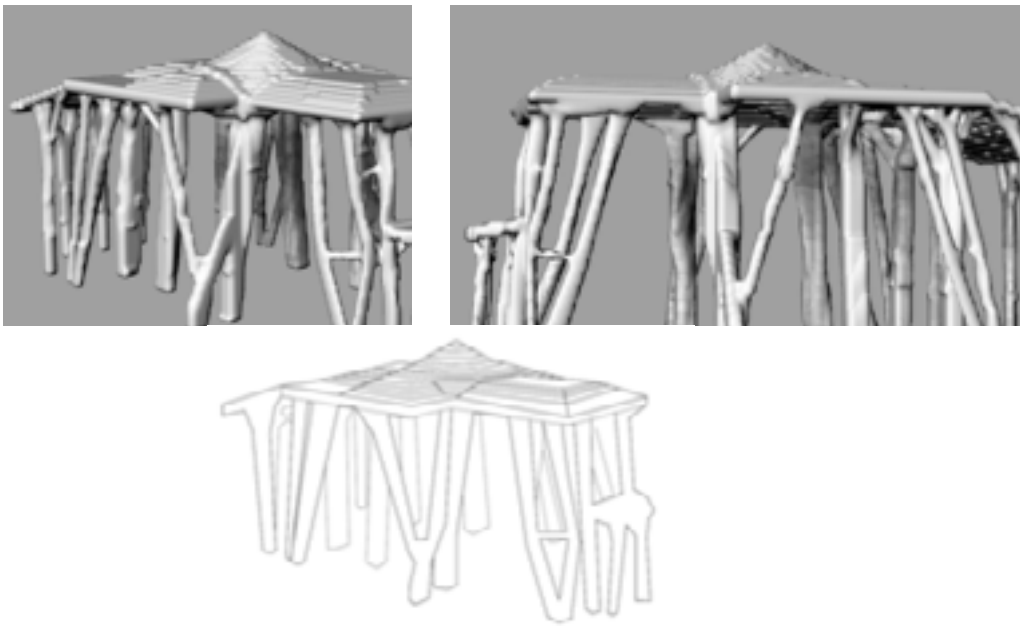

Figure 12. Softened results from Weaverbird

4. CONCLUSION

It is known that raw material shortages and our energy dependence have increased with technology. For this reason, there are new applications and research in the fields of architecture and construction, as there are in every sector. In particular, designs with a sustainable approach are among the most studied topics. This paper examines structures designed and applied with topology optimization to reduce the use of materials and energy required for structures, and topology optimization is made on a selected church.

As a result of the church's topology optimization, while the volume of the material used in the building was 1375.7 cubic meters at the beginning, it is 518.47 cubic meters when optimized according to the defined variable parameters. Also, according to the defined parameters, while there were openings in 17.1% of the walls at the beginning, there was 48.7% opening in the model obtained by optimization.

Thus, designing the forms of the structures according to the load distribution minimizes the use of materials as seen in the examples and case study. In addition, it has led to unique designs for each structure, depending on the strength forces that are different for each structure. This has been achieved by ensuring the originality of the structures by connecting them to the strength forces.

Due to the inadequacy of existing computers in optimization, the final products in this study are shown with diagrammatic models. However, in future studies, the result can be expressed in an architectural style by making material definitions for the products.

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